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学术英语课程体系材料（教材）

中国科学院大学研究生教材系列

学科英语写作教程：地学

Writing a Research Paper in Geoscience

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清华大学出版社

清华大学出版社

·北京·

内 容 简 介

本书共七章，系统讲解学术英语论文中标题、摘要、引言、方法、结果、讨论、总结与致谢的写作规范；每章包含整体概述、案例分析、功能句型、时态分析、重要语法点等具体内容，配有题型丰富、形式新颖、针对性强的练习，旨在帮助地学相关专业的学生系统了解并掌握本领域重点期刊英文论文的写作规范、结构、语步、常用词汇、功能句型等内容，全面提升其学术论文写作水平与学术思辨能力。所设练习均以真实性为首要原则，充分考虑学生可能遇到的学术阅读与写作场景。

本书适合国内高校地学相关专业的高年级本科生与硕博研究生使用，也可供地学科研工作者参考。

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总　　序

2020 年 11 月，教育部新文科建设工作组发布的《新文科建设宣言》指出："文科教育融合发展需要新文科。新科技和产业革命浪潮奔腾而至，社会问题日益综合化复杂化，应对新变化、解决复杂问题亟需跨学科专业的知识整合，推动融合发展是新文科建设的必然选择。进一步打破学科专业壁垒，推动文科专业之间深度融通、文科与理工农医交叉融合，融入现代信息技术赋能文科教育，实现自我的革故鼎新，新文科建设势在必行。"学科英语是外语学科和专业学科相互交叉、彼此融合的产物，符合国家"新文科"建设的时代愿景。开辟外语学科建设的全新思路，是当前外语教学改革的重要突破方向。

"中国科学院大学研究生教材系列"将切实满足特定专业学生群体的英语学习需求作为教材编写的重要依据，充分考虑到具体学习者群体的学习目标和学习诉求，具有以实际应用为导向的根本特质。该系列教材不仅关注教材编写前期的需求分析，同时重视教材试用阶段使用者的实际反馈，因为我们认为，直面使用者反馈是确定教材价值的关键一环，是重新审视学习者需求的宝贵机会，更是反复改进教材质量的可靠抓手。

"中国科学院大学研究生教材系列"融入现代信息技术，运用语料库的数据处理方法，整理归纳学科英语的语言特点和语篇特征。语料库方法可以十分客观快捷地捕捉学术语篇中的词汇、短语、搭配、语块、句子结构等语言层面的使用规律，正在成为学术和学科英语研究领域新近涌现的热点之一。然而，语料库技术运用于教材编写的尝试却寥寥无几，该系列教材无疑为语料库方法运用于教材编写做出了开创性的贡献。语料库的运用不仅能够呈现自然学术语境中真实的语言使用，更为重要的是，能够引导学习者建立适合自己微观研究方向的专业文献语料库，并将其作为未来学术生涯的开端以及追随学术生命成长过程的见证。学科英语语料库一方面可以成为研究者文献阅读经历不断累积的记录，另一方面也可能成为研究者写作不竭的灵感源泉和他们未来指导学生进行

专业写作的宝贵财富。基于学科英语语料库的教材建设在“授人以鱼”的同时也在“授人以渔”，而学习者也会因此获得“授人以渔”的能力。

我们正处在一个教育变革的时代。新的时代呼唤符合国家发展需求的教育理念和新颖实用的教学方法，同时也鼓励教师队伍努力探索新型的教材编写模式。“中国科学院大学研究生教材系列”积极响应时代的要求，是国家“新文科”建设指导思想下的勇敢尝试。

该系列教材的出版得到中国科学院大学教材出版中心资助，在此表示感谢。

高　原

2022 年 5 月

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前　言

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根据《学位与研究生教育发展“十三五”规划》的指导精神，我国研究生教育需要推进世界一流大学和世界一流学科建设，努力提高研究生参与各类国际学术交流活动的主动性与活跃度，加快培养能参与国际事务的高层次专门人才。中国科学院大学外语系自 2016 年起，分步骤在大学本科、硕士研究生、博士研究生三个学习阶段，对原有的通用英语课程进行学术英语课程改革。改革后，博士研究生阶段的课 程为“学科学术英语”。由此，《学科英语写作教程：地学》一书开始编写。

本书的编写主要基于近几年的地学重点期刊论文及地学论文语料库，选材真实、专业性强，贴近研究热点，全面反映了地学学科学术英文论文的写作范式。本书共七章，围绕学术英语论文中标题、摘要、引言、方法、结果、讨论、总结与致谢的写作规范展开。每章的主体内容由整体概述、案例分析、功能句型、时态分析、重要语法点等板块构成，个别章节会根据单元主题做出相应调整。其中，“重要语法点”板块依次在每章展开介词、冠词、非谓语动词、从句、衔接手法、模糊限制语、名词化等专题讲解，以更好地解决地学相关专业学生的写作痛点——容易犯语法错误、表意不清、表达不地道、缺乏写作练习等，从而帮助学生巩固语法知识，恰当使用学术写作策略，为写出高质量的英文学术论文打好基础。本书还精心设计了既注重语言能力提升又锻炼思辨能力的学术阅读与写作练习题，涵盖词语填空、选择、句子填空、文段润色、语篇提升等多种题型，旨在帮助学生全面提升其学术论文写作水平与学术思辨能力。文末还附有地学专业论文常用词汇搭配附录，能有效帮助相关专业学生尽快掌握本领域的术语搭配，提高写作的准确性与规范性。

本书适合地学相关专业的高年级本科生、硕博研究生与科研工作者使用。它既可以当作论文写作类教材，也可以当作工具参考书。在具体使用时，编者建议读者根据本书列出的语步，在平时阅读论文时继续总结相应的写作表达与句型，建立起自己的学术语料库。

由于编者水平有限，书中难免存在不足，恳请同行专家和读者朋友提出修改建议，在此表示衷心的感谢！

编　者

2022 年 10 月

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Chapter 1
Titles

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1.1 Grammatical Constructions in Titles

Generally, there are four types of grammatical constructions in titles, including full-sentence, nominal group, compound, and question constructions (Hartley, 2008). The titles of most research papers in geoscience are either nominal group constructions or compound constructions. Among the following 50 titles, 26 are in nominal group constructions, and 14 in compound constructions.

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A. Full-sentence constructions

* *Mg–O isotopes trace the origin of Mg-rich fluids in the deeply subducted continental crust of Western Alps*
* *Weak bedrock allows north-south elongation of channels in semi-arid landscapes*
* *Lateral H_2O variation in the Zealandia lithospheric mantle controls orogen width*
* *Deformation of mantle pyroxenites provides clues to geodynamic processes in subduction zones: Case study of the Cabo Ortegal Complex, Spain*
* *Understanding sea-level change is impossible without both insights from paleo studies and working across disciplines*

B. Nominal group constructions

* *Estimates of olivine-basaltic melt electrical conductivity using a digital rock physics approach*
* *Formation timescales of CV chondrites from component specific Hf–W systematics*
* *Glacier velocity variability due to rain-induced sliding and cavity formation*
* *A new boron isotope-pH calibration for Orbulina universa, with implications for understanding and accounting for "vital effects"*
* *Abrupt plant physiological changes in southern New Zealand at the termination of the Mi-1 event reflect shifts in hydroclimate and pCO_2*
* *Cosmogenic ^{22}Na as a steady-state tracer of solute transport and water age in first-order catchments*
* *Creep strength of ringwoodite measured at pressure-temperature conditions of the lower part of the mantle transition zone using a deformation-DIA apparatus*
* *Eastern Indian Ocean microcontinent formation driven by plate motion changes*
* *Influence of the Amazon River on the Nd isotope composition of deep water in the western equatorial Atlantic during the Oligocene–Miocene transition*
* *The effects of magmatic processes and crustal recycling on the molybdenum stable*

isotopic composition of Mid-Ocean Ridge Basalts

* *Two-phase deformation of lower mantle mineral analogs*
* *Complementary element relationships between chondrules and matrix in Rumuruti chondrites*
* *Continental climate gradients in North America and Western Eurasia before and after the closure of the Central American Seaway*
* *Evidence for a dynamic East Antarctic ice sheet during the mid-Miocene climate transition*
* *Hinterland drainage closure and lake formation in response to Middle Eocene Farallon slab removal, Nevada, U.S.A.*
* *Immediate propagation of deglacial environmental change to deep-marine turbidite systems along the Chile convergent margin*
* *Seasonal variations in dissolved neodymium isotope composition in the Bay of Bengal*
* *Slow fault propagation in serpentinite under conditions of high pore fluid pressure*
* *The neodymium stable isotope composition of the silicate Earth and chondrites*
* *Changes in the occurrence of extreme precipitation events at the Paleocene–Eocene thermal maximum*
* *Timescale of overturn in a magma ocean cumulate*
* *Thermal-chemical conditions of the North China Mesozoic lithospheric mantle and implication for the lithospheric thinning of cratons*
* *Testing Late Cretaceous astronomical solutions in a 15-million-year astrochronologic record from North America*
* *Surface and subsurface hydrology of debris-covered Khumbu Glacier, Nepal, revealed by dye tracing*
* *Predicted diurnal variation of the deuterium to hydrogen ratio in water at the surface of Mars caused by mass exchange with the regolith*
* *Magma interactions, crystal mush formation, timescales, and unrest during caldera collapse and lateral eruption at ocean island basaltic volcanoes (Piton de la Fournaise, la Réunion)*

C. Compound constructions

* *Cenozoic paleoaltimetry of the SE margin of the Tibetan Plateau: Constraints on the tectonic evolution of the region*
* *Linking subsurface to surface degassing at active volcanoes: A thermodynamic model with applications to Erebus volcano*
* *Lu–Hf geochronology on cm-sized garnets using microsampling: New constraints*

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on garnet growth rates and duration of metamorphism during continental collision (Menderes Massif, Turkey)

* *Conodont (U–Th)/He thermochronology: A case study from the Illinois Basin*
* *Absence of thermal influence from the African Superswell and cratonic keels on the mantle transition zone beneath southern Africa: Evidence from receiver function imaging*
* *Dissolved and particulate ^{230}Th–^{232}Th in the Central Equatorial Pacific Ocean: Evidence for far-field transport of the East Pacific Rise hydrothermal plume*
* *River network evolution as a major control for orogenic exhumation: Case study from the western Tibetan Plateau*
* *Exhumation history of the West Kunlun Mountains, northwestern Tibet: Evidence for a long-lived, rejuvenated orogen*
* *P-wave velocity structure beneath Mt. Melbourne in northern Victoria Land, Antarctica: Evidence of partial melting and volcanic magma sources*
* *Active fault system across the oceanic lithosphere of the Mozambique Channel: Implications for the Nubia-Somalia southern plate boundary*
* *Constraints on the timing and duration of orogenic events by combined Lu–Hf and Sm–Nd geochronology: An example from the Grenville orogeny*
* *Geomorphic evidence for the geometry and slip rate of a young, low-angle thrust fault: Implications for hazard assessment and fault interaction in complex tectonic environments*
* *The influence of seawater calcium ions on coral calcification mechanisms: Constraints from boron and carbon isotopes and B/Ca ratios in Pocillopora damicornis*
* *Melting experiments on the Fe–C binary system up to 255 GPa: Constraints on the carbon content in the Earth's core*

D. Question constructions

* *How do machine learning techniques help in increasing accuracy of landslide susceptibility maps?*
* *Simulating rotating fluid bodies: When is vorticity generation via density-stratification important?*
* *Rupture speed and slip velocity: What can we learn from simulated earthquakes?*
* *A ~9 Myr cycle in Cenozoic δ^{13}C record and long-term orbital eccentricity modulation: Is there a link?*
* *Epeirogeny or eustasy? Paleozoic–Mesozoic vertical motion of the North American continental interior from thermochronometry and implications for mantle dynamics*

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Based on the above 50 titles, some tips on how to write a good title can be summarized. Firstly, you should be cautious with using articles and prepositions. Titles rarely begin with the article "the". In the titles listed above, only three of them begin with "the", i.e., "The effects of magmatic processes and crustal recycling on the molybdenum stable isotopic composition of Mid-Ocean Ridge Basalts", "The neodymium stable isotope composition of the silicate Earth and chondrites", and "The influence of seawater calcium ions on coral calcification mechanisms: Constraints from boron and carbon isotopes and B/Ca ratios in Pocillopora damicornis". Also, prepositional phrases are widely used in titles, so make sure that you use prepositions correctly.

Secondly, you are not allowed to use full stops in titles. None of the above titles contains a full stop, even though some of them are full sentences. A compound construction title consists of two parts which are separated by a colon, and the first letter of the first word in the second part should be capitalized, even if the first word is an indefinite article, such as "Constraints on the timing and duration of orogenic events by combined Lu–Hf and Sm–Nd geochronology: An example from the Grenville orogeny".

Lastly, you should use modifiers properly. In the titles listed above, before or after a noun or a noun phrase, there are often some modifiers. They can either be prepositional phrases, such as "in subduction zones", "during the Oligocene–Miocene transition", and "before and after the closure of the Central American Seaway", or non-finite verbs, including "using a deformation-DIA apparatus", "using a digital rock physics approach", and "caused by mass exchange with the regolith". Using modifiers properly can make titles informative, specific, and distinctive, as they can reveal the site of your research or the novel method used in your research. Editors and readers will not be attracted by titles that are too general or do not convey any intriguing information.

1.2 Using Prepositions Properly

In this part, types of prepositions, functions of prepositional phrases, and collocations containing prepositions are introduced to help writers of research papers have a better understanding of how to use prepositions properly.

1.2.1 Types of Prepositions

A. Simple prepositions, such as "about", "at", "through", "of", "since", etc.

* *Although linear increases **of** ^{230}Th concentrations **with** depth are observed **at** both **of***

*our sites **from about** 0 **to** 2,000 m, ...*

* *Cyclic voltammograms (CVs) were performed **in** an N_2-saturated 2mM Fe(II) solution amended **with** 1mM **of** the various Me(II) **at** room temperature **at** a scan rate **of** 50 mV/s.*
* *Open system melt generation **within** a short time period would have had to be followed **by** focused channeling **of** the extracted mantle-derived melts **through** a crustal conduit.*
* *Temperature profiles were taken **with** a thermistor probe near the deepest point **in** each lake, and several measurements **within** the metalimnion **of** the stratified lakes allowed precise calculation **of** the depth **of** the thermocline—taken **as** the plane **of** the maximum rate **of** decrease **in** temperature.*
* *The next step was to filter the correlograms to enhance the signal-to-noise ratio **by** applying a singular value decomposition-based Wiener filter.*

B. Compound prepositions, such as "into", "onto", etc.

* *The combined effect of wider and faster propagating dykes allows greater volumes of magma to flow **into** the host rock surrounding the magma chamber.*
* *The recovered rare earth fraction was dried down, redissolved in 0.18 M HCl, and loaded **onto** a second cation exchange column containing 0.6 mL of Eichrom™ LN spec resin of particle size 50 μm to 100 μm.*

C. Double prepositions, such as "until after", "from among", etc.

* *No tornado warning was issued **until after** the tornado lifted.*
* *We have chosen NRI **from among** the several available metrics for phylogenetic diversity.*

D. Phrasal prepositions, such as "according to", "because of", "in spite of", etc.

* *Grayscale subvolumes were processed **according to** the procedure detailed in Miller et al. (2014) to remove noise and artifacts, improving the efficacy of automatic segmentation algorithms.*
* *Dust affects the planet's radiative balance **because of** its role in the albedo.*
* ***In spite of** the fact that Maori and Pacific movers have an equal number of UZs with high CVD rates in the Q4 highly deprived quartile, the geography of CVD for Pacific movers reveals very different patterns than those observed among Maori.*

E. Participle prepositions, such as "regarding", "concerning", "including", "given", etc.

* *We thank G. Gaetani and E. Sarafian from Woods Hole Oceanographic Institution (WHOI) for their insight **regarding** water content in mantle minerals and melts.*

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* *Unfortunately, data **concerning** the interactions of all species modeled in this work does not exist at relevant P–T conditions.*
* *The model considers all possible sources of fluid from multiple depths, **including** degassing of dissolved volatiles during crystallization and/or decompression.*
* *This is unlikely **given** that only a few percent of Hypatia is non-carbonaceous material.*

1.2.2 Functions of Prepositional Phrases

In academic writing, a prepositional phrase is frequently used as an attribute or adverbial. Some examples are shown below.

A. Used as an attribute

* *Cores were imaged using a combination of absorption-contrast and phase-contrast X-ray μ-CT at 27 keV to resolve the small density contrast **between olivine and basaltic glass**.*
* *An open-flow gas exchange system (LI-6800, LI-COR, U.S.A.) was used to measure leaf gas exchange in the newest fully expanded flag leaf **at the filling stage**.*

B. Used as an adverbial

* ***With the enforcement of** the projects of agricultural land retrieval to forest and grassland, a large area of farmland would be restored to grasslands or forests.*
* ***In the Transantarctic Mountains**, the Ferrar is intruded into the mostly terrestrial Devonian to Triassic sedimentary deposits of the Beacon Supergroup.*

1.2.3 Collocations Containing Prepositions

Writers are advised to acquire collocations containing prepositions and use them correctly in academic writing. Some examples are shown below.

A. Preposition + noun + preposition

* *However, the resulting succession of laminated crusts (thick red layer **at the bottom of** the snowpack in Fig. 7) was easily observable during field campaigns throughout the season.*

B. Verb + preposition

* *All of these models **focus on** constraining chemical equilibrium between a single melt and fluid.*

C. Adjective + preposition

> * *The result of the model run is a list of possible combinations of gases and their proportions that, when combined, are **equal to** the composition of gas measured at the surface.*

You can use online corpuses to confirm the correctness and accuracy of the collocations used in your academic papers when you are not sure about their usages. Some corpuses are recommended such as SKELL, Corpus of Contemporary American English (COCA), Just the Word, etc. Do not coin strange collocations that are not accepted by native English speakers.

1.3 Using the Definite Article "the" Properly

It is not easy for writers to use the definite article "the" in scientific writing. How to use it will be introduced in this part. Generally speaking, "the" can be used to refer to the following five aspects.

A. Something mentioned in the preceding sentence

> * *In Nancy, noble gases and **nitrogen** were extracted conjointly in samples H-N_1, H-N_2, and H-N_3 upon heating in high-vacuum with an infra-red (IR) CO_2 laser…**The nitrogen** was purified in a glass line.*
> * *In Paris, the nitrogen content and isotope composition of **two Hypatia diamond samples** were investigated...**The two samples** were weighed before their analysis.*

B. A particular area

> * *…such as **the Kuiper Belt**, where presolar components might be more abundant.*
> * *…**in the southwestern side** of the Libyan Desert Glass strewn field.*
> * *…in **the Central Equatorial Pacific Ocean** (~155°W–159°W) at two sites.*
> * ***the** Batavia and Gulden Draak microcontinents*
> * ***the** Perth Abyssal Plain*
> * ***the** Asteroid Belt*
> * ***the** Sahara*
> * ***the** Persian Gulf*
> * ***the** Black Forest*
> * ***the** Iberian Peninsula*

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C. Something unique

* ***the*** *Pacific*
* ***the*** *Earth*
* ***the*** *equator*
* ***the*** *Nile*
* ***the*** *North Pole*

D. A particular noun/method/pattern/model

* ***the*** *lattice parameter refined from the X-ray diffraction pattern*
* ***the*** *$^{3}He/^{4}He$ ratios*
* ***the*** *model calculations by Leya & Masarik (2009)*

E. A nominalization

* ***the*** *presence of contaminants and important amounts of water*
* ***the*** *release of some atmospheric Ne*
* ***the*** *right side of pure potential end-members*
* ***the*** *addition of some cosmogenic ^{3}He*
* ***the*** *isotopic spectra of Xe*

Remember, do not use "the" before: (1) names of continents, such as Asia, Africa, etc.; (2) names of most countries/territories, such as Japan, Mexico, Singapore, except for the Netherlands, the United States, etc.; (3) names of cities, towns, or states, such as Tokyo, New York, Miami; (4) names of lakes and bays, such as Lake Titicaca, Lake Tanganyika, except for a group of lakes like the Great Lakes; (5) names of mountains, such as Mount Qomolangma, Mount Fuji, except for the ranges of mountains like the Rockies; and (6) names of islands, such as Isles of Scilly, except for the island chains like the Aleutians.

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Exercises

I. Fill in the following blanks with appropriate prepositions.

1. Glacier longitudinal profiles _____ regions of active uplift

2. Constraints _____ crystal storage timescales in mixed magmas: Uranium-series disequilibria in plagioclase from Holocene magmas at Mount Hood, Oregon

3. A new hydrothermal scenario _____ the 2006 Lusi eruption, Indonesia: Insights from gas geochemistry

4. Waveform tomography imaging _____ a megasplay fault system in the seismogenic Nankai subduction zone

5. Spin transition _____ ferric iron in Al-bearing Mg-perovskite up to 200 GPa and its implication _____ the lower mantle

6. _____ 2012–2014, we measured Na and ^{22}Na in precipitation _____ Williamsburg, which is on the Coastal Plain geologic province of Virginia.

7. Five-liter samples _____ varying depths (24.5–4,601m) were collected.

8. Each Cubitainer was rinsed with trace metal grade acid (10% HCl), cleaned three times _____ Milli-Q water, air-dried in a laminar airflow hood and stored separately inside the clean laboratory of the R.

9. Voxel (3D pixel) values in the reconstructed images roughly correspond _____ material density.

10. Samples often exhibit significant decompression cracking. These cracks are voids that are not present _____ elevated pressure and temperature.

II. Fill in the following blanks with correct articles or zero article.

Paragraph One

^{230}Th ($t_{1/2}$ = 75.69 kyr) is widely used as **1.** _____ quantitative marine geochemical tracer due to its highly reactive chemical behavior. It is produced by **2.** _____ radioactive decay of ^{234}U, which is conservative in seawater and has a long residence time (~200

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kyr; Henderson & Anderson, 2003). ^{230}Th is essentially insoluble in seawater, so as it is produced, it is quickly removed from the water column by **3.** _____ adsorption onto particles which then settle to the seafloor. This process of adsorption and removal of ^{230}Th from **4.** _____ water column is called scavenging. ^{230}Th concentrations in seawater provide insights into **5.** _____ oceanographic processes such as deep oceanic circulation and mixing rates, and marine particle dynamics. In addition, ^{230}Th studies of marine sediments provide **6.** _____ important information on **7.** _____ past changes in fluxes to **8.**_____ seafloor, which can be used to better understand **9.** _____ climate-related changes in **10.** _____ marine biological productivity, dust input to the oceans, and deep water circulation once the systematics are adequately understood. (Lopez, 2015)

Paragraph Two

Using **1.** _____ revised protocol of **2.** _____ GEOTRACES program, radionuclide measurements of total and dissolved ^{230}Th and ^{232}Th were evaluated. **3.** _____ water samples were weighed and spiked with ^{229}Th for isotope dilution analysis. To induce $Fe(OH)_3$ precipitation, **4.** _____ purified Fe-carrier solution ($FeCl_3$) was added. The iron chloride was purified by back extraction with isopropyl ether. After addition of the ^{229}Th spike and the $FeCl_3$ to the seawater sample, it was left to equilibrate for a day before the addition of trace metal-grade NH_4OH to bring the pH to 8–8.5. Once at desired pH, removal of all Th and precipitation of iron hydroxide/$Fe(OH)_3$ within the seawater sample was achieved. **5.** _____ sample was left to equilibrate for five days, so **6.** _____ precipitate was able to settle undisturbed at **7.** _____ bottom of the Cubitainer. After five days, the precipitate was separated from the supernatant solution through siphoning into 1 L acid-washed Nalgene bottles, and left to equilibrate for a full day. **8.** _____ following day, **9.** _____ sample was siphoned into **10.** _____ acid-washed 50 mL centrifuge tubes, and placed in a centrifuge at 1,700 rpm for 15 minutes. Samples were centrifuged three times, decanting the supernatant each time before dissolving the precipitate in ultrapure HNO_3. The resulting solution was then evaporated in an acid-washed 15 mL Savillex beaker. Once evaporated, the sample was reconstituted in ^{8}N HNO_3. (Lopez, 2015)

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Chapter 2
Abstracts

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2.1 An Overview of the Abstract Section

An abstract is an overview of a research paper. It appears at the beginning of the paper. It can begin with introducing background information, identifying the gap(s) in previous studies, or stating your study purpose(s) or the assumption(s) you have tested. Also, it may explicitly or implicitly give information about your study methods, findings, and implications (Hartley, 2008). The sequence of the elements mentioned above is not strictly specified. You are advised to include the necessary elements required by your target journal. Four typical case studies are as follows.

Case Study One

Excerpt (Iacovino, 2015)	**Comments**
Abstract	
① Volcanic plumbing systems are the pathways through which volatiles are exchanged between the deep Earth and the atmosphere. ② The interplay of a multitude of processes occurring at various depths in the system dictates the composition and quantity of gas eventually erupted through volcanic vents. ③ Here, a model is presented as a framework for interpreting surface volcanic gas measurements in terms of subsurface degassing processes occurring throughout a volcanic plumbing system. ④ The model considers all possible sources of fluid from multiple depths, including degassing of dissolved volatiles during crystallization and/or decompression as recorded in melt inclusions plus any co-existing fluid phase present in a magma reservoir. ⑤ The former is achieved by differencing melt inclusion volatile contents between groups of melt inclusions saturated at discrete depths. ⑥ The latter is calculated using a thermodynamic model, which computes the composition of a C–O–H–S fluid in equilibrium with a melt given a minimum of five thermodynamic parameters, commonly known for natural systems (T, P, fO_2, either fH_2 or one parameter for H_2O, and either fS_2 or one parameter for CO_2). ⑦ The calculated fluids are thermodynamically decompressed and run through a mixing model, which finds all possible mixtures of subsurface fluid that match the chemistry of surface gas within ± 2.0 mol%. ⑧ The method is applied to Mount Erebus (Antarctica), an active, intraplate volcano whose gas emissions, which emanate from an active phonolitic lava lake, have	**Background:** Sentences ①② **Methodology:** Sentences ③–⑩

(Continued)

Excerpt (Iacovino, 2015)	**Comments**
been well quantified by FTIR, UV spectroscopy, and multi-gas sensors over the last several decades. ⑨ In addition, a well-characterized suite of lavas and melt inclusions, and petrological interpretations thereof, represent a wealth of knowledge about the shallow, intermediate, and deep parts of the Erebus plumbing system. ⑩ The model has been used to calculate the compositions of seven C–O–H–S fluids that originate from four distinct regions within the Erebus plumbing system and in the lava lake (deep basanite, intermediate, shallow phonolite, and lava lake phonolite equilibrium fluids, plus crystallization-induced degassing of deep, intermediate, and shallow melts). ⑪ A total of 144 possible mixtures were found.	**Results:** Sentences ⑪–⑬
⑫ In all cases, ~60% of the surface gas is sourced from deep degassing. ⑬ The remaining ~40% is made up primarily of fluid in equilibrium with the lava lake (~20%) plus intermediate (~10%) and phonolite (~5%) equilibrium fluids and minor to no contribution from all other fluid sources. ⑭ These results, whereby the surface gas signature is dominated by fluids originating from deep mafic melts, could be representative of any volcanic system comprised of a deep mafic member and shallow evolved fractionates as has been inferred at Yellowstone, Etna, and many others. ⑮ At Erebus, results of this modeling demonstrate that the degassing of stagnant magma can contribute significant fluid and energy to the system such that the continuous convection and degassing of volatile-rich magma is not necessary to explain the volcano's persistently active nature or the composition of its gas emissions.	**Implications:** Sentences ⑭ ⑮

Case Study Two

Excerpt (Morison, 2019)	**Comments**
Abstract	
① The formation and differentiation of planetary bodies are thought to involve magma oceans stages. ② We study the case of a planetary mantle crystallizing upwards from a global magma ocean. ③ In this scenario, it is often considered that the magma ocean crystallizes more rapidly than the time required for convection to develop in the solid cumulate. ④ This assumption is appealing since the temperature and composition profiles resulting from the crystallization of the magma ocean can be used as an initial condition for	**Background:** Sentence ① **Purpose:** Sentence ② **Assumption:** Sentences ③ ④

(Continued)

Excerpt (Morison, 2019)	**Comments**
convection in the solid part. ⑤ We test here this assumption with a linear stability analysis of the density profile in the solid cumulate as crystallization proceeds. ⑥ The interface between the magma ocean and the solid is a phase change interface. ⑦ Convecting matter arriving near the interface can therefore cross this boundary via melting or freezing. ⑧ We use a semi-permeable condition at the boundary between the magma ocean and the solid to account for that phenomenon. ⑨ The timescale with which convection develops in the solid is found to be several orders of magnitude smaller than the time needed to crystallize the magma ocean as soon as a few hundreds kilometers of cumulate are formed on a Mars to Earth-size planet. ⑩ The phase change boundary condition is found to decrease this timescale by several orders of magnitude. ⑪ For a Moon-size object, the possibility of melting and freezing at the top of the cumulate allows the overturn to happen before complete crystallization. ⑫ The convective patterns are also affected by melting and freezing at the boundary: The linearly most-unstable mode is a degree-1 translation mode instead of the approximately aspect-ratio-one convection rolls found with classical non-penetrative boundary conditions. ⑬ The first overturn of the crystallizing cumulate on Mars and the Moon could therefore be at the origin of their observed degree-1 features.	**Methodology:** Sentences ⑤–⑧ **Results & Discussion:** Sentences ⑨–⑬

Case Study Three

Excerpt (Whittaker et al., 2016)	**Comments**
Abstract ①The roles of plate tectonic or mantle dynamic forces in rupturing continental lithosphere remain controversial. ② Particularly, enigmatic is the rifting of microcontinents from mature continental rifted margins, with plume-driven thermal weakening commonly inferred to facilitate calving. ③ However, a role for plate tectonic reorganizations has also been suggested. ④ Here, we show that a combination of plate tectonic reorganization and plume-driven thermal weakening was required to calve the Batavia and Gulden Draak microcontinents in the Cretaceous Indian Ocean. ⑤ We reconstruct the evolution of these two microcontinents using constraints from new paleontological samples, $^{40}Ar/^{39}Ar$ ages, and	**Gap:** Sentences ①–③ **Results:** Sentences ④⑥⑦ **Methodology:** Sentence ⑤

(Continued)

Excerpt (Whittaker et al., 2016)	**Comments**
geophysical data. ⑥ Calving from India occurred at 101–104 Ma, coinciding with the onset of a dramatic change in Indian plate motion. ⑦ Critically, Kerguelen plume volcanism does not appear to have directly triggered calving. ⑧ Rather, it is likely that plume-related thermal weakening of the Indian passive margin preconditioned it for microcontinent formation, but calving was triggered by changes in plate tectonic boundary forces.	**Discussion:** Sentence ⑧

Case Study Four

Excerpt (Stewart et al., 2016)	**Comments**
Abstract	
① Dissolved and particulate neodymium (Nd) are mainly supplied to the oceans via rivers, dust, and release from marine sediments along continental margins. ② This process, together with the short oceanic residence time of Nd, gives rise to pronounced spatial gradients in oceanic $^{143}Nd/^{144}Nd$ ratios (ε_{Nd}). ③ However, we do not yet have a good understanding of the extent to which the influence of riverine point-source Nd supply can be distinguished from changes in mixing between different water masses in the marine geological record. ④ This gap in knowledge is important to fill because there is growing awareness that major global climate transitions may be associated not only with changes in large-scale ocean water mass mixing, but also with important changes in continental hydroclimate and weathering. ⑤ Here, we present ε_{Nd} data for fossilized fish teeth, planktonic foraminifera, and the Fe–Mn oxyhydroxide and detrital fractions of sediments recovered from Ocean Drilling Project (ODP) Site 926 on Ceara Rise, situated approximately 800 km from the mouth of the River Amazon. ⑥ Our records span the Mi-1 glaciation event during the Oligocene–Miocene transition (OMT; ~23 Ma). ⑦ We compare our ε_{Nd} records with data for ambient deep Atlantic northern and southern component waters to assess the influence of particulate input from the Amazon River on Nd in ancient deep waters at this site. ⑧ ε_{Nd} values for all of our fish teeth, foraminifera, and Fe–Mn oxyhydroxide samples are extremely unradiogenic ($\varepsilon_{Nd} \approx -15$); much lower than the ε_{Nd} for deep waters	**Background:** Sentences ①② **Gap:** Sentence ③ **Significance:** Sentence ④ **Results:** Sentences ⑤⑥⑧ **Methodology:** Sentence ⑦

(Continued)

Excerpt (Stewart et al., 2016)	**Comments**
of modern or Oligocene–Miocene age from the North Atlantic ($\varepsilon_{Nd} \approx -10$) and South Atlantic ($\varepsilon_{Nd} \approx -8$). ⑨ This finding suggests that partial dissolution of detrital particulate material from the Amazon ($\varepsilon_{Nd} \approx -18$) strongly influences the ε_{Nd} values of deep waters at Ceara Rise across the OMT. ⑩ We conclude that terrestrially derived inputs of Nd can affect ε_{Nd} values of deep water many hundreds of kilometers from source. ⑪ Our results both underscore the need for care in reconstructing changes in large-scale oceanic water-mass mixing using sites proximal to major rivers, and highlight the potential of these marine archives for tracing changes in continental hydroclimate and weathering.	**Discussion:** Sentences ⑨–⑪

2.2 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns used in different elements of the Abstract section are as follows.

A. Introducing the characteristics of a substance

* *Raman spectroscopy is a kind of molecular fingerprint spectrum, which* ***has been widely used in the field of*** *material composition identification and quantitative analysis.*
* *The gas distribution area* ***is characterized by*** *high resistivity anomaly.*
* *Boron isotope ratios, as measured in planktic foraminifera, can* ***be a useful tracer of*** *past ocean pH.*
* *Moreover, this kind of reductant* ***has proven to be effective in*** *remediating HOCs contaminated wastewaters.*
* *Agricultural reclamation* ***has been the major threat to*** *land use changes.*
* *The use of prefabrication for building* ***has many benefits, including*** *improved construction process efficiency.*
* *Suitable straw returning to field technology* ***is not only beneficial to*** *maintain soil fertility,* ***but also*** *to reduce environmental pollution caused by straw burning.*
* *High-temperature stable isotope fractionations can* ***provide important insights into*** *the nature and conditions of the processes involved in planetary differentiation.*
* *This* ***is composed primarily of*** *~70% volume (Mg, Fe)SiO_3 bridgmanite and ~25%*

volume (Mg, Fe)O ferropericlase.

* ***The two major components of*** *carbonaceous chondrites* ***are*** *chondrules and matrix.*
* ***They were deformed*** *in the D-DIA at 5 GPa and 800–1000 °C, with MgO accommodating the majority of strain.*
* *Ordinary chondrites (OC), as well as enstatite chondrites (EC),* ***have very low matrix fractions****.*
* *The group of Rumuruti chondrites (R chondrites)* ***is chemically and isotopically related to*** *OC and EC.*

B. Introducing the relationship between two variables

* *Deposits* ***are typically associated with*** *specific magma types formed by melting of sedimentary rocks.*
* *Seepage activity is a complicated hydro geology process that* ***is mainly correlated with*** *hydrate formation.*
* ***There is a positive exponential correlation between*** *the maximum detection resistivity and the gas ejection velocity.*
* *Some studies suggested that biomass-based ratios of fungus to bacteria* ***are positively correlated to*** *ecosystem efficiency and food web complexity.*

C. Establishing the importance of a research topic

* *Studying the response characteristics of submarine cold seepage bubble plumes* ***is of great significance to*** *determine the gas hydrate reservoir area.*
* *The acid properties of SAPO-34 molecular sieves (MSs), including the strength and density of Brönsted acids,* ***have attracted enormous attention*** *in past decades because of the excellent performance of SAPO-34 in industrial processes.*
* *How to analyze quantitatively the results obtained by comprehensive control benefit of soil erosion for well instructs of the soil and water conservation work* ***is a topic worthy of a long-term study*** *in southern China.*
* ***Understanding*** *arc magma genesis* ***is critical to*** *deciphering the construction of continental crust.*
* ***It is important to further investigate*** *this composition* ***using another approach****.*
* *We notably present some examples of bathymetric data and seismic lines showing these structures and we* ***discuss the significance of*** *this fault system in the plate tectonics framework of the East African offshore.*

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D. Identifying the gap in previous studies

* *But the extent of reported carbon reductions achieved through prefabrication remains inconsistent,* ***it is still unclear*** *how different variables influence a prefabricated building's LCCa.*
* *However, the effects of substructure variance in manganese oxide on the adsorption sites and adsorption characteristics* ***remain unclear****.*
* *Over the past decades, extensive marshlands had been converted to paddy fields in the Sanjiang Plain, China; however, the effect of this land use change on ecosystem carbon budget* ***is still much uncertainty****.*
* *However,* ***there has been little to no empirical evidence that*** *elucidates the greenhouse gas (GHG) emissions from this method.*
* *However, the acoustic velocity model* ***cannot describe the physical properties of****..., and the acoustic wave equation adopted* ***is not applicable for*** *the numerical simulation of high frequency seismic waves.*
* *These studies represent an important knowledge base but they* ***do not cover*** *the required spatial range and time-frame.*
* *So far, only few microstructural studies of natural pyroxenites* ***have been carried out****.*
* *The principal characteristics of the continental rise* ***which have not previously been explained*** *are: the persistent uniformity in morphology, sediment…*

E. Introducing the focus, aim, or argument of a research paper

* ***The intention here is to*** *approach the problem by examining Cenozoic examples of subduction initiation.*
* ***This paper focuses on*** *a review of the in-situ measurement of cold seep.*
* ***Our study is centered on*** *the high-resolution post-glacial tephrochronological record for Mocho-Choshuenco volcano.*
* ***The aim of this paper is to investigate*** *the detailed characteristics of the upper mantle discontinuities above 400 km depth.*
* *We make the database publicly available,* ***intending to provide*** *the seismological and broader scientific community* ***with a benchmark for*** *time series to be used as a testing ground in signal processing.*

F. Explaining the significance of the present study

* ***By applying this understanding to*** *the optimization of fracturing designs for the Longmaxi shale, we* ***successfully created*** *networks of well-propped fractures.*
* *Considered together with the mapping objectives,* ***these products are an important***

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and accessible way for geologists *without a technical background in machine learning* ***to*** *interrogate the results of supervised bedrock prediction.*

* ***Our dye tracing experiments have revealed previously unknown features*** *of the subsurface hydrology of a Himalayan debris-covered glacier.*
* ***Our observations are notable due to*** *the style and magnitude of the forcing (high rain rates).*
* ***The experiments highlight the role of*** *biotite and of crystallization pressure in defining separate compositional trends of residual liquids, i.e., alkaline (trachytes) versus sub-alkaline (dacite-rhyolite).*
* ***The potential applications of*** *this data collection* ***are innumerable****: from recalibrating fragility curves to training machine learning models to quantifying earthquake damage.*
* ***These analyses enable us to precisely*** *constrain the age of the sediments,* ***accurately*** *locate the sources of the deposits, and* ***place robust constraints on*** *the exhumation and magmatic history of the West Kunlun Mountains.*
* ***Our study will contribute to a better understanding of the influence of*** *climate change and increasingly serious human disturbances.*
* ***Our results provide new insights into*** *the synergistic effects of CTAB on dehalogenation of Cl-OPEs.*
* ***Our study provides the effective means*** *of land use dynamic monitoring.*

G. Introducing the study methods briefly

* *Here, we* ***present*** *a new open-ocean calibration of the planktic foraminifera Orbulina universa.*
* *Here, we* ***examine*** *glacier speed and rain-induced accelerations using...*
* *To explore how these wetland ecosystems respond to such environmental changes, we* ***examined the effect of*** *saline-alkaline stresses and water stress (flooding/drought) on water use efficiency.*
* *Here, we* ***investigate*** *the* ^{230}*Th and* ^{232}*Th depth profiles in the Central Pacific Basin.*
* *We* ***used*** *a combination of synchrotron X-ray fluorescence and high-resolution electron microprobe element mapping to compare...*
* *This study* ***assessed*** *carbon budget changes to...*
* *Here, a model* ***is presented*** *as a framework for interpreting surface volcanic gas measurements.*
* *To monitor volcanic activity and glacial movements near Jang Bogo Station, a seismic network* ***was installed*** *during the 2010–2011 Antarctic summer field season.*
* *To navigate this complexity, mafic magma diversity* ***is investigated using*** *sample suites that span short temporal and spatial scales.*

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* *In this study, land use and landscape pattern changes from 1982 to 2015* ***were analyzed using*** *remote sensing data...K-means clustering of different rainstorm patterns* ***was used to*** *differentiate watershed run-off and sedimentation features.*

H. Reporting the results briefly

* ***The results of*** *TG and Rietveld refinement* ***showed that****...*
* *The amount of plastic litter* ***has increased dramatically*** *over the last few decades in both aquatic and terrestrial environments.*
* *The software provides the inversion parameters (FDS asymptotes) as well as the limiting frequency effect and transition factor, which* ***provide information regarding*** *contribution of the SP particles to magnetic susceptibility as well as relative variation of the particle grain-size in the SP-SSD transition.*
* *Then, the obtained area under curve* ***values*** *(AUCs)* ***were obtained between*** *0.90 (in 360.009 s)* ***and*** *0.84 (in 78.307 s)*
* *Moreover,* ***an increase in*** *density, through biofouling by organisms, can* ***eventually result in*** *sinking of microplastics.*
* *Besides,* ***it is found that there is a correlation between*** *chlorine resistance and antibiotic resistance.*

I. Showing explanations for research results

* *This* ***is attributed to*** *greater preservation of the enriched melt signature arising from reactive melt transport within the mantle wedge.*
* ***Due to errors in*** *experimental procedures, we did not collect data for approximately nine samples (indicated by Table 1).*
* *Most of this difference* ***is due to*** *the greater water depth and, hence, larger inventory of* ^{230} *That the 8°N site.*
* *Dissolution of dust is the main source of dissolved* ^{232}*Th to the CEP* ***because of*** *its remoteness from the continental margins.*

J. Discussing the implications of the research

* *The results* ***indicated that*** *the largest reduction of forestland area was 648.70 km^2 during 1995–2000, and the relative change was −1.84%.*
* *At Erebus, results of this modeling* ***demonstrate that*** *the degassing of stagnant magma can contribute significant fluid and energy to the system.*
* *Finally, the factors limiting the application of Raman spectroscopy in deep sea are summarized, which can* ***provide reference for the future development of*** *Raman*

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spectroscopy technology.

* *The cavity modification via incorporating zinc ions effectively tunes the product selectivity over SAPO molecular sieves with relatively larger cavity, which* ***provides a novel strategy to*** *develop…*
* *The research results will* ***provide theoretical support for*** *the planning and design of cascade hydropower stations in tributaries of the Yangtze River as well as operation of the Three Gorges Reservoir.*
* *The results* ***suggested that*** *the NDVI alone was not able to distinguish drought-related vegetation stress from vegetation changes caused by crop rotation between corn and soybeans.*
* *Our model* ***has important implications for*** *arc magma genesis in general.*

2.3 Verb Tenses in the Abstract Section

A. Background information: Simple present tense

* *The dynamics of magmatic processes at large mafic ocean island volcanoes* ***control*** *the likely locations (central caldera versus flanks) and timing of their eruptions.*

B. Purpose: Simple present tense / Simple past tense

* *Here, we* ***report*** *the results of sixteen fluorescent dye tracing experiments conducted in April–May 2018 over the lowermost 7 km of the high-elevation, debris-covered Khumbu Glacier, Nepal, to characterize the glacier's surface and subsurface drainage system.*
* *The research* ***aimed to*** *take peat land of Changbai Mountain area as research object.*

C. Gaps in previous studies: Simple present tense

* *However, the FORC signal of particles with nonuniform magnetizations, which are the main carrier of natural remanent magnetizations in many systems,* ***is*** *still poorly understood.*
* *Crystals and their melt inclusions* ***are*** *key witnesses of these processes but* ***are*** *rarely* ***studied*** *in detail and in the same samples.*

D. Methods: Simple present tense / Simple past tense

* *Here, we* ***use*** *a coupled atmosphere-ocean general circulation model, HadCM3L, to*

study regional changes in metrics for extreme precipitation across the onset of the PETM by comparing simulations performed with possible PETM and pre-PETM greenhouse gas forcing.

* *We **analyzed** seven sediment cores recovered from marine turbidite depositional sites along the Chile continental margin.*

E. Results: Simple present tense / Simple past tense

* *Monitoring data **show** that inflation of the edifice **started** about a month before the first 2007 eruption. Magma intrusion **occurred** at ≈ 3 km below sea level, and quickly **migrated** towards shallower depths (about 1 km above sea level).*

F. Conclusions/Implications: Simple present tense / Modal auxiliaries

* *Our findings **emphasize** that the eastern branch of East African Rift System is extending largely towards the south, not only in continental domains but also through the oceanic lithosphere of the Mozambique basin.*

* *We **conclude** that turbiditic strata **may constitute** reliable recorders of climate change across a wide range of climatic zones and geomorphic conditions. However, the underlying causes for similar signal manifestations in the sinks **may differ**, ranging from maintained high system connectivity to abrupt connectivity loss.*

2.4 Using Non-finite Verbs Properly

Different from a finite verb, a non-finite verb is a verb form that does not show the tense. Also, it is inflected for neither number nor person, so it is never the main verb (the predicate) in a sentence. Different types of non-finite verbs are introduced as follows.

A. Infinitives: to + verb

* ***To address** this simultaneity (endogeneity) problem, this paper proposes the use of the IV-GMM technique.*

* *Another way **to determine** the Mo stable isotope composition of the BSE is **to use** recent oceanic basalts.*

B. Participles: Present participle / Past participle

* *Acceleration events correspond with times when bed separation also increases*

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rapidly, ***indicating*** *that the acceleration...*

* *Hydrocarbon seepage erupts along a fault to seabed as bubbles and oil drops,* ***releasing*** *a large amount of hydrocarbons.*
* *This episode of exhumation and uplift,* ***associated*** *with magmatism across western Tibet, is compatible with a double-sided lithospheric wedge model.*

C. Gerunds: Verb + ing

* ***Understanding*** *such riverine processes together with their spatial and temporal changes is central to the understanding of landscape evolution in the Himalayas.*
* ***Quantifying*** *the dust flux is challenging.*

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Exercises

I. Identify the non-finite verbs in the following sentences.

1. Here, we examine glacier speed and rain-induced accelerations using a near-continuous 26-month-long GNSS time series from a large maritime glacier (Tasman Glacier, New Zealand).

2. The short-term accelerations are superimposed on longer-term periods of enhanced velocity that persist for days to weeks and decay at similar rates to bed separation estimates and proglacial lake levels.

3. Accelerated exhumation of the mountain front at a rate of ~1.1 km/Myr since ~15 Ma supports active compressional deformation at the margins of the northwestern Tibetan Plateau.

4. Polycyclic aromatic hydrocarbons (PAHs) in 35 peat samples collected from the Mildred peat core in the Athabasca Region, Canada, were quantitatively analyzed by gas chromatograph mass spectroscopy (GCMS).

II. Read the following paragraphs and find out the four errors contained in the underlined sentences. Each underlined sentence contains only one error. In each case, only one word is involved. You should proofread the sentences and correct the errors.

1. Tibet, the highest and widest plateau on Earth, usually described as a high-elevation, low-relief geomorphic feature. However, relief (i.e., elevation difference between the highest and lowest points in a given area) is not uniform cross the plateau, with distinct morphological contrast between different parts of Tibet.

2. Central Tibet has the lowest relief compare to the rest of the plateau, likely because it is internally drained (Fig. 1a) and has low precipitation rates (Liu-Zeng et al., 2008). The internal drainage favors low relief because of internal deposition, which tends to smooth topography. **3.** Areas has significant relief (> 2 km) are limited to active rifts, such as the Nyainqentanglha range. Early studies (Shackleton & Chang, 1988) suggest that low relief formed in central Tibet from Middle to Late Miocene and corresponds to an erosion surface. However, for northern central Tibet (Qiangtang block), Rohrmann et al. (2012) suggest that **4.** a transition from a fast to slow exhumation regime, similar to the modern one, occurring during Late Cretaceous–Early Cenozoic times. Haider et al. (2013) reconstruct a similar exhumation history for the southern part of central Tibet (Lhasa block), and using thermochronology; Hetzel et al. (2011) suggest that the low-relief surface on the northern Lhasa block formed before 50 Ma. In addition, paleo

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elevation studies imply that central Tibet was already near its present elevation by Late Eocene. Thus, modern elevation and relief in central Tibet might have been reached by 45 Ma. (Gourbet et al., 2016)

III. In the following paragraph, some sentences are missing. Fill in the blanks with the most suitable ones from the list A–F. There are two extra choices, which do not fit in any of the gaps.

Regolith on Mars exchanges water with the atmosphere on a diurnal basis and this process causes significant variation in the abundance of water vapor at the surface. **1.**_____ We are therefore motivated to investigate isotopic water exchange between the atmosphere and the regolith and determine its effect on the deuterium to hydrogen ratio (D/H) of the atmosphere. We model transport of water in the regolith and regolith-atmosphere exchange by solving a transport equation including regolith adsorption, condensation, and diffusion. **2.**_____ The fractionation in adsorption is caused by the difference in the latent heat of adsorption, and that of condensation is caused by the difference in the vapor pressure. Together with a simple, bulk-aerodynamic boundary layer model, we simulate the diurnal variation of the D/H near the planetary surface. **3.**_____ The variability is mainly driven by adsorption and desorption of regolith particles, and its diurnal trend features a drop in the early morning, a rise to the peak value during the daytime, and a second drop in the late afternoon and evening, tracing the water vapor flow into and out from the regolith. The predicted D/H variation can be tested with in-situ measurements. **4.**_____ (Hu, 2019)

A. The model calculates equilibrium fractionation between HDO and H_2O in each of these processes.

B. We find that the D/H can vary by 300%–1400‰ diurnally in the equatorial and midlatitude locations, and the magnitude is greater at a colder location or season.

C. The adsorbed water is released to the atmosphere and re-adsorbed to the regolith on a diurnal basis.

D. While previous studies of regolith-atmosphere exchange focus on the abundance, recent in-situ experiments and remote sensing observations measure the isotopic composition of the atmospheric water.

E. As such, our calculations suggest stable isotope analysis to be a powerful tool in pinpointing regolith-atmosphere exchange of water on Mars.

F. On Earth, measuring the isotopic composition of water near the surface is a common way to identify the sources of boundary layer water.

IV. There are four blanks in each paragraph below, only one of which needs to be filled in with a missing sentence. Fit the following two sentences into the best positions.

A. *We ascribe this subdued effect to a transition zone around the magma chamber, which is still solid rock but with relatively low Young's modulus due to high temperatures.*

In geodynamic numerical models of volcanic systems, the volcanic basement hosting the magmatic reservoir is often assumed to exhibit constant elastic parameters with a sharp transition from the host rocks to the magmatic reservoir. **1.**_____ We assess this assumption by deriving an empirical relation between elastic parameters and temperature for Icelandic basalts by conducting a set of triaxial compression experiments between 200°C and 1,000°C. **2.**_____ Results show a significant decrease of Young's modulus from ~38 GPa to less than 4.7 GPa at around 1,000°C. Based on these laboratory data, we develop a 2D axisymmetric finite-element model including temperature-dependent elastic properties of the volcanic basement. As a case study, we use the Snæfellsjökull volcanic system, western Iceland to evaluate pressure differences in the volcanic edifice and basement due to glacial unloading of the volcano. First, we calculate the temperature field throughout the model and assign elastic properties accordingly. Then, we assess unloading-driven pressure differences in the magma chamber at various depths in models with and without temperature-dependent elastic parameters. **3.**_____ With constant elastic parameters and a sharp transition between basement and magma chamber, we obtain results comparable to other studies. However, pressure changes due to surface unloading become smaller when using more realistic temperature-dependent elastic properties. **4.**_____ We discuss our findings in the light of volcanic processes in proximity to the magma chamber, such as roof collapse, dyke injection, or deep hydrothermal circulation. Our results aim at quantifying the effects of glacial unloading on magma chamber dynamics and volcanic activity. (Bakker et al., 2016)

B. *The location of the plate boundaries is well-defined along the continental branches of the EARS which include a western branch and an eastern branch (Fig. 1).*

The East African Rift System (EARS), originally described by Suess (1891), corresponds to the northern part of the divergent plate boundary system between the Nubian (West African) and Somali (East African) plates. **5.**_____ This rift system is connected northward to the Afar hot spot which is related to the opening of the Red Sea and the Gulf of Aden, which began being active about 30 Ma ago. **6.**_____ However, it is considered that the EARS began to be active only later, starting 24 Ma ago in the Afar area. Although the EARS is commonly considered as the modern archetype of rifted plate boundaries, the current Nubia–Somalia kinematics is among the least well-known of all the major plate boundaries. **7.**_____ The

plate boundary between Nubia and Somalia developed over thousands of kilometers across the eastern part of Africa during Late Oligocene and Neogene times. **8.**_____ The eastern branch (Gregory Rift) is characterized by high volcanic activity (including Mount Kilimanjaro, the highest point of Africa) and the western branch (Albertine Rift) is characterized by a moderate volcanic activity relative to the eastern branch and by deeper basins, containing lakes and sediments. (Deville et al., 2018)

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Chapter 3
Introductions

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3.1 An Overview of the Introduction Section

According to Swales & Feak (2004), three moves should be included in the Introduction section. Writers of research papers can follow the moves to write a proper introduction.

- **Move 1: Establishing a Research Territory**
  - by showing the importance of the topic;
  - by reviewing previous studies.
- **Move 2: Establishing a Niche**
  - by indicating a gap in previous studies.
- **Move 3: Occupying the Niche**
  - by stating the purpose of new research;
  - by raising research questions / listing the hypothesis to be tested;
  - by reporting major findings.

Two typical case studies are as follows.

Case Study One

Excerpt (Chen et al., 2016)	**Comments**
Introduction ① Fluids are important for mass transfer in subduction zones. ② Arc volcanics are commonly characterized by enrichment of large ion lithophile elements (LILE) and light rare earth elements (LREE) relative to the high field strength elements (HFSE) and heavy rare earth elements (HREE). ③ This geochemical feature is generally attributed to slab-derived fluids, which transfer the characteristic signature from subducting slabs to arc volcanics via metasomatism of the mantle wedge. ④ However, it is usually tricky to trace fluids from different sources, especially those from dehydration of serpentinite. ⑤ Coesite-bearing whiteschist at Dora-Maira in the Western Alps is characterized by enrichment in Mg but depletion in Na, Ca, Fe^{2+}, and LILE relative to the host metagranite. ⑥ This provides an excellent target to study	**Prior knowledge:** Sentences ①–⑥

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(Continued)

Excerpt (Chen et al., 2016)	**Comments**
the fluid-rock interaction in a typical continental subduction zone. ⑦ Although intensive studies have been devoted to the whiteschist since the first discovery of coesite in it, its petrogenesis is still a matter of hot debate. ⑧ The controversy mainly focuses on the timing and mechanism of Mg enrichment... ⑨ Resolving the metasomatic timing and the source of metasomatic fluids in whiteschist petrogenesis can shed new light on fluid-rock interaction in subduction zones and its effect on the geochemistry of deeply subducted crustal rocks. ... ⑩ In this contribution, we present an integrated study of whole-rock Mg and O isotopes, and zircon U–Pb ages and O isotopes for whiteschist and its host rock from Dora-Maira. ⑪ The new results, integrated with previous data, shed new light not only on the origin of Mg-rich fluids for whiteschist formation in Western Alps but also on fluid-rock interaction in the continental subduction channel.	**Gaps in previous studies:** Sentences ⑦⑧ **Significance of the present study:** Sentences ⑨–⑪

Case Study Two

Excerpt (Geng et al., 2019)	**Comments**
Introduction ① Cratons, the Archean cores of continents, are normally underlain by thick (> 200 km), old, and cold lithospheric roots that persist for billions of years. ②It is traditionally thought that the negative thermal buoyancy of the cold cratonic lithosphere is largely balanced by the positive chemical buoyancy due to the depletion in iron by extensive melt extraction... ③ However, the dramatic influence of volatiles, especially water, on mantle rheology has been challenged by recent laboratory experiments, which suggest only a small effect of water on upper mantle rheology. ④ Therefore, the preservation of cratonic roots for billions of years and the mechanisms of their later remobilization require more investigation. … ⑤ Unfortunately, due to the rarity of mantle xenoliths, direct information from the lithospheric mantle during this period is sparse. ⑥ Mantle-derived primitive magmas, however, provide another important window to decipher the thermal-chemical conditions of the lithospheric	**Prior knowledge:** Sentences ①② **Gaps in previous studies**: Sentences ③–⑥

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(Continued)

Excerpt (Geng et al., 2019)	**Comments**
mantle. ⑦ Here, we present combined whole-rock chemical, Sr–Nd–Pb isotopic compositions and mineral chemistry of two suites of Early Cretaceous primitive basalts from the western Liaoning Province in the eastern NCC and use them to constrain the thermal-chemical conditions of the Mesozoic lithospheric mantle beneath the eastern NCC. ⑧ We provide key evidence to help explain how the Archean lithospheric mantle of the eastern NCC has been removed.	**Significance of the present study:** Sentences ⑦⑧

3.2 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns used in different moves of the Introduction section are as follows.

A. Establishing the importance of a research topic

* *Understanding the processes that occur in the magma plumbing system below ocean island volcanoes and how they relate to monitoring data,* ***are key current topics of research*** *because they can lead to improved volcanic hazard assessment.*
* *As such, they* ***have been the subjects of numerical studies*** *aimed at relating the behavior of individual magnetic particles and small assemblages to experimental bulk properties.*
* *Consequently, the viscosity of ringwoodite* ***is critical for*** *understanding the mantle dynamics in and around the MTZ.*
* *Thus,* ***it is fundamental to*** *take into account this mechanism on modeling.*
* *Therefore,* ***it is vital to*** *explore leaf margin conditions of woody dicots.*
* *Both problems* ***are of great importance*** *for calibration and for parameters retrieval.*
* *Constraining the nature of these building blocks of Earth* ***is important****, because...*
* *Habitat connectivity* ***is a key issue in*** *landscape ecology...*

B. Defining terms

* *The X method* ***is a valuable tool*** *used to…*
* *A landslide* ***is defined as*** *the movement of a mass of rock…*
* *Our heuristic method relies on another measurement* ***referred to as*** *"cumulative cost" of a path...*

* *Western Anatolia is composed of several metamorphic zones (**collectively referred to as** the Anatolides)…*

C. Referring to previous studies

* ***With the exceptions of** Pike & Fernandez (1999), Carvallo et al. (2003), and Roberts et al. (2017), **all of these numerical studies have concentrated on** FORC diagrams.*
* ***Several authors have proposed** the presence of a dominantly oceanic Lwandle block…extending south of the Rovuma block in the Mozambique Channel between southern Mozambique and Madagascar **(Hartnady, 2002; Horner-Johnson et al., 2007; Stamps et al., 2008, 2018; Saria et al., 2014)**.*
* ***Previous studies have mainly focused on** the influence of...*
* ***Previous studies determined that** water surface slopes increased and...*
* ***Previous studies have indicated that** low-flow stages considerably decreased...*
* ***Previous studies showed that** surface water may have been continuously transported...*
* ***Previous study suggested that** soil food webs were longer and more complex...*
* ***Previous studies demonstrated that** Oribatida mites performed important functions...*
* ***Numerous geodynamical studies have investigated** the coupled evolution of Earth's interior...*
* ***There is a growing body of literature on** the geologic distinction between lakes and...*
* *...**is situated within a growing body of literature** within human geography.*
* ***It has been shown that** the effect of any given land-management measure...*
* *When available, **it has been observed that** the quality report is not always...*
* *Researchers have pointed out that **several studies have found that** dementia patients are at...*

D. Referring to what other writers do

* ***Carvallo et al. (2003) used a** finite-difference **model to** calculate FORC distributions for SV magnetite particles.*
* ***Visser & Both (2005) argue that** these mismatches may provide a necessary…*
* ***Mayer et al. (2006) claim that** a completeness of at least 60%...*
* *While **Guimond & Simard (2010) assert that** while rural researchers…*
* *Indeed, **Oliver et al. (1999) suggested that** leaching of the U-rich…*
* ***Fyffe et al. (2019)** also **conducted a** dye tracing **study on** a debris-covered glacier in the Italian Alps (Miage Glacier)…*

E. Identifying the gap in previous studies

* *...labor market integration, however,* ***remains unanswered****.*
* *Despite this conceptual knowledge, predicting sliding velocities from effective pressure* ***remains problematic****.*
* *The cause of these artefacts* ***has not been investigated****.*
* *Second,* ***there has been very little research about*** *the relationship between glacial...*
* *In addition,* ***very little research has been undertaken to understand*** *the potential...*
* *However,* ***there is very little research on*** *assessing for resilience, resulting in...*
* ***Few studies have simulated*** *future bank erosion responses to climate...*
* *The reality is that* ***few studies have justified*** *the added expense of analyzing such...*
* ***A few studies have estimated*** *some socio-economic impacts of the drought...*
* ***Only a few studies have quantified*** *multi-temporal glacier shrinkage for...*
* *Yet,* ***relatively few studies have applied this tool to*** *trace Earth surface...*
* *It may seem surprising that* ***so few studies have analyzed****...*
* *Yet,* ***few studies have focused specifically on*** *the cause/effect relationships between...*
* ***Few studies have attempted to*** *combine both datasets for...*
* *However,* ***few studies have investigated the application of*** *integrated...*
* *The onset time of the early Yanshanian magmatism in Southeast China* ***is still controversial****.*
* *The scheme has achieved wide use* ***but several issues remain unaddressed****.*
* ***This work did however not investigate*** *the emissions generated during utilization in cast-iron stoves and* ***this study aims to fill this gap in the current literature****.*
* *In contrast, the biomarkers of these Jurassic sediments* ***have been paid little attention****.*
* *In contrast,* ***there is no such a level of knowledge of*** *the Cuenca and Valencia domains.*

F. Stating the purpose and significance of the present study

* *Here,* ***we investigate****..., and explore the effects of...on...*
* ***The paper investigates*** *how territoriality influences the actor relations in...*
* ***In this paper, we aim to better comprehend and discuss*** *oasis formation...*
* ***Instead, we aim to provide a broad overview of*** *the possibilities...*
* ***In this study, we examine the*** *petrogenesis and geological* ***significance of****...*
* ***We focus on****..., and compare it with...*
* ***The intention here is to approach the problem by examining****...*
* ***The hope is that a focus on*** *simple models and the clearest examples will encourage...*
* ***The obtained results in the present study are expected to provide further insights for****...*
* *Integration of stratigraphy and geochemistry* ***gives further insights into****...and* ***helps***

evaluate...

* *Thus,* ***further studies are needed to resolve such an argument***...
* ***This study attempts to provide additional information based on*** *coccoliths and* ***to build a more accurate*** *stratigraphic* ***framework for***...
* ***In addition to addressing these questions,*** *we* ***extend*** *our classification scheme by...*
* *The present study* ***was performed in an attempt to***...
* *This paper* ***presents****…and* ***uses this dataset to constrain***...
* *In this study,* ***comprehensive analyses of****...****have been conducted on***...
* ***The aims are to determine****...,* ***constrain****...,* *and* ***shed new lights on***...

3.3 Verb Tenses in the Introduction Section

A. Introducing the characteristics of a substance: Simple present tense / Present perfect tense / Simple future tense

* *FORC diagrams* ***are*** *a powerful tool in rock magnetic studies…*
* ***It has been observed*** *that coupled* $\delta^{18}O$ *and* $\delta^{34}S$ *values of modern pore-water sulfate at different depths in marine sediment cores* ***will bear*** *a typical slope of* > 0.70 *where microbial dissimilatory sulfate reduction is dominated by organotrophic sulfate reduction (OSR).*

B. Establishing the importance of a research topic: Simple present tense / Present perfect tense

* *With this in mind, it* ***is*** *important to assess whether a link between permeability and electrical conductivity* ***is*** *physically justified.*
* *The supraglacial hydrology of debris-covered glaciers* ***has received*** *increasing attention in recent years.*

C. Referring to previous studies: Present perfect tense / Simple past tense / Simple present tense

* *Previous studies* ***have revealed*** *that hypoxia in bottom water…*
* *Previous studies* ***determined*** *that water surface slopes increased and…*
* ***There is*** *a growing body of literature making the connection between…*

D. Referring to what other writers do: Simple past tense

* ***Embry et al. (2013) proposed*** *that each erosional sequence boundary was generated*

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during a brief tectonic episode lasting ≤ 2 Myr.

* ***Lorant et al. (1998) introduced*** *the residence time as another key factor controlling isotopic fractionation of generated gases in conventional hydrocarbon reservoirs.*

* ***Schandl et al. (1989) identified*** *several conditions of rodingitization and subdivided the rodingites into three groups characterized by increasing metamorphic grade.*

E. Referring to areas of inquiry: Present perfect tense / Simple past tense

* *Recently, studies of both modern and ancient environments associated with significant SD-AOM* ***have revealed*** *a distinctively lower* $\delta^{18}O$–$\delta^{34}S$ *slope…*

* *Experimental studies on nano-patterned arrays of SV particles* ***found*** *that FORC diagrams are significantly more complex than for SD signals.*

F. Identifying the gap in previous studies: Simple present tense / Present perfect tense

* *However, the genesis of A-type granites* ***is*** *still a matter of debate.*

* *However, a precise understanding of…****has been*** *under debate for a few decades.*

G. Stating the purpose and significance of the present study: Simple present tense / Modal auxiliaries

* *Our study* ***provides*** *the effective means of land use dynamic monitoring and…*

* *It* ***can*** *provide the reference for wetland ecosystem, especially ecosystem service…*

3.4 Paraphrasing

A paraphrase is a statement that expresses your own interpretation of important information and ideas expressed by someone else in a new form. To appropriately paraphrase, you can follow the steps below:

- read the original text until you understand its exact meaning, and then set it aside;
- write down the main points or necessary details by your short-term memory;
- change the structure of the original text by rearranging the order of sentences;
- replace keywords within the sentences with synonyms or phrases with similar meanings;
- compare your paraphrase with the original text to ensure you have not unintentionally plagiarized.

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Some examples of paraphrase are shown below:

- **Original version:** *Coral calcification is a complex biological process, many aspects of which remain poorly understood (Giri et al., 2019).*

  Plagiarized version: *Coral calcification is a complicated biological process, many aspects of which remain poorly understood.*

  Paraphrased version: *Our understanding of coral calcification, a complex biological process, is limited. (Giri et al., 2019)*

- **Original version:** *Another way to determine the Mo stable isotope composition of the BSE is to use recent oceanic basalts (Bezard et al., 2016).*

  Plagiarized version: *An alternative method for determining the Mo stable isotope composition of the BSE is to use recent oceanic basalts.*

  Paraphrased version: *Recent oceanic basalts can be used to determine the Mo stable isotope composition of the BSE. (Bezard et al., 2016)*

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3.5 Synthesizing Sources

Synthesizing is distinct from summarizing, as writers summarize key information of one or more sources without making comments or providing new insights. When synthesizing, writers can not only synthesize multiple sources but also express their attitudes towards the sources, based on which they can make new conclusions.

There are five widely-used ways for synthesizing sources, including synthesizing sources grouped by classification, by the order from distant to close, by the order from earliest to latest, by making comparison and contrast, and by giving examples. In addition to using them separately, writers can synthesize sources by combining these ways appropriately.

A. Sources grouped by classification

The following excerpt synthesizes the previous sources by introducing different methods to measure the creep strength of ringwoodite.

- ***The creep strength of ringwoodite was measured by*** *the in-situ stress-strain measurements at 21–23 GPa and 1,800 K by using a rotational Drickamer apparatus (RDA) with synchrotron X-ray...*

The creep strength of ringwoodite was also measured to 10 GPa at room temperature by *the in-situ stress-strain measurements using a deformation-DIA (D-DIA) apparatus with synchrotron X-ray. (Kawazoe et al., 2016)*

B. Sources ordered from distant to close

The following excerpt begins with introducing the function of hinterland lakes, then introduces a problem with hinterland lakes, and next focuses on the hinterland of the North American Cordillera. In this way, the authors narrowed down the topic gradually.

- *Hinterland lakes can accumulate archives of orogenic landscapes that are otherwise largely erosional and thus rarely preserved in the geologic record. Lacustrine lithofacies in particular can be sensitive indicators of local and regional basin hydrology, and can record subtle deformation caused by dynamic or isostatic processes. Due to structural deformation in orogenic belts and the often dynamic paleogeography of terrestrial depositional environments, hinterland lake strata are often difficult to reconstruct using traditional stratigraphic correlation. The hinterland of the North American Cordillera underwent contraction from the Triassic through Late Cretaceous due to viscous coupling between the subducting Farallon plate and North American lithosphere. (Smith et al., 2017)*

C. Sources ordered from earliest to latest

The following excerpt synthesizes the citations by introducing the development of relevant theories and models.

- *Following the increase in digital terrain models (DTMs) availability* ***in the 1960s****, the underlying theories and mathematical developments of modern geomorphometry (i.e., based on quantitative measurements rather than qualitative observations derived from DTMs) started to be developed* ***in the early 1970s****. These methods and algorithms were gradually automated* ***in the 1980s*** *as computers became more available. (Lecours et al., 2016)*

D. Sources ordered by making comparison and contrast

The following excerpt synthesizes the previous studies with similar findings. The linking word “Similar” connects the two findings.

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- *The pioneering study of AvéLallemant was amongst the first to explore the deformation processes in natural websterites and to highlight their complexity. It showed that under high temperature conditions (i.e., above 1,050℃), the deformation of the volumetrically dominant clinopyroxene (cpx) is mostly accommodated by dislocation creep through non-selective translation gliding, polygonization, and syntectonic recrystallization, while at lower temperatures, mechanical twining is more common.* ***Similar*** *conclusions were reached by Kirby and Kronenberg who observed dominance of kink bands and twinning at low temperatures and a switch to subgrain rotation and recrystallization at temperature higher than 1,000℃. (Henry et al., 2017)*

The following excerpt synthesizes the sources by introducing what will happen when the glacier substrate is hard or soft.

- ***When the glacier substrate is hard****, the reduction in effective pressure caused by increasing basal water pressure has a direct effect on sliding velocity by reducing ice-bed contact and increasing zones of cavitation.* ***When the glacier substrate is soft and deformable****, reducing the effective pressure reduces the shear strength of the substrate, and may result in enhanced sliding at the top of the substrate and enhanced deformation at depths of decimeters to meters within the substrate. (Horgan et al., 2015)*

E. Sources ordered by giving examples

The following excerpt uses the Papatea fault in the northern South Island as an example to demonstrate that young faults can be difficult to identify.

- *Young faults can have little stratigraphic offset and subtle geomorphic expression, which makes them difficult to identify prior to earthquake rupture and can, therefore, be overlooked in seismic hazard assessments.* ***For example,*** *the Papatea fault in the northern South Island, New Zealand, is a recently identified, structurally immature fault with small stratigraphic offset that potentially enhanced fault connectivity and increased earthquake magnitude during the 2017 Mw 7.8 Kaikoura earthquake. (Hughes et al., 2018)*

3.6 Inserting Dependent Clauses

A dependent clause has a subject and a verb, and it has to be attached to an independent clause (Fadlalla, 2019). Inserting a dependent clause into an independent one appropriately can

increase your sentence variety, thus improving the language quality of your research papers. Common types of dependent clauses are as follows.

A. Attributive clauses

* *The pre-Jurassic U–Pb age spectrum is strikingly similar to those from Triassic sediments in the eastern Pamir and Songpan-Ganzi terrane* ***that were interpreted to have close affinity****.*
* *The lower 10 km of Tasman Glacier is covered in debris (0–3 m thick, or greater) and the glacier terminates in a proglacial lake* ***that began to form in 1985 and covered 6.7 km^2 by May 2013 (Fig. 1)****.*

B. Non-restrictive / Non-defining attributive clauses

* *This article is based on hydrological and sediment monitoring data from 2002 to 2016 of four important hydrological control stations set up in the main tributaries of the Yangtze River,* ***which are Tongzilin, Gaochang, Beibei, and Wulong****.*
* *Furthermore, cascade hydro power stations were built,* ***which led to annual average sediment concentration, annual sediment load, median size of sediment, and modulus of sediment transport to decrease by 5%~79.34%****.*
* *There are few exceptions on the relationships between precipitation, floods, and sediment load in individual tributary basins,* ***which are often accompanied by a significant reduction in run-off and sediment yields****.*

C. Object clauses

* *The results* ***show that the river sediment distribution pattern and time change are almost consistent with vegetation variation characteristics and human activities****.*
* *The results* ***indicated that the precipitation and the maximal 30 minutes rainfall intensity were the most relevant factors to run-off and sediment responses****.*
* *In combination with the occurrence of synorogenic sediments on both flanks of the Kunlun terrane, these data* ***suggest that an ancient West Kunlun range had emerged above sea level by Triassic–Early Jurassic times****.*

D. Appositive clauses

* *This is due to* ***the fact that forestry and agricultural areas can easily be converted into areas of commerce and light industry****.*
* *To achieve this, the surfaces need to represent 2D dimensional probability distributions and therefore need to fulfil* ***the requirement that the volume underneath each surface is equal to 1****.*

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E. Adverbial clauses

* ***If the peak ages show little change up section***, *a situation known as a static peak, the source terrain likely experienced rapid cooling at the time corresponding to the peak ages, but exhumed slowly since then.*
* *In this case, zircon double dating allows identifying volcanogenic zircon* ***when its crystallization age (e.g., zircon U–Pb age) is equal to the corresponding cooling age (e.g., ZFT) within error***, *and thus has great potential to calibrate poorly-dated sediments in foreland basin settings.*
* *Additionally, the source areas of zircons belonging to specific age peaks can be identified* ***where modern bedrock ZFT ages are similar or younger***.
* ***Since fluid travels through distinctly different pathways***, *generalization of empirical relations that link permeability and electrical conductivity lacks a microstructural justification, and should be verified case-by-case.*
* ***Although the samples are not cogenetic***, *they evolved under similar magmatic conditions.*
* ***As India's motion became more northerly***, *resisting forces along this overall plate boundary pathway (along the WZFZ and through the PAP) increased,* ***so that other alternative plate boundary pathways became more attractive***.

F. Subject clauses

* *It is unlikely* ***that partial melting involved in the production of MORBs themselves results in a significant departure of the $\delta^{98}/^{95}$Mo of the magma from its source***.
* *Comparing Figs. 3c and 3e, it is clear* ***that the geometric structure of many voxels was misclassified using fixed sized voxels***.

G. Predicative clauses

* *Our interpretation of the episodic pulses of MMCT IRD at Site U1356* ***is that overall advance was punctuated by retreats of the ice sheet***.
* *The fact* ***is that till date, not many terrestrial impacts are documented and surely, many of them may have gone unnoticed***.

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Exercises

I. Integrate the following simple sentences in each segment into one that is more formal and logical.

1. This thrust belt probably reactivated the Paleozoic Kudi suture, given their similar trace in map view (Fig. 1). This is our inference.

_____

_____

2. Stomatal density (SD) and stomatal index (SI) in fossil Litsea calicarioides leaves reveal large changes. These changes are coincident with the three phases identified by the carbon isotope values (Fig. 4).

_____

_____

3. The Antarctic Ice Sheet is estimated to have melted from ~125% to ~50% of its modern size. There is thus far no evidence for an increase in atmospheric CO_2 associated with the Mi-1 glacial termination in the earliest Miocene.

_____

_____

4. To the southwest, the Tianshuihai–Karakoram terranes have been sliced by the Karakorum fault. Along the Karakorum fault, the Baltoro batholith intruded at 26–15 Ma.

_____

_____

5. As a result, plates show a degree of coupling. These plates should share an interlocking ridge-transform plate boundary.

_____

_____

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6. Leaf physiology and phenotype are the results of numerous environmental parameters, including Ca. This is evident.

7. Current theory concerning the leaf physiological response over millennial timescales supports our interpretation. Our interpretation is that the reduction of $g_{c[max]}$ from Phase 1 to Phase 2, and subsequent increase from Phase 2 to Phase 3 (Fig. 4), can reflect an increase in Ca during the ~20 kyr period comprising Phase 2.

8. In this case, the rift zone is small, and rifting and breakup occur relatively quickly. So, the spatiotemporal relationship between rifting and other events is potentially more easily isolated than for larger rifts between the major continents.

II. Paraphrase the following sentences.

1. The capacity of the upper mantle to transport melt, which is ultimately responsible for the production of oceanic crust, strongly depends on the spatial distribution of melt in the upper mantle.

2. The magnetotelluric (MT) method, which exploits the high conductivity of partially molten rock, is a valuable tool used to probe the melt content of the upper mantle.

3. Mountain glaciers and ice caps are anticipated to contribute significantly to sea level rise over the coming century. There are two components to this contribution: changes in surface mass balance and changes in dynamics (e.g., accelerated flow, lake, or tidewater calving).

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4. Hysteresis is often observed with identical effective pressures resulting in markedly different velocities. This hysteresis was demonstrated over short time intervals by Sugiyama & Gudmundsson (2004) who observed two distinct relationships between effective pressure and glacier speed depending on whether Pe is increasing or decreasing.

_____

_____

5. The intensification of heat stress reduces the labor capacity and hence poses a threat to socio-economic development.

_____

_____

6. As an important factor influencing the local development, a growing body of studies has been focusing on the assessment of climate change impacts on the labor system, and then adapting to potential impacts.

_____

_____

III. There are four blanks in each paragraph below, only one of which needs to be filled in with a missing sentence. Fit the following four sentences into the best positions.

A. *In contrast, the exhumation histories of the northwestern plateau margin, in particular the West Kunlun Mountains (Mts.) (Fig. 1), remain poorly constrained so far, due to scarce thermochronologic data in this vast region of remote mountains.*

1._____ Decoding mountain building processes of the Tibetan Plateau and their geodynamics requires documenting long-term orogenic scale uplift and exhumation histories. **2.**_____ Many areas of the orogen have well documented cooling histories constrained by dense thermochronologic datasets, such as the southern and eastern plateau margins. **3.**_____ As such, the onset of plateau formation in northwestern Tibet remains largely disputed, ranging from 46 Ma to 4.5 Ma. **4.**_____ (Cao, 2015)

B. *Based on data from the three-component stations, 17 volcanic events were roughly located.*

The first geophysical observations at Mt. Melbourne were set up in 1988 by the Italian Progetto Nazionale de Ricerche in Antartide (PNRA) program. **5.**_____ A network of five tilt stations was installed in 1988–1989 for continuous recording, and a seismic network was set up in 1990 that consisted of two short-period single-component and two short-period three-

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component stations constrained by a local trigger. **6.**_____ The long-period features of the events may have been caused by the active presence of magmatic fluids in the source processes or the result of fracturing processes between brittle and plastic behaviors. **7.**_____ The other seismic array was operated with three-component 5-s sensors recording continuously during the austral summers of 1993–1994 and 1994–1995 in the PNRA framework. **8.**_____ Four temporary stations were located at the vertices of a square-shaped array around Mt. Melbourne, and the crustal thicknesses at each station were computed with teleseismic receiver functions (circles with crustal thickness in Fig. 1). (Park et al., 2015)

C. *Similarly, the Rb–Sr mica ages from biotite and orthogneisses (Fig. 1B), in intrusion related contact to the metamorphic schists with a sedimentary precursor, yielded Paleocene–Early Eocene ages (~43–62 Ma), so far always considered to closely post-date the Alpine metamorphism of the basement series.*

The outcrop containing the large garnet megacrysts analyzed in this study is located inside mica schists in contact with orthogneiss featuring protolith ages around ~550 Ma (zircon U–Pb), and both lithological units are located below the Supra-Pan-African unconformity identified by Candan et al. (2011a). **9.**_____ Although the Menderes Massif as a whole has been extensively studied over the past century, its metamorphic history still remains uncertain. **10.**_____ A few petrological and geochronological studies address the effects of the Alpine overprint on Pan-African mineral assemblages and isotopic systems. **11.**_____ Published geochronologic constraints on the Alpine metamorphism are scattered between 63 Ma and 27 Ma. The Rb–Sr white mica (48–63 Ma with an average age of 56 ± 1 Ma) Ma and biotite (27–50 Ma with an average age of 35 ± 5 Ma) ages from meta-sedimentary rocks of the south-Menderes Pan-African basement were interpreted as cooling ages during Alpine metamorphism of the massif. **12.**_____ White-mica Ar–Ar analysis of paragneisses in the southwest Menderes nappe gave similar Eocene cooling ages of 43–37 Ma (Hetzel & Reischmann, 1996). More recently Catlos & Çemen (2005), reported three monazite Th–Pb ages of 47.1 ± 12.6, 44.7 ± 12.2 and 42.8 ± 7.2 Ma (2σ) from the northern part of the southern sub-massif, which were interpreted to record monazite recrystallization during decompression and extension of the Menderes massif. (Schmidt et al., 2015)

D. *Several proxy studies of the hydrological response to the Paleocene–Eocene Thermal Maximum hyperthermal, ~56 Ma, have recently invoked changes in the occurrence of extreme precipitation events to explain observations, but these changes have not been studied for the geologic past using climate models.*

Future global warming is widely anticipated to increase the occurrence of extreme

precipitation events, but such hydrological changes have received limited attention within paleoclimate studies. **13.**_____ Here, we use a coupled atmosphere-ocean general circulation model, HadCM3L, to study regional changes in metrics for extreme precipitation across the onset of the PETM by comparing simulations performed with possible PETM and pre-PETM greenhouse gas forcing. **14.**_____ Our simulations show a shift in the frequency-intensity relationship of precipitation, with extreme events increasing in importance over tropical regions including equatorial Africa and southern America. The incidence of some extreme events increases by up to 70% across the PETM in some regions. **15.**_____ While the most extreme precipitation rates tend to relate to increases in convective precipitation, in some regions dynamic changes in atmospheric circulation are also of importance. **16.**_____ Although shortcomings in the ability of general circulation models to represent the daily cycle of precipitation and the full range of extreme events preclude a direct comparison of absolute precipitation rates, our simulations provide a useful spatial framework for interpreting hydrological proxies from this time period. Our results indicate that changes in extreme precipitation behavior may be decoupled from those in mean annual precipitation, including, for example in East Africa, where the change in mean annual precipitation is small but a large increase in the size and frequency of extreme events occurs. This has important implications for the interpretation of the hydrological proxy record and our understanding of climatic, as well as biogeochemical, responses to global warming events. (Carmichael et al., 2018)

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Chapter 4
Methods

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4.1 An Overview of the Methods Section

In a research paper, the Methods section, also titled as Materials and Methods or Data and Methods, usually follows the Introduction section, explaining the research process and data analysis in detail. In this section, researchers need to introduce their study sites, materials, sampling measures, study procedures, variables, data analysis techniques, and other necessary information that enables readers to understand the researchers' study clearly (Hartley, 2008). In addition to the above-mentioned information, it is common for researchers to justify their study methods to increase the reliability of their papers. Two typical case studies are as follows.

Case Study One

Excerpt (Allabar, 2018)	**Comments**
2. Methods	
2.1 Starting Material and Capsule Preparation	
① A crystal free VAD79 glass was synthesized following the protocol of Marxer et al. (2015) with additional improvement of the final cooling step: The melt was air cooled from 1873 K to a temperature nearby the glass transition (Tg) within ~1 min to inhibit crystallization. ② Then the supercooled melt was transferred into a furnace preheated to 833 K, whereupon the furnace was switched off to maintain a cooling rate of ~5 $K \cdot min^{-1}$ to room temperature, which successfully minimized tension induced crack formation within the glass batch.	**Elaborating on study procedures while introducing instruments:** Sentences ①–⑤
③ Cylinders with 5 mm diameter were drilled out of the glass, cut to 6.5 mm length and ground at the edges to prevent capsule damage during pressurization. ④ One cylinder was embedded in epoxy resin and ground and polished for electron microprobe analysis (EMPA). ⑤ Successful homogenization of the anhydrous glass was confirmed by the EMPA using measurement conditions as described in Preuss et al. (2016) (SiO_2: 57.24%; TiO_2: 0.29%; Al_2O_3: 21.08%; FeO: 2.71%; MnO: 0.15%; MgO: 0.39%; CaO: 3.19%; Na_2O: 5.38%; K_2O: 9.47%; P_2O_5: 0.1%)…	This excerpt introduces the specific procedures involved in the study. It can be inferred from the title of each part in this excerpt that writers, instead of following a fixed structure, can structure the Methods section of their research papers in a way that fits their study.
…	
2.2 Decompression Experiments	
2.3 Sample Preparation	
2.4 FTIR Spectroscopy	
2.5 Quantitative Determination of VND and Porosity	

Case Study Two

Excerpt (Chen et al., 2016)	**Comments**
2. Geological Setting and Samples ① Dora-Maira (Fig. 1), together with outcrops at Gran Paradiso and Monte Rosa, constitute three Internal Crystalline Massifs within the Penninic Domain in the Western Alps. ② It is composed of Variscan crystalline basement and Triassic cover, and the former was intruded by Permian granitoids. ③ These rocks experienced high-pressure (HP) and ultrahigh-pressure (UHP) eclogite-facies metamorphism during the Alpine orogeny. …	**Introducing study sites and samples:** Sentences ①–③
3. Analytical Methods ④ Magnesium isotopes were measured using a Thermo Scientific Neptune Plus MC-ICPMS followed the method of An et al. (2014) at the CAS Laboratory of Crust-Mantle Materials and Environments in University of Science and Technology of China, Hefei. ⑤ Whole-rock powders were fully digested to obtain ~20 μg Mg for chemical purification. ⑥ A mixture of concentrated HF-HNO_3 was used for digestion…	**Elaborating on study methods and procedures:** Sentences ④–⑥

4.2 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns used in different elements of the Methods section are as follows.

A. Introducing the features/basic information of a substance/landscape/site

* *The main mechanisms responsible for its lithospheric thinning* ***have been suggested to include****: (1) lithospheric delamination; (2) thermal and chemical erosion; (3) weakening of the lithosphere by hydration; and (4) melt-peridotite reaction.*
* *Both sites are soil-mantled upland landscapes that* ***are underlain by*** *granodiorite.*
* *This site* ***is covered by*** *typical Mediterranean scrubs and is about two kilometers to the nearest village.*
* ***As one of the oldest Archean cratons in the world****, the North China Craton* ***preserves*** *crustal remnants as old as 3.8 Ga.*
* *Since the final cratonization at ~1.8–1.9 Ga by amalgamation of the eastern and western blocks, it* ***remained undisturbed*** *until the eruption of Ordovician (~470 Ma) kimberlites.*

* *This study was performed in six plantations of Chinese star anise of Guangxi Zhuang Autonomous Region, China at the Liuwan Forestry Center (**22°34'N, 109°51'E**), the Aisha sub-Forestry Center (**22°58'N, 108°20'E**) and…*
* *The SE Tibetan Plateau margin **is situated in** southeastern Tibet, Yunnan, western Sichuan, and Guizhou in southwestern China.*
* *The DPPR **is bounded by** Canada, the Red River of the North, and the Missouri River (Fig. 1).*
* *The headwaters of the Kay Lake valley **are made up of** sedimentary rocks of the Miocene Kailas Formation, and volcanic and plutonic rocks associated with the Cretaceous-Eocene Gangdise volcanic arc.*

B. Introducing the study instruments/materials/sites

* *Fused silica capillary tube (**300 μm OD, 50 μm ID; Polymicro Technologies, LLC**) was used to…*
* *Specimens **with largest dimensions of ≤ 700 μm were placed in 1 mm Pt or NBtubes** for analysis.*
* *All the subvolumes used in direct current simulations, with the exception of those we used to assess the potential influence of H_2O, **have dimensions 280 μm × 280 μm × 280 μm**...*
* *The samples consisted of a black shale **(MAC1-4, 25 m depth)** from the Hushpuckney Shale member of the Missourian Patoka Formation, …*

C. Justifying the study methods/steps

* *We have modeled the diffusive re-equilibration of H_2O of eight melt inclusions **using the method of** Qin et al. (1992).*
* ***Following** Di Muro et al. (2014), we **have assumed that** the largest measured concentrations have not been modified via diffusion and thus, we have used them as initial values.*
* *FORC diagrams **are constructed from** a class of partial hysteresis curves **called** first-order reversal curves (Mayergoyz, 1986).*
* *Age models of turbidite cores **are based on** published radiocarbon ages by Blumberg et al. (2008) and Bernhardt et al. (2015a).*
* *We **chose** the global eustatic sea-level curve of Lambeck et al. (2014) for comparison as it combines available records from the Pacific and the Atlantic.*
* *We **included** an additional humidity-index record based on grain-size end-member modeling (Weltje, 1997) of core GeoB7139-2 (detailed methods and interpretation in Appendix A).*

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D. Introducing the equations used

* *To study the influence of AI on microclimates, we* ***use the normalized difference vegetation index, NDV I, calculated from*** *the intensity of the near infrared (NIR) and visible red (VIS) wavelengths: i.*

$$NDVI = \frac{NIR - VIS}{NIR + VIS} \quad (1)$$

* *Lastly, the equation*

$$H_T = \frac{(V_{S0} + \delta^{v_s}) \times (V_{P0} + \delta^{v_p})}{V_{P0} + \delta^{v_p} - V_{S0} - \delta^{v_s}} \times \frac{V_{P0} - V_{S0}}{V_{P0} \times V_{S0}} H_T \quad (1)$$

is applied to convert the apparent depths (HA) into true depths (HT), ***where V_{p0} and V_{s0} are the mean P- and S-wave speeds*** *in the layer in the standard Earth model, and* ***δ^{V_p} and δ^{V_s} are the absolute P- and S-wave speed anomalies****.*

E. Describing the study methods/steps

* *Nine samples from...****were analyzed*** *for the compositions of...and the contents of...*
* *89 seawater samples* ***distributed over*** *six stations were collected...*
* *Calcium concentrations* ***were augmented through*** *the addition of $CaCl_2$.*
* *Water* ***was loaded into*** *the tube and* ***centrifuged to*** *the sealed end.*
* *The melt fraction of each subvolume* ***was calculated by*** *counting the number of...*
* *Contractions and dilations* ***were conducted*** *along all three orthogonal directions of the cubic subvolume.*
* *They* ***were carried out*** *on a suite of 120 post-glacial tephra samples from Mocho-Choshuenco, including 44 scoria cone samples.*
* *All rock samples* ***were crushed into*** *fragments 5–10 cm in diameter.*
* ***Shale samples were placed in*** *a 10% sodium hypochlorite solution for up to four weeks.*
* *Shales that did not completely disaggregate after this treatment* ***were subjected to*** *a 35% hydrogen peroxide solution for up to 24 hours.*
* *Undissolved residue* ***was washed and sieved to*** *isolate the 63–2,000 μm size fractions.*
* *Optical and cathodoluminescence (CL) microscopy observations of the cements in the studied extension veins* ***were used to*** *document the relative chronology of fracture stages.*
* *$NaMgF_3$* ***was synthesized*** *for this study from a stoichiometric mixture of NaF and MgF_2 sintered at 750 °C (see Appendix A).*
* *We* ***subjected our samples to*** *rigorous cleaning.*

* *We **faulted** intact cores of serpentinite under conditions of high pore fluid pressure in a triaxial rock deformation apparatus.*
* *We only **compiled/analyzed samples** known to have erupted in post-glacial times (18 kyr) and from volcanic centers between 37°S and 45°S.*
* *We **acquired three samples from** depths of 25–76 m in the western Illinois Basin MAC core.*
* *We **applied** the n and k values of the closest bulk composition and **used** Equation (2) to solve for the cooling time (t in seconds).*
* *We **carried out**, as a sensitivity test, a spectral analysis **using** the control points provided by the ^{18}O record.*
* *We **measured** the activities of extracellular enzymes **using** assay techniques modified from Guan (1986).*
* *Here, we **categorize** the majoritic garnets **using** an experimentally calibrated model.*
* *A ClO_2 stock solution **was prepared using** the standard method 4500-ClO_2 B.*
* *The ClO_2 concentrations in the six aliquots **were calibrated using** the iodometric method.*
* *The concentrations of chlorite and chlorate **were determined using** an ion chromatography system (ICS-3000, Dionex, U.S.A.).*
* *Raman spectroscopy measurement **was performed using** a LabRam Aramis (Horiba Jobin Yvon) at room temperature under excitation by 532 nm laser with output power of ~0.5 mW.*
* *An alpha-ejection correction **is typically calculated using** the measured dimensions of the analyzed grain and assuming an appropriate grain geometry.*
* *In brief, ClO_2 gas **was generated by** slowly adding 20 mL of H_2SO_4 (10%, v/v) to 500 mL of a 0.5 M $NaClO_2$ solution.*
* *Ultrapure water **was provided by** a water purification system (Cascada I, Pall, U.S.A.).*
* *A simulated raw water sample **was prepared by** dissolving 3 mg/L SRNOM as C, 80 mg/L $NaHCO_3$ as $CaCO_3$, 2.0 mg/L NaBr as Br...*
* *A glassy carbon (GC) electrode (3.0 mm in diameter) coated with ferrihydrite **was used as** the working electrode.*
* ***For PCR analysis**, 1 L of spring water **was filtered through** a 0.2-μm Supor®-200 membrane filter (47 mm diameter) (Pall Life Science).*
* ***For quality control**, the R_2 of the standard curve as well as the amplification efficiency **were determined**, and melting curve analysis **was performed**.*
* *Our method bypasses the need for laser fluorination of high-Cr garnets, being instead **based on** laser fluorination of a low-Cr garnet (S0068).*

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4.3 Verb Tenses in the Methods Section

A. Introducing the study instruments/materials/sites: Simple present tense

* *The glacier **has** a well-documented, expanding area of supraglacial ponds...*
* *The offshore segment of the eastern branch of the EARS **is characterized** from north to south by Neogene extension tectonics over-imposed on former strike-slip structures of the Tanzanian–northern Mozambique transform margin.*

B. Justifying the study methods/steps: Simple present tense

* *We **use** the same samples studied by Di Muro et al. (2014).*
* *The analytical conditions **are detailed** in the Supplementary Material and are the same as in Albert et al. (2015).*

C. Introducing the equations used: Simple present tense

* *And n **is** the temperature coefficient for fluorescein (0.0036℃$^{-1}$).*
* *...where u(t) **is** our observed speed time series and the background speed is a best fitting function a sin (ωt + φ) + bt + c (Section 3.1).*

D. Describing the study methods/steps: Simple past tense / Simple present tense

* *Two second-stage anvils made of cubic BN (BNS800, Sumitomo Electric Inc.) **were used** on the downstream side because of their low X-ray absorption.*
* *We **report** the details of the parameter values and equations used in the calculation in Supplementary Material.*

4.4 Cohesive Devices

Cohesion refers to the glue that can hold elements in a research paper together. The common cohesive devices are listed as follows (Fadlalla, 2019).

A. "that"/"those" + of

* ***The surface environment of** Mars is vastly different from **that of** Earth, in that the surface pressure and temperature are much lower, and the surface temperature has greater diurnal variation.*

* *This would produce **values of** $\delta^{11}B$ in Orbulina universa below **those of** ambient borate ion, which would suggest lowered microenvironment pH, counter to microelectron de observations.*

B. "this"/"that"/"these"/"those"/"such" + noun

* *Some data indicate that pH_{ECF} is increased by ~0.2–0.8 pH units relative to the surrounding seawater, while others suggest **this change** is as high or higher than ~1 pH unit.*
* *Regardless of the exact mechanism, each of **those mentioned above** produces pulses of IRD as part of dynamic cycles of ice advance and retreat.*
* *In these experiments, increases in $/Ca^{2+}/_{SW}$ did not significantly influence calcification rates but caused...To explain **these results**, we propose a mechanism by which $/CO_3^{2-}/_{ECF}$ is influenced by $/Ca^{2+}/_{SW}$.*
* ***Such chemical and isotopic characteristics** can, however, not be reconciled with mineral fractionation.*
* *However, many Red Sea fishes (and possibly other fauna) extend into the Gulf of Aden, so **that area** needs to be added to the Red Sea Province (Fig. 2).*

C. "the" + noun

* *Calcification rates were measured with the alkalinity anomaly method and are reported, along with a description of **the method**, in Giri et al. (2019).*
* *Despite **the shortcomings** outlined, Earth system models lend support to interpretations of...*

D. Logical connectors

* ***Although** these two studies have conflicting results, if the B/Ca_{SK} ratios measured in experiments displayed a rate-dependent response to increasing $/Ca^{2+}/_{SW}$, we would expect to see...*
* ***However**, even by applying a more realistic s-process, deficit of only 0.1% would result in a slope of 1.673, **while** generating an absolute change in $\varepsilon^{182}W$ of ~4.5 ε-units with respect to the terrestrial value.*
* ***Therefore**, no correction is necessary for samples All-C_2, All-NM_2, All-WM_3 and Vig_2, besides their anomalous ^{183}W.*
* ***In addition**, our reported ages overlap with the 1.7 ± 0.7 Ma chondrule formation age for H-chondrites reported by Kleine et al. (2008).*
* ***Additionally**, in the context of longstanding (>30 Myr) plume activity, a purely*

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plume-driven mechanism leaves one fundamental question.

* *Our model **starts with** a 10-m resolution lidar-derived digital elevation model and a 10-m resolution raster of spatially-distributed erosion rate.*
* *To estimate the background speed, we **first** remove 7-day asymmetric windows around all speed-up events exceeding 0.4 m d^{-1} (Fig. 5). The edited window period starts one **prior to** and ends six days **after** the peak speed.*
* ***In particular**, coupling across the WZFZ initially resisted the northward flight of India, **until** an alternative plate boundary pathway through the plume-weakened margin of Greater India became more viable.*
* ***Despite** this activity, the Batavia and Gulden Draak microcontinents remained part of the Greater India passive margin. **In contrast**, few volcanic outputs have been observed between 108–101 Ma, coeval with Batavia and Gulden Draak calving.*
* ***As a result**, plates that share an interlocking ridge-transform plate boundary show a degree of coupling.*

E. Using participles

* *Faraday cups were calibrated at the beginning of the session, **using** the inhouse calibration routine.*
* ***Combined** with approximations of typical local silicate and phosphate concentrations (from GLODAP/CARINA), monthly estimates of pH were calculated using CO_2 system, ...*

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Exercises

I. Integrate the following simple sentences in each segment into one that is more formal and logical.

1. The implications of the New Mexico CAHe dates will be described in a future contribution. These implications are not discussed further here.

_____

_____

2. Three-dimensional images of individual conodont elements were rendered from two-dimensional attenuation slices. We did it by using the software Blob3D version 1.4.

_____

_____

3. We also compiled unpublished whole-rock data on basement samples. The samples were taken in the region around Mocho-Choshuenco. We did it to assess how crustal contamination may influence magma composition.

_____

_____

4. The magnitude of cohesion of intact serpentinite is much greater than that of plate boundary fault rocks. But the processes of crack growth and coalescence are representative of those that occur in situ. The processes of crack growth and coalescence occur in these experiments.

_____

_____

5. In an experiment conducted without pore fluids and in an experiment conducted at ambient temperature, axial and radial strains (a and r) were measured with foil gages. The foil gages were affixed to the surface of the rock. Axial and radial strains were used to calculate volume strain ($v = a + 2r$).

_____

_____

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6. Secondly, the studies of Kahmen et al. (2013a, 2013b) focus on open forest or scrubland plants in a highly monsoonal to arid environment. The paleoenvironment of Foulden Maar was neither monsoonal nor arid.

7. The scenario of local ecology driving physiological changes is plausible. There are several key factors why this scenario is less likely than the case for changes in pCO_2 and rainfall as drivers of variation in gc/max/, $\delta^{13}C$ and δD.

8. Dissolved deep water ε_{Nd} at these continental margin locations is likely a function of three variables. The three variables are the magnitude of the Nd flux from sediment pore fluids, the difference between the ε_{Nd} value of the overlying water and the pore fluid, and the exposure time to this benthic flux of Nd.

9. The only method is through the analysis of reductively cleaned planktonic foraminifera. By the method, ε_{Nd} values of surface waters have been successfully reconstructed to date.

10. GNSS data were processed kinematically. We did it by using differential carrier phase positioning.

11. The primary base station was also inoperable during October 2014. This leads to an increased baseline length and degraded solutions.

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12. Understanding the causal relationship between rain-rate and velocity is complicated. We need to cross-correlate and lag the two time series.

_____

_____

II. Fill in each of the following blanks with an appropriate preposition.

We also measured Na and ^{22}Na in base flow drainage waters from Watershed 3 in the Hubbard Brook Experimental Forest (43°56′N; 71°45′W) **1.** _____ central New Hampshire, U.S.A. This watershed has been monitored for hydrologic and elemental budgets beginning in 1957 and is a member of the Long-Term Ecological Research (LTER) Network. Watershed 3 is a 42 ha catchment draining the Silurian Rangeley unit, which consists primarily **2.** _____ quartz mica schist and quartzite. Since this region was glaciated multiple times **3.** _____ the Pleistocene, thin (~1–50 cm) soils (Spodosols) are developed on till. This watershed has a total relief **4.** _____ about 60 m and is vegetated with mature northern deciduous forest dominated **5.** _____ American beech, sugar maple, yellow birch, and some red spruce **6.** _____ higher elevations. Average annual precipitation here is 1.5 m with nearly one-third of this falling as snow, and annual run-off is calculated using high-resolution (30 minutes during steady flow and six minutes **7.** _____ changing flow) gauge height (Morison, 2019). Watershed 3 has a slightly acidic pH (~6) and a relatively low dissolved load (< 2 mgL^{-1}). Given that Watershed 3 has been the hydrologic reference catchment for a wide range of paired catchment and hillslope studies for the last 50 years and has well-characterized hydrology, soils, and climate, we considered this an ideal field site **8.** _____ test ^{22}Na as a tracer. (Kaste et al., 2016)

III. There are four blanks in each paragraph below, only one of which needs to be filled in with a missing sentence. Fit the following four sentences into the best positions.

A. *Depending on how the temperature profile in the magma ocean compares with the profile of the melting temperature, two situations can occur.*

We consider a mantle that is initially fully molten and crystallizes from the bottom or some intermediate depth upward. The goal of the present study is to determine the timescale for convection to start in the solid part of the mantle as the magma ocean crystallizes. **1.**_____ For the sake of simplicity, we assume the compaction length to be small and neglect the thickness of a mush layer at the phase-change interface. **2.**_____ Matter on one side of the boundary is entirely liquid while matter on the other side is entirely solid. **3.**_____ We

nonetheless allow for compositional fractionation to occur as the mantle crystallizes. The temperature at the solid/liquid boundary is denoted *Tm* and referred to as the melting temperature. **4.**_____ Either the solidification of the ocean progresses from the bottom up, or the solidification starts from an intermediate depth leading to a set-up in which the solid part of the mantle is surrounded by two magma oceans. In this second scenario, the crystallization of the surface magma ocean (SMO) is thought to be a lot faster than the crystallization of the basal magma ocean (BMO). (Morison, 2019)

B. *After each experiment, the deformation assembly was cut in half in the plane that includes the orientation of maximum compressive stress and shear direction as presented in Fig. 3.*

Post-deformation microstructural analyses included observations using reflected light microscopy and measurements from EBSD analyses. **5.** _____ The sample was then polished using diamond lapping film with particle sizes of 30 μm down to 0.5 μm and finished by polishing for one hour with colloidal silica with a particle sizes of 0.04 μm. **6.** _____ EBSD analyses were used to measure crystallographic orientations and characterize the development of low-angle boundaries. **7.** _____ EBSD maps were made over entire cross-sections of the crystals by stitching together multiple maps using the HKL Channel 5 software. The step size used for the maps was 20 μm and the data were corrected for systematic misindexing. **8.** _____ Additional analyses, including determination of values of the Schmid factor, were carried out using the MTEX toolbox (Bachmann et al., 2010) for MATLAB®. (Tielke et al., 2016)

C. *The fourth resonance transition test involves the AM of the ~40 kyr obliquity cycle, from which the 1.2 Myr (s4–s3) obliquity cycle should emerge.*

We follow the approach that proscribes six explicit tests to identify a resonance transition in stratigraphic data series. These tests include the assessment of amplitude modulations preserved in carrier signals (precession, obliquity, eccentricity), and the integration of these assessments with high-precision radio isotopic data. **9.**_____ The first three of the resonance transition tests involve evaluation of precession and eccentricity amplitude modulations. If the 2.4 Myr (g4–g3) eccentricity cycle is present in our stratigraphic datasets, it should ideally emerge from three "carrier signals": the AM of the shortest precession term (~19 kyr), the AM of short eccentricity (123 + 95 kyr), and the AM of the 405 kyr long eccentricity cycle. **10.**_____ A number of statistical methodologies exist for extracting these hypothesized 1.2 Myr and 2.4 Myr AMs from the higher frequency carrier signals. **11.**_____ In this study, we utilize two distinct approaches: (1) AM of the 405 kyr signal is evaluated using complex demodulation; and (2) AM of the short eccentricity (~100 kyr) and obliquity terms (~40 kyr) are conducted using time-frequency

spectrum integration and a 500 kyr moving window. **12.**_____ The 19 kyr precession signal is not investigated in this study, given its extremely weak power in the Lisback and Iona datasets. Note that a fifth resonance transition test is the expected anti-phased relationship between short eccentricity AM and long eccentricity AM in the transition interval, which would confirm the underlying astronomical timescale. (Ma et al., 2019)

D. *We focus on the diurnal variation of the D/H of the boundary layer in this paper, because this variation may provide a direct probe of the amount and the composition of the water vapor flux between the atmosphere and the regolith.*

13._____ We construct a one-dimensional model to simulate transport of isotopic water in the Martian regolith and boundary layer. **14.**_____ It has a thermal diffusion module, a water transport module, and a boundary layer module. The model includes the isotope fractionation effects of adsorption, condensation, and molecular diffusion. We do not include the effects of subsurface deliquescence in this paper, and will study that subject in the future. **15.**_____ On a diurnal timescale, the D/H near the surface is decoupled from the effect of the large scale circulation, because the latitudinal mixing time for water is a few tens of sols. **16.**_____ As such we reduce the regolith-atmosphere exchange problem to a one-dimensional problem concerning the planetary boundary layer and the regolith. Except for the effects of mesoscale transport of water, our model should provide a good representation of the diurnal variability of the water abundance and isotopic composition in the boundary layer. The availability of radio isotopically dated ashes from ten biozones provides a remarkable opportunity to rigorously anchor the floating as trochronologies, and the ability to test the sensitivity of our results to timescale uncertainty (using different radioisotopic anchorings). (Hu, 2019)

IV. Improve the following paragraphs to make them more formal and logical.

1. We study both melts and crystals. We did it by employing ab initio molecular dynamics simulations based on the planar augmented wavefunctions (PAW) flavor. We used the VASP implementation. The VASP implementation has the Gamma point for sampling the Brillouin zone and generalized-gradient approximation for the exchange correlation in the PBE96 formulation. We used a kinetic energy cutoff of 550 eV for the planewave basis set, and used a kinetic energy cutoff of 800 eV for the augmentation charges. Because iron is present, all simulations which are at all volumes and temperatures are spin-polarized. This allows for the magnetic spin of the individual Fe atoms to be consistently computed at every single time step. We initiate the local magnetic moments with 1 magneton-Bohr par Fe atom. This is enough to break the symmetry of the magnetic wavefunctions that will converge to their state within a few steps.

2. Phase and orientation maps of reidite-bearing zircon grains were conducted via electron backscatter diffraction (EBSD) mapping. To do it, a TESCAN MIRA3 FE-SEM at Curtin University was used. EBSD and EDS data were collected at the same time. Oxford Instruments AZtec acquisition system with a Nordlys EBSD detector and XMax 20 mm Silicon Drift Detector was used. Panchromatic cathodoluminescence (CL) and additional BSE images were collected using the same instrument. Processing of EBSD data was performed using Oxford Instruments Channel 5.12 software.

3. We use two similar metrics calculated within GB polygons to quantify topographic asymmetry. First, we collected up to 10 topographic profiles from each GB polygon. This allows their lengths to vary. This also ensures that they span the distance between opposing ridge lines and are oriented within 45° of north-south (locations of profiles provided in supplemental material). We use these profiles to compute the ratio of the average along-profile slope on north- and south-facing slopes. Second, we calculate the ratio of the average slope of gridded data measured on north- and south-facing aspects. We refer to the ratio as the average slope ratio.

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4. Paleocurrents were measured previously at Kekeya. This shows that sediment provenance from the south. No such data exist at Sanju until now. We measured the orientation of 251 imbricated pebbles in the conglomerate beds along the Sanju section. We did it to obtain the paleo-flow orientation for provenance analysis. Further, we collected samples from eight fluvial sandstones interbedded with conglomerate layers at Sanju. We collected two medium-grained sandstones at Kekeya to complement our previous DZFT studies. About 50 zircon grains were randomly selected from most samples for U–Pb and fission-track double dating by Laser-Ablation ICP Mass Spectrometry (LA-ICP-MS). We made it by using the analytical parameters and procedures described in Appendix Table S1. For U–Pb ages, we only accept those data with ≤20% discordance. Analyses are reported as $^{206}Pb/^{238}U$ ages for zircon ages ≤1.0 Ga and $^{207}Pb/^{206}Pb$ ages for grains > 1.0 Ga. DZFT age peaks with 95% confidence interval were determined by Radial Plotter. The analytical details are presented in supplements Figs. S1, S2, and S3, and Table S1.

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Chapter 5
Results

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5.1 An Overview of the Results Section

In the Results section, researchers generally report their primary findings and make some brief comments on their findings. You may also find that in some journals, the Discussion section is merged into the Results section.

In the Results section, there are usually three common elements, namely, location element, highlighting element, and commenting element. In other words, writers are advised to let their readers know in which table or figure, what important findings can be found. Also, writers need to briefly comment on their significant findings (Cargill & Connor, 2009). Two typical case studies are as follows.

Case Study One

Excerpt (Bakker et al., 2016)	**Comments**
3.2 Finite Element Model Results with and Without Temperature Dependency ① The calculated temperature field and resulting distributions of elastic parameters are presented in Fig. 5. ② Concentrating only on the magma storage zone, our numerical results suggest that the removal of an initially 200-m-thick ice cap reduces the pressure in the magma chamber at 5 km depth (below sea level, b.s.l.) by ~0.5 bar (see Fig. 6). ③ Pressure changes do not vary significantly between models with and without imposed layering. ④ However, this pressure change strongly depends on the depth of the magma chamber. ⑤ The pressure in a magma chamber at 1 km depth b.s.l. drops by 1.4 bar compared to 0.4 bar in a magma chamber at 10 km depth b.s.l. ⑥ The pressure decrease in the magma chamber due to ice-cap unloading varies linearly with the thickness of the ice cap. ⑦ In addition, the size of the magma chamber influences the pressure decrease slightly; for smaller magma chambers (~0.5 km radius) pressure changes are in the order of 1.0 bar compared to ~0.5 bar for large magma chamber (~5 km radius).	**Location element:** Sentence ① **Highlighting element:** Sentences ②–⑦

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Case Study Two

Excerpt (Zou et al., 2021)	**Comments**
4.1 Important Geochemical Features for Predicting the Crustal Thickness ① The XGBoost model is interpretable and allows to determine the importance of features during the calculation, that is, the importance of each element for predicting crustal thickness in this study. ② The importance of a feature is calculated by the average reduction of impurity, which refers to the average reduction of impurities in data when a feature is dropped. ③ As shown in Fig. 3a, the contents of all the major elements and Ba, Sr, Rb, U, and Y are the most important features used by the XGBoost model to calculate the relationship between crustal thickness and whole-rock geochemical composition. ④ In Fig. 3b, for the basalts, contents of SiO_2, Al_2O_3, TiO_2, CaO, MgO, Zr, Ba, Nb, Na_2O, K_2O, and Y are highly controlled by the crustal thickness. ⑤ Clearly, the important geochemical features of intermediate rocks and basalt are included in almost all the major elements and some trace elements.	**Advantages of the model (optional):** Sentence ① **Reviewing the method used (optional):** Sentence ② **Location element & highlighting element:** Sentences ③④ **Commenting element:** Sentence ⑤

5.2 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns used in different elements of the Results section are as follows.

A. Describing location element

* *A brief description of...**is presented in Fig. 3**.*
* *The results of...**are listed in Table 2**.*
* *...**is described in Table 4** to perform the model training process, and...**is shown in Fig. 15**.*
* *In this section, short surface temperature datasets, recorded from May to October 2019 (**see Fig. 4**), were used to study...*
* *Spatial, monthly, and annual compositions of major ions **are illustrated in Figs. 2–4, and Table S1, respectively**, and **compared with** other world inland waters **in Table S2**.*
* *As shown in the total alkalic vs. SiO_2 diagram (**Fig. 4a**), these rocks are mainly plotted within the fields of quartz-monzonite and syenite.*

B. Introducing symbols/shapes in a figure

* ***Other abbreviations are B****—Batavia microcontinent,* ***G****—Gulden Draak microcontinent,* ***RT****—Rajmahal Traps...*
* ***Inset arrows show*** *vectors of relative motion between India and Australia.*
* ***Red star in (B) indicates*** *best-fit case with uniform erosion for areas below caprock.*
* ***Light blue bar shows*** *the timing of our interpreted microcontinent calving event.*
* ***Solid line indicates*** *linear regression through Young Womans Creek (YWC) data.*
* ***The numbers at the symbols represent*** *the Moho depths computed by receiver function studies.*
* ***Colored dashed lines in panel C link*** *samples from different size fractions.*
* ***Circles show*** *exact sample sites;* ***colored polygons show*** *interpreted volcanic regions...*
* ***Thick lines are*** *regression lines plotted through all individuals of a species.*
* ***These thinner lines are plotted as*** *either* ***solid*** *(statistically significant regressions, $p < 0.05$),* ***densely dashed*** *($p < 0.1$), or* ***sparsely dashed*** *(non-significant, $p > 0.1$).*

C. Reporting important findings

* *Fig. 10 shows the loss function in the training process of the model with* ***a tendency to decrease with*** *increasing epochs.*
* *The slope of the transmitted waveform abruptly* ***decreased*** *after the first turning point and suddenly* ***increased*** *again after the second turning point.*
* *In the tributary rivers, the concentrations of Mg^{2+} and SO_4^{2-}* ***decreased gradually from*** *the dry season* ***to*** *the wet season.*
* *The whole YRB exhibited* ***a significant decreasing trend*** *of 0.09°C/decade, indicating greater warming in TN than in TX (Table 4).*
* *The major anions* ***decreased in the following order*** *(unit in mg/L): HCO_3^- (32.3 ± 7.5) > Cl^- (143.5 ± 24.5) > SO_4^{2-} (7.8 ± 4.9) > NO_3^- (6.1 ± 3.3) > Si (2.9 ± 1.3).*
* *The V concentration of the enclaves* ***decreases sharply*** *from 127 ppm to 68.7 ppm with increasing SiO_2 from 56.09% to 61.37%.*
* *This phenomenon results from* ***a reduction in*** *fracture stiffness...*
* *In the early stage of model training, the accuracy* ***rises slowly****.*
* *For the filling thickness of 2.48 mm, the transmission coefficient always* ***increases with*** *the wave amplitude in Fig. 10.*
* ***With the increase of*** *the amplitudes of the incident waves, the transmission coefficient decreases first and then increases.*
* *The filled fracture experienced strain-hardening deformation* ***with its*** *stiffness*

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*monotonously **increasing in** the loading process...*

* *Excessive training will **improve the accuracy of** the train set, while it cannot provide an effective improvement in actual use in the future.*
* *At this time, the accuracy of the test set can **reach** 90.89% for the first-level classification of sedimentary, metamorphic, and igneous rocks.*
* *After **achieving a peak**, it then decreased and increased again when the PPV was larger than 5.9 m/s.*

D. Describing the relationship between two variables

* *Kumasi depicts a radial pattern from the urban core and **is associated with** a branching structure at the local scale.*
* *The radial pattern **is partly linked with** its central location in the country from which people can access other major cities in the north, south, east, and west directions.*
* *ΔTr **was positively correlated with** root water loss (Fig. 8), as expected.*
* ***There is no obvious correlation** that has been found between LC and the geological unit.*
* *Overall, root respiration **was significantly relative with** six of the 12 traits studied (Table 2)...*
* *We found **no apparent association between** bacteria biomass **and** bacterivores biomass.*
* *The density of Oribatidas **was not significantly related to** variables...*
* *Landslides events in layered slopes **closely depend on** the angle β between dipping direction of the slope and the dipping direction of the bedding planes.*
* *We defined a dimensionless variable χ, which **was equal to** the ratio of the fill thickness to the wavelength...*
* *It can be clearly seen that the results predicted by the static parameters of the MB-B model **matched the experimental results well**.*
* ***There is a strong linear dependency of** the horizontal runout on the width of the rock avalanche.*
* *In particular, water loss **was linearly related to** root area/volume ratio in all treatments except that recorded after 24 h drying...*
* *After 24 h drying, root water content **highlighted a linear and positive relation with** initial diameter (Fig. 3k).*

E. Comparing and contrasting

* *The intersection density varies from 58 per km^2 for Accra to 4 per km^2 for Ho, **whereas** the street density is from 10.8 km/km^2 for Accra to 1.2 km/km^2 for Ho.*

* *Our MB-B model can characterize the above complex process well,* ***while*** *the B-B model loses the capability to do so.*
* *The result predicted by the MB-B model agreed very well with the experimental result.* ***Nevertheless****, the result predicted by the B-B model initially increased abruptly as the amplitude of the incident wave increased* ***but then*** *increased gently when the PPV of the incident wave was larger than 4.5 m/s.*
* *It cannot capture the effect of particle crushing on fracture stiffness.* ***However****, our MB-B model introduced piecewise hyperbolic functions that overcome shortcomings of the B-B model.*
* ***In contrast to*** *the above two types of thermal events, hydrothermal convection often occurs along deep fault zones.*
* ***On the contrary****, roots larger than 2 mm showed an evident water loss only after 5 h drying.*

F. Describing data ranges

* *The efficiency of the road pattern indicated by the average circuity for the districts covering the 10 regional capitals indicates similar values* ***ranging from*** *1.046 for Accra* ***to*** *1.104 for Sekondi-Takoradi, based on Table 2.*
* *The width of the Jiuqu Yihe River paleo-channel in the LGM* ***ranged from*** *234m* ***to*** *1,374m and the depth* ***ranged from*** *1.3m* ***to*** *10.1m.*
* *Another observation is that the dip direction of a triangle was found to* ***vary within the range of*** *at least 180° (Fig. 5, Fig. 6).*

G. Showing comparative degree

* *Therefore, the accuracy of batches fluctuates* ***more drastically than*** *that of epochs.*
* *The dispersion of northern temperate mammal body masses* ***is higher than*** *null communities and shows correlated changes with climate, consistent with resource competition and environmental filtering.*
* *Moreover, the worst performances for both data imputation methods correspond to October with a ΔHKNN and ΔHNN* ***less than*** *24% and 44% respectively.*
* *This indicates that the uniaxial compression test can be well reproduced no matter ks* ***is smaller than****...*
* *Fig. 10 also shows that the consistence between the numerical and the experimental stress-strain curves* ***is much better than*** *that in Fig. 4.*
* *Indeed, after 24 h, the average strength of thin roots (40.0 ± 5.3 MPa)* ***was twice as large as*** *that in thicker roots (> 2 mm; 20.5 ± 2.6 MPa).*

* *Comparing both data imputation methods, KNN* ***showed a better performance*** *regardless of the number of missing data.*
* *For instance, drier roots* ***showed a much stiffer response and were more brittle****, compared with hydrated root samples (Fig. 1).*

5.3 Verb Tenses in the Results Section

A. Describing location element: Simple present tense

* *Fig. 7* ***represents*** *the contribution of purely SV particles, that is, ensembles of particles that are all in an SV remanent state.*
* *The results of the bathymetry-seismic reflection correlation* ***are synthesized*** *in Fig. 3 and examples of the most characteristic bathymetric data showing morphologic expressions at the sea-bed related to fault activity* ***are shown*** *along seismic lines of the Figs. 5 and 6.*

B. Introducing symbols/shapes in a figure: Simple present tense

* *Dashed contour lines* ***denote*** *negative ρ values.*
* *The black dashed line* ***represents*** *the east boundary of the partially subducted oceanic lithosphere beneath the South Island.*

C. Reporting the findings: Simple past tense / Simple present tense / Simple future tense

* *Particles with hard axes* ***aligned*** *closely with the applied field nucleate hard-aligned vortices at high applied field values (Fig. 8).*
* *Most of the olivine grains* ***display*** *no detectable OH peaks except for some BUR samples, which have characteristic OH absorption bands at 3597, 3572, and 3525* cm^{-1} *(Fig. 2c).*
* *When the accuracy of the model is high, the probability of the local optimum in the solution space* ***will increase*** *significantly, so the speed of accuracy improvement* ***will*** *also* ***slow down*** *and* ***approach*** *convergence.*

D. Comparing and contrasting: Simple present tense / Simple past tense / Modal auxiliaries

* *The coercivities obtained here* ***are considerably lower than*** *the commonly accepted value for natural greigites of ~60 mT.*
* *For the vertical fault model, the dip angle of the triangles cutting the vertical fault*

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> ***were significantly smaller than*** *that of the model fault dip (Fig. 3).*
> * *However, mean field approximations can overestimate the Curie temperature, so the value of the exchange integral JAB* ***could be larger than*** *this and be consistent with experimental bounds.*

5.4 Nominalization

Nominalization is an essential feature of academic writing. It can be formed by adding affixes to verbs or adjectives. For example, by adding affixes, the verb "reduce" and the adjective "available" can be converted into the nouns "reduction" and "availability" respectively.

First, let us do a warm-up activity. Please convert the following verbs or adjectives into nouns.

assess		available	
coherent		compatible	
coordinate		dominate	
emerge		evolve	
hypothesize		intensify	
infect		justify	
modify		occupy	
occur		regulate	
refine		substitute	
subsidize		transit	

Now, look at the usages of nominalization in academic writing. For example:

> * *Biologically-mediated calcification is proposed to be linked to* ***the saturation state of seawater****...*
> * *While there is some debate regarding* ***the composition of the ECF*** *and the mechanisms that regulates it over time...*
> * ***Increases in*** *Ω_{ECF} and pH_{ECF} shift the acid-base equilibrium in the ECF to adjust* ***the speciation of dissolved inorganic carbon (DIC)*** *to favor CO_3^{2-} over bicarbonate (HCO_3^-) ions.*

By using nominalization, your writing will be more abstract and more formal. Also, nominalization is a useful academic writing strategy because it conveys an objective,

impersonal tone. Lastly, it can also make your writing more concise by packing much information into a few words.

The following example can help you to better understand the advantages of using nominalizations appropriately.

- *The plume model for microcontinent formation, where microcontinent calving is driven by plume-induced thermal weakening of continental crust, has the following characteristics.* ***Firstly, it is near to a mantle plume. Secondly, it rifts from a < 25 Myr old passive continental margin. Thirdly, it is typically minor volcanism post-microcontinent formation. Lastly, it has a prolonged period of asymmetric seafloor spreading following microcontinent formation.***

The bold-faced part in the above example is not well-written, and it leaves readers with an impression that the writer is not skilled in writing. By using nominalizations, the example can be rewritten and become more formal, academic, and succinct. For example:

- *The plume model for microcontinent formation, where microcontinent calving is driven by plume-induced thermal weakening of continental crust, is characterized by:* ***(1) proximity to a mantle plume; (2) rifting from a < 25 Myr old passive continental margin; (3) typically minor volcanism post-microcontinent formation; and (4) a prolonged period of asymmetric seafloor spreading following microcontinent formation.*** *(Whittaker et al., 2016)*

But remember, you should be cautions when using nominalization as its overuse may make your writing obscure.

5.5 Usages of "with" in Academic Writing

The preposition "with" is widely used in academic writing. Using the preposition "with" appropriately can make your writing more cohesive, and the usages of it are as follows.

A . "with" + present participles

* *It is an M dimensional measurement space* ***with M values corresponding to*** *remains poorly defined in the literature.*

* *The Pacific-Antarctic samples are well suited to constrain how the Mo stable isotopic composition of magmas changes* ***with the dominant magma differentiation processes occurring at mid-ocean ridges****.*

B . "with" + past participles

* *We take a visual-fitting approach to conform Indian plate motions to observed fracture zone trends in the Enderby Basin, Wharton Basin, and Perth Abyssal Plain,* ***with particular attention paid to*** *matching the curved Wharton Basin and Enderby Basin fracture zones.*
* *No direct observations of effective pressure at the glacier sole are available, but lake level observations were made near the proglacial lake outlet (Fig. 1) using a Hobo pressure transducer* ***with data logged at 15-min intervals until April 16, 2013****.*

C . Noun + "with"

* *H_2O contents in the coexisting cpx and opx are positively correlated and define a linear array of 2.2* ***with*** *an excellent fit.*
* *The streamer had 48 seismic* ***traces with*** *inter-traces of 6.25 m and 4 hydrophones* ***SFH with*** *a spacing of 0.78 m per trace.*

D . "with"-phrases

* *The peridotite xenoliths derived from the Oligocene–Miocene lithospheric mantle across Zealandia,* ***coupled with*** *the very low elevation of the continent at this time, suggest little lateral variation in mantle equilibrium temperature.*
* *Though MT measurements* ***are consistent with*** *the presence of partial melt at mid-ocean ridges, ...*
* *The degree of interconnectivity can be assessed by the dihedral angle* ***associated with*** *its constituent solid-liquid phase boundaries.*
* *In this configuration, the melt conducts electricity* ***in parallel with*** *olivine...*
* *Melt pools* ***exist with*** *increasing frequency as melt fraction increases, ...*
* *We argue that this interpretation* ***is inconsistent with*** *microstructural observations of texturally equilibrated rocks.*
* *For example, hysteresis* ***is often observed with*** *identical effective pressures resulting in markedly different velocities.*
* *Using this setup* ***in combination with*** *Ni H-cones yielded a sensitivity of ~155 V/ppm.*
* *Such chemical and isotopic characteristics can, however, not* ***be reconciled with*** *mineral fractionation.*
* *It will be necessary to analyze samples..., ideally* ***in conjunction with*** *the analysis of mantle peridotites.*

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Exercises

I. Choose the most appropriate logical connector to fill in each of the following blanks.

1. The shape of the diurnal variation is similar when the driving forces for the variation are regolith adsorption and desorption, and their coupling with the boundary layer. The adsorbed water is enriched in HDO compared to the water vapor. _____, when there is a flux from the regolith to the atmosphere, we see an increase of the near-surface D/H (i.e., the midday rise), and when there is a flux from the atmosphere to the regolith, we see a decrease of the near-surface D/H (i.e., the morning and evening drop).

A. As a result B. By contrast C. Because D. Particularly

2. The shape becomes different when condensation occurs, mainly in that the rise of D/H is delayed (see cyan line in the right panel of Fig. 5). This is _____ when the temperature of the regolith rises, water in the regolith experiences a phase change from the condensed phase to the adsorbed phase.

A. Ø B. if C. because D. so

3. The average ratio of slopes measured along topographic profiles varied from ~1 to ~2.6 (Fig. 6), _____ the average ratio of north- and south-facing mean slopes varied between ~1 and ~1.6.

A. so B. while C. because D. if

4. At high temperatures (⩾ 1,200℃) and low stresses (⩽ 200 MPa), strain rate is a power-law function of stress, _____ at lower temperatures and higher stresses, strain rate is an exponential function of stress.

A. whereas B. although C. because D. therefore

5. Directly above and below the magma chamber, the two models differ as much as 2 bar (Fig. 8C). _____, in temperature-independent models the pressure increases by 1 bar directly above the magma chamber, _____ in temperature-dependent models there is a pressure decrease of about 0.5 bar.

A. For example; while B. In addition; but
C. Furthermore; as D. Therefore; whereas

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6. In addition, the fault did not experience additional shear stresses, as suggested by the lack of calcite twinning. _____, we assume this temperature is representative of the formation of the third stage of vein opening.

A. In particular B. Therefore C. Furthermore D. In addition

II. Integrate the following simple sentences in each segment into one that is more formal and logical.

1. Most of the Earth's surface is characterized by increases in this value. This indicates a near global increase in the intensity of the most extreme precipitation events.

_____

_____

2. This age is very close to a minimum seafloor age estimate of 101 ± 1 Ma from DSDP Site 256. The site is located to the north of the Batavia Knoll. But it is crucially immediately on the western side of the pseudofault. The pseudofault extends northward from the Batavia Knoll.

_____

_____

3. As a result, plates share an interlocking ridge-transform plate boundary. Plates also show a degree of coupling. The strength of the coupling will increase with increasing transform length. This can be achieved by requiring the breaking of older crust under shear.

_____

_____

4. The primary base station was also inoperable during October 2014. This leads to an increased baseline length and degraded solutions.

_____

_____

5. Ash B3 (93.67 ± 0.12 Ma; red star in Fig. 2a) is selected as the nominal anchor for the Iona astrochronology (RMSE = 0.121; Table 1). The same criteria noted above is used for it.

_____

_____

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6. The youngest age model for the Iona core comes from the B6 ash (−0.43 Myr, Table 1). The oldest age model for the Iona core comes from the B7 ash (+0.25 Myr, Table 1).

7. Each of the ashes (with the exception of B3) is associated with three numbers. The three numbers have the same meaning as in the Libsack core, although the 2σ total uncertainty does not include stratigraphic correlation uncertainty. This is because the dated ash beds come directly from the Iona core.

8. The magnitude of carbon isotope shifts differs from the standard curve of the English Chalk. The carbon isotope shifts were observed in the Western Interior Basin (WIB) sometimes. The standard curve of the English Chalk most likely reflects local effects and different substrates (e.g., organic matter vs. carbonate).

9. This result is consistent with field observations that document rapid headward growth of low-order channels. The growth was instigated by the exposure of readily disaggregated bedrock beneath a more cohesive soil mantle.

10. Leaves from Phase 1 have relatively high SD and SI (SD = 189 ± 43 mm^{-2}, SI = 10.2 ± 1.4). Leaves from Phase 2 have relatively low SD and SI (SD = 140 ± 70 mm^{-2}, SI = 5.1 ± 0.9). Leaves from Phase 3 show a return to the high SD and SI values of Phase 1 (SD = 243 ± 67 mm^{-2}, SI = 9.9 ± 2.3) (Appendix A, Table A6).

11. At Site 1165, the $^{40}Ar/^{39}Ar$ thermochronological ages of minerals from pebble-sized IRD fall into two main age populations. The first one is from 487 to 571 Ma (average age 530

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Ma). The other one is from 1075 to 1191 Ma (average age 1125 Ma) (Fig. 5).

_____

_____

12. We infer that the 450–600 Ma IRD comes from the local Prydz Bay sector and the 1075–1200 Ma IRD comes from Wilkes Land east of the Denman Glacier. This area includes the Aurora Subglacial Basin. The Basin is over 1,000 km distant from Site 1165. Our inference is based on these studies.

_____

_____

III. Rewrite the italicized parts in the following sentences by using nominalization appropriately.

1. Here, we focus on examining *how the relief of the westernmost Tibetan Plateau evolved* by quantifying the exhumation history of this region in the Rutog and Shiquanhe area.

_____

_____

2. The presence of high relief in western Tibet raises the question *whether an older, inherited relief can affect the present topography*.

_____

_____

3. However, *researchers analyzed detrital zircons contained in the red beds further north in the Domar area and their analysis indirectly suggests* a Jurassic deposition age.

_____

_____

4. *We further study the work by Kramers et al. (2013)* on a very unusual diamond-rich rock fragment found in the area of southwest Egypt in the southwestern side of the Libyan Desert Glass strewn field.

_____

_____

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5. Nevertheless, in each scenario, *we should know the movement of mid-depth water between 2,000 and 3,000 m, likely Pacific Deep Water (PDW)*.

6. In addition to the Xe–Q composition, *we observe radiogenic ^{129}Xe (from the decay of short-lived radioactive ^{129}I) is excessive*.

7. Our study does not confirm *there are exotic noble gases* (e.g., G component) that led Kramers et al. (2013) to propose that Hypatia is a remnant of a comet nucleus that impacted the Earth.

8. *The fact that this area does not have graphite-bearing target rock* further supports the conclusions that Hypatia must be extraterrestrial.

9. *Comparing any related predictions* with the seismic structure of the deep mantle *is necessary, as it will improve* our understanding of the Earth's long-term evolution.

10. *We use the digital rock physics approach to determine* the bulk electrical conductivity of partially molten rocks, *which can have* fine control on the physics and material properties of the system.

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11. In this work we extend the study by Kramers et al. (2013). *We conduct the isotopic analyses of all five noble gases in several Mg-sized fragments of Hypatia in two different laboratories (CRPG Nancy, France and ETH Zürich, Switzerland). We conduct a nitrogen isotope investigation performed both at CRPG (Nancy) and IPG-Paris.*

_____

_____

12. *They attempted to determine the oxygen isotopic composition in Hypatia by the Nancy Cameca 1280 ion probe, but they failed because the size of oxygen-bearing phases reduced and because there were contaminants and important amounts of water.*

_____

_____

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Chapter 6
Discussions

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6.1 An Overview of the Discussion Section

In research papers, the Discussion section usually follows the Results section. In this section, writers can review their important findings, discuss reasons contributing to the findings, make comparisons between their present findings and previous ones, introduce unexpected results, and offer suggestions for future studies (Cargill & Connor, 2009). Three typical case studies are as follows.

Case Study One

Excerpt (Ma et al., 2019)	**Comments**
5.3 Comparison with Other Geological Records That Express Secular Resonances ① Fig. 6 summarizes the geological records that report the cycles of s4–s3 and g4–g3 from the present to 270 Ma. ② Note that s4–s3 is less often reported than g4–g3. ③ During the interval from 50–100 Ma, when a possible transition of secular resonances took place according to the theoretical solutions, previous studies suggest that the 2.4-Myr g4–g3 cycle exists in most of the interval (50–80 Ma. ④ Our new study, covering 82–97 Ma, demonstrates the 2.4-Myr cycle and its temporary switch from 2.4 Myr to 1.2 Myr in g4–g3, and also reveals a 1.2-Myr cycle in s4–s3 that occurs throughout much of the study interval.	**Summarizing the findings of the present study:** Sentence ① **Making a comparison between previous studies and present studies:** Sentences ②–④

Case Study Two

Excerpt (Carmichael et al., 2018)	**Comments**
4.3 How Well Does HadCM3L Represent Extremes? ① In Fig. 8, two observational metrics for extreme precipitation-the maximum annual 1 day precipitation rate (Rx1) and the contribution to MAP of days above the 99th percentile rate (R99p) are compared with the preindustrial 1 × CO_2 HadCM3L simulation.	**Summarizing the findings of the present study and explaining the implications of the findings:** Sentences ①–⑤

(Continued)

Excerpt (Carmichael et al., 2018)	**Comments**
② In both cases, the spatial variation in the indices suggest that the model performs relatively well at simulating relative differences across the Earth's surface. ③ However, the model does a much poorer job in the simulation of the absolute precipitation rates associated with the extreme "tail" of the distribution. ④ Maximum model-simulated values are typically around a third of the observational values. ⑤ Therefore, percentage change plots or qualitative interpretations (e.g., Figs. 2, 3) may be more robust than absolute rates (e.g., Fig. 4).	
⑥ Two main groups of reasons may explain why the model underestimates the magnitude of absolute extreme precipitation rates: (1) grid resolution and (2) model parameterizations. ⑦ In the case of the former, different methods for comparing pointwise (station, gauge) estimates of extreme precipitation to those resolved on a coarse model grid remain largely untested. ⑧ By their very nature, extreme events are very localized and discontinuous. ⑨ Although the HadEx2 dataset is based on ~11,300 precipitation gauge data which are interpolated to a regular grid, whether these data are truly comparable to model data is highly uncertain; Chen & Knutson (2008) found that differences of up to 30% in daily averaged extreme precipitation rates occurred over the United States, according to interpolation scheme and whether GCM precipitation was considered to represent a point estimate or areal average rate. ⑩ Furthermore, dynamical features associated with extremes (e.g., storm tracks) are in general better represented in high resolution models than in low resolution models.	**Explaining why the model undervalues the magnitude of absolute extreme precipitation rates:** Sentences ⑥–⑩

Case Study Three

Excerpt (Bakker et al., 2016)	**Comments**
4.2 Broader Implications of Temperature-dependent Elastic Properties in Time-independent Models ① The effect at depth caused by a reduction of the vertical load due to ice-sheet removal has not been quantified before using temperature-	**The gap in previous studies and the necessity to address the gap:** Sentences ①②

(Continued)

Excerpt (Bakker et al., 2016)	**Comments**
dependent elastic parameters. ② The large difference between temperature-dependent and temperature-independent models shows that assuming temperature-independent elastic properties for the host rock does not accurately represent the physical state of shallow magmatic systems, and should be reconsidered.	
③ In low-temperature domains (shallow and/or at significant distance to the magma chamber), the pressure changes in the basement and in the edifice observed in this study (i.e., temperature-dependent) are comparable with previous findings (temperature-independent. ④ We ascribe this to the relatively low temperatures in the brittle domain away from the magmatic reservoir, so that constant elastic properties are an adequate assumption.	**Reporting one of the study findings and discussing the reason contributing to it:** Sentences ③④
⑤ However, significant differences occur in close proximity to the magma chamber and at depth and close to the brittle–ductile transition. ⑥ There, temperature-independent elastic properties are a poor assumption when modeling volcanic environments and regions are close to the solidus in a time-independent manner.	**Reporting unexpected findings:** Sentences ⑤⑥
⑦ In most previous studies, magma chambers are represented as a circle (sphere) or ellipse (ellipsoid), yet in nature the magma chamber is likely more complex. ⑧ In our models, we also prescribe the magma chamber as an ellipse at depth, but it is only associated with a temperature boundary in the temperature-dependent models.	**Making a comparison between previous studies and present studies:** Sentences ⑦⑧

6.2 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns used in different elements of the Discussion section are as follows.

A. Introducing similarities and differences

* *Our data **are thus in good agreement with** this previous interpretation.*
* *This estimate **is in accordance with** inferred Miocene paleoelevation of 1.0–2.4 km for the basin and surrounding areas determined from paleobotanical data.*
* *Tensile strength of Ulex europaeus **was also close to** that reported for similar species belonging to the Fabaceae family such as Spartium Junceum.*

* *This **is supported by** S-isotope compositions for the shergottites considered in this study, which do not show any anomalous D33S.*
* *Our data from the Xiaolongtan Basin, **however, are inconsistent with** previous geomorphic studies by…*
* *However, our inferred timing of crustal flow (13 Ma) in SE Yunnan **is not compatible with**...*
* ***In contrast to** the above ground fungal communities, we have limited understanding of...*

B. Explaining causality

* *Uplift of SE Yunnan **is probably the consequence of** lower crustal flow beneath the plateau margin since at least the Early Miocene.*
* *Assuming crustal flow **was singularly responsible for** the elevation of the region, constant near-modern elevations of NW Yunnan.*
* ***It is therefore possible that** the presence of a weak, ..., initiated the uplift of the northeastern Qiangtang Block in the Middle Eocene.*
* *This base level fall **may be triggered by** the activity of the Xianshuihe fault since ~13 Ma and the reactivation of the Longmen Shan fault since ~12–8 Ma.*
* *In this region, the ionization **is due to** the photoionization process of nitric oxide (NO) by Hydrogen Lyman series-alpha radiation (wavelength 121.5 nanometer) during daytime.*
* *Wu et al. (2011) **attribute** their elevated Fe at shallower depths **to** a dispersal of Fe from the Loihi seamount located approximately 2,000 km to the north.*
* *This dispersal **might be the cause of** the higher concentrations of Fe over a wider range of depths.*
* *We **ascribe** this negative effect **to** the higher probability for raindrops to split up at branches.*
* *Given these arguments on melt focusing into the arc crust, **it is unlikely that** source-related variations in melt chemistry (hypothesis ii) can be preserved.*
* *Influenced by the tectonic thermal events that **were caused by** the enhancement of tectonic compression and magmatic activity in the deep lithosphere...*
* *Contamination of mantle-derived magma with such rocks would **have resulted in** lower $\delta^{18}O$ and lower εHf(t) in the contaminated magma.*
* *Given the structural and morphological observations outlined above, we **propose that** surface uplift of SE Yunnan **may be the result of** lower crustal flow in this area since at least ~13 Ma.*

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C. Showing implications of the study findings

* ***These observations together suggest that*** *deposition of Eocene strata and their near-modern elevation in NW Yunnan at ~40 Ma were not related to…*
* ***Our findings propose that*** *independent self-sustaining human-to-human spread is already present in multiple major Chinese cities.*
* ***This implies that*** *the Tibetan hinterland may have exhibited a thickened crust by ~60–50 Ma.*
* ***This discrepancy infers that*** *this region has a 150 K higher temperature than the normal geotherm because of the presence of a hot plume beneath Hawaii.*
* *They* ***may be helpful to better understand*** *the mechanism of the dynamic triggering of earthquakes.*
* *In addition, this transect* ***fills a gap in*** *the sediment record likely due to poor foraminiferal preservation (Fig. 3).*
* ***It is therefore key that*** *depth habitat, seasonality, and ecology are regionally resolved for this species.*
* *Therefore,* ***the present study may provide insights into the effects of*** *soil moisture on...*
* *More broadly,* ***our experimental results indicate that*** *mantle potential temperatures along all ocean spreading centers are hotter than existing estimates.*
* ***This study proves that*** *the electrical conductivity of olivine aggregate shows a strong water-content dependence.*
* ***Our experimental measurements demonstrate that*** *the development of an interconnected network...*
* *In this study, both two and three-dimensional liquid distributions* ***reveal that*** *silicate melt is dominated by tubular melt channels.*
* *With increasing temperature, the increasing frequency of N = 3 and 4 and the decreasing silicate melt-mineral dihedral angle* ***are both indicative of*** *the increasing melt connectivity and permeability.*
* ***Field observations indicate that*** *the resulting contrast in downslope soil transport efficiency is a consequence of coarse sediment derived from the caprock.*

D. Reporting limitations of the present study

* ***However, these efforts have been limited by a lack of*** *ground shaking data for many of the events in the database.*
* ***One problem for*** *identifying the maximum fill of a channel* ***was lack of*** *preservation of the section and erosion by subsequent channeling.*
* *Nonetheless, our study* ***has several major limitations****.*
* *Although we see no evidence for such complications at Young Womans Creek,* ***it is***

not clear whether *such signals are expected or resolvable.*

* ***It should be noted that the experimental study ignored the effect of*** *the triaxial stress state.*
* ***Uncertainties, however, remain*** *about the deglaciation history of the Lake District. Earliest signs of deglaciation are dated to 24.8–28.0 kyr...**Nevertheless**, the timeframe of deglaciation for some of the lakes coincides with the decline of turbidite deposition along similar latitudes.*
* ***Finally, we should point out that we are uncertain if****..., **but such uncertainty can be addressed by analyzing**...*

E. Reporting unexpected findings

* ***However, the results of the present study is considerably lower than those*** *(1.6–2.9 GPa) determined at 23 GPa, 1,800 K...**One of the causes for the discrepancy may be*** *complexity of the deformation geometry of the RDA experiments, as discussed later.*
* ***Thus, it might be expected that*** *hillslope form reveals a similar contrast.* ***Instead, we find that*** *hillslopes where the caprock has been preserved on ridges are systematically steeper (mean slope = 20°–30°; Fig. 2B) than hillslopes...**We hypothesize that this contrast in hillslope erodibility emerges due to**...*

F. Offering suggestions for future studies

* ***In future studies, it would be of interest to test****...*
* ***Future works will mainly focus on****...*
* *The effects of interparticle magnetostatic...**are left for a future study**.*
* *This provides additional evidence to support the pattern of the La2004 model in this time interval, and* ***can be further investigated to evaluate****...*
* ***Further studies are therefore needed to investigate*** *the influence of these factors.*
* ***Therefore****, ...**should be used to more accurately determine*** *the homogenization temperatures of the coexisting inclusion assemblages.*
* ***Further experimental studies may provide****...*
* *But whether...**remains for further study**.*
* ***A further study*** *of these locations* ***may enable further unraveling of*** *how plumes and tectonic processes interact to break continents apart.*

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6.3 Verb Tenses in the Discussion Section

A. Introducing similarities and differences: Simple present tense

* *The ages proposed for these horizons **are consistent with** the interpretations of Franke et al. (2015).*
* *Di Muro et al. (2014) stress that the high-temperature range (> 1200℃) **is inconsistent with** the low average Fo content in olivine and the relatively evolved composition of aphyric lavas and glassy matrix melts.*

B. Explaining causality: Simple present tense / Modal auxiliaries

* *These different trends **are possibly controlled by** inherited fracture zones within the oceanic lithosphere…*
* *In this scenario, dykes that do not intercept previously emplaced magma pockets **may result in** failed eruptions.*

C. Showing implications of the present study: Simple present tense / Simple past tense / Modal auxiliaries

* *Our study **suggests** that the response time of a system is significantly influenced by temporal changes of connectivity.*
* *However, our results **have** qualitative applicability beyond greigites, for magnetic minerals with cubic MCA such as magnetite and iron, which are known to occur as non-interacting particles.*
* *However, turbidites do not mirror a sedimentary signal that shows increased Qs due to glacial melting, suggesting that sediment **was released into** partly ice-free piedmont lakes.*
* *These findings **provided** a novel mechanism of tripartite interactions between the devastating fungal pathogen, …*
* *Electrical conductivity profiles **can provide constraints on** the thermal and chemical states of the mantle.*

D. Reporting limitations / unexpected findings: Simple present tense / Simple past tense / Modal auxiliaries

* *Although the spatial patterns described here are specific to Eocene boundary*

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conditions, ***it is noteworthy that there are several similarities*** *between simulated PETM behavior and future predicted precipitation change.*

* ***Their study also demonstrates that*** *the occurrence of the rarest events can differ markedly from other measures of the distribution.*
* *In addition, the effect of loading rate on the compression behavior of the filled fracture* ***was not considered in the study of*** *the seismic response of the filled fracture.*
* *However, these nucleation and annihilation events* ***make a negligible contribution to*** *the FORC diagram because the change in magnetization of a particle nucleating/annihilating a hard-aligned vortex from/to a SD state* ***can be*** *as low as 1%.*

E. Offering suggestions for future studies: Simple present tense / Simple future tense / Modal auxiliaries

* ***More studies that contrast*** *the depths and magmatic processes inferred from monitoring networks with those obtained from crystals and host melt inclusions* ***should be able to*** *clarify the different architecture of volcanic systems.*
* *In the future, larger datasets* ***will enable****...*
* *However, the role of magma supply rates that we propose to shape the plumbing systems of these volcanoes* ***should be further investigated by*** *numerical or analogue experiments.*
* ***Further work on*** *the triple sulfur isotope composition of pyrite and H2S in modern SD-AOM-dominated environments* ***is needed*** *before we can apply these new findings to the sedimentary record.*
* ***Further comparisons*** *of metrics utilized for future climate studies with paleoclimate simulations* ***could assist in*** *identifying changes that are common to warm climate periods.*

6.4 Using Hedges

Hedges can be used to express tentativeness and possibility in communication (Hyland, 1996). It is necessary for writers to acquire how to use hedges appropriately, as they are an important feature of scientific writing. Different kinds of hedges and their examples in geoscience papers are shown below.

A. Modal auxiliaries

* *However, it indicates a more local effect* ***should*** *be considered.*
* *Rapid local ice loss during this period, which has been linked to reverse bed slopes in*

*the Amery Depression, **would** result in rapid land uplift and a fall in the height of the geoid, both of which would offset the far-field eustatic signal.*

* *However, there is no evidence for a significant regional event that **can** be correlated with the main exhumation event at about 10–9 Ma.*
* *Because the confidence envelopes overlap, the discrepancy between these four models **could** be due to insufficient resolution of our data.*
* *Second, western Tibet exhumation **may** be related to regional geodynamics.*
* *A similar process **might** have also led to the super-chondritic Si/Mg ratio in H chondrites, and even to that in all OC.*
* *Our models suggest that these processes **may not** be affected as dramatically as currently thought.*

B. Verbs

* *We **assume** that the first stage of mode 1 vein opening corresponds to the first increment of the Cotiella thrust fault activity.*
* *Furthermore, the Shiquanhe thrust **seems to** have a limited lateral extent (≤ 100 km) and its throw is about 7 km.*
* *The samples **appear to** record different rates of rapid cooling...*

C. Adjectives

* *Another **possible** explanation of the ~11–9 Ma event is the reorganization of the river network.*
* *In summary, the most **likely** scenario is that during a first stage, the Bangong valley was connected to the sea and deep valleys formed (Fig. 8A).*

D. Adverbs

* *Our reconstruction is **basically** in line with other estimates of continental temperatures.*
* *Moreover, the continental temperature patterns inferred from palaeobotanical data **largely** agree with results obtained from coeval marine archives.*
* *This area of the Natal valley is **possibly** associated with volcanic seamounts which might be related to the EARS extension tectonics.*
* *This difference is **partially** reflected in the small but statistically insignificant decrease in δ^{11}BSK and δ^{13}CSK values.*
* *Therefore, some of the faults were **probably** already active as soon as Miocene times which is consistent with the tectonic framework of the EARS.*
* *These faults are **mostly** straight (planar), whereas the main faults are **mainly** listric north of 20°S.*

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E. Other expressions

* *In this model,* ***it is assumed that*** *all fluids contribute evenly across all species.*
* ***It is reasonable to assume that*** *the Mg content of whiteschist is largely derived from metasomatic fluids due to the low Mg content of metagranite.*
* ***It may be that*** *some fluids contribute more of one species and less of another (i.e., the contribution of a fluid to the total gas budget is not equal to the equilibrium composition).*
* ***It would be possible****, given pyrrhotite compositions and modal abundances for each magma type,* ***to*** *calculate the loss of S to the solid phase.*
* ***It seems unlikely that*** *this is related to the unusually high salinity levels (> 40) seen in the Gulf of Aqaba (Eilat).*
* *As such* ***it is probable that*** *$CaCO_3$ analyzed from these tows experienced irradiation levels well above those required to compensate for the acidifying effects of respired CO_2.*

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Exercises

I. Read the following paragraph and find out the four errors contained in the underlined sentences. Each underlined sentence contains only one error. In each case, only one word is involved. You should proofread the sentences and correct the errors.

As briefly summarized in the introduction, **1.** the most recent seismic tomographic study has supported the model of a mantle flow induce by an edge effect in the mantle circulation at the lithospheric step between the thick East Antarctic Craton and thin Ross Sea crust based on structural and morphotectonic analyses, aeromagnetic data, and thermobarometry with mantle xenoliths. The edge flow model is also strongly consistent with the E–W fast directions from the seismic anisotropic results. Based on the edge flow model and our tomographic results, we tried to explain the origin of the low-velocity anomalies beneath Mt. Melbourne and the Priestley Fault. **2.** In order to infer the shapes of the anomalies from our inversion results, we should consider the spatial distributions of the resolution in addition to the underestimate amplitudes of the anomalies. A resolution test was performed with the same input model in Fig. 3 except for L2 coming vertically from a 120 km depth and no dipping to the eastern side of the model; the recovered model was very similar to our best target model, as shown in Fig. 4. The resolution tests revealed limited resolutions for the structure at the eastern edge of the model space and small structures over the entire model space, and we cannot rule out that the anomaly beneath Mt. Melbourne came from deeper depths on the eastern side. Our model showed no low-velocity anomalies below a depth of 120 km, and the low-velocity anomaly beneath the Priestley Fault rose to shallower depths up to ~30 km. **3.** One possible mechanism is that the edge-driven convection due to different thicknesses of the lithosphere cause mantle partial melting localized just beneath Mt. Melbourne or the eastern side at a depth of ~110 km. **4.** The partially melted material moves up to a depth of 40 km beneath Mt. Melbourne and stretches simultaneously to the southern tip of the Deep Freeze Range at depths of 40–80 km, which the Moho depths are relatively shallow. (Park et al., 2015)

II. Rewrite the italicized parts in the following sentences by using appropriate hedging expressions.

1. The continuity of the diatomite is episodically interrupted by turbidites rich in plant material, *which represent lakeside slumping*.

_____

_____

2. *We confirm* that rain-induced speed-up events *have a positive contribution to* displacement of between 2% and 13% per annum.

3. At first glance, *these results conflict with our interpretation* that fossil leaves in the Foulden Maar sediments record changes in Ca. However, the anthropogenic Ca rise of the recent past does not provide a good analogy to the Foulden Maar record, due to differences in timescale.

4. In any case, because our samples are located ≥ 140 km east of the proposed Angmong fault, and would be in the hanging wall, *this fault will never affect their exhumation history.*

5. *Our findings must have important implications* for future numerical studies and the understanding of various geological processes.

6. *Such pressure change must cause* deglaciation-triggered melt pumping from the mantle, which in turn *replenishes* the shallow magmatic reservoirs.

7. *This is related to* the rheological properties of these levels which can correspond to relatively plastic clays-rich horizons.

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8. *It must be the fact that* the 2017 discharge measurements do not reflect longer-term conditions.

9. The crystal-rich magma would have encountered a preexisting structural discontinuity, *definitely compensating* for the lack of buoyancy due to the high crystal cargo and triggering a lateral eruption.

10. During the LGM and the deglacial, *turbidity currents must be triggered by* various mechanisms (earthquakes, storms, hyperpycnal discharge, submarine slope failure), which we are unable to resolve.

11. Compared to Site A and H, Site SA features only a single offshore record *that is unrepresentative for* the entire region as absolute values of turbidite frequency and thickness strongly depend on site location.

12. This area of the Natal valley *is associated with* volcanic seamounts *which is related to* the EARS extension tectonics.

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III. There are four blanks in each paragraph below, only one of which needs to be filled in with a missing sentence. Fit the following three sentences into the best positions.

A. *This scenario is supported by two sets of independent evidence.*

1. _____ The absence of Middle Jurassic–Cretaceous marine sediments within the Songpan–Ganzi, Kunlun, and northern Tianshuihai terranes suggests that large parts of northwestern Tibet formed positive topography above sea level at this time (Fig. 8B). **2.** _____ First, thick Jurassic–Cretaceous terrestrial deposits in the piedmont of the eastern Pamir were apparently sourced from a Permian–Triassic arc-accretionary prism equivalent to the Songpan–Ganzi and Kunlun terranes. **3.** _____ Second, a growing body of evidence shows significant crustal shortening and thickening throughout western Tibet and the Pamir during the Middle–Late Mesozoic, probably related to the Lhasa–Qiangtang collision, or alternatively protracted underthrusting of the Lhasa terrane beneath the Qiangtang. **4.** _____ (Cao, 2015)

B. *Furthermore, the proposed geometry of the SSCF (whether north- or south-dipping) is unknown, and the age, surface expression, subsurface-dip, activity, and slip rate have not been thoroughly investigated.*

Previous geological mapping has included minor unnamed fault segments along a section of the proposed SSCF with no indication of the subsurface geometry or connectivity. **5.** _____ Additionally, a structure named the Pagenkopp fault has been mapped from well data at the eastern end of the proposed surface trace of the SSCF. **6.** _____ However, despite much previous mapping within the Santa Clara River Valley (Fig. 1), a continuous fault along the northern Santa Clara River Valley has not been characterized by any geological or geomorphic field evidence, or subsurface data. **7.** _____ Without accurate characterization of the SSCF, a rigorous assessment of seismic hazard in this densely populated and tectonically active area of southern California remains incomplete. **8.** _____ (Hughes et al., 2018)

C. *However, it apparently fails to explain Late Oligocene–Early Miocene brittle upper crustal deformation and rock uplift along the West Kunlun mountain front.*

Two end-member models have been proposed to account for Neogene tectonics and magmatism in the West Kunlun ranges. In a northward wedging model, the West Kunlun orogen behaves like a wedge overriding the Tarim plate via thrusting along the frontal faults, and the Tarim lithosphere plunges southward deeply beneath the mountains as imaged by teleseismic data. **9.** _____ This model explains the upper crustal deformation pattern and deep lithosphere architecture of northwestern Tibet, but fails to explain Neogene magmatism in

the Tianshuihai and Karakoram. **10.** _____ The second model of lower crustal flow predicts the existence of partially molten zones in the middle to lower crust beneath the Tibetan Plateau. **11.** _____ This model is used to explain the Late Miocene–Quaternary eruption of shoshonitic volcanic rocks in northwestern Tibet. **12.** _____ (Cao, 2015)

IV. In the following paragraphs, some sentences are missing. Fill in the blanks with the most suitable ones from the list A–E. There is one extra choice, which does not fit in any of the gaps.

5.4.3 Paleocene–Early Eocene

Paleocene–Early Eocene magmatism in the Tianshuihai terrane, synchronous with volcanism in the Qiangtang terrane of central Tibet, favors a model of partial melting of a thickened lower crust, consistent with geophysical observations of a high-conductivity, low-velocity zone in the lower to middle crust across western Tibet. Similar crustal thickening and melting are also inferred from dehydration melting along with prograde metamorphism of hydrous silicate glass inclusions in xenoliths from the deep crust of the southeastern Pamir. However, the magnitude of crustal deformation seems insufficient to induce considerable regional surface uplift, compared with that in the Middle–Late Mesozoic.

1. _____ Scattered Paleocene–Early Eocene peak ages with large lag-time intervals indicate that the south Kunlun probably remained in the partial annealing zone at this time, and was exhumed to the surface and eroded immediately to the foreland basin by the Late Oligocene–Miocene (see Section 5.4.4 for discussion). In principle, when a crustal column is exhumed, cooling ages of rocks young downward along the structural section, successively presenting unreset, partially reset, and younger fully reset ages. **2.** _____ Accordingly, static Early Cretaceous (P3), moving Paleocene–Early Eocene (P2), and moving Late Oligocene–Miocene (P1) peak ages, derived from a common source in the south Kunlun likely record an age pattern as predicted from a structurally exhumed section (Fig. 6).

3. _____ Third, a growing body of evidence shows that a more extensive phase of surface uplift and rock exhumation occurred later, during Neogene times. **4.** _____ The Main Pamir–Tam Karaul thrust system could have served as a first-order tectonic boundary defining the northwest limit of Late Mesozoic to Eocene Tibet, as tentatively outlined in previous studies. (Cao, 2015)

A. Second, the persistence of the Paratethys Sea in the southern Tarim basin implies that the north Kunlun terrane resided near sea level during the Early Eocene.

B. We thus infer that the Early Cenozoic crustal architecture of northwestern Tibet was largely inherited from pre-existing thickened crust, consistent with geological observations in the nearby Domar area in western Qiangtang.

C. First, we see little evidence for prominent rock exhumation in the study area during the Early Cenozoic, although thrusting-driven erosional exhumation, related to the India–Asia collision, probably occurred at ~50 Ma in the northeastern Pamir.

D. Any valid geodynamic mechanism should explain the first-order pattern of tectonism, magmatism, and exhumation that approximately commenced during Late Oligocene–Early Miocene times across western Tibet.

E. This age pattern can be imprinted on detrital samples collected in the foreland basin.

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Chapter 7
Conclusions and Acknowledgements

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7.1 An Overview of the Conclusions Section

In the Conclusions section, usually the last part of the main body of a research paper, writers need to summarize their study methods and findings, reiterate their study significance and contributions, and give suggestions for future research. Some readers may think that the Conclusions section is similar to the Abstract section, as the components of them are similar, and both should be short. However, there are differences between these two sections in summarization level and function. The summarization level of the Abstract section is higher than that of the Conclusions section. In addition, the Abstract section leaves readers with an impression of being general and intriguing, and serves as a function of attracting readers' attention, while the Conclusions section aims to summarize research findings and emphasize research significance. It is inevitable that the Abstract and Conclusion sections may contain the same information. In this case, writers should express the same information in the two sections by using different words and expressions.

In the following contrast between the Conclusions section and the Abstract section, both of them analyze the reason contributing to the first pulse of rapid exhumation, but the writers use different words and expressions to explain it.

- **Abstract:** *The first cooling event, at about 20 Ma,* ① ***was likely related to*** ② ***a major geodynamic event*** *such as slab breakoff that induced contemporaneous potassic and ultrapotassic magmatism. The second rapid cooling pulse from ~11 Ma to 9 Ma and subsequent negligible cooling was most likely controlled by a local factor such as Indus and Shyok river network reorganization* ③ ***caused by dextral motion of the Karakorum fault.*** *We discuss these interpretations and their limitations in this contribution… (Gourbet et al., 2016)*
- **Conclusions:** *We* ① ***attribute*** *the first pulse of rapid exhumation* ***to*** *the* ② ***geodynamic processes*** *responsible for the early Miocene potassic and ultrapotassic volcanic activity occurring in this region. The latest pulse is related to a river network reorganization* ③ ***due to the strike-slip motion of the Karakorum fault*** *that connected the Bangong valley to the paleo-Shyok river, leading to an externally drained system and a transient acceleration of the erosion… (Gourbet et al., 2016)*

After making a contrast between the two sections, two typical case studies are given below, through which the elements that should be included in the Conclusions section are shown.

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Case Study One

Excerpt (Gourbet et al., 2016)	**Comments**
① Apatite (U–Th–Sm)/He and $^{4}He/^{3}He$ thermochronometry in the Rutog area (Rutog batholith), between the Karakorum dextral strike-slip fault and the sinistral Longmu–Gozha Co strike-slip fault, indicate that western Tibet experienced slow exhumation rates since the Oligocene, except during two moderate exhumation pulses occurring from 19 Ma to 17 Ma and ~ 11–9 Ma, leading to a total incision of about 1,500 m. ② We attribute the first pulse of rapid exhumation to the geodynamic processes responsible for the early Miocene potassic and ultrapotassic volcanic activity occurring in this region. ③ The latest pulse is related to a river network reorganization due to the strike-slip motion of the Karakorum fault that connected the Bangong valley to the paleo-Shyok river, leading to an externally drained system and a transient acceleration of the erosion. ④ The exhumation has been negligible since 9 Ma, partly because western Tibet has been mostly internally drained since 4 Ma, due to the damming of the Bangong Lake. ⑤ Finally, this case study shows the importance of river network distribution on the control of exhumation. ⑥ Not only does the river distribution control whether or not geodynamic change can be imprinted on the thermochronological record, but it can also directly affect the exhumation rate.	**Reviewing primary findings:** Sentence ① **Discussing results briefly:** Sentences ②–④ **Emphasizing study significance:** Sentences ⑤⑥

Case Study Two

Excerpt (Pierce et al., 2017)	**Comments**
① The delivery of large pulses of ice-rafted material from 14.1 Ma to 13.8 Ma found at IODP Site U1356 and ODP Site 1165 provides a direct and proximal record of the mid-Miocene Climate Transition (MMCT) that links the discontinuous evidence for this major climate transition from terrestrial Antarctic sites to far-field oxygen isotope and sea level records. ② A series of MMCT IRD pulses at Site U1356 suggest that the transition includes stepped advance and retreat of the ice edge superimposed on the overall MMCT ice advance. ③ Provenance	**Reviewing primary findings:** Sentences ①③

(Continued)

Excerpt (Pierce et al., 2017)	**Comments**
results using $^{40}Ar/^{39}Ar$ of ice-rafted hornblende grains from the MMCT at Site U1356 show that: (1) The MMCT IRD is dominated by thermochronological ages of 1,400–1,550 Ma, the same age as the Mertz Shear Zone and the eastern side of the Adélie and Gawler Cratons, but in contrast to the majority of recent IRD from core tops along this sector of the coast, which has a make-up more similar to the coastal outcrops. ④ This implies that the edge of the MMCT ice sheet was eroding bedrock sources inland from the present-day ice edge. (2) ⑤ The IRD data are strong evidence for the presence of a 1,400–1,550 Ma thermochronological province running along the eastern edge of the Adélie Craton, which would geographically link the eastern Gawler Craton of Australia and the area inland of the Nimrod Glacier in the Transantarctic Mountains, forming the continuous eastern margin of the Mawson Continent. (3) ⑥ The $^{40}Ar/^{39}Ar$ signature also points to active erosion of the deep upper troughs of the Western Basin, which include the Mertz Shear Zone and the eastern Adélie Craton, by paleo ice streams during the MMCT. ⑦ The changing provenance of fine-grained sediment over the MMCT, based on Nd isotope data, implies repeated advance of the ice sheet from the Antarctic interior into the Wilkes Subglacial Basin (WSB). ⑧ The Nd data also suggest that the jökulhlaups previously inferred from bedrock topography in the Central Basin of the Wilkes Subglacial Basin could have occurred during the MMCT.	**Discussing results briefly:** Sentences ②, ④–⑧
... ⑨ This work highlights the value of provenance studies and of scientific offshore drilling for revealing the history of the Antarctic ice sheets and the geology hidden under the ice.	**Emphasizing study significance:** Sentence ⑨

7.2 An Overview of the Acknowledgements Section

It is very necessary for writers to thank the researchers who offered assistance and the organizations that financially supported their research at the end of their research paper. Two typical case studies are shown below.

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Case Study Three

Excerpt (Pierce et al., 2017)	**Comments**
Acknowledgements This work was funded by NSF Grant ANT 0944489 to TW, TvdF, and SRH; NSF Grant ANT 538580 to SRH, TvdF, and SLG; NSF Grant ANT 0838842 to SP; Royal Society Grant IE110878 to SRH and TvdF, and NERC funding to TvdF (NE/L004607/1, NE/I006257/1, NE/H014144/1, NE/H025162/1). ELP thanks G. Mesko, J. Gombiner, and K. Kreissig for lab assistance. We thank IODP for the Site U1356 and Site 1165 core samples.	The writers express their sincere gratitude to the institutions that financially supported their study and the researchers who gave them pertinent and inspiring suggestions and assisted their study.

Case Study Four

Excerpt (Gourbet et al., 2016)	**Comments**
Acknowledgements We thank Kerry Gallagher for his help with QTQt and Nick Fylstra for his assistance in the Noble Gas Thermochronometry lab. Liu Xiaobing and Liu Xiaohan are acknowledged for their assistance for organizing fieldwork, François Senebier for his technical assistance at ISTerre (Grenoble), and Nicolas Arnaud for helping us with the Ar data. M. Murphy and an anonymous reviewer helped improving this manuscript. This study was supported by the Explo'ra Doc program of the Région Rhône-Alpes, the SYSTER (INSU) and the Cai Yuanpei No. 531 27968UC (French Ministry of Foreign Affairs) programs.	The writers express their sincere gratitude to the institutions that financially supported their study and the researchers who gave them pertinent and inspiring suggestions and assisted their study.

7.3 Useful Expressions and Sentence Patterns

Useful expressions and sentence patterns for showing gratitude are as follows.

* ***This study was funded by*** *the Geological Survey of China (No: 1212011121261).*
* ***This study was supported by*** *a Victoria University of Wellington Research Establishment Grant.*
* ***This work was aided by*** *NERC Ph.D. studentships.*
* ***This manuscript has also benefited greatly from*** *the thoughtful comments of reviewers Alain Burgisser and Andrea Di Muro.*

* ***We thank*** *P. Gillette and T. Capo* ***for*** *providing us with space in the University of Miami's experimental hatchery facility to conduct these experiments.*
* ***We are indebted to*** *Gavin Foster, Carrie Lear, Dan Murphy, Fred Le Moigne, Helen Griffin, and Anya Crocker* ***for*** *their advice and helpful discussions of the manuscript.*
* ***We wish to thank*** *Alpha Exploration Ltd.* ***for*** *providing data for this study, and especially to Alasdair Smith for his support.*
* ***The authors are grateful to*** *the anonymous reviewers and the editor* ***for*** *their helpful and constructive comments that greatly helped improve the manuscript.*
* *Wei Huang, Andy Juhl, Betina Fleming, and Nicole deRoberts* ***are acknowledged for*** *technical support.*
* *Joseph Knight* ***kindly provided insightful discussions and reviews*** *which improved the paper.*

7.4 Sentence Structures

Simple sentences, complex sentences, and compound sentences are widely used in academic writing.

A simple sentence is a sentence with only one independent clause. Though a simple sentence doesn't contain any dependent clauses, it isn't always short.

* ***Field-based measurements*** *of these properties, combined with data from laboratory experiments and numerical simulations of LPO development,* ***form*** *a framework for interpreting the structure and flow behavior of Earth's upper mantle.*
* *In order to use the ^{10}Be concentrations of our 17 nested catchment samples to interpret spatial patterns in erosion rate,* ***we used*** *a spatially-distributed ^{10}Be flux model to compare predicted and measured in situ-produced ^{10}Be concentrations in quartz for four different spatially-distributed erosion scenarios.*

A complex sentence is one with an independent clause and at least one dependent clause.

* *The groundmass is characterized by (1) lath-like feldspars // **that** exhibit anastomosing flow alignment, and (2) alteration of glassy components to clay minerals giving the thin section a cloudy appearance.*
* *Larger, nested catchments have intermediate apparent erosion rates // **that** smoothly integrate the variability found in lower-order tributary samples (Fig. 2A).*

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A compound sentence has at least two independent clauses that have related ideas. The two clauses are connected by a comma and a conjunction such as “and”, “but”, or “so”.

> * *Beginning at approximately 80 Ma, volcanism in the Sierra Nevada ceased due to flattening of the slab, // **and** deep-seated contractile deformation occurred across the Laramide foreland.*
> * *The Elko Formation likely does not encompass the MECO, // **but** this global warming event may be recorded in the Ca 40.45 ± 0.25 Ma tuff of Nelson Creek.*

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Exercises

I. Read the following two paragraphs and find out the eight errors contained in the underlined sentences. Each underlined sentence contains only one error. In each case, only one word is involved. You should proofread the sentences and correct the errors.

Conclusions

This contribution resolves some inconsistencies between previous planktic foraminiferal calibrations and in vitro observations, and **1.** provides further support for the importance of microenvironment alteration in dictating foraminiferal vital affects. Our new calibration for Orbulina universa provides one of the most tightly-constrained calibrations of any species to date, **2.** which derived from open-ocean samples without risk of artefacts from culture. Better understanding of foraminiferal autecology and seasonality in the open ocean could in future constrain such calibrations still further. Together with apparently negligible size-fraction or cryptospecies effects in $\delta^{11}B$ and this species' broad geographic range, long fossil record, and large and easily recognizable morphology, **3.** this calibration should be prove a very useful tool for reconstruction of past pH and pCO_2. In addition, through comparison with new and published measurements of other foraminiferal species, **4.** an increasingly congruent picture of the nature of foraminiferal vital effects are emerging. Although ultimately more advanced models of foraminiferal microenvironment alteration and biomineralization—grounded in more extensive physiological and geochemical measurements—are needed, we outline some practical solutions to allow approximation of vital effects in extinct species. These approaches, we suggest, can permit greater confidence in absolute values of ocean pH and atmospheric pCO_2 calculated from the $\delta^{11}B$ of extinct foraminiferal species, thereby extending the utility of the boron isotope-pH proxy.

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MS analyses and Nick Marsh for the XRF analyses. We thank Steve Sparks, Lars Hansen, Stephen Turner, Stefan Lachowycz, and **7.** Richard Katz for helpful discussions on various aspects of manuscript. **8.** We also thank Oliver Shorttle and an anonymity reviewer for thorough and constructive reviews which resulted in substantial improvement of this paper, and Mike Bickle for editorial handling. (Henehan, 2016)

II. In the following paragraphs, some sentences are missing. Fill in the blanks with the most suitable ones from the list A–E. There is one extra choice, which does not fit in any of the gaps.

We present evidence that ferropericlase may become interconnected in the lower mantle, leading to reduced viscosity and weakening of CPO. **1.** _____

While our results strongly suggest reduction of CPO due to ferropericlase controlling deformation, results presented here cannot constrain which deformation mechanism is responsible for CPO reduction. Future systematic deformation experiments on bridgmanite-ferropericlase aggregates coupled with in-situ microtomography and/or ex-situ electron microscopy may help to construct deformation maps that can be extrapolated to better constrain likely deformation mechanisms in the lower mantle. **2.** _____ Alternatively, two-phase deformation of lower mantle minerals may be predicted by comprehensive models that allow for not only dislocation slip but also grain nucleation, grain growth, grain-boundary migration, and lattice diffusion creep. In addition, the effects of starting microstructure, strength contrast, and aggregate strain should be looked at more closely. **3.** _____ Future experiments should be done to compare results for samples with different starting microstructures. As shown here, the viscoplastic fast Fourier transform-based approach is a valuable tool for predicting stress and strain partitioning and CPO development in polyphase samples with different starting microstructures. We compare results here to previous studies to examine the role strength contrast between the two-phase plays in determining the deformation-controlling phase and suggest that this may evolve with strain, but more systematic studies are necessary. **4.** _____ (Kaercher et al., 2016)

A. Modeling of two-phase deformation using VPFFT or finite element methods may be best suited for this pursuit as well.

B. Such experiments are becoming increasingly feasible (with larger, more easily recoverable samples) thanks to increased pressure range of large volume presses (T-cups, Drickamer, D-DIA).

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C. Results here indicate that temperature did not greatly affect CPO development in two-phase samples, but has a stronger effect on aggregate strength (Fig. 2b).

D. The starting microstructure here had $NaMgF_3$ and NaCl already highly connected.

E. These results reiterate the importance of including the effect of secondary phase ferropericlase on rheology in geophysical models of the lower mantle.

III. Improve the italicized parts in the following sentences to make them more formal and logical.

1. *We have another explanation for* the marine turbidite depositional pattern at site H. The explanation is related to the decreased moisture supply.

_____

_____

2. According to our continental data, temperatures of the lower mid- and low-latitudes were at the present-day level, *or even a few degrees below the present-day level*.

_____

_____

3. In both the Middle and Late Miocene time slice, the higher mid- and high-latitudes were considerably warmer than present, *which does not depend on* prevailing atmospheric pCO_2 conditions.

_____

_____

4. Although *changing plate boundary forces are* less clear-cut than those at the Perth Abyssal Plain microcontinents, *changing plate boundary forces* have also been proposed to have played a role in calving both the Seychelles and Jan Mayen microcontinents.

_____

_____

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5. Our results are influenced *by the time of* our experiments early in the melt season: *We can know more* by repeating these tests during or after the monsoon season when the subsurface hydrology *becomes* more developed after sustained large inputs to the system.

6. Earthquakes *whose magnitude can reach* Mw 6.1 around the Davie Ridge and Mw 5.7 around the Europa–Bassas da India Islands *happened* along the fault zone during the last decades.

7. *We do not have access to the actual samples from these studies. But* the chemistry, mineralogy, and preparation procedures are nominally the same *as our own. This suggests* that there is an additional contribution to *the bulk conductivity. This* cannot be accounted for by separately considering the electrical conductivity of olivine and melt.

8. *A self-consistent study would be immensely valuable to the field. In this study,* digital rock physics simulations are supplemented by impedance spectroscopy of the same samples, *similar to Watson & Roberts (2011)*.

9. We speculate the existence of a thin, electrochemically distinct layer at the olivine-melt interface. *The layer* might may account for the apparent discrepancy between the bulk electrical conductivities measured and *the bulk electrical conductivities we computed. We computed those* using real partial melt geometries.

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10. The electrical conductivity of the deformed sample overlapped the parallel mixing bound (i.e., electrical conduction through parallel pipes). *This* is consistent with deformation-induced melt segregation. *The electrical conductivity of the deformed sample was measured in the shear direction*.

11. The Miocene Climate Optimum preceded the MMCT. *The Miocene Climate Optimum has* oscillating but reduced ice volume and high sea level.

12. *We compared our results with the results* obtained by Singh et al. (2012). *It indicates* that dissolved Nd concentrations of seawater samples collected in June 2012 are generally 15%–25% lower than *dissolved Nd concentrations* of samples collected in November 2008.

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Appendix I Frequently-used Collocations in Geoscience Papers

A collocation has two or more words that often go together. These combinations are more likely to be accepted by native speakers. In geoscience papers, there are also a lot of collocations that can be accepted by researchers in this field. Four types of collocations are widely used and their examples are listed below. Try to use them correctly, so as to make your scientific writing more understandable.

adjective + noun

abaxial leaf	背面叶
abiotic apatite	非生物磷灰石
abnormal sensor current	传感器电流异常
abrupt increase	突然增加
abundant empirical evidence	丰富的实验证据
abundant impurity	大量杂质
acetic aid	醋酸
acid neutral fraction	酸性中性馏分
active volcano	活火山
additional illumination	额外的照明
additional overburden	额外的负担
additional sample	附加样本
additional slip plane	附加滑移面
adjacent basin	邻近的盆地
adjacent hydrographic measurement	邻近水文测量
adjacent region	邻近地区
adjacent unit	相邻单元
aeromagnetic data	航磁数据
alternative possibility	替代可能性
ambient borate	周边硼酸盐
ambient level	环境水平

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ambient seawater	周边海水
amorphous carbon rich lithology	无定形富碳岩性
analytical inaccuracy	分析误差
analytical parameter	分析参数
analytical procedure	分析程序
analytical reproducibility	分析重现性
analytical spot	分析点
ancient atmosphere	古老大气层
anhydrous condition	无水状态
anisotropic result	各向异性结果
anisotropic viscosity	各向异性黏度
anomalous measurement	异常测量
anomalous result	异常结果
anonymous reviewer	匿名审稿人
anthropogenic carbon emission	人为碳排放
aperture size	孔径大小
apparent discrepancy	明显差异
aquatic contribution	水生贡献
aqueous borate ion	硼酸根离子水溶液
areal density of stomata	气孔面积密度
arid environment	干旱环境
artificial structure	人工结构
asthenospheric condition	软流圈条件
asthenospheric mantle	软流圈地幔
asthenospheric upper mantle	软流圈上地幔
atmospheric carbon	大气碳
atmospheric entry	大气入口
atmospheric gas	大气
atmospheric noble gas	大气稀有气体
atmospheric value	大气值
atmospheric variability	大气变化率
available data	可用数据
basal age	基础年龄
basaltic rock	玄武岩
basinal sedimentary	盆地沉积
benthic foraminifera	底栖有孔虫

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benthic species	底栖物种
binocular microscope	双目显微镜
biogenic carbon	生物碳
biostratigraphic indicator	生物地层指标
biotic calcite	生物方解石
black shale	黑色页岩
boric acid	硼酸
brittle and plastic behavior	脆性和塑性行为
bulk sample	大块样品
bulk sedimentary	大块状沉积物
calcareous shale	钙质页岩
carbonaceous chondrite	碳质球粒陨石
cautionary example	警示示例
Cenozoic volcanic rock age	新生代火山岩年龄
chemical composition range	化学成分范围
chemical diffusion	化学扩散
chemical nature	化学性质
chemical weathering	化学风化
chondritic insoluble organic matter	球粒装不可溶有机物
chronological uncertainty	时间不确定性
chronostratigraphic framework	年代地层结构
clastic sediment	碎屑沉积物
clastic sedimentary rock	碎屑沉积岩
climatic threshold	气候阈值
close morphological resemblance	闭合形态相似
coastal region	沿海地区
colloidal silica	胶体二氧化硅
cometary matter	彗星物质
cometary origin	彗星起源
compositional gradient	成分梯度
comprehensive dataset	综合数据集
compressional deformation	压缩变形
compressional structure	压缩结构
compressive creep experiment	压缩蠕变实验
compressive stress	压应力
considerable variability	相当大的可变性

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consistent convergence	一致趋同
constitutive equation	组成方程
constitutive mineral	组成矿物
constitutive relationship	组成关系
constructive comment	建设性意见
contemporary volcanism	当代火山活动
continental crust	大陆地壳
continental subduction channel	大陆俯冲通道
continuous exhumation	持续发掘
continuous recording	连续记载
continuous seismic data	连续地震数据
convective removal	对流清除
core suggestion	核心建议
cosmogenic noble gas	宇宙稀有气体
cosmogenic radionuclide data	宇宙成因放射性核素数据
crustal and topographic feature	晶体和地形特征
crustal architecture	地壳建筑
crustal assemblage	地壳组合
crustal column	地壳柱
crustal deformation	地壳变形
crustal material	地壳物质
crustal thickness	地壳厚度
crystal lattice	水晶格子
crystallographic axis	结晶轴
crystallographic orientation	晶体取向
crystallographic plane	晶面
crystallographic reference	晶体学参考
current high topography	当前高地势
current size	现有规模
current study	当前研究
cylindrical correction	圆柱校正
dateable mineral	可测年代的矿物
deep basal cavity	深基底腔
deep lithosphere architecture	深层岩石圈结构
deep ocean and atmosphere	深海和大气
depositional age	沉积年代

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depositional environment	沉积环境
depositional sequence	沉积序列
detrital geo-thermochronologic analysis	分散地热年代分析
detrital zircon	碎屑锆石
diagenetic alteration history	成岩蚀变史
diagenetic fluid	成岩流体
diagenetic recrystallization	成岩重结晶
different degrees	不同程度
different elevations	不同标高
different hydrous minerals	不同的含水矿物
different magnitudes	不同幅度
different patterns	不同模式
different plant species	不同的植物种类
different rims	不同轮辋
different thicknesses	不同厚度
different tissue types	不同的组织类型
diffusive boundary layer	扩散边界层
diffusive pathway	扩散途径
diffusive profile	扩散轮廓
direct evidence	直接证据
direct impact	直接影响
direct measurement	直接测量
direct shear geometry	直剪几何
distinct peristomatal rim	明显的气孔缘环
distinct phase	截然不同的阶段
distinguishable morphology	可区分的形态
dominant canopy component	主要冠层成分
dominant dislocation	显性错位
dominant slip system	主导滑移系统
ductile property	延展性
dynamic simulation	动态模拟
earlier collision	早期碰撞
earlier version	早期版本
early diagenesis	早期成岩作用
eastward crustal extrusion	地壳向东挤压
electrical conductivity	电导率

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electrical pulse	电脉冲
elemental combustion system	元素燃烧系统
elemental ratio	元素比例
enigmatic pebble	神秘的卵石
environmental factor	环境因素
environmental signal	环境信号
environmental stimuli	环境刺激
environmental variable	环境变量
environmental variation	环境变化
epicentral distance	震中距离
epidermal cell	表皮细胞
epidermal cell density	表皮细胞密度
epitactic orientation relationship	外部取向关系
equivalent spherical radius	等量球半径
equivalent strain rate	等效应变率
equivalent stress	等效应力
equivalent value	等效值
erosional exhumation	侵蚀剥落
evaporitic sediment	蒸发沉积物
evolutionary history	进化史
exponential creep equation	指数蠕变方程
exponential law component	指数律成分
exponential regime	指数制度
extensive exhumation	深度发掘
extensive tectonism	深度构造
external detector	外部检测器
external fluid	外部流体
external inflow	外部流入
external reproducibility	外部再现性
extinct species	已灭绝的物种
extraterrestrial material	宇宙物质
extraterrestrial nature	宇宙特征
extraterrestrial object	宇宙物体
extreme moisture deficit	极度缺水
fluid inclusion study	流体包裹体研究
fluvial and lacustrine sediment	河湖沉积物

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fluvial sandstone	河流砂岩
foraminiferal calcite	有孔虫方解石
foraminiferal carbonate	有孔虫碳酸盐
foraminiferal test	有孔虫试验
formic acid	甲酸
fruitful discussion	富有成果的讨论
fumarolic activity	气流活动
future research	未来的研究
gametogenic calcite	配子方解石
generational turnover	代际更替
genetic link	遗传联系
genotypic trait evolution	基因型性状进化
geochemical feature	地球化学特征
geochemical proxy system	地球化学代理系统
geochemical reservoir	地球化学储层
geochemical signature	地球化学特征
geodynamic mechanism	地球动力学机制
geodynamic model	地球动力学模型
geographic range	地理范围
geographical distribution	地域分布
geological and seismological studies	地质和地震学
geological context	地质背景
geological information	地质信息
geological observation	地质观察
geological setting	地质环境
geological sketch map	地质示意图
geological survey	地质调查
geological timescale	地质时间尺度
geometric alpha-ejection correction	几何阿尔法喷射校正
geometric correction	几何校正
geophysical observation	地球物理观测
geothermal activity	地热活动
geothermal gradient	地热梯度
glacial and interglacial state/time	冰川和间冰期
glacial and submarine volcanic rock	冰川和海底火山岩
glacial expansion	冰川扩张

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glacial movement	冰川运动
glacial termination	冰川终止
global climatic consequence	全球气候变化后果
good analogy	恰当的类比
good representation	有代表性
gradual ecosystem response	渐进的生态系统反应
granitic gneiss	花岗片麻岩
granitic magma	花岗岩岩浆
granitic protolith	花岗原生岩
gravitational potential energy	重力势能
greater dispersion	较大面积分散
greater fraction	较大的比重
heavier isotope	较重的同位素
heavy and light nitrogen	重氮和轻氮
helpful comment	有用的评论
heterogeneous metasomatism	异质交代作用
high dispersion	高分散
higher density	更高的密度
highest load step	最高负载阶跃
historical leaf	历史叶子
hydrographic measurement	水文测量
ideal region	理想区域
identical major element	相同的主要元素
identical thermal history	相同的热历史
identical treatment principle	相同的处理原则
identical value	相同的价值
igneous apatite	火成磷灰石
immediate vicinity	邻近地区
important element	重要元素
important geochemical tracer	重要的地球化学示踪剂
important implication	重要意义
important microphysical process	重要的微物理过程
important parameter	重要参数
independent evidence	独立证据
independent mechanism	独立机制
independent rotational axe	独立旋转轴

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indigenous component	本土成分
individual detrital zircon	单个碎屑锆石
individual dislocation slip system	个别脱位滑移系统
individual measurement	单独测量
individual sample	个别样本
initial diagenesis	初始成岩作用
initial model	初始模型
inorganic calcite	无机方解石
inorganic carbon	无机碳
inorganic precipitation experiment	无机沉淀实验
insightful comment	有见地的评论
insufficient data	数据不足
insufficient resolution	分辨率不足
intensive study	强化学习
intercellular carbon	细胞间碳
internal climate feedback	内部气候反馈
ionic species	离子种类
isotopic analysis	同位素分析
isotopic composition	同位素成分
isotopic disequilibrium	同位素不平衡
isotopic fractionation	同位素分馏
isotopic ration	同位素比
kinetic energy	动能
large bolide	大型火流星
large composite basin	大型复合盆地
large conodont	大牙形石
large genome size	大基因组
large global temperature rise	全球气温大幅上升
larger epidermal cell	较大的表皮细胞
largest orogenic highland	最大的造山带
latter observation	后期观察
light availability	可用光
light condition	光照条件
light level	亮度
light stable isotope	光稳定同位素
liquid nitrogen temperature	液氮温度

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lithospheric cause	岩石圈成因
lithospheric condition	岩石圈条件
lithospheric mantle	岩石圈地幔
lithospheric root	岩石圈根部
lithospheric wedge model	岩石圈楔形模型
local decompression	局部减压
local ecology	当地生态
local moisture	局部水分
local shallow structure	局部浅层构造
local signal	本地信号
long timescale	长时间
low metabolic rate	代谢率低
low parameter	低参数
low stress	低压
low temperature	低温
low value	低价值
lower crustal	下地壳
lower mantle	下地幔
lower ration	低量配给
magmatic activity	岩浆活动
magmatic belt	岩浆带
magmatic domain	岩浆域
magmatic fluid	岩浆液
magmatic history	岩浆史
magmatic rock	岩浆岩
magmatic zircon	岩浆锆石
magnetic polarity	磁极性
magnetic reversal	磁反转
magnetostratigraphic correlation	磁地层相关性
magnetostratigraphic result	磁地层结果
main component	主要成分
major structure and topography	主要结构和地形
marine sediment	海洋沉积物
marine sedimentary rock	海洋沉积岩
marine temperature	海洋温度
mass redistribution	大规模再分配

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maximum burial temperature	最高埋藏温度
maximum conductance	最大电导
maximum extent	最大程度
maximum temperature	最高温度
mean value	平均值
meaningful information	有意义的信息
mechanical behavior	机械性能
mechanistic understanding	机械的理解
metabolic process	代谢过程
metamorphic age	变质年代
metamorphic basement	变质基底
metamorphic dehydration	变质脱水
metamorphic domain	变质域
metamorphic fluid	变质流体
metamorphic growth zone	变质生长带
metamorphic origin	变质起源
metamorphic rock	变质岩
metasomatic fluid	交代体液
meteoritic class	陨石级
meteoritic lithology	陨石岩性
meteoritic material	陨石物质
micritic limestone	微晶石灰岩
micromorphological parameter	微形态参数
micromorphological property	微观形态特性
microstructural analyse	微观结构分析
microstructural observation	微观结构观察
mineral distribution	矿物分布
minor component	次要成分
minor influence	轻微影响
minor rotation	轻微旋转
minor subcanopy component	微型的亚冠层组件
molecular ratio	分子比
monometamorphic complex	单变态复合体
morphologic component	形态成分
morphologic term	形态学术语
morphological measurement	形态测量

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morphological property	形态特性
morphological similarity	形态相似
morphological trait	形态特征
narrow band	窄带
narrow peak	窄峰
natural biogenic precipitation	自然生物沉淀
negative feedback	负面反馈
negative value	负值
new correlation	新的相关性
new zircon	新锆石
noble gas	稀有气体
normal polarity	正常极性
northern and southern unit	南北单元
northern boundary	北部边界
northern limb	北翼
northward subduction	向北俯冲
northwest direction	西北方向
numerical simulation	数值模拟
numerous environmental parameters	众多环境参数
obvious impact	明显的影响
oceanic lithosphere	海洋岩石圈
oceanic mantle	海洋地幔
oceanic remnant	海洋遗迹
oceanic slab	大洋板
oceanographic data	海洋数据
ontogenetic migration	本体迁移
opening time fraction	开放时间段
operational conductance	操作电导
operational rate	运作率
optimal climatic range	最佳气候范围
optimal photosynthetic rate	最佳光合速率
optimal range	最佳范围
orbital configuration	轨道配置
ordinary chondrite	普通球粒陨石
organic material	有机物质
organic metamorphism	有机变质

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orogenic belt	造山带
orogenic process	造山过程
orogenic history	造山史
paleogeographic reconstruction	古地理重建
partial zone	部分区域
peak temperature	峰值温度
peripheral foreland basin	外围前陆盆地
petrogenetic model	成岩模型
petrological and geochemical observation	岩石地球化学观测
petrological thermobarometry	岩石热压法
phenotypic change	表型改变
photosynthetic activity	光合活性
photosynthetic carbon	光合碳
photosynthetic compensation	光合补偿
photosynthetic process	光合作用过程
photosynthetic rate	光合速率
photosynthetic symbiont	光合共生体
phreatomagmatic explosion crater	岩浆喷发口
physical parameter	物理参数
physical property	物理特性
physiological change	生理变化
physiological response	生理反应
planktic foraminifera	浮游孔虫
plastic leaf phenotype	塑性叶表型
plausible geodynamic explanation	合理的地球动力学解释
polymetamorphic complex	多变态复合物
poor crystallinity	结晶度差
positive bias	正偏向
positive feedback	正面反馈
positive topography	正地形
positive value	正值
post-depositional temperature	沉积后的温度
post-formative ejecta	后期形成喷射物
potential disintegration	有解体可能性
potential geological implication	潜在的地质意义
potential impact	潜在影响

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potential source	潜在来源
potential target	潜在目标
present dataset	当前数据集
present study	当前研究
previous conodont	早期牙形石
previous diffusion experiment	先前的扩散实验
previous estimate	先前的估计
previous interpretation	前述解释
previous leaf generation	前叶世代
primary source	主要来源
primitive achondrite group	原始无球粒陨石群
principal component analysis	主要成分分析
prominent feature	突出特点
pyroclastic infill	火山碎屑岩
quantitative estimate	定量估计
quantitative palaeoecological signal	定量古生态信号
radioactive decay	放射性衰变
real value	实际价值
recent eruption	最近喷发
recent revision	近期修订
recognizable morphology	可识别的形态
red line	红线
regional correlation	区域相关性
regional crustal structure	区域地壳结构
regional difference	区域差异
regional exhumation	区域发掘
regional sedimentary	区域性沉积
regional vegetation	区域植被
regular epidermal cell	常规表皮细胞
regular knot	常规结
relative elemental abundance	相对元素丰度
relative strength	相对强度
relative travel time	相对传输时间
relative value	相对价值
relative velocity structure	相对速度结构
reliable concentration	可靠浓度

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remote mountain	偏远山区
representative example	有代表性的例子
reproducible data	可复制数据
reproducible subset	可复制子集
residual time	剩余时间
rheological behavior	流变行为
rheological regime	流变状态
robust difference	稳健差异
same mechanistic response	相同的机械反应
schematic diagram	示意图
schematic visualization	示意图可视化
secondary encrustation	二次结壳
sedimentary provenance	沉积物源
seismic array	地震阵列
seismic network	地震台网
seismic reflection data	地震反射数据
seismic station	地震台
seismic wave	地震波
selective process	选择过程
semi-quantitative indicator	半定量指标
significant contribution	显著贡献
significant correlation	显著相关
significant deviation	显著偏差
significant dextral transpression	明显的右旋挤压
significant fractionation	显著分馏
significant overlap	显著重叠
similar bedrock	类似的基岩
similar span	相似跨度
similar temperature sensitivity range	相似的温度灵敏度范围
simultaneous exhumation	同时发掘
single conodont element	单牙形元素
single crystal	单晶
single limestone sample	单个石灰石样品
sizeable blank correction	大量空白校正
slowest diffusing species	扩散最慢的物种
small crystal	小型晶体

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small crystallite size	微晶尺寸
small scale	小规模
small structure	小型结构
smaller volume estimate	较小的体积估算
solar system	太阳系
solid line	实线
southern basin	南部盆地
southern margin	南缘
southern tip	南端
spatial distribution	空间分布
spatial occurrence	空间发生
specific age peak	特定年龄峰值
specific crystallographic axe	特定结晶轴
specific morphotype	特定形态
specific slip system	特定滑移系统
specific source	具体来源
stable isotope	稳定同位素
static peak	静态峰值
steady exhumation	持续发掘
stepwise extraction	逐步提取
stepwise manner	循序渐进
stomatal density	气孔密度
stomatal index	气孔指数
stomatal scale	气孔大小
straightforward explanation	简明的解释
stratigraphic age	地层年代
stratigraphic column	地层柱
stratigraphic log	地层日志
strong morphological similarity	形态相似性强
strong negative correlation	强负相关
structural and morphotectonic analysis	结构和形态构造分析
structural section	结构截面
suboptimal range	次优范围
subsequent generation	后代
substantial temperature rise	温度大幅上升
substantial underestimate	严重低估

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subtropical environment	亚热带环境
successive leaf generation	连续叶生成
sufficient precision	足够的精度
supracrustal rock	地壳上岩
surficial adsorption	表面吸附
syndepositional volcanism	沉积性火山作用
synorogenic sediment	共生沉积物
synthetic diamond	合成钻石
synthetic target	合成目标
systematic bias	系统偏差
systematic correlation	系统相关
systematic difference	系统差异
taxonomic identification	分类鉴定
tectonic evolution	构造演化
tectonic feature	构造特征
tectonic surface	构造面
teleseismic data	远震数据
teleseismic receiver	远震接收机
temporal resolution	时间分辨率
temporal variation	时间变化
terrestrial and shallow marine deposition	陆地和浅海沉积
terrestrial atmospheric pattern	地球大气模式
terrestrial contamination	陆地污染
terrestrial deposit	陆地沉积
terrestrial ecosystem	陆地生态系统
terrestrial environmental change	陆地环境变化
terrestrial leaf matter	陆地叶片
terrestrial leaf wax	陆地叶蜡
terrestrial organic carbon	陆地有机碳
terrestrial origin	陆地起源
terrestrial record	地面记录
terrestrial rock	陆地岩石
terrestrial sample	陆地样本
terrestrial sediment	陆地沉积物
terrestrial sedimentary rock	陆地沉积岩
theoretical travel time	理论传输时间

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thermal diffusion	热扩散
thermal energy	热能
thermal evolution	热演化
thermal history	热历史
tomographic image	断层扫描图像
tomographic inversion	断层扫描反演
tomographic method	断层扫描法
topographic development	地形发展
topographic evolution	地形演变
topographic height	地形高度
topographic unit	地形单位
total alkalinity	总碱度
total extraction	总萃取量
traditional bootstrap	传统引导
triaxial compression experiment	三轴压缩实验
turbulent flow	湍流
twin configuration	孪生结构
typical continental subduction	典型的大陆俯冲
typical lithospheric stress	典型的岩石圈应力
typical local silicate	典型的局部硅酸盐
typical mineral assemblage	典型的矿物组合
ubiquitous component phase	普遍的成分阶段
ultramafic intrusion	超基性岩体
ultravolatile element	超挥发性元素
uneven representation	代表不均
uniaxial or triaxial compression	单轴或三轴压缩
unradiogenic limestone	非放射性石灰石
upper limit	上限
upper mantle	上地幔
useful tracer	有效示踪剂
valuable discussion	有价值的讨论
variable concentration	可变浓度
variable proportion	可变比例
variable size	可变尺寸
variable temperature and salinity	可变的温度和盐度
various angles	各种角度

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various controlled experiments	各种对照实验
various leaf properties	各种叶片特性
vertical extrusion	垂直挤压
vertical profile	垂直轮廓
vertical structure	垂直结构
viable boron	活性硼
viable source	可靠的来源
visible example	明显的例子
visual inspection	肉眼观察
visual qualification	视觉鉴定
vital effect	重要作用
volatile element	挥发性元素
volcanic activity	火山活动
volcanic arc	火山弧
volcanic ash layer	火山灰层
volcanic event	火山事件
volcanic field	火山地带
volcanic magma source	火山岩浆源
volcanic origin	火山成因
volcanic rock	火山岩
volcanogenic zircon	火山锆石
weak retrogression	弱回归
western edge	西缘
widespread coeval deposition	大面积同期沉积
young peak	新生高峰

adverb + adjective

apparently negligible	显然可以忽略不计的
approximately equal	大致相等的
bimonthly hydrographic	双月进行的水文的
broadly compatible	广泛兼容的
certainly shorter	肯定更短的
comparatively scarce	比较稀缺的
considerably higher	相当高的
considerably large	相当大的

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consistently low	持续走低的
directly analogous	直接类似的
easily distinguishable	容易区分的
easily recognizable	容易识别的
ecologically analogous	生态上相似的
essentially identical	本质上相同的
essentially pure	基本纯净的
extremely heavy	非常沉重的
extremely high	非常高的
extremely rare	非常稀有的
freshly exposed	刚刚暴露的
fully compatible	完全兼容的
fully quantifiable	完全可量化的
fully reset	完全重置的
fundamentally well-founded	基本上是有根据的
generally consistent	大体一致的
geographically widespread	地域广泛的
geologically unreasonable	地质上不合理的
highly dispersed	高度分散的
highly monsoonal	强季风的
highly variable	高度变化的
increasingly congruent	越来越一致的
insufficiently unusual	异常不足的
internally consistent	内部一致的
intrinsically difficult	本质上很难的
isotopically similar	同位素相似的
largely consistent	基本上一致的
likely negligible	可忽略的
markedly different	显著不同的
merely facultative	仅具有兼容性的
mostly euhedral	大部分为自形的
mostly peraluminous	多数过铝的
mostly similar	大体相似的

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nearly identical	几乎相同的
partially reset	部分重置的
particularly low	特别低的
particularly rich	特别富足的
partly attributable	部分归因的
physiologically analogous	生理上类似的
relatively consistent	相对一致的
remarkably homogeneous	极其同质化的
roughly equal	大致相等的
roughly simultaneous	大致同时的
specifically contemporaneous	特别是同时期的
statistically significant	具有统计意义的
strikingly similar	惊人相似的
strongly biased	非常有倾向性的
strongly dependent	强烈依赖的
substantially younger	年轻得多的
sufficiently high	足够高的
tectonically lower	构造低的
unrealistically low	低得离谱的
unreasonably long	漫长的

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adverb + verb

accurately locate	准确定位
accurately simulate	准确模拟
accurately trace	准确追踪
alternatively protract	交替拖延
approximately commence	大约……开始
be apparently sourced	显然来自……
be carefully controlled	被精细控制
be clearly resolved	尚未明确解决
be clearly shown	清楚地显示
be commonly characterized	通常具有……特征
be commonly explained	通常被解释为
be commonly observed	通常可被观察到

be commonly used	通常被用于
be considered environmentally	被认为对环境有……作用
be episodically interrupted	偶然被中断了
be essentially trapped	本质上受困于
be fairly well understood	可以很好被理解
be generally accepted	被普遍接受
be genetically linked	有遗传联系
be largely inherited	在很大程度上被继承
be likely reactivated	可能已被重新激活
be not evenly distributed	分布不均
be optimally located	位于最佳位置
be preferentially sampled	被优先采样
be primarily controlled	主要受控于
be primarily influenced	主要受到……影响
be repeatedly processed	被反复加工
be roughly located	大致位于
be sequentially analyzed	被依次分析
be strongly supported	被强烈支持
be subsequently criticized by	随后遭到了批评
be subsequently split into	随后被分为
be unevenly distributed	分布不均
be widely used	被广泛使用
briefly summarize	简要总结
cannot be easily derived	不能轻易得出
cannot be independently measured	不能被独立测量
chemically and isotopically fractionate	化学和同位素分馏
clearly reveal	清楚地揭示
closely relate	密切相关
closely resemble	非常相似
completely disaggregate	完全分解
conservatively assume	保守地假设
considerably offset	大大抵消
consistently show	始终显示
definitively associate	明确地联系
directly decide	直接决定

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effectively respond	有效回应
effectively restrict	有效限制
equivocally interpret	模棱两可地解释
fully propagate	充分传播
greatly deviate	严重偏离
irreversibly change	不可逆转地改变
iteratively solve	迭代地解决
mainly consist of	主要包括
mainly correspond to	主要回应
mainly focus on	主要集中在
moderately metamorphose	适度变形/变态
mostly show	大多数情况下表示
necessarily exclude	必然排除
necessarily imply	必然暗示
originally include	最初包括
partially match	部分匹配
partly accommodate	部分容纳
possibly provide	可能提供
possibly suggest	可能暗示
potentially provide	可能提供
potentially reflect	可能反映出
primarily originate	主要起源于
primarily reflect	主要反映
probably initiate	可能发起
probably occur	可能发生
probably reside in	可能居住
properly resolve	妥善解决
randomly generate	随机产生
rarely preserve	很少保存
significantly raise	大幅度提高
simultaneously activate	同时激活
simultaneously explore	同时探索
slightly accelerate	略有加速
sporadically occur	偶尔发生
structurally correlate	结构上相关

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tentatively apply	暂时适用
tentatively suggest	暂时建议
tightly constrain	严格约束
undoubtedly confirm and strengthen	无疑证实和加强
unequivocally show	明确显示
visually inspect	用肉眼观察

verb + adverb

come vertically	垂直进入
consist essentially of	本质上包括
depend on strongly	强烈依靠
differ from significantly	差异很大
exhume slowly	慢慢发掘
extend spatially	空间延伸
flow laterally	横向流动
last approximately	大约持续……
occur primarily	主要发生
operate simultaneously	同时操作
produce directly	直接生产
vary systematically	系统地变化

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Appendix II Keys to Exercises

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Chapter 1

I.

1. in	2. on	3. for	4. of	5. of; for
6. During; in	7. at	8. with	9. to	10. at

II.

Paragraph One

1. a	2. the	3. Ø	4. the	5. Ø
6. Ø	7. Ø	8. the	9. Ø	10. Ø

Paragraph Two

1. the	2. the	3. Ø	4. a	5. The
6. the	7. the	8. The	9. the	10. Ø

Chapter 2

I.

1. using	2. enhanced	3. accelerated	4. collected

II.

1. is usually described	2. compared
3. Areas with significant relief	4. occurred

III.

1. D　　2. A　　3. B　　4. E

IV.

4. A　　8. B

Chapter 3

I.

1. We infer that this thrust belt probably reactivated the Paleozoic Kudi suture, given their similar trace in map view (Fig. 1).

2. Stomatal density (SD) and stomatal index (SI) in fossil Litsea calicarioides leaves reveal large changes that are coincident with the three phases identified by the carbon isotope values (Fig. 4).

3. Although the Antarctic Ice Sheet is estimated to have melted from ~125% to ~50% of its modern size, there is thus far no evidence for an increase in atmospheric CO_2 associated with the Mi-1 glacial termination in the earliest Miocene.

4. To the southwest, the Tianshuihai–Karakoram terranes have been sliced by the Karakorum fault, along which the Baltoro batholith intruded at 26–15 Ma.

5. As a result, plates that share an interlocking ridge-transform plate boundary show a degree of coupling.

6. It is evident that leaf physiology and phenotype are the results of numerous environmental parameters, including Ca.

7. Current theory concerning the leaf physiological response over millennial timescales supports our interpretation that the reduction of $g_{c[max]}$ from Phase 1 to Phase 2, and subsequent increase from Phase 2 to Phase 3 (Fig. 4), can reflect an increase in Ca during the ~20 kyr period comprising Phase 2.

8. In this case, the rift zone is small, and rifting and breakup occur relatively quickly, so that the spatiotemporal relationship between rifting and other events is potentially more easily isolated than for larger rifts between the major continents.

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II.

1. The spatial distribution of melt in the upper mantle largely determines the mantle's ability to transport melt, which creates oceanic crust.

2. The melt content of the upper mantle can be examined by the magnetotelluric (MT) method, using the good conductivity of partially molten rock.

3. During the next 100 years, sea level is likely to rise because of mountain glaciers and ice caps, and two factors—changes in surface mass balance and changes in dynamics—are responsible for the rise.

4. When the same effective pressures lead to dramatically different moving speeds, hysteresis—a retardation—often occurs. Sugiyama & Gudmundsson (2004) found the increase or decrease of Pe affected the relationship between effective pressure and glacier speed; they showed the hysteresis over short time intervals.

5. When heat stress increases, the labor capacity will go down, which may hamper socio-economic development.

6. Climate change is vital to the local development. More and more studies have been investigating how climate change may influence the labor system and how to get used to that influence.

III.

3. A 6. B 12. C 13. D

Chapter 4

I.

1. The implications of the New Mexico CAHe dates will be described in a future contribution and are not discussed further here.

2. Three-dimensional images of individual conodont elements were rendered from two-dimensional attenuation slices using the software Blob3D version 1.4.

3. To assess how crustal contamination may influence magma composition, we also compiled unpublished whole-rock data on basement samples taken in the region around Mocho-Choshuenco.

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4. Although the magnitude of cohesion of intact serpentinite is much greater than that of plate boundary fault rocks, the processes of crack growth and coalescence that occur in these experiments are representative of those that occur in situ.

5. In experiments conducted without pore fluids and at ambient temperature, axial and radial strains (*a* and *r*) were measured with foil gages affixed to the surface of the rock and used to calculate volume strain ($v = a + 2r$).

6. Secondly, the studies of Kahmen et al. (2013a, 2013b) focus on open forest or scrubland plants in a highly monsoonal to arid environment, whereas the paleoenvironment of Foulden Maar was neither monsoonal nor arid.

7. The scenario of local ecology driving physiological changes is plausible; however, there are several key factors why this scenario is less likely than the case for changes in pCO_2 and rainfall as drivers of variation in gc/max/, $\delta^{13}C$ and δD.

8. Dissolved deep water ε_{Nd} at these continental margin locations is likely a function of three variables: (1) the magnitude of the Nd flux from sediment pore fluids; (2) the difference between the εNd value of the overlying water and the pore fluid; and (3) the exposure time to this benthic flux of Nd.

9. The only method by which ε_{Nd} values of surface waters have been successfully reconstructed to date is through the analysis of reductively cleaned planktonic foraminifera.

10. GNSS data were processed kinematically using differential carrier phase positioning.

11. The primary base station was also inoperable during October 2014, leading to an increased baseline length and degraded solutions.

12. Understanding the causal relationship between rain-rate and velocity is complicated by the need to cross-correlate and lag the two time series.

II.

1. in	2. of	3. during	4. of
5. by	6. at	7. during	8. to

III.

4. A	5. B	10. C	15. D

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IV.

1. We study both melts and crystals by employing ab initio molecular dynamics simulations based on the planar augmented wavefunctions (PAW) flavor. We used the VASP implementation with the Gamma point for sampling the Brillouin zone and generalized-gradient approximation for the exchange correlation in the PBE96 formulation. We used a kinetic energy cutoff of 550 eV for the planewave basis set and of 800 eV for the augmentation charges. Because of the presence of iron, all simulations, at all volumes and temperatures are spin-polarized. This allows for the magnetic spin of the individual Fe atoms to be consistently computed at every single time step. We initiate the local magnetic moments with 1 magneton-Bohr par Fe atom. This is enough to break the symmetry of the magnetic wavefunctions that will converge to their state within a few steps.

2. Phase and orientation maps of reidite-bearing zircon grains were conducted via electron backscatter diffraction (EBSD) mapping using a TESCAN MIRA3 FE-SEM at Curtin University. EBSD and EDS data were collected simultaneously using Oxford Instruments AZtec acquisition system with a Nordlys EBSD detector and XMax 20 mm Silicon Drift Detector. Panchromatic cathodoluminescence (CL) and additional BSE images were collected using the same instrument. Processing of EBSD data was performed using Oxford Instruments Channel 5.12 software.

3. We use two similar metrics calculated within GB polygons to quantify topographic asymmetry. First, we collected up to 10 topographic profiles from each GB polygon, allowing their lengths to vary, while ensuring that they span the distance between opposing ridge lines and are oriented within 45° of north-south (locations of profiles provided in supplemental material). We use these profiles to compute the ratio of the average along-profile slope on north- and south-facing slopes. Second, we calculate the ratio of the average slope of gridded data measured on north- and south-facing aspects, which we refer to as the average slope ratio.

4. Paleocurrents were measured previously at Kekeya, showing sediment provenance from the south, but no such data exist at Sanju until now. We measured the orientation of 251 imbricated pebbles in the conglomerate beds along the Sanju section to obtain the paleo-flow orientation for provenance analysis. Further, we collected samples from eight fluvial sandstones interbedded with conglomerate layers at Sanju, and two medium-grained sandstones at Kekeya to complement our previous DZFT studies. About 50 zircon grains were randomly selected from most samples for U–Pb and fission-track

double dating by Laser-Ablation ICP Mass Spectrometry (LA-ICP-MS), using the analytical parameters and procedures described in Appendix Table S1. For U–Pb ages, we only accept those data with ≤ 20% discordance. Analyses are reported as $^{206}Pb/^{238}U$ ages for zircon ages ≤ 1.0 Ga and $^{207}Pb/^{206}Pb$ ages for grains > 1.0 Ga. DZFT age peaks with 95% confidence interval were determined by Radial Plotter. The analytical details are presented in supplements Figs. S1, S2, and S3, and Table S1.

Chapter 5

assess	**assessment**	available	**availability**
coherent	**coherence**	compatible	**compatibility**
coordinate	**coordination**	dominate	**domination**
emerge	**emergence**	evolve	**evolvement**
hypothesize	**hypothesis**	intensify	**intensification**
infect	**infection**	justify	**justification**
modify	**modification**	occupy	**occupation**
occur	**occurrence**	regulate	**regulation**
refine	**refinement**	substitute	**substitution**
subsidize	**subsidization**	transit	**transition**

I.

1. A　　2. C　　3. B　　4. A　　5. A　　6. B

II.

1. Most of the Earth's surface is characterized by increases in this value, indicating a near global increase in the intensity of the most extreme precipitation events.

2. This age is very close to a minimum seafloor age estimate of 101 ± 1 Ma from DSDP Site 256, located to the north of the Batavia Knoll, but crucially immediately on the western side of the pseudofault extending northward from the Batavia Knoll.

3. As a result, plates that share an interlocking ridge-transform plate boundary show a degree of coupling, and the strength of the coupling will increase with increasing transform length by requiring the breaking of older crust under shear.

4. The primary base station was also inoperable during October 2014, leading to an

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increased baseline length and degraded solutions.

5. Using the same criteria noted above, ash B3 (93.67 ± 0.12 Ma; red star in Fig. 2a) is selected as the nominal anchor for the Iona astrochronology (RMSE = 0.121; Table 1).

6. The youngest age model for the Iona core comes from the B6 ash (−0.43 Myr, Table 1), while the oldest one comes from the B7 ash (+0.25 Myr, Table 1).

7. Each of the ashes (with the exception of B3) is associated with three numbers, which have the same meaning as in the Libsack core, although the 2σ total uncertainty does not include stratigraphic correlation uncertainty since the dated ash beds come directly from the Iona core.

8. The magnitude of carbon isotope shifts sometimes observed in the Western Interior Basin (WIB) differs from the standard curve of the English Chalk, most likely reflecting local effects and different substrates (e.g., organic matter vs. carbonate).

9. This result is consistent with field observations that document rapid headward growth of low-order channels, instigated by the exposure of readily disaggregated bedrock beneath a more cohesive soil mantle.

10. Leaves from Phase 1 have relatively high SD and SI (SD = 189 ± 43 mm^{-2}, SI = 10.2 ± 1.4), those from Phase 2 have relatively low SD and SI (SD = 140 ± 70 mm^{-2}, SI = 5.1 ± 0.9), and those from Phase 3 show a return to the high SD and SI values of Phase 1 (SD = 243 ± 67 mm^{-2}, SI = 9.9 ± 2.3) (Appendix A, Table A6).

11. At Site 1165, the $^{40}Ar/^{39}Ar$ thermochronological ages of minerals from pebble-sized IRD fall into two main age populations, one from 487 to 571 Ma (average age 530 Ma) and the other from 1075 to 1191 Ma (average age 1125 Ma) (Fig. 5).

12. Based on these studies, we infer that the 450–600 Ma IRD comes from the local Prydz Bay sector and the 1075–1200 Ma IRD from Wilkes Land east of the Denman Glacier, an area that includes the Aurora Subglacial Basin, over 1,000 km distant from Site 1165.

III.

1. Here, we focus on examining the relief evolution of the westernmost Tibetan Plateau by quantifying the exhumation history of this region in the Rutog and Shiquanhe area.

2. The presence of high relief in western Tibet raises the question of the possible influence

of an older, inherited relief on the present topography.

3. However, analysis of detrital zircons contained in the red beds further north in the Domar area performed by researchers indirectly suggests a Jurassic deposition age.

4. This is a follow-up study of a work by Kramers et al. (2013) on a very unusual diamond-rich rock fragment found in the area of southwest Egypt in the southwestern side of the Libyan Desert Glass strewn field.

5. Nevertheless, in each scenario, knowledge of the movement of mid-depth water between 2,000 and 3,000 m, likely Pacific Deep Water (PDW), is necessary.

6. In addition to the Xe–Q composition, an excess of radiogenic ^{129}Xe (from the decay of short-lived radioactive ^{129}I) is observed.

7. Our study does not confirm the presence of exotic noble gases (e.g., G component) that led Kramers et al. (2013) to propose that Hypatia is a remnant of a comet nucleus that impacted the Earth.

8. The absence of graphite-bearing target rock in this area further supports the conclusions that Hypatia must be extraterrestrial.

9. Comparison of any related predictions with the seismic structure of the deep mantle will improve our understanding of the Earth's long-term evolution.

10. Our digital rock physics approach for determining the bulk electrical conductivity of partially molten rocks has the benefit of having fine control on the physics and material properties of the system.

11. In this work we extend the study by Kramers et al. (2013) with isotopic analyses of all five noble gases in several Mg-sized fragments of Hypatia in two different laboratories (CRPG Nancy, France and ETH Zürich, Switzerland) and with a nitrogen isotope investigation performed both at CRPG (Nancy) and IPG-Paris.

12. An attempt to determine the oxygen isotopic composition in Hypatia by the Nancy Cameca 1280 ion probe failed because of the reduced size of oxygen-bearing phases and the presence of contaminants and important amounts of water.

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Chapter 6

I.

1. induced 2. underestimated 3. causes

4. replace “which” with “where”

II.

1. The continuity of the diatomite is episodically interrupted by turbidites rich in plant material, which probably represent lakeside slumping.

2. We estimate that rain-induced speed-up events are likely to have a positive contribution to displacement of between 2% and 13% per annum.

3. At first glance, these results seem to conflict with our interpretation that fossil leaves in the Foulden Maar sediments record changes in Ca. However, the anthropogenic Ca rise of the recent past does not provide a good analogy to the Foulden Maar record, due to differences in timescale.

4. In any case, because our samples are located ⩾ 140 km east of the proposed Angmong fault, and would be in the hanging wall, this fault should not affect their exhumation history.

5. Our findings may have important implications for future numerical studies and the understanding of various geological processes.

6. Such pressure change may cause deglaciation-triggered melt pumping from the mantle, which in turn may replenish the shallow magmatic reservoirs.

7. This could be related to the rheological properties of these levels which can correspond to relatively plastic clays-rich horizons.

8. It is possible that the 2017 discharge measurements do not reflect longer-term conditions.

9. The crystal-rich magma would have encountered a preexisting structural discontinuity, probably compensating for the lack of buoyancy due to the high crystal cargo and triggering a lateral eruption.

10. During the LGM and the deglacial, turbidity currents may have been triggered by

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various mechanisms (earthquakes, storms, hyperpycnal discharge, submarine slope failure), which we are unable to resolve.

11. Compared to Site A and H, Site SA features only a single offshore record that may be unrepresentative for the entire region as absolute values of turbidite frequency and thickness strongly depend on site location.

12. This area of the Natal valley is possibly associated with volcanic seamounts which might be related to the EARS extension tectonics

III.

2. A 7. B 12. C

IV.

1. C 2. E 3. A 4. B

Chapter 7

I.

1. effects 2. delete "which" / which are 3. delete "be" 4. is emerging

5. grants 6. appreciate 7. the manuscript 8. anonymous

II.

1. E 2. B 3. D 4. A

III.

1. An alternative explanation for the marine turbidite depositional pattern at site H is related to the decreased moisture supply.

2. According to our continental data, temperatures of the lower mid- and low-latitudes were at the present-day level, or even a few degrees below,

3. In both the Middle and Late Miocene time slice, the higher mid- and high-latitudes were considerably warmer than present, independent of prevailing atmospheric pCO_2 conditions.

4. Although less clear-cut than those at the Perth Abyssal Plain microcontinents, changing

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plate boundary forces have also been proposed to have played a role in calving both the Seychelles and Jan Mayen microcontinents.

5. Our results are influenced by the timing of our experiments early in the melt season: Much more could be learned by repeating these tests during or after the monsoon season when the subsurface hydrology may become more developed after sustained large inputs to the system.

6. Earthquakes with magnitude reaching Mw 6.1 around the Davie Ridge and Mw 5.7 around the Europa–Bassas da India Islands occurred along the fault zone during the last decades.

7. Although we do not have access to the actual samples from these studies, the chemistry, mineralogy, and preparation procedures are nominally the same as our own, suggesting that there is an additional contribution to the bulk conductivity that cannot be accounted for by separately considering the electrical conductivity of olivine and melt.

8. A self-consistent study in which digital rock physics simulations are supplemented by impedance spectroscopy of the same samples, similar to Watson & Roberts (2011), would be immensely valuable to the field.

9. We speculate the existence of a thin, electrochemically distinct layer at the olivine-melt interface that might may account for the apparent discrepancy between the bulk electrical conductivities measured and those we computed using real partial melt geometries.

10. The electrical conductivity of the deformed sample, measured in the shear direction, overlapped the parallel mixing bound (i.e., electrical conduction through parallel pipes), which is consistent with deformation-induced melt segregation.

11. The Miocene Climate Optimum preceded the MMCT and was characterized by oscillating but reduced ice volume and high sea level.

12. Comparison with results obtained by Singh et al. (2012) indicates that dissolved Nd concentrations of seawater samples collected in June 2012 are generally 15%–25% lower than those of samples collected in November 2008.

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中国科学院大学研究生教材系列

学科英语写作教程：化学

Writing a Research Paper in Chemistry

总主编◎高　原　张红晖

主　编◎杜　朋

清华大学出版社

清华大学出版社

·北京·

内 容 简 介

本教程旨在帮助化学专业的同仁有效提高英文论文写作水平，介绍了学术论文写作的特点、要点，以及自建语料库的方法及其基本应用，通过课前引入、教学活动、常用表达积累等环节，循序渐进引导学生发现、学习并掌握各章节的重难点。附录部分还提供了常用化学词缀表、示例论文等拓展学习资源。本教材教学目标明确，学科特色鲜明，既可作为化学相关专业硕博研究生学术英语写作教材，也可作为学术论文写作的参考工具书。

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总　　序

2020 年 11 月，教育部新文科建设工作组发布的《新文科建设宣言》指出："文科教育融合发展需要新文科。新科技和产业革命浪潮奔腾而至，社会问题日益综合化复杂化，应对新变化、解决复杂问题亟需跨学科专业的知识整合，推动融合发展是新文科建设的必然选择。进一步打破学科专业壁垒，推动文科专业之间深度融通、文科与理工农医交叉融合，融入现代信息技术赋能文科教育，实现自我的革故鼎新，新文科建设势在必行。"学科英语是外语学科和专业学科相互交叉、彼此融合的产物，符合国家"新文科"建设的时代愿景。开辟外语学科建设的全新思路，是当前外语教学改革的重要突破方向。

"中国科学院大学研究生教材系列"将切实满足特定专业学生群体的英语学习需求作为教材编写的重要依据，充分考虑到具体学习者群体的学习目标和学习诉求，具有以实际应用为导向的根本特质。该系列教材不仅关注教材编写前期的需求分析，同时重视教材试用阶段使用者的实际反馈，因为我们认为，直面使用者反馈是确定教材价值的关键一环，是重新审视学习者需求的宝贵机会，更是反复改进教材质量的可靠抓手。

"中国科学院大学研究生教材系列"融入现代信息技术，运用语料库的数据处理方法，整理归纳学科英语的语言特点和语篇特征。语料库方法可以十分客观快捷地捕捉学术语篇中的词汇、短语、搭配、语块、句子结构等语言层面的使用规律，正在成为学术和学科英语研究领域新近涌现的热点之一。然而，语料库技术运用于教材编写的尝试却寥寥无几，该系列教材无疑为语料库方法运用于教材编写做出了开创性的贡献。语料库的运用不仅能够呈现自然学术语境中真实的语言使用，更为重要的是，能够引导学习者建立适合自己微观研究方向的专业文献语料库，并将其作为未来学术生涯的开端以及追随学术生命成长过程的见证。学科英语语料库一方面可以成为研究者文献阅读经历不断累积的记录，另一方面也可能成为研究者写作不竭的灵感源泉和他们未来指导学生进行

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专业写作的宝贵财富。基于学科英语语料库的教材建设在“授人以鱼”的同时也在“授人以渔”，而学习者也会因此获得“授人以渔”的能力。

我们正处在一个教育变革的时代。新的时代呼唤符合国家发展需求的教育理念和新颖实用的教学方法，同时也鼓励教师队伍努力探索新型的教材编写模式。“中国科学院大学研究生教材系列”积极响应时代的要求，是国家“新文科”建设指导思想下的勇敢尝试。

该系列教材的出版得到中国科学院大学教材出版中心资助，在此表示感谢。

高　原

2022 年 5 月

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前　言

21 世纪初，清华大学出版社曾出版过一本名为《英汉双语化学入门》的教材。该书曾入选教育部普通高等教育“十一五”国家级规划教材，是当时国内少有的着眼理工科专业英语的教科书。此书作者为已故中国科学院院士、南开大学化学系教授申泮文先生。他不仅以此教材为本科生开课，通过原汁原味的英语介绍化学专业基础知识，还在书中向读者传授了快速自学英语的方法。在当时的科学家群体中如此真诚关心学生英语学习之人实属罕见。

近年来，我国学者在国际科研舞台上扮演着日益重要的角色，而能否用英语在国际顶级学术期刊上发表论文无疑是衡量我国科研人员水准的主要依据之一。这就对我国科学专业领域的学习者和科研工作者的英文水平提出了更高的要求。拿化学专业来说，用英语撰写毕业论文并尽可能发表在国际期刊上已成为国内各大高校化学专业对研究生的基本要求。无论是为了应对眼前毕业需要还是为了谋求未来学术发展，英文专业论文写作能力的重要性不言而喻。

本教程旨在帮助化学专业的同仁更有效率地提高英文论文写作水平，在国际发表过程中少在语言问题上走弯路。

内容概览：

本教程共分为五章。第一章介绍如何自建专业语料库及其基本应用。第二章至第五章分别聚焦论文的 Introduction、Methods、Results 和 Discussion 部分，其中每章开头为 Corpus in Use 活动，引导学生利用自建专业语料库探索该章节所聚焦的论文部分的主要语言特点及难点；每章中间为一系列设计连贯的教学活动（Activity），用来操练各部分的写作重点；每章结尾按照写作逻辑和语言功能列出了该论文部分的常用功能语句（Functional Expressions and Sentences）。本教程还在附录部分为读者提供了常用化学词缀表（Appendix II Common Affixes in Chemistry）、常用化学缩略语和首字母缩写词表（Appendix III Common Chemical Abbreviations and Acronyms）以及一篇选自 *Nature Chemistry* 的示例论文

（Appendix IV Model Research Article）。全书活动练习配有答案（Appendix I Keys to Exercises）。

教程特色：

一、基于语料库编写。全书教学活动中所用的语言实例和常用功能语句均基于编者建立的化学专业语料库，利用语料库软件 AntConc 检索结果，辅以人工识别筛选而来。为了建立用于编写本书的语料库，编者收集了来自 *JACS*、*Nature Chemistry*、*Inorganic Chemistry*、*ACS Catalysis*、*Analytical Chemistry* 等国际期刊的论文共 280 篇，主要涉及无机化学（50 篇）、有机化学（50 篇）、物理化学（50 篇）、分析化学（50 篇）、高分子化学（50 篇）和其他专业方向（30 篇）。

二、授之以渔。本教程指导学习者自建化学专业语料库，并通过 Corpus in Use 活动帮助其练习使用语料库软件进行检索，传授学生自主探索本学科论文语言特点的方法。

三、精讲多练。本教程针对学生论文写作时的痛点和难点，设计了大量的教学活动（Activity），帮助学生高效、切实地提高论文写作能力。学生通常需要在活动中完成一个层层递进的学习过程，即“观察例文 → 理解逻辑 → 识别功能语句 → 练习功能语句用法 → 在语境中运用功能语句”。教学活动之间必要之处配有语言精练的讲解，既能帮助学习者进一步理解所学，也不会对非英语专业人士造成过大的阅读负担。全书的讲解部分均在灰色方框内，用斜体字呈现，例如：

The main purpose of the Introduction of a paper is to justify the research. ... so they can tell a better story based on the whole picture of the research. (See Page 9.)

教程适用对象：

化学及相关专业研究生；化学方向学科英语教师。

本教程既可帮助学习者短时间内掌握化学英语论文写作的核心，也可作为论文写作的案头参考工具书，还向读者介绍了自建学科语料库的学习方法。希望这本教程能为读者的科研论文写作与发表助一臂之力。并且，和申泮文先生一样，编者也祝愿化学专业的朋友们都能学好英语。

杜　朋

2022 年 6 月

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Chapter 1
Building Your Own Corpus

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1.1 What Is a Corpus?

A corpus is a principled collection of texts, written and/or spoken, which is stored on a computer (Biber et al., 1999). This collection of texts can be used for qualitative and quantitative analysis. This analysis can be carried out rapidly by using a computer.

There are several online corpora available, such as BNC (British National Corpus), BAWE (British Academic Written English), and COCA (Corpus of Contemporary American English). Learners of English can use them to improve their English by observing authentic language examples, which is more reliable than a speaker's intuition. For example, if you search for *lack* in BNC, you will get the following concordance.

much had nothing over, and he that gathered little had no	**lack**	, they gathered every man according to his e
New York Times saying: In looking at a painting today, " to	**lack**	a persuasive theory is to lack something cruc
because physical entities — such as neurons -	**lack**	certain qualities — such as intentionality or
this " homelessness " " anyway? Homelessness to me is a	**lack**	in any particular individual 's case of whateve
an do about our muscle type. The only way to minimise this	**lack**	is by yet further skill-acquisition. Yet no matte
tournament in every way, despite suffering from so many	**lack**	lustre performances from some of the leading
if an organism had a memory this bad it would ipso facto	**lack**	object permanence. Moreover, we know that
, the non-conserver is failing to exert central control (	**lack**	of " direction, inhibition, and co-ordination ")
hem with a clicking heels bow. Despite his almost complete	**lack**	of English and the poor Italian the others pos
than a harsh, faceless drive for productivity. Even the	**lack**	of a catchy slogan at the decade 's end (" Th
pensions and living alone had a car. The combination of	**lack**	of access to a car, difficulty in using public tra
rope, Amnesty released a document outlining the apparent	**lack**	of accountability of the security forces. Death
me, as if he could not quite believe my laughter and my	**lack**	of agitation. I smiled at both of them and told
a part of what is important to me. I do not suffer from a	**lack**	of ambition, I simply accept life as it is. " Man

Figure 1.1

By observing this concordance, we can see that *of* should not be used after the verb *lack*. For students who study chemistry, however, a chemistry-specific corpus needs to be built to enable these students to learn language features in chemical research articles.

1.2 How to Build a Chemistry-specific Corpus

You can build this chemistry-specific corpus by collecting chemical research articles. To guarantee the size of this corpus, you are expected to collect at least 30 full articles from your target journals. It may be difficult for an individual to build such a large corpus, but this can be done by working together with your classmates. You and your classmates can build your chemistry-specific corpus and learn how to use it in the following steps.

Step 1: Form a group of six people who have the same or similar research direction, e.g. inorganic chemistry.

Step 2: For each group member, find five full research articles published in recent five years from your target journal, the journal where you want to publish your article, e.g. *Journal of the American Chemical Society*. These articles should have at least four sections, including Introduction, Methods, Results, and Discussion. If you do not have a target journal, you can ask your supervisor for help.

Step 3: Collect the text documents (.txt) of the five articles. You can follow these steps:

1. Visit the target journal website and access the full text of the article you want to collect.

2. Copy the text, paste it to "记事本" on your computer.

3. Omit tables, figures, acknowledgements, supplementary information, and references.

4. Save the file by section (Abstract, Introduction, Methods, Results, Discussion).

5. Put the saved files into different folders.

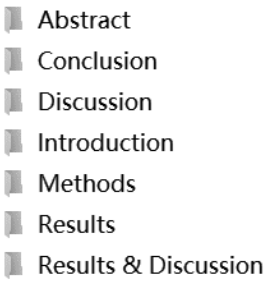

Figure 1.2

6. Congratulations! You have built your chemistry-specific corpus.

Step 4: Download a corpus tool.

1. Search "AntConc Laurence Anthony" in your search engine. Visit the official website of AntConc.

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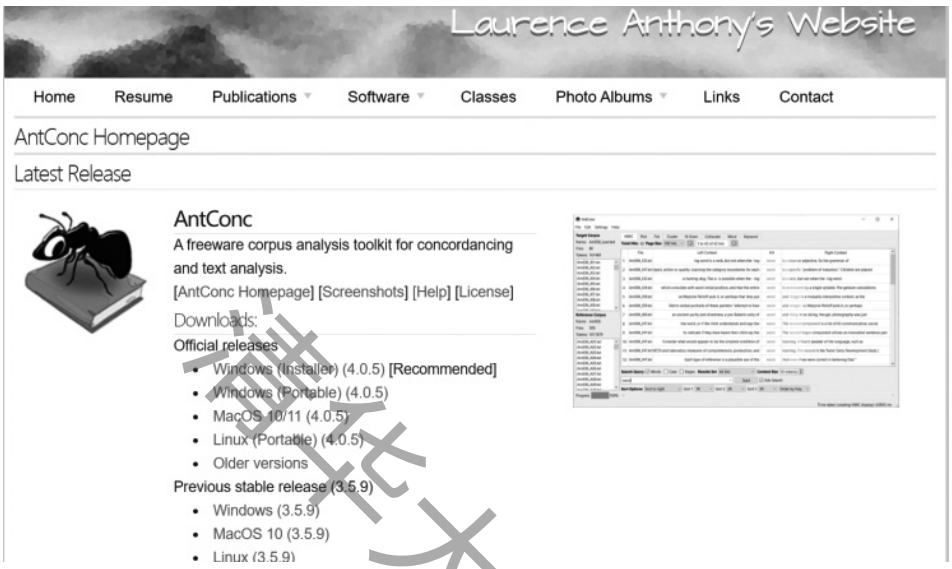

Figure 1.3

2. Download different versions of AntConc according to your computer system.

3. Click "Help" on the home page and learn the basic operation of AntConc. Use the corpus you just built for practice.

1.3 What You Can Do with Your Own Corpus

With you own chemistry-specific corpus, you will be able to investigate some interesting features of the language used in chemical research papers. For example, you can look at in what way the verbs *decrease* and *reduce* are used differently by using the "Concordance" function. You may get results like these.

mainly used in conventional CCC to	decrease retention time for analytes with large
only several milliseconds, and need to	decrease retraction velocity to reduce instability due
erties. Fluorescence lifetimes and quantum yields	decrease significantly upon bromide substitution on the
and stress at constant strain both	decrease slightly after the first cycle, suggesting
remedy or functional food to help	decrease stress and fatigue in health care [2,3].
isplaying a considerably high crystallinity. This	decrease suggests that PC71BM has merged
/z 202 and 216 show a disproportionately larger	decrease than the aliphatic ions (m/z 202
brain parenchyma cells is promising to	decrease the Ab burden [28]. However, insufficient BACE1
of H2O2 (100 μM) could remarkably	decrease the absorption of DPBF by 31%. Control
lithium-ion cell are favorable to	decrease the battery internal resistance due to
lithium-ion cell is favorable to	decrease the battery internal resistance due to
over 60 h with almost no potential	decrease. The catalyst is ideally suited for
lectron-withdrawing \xA8CCF3 group significantly	decrease the CTC formation through the steric

Figure 1.4

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peak resolution as well as to	reduce retention time [23\xA8C26]. Elution\xA8
5 -SNAP doped PVDF tubingcan more effectively	reduce risk of bacterial infections. Interestingly, com
self-discharge should be minimized. To	reduce self-discharge, it is appropriate to
, we report a new approach to	reduce self-discharge of supercapacitor based on
lower molecular weights were synthesized to	reduce severe aggregation to study the relationship
higher temperatures, however, their ROM rates	reduce sharply as their TT-CM conversion
SAPs showed that SAPs could effectively	reduce shrinkage, cracking potential, and change the
drug solubility, enhance therapeutic effect and	reduce side effects [1], [2], [3], [4], [5], [6], [7], [
3 perovskite, the(001) peak is observed to	reduce, simultaneously, new peaks atcorresponding to (11
to be a simple method to	reduce surface tension and to improve drop
at intraventricular injection of Infliximab could	reduce tau hyperphosphorylation significantly in APP/PS1
inter-molecular interac- tions, which should	reduce Tg [29,30]. PI-1, derived from the rigid
3 groups can also be effective to	reduce the absorptions at 1310 and 1550 nm.
of the PIs so as to	reduce the absorptions of C\xA8CH
be catalyzed.34, 35 Therefore, LTO may likewise	reduce the activation energy of the sulfolane (

Figure 1.5

From these concordances, we can see that *decrease* is used both as an intransitive and transitive verb, while *reduce* is often used only as a transitive verb.

1.4 How to Create a Chemistry-specific Word List

To many first-year chemistry postgraduate students, it is difficult to read research papers because of the large number of unknown words. If you have a list of words that are frequently used in the papers of your research direction, then you will be able to learn these words extensively. This would greatly improve your reading speed and efficiency.

You can do this by using the "Word List" function of AntConc. Load your corpus and click "Word List" button, and then AntConc will generate a word list of your corpus by frequency.

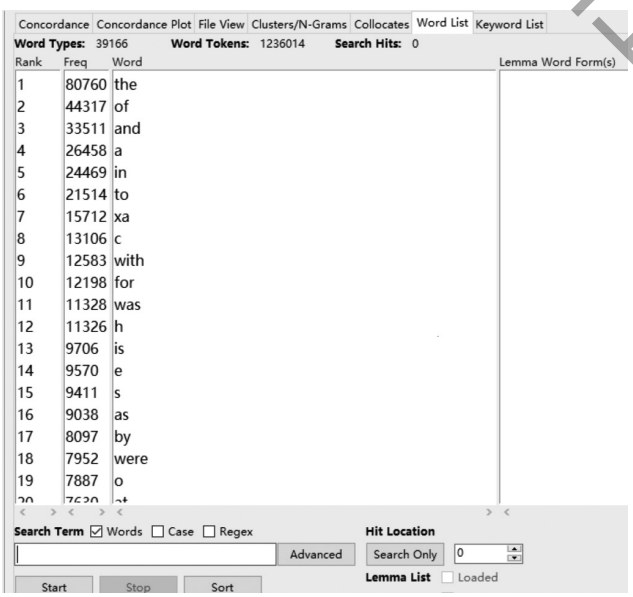

Figure 1.6

Of course, there are lots of unwanted words in this word list, such as articles, prepositions, pronouns, auxiliary verbs and words you have already known. You can work with group members to select the words that are meaningful to you and create your own word list specific to your research direction.

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Chapter 2
Introduction

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Corpus in Use

In addition to making a chemistry-specific word list, corpus tools can help us do many other things, especially in learning vocabulary. By searching a corpus, we can quickly find out how to use some confusable words by observing a large number of authentic language examples presented in the concordance. For example, *although* and *despite* are two words that often appear in the Introduction of a paper. Writers often use these two words to introduce an unsolved problem or to identify a knowledge gap. But these two words are used differently. Can you now find the difference by searching your own corpus and then complete the following tasks?

I. Combine these sentences using "*Although*…," to form contrastive statements identifying knowledge gap.

1. Little research has been reported on the application of amide functionalized carbon supports.
Many studies have reported the use of nitrogen doped carbon nanostructures.

_____

_____

2. Many researchers have designed novel endcapping agents to develop new imide resins.
Few studies on the imide oligomers derived from fluorinated phenyethynyl-contained endcapping agents could be found in the literature.

_____

_____

3. The identification of novel, non-steroidal RORg antagonists for therapeutic use still remains an urgent need.
Significant progress has been made in developing RORg antagonists.

_____

_____

II. Combine these sentences using "*Despite*…," to form contrastive statements identifying knowledge gap.

1. There have been encouraging advances during the past few years.
The NRR activity and selectivity are still far from satisfactory.

_____

_____

2. There has been no general and practical solution to allow for the use of amine bases in Pd-catalyzed C-N cross-coupling.
Researchers have made considerable efforts.

_____

_____

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3. We have achieved great progress in the development and optimization of triazolylidene carbenes as catalysts for enantioselective reactions.
Fundamental studies of these species are relatively limited.

_____

_____

Lead-in Questions

Despite other variations, many research papers adopt the following IMRD (Introduction, Methods, Results, and Discussion) structure. Work in pairs and discuss the following questions.

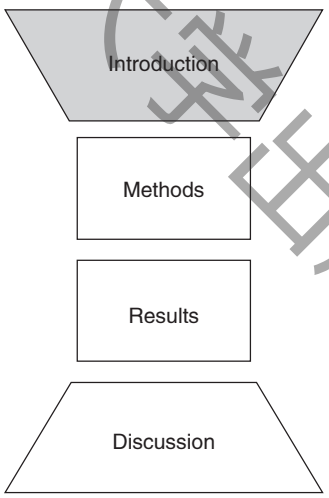

Figure 2.1

1. What is the purpose of an Introduction?

2. Why do you think in the above figure the Introduction section is drawn in that shape?

The main purpose of the Introduction of a paper is to justify the research. Writing an Introduction is like telling a story of why you decided to do your research and why it is worth doing. Although Introduction is always the first section of a paper, writers often start to write this section after finishing Methods, Results, and Discussion, so they can tell a better story based on the whole picture of the research.

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2.1 A Story to Justify the Research

• *Activity 1*

A. To justify your research, in the Introduction you need to tell readers the Known, Unknown, Question, and Approach. Match the description for each of them.

1. Known	**a.** Research aim, question, or hypothesis
2. Unknown	**b.** What is established or believed about the topic
3. Question	**c.** Ways to find out the answer to the question
4. Approach	**d.** Problems, knowledge gaps, possibilities

B. Read the following simplified Introduction. Identify the Known, Unknown, Question, and Approach.

① Steroids are a large family of physiologically and pharmaceutically important natural products. ② Previous studies toward the chemical synthesis of steroids have facilitated the development of steroid based drugs. ③ However, the additional biological functions of structurally unusual steroids, such as Aplysiasecosterol A (1), remain to be explored. ④ In this work, we aim to explore the biology of Aplysiasecosterol A by accomplishing the first and asymmetric total synthesis of (1) in a convergent fashion.

Source: Lu, Z., Zhang, X., Guo, Z., Chen, Y., Mu, T., & Li, A. (2018). Total Synthesis of Aplysiasecosterol A. *Journal of the American Chemical Society*, *140*(29), 9211–9218.

1. Known: Sentence(s) _____

2. Unknown: Sentence(s) _____

3. Question: Sentence(s) _____

4. Approach: Sentence(s) _____

In the simplified Introduction, are there any words and expressions signaling the Known, Unknown, Question, and Approach? Underline them and then compare your answer with your partner.

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C. Use some of the signal language you underlined in Exercise B to complete the following paragraph.

Recently, _____ have reported different kinds of strategies to achieve controllable generation of NO triggered by UV, vis, and even NIR light. _____, the poor tissue penetration of UV and vis as well as the low efficiency of NIR light significantly limits their effective applications. In this study, we _____ overcome these problems _____ introducing scintillating nanoparticles (SCNPs) as the energy transducers to convert the high-penetrating X-ray into UV-vis lights in situ, and further activate the surrounding photoactive donors to release NO.

Source: Du, Z., Zhang, X., Guo, Z., Xie, J., Dong, X., Zhu, S., Du, J., Gu, Z., & Zhao Y. (2018). X-Ray-controlled Generation of Peroxynitrite Based on Nanosized LiLuF4: Ce3+ Scintillators and Their Applications for Radiosensitization. *Advanced Materials*, *30*(43), e1804046.

Now look at the papers in your research field and highlight words and expressions signaling the Known, Unknown, Question, and Approach.

2.2 Big Issue vs. Research Question

In research papers, writers often tell a story about solving a problem. They tend to present this problem in the Introduction from general to specific. This means they need to identify the big issue that attracts attention in a certain research field and to state their own specific research question. It is important to understand the difference between the big issue and the research question.

• *Activity 2*

For each of the following sentence pairs, identify the big issue (BI) and the research question (RQ).

1. a. How to develop a method for monitoring the biological HClO in living organisms.
b. How to prepare a photostable and biocompatible fluorescent probes for accurate imaging of biological HClO in multiple living animals to assess the usefulness of this probe.

2. a. What are the chemical and biological functions of secosteroids, a subclass of steroids featuring a ring cleavage of the original tetracyclic framework?
b. What are the additional functions of structurally unusual steroids?

3. a. How to accurately isolate and detect disease-specific exosomes.

b. How to develop methods for direct exosome isolation and subsequent naked-eye, colorimetric, and electrochemical detection that avoid the use of a commercial "total exosome isolation kit"-based preisolation step commonly used in existing exosome-analysis methods.

2.3 Telling the Story

Readers may feel confused if they only know the big issue and the research question but have no idea where they come from. To make the story in the Introducton logical and easy to follow, writers also need to provide readers with more information, such as the background about the research topic, explanation of key terms, and the knowledge gap based on the Known and Unknown.

• *Activity 3*

Read the Introduction of a research paper and answer the questions.

Cancer, known as a life-threatening disease, causes millions of people to die every year due to its high metastatic diffusion capacity and fatality rate, and it significantly affects the human health and public safety. Early and accurate diagnosis of cancer, which may offer valuable information on enhancing the therapeutic efficiency and play a critical role in improving survival rate of cancer patients, is in great demand.

With the development of biological and medical techniques, tumor biomarkers appeared and served as important indices for risk assessment and early cancer detection. Unfortunately, traditional techniques, including X-ray, CT, and B ultrasound concentrating on morphological changes of tissues, cannot meet this demand, and they result in missing the best times for cancer therapy.

Given the problems above, considerable efforts have been devoted to developing novel biosensing techniques for cancer early diagnosis through identifying the abnormal expression of tumor biomarkers in biological samples. Among these techniques, the homogeneous electrochemical sensing strategy is regarded as an ideal tool due to its immobilization-free characteristic, which not only simplifies the operation procedure and lowers the detection cost but also avoids the steric hindrance effect to strengthen the recognition and response efficiency.

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However, it is worth noting, that these reported homogeneous electrochemical techniques have several of the following drawbacks. First, most of the previously reported homogeneous electrochemical strategies suffered from the complicated and expensive signal molecule-participated labeling procedure, making the development of homogeneous electrochemical biosensors more difficult. Second, in order to improve the sensitivity, such developed biosensors depend on enzyme-assisted signal amplification strategies, which failed to achieve fast detection and would heighten the cost. Third, all the homogeneous electrochemical biosensors commit themselves to single tumor biomarker detection, easily resulting in false positive diagnosis because the expression level of tumor biomarkers can also be influenced by other factors (inflammation and infection).

For the sake of addressing the issues above and as a continuation of our studies, we attempt, here, to develop a label-free and enzyme-free homogeneous electrochemical strategy for ultrasensitive and simultaneous detection of multiple tumor biomarkers.

Source: Chang, J., Wang, X., Wang, J., Li, H., & Li, F. (2019). Nucleic Acid-functionalized Metal-organic Framework-based Homogeneous Electrochemical Biosensor for Simultaneous Detection of Multiple Tumor Biomarkers. *Analytical Chemistry*, *91*, 3604 – 3610.

1. What is the general research topic?

_____

2. What is the big issue of this study?

_____

3. What is the knowledge gap?

_____

4. How is information about the knowledge gap organized?

_____

5. What is the research aim?

_____

6. How does the research aim connect to the knowledge gap?

_____

Now compare your answers with a partner and discuss what signal language may help you find out these answers quickly.

From Activity 3, we can see that an Introduction covers lots of information. This section therefore should be well-organized. A common organization of Introduction includes three major parts: Opening, Funnel, and Aim. In each part, writers focus on different purposes and tend to use signal language to indicate these purposes.

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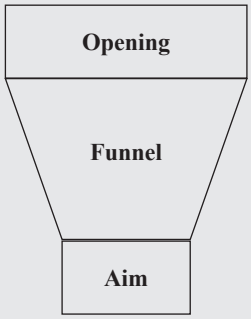

Figure 2.2

2.4 Writing the Opening

The opening part of an Introduction should engage and attract the reader's attention, so writers usually begin the Introduction with the significance of the research topic. They may also need to define and explain the key terms in this study and finally identify the big issue facing the research community.

• *Activity 4*

A. Read the first two paragraphs of the Introduction in Activity 3 and look at the opening sentences in the following paper. Work in pairs and discuss the purpose of the opening part.

CO_2 is a major greenhouse gas, contributing to global warming and climate change. The largest source of CO_2 emissions is from the burning of fossil fuels for heat, electricity, and transportation. The EU has committed to cutting greenhouse gas emissions to 80% below 1990 levels by 2050. The process of capturing CO_2 is the most efficient abatement technique in terms of tons of CO_2 removed from the atmosphere; however, the subsequent carbon storage has significant shortcomings, including high investment costs, uncertainty of potential long-term storage capacity, and increased public resistance.

Source: Wang, L., Yi, Y., Guo, H., & Tu, X. (2018). Atmospheric Pressure and Room Temperature Synthesis of Methanol Through Plasma-catalytic Hydrogenation of CO_2. *ACS Catalysis*, *8*(1), 90 –100.

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B. Read the opening of the following paper and identify the significance, key term and big issue.

① Steroids are a large family of physiologically and pharmaceutically important natural products. ② They often serve as signaling molecules for activation of steroid hormone receptors. ③ Despite the progress achieved in this field, the additional biological functions of structurally unusual steroids remain to be explored.

Source: Lu, Z., Zhang, X., Guo, Z., Chen, Y., Mu, T., & Li, A. (2018). Total Synthesis of Aplysiasecosterol A. *Journal of the American Chemical Society*, *140*(29), 9211– 9218.

• *Activity 5*

A. In the opening part, writers often use different expressions to establish the significance of the research in several ways. Put the expressions below in the correct category.

vital for	a promising tool	of great importance	extensively studied
a powerful technology	key role	be studied for centuries	economically important
useful method	low-cost	enormous interest	economically friendly

Research interest: _____

Usefulness: _____

Economic reasons: _____

Importance: _____

B. Use some of the above expressions to complete the following sentences.

1. Metal iodates have been _____ in the 1970s by Bell Laboratories.
2. DAPK plays a(n) _____ in a wide variety of cell death signaling pathways.
3. Nanocarriers are considered to be _____ in the delivery of drugs and genes.
4. Optically active organoboron compounds are _____ in synthetic chemistry.
5. Planting concrete has been regarded as a(n) _____ alternative to traditional impervious concrete.
6. DMFCs have attracted _____ as a potential green power source used for multi-functional electronic devices and vehicles.

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• *Activity 6*

A. Read the two texts in Activity 4 and write down the expressions signaling the big issue. Then read the papers you collected and see if you can find out more signal language for the big issue.

Text A:

Text B:

B. Use the words and expressions below to complete sentences.

however (×3)	although	despite	not…yet
remains unconquered	several limitations	a major problem	there is much room
remains challenging	rarely		

1. _____, _____ associated with sulfonated polyimides is their poor water stability.
2. _____ significant advances, _____ for improvement in efficiency, lifetime, and safety of metal and metal-ion batteries.
3. _____ the field of organic electronics has witnessed much progress in device performance during the past few years, _____ are holding back its further development.
4. _____, the largest challenge concerning the reliability of the catalyst _____.
5. Water-dispersed microcapsule formulations have _____ been industrialized _____ and even _____ reported.
6. _____, it _____ to develop therapeutic nanoparticles for brain diseases such as Alzheimer's disease.

2.5 Writing the Funnel

After the Opening, writers need to narrow the big issue down to the research aim or research question. This narrow-down part is often called the Funnel. In the Funnel, writers review previous studies, construct a knowledge gap, and justify their research question by referencing to literature, including published research articles, review articles, books in a given field, etc.

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• *Activity 7*

A. Read the following Introduction and put the Funnel (a–d) into the right order.

Steroids are a large family of physiologically and pharmaceutically important natural products. They often serve as signaling molecules for activation of steroid hormone receptors. However, the additional biological functions of structurally unusual steroids remain to be explored.

a. In 2015, Kigoshi, Kita, and Kawamura reported the isolation of Aplysiasecosterol A from the sea hare Aplysia kurodai. This secosteroid possesses an unprecedented tricyclic γ-diketone core attached by a densely substituted cyclopentane moiety.

b. Studies toward the chemical synthesis of steroids have facilitated the development of steroid based drugs and the evolution of the strategies and methods for the construction of polycyclic molecules. In the past decade, the renaissance in this area resulted in a series of elegant syntheses of structurally and biologically interesting steroids, such as batrachotoxinin A, cephalostatins, cortistatins, cyclocitrinol, cyclopamine, dafachronic acid A, hydroxysarmentogenin, nakiterpiosin, and ouabagenin.

c. However, the biology of Aplysiasecosterol A has not been sufficiently explored, presumably due to its natural scarcity, posing a considerable challenge for a de novo synthesis.

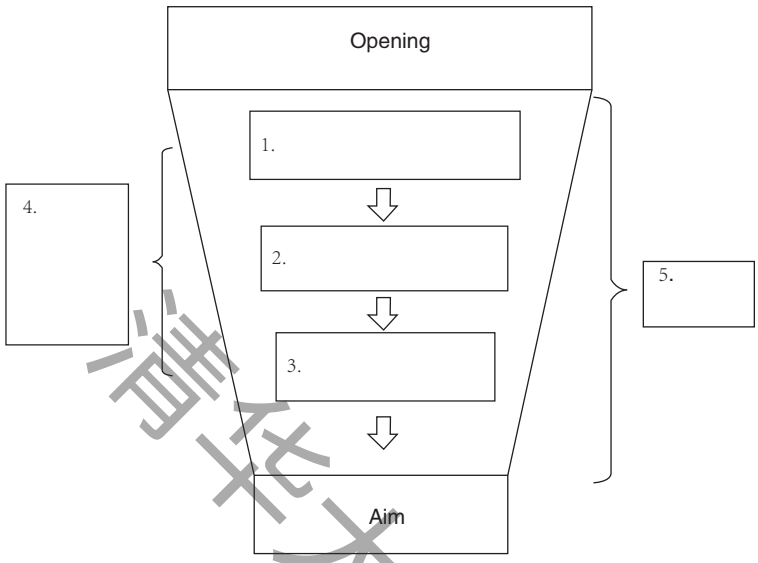
d. In 2016, Sung, Sheu, Wu, and co-workers reported the isolation of pinnigorgiols A, B, D, and E (4−7) from the gorgonian Pinnigorgia sp., which share an Aplysiasecosterol A type scaffold and vary slightly in their side chains. Interestingly, 4 was found to induce apoptosis of hepatic stellate cells via the ROS−ERK/JNK−Caspase-3 signaling pathway.

Herein, we report the first asymmetric total synthesis of Aplysiasecosterol A.

Source: Lu, Z., Zhang, X., Guo, Z., Chen, Y., Mu, T., & Li, A. (2018). Total Synthesis of Aplysiasecosterol A. *Journal of the American Chemical Society*, *140*(29), 9211–9218.

B. Use the words and expressions below to compete the diagram.

Funnel	Specific Studies	Framing the Knowledge Gap
Overview of Previous Studies	Knowledge Gap	



• *Activity 8*

A. Read the following paragraph and identify the signal language highlighting the knowledge gap.

The development of methods that generate enantioenriched N-alkylated indoles has been an active area of research for the past few years. The majority of these processes involve the enantioselective N-allylation of indoles with electron-withdrawing groups or with substituents blocking the C3 position. In addition, two-step procedures including N-allylation/oxidation of indolines and N-allylation/Fischer indolization of aryl hydrazines have been developed. Despite these notable advances, methods for highly enantioselective N-alkylation (nonallylic alkylation) of indoles with broad substrate scope remain rare. The difficulty in controlling regioselectivity in indole alkylation reactions originates from the nucleophilic character of the indole, with the C3 position being much more nucleophilic than N or other positions. We hypothesized that if the indole could be employed as an electrophile instead of as a nucleophile, alkylation reactions could potentially occur at positions other than C3.

Source: Dennis, J., White, N., Liu, R., & Buchwald, S. (2018). Palladium-catalyzed Carbon−nitrogen (C−N) Bond Formation Has Become a Valuable Tool in the Modern Synthesis of Structurally Complex Target Molecules. *Journal of the American Chemical Society*, *140*(13), 4721–4725.

Read the papers you collected and find out more signal language of this kind.

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B. A common way to highlight a knowledge gap is to use a negative subject to begin the sentence. This kind of subjects often include the following nouns: *research, study, work, investigation, attempt, information, researcher, attention*. Which of these nouns are countable and which are uncountable? Put the countable and uncountable nouns respectively into the correct box below.

However, few [ ] ... However, little [ ] ...

C. Use the above two structures to revise the following sentences to highlight the gap.

1. X has been reported on the application of amide functionalized carbon supports.

_____

2. X are carried out directly using corrosive biofilm in the rust layer.

_____

3. X has been focused on the utilization of sulfone units in helicene synthesis.

_____

4. To our knowledge, X have been carried out on the correlation between the microstructure and gas separation performance of polyimide membranes.

_____

5. There are relatively X about the influence of anions on the crystal structures of L so far.

_____

2.6 Writing the Aim

At the end of an Introduction is the Aim, where writers often state research aim, research question or hypothesis. For many chemistry papers, writers also briefly introduce the experimental approach in this part.

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• *Activity 9*

Read the following two texts and the text in Activity 8-A, and then identify the signal language highlighting the research aim, research question, hypothesis and experimental approach.

Consequently, the crucial boundaries between the physiology and pathology of BACE1 indicate that its expression must be precisely regulated, allowing the enzyme to perform its physiological functions while avoiding serious consequences of over-or under-expression. The BACE1 antisense (BACE1-AS) is a natural antisense transcript non-coding RNA that regulates BACE1 expression. The reduction of Ab by BACE1-AS knockdown with specific siRNA has been demonstrated previously via 14-day continuous pump-mediated infusion. Herein, we aim to achieve the BACE1-AS down-regulation through the less invasive intravenous administration by delivering the BACE1-AS shRNA encoding plasmids (pshBACE1-AS), which are more stable in circulation than siRNA.

Source: Liu, Y., An, S., Li, J., Kuang, Y., He, X., Guo, Y., Ma, H., Zhang, Y., Ji, Bin., & Jiang, C. (2016). Brain-targeted Co-delivery of Therapeutic Gene and Peptide by Multifunctional Nanoparticles in Alzheimer's Disease Mice. *Biomaterials*, *80*, 33–45.

With regard to chiroptical phenomena leading possibly to non-linear optics applications, circularly polarized luminescence (CPL) has been studied in the past and more recently, CPL exhibited by simple hexahelicenes, like carbo [6]-helicene, the shortest configurationally stable helicene at room temperature, however was rather weak, whereas other putative systems for non-linear optoelectronics, such as inherently chiral thiophene systems, were found to exhibit significant CPL both in monomeric, dimeric and higher-order oligomeric forms.

In this work, we wish to examine whether and to what extent the presence of hetero-atoms in the helicene backbone could promote a CPL response, since in previous work, the presence of a nitrogen atom in the hexahelicene backbone in position 2, leads to an increase in CPL.

Source: Abbate, S., Bazzini, C., Caronna, T., Fontana, F., Gangemi, F., Lebon, F, Longhi, G., Mele, A., & Natali Sora, I. (2007). Experimental and Calculated Circular Dichroism Spectra of Monoaza Helicenes. *Inorganica Chimica Acta*, *360*, 908–912.

Read the papers you collected and find out more signal language of this kind.

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• *Activity 10*

A. It is important to use specific language to signal the reader that you are stating the research aim, research question or hypothesis. Use the expressions in the box to rewrite the sentences below.

In this work, we examine…	Herein, we investigate…
The purpose of this study is to determine…	In this study we hypothesized that…

1. Is PhABCG1 involved in VOC emission?

_____

_____

2. What are the preferred pathways for CH_3OH formation from CO_2?

_____

_____

3. What types of Pd-Cu bimetallic alloy structures on the surface facilitate CO_2 hydrogenation to CH_3OH?

_____

_____

4. Both transmittance and reflectance spectra are probably appropriate for sensing experiments with these MCM structures.

_____

_____

B. Some other verbs are also used when stating a research aim. Use the verbs in the box to complete the sentences below.

report	identify	analyze	design	test	explore

1. The goal of this study was to _____ the active constituents of N. chinensis.

2. In this work, we decided to _____ the robustness of diradical 2 toward evaporation.

3. With these in mind, we aim to _____ an inorganic–organic hybrid lead-halide semiconductor.

4. Inspired by this, we are fascinated to _____ more interesting structures and properties of sulfonic ligand MOFs.

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5. In this study, we _____ the successful application of structure-based virtual screening in novel RORg antagonist discovery.
6. The purpose of the present study is therefore to _____ the effect of applying urea modified multiwall carbon nanotubes as support for Pt nanoparticles.

• *Activity 11*

A. Match signal language for an experimental approach with its corresponding research aim, research question or hypothesis.

1. In this work, we question whether…	**a.** To test this hypothesis, we…
2. Herein, we investigate…	**b.** For this purpose, we…
3. The purpose of this study is to determine…	**c.** To answer this question, we…
4. In this study we hypothesized that…	**d.** For this investigation, we…

B. You can write a separate sentence to introduce the experimental approach after stating the research aim, research question or hypothesis. Match the questions and approaches below. Then use some of the signal language in A to write two cohesive sentences.

Questions	Approaches
What is the samples' effect on the resistance to carbon deposition and catalytic activity?	Used the simple solvent-swelling method.
Is it possible to impregnate a synthetically fluorinated NO donor into fluoropolymers?	Tested samples prepared with glycine, urea and without fuel.

1. _____

_____

2. _____

_____

C. You can also use linking words to combine the sentence stating the research question and the sentence introducing the experimental approach. These linking words include *by*, *using*, *by using*. Use them to respectively combine the two pairs of separate sentences you wrote in B into two signal sentences.

1. _____

2. _____

编委会内部资料

Functional Expressions and Sentences

A. Establishing the significance of the general research topic

* *X is vital for...*
* *X lays the foundation for…*
* *X is of great importance for...*
* *X has been widely investigated by…*
* *X has attracted extensive studies on…*
* *X may also play an important role in…*
* *X is fundamental to Y since it enables…*
* *X, which…, provides a promising tool for…*
* *X has received particular attention because...*
* *X is of significant importance. For example,...*
* *X is one of the most promising approaches to...*
* *X is the most powerful technology to analyze…*
* *X has demonstrated to be an excellent tool for…*
* *Understanding of X is of extreme importance for…*
* *Over the last decade, X has found applications in…*
* *X has received attention for its potential ability to...*
* *X is widely used in many industrial fields, such as...*
* *Because of…, X has attracted significant attention.*
* *X has been a well-known phenomenon for centuries.*
* *X is essential for many biological processes, such as…*
* *X as...is one of the most promising technologies to...*
* *X has been studied for centuries and it is now related to...*
* *For this reason, X has attracted enormous interest from…*
* *Accordingly, X is of great significance, which is helpful to…*
* *In the past decades, X has attracted great attentions owing to...*
* *X has been regarded as one of the most promising methods to...*
* *X could significantly improve the survival rate of patients with...*
* *X and its compounds are extensively used in different industries such as…*
* *X has attracted considerable interest across the scientific community for decades.*
* *X has received increasing attention as the promising…due to the advantages of...*

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* *A growing body of theoretical and experimental research is attempting to understand…*
* *X has attracted tremendous attention because of its crucial roles in various fields, such as...*
* *X differs significantly from Y due to…, which may find application in many areas, such as…*
* *X, which usually refers to…, is one of the most widely used strategies during the past decades.*
* *X has been extensively applied as...in many fields due to its attractive characteristics of...*
* *X has currently attracted enormous research interest because of its great promising use for a wide range including...*
* *In recent years, X has shown enormous progress primarily due to an emergence of...and the development of...*
* *X, which..., has emerged as one of the most promising strategies to solve serious environmental and energy problems.*

B. Identifying the big issue

* *X poses a serious threat to...*
* *X raises great concerns about…*
* *An important question related to…is…*
* *Up to now, it is still a great challenge to…*
* *However, the issue of…cannot be ignored.*
* *However, X poses a technical challenge for...*
* *X has caused severe…pollution, particularly in...*
* *X has become a serious environmental problem in…*
* *Therefore, X has been of a long-standing concern in…*
* *The lack of X remains a key barrier for the use of technology to...*
* *However, X is severely impeded because of its...(disadvantages)*
* *Although X is frequently used to..., Y often has adverse side effects.*
* *Nevertheless, X is…(disadvantages), which greatly restricts its application.*
* *However, only a small number of X can..., which restricts the application of Y in...*
* *X has become a critical environmental problem worldwide and is particularly apparent in...*
* *X, which has been widely used to prepare Y, is not preferred for environmental reasons currently.*
* *Although X might be effective to some degree, its widespread application is restricted because of...(disadvantages)*

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C. Introducing recent research development in general

* *Early studies suggested…*
* *Up to date, studies have shown…*
* *Several studies have investigated…*
* *…experiments have revealed that…*
* *…materials have been explored for...*
* *…has been revealed by many studies.*
* *A line of studies has demonstrated that...*
* *Research efforts have largely focused on…*
* *Several strategies have been explored for...*
* *Tremendous efforts have been devoted to…*
* *In recent years, X has been regarded as an emerging…*
* *Various methods have been used to…, such as…*
* *X has so far been the dominating…reagents for…*
* *Recent research attempts focus on… For example,…*
* *Since the first report of X, …has been explored for…*
* *Recently, X has emerged as promising materials for…*
* *…strategy has been originally coined and developed since…*
* *Various…systems have been exploited based on…to achieve…*
* *In particular, significant progress has been reported recently on…*
* *To date, a wide range of…applications have been demonstrated.*
* *In recent years, X has been identified as a promising approach to…*
* *Intensive research efforts have been made to design and synthesize…*
* *X is extensively studied due to the excellent properties. For example,…*
* *Since the discovery of X, a wide interest in the study of…has emerged.*
* *In the last 20 years, rapid development of X has provided effective ways to…*
* *Over the past 15 years, substantial progress has been made in understanding how…*
* *In the last few decades, considerable progress has been made in the development of X.*
* *Over the last few years, the design and application of... have achieved great successes.*
* *X has been developed over the last two decades for various applications ranging from…to…*
* *X, another effective strategy, ...(advantages) and thus has been widely utilized for Y in recent years.*
* *In recent years, considerable efforts have been devoted to X because of its wide applications in...*
* *Recently, considerable efforts have been invested/given to X because it exhibits unique*

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properties, such as...

* *A study of the X therefore provides an opportunity to…, in addition to expanding our limited knowledge of...*

D. General reference to previous research: highlighting paucity of research

* *It still remains challenging to…*
* *However, this approach cannot…*
* *Despite…, it is unclear whether…*
* *To our knowledge, no studies have...*
* *However, how X relates to Y is unknown.*
* *However, X has largely been overlooked.*
* *In terms of...research, X remains unstudied.*
* *Hence, X has not been solved systematically.*
* *However, little attention has been focused on…*
* *However, until now, X remains poorly understood.*
* *By now, only a handful of studies have focused on…*
* *However, …remains an unsolved challenge due to…*
* *At present, few…have been successively developed.*
* *X is still not clear as there are few studies in this area.*
* *Consequently, the development of X is in great demand.*
* *However, X suffers from significant limitations including…*
* *The intrinsic challenge of…makes it difficult to develop…*
* *Unfortunately, most of the involved systems are limited to…*
* *While X has been investigated, Y remains largely unexplored.*
* *However, X will lead to…and…will aggravate the problem.*
* *However, the mechanism of X has not yet been fully elucidated.*
* *However, this simplistic mechanism has recently been challenged.*
* *Multiple studies have demonstrated..., yet X remain to be explored.*
* *Although Diels–Alder reactions represent…, challenges in…do exist.*
* *However, the molecular mechanisms that...are incompletely understood.*
* *Currently, there are no specific methods to…and…could only rely on…*
* *However, X still remains a great challenge, limiting its practical application.*
* *One possibility to improve X is to…, which comes at a cost of...*
* *Owing to…, X possess poor…, therefore, leading to an unsatisfactory effect.*
* *Although…, the critical issue of… still encourages the community to advance...*
* *X, however, is not completely understood due to relatively few studies in this field.*

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* *However, to our knowledge, investigations in recent years have provided no data on...*
* *According to our understanding, to date successful use of X has not yet been published.*
* *Unfortunately, although X has been frequently reported, ...is hitherto scarcely known.*
* *Clearly, X causes a great challenge for the fabrication of...to achieve best performance.*
* *However, most of the previous studies only focused on..., and systematic studies on... are still scarce.*
* *While the fundamental chemistry of X is fairly well understood, there is surprisingly little information on Y.*
* *Although this method is an efficient strategy for…, it is inapplicable to…*
* *To date, X has received little attention.*
* *Despite…, X often remains a serious bottleneck for long-term measurements.*
* *Another major challenge is to…*
* *Some…systems have been developed to…, exhibiting remarkable effects, but it is inescapable to face the limitation of…*
* *Although X has been described extensively in a range of...globally, the literature describing the presence of X is limited.*
* *Even though X is now well established, few studies have successfully applied it to Y and there is currently no consistent way to Z.*

E. Reporting findings of previous studies

* *It was reported that…*
* *It was also found that…*
* *Most research to date has shown that…*
* *Previous studies have identified X...*
* *Previous studies have shown that…*
* *Plenty of evidence suggests that…*
* *Recent research has demonstrated that…*
* *Recent studies increasingly consider…*
* *Recent studies showed/reported that….*
* *Recent studies/investigations have shown that...*
* *Several studies describe...*
* *Some studies have shown that…*
* *Other studies have pointed out that…*
* *Some researchers have proposed that…*
* *The methods for...mainly include...*
* *The commonly used methods include...*

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* *The latest findings provide further evidence...*
* *The factors responsible for this change may include...*
* *Genome-wide transcriptomic studies have identified...*
* *Animal and human experiments have provided evidence for...*
* *Some recent theoretical models and mechanisms have been proposed to provide guide and reference for future development of...*

* *X is known to…*
* *X has been applied to…*
* *X was found to exhibit …*
* *X was found…in our previous work.*
* *X is considered an important component of...*
* *X, which has been reported to have…effect on…*
* *X has become a popular and useful analytical tool in...*
* *X is capable of yielding a high level of…under…even with…*
* *X has previously been shown to have good potential to reduce...*
* *X has been shown to impact..., leading to increased incidence of...*
* *X was also found to…, although no structural detail has yet been reported.*
* *X has enabled…and paved the way toward commercially available devices.*

* *Previously, we reported...*
* *Previously, Thomson et al. (2013) demonstrated that X impairs...*
* *Recently, Thomson et al. (2013) reported that…*
* *Recently, scientists proposed a novel method to…*
* *Recently, …was reported by Hou and co-workers.*
* *Recently, a small number of…have been studied due to…*
* *Recently, some investigators have demonstrated the application of…*
* *Recently, an alternative process for…was proposed and studied in detail.*
* *Recently, a novel approach for…was developed and high performance has been demonstrated.*
* *More recently it has been shown that…*
* *Very recently, ...has achieved a high PCE of...*
* *Very recently, ...has been reported by Thomson et al. (2013).*

* *In our previous works, we showed that…*
* *In subsequent studies, X was found to…*
* *In recent works, …has been manifested by...*

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* *In the past years, ...has been designed for…*
* *At present, the commonly used...materials are...*
* *Until now, various…have been constructed and showed enhanced activity.*
* *To improve the efficacy of X and reduce side effects, numerous strategies have been proposed in recent years, such as…*
* *In this context, several studies focused on..., with a wide variety of additives, have been published.*
* *The ingestion of X has shown to have negative effects on... from different environments in laboratory-based studies.*

* *Thomson et al. (2013) investigated…*
* *Thomson et al. (2013), using..., observed that…*
* *Thomson et al. (2013) reported the evidence of…*
* *Thomson et al. (2013) reported that..., particularly...*
* *Thomson et al. (2013) demonstrated for the first time that...*
* *Thomson and co-workers briefly reviewed the most relevant…studies on…*
* *…was revealed by Thomson et al. (2013).*
* *…has been reported by Thomson et al. (2013).*
* *One of the earliest...was reported by Thomson et al. (2013).*

F. Highlighting a knowledge gap in the research field or weaknesses of previous research

* *X shows a great challenge to...due to...*
* *X is not suitable for industrial production.*
* *A major disadvantage of this approach is...*
* *One problem is that… Another problem is that…*
* *In particular, it is extremely difficult to achieve…*
* *Overall, due to..., ...is still not entirely understood.*
* *So far, it is not possible to completely…in any…method.*
* *This strategy allows for…, but restrictions currently exist for…*
* *This means that a crucial link in understanding...is still to be established.*
* *Some serious disadvantages of X limit the development of Y, for instance, ...*
* *At the same time, the...problem in actual industrial production cannot be ignored.*
* *While extensively developed, X usually exhibits low levels of…and the scope of Y remains limited.*
* *Only X was reported for the...method, which needs further improvements to meet the requirements of practical applications.*

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* *Although…, …is difficult.*
* *Although..., it is constrained by...*
* *Although X represents..., it may not thoroughly predict...*
* *Although X has been frequently reported, Y was usually absent in the...*
* *Although this method is an efficient strategy for…, it is inapplicable to…*
* *Although all these methods are able to..., they commonly lack sensitivity for...*
* *Although this method allows for..., X still constitutes an analytical challenge for...*
* *Although the performance of X has been improved, there are still some drawbacks in..., for example, ..., which may limit the further efficiency improvements of…*
* *Even though…, few studies have successfully applied…and there is currently no consistent way to...*

* *However, one limitation of X is...*
* *However, ...has remained unclear.*
* *However, such a method is unable to…*
* *However, X remains a challenge, because of...*
* *However, the realization of…is still challenging.*
* *However, the details of X remain to be elucidated.*
* *However, its key problem for industrial application is...*
* *However, …, making detection and analysis extremely challenging.*
* *However, as far as we know, no attempt has been made using this kind of X to…*
* *However, ...of using X has yet to be studied.*
* *However, X has some disadvantages such as…, leading to limitations in its widespread application and commercialization.*

* *Despite the importance of…, studies have rarely focused on…*
* *Despite the early success in…, …limits its further application.*
* *Despite the above-mentioned pioneering work, X has not been evaluated systematically.*
* *In spite of numerous studies on X, surprisingly little is known about the effect of Y.*
* *Nevertheless, there remain several shortcomings:…*
* *Nevertheless, X is rarely studied because of lacking…*
* *Nevertheless, most of the reported reactions show low...*

* *To the best of our knowledge, X is yet to be reported.*
* *To the best of our knowledge, X has not been reported yet.*
* *To the best of our knowledge, the application of X has not been reported.*

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G. Stating the research aim or research question

* *The aim of this study is to…*
* *...is also presented and discussed.*
* *We here report the development of...*
* *The effects of X were also investigated.*
* *As far as we are aware, this study focuses on…*
* *In addition to exploring…, we also investigated...*
* *In continuing our effort, here we report...by using…*
* *Here/Herein, we report/study/present/describe/evaluate/...*
* *The objectives of this study were to detect...and to discuss...*
* *The effects of several factors on...were evaluated in this study.*
* *Additionally, we aimed to highlight whether..., thus providing insights on…*
* *We aimed to study/explore/investigate/examine/evaluate/demonstrate/determine…*
* *The work presented here is part of a series of studies in which we aim to understand...*

* *In the present study, we investigated...*
* *In this work/study, we report/focus on…*
* *In this paper, further attempts were made to explore...*
* *In this study, we proposed a novel linkage strategy for...*
* *In this study, to attain a significant improvement in…, we…*
* *In this work we compare and contrast…, with a particular focus on…*
* *In this work we wish to examine whether and to what extent X could…*
* *Throughout this paper, X will be investigated and it will be discussed in view of…*

* *To address this issue, we performed...*
* *To verify our hypothesis, we aimed to...*
* *To explore X, therefore, herein we report…*
* *To mitigate these challenges, we have demonstrated...*
* *To overcome these drawbacks, X has been widely studied.*

* *Hence, there is an urgent need to develop…*
* *Therefore, this work studies... and aims to...*
* *Therefore, in this study, we primarily focused on…*
* *Therefore, in order to find out X, a new approach for...was proposed.*
* *Therefore, a comprehensive analysis that can detect X is urgently needed.*
* *Therefore, in this paper, X is studied in detail, by evaluating the main factors, and their*

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possible interactions, in order to optimize it.

* *Thus, there is an utmost urgency to develop X that could compensate for the shortcomings of...*

H. Stating the research hypothesis

* *We thus hypothesized that…*
* *We therefore inferred that…*
* *Therefore, we hypothesize that…*
* *The effect of X may have an impact on...*
* *As a consequence, we can suppose that…*
* *Based on our previous results, we hypothesized that…*

I. Highlighting the significance and novelty of the research

* *Therefore, this work shed light on…*
* *Here we investigated for the first time...*
* *Our research opens a new strategy to…*
* *Thus, better understanding X will enable…*
* *This work may provide a new insight into...*
* *Our study is the first thorough investigation that…*
* *Thus, this work lays the foundation for understanding…*
* *Therefore, it would be of great significance to develop…*
* *This work provides a unique platform and resource for...*
* *More importantly, X would open a window to real applications.*
* *The findings in our study will provide valuable information for…*
* *This study not only provides a possible insight into…, but also paves the way for…*
* *The exploration of X may not only widen the scope of…but also provide a clearer understanding of…*
* *This work demonstrates the potential of organic materials in…, thus making way for the application of…*
* *Therefore, a new strategy of...within the physiological range would significantly expand the application areas.*

J. Summarizing the research design and methods

* *Here, we used X to…*
* *We used X as a novel tool to...*
* *We establish a methodology to...*

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* *Also, we characterized X using...*
* *In this study, we generated X using...*
* *Specifically, we investigated X using...*
* *In this work, we propose a method to…*
* *In this work, we design and synthesize…*
* *Herein, we engineered a novel tool for…*
* *In the current work we have used X as Y to...*
* *To circumvent the..., X has been developed to…*
* *Herein, we fabricate X to increase the efficiency.*
* *Our X strategy first involved... Next, ... Finally, ...*
* *Here we report a(n)…approach enabled by the…to…*
* *On the basis of…, we developed a new method to…*
* *In this work, we designed and synthesized a novel...*
* *To overcome these bottlenecks of…, we designed X.*
* *Based on the above considerations, X was designed.*
* *The property of X was studied by a series of methods.*
* *Therefore, X would be an effective method to realize Y.*
* *We design a(n)…molecule for the robust synthesis of…to…*
* *Three different preparative approaches were developed.*
* *The analytical methods developed for X detection include...*
* *X has been designed for developing the ligand-gated channel.*
* *The chemical structure of X was characterized by...(instruments).*
* *X is adopted as a promising strategy for further development of...*
* *In this work, X was prepared via...method and Y was obtained by...*
* *In order to achieve…, X should be optimized to be...to prevent the...*
* *We monitored and characterized X by different techniques, including...*
* *Based on these considerations, in this work, we design and synthesize…*
* *A test compound of...was selected for detailed mechanistic investigation.*
* *We systematically compared...and we performed detailed comparison of...*
* *We focus on the development of a(n)…strategy for comprehensive…analysis.*
* *In this paper, we chose X as..., and integrated it into one molecule via...*
* *X was identified, and Y was evaluated via...based on the identified products.*
* *This paper presents an extended...model which takes into account the influence of...*
* *In this work, quantum chemical simulations and experiments are combined to establish…*
* *Herein, we will discuss...of X, summarize several methods for X formation and its future perspectives.*

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* *We used a combination of...approaches to elucidate and determine the fundamental mechanisms...*
* *This manuscript presents a(n)... strategy that consists of three phases. The first phase is... The second phase is... The third phase is...*

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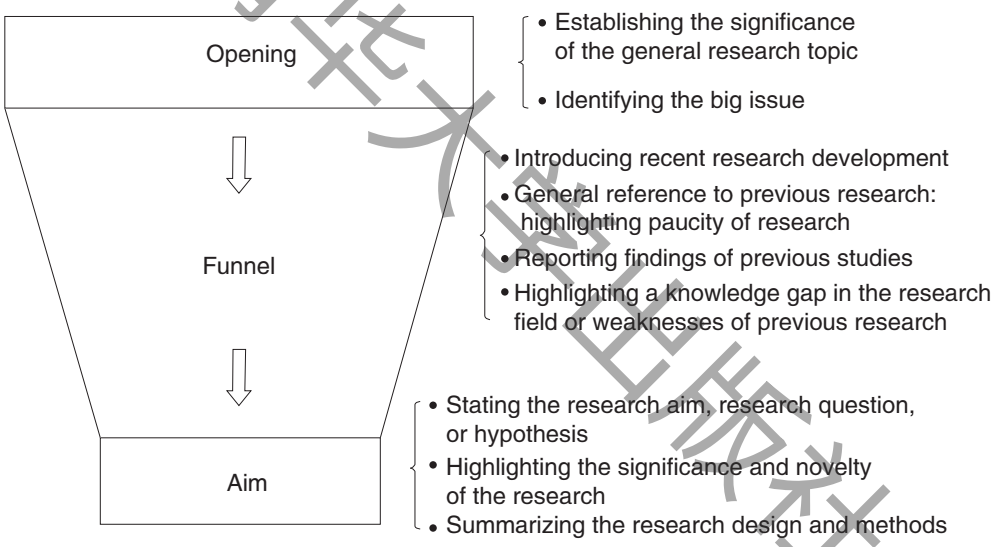
Assignments

• *Reading*

Read the Introduction section of the article in Appendix IV. Try to find out the functional expressions and sentences according to the following model for Introduction.



• *Writing*

Review what you learned in this chapter and use the above model to write an Introduction for your current or undergraduate research topic.

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Chapter 3
Methods

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Corpus in Use

As we all know, prepositions are difficult for many English learners. A large number of prepositions will be used when describing chemical reaction conditions, such as temperature, concentration, air pressure and experimental instruments in the Methods section of a paper. To solve this problem, you can explore the use of common prepositions such as *in*, *at*, *by*, *with* and *to* in the Methods section by investigating in your own corpus.

Investigate your corpus and fill in the blanks with appropriate prepositions.

1. As shown _____ Figure 4, a bright image was observed _____ the red channel.
2. In the case of the hydrated sodium ion in perchlorate solution, the main peak is observed _____ 2544 cm\xA8C1.
3. However, these polysodium ions have never been observed _____ aqueous solution.
4. As discussed _____ Section 3.5.1, Pd-Cu (0.50) still consists of phases other than the dominant Pd-Cu alloy phase.
5. As has been demonstrated _____ previous studies, organic polymer materials have advantages over inorganic substrates.
6. As can be seen _____ a comparison of the two tables, peak oxygen uptake and exercise capacity are reliable predictors of quality of life.
7. It was coupled _____ a bundle of 8 400 \xA6\xCCm-core optical fibers as an excitation source.
8. All measurements were performed _____ room temperature.
9. Adsorption energies were calculated _____ \xA6\xA4E.
10. The number density of the particles was calculated _____ the total amount of gold used for the synthesis.
11. The detection limit that was then calculated _____ the following equation.
12. The emission signal was collected _____ the same objective and analyzed _____ an Acton spectrometer equipped _____ a liquid helium cooled CCD.

测试专用

Lead-in Questions

Although Methods is not the first section in a research paper, writers often choose to write this section earlier than the other sections when preparing their manuscripts. Work in pairs and discuss the following questions.

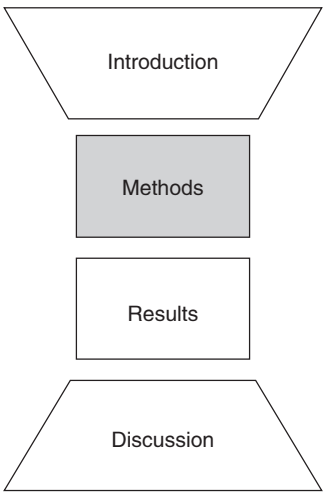

Figure 3.1

1. Why do writers often write Methods first?

2. What is the purpose of Methods?

3.1 Purpose, Tense, and Voice

In many chemical journals the Methods section is also called Experimental Section, Materials and Methods, or Computational and Experimental Methods. Some chemical journals require the writer to present information about Methods in a section called Supplementary Information.

The main purpose of this section is to tell the reader what researchers did to answer the research question and justify what they did. For a chemical research paper, in particular, the writer also needs to provide enough experimental details. Another thing that should be aware of is the tense and voice commonly used in this section.

• *Activity 1*

A. These sentences are from the Methods section of a research article "Changes in the Chemistry of Groundwater in the Chalk of the London Basin". First, put them into the correct order. Then, match the functions (a–i) with the nine sentences.

1. A total of 18 samples was collected and then analyzed for the isotopes mentioned earlier.
2. The samples were subsequently shipped to ISF for analysis by accelerator mass spectrometry (AMS).
3. The sites were selected from the London Basin area, which is located in the southeast of England and has been frequently used to interpret groundwater evolution.
4. Samples 1–9 were collected in thoroughly-rinsed 25 ml brown glass bottles which were filled to the top and then sealed tightly to prevent contamination.
5. The current investigation involved sampling and analyzing six sites to measure changes in groundwater chemistry.
6. Samples 10–18 were prepared in our laboratory using a revised version of the precipitation method established by the ISF Institute in Germany.
7. All tubing used was stainless steel, and although two samples were at risk of CFC contamination as a result of brief contact with plastic, variation among samples was negligible.
8. The filled bottles were shipped directly to two separate laboratories at Reading University, where they were analyzed using standard methods suitably miniaturized to handle small quantities of water.
9. This method obtains a precipitate through the addition of $BaCl_2.2H_2O$; the resulting

precipitate can be washed and stored easily.

a. The writer provides background information and justification.
b. The writer provides details about what was done and shows that care was taken.
c. The writer describes what was done by referring to existing methods in the literature.
d. The writer provides more details of the method.
e. The writer offers a general overview of this section.
f. The writer provides an overview of the procedure/method itself.
g. The writer continues to describe what was done in detail, using language which communicates that care was taken.
h. The writer provides more detailed information about the method and shows that it has been a good choice.
i. The writer mentions a possible difficulty.

B. Read this Methods section and see what tense and voice are mainly used. Work in pairs and discuss why this tense and voice are mainly used. Are there any other tenses being used? Why?

The current investigation involved sampling and analyzing six sites to measure changes in ground water chemistry. The sites were selected from the London Basin area, which is located in the southeast of England and has been frequently used to interpret groundwater evolution.

A total of 18 samples was collected and then analyzed for the isotopes mentioned earlier. Samples 1–9 were collected in thoroughly-rinsed 25 ml brown glass bottles which were filled to the top and then sealed tightly to prevent contamination. The filled bottles were shipped directly to two separate laboratories at Reading University, where they were analyzed using standard methods miniaturized to handle small quantities of water. Samples 10–18 were prepared in our laboratory using a revised version of the precipitation method established by the ISF Institute in Germany. This method obtains a precipitate through the addition of $BaCl_2.2H_2O$; the resulting precipitate can be washed and stored easily. The samples were subsequently shipped to ISF for analysis by accelerator mass spectrometry (AMS). All tubing used was stainless steel, and although two samples were at risk of CFO contamination as a result of brief contact with plastic, variation among samples was negligible.

Source: Glasman-Deal, H. (2009). *Science Research Writing for Non-native Speakers of English*. London: Imperial College Press, pp 58–66.

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3.2 Using Passive Voice in Methods

Passive voice is often used when people care more about the event (what happened) instead of the agent (who made the event happened). When reading a Methods section, readers pay more attention to the event (what the researchers did) rather than the agent (who the researchers are), so passive voice is often used to describe the procedure or methods. For example, a total of 18 samples were collected and then analyzed for the isotopes mentioned earlier.

• *Activity 2*

Rewrite the sentences below by using passive voice so that they focus on the underlined part.

1. I recorded the electrical signals.

_____

2. The researchers fixed the frequency of the power supply.

_____

3. We carried out plasma hydrogenation of CO_2.

_____

4. The experiment measured the change of the gas volume before and after the reaction.

_____

5. To evaluate the reaction performance of CO_2 hydrogenation to methanol, we calculated the concentration of major products in the condensate.

_____

3.3 Dealing with Experimental Details

When writing Methods, writers need to provide sufficient details about their experimental procedure or research design, including what they did, materials (size, color, weight), instruments (appearance and function), reaction conditions (temperature, pressure, concentration), etc. This shows the credibility of their research and gives enough information for other researchers to repeat the research.

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However, texts with overwhelming details are difficult to read. You should select those important details relevant to the success of the methods and write about them in a concise way. The following sentence pattern is commonly used.

What was done +	**Linking words +**	**Details**
The signals were recorded	*using/by using*	*a four-channel digital oscilloscope.*

When writing this part, it is also important to describe the experimental procedure clearly and indicate that appropriate care was taken during the experimental operation.

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• Activity 3

Use the following words and expressions to complete sentences providing sufficient details about methods.

1. carry out, plasma hydrogenation of CO_2, using, different DBD reactors, atmospheric pressure, at

_____

2. feed into, the DBD reactor, a mixture of H_2 and CO_2, at a total flow rate of 40 ml/min

_____

3. the discharge power, calculate, 10 W, the Q-U Lissajous method, by using, fix, at, in this work, and

_____

4. the gaseous products, analyze, a gas chromatograph, equipped with, a thermal conductivity detector (TCD) and a flame ionized detector (FID), using

_____

• Activity 4

To describe experimental procedure clearly, sequence expressions are often used. Complete the sentences below with the sequence expressions in the box.

after	first step	prior to	when	at the end of	subsequently	next

1. _____ testing, the test solution was purged with high-purity N_2.
2. The samples were _____ diluted 10-fold to get a 50% acetonitrile solution.
3. _____ being stirred at 80°C for 5 h, the solution was concentrated.

4. The _____ day, the cells were incubated with AP21998 at 25°C for 80 minutes.
5. _____ a positive voltage was swept across the device, a steady increase in current was observed.
6. The _____ was to make the graphite electrode as a substrate for Pt catalyst electrodeposition.
7. _____ the reaction, the reactor was cooled to room temperature.

• *Activity 5*

Chemical experiments require careful operations. Use the words and expressions in the box to complete the sentences indicating that appropriate care was taken during the experimental procedure.

tightly	slowly	under identical conditions	carefully
every	to prevent	three times	quickly

1. Cells were washed with DPBS for _____.
2. The hot solution was poured _____ into 100 ml of water.
3. Finally, the samples were _____ placed on the plate.
4. Then the membrane was taken out, _____ wiped with a tissue paper and weighed on a micro-balance.
5. The bottle was also _____ covered by a parafilm tape _____ the evaporation of water.
6. These tubes were kept _____ at room temperature and weighed _____ three days for 30 days.

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Functional Expressions and Sentences

A. Restating research purpose and providing a general introduction of this section

* *To reveal X, Y was employed as…*
* *To study X / the effect of X…, Y was performed in…*
* *To synthesize X, we carried out…*
* *To verify the impact of X, we applied…*
* *To investigate whether..., this study was done using…*
* *With the aim of gaining insights into X, various mathematical models including...were employed.*

B. Giving the source of materials or equipment used

* *X was supplied by…*
* *X was provided by Tianjin Fuyu Fine Chemical Co., Ltd.*
* *X was obtained from Sigma-Aldrich (St. Louis, MO, USA).*
* *X was purchased from Beijing Bomi Chemicals Corp., China.*
* *X was sourced from a local supplier with the water absorption capacity of…*
* *The genes of all the other enzymes were synthesized from Gene Universal.*

C. Providing an overview of the materials or methods

* *All calculations were based on…*
* *Gradient programming was used to perform…*
* *All measurements were performed at room temperature.*
* *X was characterized by a comprehensive set of techniques.*
* *All reagents were of analytical grade and all solutions were prepared with distilled water.*
* *All regents and chemicals are obtained commercially and used without further purification.*
* *All chemicals used were of analytical grade and used as received without further purification.*

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D. Describing experimental procedure: typical subjects + verbs in passive forms

* *The mixture was*	*poured into...* *extracted with...* *reacted for 12 h at 80 °C.* *stirred at 100 °C for 24 h.* *concentrated under vacuum.* *allowed to react for 3 h at 75 °C.* *centrifuged at 700 rpm for 5 min.* *centrifuged and washed by…twice.* *heated to 100 °C / under reflux at 100 °C.* *cooled to room temperature and stirred for 3 h.* *filtered through…and the filtrate was evaporated…*
* *The solution was*	*poured into…* *transferred to…* *dried with/via…* *heated to reflux.* *passed through a(n)…* *concentrated to give…* *cooled to 50 \xA1\xE3C.* *stirred at 100 °C for 12 h.* *diluted with…/to 500 ml by…* *cooled down to room temperature.*
* *The samples were*	*exposed to…* *rinsed with…* *stained with…* *dissolved in…* *washed with…* *evaluated by…* *transferred to…* *imaged using…* *analyzed with…* *incubated with…* *fabricated with…* *characterized by…* *prepared with/in…* *irradiated with.../twice for 5s.* *heated from 100°C to 200°C.* *outgassed at 80 \xA1\xE3C for 12 h.*

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* *The reaction was*	*completed.* *monitored by…* *worked up by…* *quenched by/with…* *carried out by/in/at…* *stirred at room temperature for 5 h.* *kept at 200°C / at 500 Pa / under...atmosphere for 12 h.*
* *The residue was* * *The resulting residue was*	*dried in…* *purified by…* *dissolved in…* *dispersed in…* *extracted with…*
* *The cells were*	*seeded in…* *fixed with…* *rinsed with…* *stained with…* *washed with…* *transfected with…* *assembled using…* *cultured with/in…* *harvested after 24 h.* *observed under/by…* *incubated for/with/at...*

E. Describing experimental procedure: sequence expressions

* *The first step was to…*
* *In the first step, X was…*
* *During the second step, …*
* *To achieve X, we first prepared…*
* *The resultant mixture was first stirred at the same temperature for 30 min and then cooled to…*

* *Prior to a test, the catalysts were reduced by…*
* *Prior to testing, the specimens were sanitized using…*

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* *Prior to analysis, all dried samples were derivatized using…*
* *Prior to experiments, the exposed surfaces of samples were…*

* *Next, a layer of unlabeled polymer was…*
* *The next day, the cells were incubated with…*
* *The residue was used in the next step without purification.*
* *In the next step, ...was filtered and properly washed with ethanol.*

* *X was then added to the mixture.*
* *Then a certain amount of Li was deposited.*
* *The resultant mixture was then stirred at the same temperature for 0.5 h.*
* *The samples were then rinsed with deionized water, …, and subsequently…*

* *The resultant mixture was subsequently extruded 20 times.*
* *Thermodynamic parameters were subsequently calculated with the formula…*
* *The samples were subsequently diluted 10-fold to get a 50% acetonitrile solution.*
* *Subsequently, the solution was dialyzed against deionized water for 24 h.*

* *After 15 min / 12–14 days / 24 h / 10 cycles, …*
* *After cooled to ambient temperature, X was…*
* *After removal of the culture medium, X was…*
* *After the reaction, the mixture was poured into…*
* *After that, the cells were washed three times with…*
* *After sonication for...min, the aqueous solutions…*
* *After cooling to room temperature, the solution was…*
* *After washing three times with the culture medium, X was…*
* *After stirring at room temperature for 24 h, the mixture was…*
* *After cultured overnight / for 24 h, the medium was replaced by…*
* *After being stirred at 80°C for 24 h, the solution was concentrated.*
* *After the reaction was completed, the reaction mixture was cooled to 37°C.*
* *After incubation for 24 h in culture dishes, HeLa cells were washed with PBS and then treated with...*
* *After that, the solution was cooled down to room temperature, and then X was slowly added with agitation.*

* *Once the solution became homogeneous, X was added.*

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* *Once the solutions filtered, the solvent was evaporated and…*
* *Once the addition was complete, the reaction was monitored by…*
* *Once synthesized, the polymer was transformed into radical forms via...*
* *Once the mean tumor volume reached approximately 125 mm^3, the mice were divided into four groups stochastically.*

* *When these polymer solutions were exposed to UV irradiation, …*
* *When the absorption peaks of H_2O were no longer observed, O_3 was introduced…*
* *When a positive voltage was swept across the device, a steady increase in current was observed.*
* *When the tumor volume had reached approximately 90 mm^3, the mice were randomly divided into the following six groups at day 0 and then received different treatments.*

* *Finally, the samples were carefully placed on the plate.*
* *Finally, the cell cycle distribution was analyzed by flow cytometry.*
* *At the end of the aging period, they were cooled to room temperature.*
* *Crystal decay was monitored by...at the end of data collection.*
* *Their final weight and dimension were measured for density, shrinkage, and porosity.*

F. Describing experimental procedure: infinitive of purposes

* *In order to investigate…, …*
* *In order to estimate X, Y was…*
* *In order to remove X…, Y was…*
* *In order to minimize the effect of X, Y was…*
* *In order to calculate X, the following formula is used.*

* *To avoid…, …*
* *To check…, …*
* *To obtain…, …*
* *To control…, …*
* *To remove…, …*
* *To prepare…, …*
* *To calculate…, …*
* *To determine…, …*
* *To quantify X, we…*
* *To verify X, Y was…*
* *To compare X and Y, …*

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* *To evaluate the effects of…, …*
* *To achieve a correct condition, …*
* *To ensure the accuracy of the results, …*
* *To further analyze/explain/investigate…, …*
* *To investigate X / the effect of X / whether…, …*
* *To ensure overall neutrality of the system, …*
* *To ensure the stability of the measurement, …*
* *To achieve fair comparison among all samples, …*
* *To fabricate electrochromic film substrates for SERS tests, …*
* *To increase the range/stability/solubility/wettability of..., …*
* *To prevent decomposition, the product was stored under…*
* *To prevent possible crevice corrosion, the specimens were treated using the following procedures.*
* *To accurately estimate X in a computationally efficient manner, 3D coordinates were generated for…*
* *To analyze…, the Bitplane (Concord, MA, USA) Imaris 3D/4D image processing and analysis software (version 8.4) was used.*

G. Describing experimental procedure: using/by/via + instrument/method

* *The slices were cut using a Diatome diamond knife.*
* *Using an alternative indirect method, we investigated…*
* *Analytical NMR spectra were recorded using a Bruker Avance III spectrometer.*

* *Cloud point curve was determined by a titration method at 25 \xA1\xF0C.*
* *By controlling the temperature and eliminating O_2 from the system, biomass fuel…*
* *The initial concentration of dissolved oxygen in the media was measured by a dissolved oxygen meter.*

* *Phase purity of all samples was confirmed via X-ray diffraction.*
* *The solution was dried via reduced-pressure distillation to obtain dry precipitation.*
* *Electrical connection to the electrode was made via an Au wire covered in parafilm to prevent exposure to electrolyte.*

H. Justifying choices made about methods

* *A preliminary test of X confirmed…*
* *This demonstrates the necessity of…*

* *These procedures were selected because...*
* *The porous nature of X was confirmed with…*
* *X shows the expected mass increase after reduction…*
* *X was tested using the water vacuum saturation method.*
* *Although this method may…, our measurements indicate that…*
* *This choice does not affect the interpretation of the results because…*

I. Indicating that appropriate care was taken

* *All samples was analyzed in triplicate.*
* *To avoid…, …was carried out for 15 min in the dark.*
* *All these procedures were performed in a N_2 atmosphere.*
* *Samples were cured for 30 days followed by drying at 75°C for 2 h.*
* *To evaluate reproducibility, each fermentation was carried out three times.*
* *These tubes were kept under identical conditions at room temperature and weighed every three 3 days for 30 days.*
* *The dried samples were carefully stuck onto X with Y and were sputter-coated with Z to make the sample conductive before testing.*

J. Relating materials or methods to previous studies

* *X has been described in our previous studies.*
* *The calculation was based on Flory's equilibrium theory, where…*
* *Using analogous methods to our previous work, X was introduced…*
* *The synthesis of X was done according to the procedure of Smith (1973).*
* *X mutations were carried out according to the PCR-based strategy using…*
* *X was prepared according to the procedure used by Smith et al. (2003).*
* *X was prepared according to the methods reported by Wang et al. (1998).*
* *According to previous reports by Wang et al., X was prepared using the following methods.*
* *The experimental procedure was carried out according to Smith et al. (2001) with some modifications.*

K. Indicating where problems occurred

* *X gave poor reactivity due to the lack of…*
* *Although…, X still results in problematic limited solubility.*
* *In addition, external mass transfer limitations are confirmed by…*
* *As there is a lack of major databases for process design related to X, …*

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* *X cannot be measured due to the limitation of measurement technique.*
* *The substrate is not represented explicitly in the simulations, which may slightly reduce the overall red shift compared to the experimental results.*
* *Although an orthorhombic cell was assigned by the data collection program, satisfactory solution could not be obtained with orthorhombic space groups.*

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Assignments

• *Reading*

Read the Methods section of the article in Appendix IV. Try to find out the functional expressions and sentences according to the following model for Methods.

• Restating research purpose and providing a general introduction of this section • Giving the source of materials or equipment used
• Providing an overview of the materials or methods • Describing experimental procedure in detail • Justifying choices made about methods • Indicating that appropriate care was taken
• Relating materials or methods to previous studies
• Indicating where problems occurred

• *Writing*

Review what you learned in this chapter and use the above model to write a Methods for your current or undergraduate research topic.

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Chapter 4
Results

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Corpus in Use

The main purpose of a Results section is to report the research findings. Therefore, reporting verbs are often used in this section. Common reporting verbs include *show*, *report*, *suggest*, *indicate*, *demonstrate*, *present*, etc. Is it possible for us to find out the most frequently used reporting verbs in Results? You can realize this by using corpus tools. Please use the Word List function of AntConc to seek the top ten verbs in Results according to your corpus. Compare the results with groups of other research directions, and see if there are any differences. Then use the Concordance function to observe how to use these verbs.

I. Use your corpus to find out the top ten frequently used verbs in Results.

1. _____ **6.** _____

2. _____ **7.** _____

3. _____ **8.** _____

4. _____ **9.** _____

5. _____ **10.** _____

II. With the help of your corpus, decide whether each verb in the table can be followed by a noun (noun structure), a *that*-clause, or both.

Verbs in Results section	Noun (noun structure)	*that*-clause
observe		
show		
use		
obtain		
find		
report		
calculate		
compare		
prepare		
determine		

Lead-in Questions

Work in pairs and discuss what the following picture implies.

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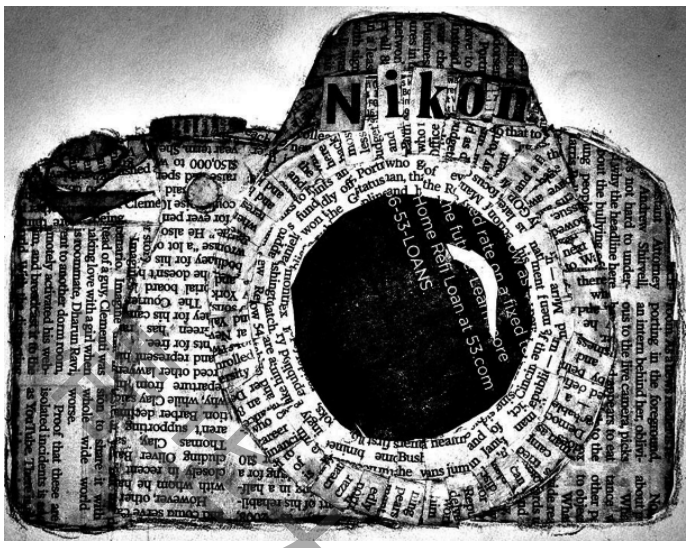


Figure 4.1

In a Results section, writers often use visual illustrations to help readers understand the results better. Common visual illustrations include line graphs, bar graphs, pie charts, tables, diagrams, and maps. In most chemical research papers, tables and figures are often used as visual illustrations and they are crucial to successful publication of a paper.

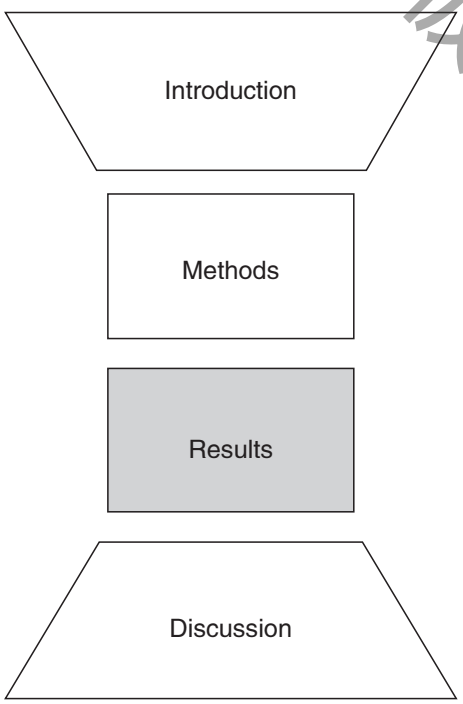


Figure 4.2

4.1 Visual Illustrations

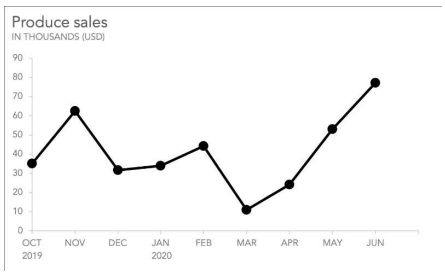
• *Activity 1*

There are six examples of common visual illustrations used in academic texts. Complete the table below with the use of (a– f) and the example (A–F) of each type.

Uses: a. location b. comparison c. proportion

d. steps in a process e. changes by time f. statistical display

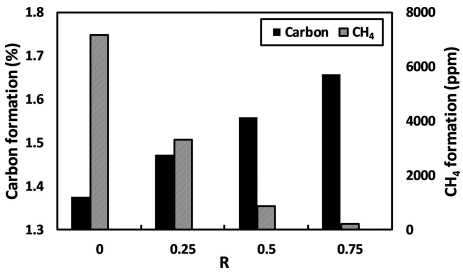
Types	Uses	Example
diagram		
table		
map		
pie chart		
bar graph		
line graph		



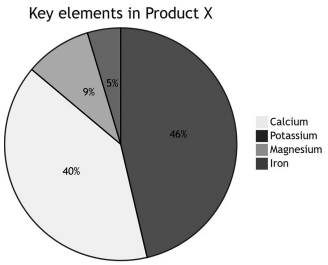
A

Year	CO_2 concentration (ppm)	Mean Annual Temperature (°C)	Mean Annual Precipitation (mm)
2012	366	10	500
2013	378	11	800
2014	382	12	940
2015	390	13	260
2016	405	14	710
2017	410	15	1430

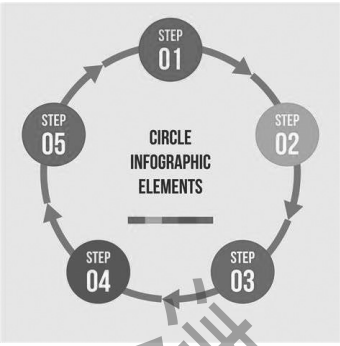
B



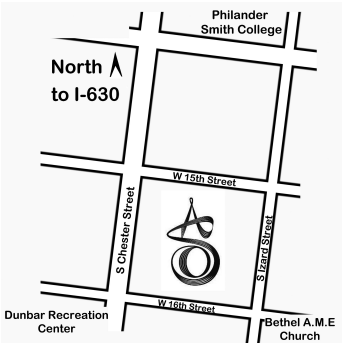
C



D



E



F

4.2 Tables vs. Figures

For chemical papers, using good tables and figures as visual illustrations is critical. Tables are the arrangements of numbers and descriptions in rows and columns. They are often used for quantitative data. Figures, on the other hand, are usually graphs like line graphs, bar graphs and pie charts. They are often used for visualizing a trend of your data or the comparison between different sets of data. A table has a title, also known as a legend, telling the reader what the table is showing. Unlike tables, a figure legend is longer, containing a title and a caption. A caption should be a few sentences about what you need to know to interpret the data shown in the figure.

• *Activity 2*

A. Look at the following table and figure. What differences can you see?

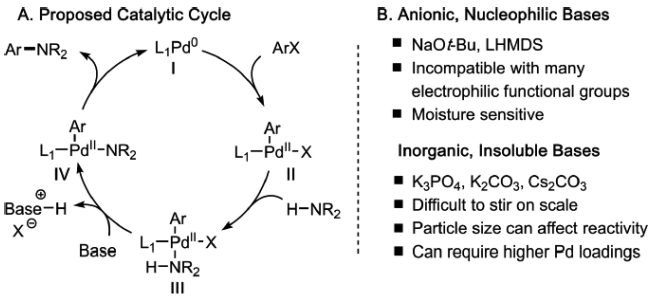
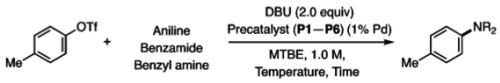
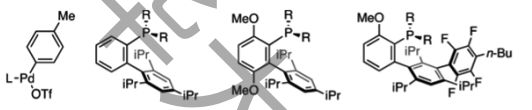


Figure 1. (A) The proposed catalytic cycle for the palladium-catalyzed coupling of aryl halides with amines: **I**, monoligated Pd(0); **II**, oxidative addition (OA) complex; **III**, amine-bound OA complex; **IV**, amido complex. (B) Synthetic considerations for bases employed in C−N coupling.

Table 1. Comparison of Ligands in Pd-Catalyzed Amination Facilitated by DBU[a]



precatalyst	nucleophile	temp (°C)	time	yield (%)
P1	aniline	RT	20 min	0
P2	aniline	RT	20 min	30
P3	aniline	RT	20 min	0
P4	aniline	RT	20 min	61
P5	aniline	RT	20 min	99
P6	aniline	RT	20 min	99
COD(**L6**-Pd)$_2$	aniline	RT	3 h	99
COD(**L6**-Pd)$_2$	benzamide	RT	16 h	76
COD(**L6**-Pd)$_2$	benzamide	60	16 h	97
COD(**L6**-Pd)$_2$	benzyl amine	60	16 h	98



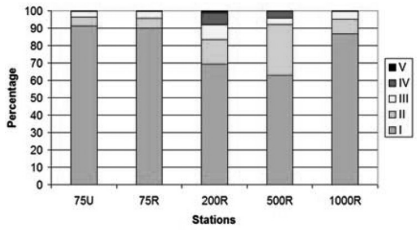
L1, R = Cy, XPhos
L2, R = *t*-Bu, *t*-BuXPhos
L3, R = Cy, BrettPhos
L4, R = *t*-Bu, *t*-BuBrettPhos
L5, R = Ad, AdBrettPhos
L6, R = Ad, AlPhos
L7, R = *t*-Bu, *t*-BuAlPhos
L8, R = Cy, CyAlPhos

[a]Reaction conditions: aryl triflate (0.25 mmol), nucleophile (0.30 mmol), DBU (0.50 mmol), precatalyst (1% Pd; 2.5 μmol or 1.25 μmol dimer), MTBE (0.25 mL). GC and ^{1}H NMR yields referenced to hexamethylbenzene as an internal standard. MTBE = methyl *tert*-butyl ether.

Source: Dennis, J., White, N., Liu, R., & Buchwald, S. (2018). Palladium-catalyzed Carbon−Nitrogen (C−N) Bond Formation Has Become a Valuable Tool in the Modern Synthesis of Structurally Complex Target Molecules. *Journal of the American Chemical Society, 140(*13), 4721–4725.

B. You can present data by either tables or figures. Look at the following table and figure showing the same set of data. Which one do you think should be used in the paper?

	ECOLOGICAL GROUP				
Station	**I**	**II**	**III**	**IV**	**V**
75U	91.3	5.3	3.2	0.2	0.0
75R	89.8	6.1	3.6	0.5	0.0
200R	69.3	14.2	8.6	6.8	1.1
500R	63.0	29.5	3.4	4.2	0.0
1000R	86.7	8.5	4.5	0.2	0.0



Source: Borja, A. (2014, June 24). 11 Steps to Structuring a Science Paper Editor Will Take Seriously. Elsevier website.

4.3 Presenting Results

Your experiment may generate a large quantity of data. Do you need to include all these experimental data in your paper? Are these data the results of your study? How do you decide whether the results should be presented or not? Before answering these questions, you need to understand the difference among data, results, and implication.

• *Activity 3*

A. Match the terms with their correct descriptions and examples.

Terms	**Descriptions**
Data	a. General statements that interpret data
Results	b. Thoughts, hypotheses, and speculation about what the results may mean for the big issue you identified
Implication	c. Facts obtained from experiments and observations

Examples

Example 1	+2.30, +3.46, +3.52 and +3.27 kcal/mol
Example 2	Our results suggest that a selection pathway based on energy-dissipative cycling could have driven the selective synthesis of phospholipids on early Earth.
Example 3	Propranolol given during normal ventilation decreased phospholipid concentration.

B. Work in pairs and discuss which of the following elements can be included in a Results section.Then tick your choices.

- ☐ Data
- ☐ Results that don't fit hypothesis
- ☐ Results not related to the research question
- ☐ Implications
- ☐ Research aim

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☐ Statistical analysis

☐ Experimental results

C. Now work in a group and discuss how to decide what to present and not to present in a Results section.

• *Activity 4*

A. Organize the common steps of table and figure descriptions (a–d) according to the following paragraph.

① Experiments utilizing p-tolyl-OA complexes (Figure 1) as catalysts (1.0 mol %) to couple p-tolyl triflate with aniline revealed that multiple ligands are capable of facilitating the desired reaction (Table 1). ② Precatalyst P6 bearing L6 (AlPhos) and P5 (AdBrettPhos) provided nearly quantitative cross-coupling product at room temperature. ③ P4 (t-BuBrettPhos) provided the desired product in moderate yields and ligands bearing cyclohexyl (Cy) groups on the phosphine, including P3 (BrettPhos) and L1 (XPhos), failed to yield any of the desired product. ④ While P5 is highly reactive, the ligand from which it is derived is known to undergo an in situ ligand modification in the presence of aryl halides, generating different active catalytic species for each ArX substrate.

Source: Dennis, J., White, N., Liu, R., & Buchwald, S. (2018). Palladium-catalyzed Carbon−Nitrogen (C−N) Bond Formation Has Become a Valuable Tool in the Modern Synthesis of Structurally Complex Target Molecules. *Journal of the American Chemical Society*, *140*(13), 4721–4725.

a. Choose only those results that answer your research question
b. Write a topic sentence stating the results and locating the table or figure
c. Analyze the data in the table or figure and interpret the results
d. Select data from the table or figure to support the topic sentence

B. According to the above organization you worked out, put the following sentences into the correct order.

1. Substrates bearing acidic functional groups, such as an unprotected pyrazole, an indole, and a phenol, are also compatible with the weakly basic reaction conditions when an excess of base is used.

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2. To explore the scope of the methodology, a variety of aryl halides, triflates, and nucleophiles were tested (Table 2).

3. Both five- and six-membered heterocyclic amines, including a pyrazine, a thiazole, and an oxazole were coupled in high yield under the optimized reaction conditions.

Source: Dennis, J., White, N., Liu, R., & Buchwald, S. (2018). Palladium-catalyzed Carbon−Nitrogen (C−N) Bond Formation Has Become a Valuable Tool in the Modern Synthesis of Structurally Complex Target Molecules. *Journal of the American Chemical Society*, *140*(13), 4721– 4725.

4.4 Subordinating Table and Figure Legends

Tables and figures are used to illustrate results, so writers need to locate tables and figures in their papers. For example,

Our experimental results are shown in Figure 2. Interestingly, both catalysts exhibit higher CH_3OH selectivity upon H_2O addition at a comparable level of CO_2 conversion.

In Results, however, we should emphasize the results interpreted from data rather than the tables and figures themselves. It is more powerful to write a sentence about results as the topic sentence than to write a sentence only about table or figure legends. Therefore, we can subordinate table and figure legends by citing them in parentheses after writing a result statement. For example,

Interestingly, both catalysts exhibit higher CH_3OH selectivity upon H_2O addition at a comparable level of CO_2 conversion (Figure 2).

• *Activity 5*

Revise the following sentences by using parentheses to subordinate table and figure legends.

1. Figure 1 shows the size distribution of GNPs. The size distribution has an average size of 60 \xA1\xC0 9 nm together with a typical TEM image as an inset.

_____

_____

2. Factors influencing the crystal habit are shown in Figure 2. The crystal habit is clearly reflected on the crystal structure of the solids.

_____

3. The results of our experiment are presented in Table 3. Clearly, the alloy formation could considerably decrease the crystallite size of the Cu phase.

4.5 Subordinating Methods

In a Results section, writer may also write about methods to remind readers. However, it would be strange to write a separate sentence about methods in Results, where the focus should be results. There are several ways to subordinate methods in a Results section.

• *Activity 6*

A. Methods subordinated as subject: Revise the sentences below and make methods as the subject of the revised sentence.

E.g. We used DAPC analysis to examine mice during the acute and chronic phase. This analysis revealed a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

↓

DAPC analysis of mice revealed a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

1. H_2O_2 was added to convert GSH into GSSG. A significant fluorescence enhancement was observed (Figure 1).

2. An electrochemical testing was carried out. Chemical states of CoP/NCNHP catalyst are nearly not changed.

B. Methods subordinated in transition phrase: Revise these following sentences and put methods in a transition phrase.

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E.g. We used DAPC analysis to examine mice during the acute and chronic phase. This analysis revealed a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

↓

After DAPC analysis of mice, we identified a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

1. H_2O_2 was added to convert GSH into GSSG. A significant fluorescence enhancement was observed (Figure 1).

_____

_____

2. An electrochemical testing was carried out. Chemical states of CoP/NCNHP catalyst are nearly not changed.

_____

_____

C. Methods subordinated in transition clause: Revise these following sentences and put methods in a transition clause.

E.g. We used DAPC analysis to examine mice during the acute and chronic phase. This analysis revealed a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

↓

When DAPC analysis of mice was used, we identified a clear distinction between healthy and infected individuals during the acute and chronic phases (Figure 5).

1. H_2O_2 was added to convert GSH into GSSG. A significant fluorescence enhancement was observed (Figure 1).

_____

2. We completed a desired catalytic reaction. Magnetic stir bars can then be easily separated from the reaction mixture.

_____

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Functional Expressions and Sentences

A. Reference to aim, research questions or methods

* *For this purpose, we...*
* *We next investigated...*
* *To study the origin of X, we...*
* *We measured…to investigate...*
* *X was employed to investigate...*
* *X was carried out to investigate…*
* *We next tested X conditions on...*
* *To assess..., X was performed.*
* *X was demonstrated by analysis of...*
* *To assess the performance of X, we...*
* *To broadly examine..., we analyzed...*
* *To better resolve..., X was performed.*
* *Therefore, our efforts were focused on...*
* *To exclude that..., X was treated with...*
* *To begin, we tested the performance of...*
* *X is further probed via Y measurements.*
* *Since..., we sought to determine whether...*
* *In this work, we overcame…challenge by...*
* *The purpose of this study was to determine...*
* *To estimate/study..., we display...in Figure 1.*
* *To gain further insight into…, we performed…*
* *To enable the systematic study of…, we first...*
* *To obtain more information about..., we used...*
* *For the measurements of…, X was performed.*
* *To test if X is applicable to Y, we first examined...*
* *To assess the impact of X, Y was determined by...*
* *To elucidate…, we have determined…by (method).*
* *To investigate/evaluate/assess/explore/examine..., we…*
* *To further investigate the effect of X on Y, we synthesized Z.*
* *To demonstrate the utility of X process, we incorporated Y into Z.*

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* *X is generated with a common fabrication technique used for...*
* *In order to obtain X, parameters such as…were optimized when...*
* *To gain insight into the structural details and morphology of A, we…*
* *To figure out X, …was brought into operation, as displayed in Figure 1.*
* *To delineate/investigate/evaluate..., we used/turned to...(instrument or method)*
* *To assess X, Y is investigated through molecular simulation using Gaussian program package and the density functional theory (DFT).*

B. Locating data in a table or figure

* *Table/Figure 1 shows...*
* *As shown in Table/Figure 1, ...*
* *...are evaluated/shown in Table/Figure 1.*
* *The results of…are listed in Table/Figure1.*
* *It can be seen from Table/Figure 1 that…*
* *The result is represented in Table/Figure 1.*
* *As depicted in Table/Figure 1, X shows…, indicating...*
* *Further analyses of...are provided in Table/Figure 1.*
* *The key parameters…are summarized in Table/Figure 1.*
* *Table/Figure 1 presents/depicts/provides/indicates…*
* *The data in Table/Figure 1 are unambiguous evidence that…*
* *To understand…, …experiments were carried out in Table/Figure 1.*
* *As shown in Table/Figure 1, the concentration decreased from… to...*
* *As presented/depicted/provided/indicated in Table/Figure 1, …*
* *As summarized in Table/Figure 1, this method displayed X in the range of...*
* *The currents across each membrane stack were increasing...(Table/Figure 1).*
* *We were able to identify X, the thicknesses of which are summarized in Table/Figure 1.*
* *To investigate..., …were performed, and...were pleasing when optimizing the synthesis conditions (Table/Figure 1).*

C. Statements of positive results

* *This suggests that...*
* *As expected, we observed...*
* *These observations confirm that…*
* *We observed the production of X.*
* *X showed dramatically increased...*
* *This demonstrates that X increased...*

* *Meanwhile, X showed an increase in...*
* *However, the latter results reveal that…*
* *This is consistent with the results from…*
* *This result further confirms the viability of...*
* *These data prove that X results in Y without Z.*
* *Consequently, it was observed that X exhibited...*
* *These results (Figure 1) confirm…, suggesting...*
* *With the success in..., we took a step further to...*
* *As expected, X was the most significantly enhanced by...*
* *The cell yields…, which are comparable to previous results.*
* *To some extent, it indicated that X would be increased with Y.*
* *When compared to X, a greater Y was observed in Z (Figure 1).*
* *In comparison to X, the appearance of Y confirms the successful...*
* *The above results all illustrated that X was successfully deposited onto...*
* *This value is in excellent agreement with..., confirming the possibility of...*

D. Statements of negative results

* *No product was detected in…*
* *Notably, X was not found to...*
* *X showed negligible Y production.*
* *Unfortunately, X is not sufficient to...*
* *However, when…, no X was observed.*
* *Contrary to our expectations, X did not…*
* *It is unclear why X was not detected with...*
* *However, for..., X did not perform as well as Y.*
* *These experiments yielded no apparent benefit of...*
* *X does not exhibit in this range, which indicates that...*
* *Although we were able to confirm..., we did not observe...*
* *In addition, we find that X does not seem to perform well in Y.*
* *However, when we..., the acquisition failed 2 of 3 times due to...*
* *Although previous efforts have demonstrated…, …has not been reported.*
* *In the experimental range studied, the other factors and their interactions do not present a significant effect on...*

E. Reporting a reaction

* *We formed X with Y.*

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* *X was treated with Y at…temperature.*
* *After soaking in..., X was then placed into...*
* *To test X, Y was beveled into two parts to...*
* *X synthesized in this study was prepared by using...*
* *Moreover, a blank experiment was also conducted to understand...*
* *In the synthesis, while X was deliberately selected as..., Y was used as...respectively (Scheme 1).*
* *In this study, in addition to X in the Introduction section, another stepwise reaction is employed to...*

F. Highlighting significant, interesting or surprising results

* *Notably, ...*
* *It should be noted that…*
* *It is worth noticing that…*
* *Interestingly, X revealed that...*
* *Interestingly, X was observed to...*
* *Surprisingly, the results revealed that...*
* *Unlike X, Y emerged as two different signals.*
* *A particular advantage of X described here is...*
* *X indicated excellent reproducibility (Figure 1).*
* *However, our sample exhibited an unusual trend on...*
* *Impressively, ..., which is the highest recorded value for…*
* *There is a significant correlation between X and Y (Figure 1).*
* *To the best of our knowledge, X is the top value reported so far for...*
* *As shown in Figure 1, there were significant differences between X and Y.*
* *The results demonstrated that both X and Y were essential for Z, and further explained that...*
* *Compared to..., X increased, which significantly improved Y (see in Supplementary Figure 1).*
* *The obtained X exhibited excellent film forming property, and Y gave colorless, transparent and flexible films (Figure 1).*
* *It is rather unusual to observe X in…, unless it is somehow influenced by some external or internal driving forces, such as...*

G. Summary of the results

* *We could conclude that…*

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* *Hence, we conclude that...*
* *These results indicated that…*
* *These results suggested that...*
* *These results further demonstrate...*
* *Therefore, it can be concluded that...*
* *The above results demonstrate that...*
* *Together, these results demonstrate...*
* *This study essentially demonstrates…*
* *Taken together, our results imply that...*
* *There is thus a pressing need to identify...*
* *The experiments revealed/confirmed that...*
* *This study shows that X plays a vital role in...*
* *To this end, we summed up...and compared...*
* *In summary, we successfully demonstrated that...*
* *Taken together, our results provide important insights into...*
* *To sum up, the mechanisms of X may be summarized as follows.*
* *Due to its excellent selective..., X shows encouraging potential for...*
* *Therefore, the significant increase observed in X could be justified as...*
* *These results offer high probability of greatly improved X once Y is studied.*
* *These results demonstrated that..., thereby indicating that...*
* *Thus, it can be surmised that...*
* *Three reasons can be discussed to explain this phenomenon.*
* *Although X was demonstrated in this study, our method is expected to be applicable for...*

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Assignments

• *Reading*

Read the Results of the article in Appendix IV. Try to find out the functional expressions and sentences according to the following model for Results.

• Reference to aim, research questions or methods
• Describing data in a table or figure ♦ Locating data in a table or figure ♦ Highlighting significant data in a table or figure
• Reporting and commenting results ♦ Statements of positive results ♦ Statements of negative results ♦ Reporting a reaction ♦ Highlighting significant, interesting or surprising results
• Summary of the results

• *Writing*

Review what you learned in this chapter and use the above model to write a Results section for your current or undergraduate research topic.

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Chapter 5
Discussion

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Corpus in Use

In Discussion, writers often look at the large picture of the research field. When doing this, they tend to adopt a tentative tone rather than an absolutely certain attitude. They also try to show different levels of certainty when writing about implications, speculations, applications and recommendations. For these purposes, modal verbs like *may*, *might*, *would*, *could* and *should* are often used. How to use these modal verbs accurately is always challenging to English learners. Please use your corpus to investigate these words and learn how to appropriately use them in Discussion by observing the concordance. Then try to do the following exercise.

Investigate your corpus and see how frequently the following modal verbs are used in Discussion.

Modal verbs	Frequency
may	
might	
would	
could	
should	
must	

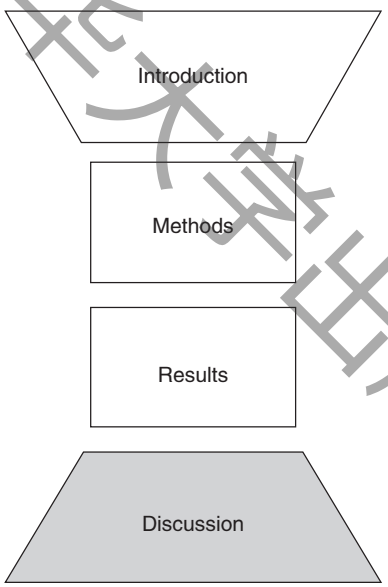

Figure 5.1

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Lead-in Questions

The main purposes of Discussion are to answer the research question, explain how results support that answer and explain how the answer is related to previous research. Work in pairs and discuss the following questions.

1. How does the information in the Results section of a paper differ from the Discussion section?

2. Some papers include a Conclusion section. What is the difference between Discussion and Conclusion?

5.1 Developing a Model

The Discussion of a paper is to state the answer to the research question, support the answer with key results, and interpret the meaning of these results. You should also relate your findings to previous research and relate your research to the big issue addressed at the beginning of Introduction.

• *Activity 1*

The Discussion below is from a research paper aiming to investigate the development of a biomimetic model complex of [Fe]-hydrogenase that incorporates a Mn, as opposed to a Fe, metal center. Read this section and use the expressions below to complete the model for Discussion.

Discussion

The active sites of both the semi-synthetic [Mn]- and [Fe]-hydrogenase lack the GMP moiety and two methyl groups in the pyridinol group of the native cofactor (Fig. 1a), which should be the principle reason for their specific activity being only a few percent of that of native [Fe]-hydrogenase. Direct comparison of the semi-synthetic [Mn]- and [Fe]-hydrogenases, however, reveals the relative catalytic competency of the two different metals. The occupancy-normalized specific activity of [Mn]-hydrogenase is 25% higher than that in the analogous [Fe]-hydrogenase for the forward reaction (3 U mg^{-1} at a 50% active site occupancy), which is the physiological reaction during methanogenesis. Thus, Mn appears to be more active than Fe for enzymatic H_2 activation.

In summary, a Mn(i) model of the active site of [Fe]-hydrogenase that is capable of splitting H_2 and catalyzing hydrogenation reactions has been prepared. Reconstitution of the apoenzyme of [Fe]-hydrogenase with this Mn(i) model leads to a [Mn]-hydrogenase, which is active for the [Fe]-hydrogenase reactions. These findings demonstrate the catalytic functionality of a non-native metal in a hydrogenase enzyme. The molar activity of this semi-synthetic [Mn]-hydrogenase is higher than that of its Fe analogue, which raises an intriguing question—why does nature choose Fe over Mn?

Source: Pan, H. J., Huang, G., Wodrich, M. D., Tirani, F. F., Ataka, K., Shima, S., & Hu, X. (2019). A Catalytically Active [Mn]-hydrogenase Incorporating a Non-native Metal Cofactor. *Nature Chemistry*, *11*(7), 669–675.

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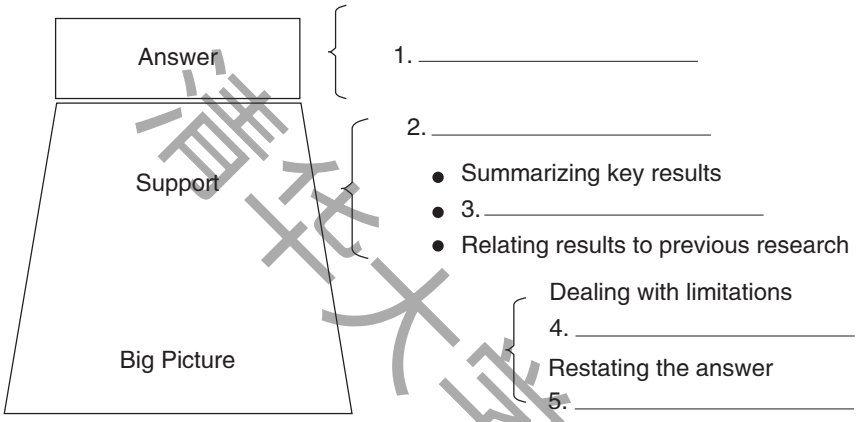
Interpreting the results
Relating to the big issue
Answering the research question
Re-summarizing the results in general
Supporting the answer with results



5.2 Answering the Research Question

At the beginning of Discussion, try to answer the research question exactly as it was asked at the end of Introduction, using the same key terms, the same verbs if possible, and the same perspective. This can build good cohesion and coherence in your writing and thus help the reader follow your logic easily. For example, if the research question is "Does sympathetic stimulation increase norepinephrine synthesis in rat superior cervical ganglia in vivo?" The answer can be written as either "This study shows that sympathetic stimulation increases norepinephrine synthesis in rat superior cervical ganglia in vivo." or "This study shows that sympathetic stimulation does not increase norepinephrine synthesis in rat superior cervical ganglia in vivo."

• *Activity 2*

A. Use the following signal language to answer the research question exactly as it was asked.

This study shows that
Our results indicate that
In this study, we found that

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In this study, we have shown that
In this study, we provide evidence that

Research Question (Aim, Hypothesis):

1. In this work, we examine whether PhABCG1 is involved in VOC emission.

_____

_____

2. The purpose of this study is to examine whether Mn addition promotes the formation of olefins.

_____

_____

3. In this study we hypothesized that both transmittance and reflectance spectra are appropriate for sensing experiments with these MCM structures.

_____

_____

B. Based on the research question and the result(s), use the signal language in A to write an answer to begin the Discussion.

Research Question (Aim):

The purpose of this study is to investigate whether exposing oilseed rape seeds to neonicotinoids affects reproductive potential in wild bee populations.

Result(s):

In wild bees, the number of queens was 24% lower after neonicitinoid treatment compared to the control (P = 0.01, explained variance = 59%) …

Answer (Discussion):

_____

_____

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5.3 Supporting the Answer with Results

After answering the research question at the beginning of Discussion, you need to use relevant results as support to convince the reader that the answer is valid. However, do not simply repeat the result already given in the Results section.

• *Activity 3*

A. Read the result given in the Results section and the result presented in the Discussion section. What are the differences?

Result (Results):

In wild bees, the number of queens was 24% lower after neonicitinoid treatment compared to the control (P = 0.01, explained variance = 59%) …

Result (Discussion):

Neonicotinoid treatment decreased the number of queens in wild bee populations. Sublethal amount of neonicotinoids may have harmful effects on the reproduction of wild bees.

B. Use the following two transition phrases to connect the Answer (Discussion) and Result (Discussion) in A.

In our experiments, …　　We found that…

Answer (Discussion):

This study shows that exposing oilseed rape seeds to neonicotinoids affects reproductive potential in wild bee populations.

_____

_____

C. Use the following signal language to interpret the result in the box.

This result indicates that….　　This finding indicates that…

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This change/increase/decrease implies that… These findings suggest that…

This (summary of result) suggests…

We found that neonicotinoid treatment decreased the number of queens in wild bee populations.

D. Use the transition phrases and signal language you learned in B and C to summarize and interpret the following result (Results).

Of all of the environmental variables examined, pH showed the highest correlation with the bacterial community composition (r ¼ 0.677, P < 0.001), while adding the other factors did not improve the correlation (Table 3).

5.4 Relating Results to Previous Research

• *Activity 4*

A. Read the following texts and identify whether the results confirm, expand or contradict previous research results. What signal language indicates the relation between the results in present studies and in previous research?

1. The obtained results broaden the existing knowledge about the methane pathway of hydrocarbons formation from…
2. These findings show that…, which is again consistent with prior work by Chaffin et al.
3. This is in stark contrast to previous observations in carbonyl–olefin ring-opening metathesis reactions in which…

Try to find more signal language of this kind in the papers you collected.

B. Use the signal language in the box to complete the sentences below.

good agreement with	contradict	expand	comparable to

1. The obtained values are _____ recent studies also using SPR.

2. These results _____ previous reports which correlated higher hydrogen turnover frequencies.

3. These values are in _____ those reported by Ruprecht et al.

4. Our findings _____ the scope of prior work.

C. Based on the following information, write a paragraph that summarizes your result (Discussion), interprets that result, and relates it to previous research. Use the signal language and transition phrases you learned in previous activities.

Result (Results)

Of all of the environmental variables examined, pH showed the highest correlation with the bacterial community composition (r ¼ 0.677, P < 0.001), while adding the other factors did not improve the correlation.

Previous Research

Snow et al., 2012: pH showed no significant correlation with bacterial community composition.

Porter et al., 2017: pH was used to successfully predict bacterial community composition.

_____

_____

_____

_____

_____

_____

_____

_____

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5.5 Ending Discussion

When ending a Discussion section, as a reminder to the reader, writers may summarize the key results again and restate the answer to the research question. Then they often relate their research to the big issue identified at the Opening.

The end of Discussion should be powerful and provide a take-home message for the reader, highlighting the contribution of your research to the science community. This can be done by stating implications, speculations, applications or recommendations.

• *Activity 5*

Read the following paragraph and identify which sentences summarize results in general, restate the answer, and relate to the big issue.

① In summary, a Mn(i) model of the active site of [Fe]-hydrogenase that is capable of splitting H_2 and catalyzing hydrogenation reactions has been prepared. ② Reconstitution of the apoenzyme of [Fe]-hydrogenase with this Mn(i) model leads to a [Mn]-hydrogenase, which is active for the [Fe]-hydrogenase reactions. ③ These findings demonstrate the catalytic functionality of a non-native metal in a hydrogenase enzyme. ④ The molar activity of this semi-synthetic [Mn]-hydrogenase is higher than that of its Fe analogue, which raises an intriguing question—why does nature choose Fe over Mn?

Source: Pan, H. J., Huang, G., Wodrich, M. D., Tirani, F. F., Ataka, K., Shima, S., & Hu, X. (2019). A Catalytically Active [Mn]-hydrogenase Incorporating a Non-native Metal Cofactor. *Nature Chemistry*, *11*(7), 669–675.

1.Summarizing results in general: _____

2.Restating the answer: _____

3.Relating to the big issue:_____

• *Activity 6*

A. Match the terms with the descriptions.

1. Implication	**a.** Statement of advice based on results
2. Speculation	**b.** A possible future effect or result of answer
3. Application	**c.** Uses to which answers can be put
4. Recommendation	**d.** A logical guess that follows from an answer

B. For each of the following statements, identify whether it is an implication, speculation, recommendation, or application. What signal language indicates an implication, speculation, recommendation, or application?

1. The results imply that a uniform size hydrophilic domain (or clusters) does(do) not form in the hydrated polyimide ionomers.

2. Future work here should explore the potential to apply regional-TECs calculated from one section to sections from other animals.

3. The results here point to this design strategy as one that might be applicable to a wide range of emerging electrochemical applications.

4. We can reasonably speculate that the gold on the surface of the catalysts played a key role in the dissociation of hydrogen.

Try to find more signal language of this kind in the papers you collected.

C. Writers use different modal verbs to show different levels of certainty when stating an implication, speculation, recommendation, or application. According to the following information, complete the sentences.

Most Certain	application	(none)	can, will
	recommendation	recommend	should
	implication	suggest/imply	may, might
Least Certain	speculation	speculate	may, might

1. Our findings in mice, together with findings from studies of human coronary arteries, _____ (implication) that H1 blockers _____ _____ (antagonize)

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histamine-mediated vasoconstriction and vasospasm in patients with atherosclerotic coronary artery disease and thus _____ _____ (have) therapeutic value.

2. Future applications of such approaches _____ _____ (consider) the most appropriate summary statistic, possibly the median intensity. (recommendation)

3. We _____ (speculation) therefore that these lanthanide metal ions _____ _____ (have) no effect on the photoluminescence and radioluminescence behavior of the structures 1 and 2.

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Functional Expressions and Sentences

A. Answering the research question

* *We have found that…*
* *We can conclude that…*
* *Our works indicate that…*
* *Our results suggest that…*
* *Our results indicate that…*
* *These results show that…*
* *These results have verified that…*
* *These results have confirmed that…*
* *Our studies suggest that…*
* *Our studies revealed that…*
* *Our studies have shown that…*
* *These observations indicate that…*
* *According to the results of X, we confirm that…*
* *X was dominated by Y, which is also evidenced by…*

B. Stating unexpected outcome

* *It is unexpected that…*
* *Interestingly, X is found to…*
* *However, it is surprising that…*
* *It might be surprising to see X.*
* *This is rather unexpected, since…*
* *A surprising observation in our study was…*
* *X was unexpected and not in agreement with…*
* *More interestingly, unexpected X was obtained.*

C. Supporting the answer with results: summarizing key results

* *We found that...*
* *In our experiments, …*
* *It is noteworthy that…*

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* *Our results confirm that…*
* *From X it is observed that…*
* *From our data, we can make a conclusion that…*

D. Supporting the answer with results: interpreting results

* *This suggests that…*
* *This indicates that…*
* *This revealed that…*
* *…, revealing that…*
* *Thus, it is clear that…*
* *X demonstrates that…*
* *…, demonstrating that…*
* *…, further confirming…*
* *By…, we verified that...*
* *It is worthy to note that...*
* *…, which may be due to…*
* *The results showed that…*
* *This provides evidence that…*
* *…can be explained as follows.*
* *This result may be ascribed to…*
* *…, which may be attributed to…*
* *X was observed, indicating that…*
* *X was observed, which confirms…*
* *By analyzing…, we concluded that...*
* *It can be seen obviously from…that…*
* *Theoretical and experimental results indicate that...*
* *According to…, X can be detected, which confirms that…*

E. Supporting the answer with results: relating results to previous research

* *This is in consistent with…*
* *…, (which is) in consistent with…*
* *This is in (good) agreement with…*
* *…, (which is) in (good) agreement with…*
* *X has also been proved by Wei and co-workers (2018).*
* *These observations agree with the results by…, assuming that…*
* *The X performance of A is also compared with previously reported Y.*

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* *This value is comparable with the data reported by other groups that…*
* *X is consistent with previous literature/research/studies/reports/results.*
* *This matches well with the results in previous works, proving the importance of…*
* *X is in (good) agreement with previous literature/research/studies/reports/results.*
* *A comparison of the obtained result with available references reveals that…*

* *X expands the scope of…*
* *This is superior to X samples reported previously.*
* *The obtained results broaden the existing knowledge about…*
* *It is important to note that X does not merely surpass previous works.*

* *…, which is inconsistent with…*
* *This contradicts the hypothesis that…*
* *This contradicts previous reports which believe that…*
* *Previous works concluded that… However, our findings show that…*

F. Dealing with limitations

* *However, X is generally restricted by...*
* *Because of this potential limitation, we…*
* *However, the byproduct formation is negligible in this study.*

G. Re-summarizing results in general

* *In conclusion, …*
* *We conclude that…*
* *In summary, we have reported that…*
* *In summary, we have demonstrated that…*
* *In summary, we synthesized and characterized a novel catalyst…*

H. Restating the answer

* *The result demonstrates that…*
* *The results above substantiate that…*
* *Therefore, it may be concluded that…*
* *In this study, X has been successfully…*
* *Overall, these results clearly indicate that…*
* *On the basis of these results, we propose that…*

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I. Relating to the big issue

* *Future work here should explore…*
* *We (thus/therefore) speculate that…*
* *Thus, we expect that the probe will…*
* *In the near future, we will focus on…*
* *X will require extensive future studies…*
* *Based on these results, we envision that…*
* *In the future, X will be further optimized by…*
* *This strategy of X can be expected to be applicable to…*
* *Taking a step further, the current study further explores…*
* *Future efforts should focus on / will be dedicated toward…*
* *These results could help guide future molecular design by…*
* *Research is currently ongoing to understand the impact of…*
* *The resulting devices yielded no efficiency, suggesting that…*
* *Significantly, this work provides a feasible design strategy for…*
* *Considering its other advantages, X should be as competitive as…*
* *This discovery opens a new direction of modifications to achieve…*
* *One future development is to… Another important development is to…*
* *Finally, … are little understood, and insights from X will be essential for…*
* *We expect in the near future an increasing attention to this field of research.*
* *X may open new opportunities for Y and thereby broaden the scope of their application.*
* *From practical applications, it remains crucial and an important research direction for…*
* *We believe that this work may contribute relevant knowledge and understanding to the future development of…*
* *The discovery of X not only proves..., but also has a great potential to...*

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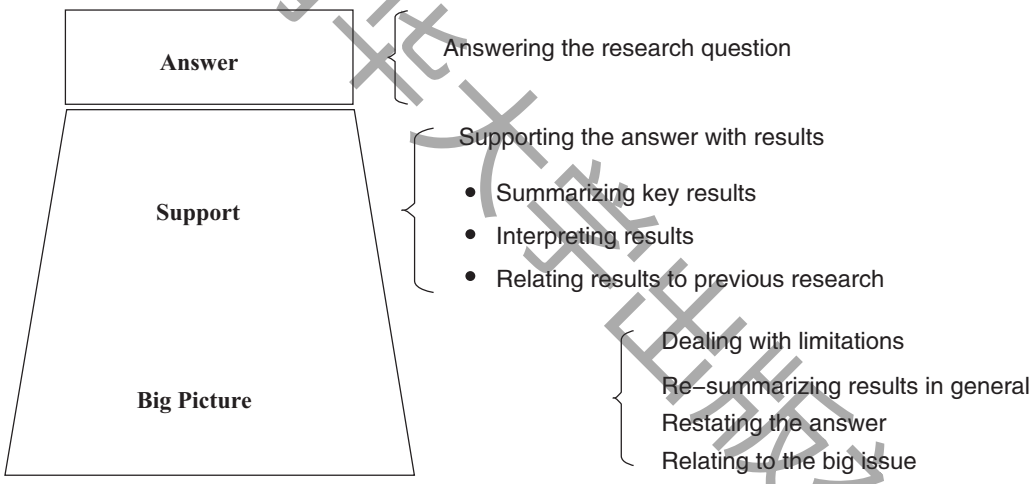
Assignments

• *Reading*

Read the Discussion of the article in Appendix IV. Try to find out the functional expressions and sentences according to the following model for Discussion.



• *Writing*

Review what you learned in this chapter and use the above model to write a Discussion for your current or undergraduate research topic.

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Appendixes

Appendix I Keys to Exercises

Chapter 2 Introduction

Corpus in Use

I

1. Although many studies have reported the use of nitrogen doped carbon nanostructures, little research has been reported on the application of amide functionalized carbon supports.

2. Although many researchers have designed novel endcapping agents to develop new imide resins, few studies on the imide oligomers derived from fluorinated phenyethynyl-contained endcapping agents could be found in the literature.

3. Although significant progress has been made in developing RORg antagonists, the identification of novel, non-steroidal RORg antagonists for therapeutic use still remains an urgent need.

II

1. Despite the encouraging advances during the past few years, the NRR activity and selectivity are still far from satisfactory.

2. Despite researchers' considerable efforts, there has been no general and practical solution to allow for the use of amine bases in Pd-catalyzed C-N cross-coupling.

3. Despite great progress in the development and optimization of triazolylidene carbenes as catalysts for enantioselective reactions, fundamental studies of these species are relatively limited.

Lead-in Questions

1. To tell the research question or research aim and to justify the research.

2. Because an Introduction usually starts from a general picture of the research field, addresses the big issue of this field, and then is narrowed down to a specific research question or research aim.

Activity 1

A

1. b　2. d　3. a　4. c

B

1. Known:　Sentences ①&②

2. Unknown: Sentence ③

3. Question:　Sentence ④

4. Approach: Sentence ④

① Steroids are a large family of physiologically and pharmaceutically important natural products. ② Previous studies toward the chemical synthesis of steroids have facilitated the development of steroid based drugs. ③ However, the additional biological functions of structurally unusual steroids, such as Aplysiasecosterol A (1), remain to be explored. ④ In this work, we aim to explore the biology of Aplysiasecosterol A by accomplishing the first and asymmetric total synthesis of (1) in a convergent fashion.

C

previous studies; However; aim to; by

Activity 2

1. BI, RQ　2. RQ, BI　3. BI, RQ

Activity 3

1. Cancer diagnosis.

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2. Traditional techniques cannot meet the great demand of early and accurate cancer diagnosis.

3. The reported homogeneous electrochemical techniques have several drawbacks.

4. It was divided into three aspects by using sequential expressions *First*, *Second*, and *Third.*

5. To develop a label-free and enzyme-free homogeneous electrochemical strategy for ultrasensitive and simultaneous detection of multiple tumor biomarkers.

6. The research aim is to develop a cancer diagnosis technique with three traits: label-free, enzyme-free, and able to do multiple tumor biomarker detection. These traits are respectively aimed at the three aspects of drawbacks mentioned in the knowledge gap.

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Activity 4

A

To establish the significance of the research topic, introduce key terms, and identify the big issue.

B

Significance: Sentences ①&②

Key term: steroids

Big issue: Sentence ③

Activity 5

A

Research interest: extensively studied, be studied for centuries, enormous interest

Usefulness: a promising tool, a powerful technology, useful method

Economic reasons: economically important, low-cost, economically friendly

Importance: vital for, of great importance, key role

B

1. extensively studied 2. key role 3. a promising tool

4. of great importance 5. economically friendly 6. enormous interest

Activity 6

A

Text A: however, ...has significant shortcomings, including…

Text B: Despite…, …remain to be explored.

B

1. However, a major problem 2. Despite, there is much room

3. Although, several limitations 4. However, remains unconquered

5. not, yet, rarely 6. However, remains challenging

Activity 7

A

b a d c

B

1. Overview of Previous Studies 2. Specific Studies 3. Knowledge Gap

4. Framing the Knowledge Gap 5. Funnel

Activity 8

A

Despite these notable advances, methods for highly enantioselective N-alkylation (nonallylic alkylation) of indoles with broad substrate scope remain rare.

B

However, few studies/investigations/attempts/researchers…

However, little research/work/information/attention...

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C

1. However, little research has been reported on the application of amide functionalized carbon supports.

2. However, few studies/investigations/attempts are carried out directly using cor-rosive biofilm in the rust layer.

3. However, little research/attention has been focused on the utilization of sulfone units in helicene synthesis.

4. To our knowledge, however, few studies/investigations/attempts have been carried out on the correlation between the microstructure and gas separation performance of polyimide membranes.

5. However, there are relatively few studies/investigations/attempts about the influence of anions on the crystal structures of L so far.

Activity 9

Research aim: Herein, we aim to achieve…

Research question: In this work, we wish to examine whether and to what extent…

Hypothesis: We hypothesized that…

Experimental approach: through the less invasive intravenous administration by…

Activity 10

A (possible answers)

1. In this work, we examine whether PhABCG1 is involved in VOC emission.

2. The purpose of this study is to determine the preferred pathways for CH_3OH formation from CO_2.

3. Herein, we investigate what types of Pd-Cu bimetallic alloy structures on the surface facilitate CO_2 hydrogenation to CH_3OH.

4. In this study we hypothesized that both transmittance and reflectance spectra are appropriate for sensing experiments with these MCM structures.

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B

1. identify 2. test 3. design 4. explore/analyze 5. report 6. analyze/explore

Activity 11

A

1. c 2. d 3. b 4. a

B (possible answers)

1. The purpose of this study is to determine the samples' effect on the resistance to carbon deposition and catalytic activity. For this purpose, we tested these samples prepared with glycine, urea and without fuel.

2. In this study we hypothesized that it should be possible to impregnate a synthetically fluorinated NO donor into fluoropolymers. To test this hypothesis, we used the simple solvent-swelling method.

C

1. The purpose of this study is to determine the samples' effect on the resistance to carbon deposition and catalytic activity by testing these samples prepared with glycine, urea and without fuel.

2. In this study we hypothesized that it should be possible to impregnate a synthetically fluorinated NO donor into fluoropolymers using the simple solvent-swelling method.

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Chapter 3 Methods

Corpus in Use

1. in, in 2. at 3. in 4. in 5. in 6. from/through 7. with/to 8. at

9. at 10. from 11. with 12. by, by, with

Lead-in Questions

1. Because Methods is about things they have already done.

2. To tell the reader how the research question is answered.

Activity 1

A

5. e　3. a　1. f　4. b　8. d　6. c　9. h　2. g　7. i

B

Past simple and passive voice are mainly used. Past simple is used to describe things that were already done. When reading a Methods section, readers care more about what was done instead of who did it, so passive voice is used to make the text less personal. This also implies that any researcher can repeat the research by using the same methods.

Present simple is also used. This is either to show a fact (*The sites were selected from the London Basin area, which* is *located in*...) or to describe a standard procedure or methods (*This method* obtains *a precipitate through*...).

Activity 2

1. The electrical signals were recorded.

2. The frequency of the power supply was fixed.

3. Plasma hydrogenation of CO_2 were carried out.

4. The change of the gas volume before and after the reaction was measured.

5. To evaluate the reaction performance of CO_2 hydrogenation to methanol, the concentration of major products in the condensate was calculated.

Activity 3

1. Plasma hydrogenation of CO_2 was carried out using different DBD reactors at atmospheric pressure.

2. A mixture of H_2 and CO_2 was fed into the DBD reactor at a total flow rate of 40 ml/min.

3. In this work, the discharge power was calculated by using the Q-U Lissajous method and was fixed at 10 W.

4. The gaseous products were analyzed using a gas chromatograph equipped with a thermal

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conductivity detector (TCD) and a flame ionized detector (FID).

Activity 4

1. Prior to 2. subsequently 3. After 4. next 5. When 6. first step

7. At the end of

Activity 5

1. three times 2. slowly 3. carefully 4. quickly 5. tightly, to prevent

6. under identical conditions, every

Chapter 4 Results

Corpus in Use

I

Students' own answers.

II

Verbs in Results section	Noun (noun structure)	*that*-clause
observe	Y	Y
show	Y	Y
use	Y	N
obtain	Y	N
find	Y	Y
report	Y	Y
calculate	Y	N
compare	Y	N
prepare	Y	N
determine	Y	Y

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Lead-in Questions

One picture is worth a thousand words. This is why visual illustrations are useful and important when writing the Results section.

Activity 1

Types	Uses	Example
diagram	d	E
table	f	B
map	a	F
pie chart	c	D
bar graph	b	C
line graph	e	A

Activity 2

A

The table contains statistic data, while the figure only contains visual illustration. The table legend is above the table, while the figure legend is on the bottom.

B

It depends on your objectives. If you want to stress numbers, you can present your data as table. If you want to compare gradients, you can show your data as figure. But never duplicate the information you already described by using both table and figure.

Activity 3

A

Data: c, example 1; Results: a, example 3; Implication: b, example 2

B

Data

Results that don't fit hypothesis

Research aim

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Statistical analysis

Experimental results

C

It depends on whether the presentation of data helps answer the research question.

Activity 4

A

1. c　　2. a　　3. b　　4. d

B

2　3　1

Activity 5

1. The size distribution of GNP has an average size of 60 \xA1\xC0 9 nm together with a typical TEM image as an inset (Figure 1).

2. The crystal habit is clearly reflected on the crystal structure of the solids (Figure 2).

3. Clearly, the alloy formation could considerably decrease the crystallite size of the Cu phase (Table 3).

Activity 6

A

1. Adding H_2O_2 to convert GSH into GSSG significantly enhances fluorescence (Figure 1).

2. The electrochemical testing does not change the chemical states of CoP/NCNHP catalyst.

B

1. After adding H_2O_2 to convert GSH into GSSG, a significant fluorescence enhancement was observed (Figure 1).

2. According to an electrochemical testing, chemical states of CoP/NCNHP catalyst are nearly not changed.

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C

1. When H_2O_2 was added to convert GSH into GSSG, a significant fluorescence enhancement was observed (Figure 1).

2. When we completed a desired catalytic reaction, magnetic stir bars could then be easily separated from the reaction mixture.

Chapter 5 Discussion

Corpus in Use

Students' own answers.

Lead-in Questions

1. The information in the Results section highlights the key research findings. The Discussion section explains what the results mean and how they move research in the area forward. The Discussion section also relates the current research to previous research.

2. A Discussion focuses on interpreting the results. A Conclusion is a short summary of the whole research article.

Activity 1

1. Answering the research question

2. Supporting the answer with results

3. Interpreting the results

4. Re-summarizing the results in general

5. Relating to the big picture

Activity 2

A (possible answers)

1. This study shows that PhABCG1 is involved in VOC emission.

2. Our results indicate that Mn addition does not promote the formation of olefins.

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3. In this study, we have shown that both transmittance and reflectance spectra are appropriate for sensing experiments with these MCM structures.

B (possible answer)

This study shows that exposing oilseed rape seeds to neonicotinoids affects reproductive potential in wild bee populations.

Activity 3

A

The result presented in Discussion is a summary (Neonicotinoid treatment decreased the number of queens in wild bee populations.) and interpretation (Sublethal amount of neonicotinoids may have harmful effects on the reproduction of wild bees.) of the result in Results.

B

This study shows that exposing oilseed rape seeds to neonicotinoids affects reproductive potential in wild bee populations. We found that / In our experiments, neonicotinoid treatment decreased the number of queens in wild bee populations. Sublethal amount of neonicotinoids may have harmful effects on the reproduction of wild bees.

C (possible answer)

This decrease implies that sublethal amount of neonicotinoids may have harmful effects on the reproduction of wild bees.

D (possible answer)

We found that there was a significant correlation between the bacterial community composition and soil pH. This finding indicates that pH is an important predictor of the community composition.

Activity 4

A

1. expand (broaden)　　2. confirm (is consistent with)　　3. contradict (is in stark contrast to)

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B

1. comparable to 2. contradict 3. good agreement with 4. expand

C (possible answer)

We found that there was a significant correlation between the bacterial community composition and soil pH. This suggests that pH is an important predictor of the community composition, which is consistent with Porter et al.'s study (2017). However, our finding contrasts with earlier findings that pH showed no significant correlation with bacterial community composition (Snow et al., 2012).

Activity 5

Summarizing results: ① ②

Restating the answer: ③

Relating to the big issue: ④

Activity 6

A

1. b 2. d 3. c 4. a

B

1. implication (imply)
2. recommendation (should)
3. application (be applicable to)
4. speculation (speculate)

C

1. imply/suggest; may/might antagonize; may/might have

2. should consider

3. speculate; may/might have

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Appendix II Common Affixes in Chemistry

Affix	Meaning	Example
a-	not, without	amorphous 无定形的 asymmetric 非对称的
alkal-	soda ash, alkali	alkaline 碱性的；含碱的 alkali metal 碱金属
allo-	other, different	allogene 异基因 allotrope 同素异形体
amin-	ammonia	amine 胺基 amino acid 氨基酸
amph-	double, on both sides	amphibian 两栖动物；两栖的 amphoteric 两性的（酸性的或碱性的）
anti-	against, opposite	antibiotics 抗生素 antiseptic 防腐的
aqu-	water	aquatic 水生的 aqueous solution 水溶液
baro-	pressure	barometer 气压表 barometric 气压的
bi-	two	bichloride 二氯化物 binary compound 二元化合物
bio-	life	biochemistry 生物化学 biosynthesis 生物合成
carbo-	coal, carbon	carbohydrate 碳水化合物 carbonate 碳酸盐
chem-	chemistry	chemical 化学品 chemotherapy 化学疗法
com-	with, together	composition 组成 compound 化合物
conjug-	joined together	conjugate acid 共轭酸 conjugation reaction 结合反应
cosm-	the world or universe	cosmic ray 宇宙射线 cosmochemistry 宇宙化学；天体化学
cry-	cold	cryesthesia 冷觉过敏 cryogenic 冷冻的；低温的
de-	down, without, from	decomposition 分解；腐烂 dehydrate 脱水；去水

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(Continued)

Affix	Meaning	Example
dens-	thick	density 密度 densimeter 密度计
di-	separate, double, across	dioxide 二氧化物 disaccharide 二糖
dis-	separate, apart	disappear 消失 dissociation 离解（作用）
duct-	lead	ductal 管的；导管的 ductile 易延展的
electr-	electrode	electron 电子 electrolyte 电解质；电解液
elem-	basic	element 元素 elementary 初级的；简单的
en-	in, into	endothermic 吸热的
equ-	equal	equation 等式；方程式 equilibrium 化学平衡
exo-	out, outside, without	exothermic 放热的
ferr-	iron	ferrite 铁氧体 ferromagnetism 磁铁性
fiss-	cleft, split	fission 裂变；分裂
flu-	flow	fluctuate 波动 fluids 流体
fract-	break, broken	fracture 断裂；断口 fractional distillation 分馏
gen-	bear, produce, beginning	gene 基因 genome 基因组；染色体组
glyc-	sweet	glycogen 糖原；动物淀粉 glycolysis 糖酵解 glycolipid 糖脂类
graph-	write, writing	graphite 石墨 graphene 石墨烯
halo-	salt	halogen 卤素 halometer 盐量计
hetero-	other, different	heterogeneity 异质性；非均匀性 heterogeneous mixture 不均匀混合物 heterovalent 多价的

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(Continued)

Affix	Meaning	Example
hom-	same, alike	homogeneity 同质性；均匀性 homogeneous mixture 均匀混合物 homokaryon 同核体
hybrid-	mongrel, hybrid, combination	hybrid orbital 杂化轨道 hybridization 杂交
hydr-	water	hydration 水合作用 hydrolysis 水解作用
hyper-	over, above, excessive	hyperplastic 增生的 hyperspectral image 高光谱图像
hypo-	under, beneath	hypochlorous acid 次氯酸 hypoderm 皮下组织；下皮
im-	not	immiscible 不相溶的 impermeable 不渗透的
in-	in, into	inactive 不活泼的 inorganic 无机的
iso-	equal	isohydric 等氢离子的 isomer 同分异构体
kine-	move, moving, movement	kinematics 运动学 kinetics 动力学 kinetic energy 动能
lip-	fat	lipase 脂肪酶 lipoprotein 脂蛋白
liqu-	fluid, liquid	liquefy 液化 liquable 可液化的
macro-	large, long	macromolecule 大分子
malle-	hammer	malleable 有延展性的 malleableize 韧化
meta-	between, change	metabolism 代谢
misc-	mix	miscible 可溶混的 miscibility 溶混性
mono-	single, one	monomer 单体 monoxide 一氧化物 carbon monoxide 一氧化碳
morph-	form	morphology 形态学 morphactin 形态素；整形素

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(Continued)

Affix	Meaning	Example
neo-	new, recent	neonate 新生儿 neoantigen 新抗原
non-	not	nonpolar 非极性的
nuc-	nut, center	nuciform 坚果状的；核子状的 nucleus 原子核；细胞核
oct-	eight	octane 辛烷 octet rule 八隅规则
orbi-	circle	orbicular 球状的 orbital 轨道的
oxid-	oxygen	oxide 氧化物 oxidizer 氧化剂
photo-	light	photochemical smog 光化雾 photon 光子 photosynthesis 光合作用
polar-	of the pole, polarity	polar covalent 极性共价 polarity 极性
poly-	many	polymer 聚合物 polysulfide 多硫化物
pro-	forward, positive, for, in front of	prochiral 前手性的 proton 质子
quant-	how much	quantitative 量化的；定量的 quantum 量子；量子的
radi-	ray, radius	radiation 辐射 radioactive 放射性的
sali-	salt	saline 盐的；生理盐水 salinity 盐度；盐分
solu-	dissolve	solubility 溶解度；可溶性 solution 溶液
spect-	see, look at	spectrum 光谱；波谱 spectator ions 旁观离子
syn-	together, with	synthesize 合成；结合 synthetic 合成的；人造的
therm-	heat	thermal 热的；热量的 thermochemistry 热化学 thermometer 温度计

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(Continued)

Affix	Meaning	Example
trans-	across, through	transisomer 反式异构体 transition elements 过渡元素
un-	not	uncatalyzed 非催化的 undamped 无阻尼的 unsaturated 不饱和的
vapor-	steam, vapor	vaporability 挥发性；汽化性 vaporization 蒸发
vulcan-	fire	vulcanize 硫化 vulcanizer 硫化剂
-ane	single covalent bond	methane 甲烷 ethane 乙烷 propane 丙烷
-ene	double covalent bond	ethylene 乙烯 polypropylene 聚丙烯
-ide	a chemical made up of two or more elements	sodium chloride 氯化钠 hydroxide 氢氧化物
-ion	process	fusion 聚变；融合 diffusion 扩散
-lysis	loose, loosening, breaking	analysis 分析 electrolysis 电解
-oid	like, form	alkaloid 生物碱 metalloid 类金属的
-mer	part	dimer 二聚物 trimer 三聚物
-meter	measure	calorimeter 热量计 fluidimeter 粘度计；流度计
-thesis	an arranging, statement	hypothesis 假设 synthesis 合成
-yne	triple covalent bond	benzyne 苯炔 ethyne 乙炔

Source: Adapted from Herr, N., & Cunningham, J. (1999). *Hands-on Chemistry Activities with Real-life Applications*. New York: The Center for Applied Research in Education.

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Appendix III Common Chemical Abbreviations and Acronyms

Å	angstrom
A	absorbance
α	observed rotation
[α]	specific rotation (units (deg•mL)/(g•dm) are understood)
abs	absolute
Ac	acetyl
acac	acetylacetonate
AcOH	acetic acid
Ac2O	acetic anhydride
AIBN	azobisisobutyronitrile
Ala	alanine
AM1	Austin model 1 (semiempirical MM method)
AMP	adenosine 5'-monophosphate
amu	atomic mass units
Anal.	combustion elemental analysis
anhyd	anhydrous
aq	aqueous
Ar	aryl
atm	atmosphere
ATP	adenosine-5'-triphosphate
ATR	attenuated total reflectance
au	atomic units
av	average

9-BBN-H	9-borabicyclo[3.3.1]nonane
BET	Brunauer-Emmett-Teller (absorption isotherm)
BINAP	2,2'-bis(diphenylphosphanyl)-1,1'-binaphthyl
bipy	2,2'-bipyridine or 2,2'-bipyridyl

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(Continued)

Bn	benzyl (PhCH2 also Bzl)
Boc	tert-butoxycarbonyl
bp	boiling point
bpy	2,2'-bipyridine or 2,2'-bipyridyl
Br	bromine
br	broad (spectral peak)
BSA	bovine serum albumin
Bu	butyl
BuLi	butyl lithium (also n-BuLi)
Bz	benzoyl (PhCO also bz)

°C	degrees Celsius
calcd	calculated (for MS analysis)
cAMP	adenosine cyclic 3',5'-phosphate
CAN	ceric ammonium nitrate
cat	catalytic
CBZ, Cbz	benzyloxycarbonyl (protecting group)
CC	coupled cluster (computational method)
cc	cubic centimeters
CD	circular dichroism
cDNA	circular DNA
c-Hex	cyclohexyl (Thieme Cy)
CI	chemical ionization
CIF	crystallographic information file
Cl	chlorine
cm	centimeter
cm^{-1}	wavenumbers(s)
cmc	critical micelle concentration
13C NMR	carbon NMR
cod	1,5-cyclooctadiene

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(Continued)

compd	compound
concn	concentration
COSY	correlation spectroscopy (2D NMR method)
Cp	cyclopentadienyl
Cp	heat capacity at constant pressure
CPK	Corey-Pauling-Koltun (models)
CP/MAS	cross-polarization/magic angle spinning (NMR)
cryst	crystalline
CSA	camphorsulfonic acid
CT	charge transfer
CV	cyclic voltammetry
δ	chemical shift (ppm) downfield from TMS
d	days; doublet (spectral)
d	density
D	debye
D	diffusion coefficient
DABCO	1,4-diazabicyclo[2.2.2]octane
dansyl	5-(dimethylamino)-1-naphthalenesulfonyl
DBN	1,5-diazabicyclo[4.3.0]non-5-ene
DBU	1,8-diazabicyclo[5.4.0]undec-7-ene
DCC	N,N'-dicyclohexylcarbodiimide
DCE	1,2-dichloroethane
DCM	use CH2Cl2 instead
DDQ	2,3-dichloro-5,6-dicyano-1,4-benzoquinone
de	diastereomeric excess
DEAD	diethyl azodicarboxylate
dec	decomposition (for mp)
DIAD	diisopropyl azodicarboxylate
DIBALH	diisobutylaluminum hydride

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(Continued)

DIC	diisopropylcarbodiimide
dil	dilute
DIPEA	N,N-diisopropylethylamine
DMA	dimethylacetamide
DMAP	4-(N,N-dimethylamino)pyridine
DME	1,2-dimethoxyethane
DMF	dimethylformamide
DMP	Des-Martin periodinane
DMPU	N,N'-dimethylpropylene urea
DMSO	dimethylsulfoxide
DMTrCl	4,4-dimethoxytrityl chloride
dp	degree of polymerization
DPPA	diphenylphosphoryl azide
DPS	tert-butyldiphenylsilyl
dr	diastereomeric ratio
DTT	dithiothreitol
ε	molar absorptivity
ee	enantiomeric excess
EDC or EDCI	N-ethyl-N'-(3-dimethylaminopropyl)carbodiimide
EDTA	ethylenediaminetetraacetic acid
EGDMA	ethylene glycol dimethacrylate
EI	electron impact
EPR	electron paramagnetic resonance
eq	equation
equiv	equivalents
ESI	electrospray ionization
Et	ethyl
Et3N	triethylamine (use instead of TEA)
eu	entropy units

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(Continued)

FAB	fast atom bombardment (in MS)
Fc	ferrocenyl
Fmoc	9-fluorenylmethoxycarbonyl
fp	freezing point
FT	Fourier transform
g	gram(s); gas
G	gauss
G	Gibbs free energy
GC	gas chromatography
h	hours(s)
h	Planck constant
H	henry (units)
H	enthalpy
HMDS	hexamethyldisilazane
HMPA	hexamethylphosphoric triamide
H NMR	proton NMR
HOMO	highest occupied molecular orbital
HPLC	high-performance liquid chromatography
HRMS	high-resolution mass spectrometry
HNMR	proton NMR
insol	insoluble
IR	infrared
isc	intersystem crossing
J	Joule
J	coupling constant in NMR

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(Continued)

k	kilo
k	rate constant; Boltzmann constant
K	Kelvin
K	equilibrium constant
KHMDS	potassium hexamethyldisilazide
l	liquid
L	liter; ligand
LAH	lithium aluminum hydride
LDA	lithium diisopropylamide
LHMDS	lithium hexamethyldisilazane
lit.	literature value
λ_{max}	max UV-vis wavelength
LUMO	lowest unoccupied molecular orbital
m	meter; milli; multiplet (spectral)
M	molar (moles per liter)
M+	parent molecular ion (in MS)
Φ06Δ	micro
max	maximum
m-CPBA	meta-chloroperoxybenzoic acid
MAA	methacrylic acid
MALDI	matrix-assisted laser desorption ionization (in MS)
Me	methyl
MeCN	acetonitrile
MEK	methyl ethyl ketone
MEMCl	2-methoxyethoxymethyl chloride
Mes	mesityl (2,4,6-trimethylphenyl)
MHz	megahertz
min	minute(s); minimum

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(Continued)

MIP	molecularly imprinted polymer
mL	milliliter
mm	millimeter
mM	millimolar (moles per liter)
mmol	millimole(s)
MMA	methyl methacrylate
MN	number average molecular weight
mo	month
mol	mole(s)
mol wt	molecular weight
MOM	methoxymethyl
mp	melting point
MS	mass spectrometry; molecular sieves
Ms	mesyl (methanesulfonyl)
MTBE	methyl tert-butyl ether
MVK	methyl vinyl ketone
MW	weight average molecular weight
m/z	mass to charge ratio (in MS)

N	normal (equiv per liter)
NADH	nicotinamide adenine dinucleotide hydride
n-Bu	normal butyl (primary)
NBS	N-bromosuccinimide
NCS	N-chlorosuccinimide
NMO	N-methylmorpholine N-oxide
NMP	N-methyl-2-pyrrolidinone
NMR	nuclear magnetic resonance
NOE	nuclear overhauser effect
no.	number
Nu	nucleophile

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(Continued)

obsd	observed
OD	optical density
op	optical purity
oxdn	oxidation

Pa	Pascal
PBS	phosphate-buffered saline
PCC	pyridinium chlorochromate
PDC	pyridinium dichromate
PEG	polyethylene glycol
PET	photoinduced electron transfer
pH	proton log units
Ph	phenyl
Phth	phthaloyl
PMB	p-methoxybenzyl
PPA	polyphosphoric acid
pp	pages
ppm	part per million
ppt	precipitate
Pr	propyl
PTSA	p-toluenesulfonic acid
Pv	pivaloyl
py	pyridine

q	quartet (spectral)
quin	quintet (spectral)

R	gas constant
R	alkyl group

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(Continued)

RCM	ring-closing metathesis
recryst	recrystallized
red	reduction
Red-Al®	sodium bis (2-methoxyethoxy) aluminum hydride
redox	reduction-oxidation
rel	relative
Rf	retention factor (in chromatography)
ROMP	ring-opening metathesis polymerization
rt	room temperature (Thieme publishing r.t.)
s	seconds; singlet (spectral); solid
S	entropy
SAR	structure-activity relationship
sat.	saturated
s-Bu	sec-butyl
SD	standard deviation
SE	standard error
SEM	scanning electron microscope
sept	septet (spectral)
SET	single electron transfer
sext	sextet (spectral)
sh	sharp (spectral), shoulder (spectral)
SN1	unimolecular nucleophilic substitution
sol	solid
soln	solution
t	triplet (spectral)
t	time or temp in °C
T	temperature in kelvin
t-Bu	tert-butyl

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(Continued)

TBS	tert-butyldimethylsilyl
temp	temperature
TES	triethylsilane
TCE	2,2,2-trichloroethyl
TCNE	tetracyanoethylene
Tf	trifluoromethanesulfonyl (triflyl)
TFA	trifluoroacetic acid
TFAA	trifluoroacetic anhydride
THF	tetrahydrofuran
THP	tetrahydropyran
TIPS	triisopropylsilyl
TLC	thin-layer chromatography
TMEDA	N,N,N',N'-tetramethyl-1,2-ethylenediamine
TMS	trimethylsilyl or tetramethylsilane
TOF	time of flight (in MS)
Tol	toluene
tosyl	p-toluenesulfonyl
TPS	triphenylsilyl
t_R	retention time (in chromatography)
Tr	triphenylmethyl (trityl)
Troc	2,2,2-trichloroethyl chloroformate
trityl	triphenylmethyl
Ts	p-toluenesulfonyl (tosyl)
TS	transition state

UV-vis	ultraviolet-visible absorption spectroscopy

VDW	van der Waals (interaction)
vis	visible
vol	volume

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(Continued)

vs.	versus
v/v	volume to volume ratio
wt	weight
w/w	weight to weight ratio
X-ray	X-ray (capital X)

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Appendix IV Model Research Article

A Molecular Multi-gene Classifier for Disease Diagnostics[1,2]

Randolph Lopez, Ruofan Wang and Georg Seelig

Introduction[3]

Gene expression changes are associated with every human disease. Monitoring such changes enables clinicians to perform diagnosis, evaluate therapeutic efficacy and predict disease recurrence. Existing methods for high-throughput RNA detection such as quantitative reverse transcription PCR (RT-qPCR), microarrays or RNA sequencing can in principle be used to quantitatively monitor gene expression changes in diagnostic applications, but they remain cost-prohibitive in situations where recurrent monitoring or regular screenings are necessary. Moreover, the experimental complexity and the need for in silico computational analysis of the resulting data mean that such tests can only be performed in specialized laboratory settings. To overcome these limitations of complexity and cost it is necessary to develop instrument-free diagnostic tests that can be administered and interpreted directly at the point of care.

In the past two decades, researchers have found that peripheral gene expression (for example, whole blood, platelets, exosomes, plasma or saliva) is consistently altered between cancer patients and healthy controls. For instance, relative quantitation of telomerase reverse transcriptase (hTERT) RNA in blood or serum has diagnostic and prognostic value in many different cancer types. Researchers have also demonstrated that a classifier based on a patient's blood RNA profile can distinguish between bacterial and viral infections. Discriminating between these two groups is essential to address inappropriate prescription of antibiotics and combat antibiotic resistance. Importantly, early cancer diagnostics and combating antimicrobial resistance are just two examples of medical applications that would benefit from rapid and inexpensive gene expression diagnostics for use at home or the point of care.

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1 The main purpose of including this model is to help students understand the logic of research papers and identify functional expressions and sentences, so the figures in this article have been omitted.

2 Journals have different format guidelines, so it is common to see variations of the IMRD structure. For example, *Nature Chemistry*, from which this article was chosen, specifically requires Methods to be the last section rather than the second section of the main text. You may also see this organization in other journals.

3 *Nature Chemistry* also requires an Introduction without heading. This heading was added by the author of this book.

Recent work in cell-free synthetic biology and DNA nano-technology has demonstrated progress towards the goal of creating low-cost RNA diagnostics. For example, a test for Zika virus has been developed by embedding a set of engineered molecular components for RNA sensing and signal amplification in a paper matrix. Detection of the RNA marker is converted into a colorimetric signal that allows intuitive interpretation. However, to broaden the utility of such tests beyond applications where detection of a single marker is sufficient, it will be necessary to develop "molecular computation" technologies that can convert information encoded in multi-gene expression signatures into interpretable yes/no answers.

Cell-free molecular circuits with dozens of interconnected components have been experimentally demonstrated and provide proof of principle that complex computation can be embedded in molecular substrates. However, rationally designed molecular circuits realized so far are not well matched to diagnostic applications. For instance, it is often assumed that inputs take Boolean values (high or low), an assumption that is not naturally compatible with RNA inputs derived from a biological sample. In contrast, computational gene expression classifiers are commonly built using logistic regression, support vector machines (SVMs) or neural network approaches that take better advantage of the information encoded in the actual levels of the biomolecules of interest. Finally, inputs are typically short, unstructured oligonucleotides with carefully designed sequences rather than long biological RNAs with extensive secondary structure. To realize the potential of DNA computation for diagnostic applications it is thus necessary to develop molecular classifiers that operate directly on RNA inputs and produce a result rapidly and robustly.

Here, we address this challenge and demonstrate a framework for creating a DNA-based molecular "computer" capable of performing multi-gene classification (Fig. 1a). In our workflow, publicly available, labelled (for example, bacterial infection vs viral infection) gene expression data are first used to train an in silico linear classifier, specifically an SVM. During training, constraints are imposed to find the minimal set of genes that need to be considered for classification with a desired accuracy. The resulting model consists of a set of input features (the RNA transcripts), a positive or negative weight associated with each feature, and a set of mathematical operations (summation and comparison to a threshold) performed over these inputs. Once an optimal model has been obtained, a computational tool translates all parameters and mathematical functions into a novel class of DNA probes that realize the classifier at the molecular level. In the following, we first test each molecular classifier component individually, starting with RNA detection and assignment of weights. Finally, we validate the entire workflow by implementing molecular classifiers for the two applications introduced above, namely early cancer diagnostics based on ratiometric detection of hTERT, and distinguishing

between bacterial and viral infections based on a panel of host genes.

Results

Detection of transcripts through assisted hybridization. The first step in our implementation of a molecular classifier is the detection of RNA transcripts (Fig. 1b). Initially, we pursued an approach using competitive hybridization (or strand displacement) probes at room temperature (Supplementary Section 2 and Supplementary Fig. 1). However, we found that the high degree of secondary structure in RNA transcripts severely limited the probe binding efficiency. The use of computational tools for identifying unstructured stretches of RNA ameliorated the situation somewhat, but binding kinetics still varied widely (Supplementary Fig. 2). Moreover, the number of potential probe binding sites on a transcript was determined entirely by the secondary structure and could not be tuned at will, which is incompatible with our molecular computation scheme, as described in the section "Molecular implementation of weights".

To enable robust detection of a larger number of target regions within a transcript, we developed an assisted hybridization protocol. Specifically, we designed a two-stage reaction whereby an input sequence within the target RNA transcript (domain a) is thermally or chemically annealed to a hybridization probe consisting of two partially complementary strands (Fig. 1c). Additional helper strands (60 nt) are included in the reaction. Helper strands hybridize adjacent to the targeted region on the RNA to further help unfold its secondary structure and to prevent binding between the adjacent RNA regions and the single-stranded domain of the hybridization probe. As a result of this initial reaction the longer probe strand becomes attached to the transcript and a short toehold (domain t1*) is exposed within that strand. Domain a* in the hybridization probe is partially double-stranded (15 nt single-stranded and 15 nt double-stranded) and is complementary to the target sequence. On binding to its target, hybridization results in a maximum overall gain of 9 bp, making this reaction thermodynamically favourable. Subsequently, a fluorescent reporter is added to the solution and reacts with the bound strand through toehold-mediated strand displacement, resulting in an increase in fluorescence. If the target RNA is not present, the translator probe reforms upon annealing and cannot interact with the fluorescent reporter. Importantly, because of the two-stage design, the target sequence on the transcript is completely independent of the reporter sequence.

To experimentally test this strategy, we designed hybridization probes to target three different regions of an mRNA coding for the fusion protein histone 2B Citrine (Citrine) as well as a control hybridization probe specific to GAPDH. For an initial test of the probe design with an unstructured target, a short oligonucleotide encoding the target sequence (30 nM) was added to each probe at room temperature. As designed, addition of the target oligonucleotide resulted

in increased signal from a downstream fluorescent reporter (Fig. 1d). In contrast, addition of in vitro transcribed Citrine RNA (30 nM) did not result in increased fluorescence, because the secondary structure of the RNA transcript hindered the strand displacement reaction. We then tested whether addition of the helper strands could aid hybridization between the RNA target and probe at room temperature, but we observed significant triggering for only one hybridization probe (Supplementary Fig. 3).

Subsequently, we implemented a thermal annealing strategy where the hybridization probe and corresponding helper strands were annealed with the Citrine RNA transcript before addition of the fluorescent reporter. Thermal annealing was performed by heating reactants to 70 °C for 10 s and subsequently cooling to 25 °C at a rate of −1 °C per 10s. As expected, we observed a fluorescent response equivalent to the concentration of added transcript in all Citrine probes while the GAPDH probe showed no increased in fluorescence (Fig. 1e). We carried out the same reaction without addition of helper strands and we observed a lower fluorescence response across all conditions. These results suggest that the helper strands have a role in suppressing non-specific binding between single-stranded overhangs in the probe and single-stranded domains in the RNA target. We also observed very little increase in fluorescence in the case where no transcript was added. Moreover, we performed thermal annealing experiments in a background of cellular mRNA extracted from HEK293 cells without observing any unspecific triggering (Supplementary Fig. 4).

Thermal annealing is not ideal for point-of-care diagnostic applications, so we also implemented a chemical denaturing strategy for unfolding RNA targets. Following previous work, we evaluated the use of urea and subsequent addition of MgCl2 as a method to denature and renature nucleic acid base pairing. We implemented this chemical annealing strategy by incubating a hybridization probe, helper strands and the corresponding target in 6.4 M urea for 15 min followed by incubation with Mg2+ for 15 min. We observed a target-specific increase in fluorescence equivalent to thermal annealing conditions when adding the Citrine RNA transcript or a target oligonucleotide (Fig. 1f).

We note that this assisted hybridization strategy is quite distinct from earlier work in dynamic DNA nanotechnology that generally aimed to create fully autonomous systems that require minimal intervention from an experimentalist. However, we found that separating the detection reaction into an annealing step followed by a more conventional strand displacement-based reporter reaction improved not only the robustness of input detection but also dramatically accelerated it. Both features are crucial for designing a practical diagnostic test.

Molecular implementation of weights. In a gene expression classifier, RNA transcripts

have varying levels of influence on the classifier outcome. In silico, every transcript is assigned a numerical weight capturing its importance (Fig. 2a). At the molecular level, we implemented these weights by designing multiple hybridization probes that target different regions within each RNA. For example, weights n = 1, 2, N are realized by having 1, 2 or N distinct probes targeting the same transcript (Fig. 2b). Even though the targeted sequences on the transcript are different, each probe contains an identical output strand (domains t1*x* in Fig. 1c), which then triggers a fluorescent reporter. Every additional hybridization probe results in a proportional increase in the steady-state fluorescence signal. The fluorescence due to mRNA1 should thus be proportional to the product w1*[mRNA1], where w1 is an integer weight and [mRNA1] is the concentration of mRNA1.

We implemented this set-up experimentally by designing reactions with 1, 2, 3 or 4 probes targeting contiguous regions on the Citrine transcript. To avoid saturation of the reporter complex, we operated the system in a regime where reporter and hybridization probes far exceeded the transcript concentration. We measured the fluorescence signal corresponding to the reporter complex before and after addition of the hybridized probe–RNA complexes until a steady state was reached (Fig. 2c). As expected, we found that the steady-state signal was linearly proportional to the number of hybridization probes bound to the RNA transcript for all RNA concentrations tested, demonstrating that this mechanism can be used to assign an integer-valued weight to an RNA transcript (Fig. 2d).

Summation and thresholding. Building a complete linear classifier requires a mechanism for summing up weights and comparing the sum to a threshold value to obtain the desired yes/no answer (Fig. 3a). If there are multiple transcripts with different weights of the same sign, we can compute the sum of their contributions simply by using the same output sequence across all probes. The total concentration of output strands and thus the final fluorescence signal is then proportional to the sum w1*[mRNA1] + … + wN*[mRNAN].

Weights with negative values can be implemented using a distinct output sequence for the negative probes. The sums of negative and positive weights in a classifier are then represented by the total concentrations of two distinct output strands.

To complete the summation, the individual sums of positive and negative weights—represented by (positive) concentrations of two distinct nucleic acids sequences—need to be subtracted from one another. Intuitively, such a subtraction can be realized as a chemical reaction whereby stoichiometric amounts of positive and negative output strands annihilate each other until only the majority species is left. The concentration of that species then is the final result of the summation over all weights. To implement such a stoichiometric annihilation

reaction between two nucleic acid species of unrelated sequence, we take advantage of the cooperative hybridization mechanism ("annihilator" gate) introduced by Zhang.

The final step in the molecular computation pipeline is to compare the result of the summation to a threshold value. In the simplest case, the threshold value is set to zero and the class a specific input sample belongs to is determined simply by the sign of the final sum. Non-zero threshold values can be realized by spiking the corresponding amount of negative or positive output strand into the reaction, which biases the sum by a controlled amount.

Molecular thresholding of RNA transcripts. To experimentally test whether an off-the-shelf thresholding (or subtraction) element could be used in conjunction with our RNA detection scheme we created a DNA circuit consisting of three modules: a translator gate that connects the output strand from the assisted hybridization reaction to the threshold element, an annihilator gate and a single-stranded reference oligonucleotide that together act as the threshold element, and a catalytic reporter that amplifies any signal exceeding the threshold value to a constant level, allowing for a yes/no answer (Supplementary Fig. 5).

We tested this molecular thresholding system on three different transcripts (hTERT, EGFR, GAPDH) commonly used as biomarkers or reference genes for diagnostic purposes. To accommodate different RNAs, only the hybridization probe and helper strands needed to be switched, while all other strand displacement components are retained, demonstrating the modularity of the design. Each mRNA was individually transcribed in vitro from a complementary DNA (cDNA) template and quantified. For each transcript, we evaluated four experimental conditions using thermal annealing with varying ratios of transcript to reference oligonucleotide. Steady-state fluorescence values were acquired 2 h after addition of a catalytic amplifier and fluorescent reporter. With all three transcripts, we only observed an increase in fluorescence when the amount of transcript exceeded the amount of threshold.

A two-gene diagnostic classifier. For an experimental test of a full two-input classifier circuit, we selected hTERT, a cancer biomarker, as the target (associated with a positive weight) and GAPDH, a common internal reference gene in RT–qPCR experiments as the reference RNA (associated with a negative weight) (Fig. 3b). Relative quantitation of HTERT to GAPDH in human plasma has been suggested as an early diagnostic and prognostic biomarker in human cancer. The thresholding (subtraction) and amplification reaction are performed exactly as above, but, instead of an external reference strand to set the threshold value, there now is an internal reference RNA associated with a negative weight that effectively sets a threshold (Supplementary Fig. 6).

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We evaluated four classifiers with an hTERT weight of +1 and GAPDH weights of −1, −2, −3 and −4 (Fig. 3c). A sample containing both RNA transcripts was first combined with corresponding hybridization probes and helper strands. hTERT transcript was present at 15 nM while GAPDH transcript was titrated from 0 nM to 14 nM with all DNA circuits components added at higher, non-limiting concentrations. We also characterized a classifier response with an hTERT weight of +1 and GAPDH weight of −2 with a range of concentrations of each transcript (0 nM to 20 nM) (Fig. 3d,e). Overall, we evaluated 64 different experimental conditions where we recorded fluorescence levels for 2 h after addition of strand displacement components. We only observed a significant increase in fluorescence in conditions when the amount of hTERT transcript was above the threshold set by the product of the GAPDH transcript concentration and weight, in agreement with the classifier design.

Training a multi-gene SVM. We next sought to scale up our molecular classifier framework. Discriminating between viral and bacterial infections using molecular gene expression classification is a promising application because it requires a rapid, cost-effective and self-contained process to be implemented in a clinical setting. In 2016, a peripheral whole-blood gene expression classifier with 130 genes was developed to differentiate between bacterial infections, viral infections, non-infectious illness and healthy controls with 87% accuracy10.

To build a molecular classifier, we first simplified the classification problem by distinguishing only between viral and bacterial infections. We used the publicly available gene expression data corresponding to 115 viral infections and 70 bacterial infections for classifier training10. For each patient, gene expression values for 14,500 human genes were measured. We implemented an SVM to determine the minimal set of genes and corresponding weights for this classification problem. This process involved iterating through multiple sets of features (genes) and associated weights until converging to a solution that resulted in the best classification outcome.

We trained an SVM algorithm with the following constraints: First we required a low number of genes (<10) to allow for the classifier to be implemented at the molecular level. Second, we constrained weights to integer values between −5 to +5. This choice was made to limit the number of probes for a single gene as well as the overall size of the classifier. Third, we made the misclassification penalty for bacterial samples three times higher than that for viral samples. This choice was made because the worst possible outcome is to incorrectly diagnose a bacterial infection as viral, delaying the use of antibiotics. Even though this classification model performed well in the validation set, it is important to note that a model with a higher number of features may be more robust when encountering gene expression variability absent in the

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training data set. We selected nine classifiers with at least 80% accuracy in the training set and validated them using a different gene expression data set. We selected the classification model with the highest performance in the validation set to build a molecular classifier (Fig. 4a). The selected classifier correctly labelled 94% and 80% of bacterial and viral samples in the training set and 89% of bacterial and 90% of viral samples in the validation set (Fig. 4b,c).

A molecular implementation of the bacterial vs viral classifier. Next, we designed a molecular implementation of the bacterial vs viral classifier. First, we selected regions in each transcript that consisted of individual exons that were at least 200 bp long such that they could fit multiple hybridization probes. Due to the large number of transcripts and associated probes, we implemented a probe design tool for systematically generating the necessary DNA components for molecular classification. Each transcript was assigned a number of hybridization probes and helper strands, based on the weights learned in silico. Positive and negative transcripts were assigned hybridization probes with different output domains such that the concentrations of the positive and negative output strands represent the weighted sums of the respective RNA inputs, as described above. The complete DNA classifier consists of 20 hybridization probes and 14 helper strands (two for each transcript). A strand displacement cascade using two translator gates and two fluorescent reporters aggregate the signal generated by the hybridization module. Overall, the circuit consists of 62 different oligonucleotides.

Rather than performing the subtraction at the molecular level as we have done in the previous example, we chose to use two distinct fluorophores to read out the positive and negative output strands individually, which allowed us to more quantitatively characterize the performance of individual classifier components. A fluorescent reporter containing a 6-FAM (fluorescein) (FAM) and a quencher was associated with positive/bacterial transcripts, while a fluorescent reporter containing a 6-carboxyl-X-rhodamine (ROX) and a quencher was associate with negative/viral transcripts (Fig. 5a). Upon reporter calibration, the fluorescence signal from the ROX reporter can be subtracted from the FAM reporter signal to obtain a normalized signal used for classification ([FAM] − [ROX] nM). Samples resulting in a normalized signal of [FAM] − [ROX] > 0 belong to the bacterial infection category, and samples for which this signal is less than zero belong to the viral infection category.

After assembling the molecular classifier, we first used synthetic DNA oligonucleotide targets to individually test all 20 hybridization probes. Upon thermal annealing and subsequent strand displacement, we confirmed that each oligonucleotide target triggered the intended fluorescent channel with the expected signal intensity (corresponding to a unit weight) while the signal remained near background in the other channel (Fig. 5b). Subsequently, we tested the molecular classifier using in vitro transcribed RNA species. After addition of each RNA

transcript to the molecular classifier, we again measured the fluorescence response across both channels. For each transcript, we only observed significant increase in fluorescence in the expected channel. After calibration and subtraction of both channel fluorescence signals, we obtained a normalized signal for each transcript addition ([FAM] – [ROX] nM). We found this normalized signal to be proportional to the weight assigned to each gene, suggesting that the molecular weight implementation was performed correctly (Fig. 5c).

Finally, we tested our molecular classifier with samples containing RNA molecules matching the expression profiles from the training set microarray data. We selected 12 samples corresponding to six patients with viral and six patients with bacterial infections (Fig. 5d). We replicated the original gene expression profile by adding each cDNA amplicon based on its expected concentration as calculated from the microarray data. Each amplicon contained a T7 promoter for RNA transcription. Samples were then diluted to approximately 10 picomolar followed by in vitro transcription, which resulted in 1,000× amplification (Fig. 5e). As expected, upon addition of each sample to the molecular classifier, we observed significant triggering in both fluorescence channels. All samples were classified correctly based on the normalized signal intensity. Furthermore, we found a strong correlation between the normalized signal intensity and the corresponding computational output for each sample as estimated using the corresponding SVM model (Fig. 5f).

Discussion

We have introduced a systematic framework for translating an in silico gene expression classifier into DNA circuitry. We confirmed the robustness of this framework by building two distinct classifiers with varying numbers of weights and inputs. Using our approach, any in silico classifier can in principle be converted into a molecular classifier, synthesized for rapid prototyping and experimentally validated.

We developed three novel building blocks to enable molecular computation with RNA transcripts as inputs. First, breaking up transcript detection into two separate steps (assisted hybridization and strand displacement) enabled us to robustly perform molecular computing with any RNA transcript as an input. Second, by varying the number of probes that hybridize to an RNA transcript we were able to differentially weigh the importance of transcripts. Third, by designing probes with shared output sequences we were able to compute the weighted sum of multiple transcripts. So far, we have used these building blocks to create classifiers with up to seven distinct RNA inputs and up to five (positive or negative) probes per transcript. However, the size of the classifiers could in principle be scaled to tens or hundreds of targets with the number of weights only limited by the size of the transcripts. In principle, potential crosstalk

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between probes and incorrect targets becomes more likely when the number of probes is higher. Nevertheless, a thermodynamic simulation of these interactions can inform the selection of probes across the length of a target RNA transcript that exhibit little or no crosstalk.

Compared with existing methods for gene expression analysis, our approach is well suited to the inexpensive and rapid examination of clinical samples (Supplementary Table 5). Because of its experimental simplicity, our workflow is fast: the combined reaction time for the assisted hybridization module and strand displacement reaction was under 20 min with no additional time required for computational analysis and data interpretation. More fundamentally, the amount of work required to perform gene expression classification using our framework is independent of the number of genes in the assay. The complexity of RT–qPCR experiments, the current gold standard for gene expression profiling in the clinic, in contrast scales linearly with the number of genes being analysed. The DNA-based classification workflow thus dramatically reduces the need for liquid handling, making it a good fit for point-of-care applications. RNA sequencing and barcoded RNA hybridization (Nanostring) also allow for multiplexed gene expression analysis in a single reaction, but require expensive instrumentation or consumables. In contrast, we can perform expression analysis by harnessing DNA computation while relying on inexpensive instrumentation (a thermocycler and a fluorescence reader). Finally, all alternative approaches provide information about the expression of individual genes in a panel, while our approach aggregates this information at the molecular level and provides a single, easy-to-interpret diagnosis, enabling fast turnaround.

It should be noted, however, that the rate of the strand displacement reaction is highly dependent on the concentration of RNA inputs, and including a pre-amplification step in the workflow would increase the processing time. Here, we have demonstrated amplification of a mixture of cDNA amplicons in the low picomolar range using in vitro transcription before molecular classification. However, RNA transcripts are typically present at attomolar or femtomolar concentrations in tissue and blood RNA samples. Other amplification strategies, such as rolling-circle amplification or loop-mediated isothermal amplification, will need to be explored for further amplification and may be more suited for point-of-care applications. Moreover, the output of the classification can be measured using a different readout system such as a paper-based substrate or a colorimetric reaction to further increase the sensitivity or simplify readout of the results.

Still, by demonstrating a robust and modular approach for instrument-free analysis of complex gene expression signatures, our work fills an important gap in the existing toolbox for engineering affordable point-of-care diagnostics. The number of clinical studies examining how variations in peripheral gene expression are associated with disease diagnostics, monitoring and

prognosis is ever increasing, and the use of molecular computation for gene expression analysis suggests a path towards translating this academic knowledge into future diagnostics.

Methods

DNA oligonucleotides. All DNA oligonucleotides were purchased from Integrated DNA Technology (IDT). Individual DNA oligonucleotides were suspended to 100 μM and stored in water. Fluorophore and quencher-labelled oligonucleotides were ordered HPLC-purified, except for <q> FAM-labelled oligonucleotides. Unlabelled oligonucleotides were unpurified.

Hybridization probe preparation. Hybridization probes consisted of annealed complex of two DNA oligonucleotides: a 21 nt bottom strand and a 56 nt top strand. The strands were mixed stoichiometrically with 30% excess of the bottom strand and then thermally annealed (heated to 98 °C for 10 s and cooled uniformly from 98 °C to 25 °C over the course of 73 min).

Hybridization probes for the viral/bacterial classifier. A total of 40 oligonucleotides (top and bottom strands) corresponding to 20 hybridization probes were ordered using IDT 25 nmol DNA Plate Oligo synthesis normalized to 100 μM on IDT LabReady buffer. For purification, 20 top strands and 20 bottom strands were pooled together, respectively, and purified as a mixture using 12% urea 19:1 acrylamide: bisacrylamide gel (SequaGel UreaGel System, National Diagnostics). Subsequently, gel bands were visualized using ultraviolet light with a fluorescent backplate, and then cut out and eluted into 1 ml 1 × TAE, 12.5 mM Mg2+ for 12 h. Concentrations were calculated by measuring absorbance at 260 nm (Eppendorf Biophotometer plus) and using an IDT-specified extinction coefficient.

Strand displacement probe preparation. Strand displacement probes (translators, reporters, catalytic amplifiers and annihilator gates) consisted of annealed complexes of two or more DNA oligonucleotides. The strands were mixed stoichiometrically with 10% excess of the target binding strand for the translator, catalytic amplifier gate and annihilator gate. Subsequently, DNA complexes were thermally annealed (heated to 98 °C for 10 s and cooled uniformly from 98 °C to 25 °C over the course of 73 min). After annealing, individual probes were purified using a 12% non-denaturing PAGE gel as described above.

Cellular mRNA preparation. Cellular mRNA was extracted from the HEK293 (ATCC 30-2003) human cell line using a magnetic isolation kit for mRNA (NEB Next Poly(A) mRNA Magnetic Isolation kit #E7490). Cellular mRNA was aliquoted and stored in nuclease-free water with RNAse inhibitor (NEB) at −80 °C until needed.

RNA target preparation. Amplicons corresponding to RNA target sequences

were generated by PCR amplification of HEK293 cDNA or human genomic DNA (ThermoFisher catalogue no. 4312660). Amplification of each target was carried out with a corresponding forward primer containing a T7 RNA polymerase promoter sequence (5-TAATACGACTCACTATAGGG-3). After amplification, each product was visualized on a 1.5% agarose gel and the correct band was excised and processed with a gel extraction kit (QIAGEN catalogue no. 28704). RNA targets were generated using a T7 RiboMAX Express Large-Scale RNA Production System (Promega). Purification of RNA targets was carried out using a phenol/ chloroform extraction protocol. Final RNA concentrations were determined using absorbance at 260 nm and an estimated extinction coefficient for the corresponding single-stranded RNA. RNA was aliquoted and stored in nuclease-free water with RNAse inhibitor (NEB) at −80 °C until needed.

Time-course fluorescence measurements. For experiments using individual transcripts, kinetic fluorescence measurements were performed using a Horiba FluoroMax 3 spectrofluorometer and Hellma Semi-Micro 114F cuvettes. An external temperature bath maintained the reaction temperature at 25 °C. A four-sample changer was used so that time-based fluorescence experiments were performed in groups of four. For experiments related to comparison across multiple transcripts (for example, hTERT vs GAPDH classifier, viral vs bacterial classifier), kinetic fluorescence measurements were performed using a fluorescence plate reader for higher measurement throughput (Biotek Synergy HTX). Thermal annealing and strand displacement reactions were carried out in 1 × TAE, 12.5 mM Mg2+.

Fluorescence normalization. Arbitrary fluorescence units were converted to concentrations using a calibration curve of each reporter complex. To create a calibration curve, annealed reporter complex stock was suspended in 1 × TAE/ Mg2+ and an initial baseline fluorescence signal was recorded. This was followed by stepwise addition of known concentrations of reporter triggering strands. After each trigger strand addition, the steady state was recorded.

Viral/bacterial SVM training and validation. To train the SVM algorithm, we obtained microarray data (NCBI GSE63990) for 273 ill patients and 44 healthy volunteers. We processed the data set by first selecting samples labelled only as bacterial or viral infections (70 and 115 samples, respectively) and transforming the microarray gene expression ratios by logarithm (base 2) to estimate biological expression levels. We trained an SVM algorithm (classifier with a linear kernel) on this data set to distinguish between viral and bacterial classes using the SVM. Linear SVC function from Python library sklearn. We used a squared hinge loss function with L1 norm while iterating through multiple penalty parameters to obtain SVM classifiers with a varying number of features. We found nine models that employed fewer than ten genes while maintaining a classification accuracy of 80% or higher in the training set. We evaluated

these classifiers using a different microarray data set (NCBI GSE6269) where they performed similarly well (area under the curve (AUC) > 0.90). Finally, we selected the classifier with the highest AUC value for experimental implementation.

Computational tool for generating hybridization probes from the in silico classifier. First, we generated an input file containing each transcript sequence and their corresponding weights from the in silico classifier. A python script sliced the transcript sequence to generate helper strands (first and last 60 nt), hybridization targets (30 nt each) and hybridization probes. Hybridization probes were generated with either a positive or negative sequence domain based on the classifier weight. The output of this script contains each component sequence (helper, top strand hybridization probe, bottom strand hybridization probe and target sequence) and name.

Reporting Summary. Further information on experimental design is available in the Nature Research Reporting Summary linked to this article.

Code availability. Computer code used in the computational sections of this work is available in the GitHub repository (https://github.com/rmlb/classifier_ probegen/) or from the corresponding author upon request.

Data availability. Characterization data and experimental protocols for this work are available within this manuscript and its associated Supplementary Information, or from the corresponding author upon request.

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中国科学院大学研究生教材系列

学科英语写作教程：电子工程

Writing a Research Paper in Electronics Engineering

总主编◎高　原　张红晖

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·北京·

内 容 简 介

本教材共分为六章，编者选取 IEEE 期刊文章自建语料库，真实呈现期刊论文的体裁特征和语言规范。围绕 IEEE 期刊论文常见的 IMRD 结构展开，详细介绍了学术论文写作各个环节包含的步骤以及目的，同时也关注每个部分的常见语言点，辅以相应练习，助力学生提高学术论文写作能力。

本教材既可作为学术英语写作教材，也可作为学术论文写作的参考工具书。

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总　　序

2020 年 11 月，教育部新文科建设工作组发布的《新文科建设宣言》指出："文科教育融合发展需要新文科。新科技和产业革命浪潮奔腾而至，社会问题日益综合化复杂化，应对新变化、解决复杂问题亟需跨学科专业的知识整合，推动融合发展是新文科建设的必然选择。进一步打破学科专业壁垒，推动文科专业之间深度融通、文科与理工农医交叉融合，融入现代信息技术赋能文科教育，实现自我的革故鼎新，新文科建设势在必行。"学科英语是外语学科和专业学科相互交叉、彼此融合的产物，符合国家"新文科"建设的时代愿景。开辟外语学科建设的全新思路，是当前外语教学改革的重要突破方向。

"中国科学院大学研究生教材系列"将切实满足特定专业学生群体的英语学习需求作为教材编写的重要依据，充分考虑到具体学习者群体的学习目标和学习诉求，具有以实际应用为导向的根本特质。该系列教材不仅关注教材编写前期的需求分析，同时重视教材试用阶段使用者的实际反馈，因为我们认为，直面使用者反馈是确定教材价值的关键一环，是重新审视学习者需求的宝贵机会，更是反复改进教材质量的可靠抓手。

"中国科学院大学研究生教材系列"融入现代信息技术，运用语料库的数据处理方法，整理归纳学科英语的语言特点和语篇特征。语料库方法可以十分客观快捷地捕捉学术语篇中的词汇、短语、搭配、语块、句子结构等语言层面的使用规律，正在成为学术和学科英语研究领域新近涌现的热点之一。然而，语料库技术运用于教材编写的尝试却寥寥无几，该系列教材无疑为语料库方法运用于教材编写做出了开创性的贡献。语料库的运用不仅能够呈现自然学术语境中真实的语言使用，更为重要的是，能够引导学习者建立适合自己微观研究方向的专业文献语料库，并将其作为未来学术生涯的开端以及追随学术生命成长过程的见证。学科英语语料库一方面可以成为研究者文献阅读经历不断累积的记录，另一方面也可能成为研究者写作不竭的灵感源泉和他们未来指导学生进行

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专业写作的宝贵财富。基于学科英语语料库的教材建设在“授人以鱼”的同时也在“授人以渔”，而学习者也会因此获得“授人以渔”的能力。

我们正处在一个教育变革的时代。新的时代呼唤符合国家发展需求的教育理念和新颖实用的教学方法，同时也鼓励教师队伍努力探索新型的教材编写模式。“中国科学院大学研究生教材系列”积极响应时代的要求，是国家“新文科”建设指导思想下的勇敢尝试。

该系列教材的出版得到中国科学院大学教材出版中心资助，在此表示感谢。

高　原

2022 年 5 月

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前　言

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《学科英语写作教程：电子工程》是以语料库为基础学习学术论文写作，帮助学生做好国际期刊论文发表准备的教材。本书以学术论文常用的 IMRD 结构为基础，每个章节都延伸出适用 IEEE 期刊的语步，帮助学生理解学术论文写作的各个部分以及整体框架，并熟练掌握学术论文中的一些体裁特征，使用符合 IEEE 期刊规范的结构和语言。

一、教材对象

本教材主要面向具备较好的英语基础、有学术论文发表需求的硕士和博士研究生，也适合想要提高学术论文写作技巧的研究人员。

二、教材特点

本教材选取丰富的期刊文章自建语料库，全方位为读者呈现学术论文写作的要点和特点。主要特色如下：

1. 本教材自建语料库，语料来自 IEEE 影响因子 5 以上的 11 种期刊，具体为 *Internet of Things, Transactions on Automatic Control, Transactions on Automation Science and Engineering, Transactions on Communications, Transactions on Circuits and Systems for Video Technology, Transactions on Geoscience and Remote Sensing, Transactions on Mobile Computing, Transactions on Multimedia, Transactions on Pattern Analysis and Machine Intelligence, Transactions on Vehicular Technology*，*Computational Intelligence Magazine*，均为这些期刊中的高被引文章或者 2016 年以后发表的文章，共计 87 篇，约 55 万字。

2. 本教材所选语料的体例和格式也都保留了期刊论文的特点，目的是尽可能让读者熟悉真实的学术论文结构和语言特点。

3. 本教材强调学术论文的体裁特征和规范，详尽地展示了论文写作整体框架和各个

部分的语言特征。

三、内容安排

本教材以 Introduction, Method, Results 和 Discussion 为基本结构，详细描述了每个部分展开的步骤以及相关的语言要点。同时，本教材配有丰富的练习，方便读者在每个单元的学习之后及时练习。

全书以 IMRD 基本结构为主线，每个部分按照数个不同 Move (语步) 展开，详细解释了每个语步分别包括哪些步骤，以及其在论文中的作用和目的。同时，还针对有些期刊的结构，介绍了文献综述以及摘要的写法，帮助学生更好地理解这几个部分的写作。

本书每个语步和步骤都辅以丰富的例证，供学生模仿借鉴。同时，每个单元都以语步为单位，设几个 Language Focus (语言要点)，重点关注有关部分需要注意的语言特征，如被动语态、v-ing 表因果关系等，让学生能够意识到，针对学术论文写作的不同部分，我们也应该使用相应的语言技巧。另外，每个单元设有练习，练习本单元相应的语步和语言点。

本教材是编者在近年教学实践基础上的经验积累和突破。编者水平有限，时间仓促，书中难免会有错误和不足之处，欢迎读者朋友们批评指正。

编　者

2022 年 6 月

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Chapter 1
Building an IEEE Journal Corpus

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1.1 Lead-in

Corpus can be used as a computer-based tool for description of language, and enables analysis of a certain scope of language (Bieber, 1993). For example, a subject-specific corpus would help analyze the styles of language use in a particular subject.

For this textbook, a corpus of about 550,000 words gathered from 87 articles published during 2016—2021 in 11 IEEE (Institute of Electrical and Electronic Engineers) journals is built for the analysis of rhetorical moves and steps within each section of a research article as well as the specific language styles used accordingly. These articles were selected from journals on different topics. It should be admitted that the average selection of 8 articles per journal may not be able to fully present the variations of rhetorical moves and language styles. However, the corpus is well managed in terms of representativeness through the following criteria:

(1) The journals are with impact factors above 5, i.e. *Internet of Things, Transactions on Automatic Control, Transactions on Automation Science and Engineering, Transactions on Communications, Transactions on Geoscience and Remote Sensing, Transactions on Circuits and Systems for Video Technology, Transactions on Mobile Computing, Transactions on Multimedia, Transactions on Pattern Analysis and Machine Intelligence, Transactions on Vehicular Technology, Computational Intelligence Magazine*, and they cover a wide spectrum of topics within IEEE field;

(2) The articles are either highly cited or newly published (within three years);

(3) The articles contain four basic sections: Introduction, Methods, Results and Discussion;

(4) The articles are written by native English speakers;

(5) The articles are selected based on academic rigor, high-quality writing and clear presentation.

It is notable that the corpus is open to new articles from different journals.

1.2 Coding

After data collection, we can convert the articles into plain text and then proceed to data coding. Coding consists of two phases: One is manual annotation of moves and steps, and the other is automatic semantic tagging of words with a parser.

1.2.1 Move Coding

Based on the functional segments of a text, different Moves and Steps in the four main

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sections are identified, as shown in the following table:

Table 1.1 Moves and Steps in a research article

Sections	Moves	Steps
Introduction	Establishing a research territory	Claiming the centrality
		Making topic generalization(s)
		Reviewing items of previous research
	Establishing the niche	Counter-claiming
		Indicating a research gap
		Question-raising
		Continuing a tradition
	Occupying the niche	The purpose of the current research
		The main features of the current research
		Stating the outline of the article
Methods	Contextualizing the study methods	Stating the purpose of the methods
		Referencing previous works
		Identifying the methodological approaches
	Describing the study	Rationalizing the methods
		Describing the data
		Describing experimental/study procedures
	Establishing credibility	
Results	Contextualizing results	Providing background information
		Listing procedures or methodological techniques
		Stating research questions or hypothesis
		Describing aims and purposes
		Referring to previous research
		Summarizing main results
	Reporting results	Showing results by figures or tables
	Summarizing results	Instantiating results
		Invalidating results

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(Continued)

Sections	Moves	Steps
Discussion	Revisiting previous sections	Revisiting the Introduction
		Revisiting the Methodology
		Revisiting the Results
	Consolidating results	Reporting results
		Comparing results
		Evaluating results
	Stating limitations and future research	

To annotate the data, we need to use a corpus tool, UAM Corpus Tool. It is developed by Mick O'Donell and is easy to use. You can download it for free from the UAM Corpus Tool website.

First, we can click "Start New Project" (Figure.1.1), and name our new project "IEEE project".

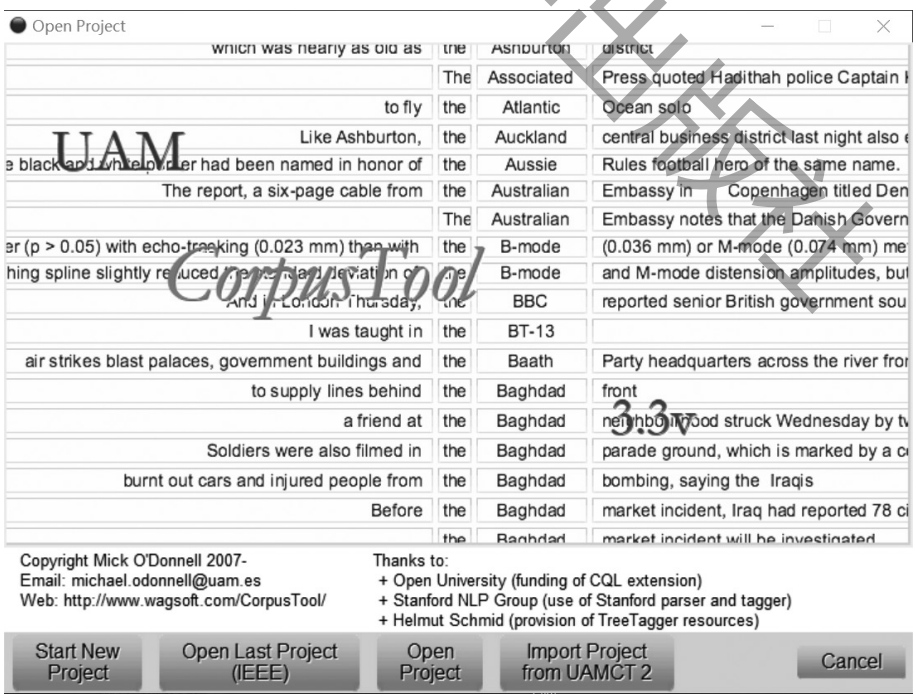

Figure 1.1 Start a new project in UAM Corpus Tool

Second, before we extend our corpus, we can chunk all the articles in sections (i.e., Introduction, Methods, Results and Discussion), and save them into separate plain text files. Then, we can add files to our corpus, and incorporate them all at once or one by one (Figure.1.2).

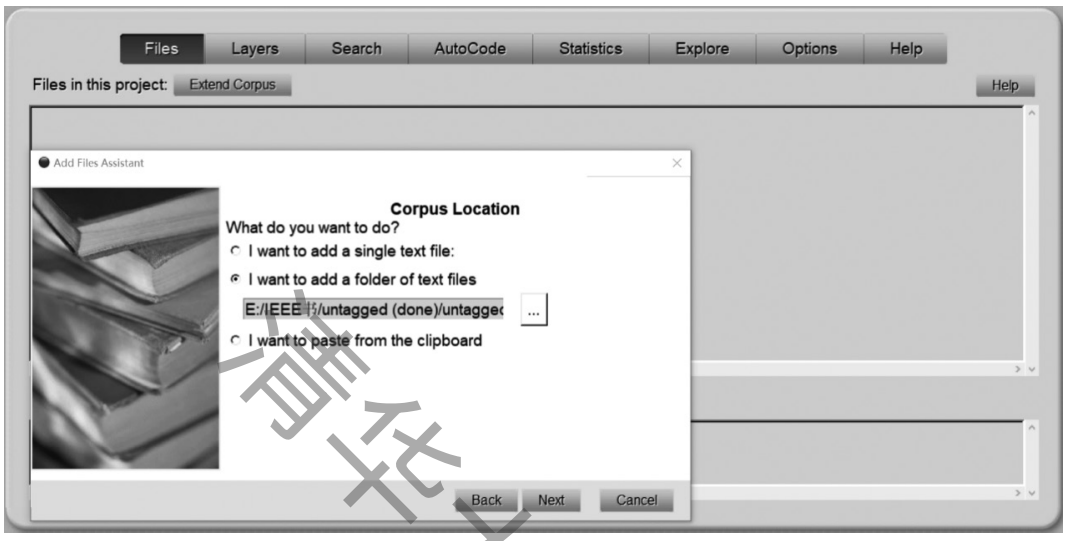

Figure 1.2 Add files to your corpus

Third, we need to add layers to our files (Figure.1.3). We can name the first layer "Moves", and a second layer "Steps" for further annotation.

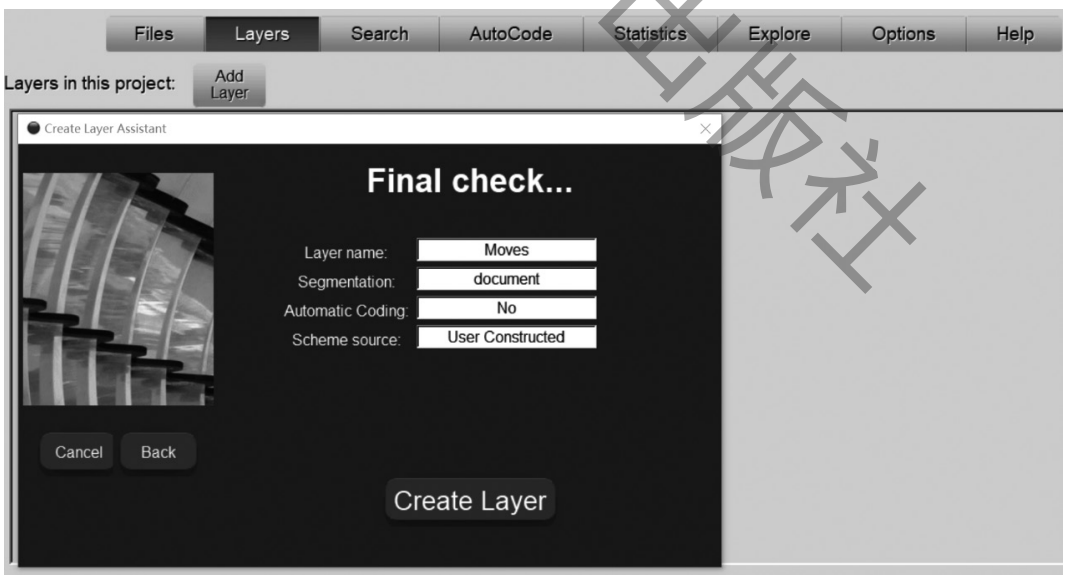

Figure 1.3 Add layers to your files

Fourth, we can create a system for our annotation. Choose the "Manual Annotation" type, and "Design your own scheme", and do not auto-segment the text (Figure.1.4).

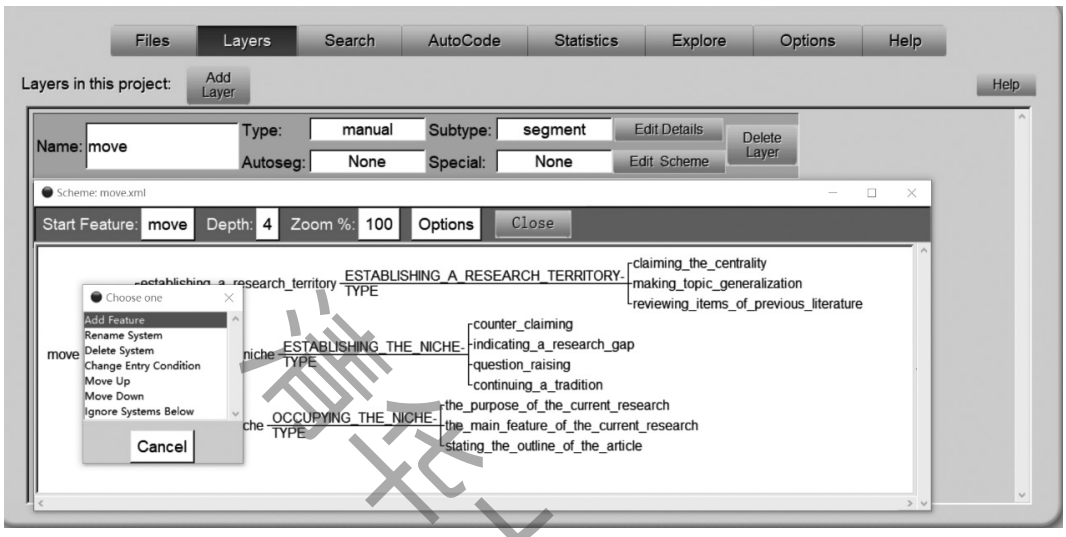

Figure 1.4 Design your own scheme

Then, by right clicking to add systems and features to the tree structure, we can get a system of Moves and Steps for Introduction.

After building up layers of moves and steps, we can get back to "Files" view, and select the paragraphs and sentences by clicking the bottom buttons to annotate the file (Figure.1.5). Once the annotation is done, we can use the files for further analysis.

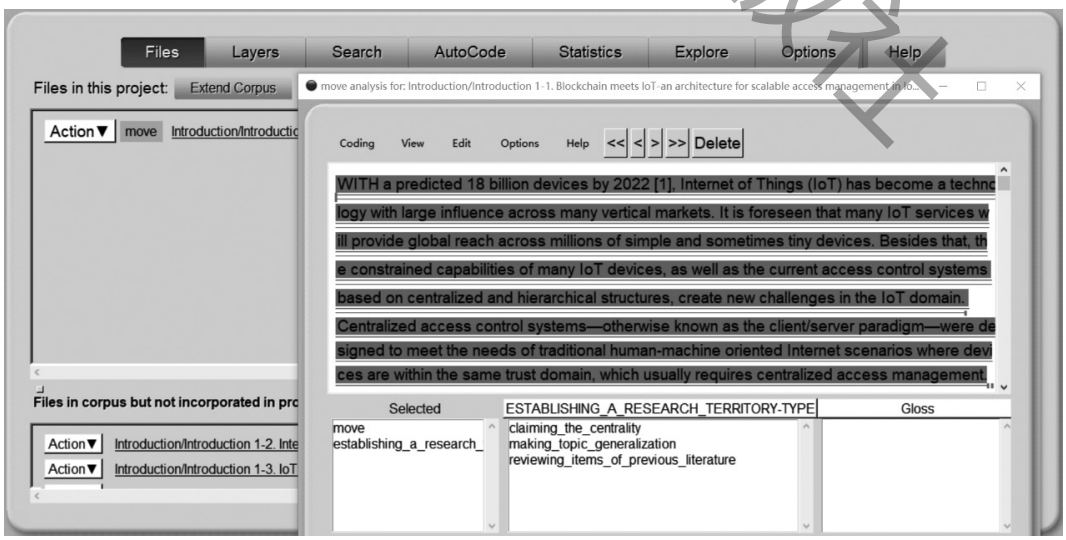

Figure 1.5 Annotate your files

For further introduction of UAM Corpus Tool, you can get detailed instructions from the homepage of the UAM Corpus Tool website.

1.2.2 Semantic Coding

We also need to tag the texts semantically. We can do this by adding another layer (Figure.1.6). First, click automatic annotation, and give our layer a name "POS", and then choose "Part of Speech (POS)", and then "Stanford Tagger". After that, the texts can be automatically annotated.

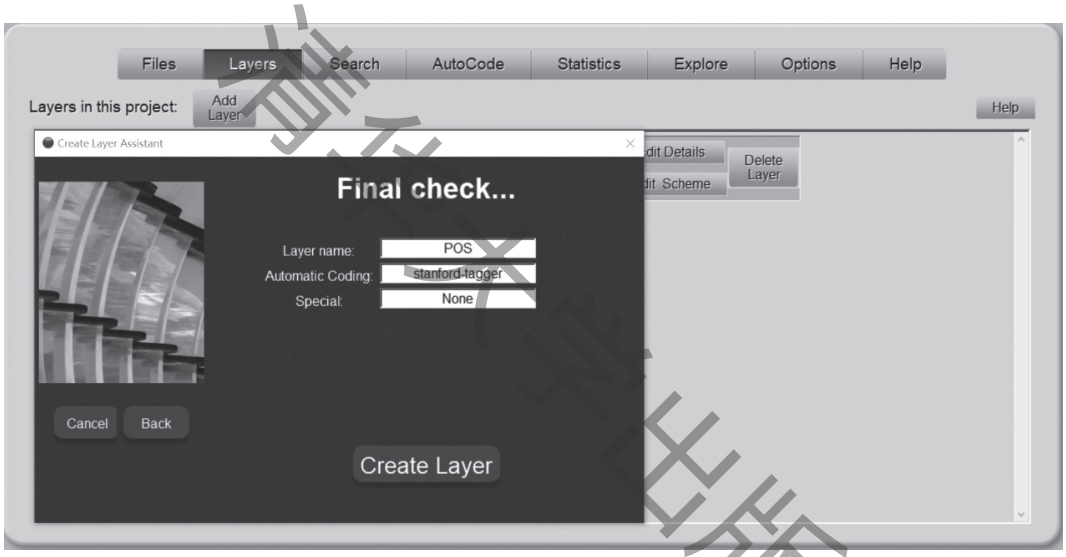

Figure 1.6 Autotag your files

Now, we have built a corpus of our own, which is ready for further analysis.

You can also use AntConc, a free concordance program (you can download it for free from Lawrence Anthony's Website) to analyze your data.

Exercise

Try to build your own corpus according to what you have learned in this chapter.

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Chapter 2
Introducing Background

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2.1 Lead-in

Read the following figure of doing a research and answer the following questions.

1. What parts in the figure do you think should be included in the Introduction of a research article?

2. What work should you do when doing background research?

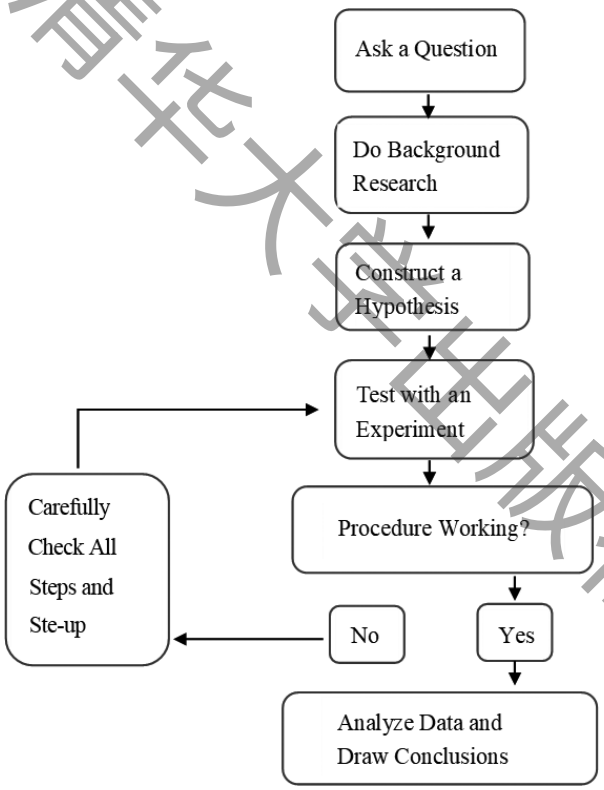

Figure 2.1 Research process (retrieved from Science Buddies Organization website)

An Introduction serves as the beginning of a research article. It is a guide for readers to quickly overview the research field as well as grasp the main content of the current research.

An Introduction is important in that you should tell a story about your research and get readers' attention by presenting them with the latest research trends and telling them how you manage to solve the problems that can expand the research field. To tell a good story, there are some tactics to use. No matter what the subject of research is, an Introduction usually consists of the following parts:

- establishing the context of the topic;
- reviewing the previous literature;
- indicating the research gap;
- stating the importance/purpose of the current research.

The patterns of an Introduction have been identified by different research, among which Toulmin's (1972) and Zappen's (1983) problem-solution model and Swales' (1990) CARS (Create a Research Space) model are the most cited. In this book, the latter is adopted. Swales (1990) identifies three basic rhetorical Moves in an Introduction:

- **Move 1: Establishing a research territory**

  Step 1 Claiming the centrality and/or

  Step 2 Making topic generalization(s) and/or

  Step 3 Reviewing items of previous research

- **Move 2: Establishing a niche**

  Step 1A Counter-claiming or

  Step 1B Indicating a research gap or

  Step 1C Question-raising or

  Step 1D Continuing a tradition

- **Move 3: Occupying the niche**

  Step 1A Outlining purposes or

  Step 1B Announcing present research

  Step 2 Announcing principal findings

  Step 3 Indicating the article's structure (optional)

Within each Move, a few obligatory and optional moves can be adopted to guide the structure of an Introduction.

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In a word, in an Introduction, you need to tell the reader: What field your research is in, what topic you are focusing on, and why this topic is important. Sometimes, you can also briefly introduce how your research is conducted and how the article is organized.

2.2 Establishing a Research Territory

In the first part of an Introduction, you need to establish a research territory, which is the area that your research belongs to. You need to justify that your research is part of a significant research area by defining the topic, stating the specific problem to be addressed, and explaining why the problem is of interest/importance.

2.2.1 Claiming the Centrality

This very first step is a claim that appeals to the research community to accept the research to be reported as part of a lively, significant or well-established research area (Swales, 1990). We can begin with the definition of a topic or the general research area. Take the following paragraph as an example:

Excerpt	Comment
① Simultaneous localization and mapping (SLAM) and visual odometry (VO) are fundamental building blocks for many emerging technologies—from autonomous cars and UAVs to virtual and augmented reality. ② Realtime methods for SLAM and VO have made significant progress in recent years. ③ While for a long time the field was dominated by feature-based(indirect) methods, in recent years a number of different approaches have gained in popularity, namely direct and dense formulations.	The authors begin with the introduction of two terms (SLAM and VO) that specify the research in a certain field, that is, from autonomous cars and UAVs to virtual and augmented reality. This direct location of the research gives readers a clear direction of the research area. Then, the authors point out the progress made in these two technologies by reviewing the previous methods and introducing the new approaches in recent years.

(Engel, J., Koltun, V. & Cremers, D. 2017. Direct sparse odometry. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *40(3)*: 611–625.)

This is the first paragraph of an Introduction of an IEEE research paper. It uses only three sentences to establish the research context for this paper. Readers can assume that the following would review the previous methods used for SLAM and VO, and then emphasize the current

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approaches. In fact, the paper continues to compare and contrast different approaches and explains what method is proposed in this paper.

The centrality claim can also include interest or importance, or claim that the research area is active by referring to other investigators (Swale, 1990). The first kind is more common, for example:

Excerpt	Comment
① Unmanned aerial vehicles (UAVs) are increasingly being used for intelligence, defense, and civilian information gathering and monitoring. ② This is particularly due to their utility in high endurance and perilous environments that are—as characterized by—dull, dirty, and dangerous. ③ A popular application of UAVs is information collection via surveillance of an area of operations. ④ Often, a fleet of UAVs is dispatched for large geographical coverage and multiple intelligence, surveillance, and reconnaissance (ISR) missions where the goal is to maximize the amount of information collected, and this results in the problem of routing and coordination.	This article begins with *X is increasingly being used for Y*. *X* is a specific research topic that is going to be conducted in the article, while *Y* usually refers to some general fields. This sentence claims the importance of *X* in different areas and its wide application, indicating huge potential research significance. Then, the focus moves from some general areas to a specific research area (i.e., "information collection via surveillance of an area of operations") in Sentence ③, thus introducing the research problem in the article, that is "the problem of routing and coordination" in Sentence ④.

(Thakoor, O., Garg, J. & Nagi, R. 2019. Multiagent UAV routing: A game theory analysis with tight price of anarchy bounds. *IEEE Transactions on Automation Science and Engineering*, *17(1)*: 100–116.)

The first paragraph states clearly what we are going to study, and we should also make this topic seem interesting to the readers. The common sentence patterns used to begin an Introduction are shown below:

* *X has been defined in [reference] as...*
* *X is an interesting...scheme for future...because it has...*
* *X has been technically challenged by exponentially increasing demands for...*
* *X and Y play a key role in...*
* *X will increase sevenfold between 2016 and 2021, reaching...by the end of 2021, and Y will account for over 80% of the total X.*
* *In the last years, X has suffered an exponential growth, supported by the increasing popularity of Y, such as...*

* *The increasing request for X motivates both academia and industry to invest in alternative solutions. X and Y were originally introduced about 60 years ago in Russia [reference]. Their exceptional robustness and good computational efficiency have immediately gained them much interest and many advocates in the...community.*
* *X is considered to be indispensable for Y providing a wide variety of inherent features such as...*
* *The development and growth of X in the past decade has led to the rapid adoption of Y and Z for...*

2.2.2 Making Topic Generalization(s)

This step "expresses in general terms the current state of the art of knowledge, of technique, or ... of current requirements for further progress" (Swales, 1990, p. 146). Note that the Step 1 and Step 2 are not always in a sequence and sometimes they overlap.

Excerpt	Comment
① Learning from data is essential to every area of science. ② It is the core of statistics and artificial intelligence, and is becoming ever more prevalent also in the engineering domain. ③ Control engineering is one of the domains where learning from data is now considered as a prime issue.	This paragraph develops from general to specific, beginning with a topic generalization sentence. Then, more details about the phenomena are added in Sentence ②. Sentence ③ narrows down the topic, and emphasizes the importance of leaning from data, which sets a foundation for further elaboration on this topic.

(De Persis, C. & Tesi, P. 2019. Formulas for data-driven control: Stabilization, optimality, and robustness. *IEEE Transactions on Automatic Control*, *65(3)*: 909–924.)

Generally, the first paragraph begins with a statement about "knowledge or practice", or statement about "phenomena" (Swales, 1990, p. 146). Here, the sentence pattern *X (a research subject) is adj. to Y (an area)* is adopted to describe a phenomenon about learning from data, which is the topic of the research.

Here are more sentence patterns to make topic generalization(s):

* *With..., X has become a technology with large influence across many fields.*
* *X not only offers improvements in..., but also greatly improves..., including...*
* *X is...(attribute) with...(another attribute). Its continuous operation leads to...*
* *The benefits of X are understood across industries, with...(different industries).*
* *X is one of the major developments of this paradigm, where...*
* *A major development of X was the introduction of Y.*

* *Although it is common to study problems in which..., there are scenarios in which...*
* *X can be seen as a typical case of Y and Z. These systems (i.e., Y and Z) can be decomposed into...and...*
* *A significant amount of research effort has been devoted to X to enhance...*
* *X is a...(attribute) that has shown good performance for solving difficult, time-critical problems when compared to other...methods, notably...*
* *Recent advances in...have enabled the development of X.*

2.2.3 Reviewing Items of Previous Research

Reviewing items of previous research is obligatory in almost every research article. As we all know, every research is closely related to the previous ones, either as a development or as a rebuttal of the previous research. Thus, literature review is a non-negligible part of a research paper.

A comprehensive literature review reveals the authors' ability in understanding the general field and synthesizing the previous literature to support their research. In some research papers, literature review is a subsection of the Introduction, while in some other papers, it can serve as a separate section. Wherever the literature review part is, its function is to introduce the state-of-the-art technologies/research on the topic, and it basically follows the similar structure and uses the similar sentence patterns. Through the review, the authors can justify their research by pointing out the weakness or research gap of the previous research.

Excerpt	Comment
① Considerable research has been undertaken on load balancing in a homogeneous wireless network, such as [9] and [10]. ② On the contrary, few studies have been done with respect to a hybrid Li-Fi and Wi-Fi network, and those few treat heterogeneous APs in the same way as in a homogeneous network. ③ In [11], a distributed load balancing method was proposed based on game theory, which requires quantities of iterations to reach a steady state. ④ With the aim of maximizing the overall throughput, [12] reported a centralized optimization method, which requires extensive computational complexity. ⑤ Those methods were developed from the APS solutions in a homogeneous network, and they fail to exploit the distinguishing characteristics between Li-Fi and Wi-Fi.	The review begins with a brief summary. Sentence ② then points out the few studies relevant to the current research. In the following sentences ③ and ④, specific methods used in previous research are introduced, followed by an inference made from the previous methods.

(Wu, X., Safari, M. & Haas, H. 2017. Access point selection for hybrid Li-Fi and Wi-Fi networks. *IEEE Transactions on Communications*, *65(12)*: 5375–5385.)

The structure of this literature review part can be simplified as: *Considerable research has been undertaken on X (a specific field). On the contrary, few studies have been done with respect to Y (another specific field). In [reference], there were details about X. [reference] reported more details. The previous mentioned methods fail to reach Y.*

The above paragraph is a clear example of reviewing previous literature. Its purpose is clear—to provide a method that can solve the problem Y. It begins with "Considerable research has been undertaken on..." Some examples of similar expressions are shown below. X stands for the research subject/topic, and Y stands for the research area or application.

* *X has been conducted in Y.*
* *X has already been studied from several points of view.*
* *X has long been studied in Y.*
* *X has been investigated for decades in Y.*
* *X as Y has been suggested and explored by many.*
* *There has been extensive research on X.*
* *Many X have been proposed in literature, usually in Y.*
* *X is a topic that has been studied in much detail in the research literature in the past and extensive reviews exist.*

The above expressions are usually used in the beginning of the literature review part. They serve to introduce the general research on this field but do not provide enough details for further elaboration. Then, the review part continues to introduce different perspectives on the research topic as well as to explore the potential weaknesses or problems the previous works have.

2.2.4 Language Focus

In literature review, citations are an indispensable part. They are central to persuasion, as they permit writers to engage in dialogue with source texts; provide justification and evidence for arguments and claims; demonstrate familiarity with the literature; show (dis)alignment with particular scholarship; and establish credibility (Hyland, 1999).

You might have noticed that in the above examples, there are different ways of intext citation: author-prominent and information-prominent. An author prominent citation is in the form of *author (year)+claim* (*e.g., "Kingma et al. [14]*① *take a similar view of dropout..."*), while an information-prominent citation is in the form of *claim+author (year)* (*e.g., "Industrial environments contain many hazardous areas that could benefit from robot assistance. Mining*

① This is the original reference in the cited article, and its form differs according to the specific journal.

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operations [12] and structure inspection [13] are two such environments."). Note that "*Dropout was introduced by Srivastava et al. [3]*" is also an author-prominent citation.

Based on the corpus used in this book, we can tell that more information-prominent citations are used than author-prominent ones. In the corpus, the Introduction part has all together 1,165 citations. Citations account for 16.2 words per 1,000 words. Only 6% of the citations are author-prominent. This is because when reviewing literature, we are not just listing what have been done by whom, instead, we need to synthesize what we have read and present them in an organized way. Information-prominent citations are usually used to support a particular point, or deal with information that is not controversial. When we develop our own claims, we tend to use those information-prominent citations to make our claim solid and convincing. On the other hand, author-prominent citations are used for those ideas that we wish to emphasize the author(s), or to explore in detail, or to make compare and contrast. Hence, more citations are used in supporting sentences rather than used in claims. "Citation in the hard disciplines is therefore a means of integrating new claims into current knowledge while drawing on it as supporting testimony, situating the new work in the scaffolding of already accredited facts" (Hyland, 1999, p. 354).

Here are some examples of author-prominent citations:

* *For...systems, there is actually a fundamental result, which answers this question, proposed by AUTHORS [reference]. Initial work for...was developed by AUTHORS [reference].*
* *This strategy has been recently extended by AUTHORS [reference].*
* *The earliest work focused on..., ...and...of...was by AUTHORS [reference].*
* *AUTHORS [reference] discussed necessary and sufficient conditions under which...could be successful without being detected.*
* *AUTHORS [reference] designed a...that balances...and...for...*
* *AUTHORS [reference] have shown that their...effectively combines the positive properties of...and...approaches, producing...solutions independent of...*
* *Measurements by AUTHORS showed that better...was obtained for...than for... [reference], due to...*
* *AUTHORS performed wide...studies in the..., ..., and...GHz bands in..., and measurements showed significant signal attenuation (as great as...dB) due to...[reference].*
* *AUTHORS [reference] proposed a generic model of...*
* *AUTHORS [reference] defined the...as..., and then matched them through a...process.*
* *AUTHORS [reference] presented a...method that first applies...to..., then performs..., and finally...are aligned by...*
* *AUTHORS [reference] suggested to use...for..., by also incorporating a probabilistic measure to ensure robustness against...*

* *AUTHORS [reference] also followed a...representation of..., before matching them.*
* *AUTHORS [reference] extended their previous approach in...problem [reference], to the case of ...*
* *AUTHORS [reference] employ an approximated...specified interactively by the users while the more recent... [reference] system uses...and...to...*
* *The method introduced by AUTHORS [reference] interprets...through a...model that accounts for...in addition to..., and assumes that...*
* *AUTHORS [reference] demonstrate that, within their...framework, ...is the most informative feature while other features contribute complementary information.*
* *AUTHORS [reference] estimate...by applying a...function, before applying...prior [reference], refined iteratively by...as a post-processing step.*
* *AUTHORS [reference] introduce a...that is specific to...*
* *Both AUTHORS [reference] and AUTHORS [reference] used a...model with assumed known...index to estimate...from...*
* *AUTHORS [reference] took a similar approach but used a specular...model suitable for...*
* *AUTHORS [reference] also assumed...to disambiguate...; however, their approach can also estimate...*
* *As in our proposed method, AUTHORS [reference] exploited this via...*
* *Recently, AUTHORS [reference] derived constraints that allowed..., ...and...to be estimated from...under...(condition).*
* *AUTHORS [reference] combine...with...from...and resolve ambiguities via a...process.*
* *AUTHORS [reference] state that "...".*
* *AUTHORS [reference] conducted experiments showing that...*
* *AUTHORS [reference] improve...by building an approximate nearest neighbor graph.*
* *AUTHORS [reference] build a visual representation for...while generating...*
* *The work of...(year) of AUTHORS [reference] still provides a good frame of reference for reviewing the literature, describing methodologies on..., features and data association for general purposes.*

According to Hyland (1999), citations are incorporated into the articles as a quotation, summary or generalization from several sources. Various reporting verbs are used in these sentences. In the corpus of this book, the most used 10 reporting verbs are: *state, provide, show, propose, present, develop, consider, describe, estimate, evaluate*.

In a word, before writing up a research article, we must have read a large quantity of relevant literature. As to the way we synthesize and present the literature to our reader, we have

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to be very familiar with the research topic and be able to use the literature to develop and refine our argument. To make an article profound and the argument convincing from the beginning to the end, sometimes, we can present part of the literature review in the Introduction, and leave the other parts in the Discussion to support our conclusion. The length of literature review varies according to the purpose of the review. As mentioned before, some articles have a dedicated section for literature review, which introduces the previous works critically and elaborates their relationship with the current research.

2.3 Establishing a Niche

The purpose of this move is to locate our research in a broad research field, so that our contribution can be foregrounded and evaluated. Through reading the previous research, we can find what have been done, how they are done, how they can be improved, and what has yet to be done, then we can develop our own research questions/hypothesis from the findings and create our own research space. This is called "establishing a niche". This step can be realized in different ways: (1) counter-claiming; (2) indicating a gap; (3) question raising; (4) continuing a tradition (Swales, 1990, p. 141).

2.3.1 Counter-claiming

We can make a counterclaim that the previous work has not covered a certain research topic, or has some limitations, by using "negative or quasi-negative quantifiers", "lexical negation", or "negation in the verb phrase" (Swales, 1990, p. 155).

Negative or quasi-negative quantifiers include *no*, *little*, *none*, *few*, *neither...nor*, etc. In the corpus, we can find the following instances of these quantifiers:

* *To the authors' best acknowledge, so far there has been <u>no</u> method specially tailored for...*
* *To the best of our knowledge, <u>no</u> result is known for...with the total value function we consider in this paper.*
* *However, ...are not interpretable and have <u>little</u> connection to...This is a limitation for...*
* *While…offers a great opportunity to increase capacity, <u>little</u> is known about the...characteristics for...networks in...environments at these carrier frequencies.*
* *Although...and...have been investigated under various...operations and...models for the past...years, the same problem under...<u>has not been</u> thoroughly analyzed even for the simplest...model.*
* *However, traditional techniques <u>cannot</u> still match...*

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* *After the development of the best analytical solution, little improvement in...was achieved until the advent of...*
* *To date, few studies have been carried out to investigate..., and those few are focused on...*
* *Aside from work conducted by authors at...University, there have been relatively few published...studies at...bands in...environments for...and...*
* *On the contrary, few studies have been done with respect to...*
* *Although the limitations to…are well known, few works propose…methods, of which...are examples, but often requiring additional assumptions.*
* *There are few studies that have considered...in their analysis.*

Lexical negation means direct negation without any quantifier but with the use of some words, like verbs (*fail*, *lack*), adjectives (*inconclusive*, *misleading*, *limited*, *questionable*, *unable*), nouns (*lack*, *failure*, *limitation*), etc.

* *A...may take a detailed assumption of..., but then may fail on an articulated object.*
* *However, the above methods fail to consider...caused by...*
* *Further, ...uses an extremely wide RF bandwidth, which may limit its application to...and...applications.*
* *Developing...is an ill-posed problem due to lack of information about...and...*
* *We showed that, in guaranteeing..., ...constraints can limit...*
* *While…, these…systems are limited to…This limitation can cause…when…and consequently affect...*
* *Despite their valuable achievements, these strategies suffer from a number of issues that reduce their practical applicability.*
* *However, ...has largely been ignored in...and...analysis.*
* *However, ...methodologies are known to be undesirable in the context of..., as they are not...and cannot easily incorporate..., ..., and...of...*
* *However, ...and...are often unknown in practice, implying...may require...*
* *With current mobile network designs, such required flexibility and elasticity are hard to realize, particularly due to the traditional usage of...that can neither dynamically...nor be easily upgraded with new functions.*
* *However, existing…methods mostly work on…task solely [reference], without exploiting...for...*
* *However, the performance of the existing...will degrade for...since it assumes...*
* *However, ...may deteriorate the...performance, and therefore it is important to find the optimal trade-off between...and..., which can be cast as a...problem.*
* *The fundamental problem of finding a...remains challenging.*

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Negation in the verb phrase refers to the use of *not* or some other adverbs like *rarely*, *seldom*, etc.

> * *For these reasons, traditional solutions building on...techniques are not affordable (because of...reasons) or simply impossible (when...is not known).*
> * *However, this might not be a valid assumption for..., where it is most likely for...to have..., both from...*
> * *The goal of meeting the desired service guarantees need to consider...aspects, as a...network will likely not be able to meet the service required by...*
> * *The...most commonly used in...does indeed enforce the creation of..., but the other defining properties of...do not seem to be explicitly enforced by the commonly used...*

2.3.2 Indicating a Research Gap

A research gap, in other words, what has not been done by the previous research, motivates us to do the current research. For the following parts of the article, we need to elaborate on how we would fill the gap, why our research is important and what contribution it will make to the field. Indicating a research gap can be realized by counter-claiming. The sentences we can use to identify the gap are:

> * *However, ...has been ignored by previous...methods, which limits their...abilities under...*
> * *However, to the best of our knowledge, ...for...has not been analyzed.*
> * *Understanding the impact of...on...and...of...systems, however, has not yet been considered.*
> * *The technique is simple, however, ...is marginally inaccurate. Notably, none of the methods [reference] solve the...issue.*
> * *Nevertheless, none of these studies has considered...and has mainly assumed...with hypothetical moments for...*
> * *Note that, apart from [reference], none of the previously mentioned works includes...and...in their modeling.*

2.3.3 Question-raising

By reviewing previous literature, we can identify the question to be answered or the problem to be solved, and then establish the niche.

> * *A main question is how to design...systems directly from...Besides their theoretical value, answers to this question could have a major practical impact especially in those situations where...can be difficult and time-consuming.*

* *A central question in...is how to replace...model with data.*
* *While the former problem has the optimal outcome, it is unclear as to...due to...This paper provides an answer to this question.*
* *...is a fundamental problem in...systems that requires...to...*
* *We believe that...is still not a solved problem and would like to highlight some of the challenges briefly.*
* *The design of a...that achieves such goal in this...market is still an open problem.*
* *In...and...research, it is an open problem to...*
* *A classical problem here is to maximize the probability of detecting a hidden target.*
* *However, the fundamental problem of finding...remains challenging.*

2.3.4 Continuing a Tradition

Some research niches are established by extending the previous work or making a few adjustments.

* *However, these studies assumed..., whereas in actual situations, ...always appear.*
* *The main focus in the above-mentioned studies, e.g. [reference], however, is on... Despite its relevance and importance, to the best of our knowledge, ...has not been fully investigated.*
* *The...performance can be further improved by using...approach.*
* *We build on results from related disciplines and extend existing techniques in various directions.*
* *This paper extends [reference] with three main contributions.*
* *Even though much research in this field has already been done, the original approach proposed in [reference] is still very popular. Therefore, in this paper, we extend the results of [reference] in order to obtain..., and to ensure...system without...*
* *It is possible to extend the...techniques developed in [reference] to...scenarios.*
* *In contrast to existing approaches, our method further takes full advantage of..., including..., ..., and...*

Although Move 2 takes only a couple of sentences in an Introduction, it's not insignificant. With the research niche clearly stated, we can create a research space that our readers can precisely identify. The niche also determines how we would develop our research question/hypothesis, which makes the essential part of our research and reflects our originality and innovativeness.

Excerpt	Comment
The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet [reference 1].	**Move 1** **Step 1:** Claiming the centrality
The IoT concept, hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations.	**Move 1** **Step 2:** Making topic generalization
This paradigm indeed finds application in many different domains, such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and many others [reference 2].	**Move 1** **Step 3:** Reviewing items of previous research
However, such a heterogeneous field of application makes the identification of solutions capable of satisfying the requirements of all possible application scenarios a formidable challenge. This difficulty has led to the proliferation of different and, sometimes, incompatible proposals for the practical realization of IoT systems. Therefore, from a system perspective, the realization of an IoT network, together with the required backend network services and devices, still lacks an established best practice because of its novelty and complexity. In addition to the technical difficulties, the adoption of the IoT paradigm is also hindered by the lack of a clear and widely accepted business model that can attract investments to promote the deployment of these technologies [reference 3].	**Move 2** Establishing a niche

(Zanella, A., Bui, N., Castellani, A., Vangelista, L. & Zorzi, M. 2014. Internet of Things for smart cities. *IEEE Internet of Things Journal*, *1*(1): 22–32.)

The above excerpt is well written and quite typical in the first two moves. In the beginning, it arouses readers' interest by depicting a picture of our future with the Internet of Things (IoT).

This way of introducing the topic is effective not only in its vividness, but also in detailed elaboration on the characteristics of IoT. After the general introduction of the concept of IoT, the authors continue to provide more information, which points out the future application of IoT and its advantages. Then, a brief review of its application is made to pave the way for the current research. Move 2 is realized through a counter-claim that approves the wide application of IoT as well as states the challenge faced accordingly. The negation used to point out the problem the state-of-art IoT is mainly lexical, such as *challenge (n.), difficulty (n.), lack (v. & n.), hinder (v.), incompatible (adj.)*. This avoids direct negation such as the use of some negative quantifiers, which is a euphemistic presentation of the limitation of previous work. By doing so, the authors clarify their stance and also make their evaluation of the previous work more acceptable to the audience, especially those who have made contributions to the field.

2.3.5 Language Focus: Polarity and Modality

You might have noticed that when determining the research gap, the authors usually does not directly deny the previous works nor use assertive words to point out the limitation of them. "It is believed that the use of not in conjunction with many verbs is seen as providing a potentially hostile depiction of previous work" (Swale, 1990, p. 156). To weaken this hostility, they choose relatively mild lexical terms or expressions to show their academic rigor.

The mild argumentation is usually realized through Polarity and Modality. Polarity refers to the "opposition between positive ('It is.' 'Do that!') and negative ('It isn't.' 'Don't do that!')" (Halliday & Matthiessen, 2014, p. 172), so it is "a choice between yes and no", which, however, is not the only possibility; "there are intermediate degrees, various kinds of indeterminacy that fall in between, such as 'sometimes' or 'maybe'. [...] What the modality system does is to construe the region of uncertainty that lies between 'yes' and 'no'." (Halliday & Matthiessen, 2014, p. 176).

"In a proposition, the meaning of the positive and negative pole is asserting and denying" (Halliday & Matthiessen, 2014, p. 177). In between these two poles are those intermediate degrees, which are in two kinds: (1) degrees of probability, such as *certainly, probably, possibly*; (2) degrees of usuality, such as *always, usually, sometimes*. Both probability and usuality can be realized in three ways: (1) by a modal verb, such as *will, can, may*; (2) by a modal adjunct of probability or usuality, such as *probably, usually*; (3) by both together, such as *will probably, may possibly* (Halliday & Matthiessen, 2014, p. 177).

Probability and usuality can be used in a proposition to weaken the assertiveness, for example,

> * *It is foreseen that many...<u>will</u> provide...across millions of simple and <u>sometimes</u> tiny devices.*

* *On the other hand, ...can be managed by several managers at the same time. Moreover, many...and...will be too limited in terms of..., ..., and...to be able to operate properly using the current systems.*
* *In this paper, due to the nature of..., we shall design...that...*
* *Given..., multiple...functions plausibly could have generated them.*
* *A...might predict...to better anticipate..., but then may have difficulty in...*
* *However, in many applications, such as...and..., their...may be unknown and time-varying.*
* *Building on these..., several novel key concepts have been proposed for next generation 5G networks, out of those, ...is probably the most important one.*
* *However, these studies assumed a...containing...in their experiments, whereas in actual situations, novel classes always appear.*
* *However, prior...and...are often unknown in practice, implying the estimation may require...*
* *This difficulty has led to...and sometimes incompatible proposals for the practical realization of...*
* *The...search has the property that it will always...*
* *...is the general trend in the...research due to its..., which often can have several issues as discussed in...*

2.4 Occupying the Niche

Once the research niche is established, we need to attempt to occupy it. "The role of Move 3 is to turn the niche established in Move 2 into the research space that justifies the present article" (Swales, 1990, p. 159). To be specific, Move 3 is the development of Move 2. It substantiates the counter-claim that has been made, fills the research gap created, answers the specific question raised or continues the tradition established in Move 2 (Swales, 1990, p. 159). In other words, the focus of Move 3 has shifted from previous work to the current research. Therefore, it is required to outline the purpose or state the nature of the present work.

2.4.1 The Purpose of the Current Research

After introducing the general research field and establishing the research space, the authors can finally set about introducing their own research. This process is from general to specific from Move 1 to Move 3. The focus flows from the general research field to some previous work and then to the current research. In this Move, the most essential part is to clearly tell the readers why you do this research, and what you want from it, and why it is important.

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* *The purpose of this paper is to give a complete description of the challenge, for two purposes: first to acquaint the reader with the state of the art in..., and secondly to provide guidance and lessons learnt for the benefit of...in future.*
* *This paper aims to solve both of these problems and thus address the two main drawbacks of...approaches...and lack of a...*
* *In addition, specific details of the...aspects of...are not well-documented in the literature; this paper aims to fill the gap.*
* *While the former problem has the optimal outcome, it is unclear as to...due to...in the latter. This paper provides an answer to this question.*
* *This paper addresses the need for...with...tools in evaluations of...protocols.*
* *This paper builds upon the...to demonstrate an approach leveraging...to address..., ..., and...for next generation...*
* *This paper explores in detail the use of...to image...within the network area.*
* *This paper proposes novel...and...methods using the...model.*
* *This paper intends to provide...and...concepts for...using...*
* *This paper is intended to provide an in-depth treatment of some of the aspects and techniques associated with...*
* *This paper introduces two new aspects to consider when...*
* *The main objective of this paper is to design a...strategy for...that is...*
* *The goal of this paper is to develop a data-driven approach to design...to... with unknown parameters, against...*
* *The goal of this work is to improve...to answer the following questions.*
* *The aim of the survey is to assess the state of the art in..., with an emphasis on...and...of...*
* *In this paper, we extend the results of [reference] in order to obtain a..., and to ensure...without increasing...*

2.4.2 The Main Features of the Current Research

The authors can also state the main contribution, describe the important features/results, or briefly introduce the methodology of their research.

* *In particular, this paper contributes to the design of a new...architecture for...using...technology.*
* *In essence, the main contributions of this paper are as follows: We formulate a... problem in the...Network with...constraints, and we show that...for this problem is hard.*
* *In this paper, we propose a...for...systems with...*

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* *In this paper, we present a new dataset and framework for the problem, and perform larger comparisons both in term of the methods and the metrics considered.*
* *In this paper, we show that there is nearly no capacity-delay tradeoff for...*
* *The main contributions of this paper are as follows...*
* *Our contributions can be summarized in the following steps: ...*
* *One of the novel contributions presented in this work is the...tool.*
* *In this paper, we improve over the previous approach in different ways.*
* *In this paper, we evaluate the most promising…in the literature, propose new algorithms and improvements to existing ones, present a method for performing...and..., and discuss the problem of...to very large data sets using ...*
* *Thus, in this paper, we cast all of our previous work in a...approach for..., and elucidate practices that will allow...to compare...and...results in a more unified manner.*
* *In this work, we consider...acquired using...and investigate a new...algorithm that does not rely on..., but on...*
* *We describe...adopted for the realization of...and report some of the...that have been collected by the system in its first operational days.*
* *Most previous attempts have proposed to stitch together existing solutions of the above sub-problems, in order to... In contrast, we would like to present in this work a...model that takes...as...and is trained to...*
* *Our main contribution in this work is a method able to... This work is an extension of the one presented in [reference]. In this paper, we improve over the previous approach in different ways. First, we allow... This brings more flexibility to the model which... Also, we introduce a new term in the minimization... Furthermore, we show how our method can be used when... Lastly, in this paper, we present a new dataset and framework for the problem, and perform larger comparisons both in terms of...and... Our results outperform the rest of the algorithms both quantitative and qualitatively.*
* *Unlike most research in this field and our previous work in [reference], in this paper a...scenario of...is considered.*

2.4.3 Language Focus

1) V-ing as a Result

When you establish your research niche by pointing out the limitations or research gap of previous research, you may need to elaborate on the result of the limitation or gap, so as to highlight the significance or contribution of your research. A *(thus) + v-ing* clause of result would be "particularly useful as alternatives to traditional logical connectors like *therefore* and *as a result*" (Swales & Feak, 2012, p. 115). For example:

Main clause	*Ideally, this federated infrastructure will involve cloud resources at the mobile edge,*
(Optional *thus/thereby*) + *v-ing*	*thus bringing services as close to end users as possible.*

More sentence patterns are shown below:

* *We relate such a...to..., and show that in..., ...reduces..., thus establishing a connection to...principles.*
* *This objective can be pursued by the deployment of..., i.e., a...that provides...access to..., thus unleashing potential synergies and increasing...*
* *We evaluate the...properties of...as a whole, thus showing the benefits of combining the two modules.*
* *This is the most widely-used formulation, estimating…from…, thereby using a...without...*
* *Their biggest advantage, however, is the fact that they can be..., thereby making...*
* *The goal of the contest is to advance the development of...that can..., such as..., resulting in...*
* *Indeed, ...are processed sequentially, resulting in a...which is important for...*
* *As opposed to other solutions, the design operates in a single smart contract, simplifying the whole process in...and reducing...*
* *Although there is not yet a formal and widely accepted definition of..., the final aim is to..., increasing the quality of..., while reducing the operational costs of...*
* *For..., ...allows to..., adjusting...to the...needs.*
* *Using the...methods in [reference] might cause frequent and unnecessary..., leading to...*
* *This has naturally increased the confidence in..., leading to the idea of using...to support...*
* *Our...has some critical differences with these well-studied..., in terms of...and..., and hence, the results established for them do not directly apply in our case, making our theoretical results on the existence of..., interesting and nontrivial.*
* *In the past, these systems were stand alone and isolated from the world, making them unsusceptible to...*

2) The Use of Deictic Signals

As mentioned before, the focus of Move 3 is on the current research. Therefore, in this move, the authors tend to use more deictic elements to refer to the present research, such as *this, the present, we, here, now, herein* (Swales, 1990, p. 159).

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* *Our work in this area shows that...can introduce...to secure these systems.*
* *Toward this goal, we propose a...that measures...*
* *In this paper, we present a new architecture for...*
* *The objective of this paper is to discuss...framework for the design of a(n)...*
* *The work presented in this paper differs from our earlier results in the following three aspects.*
* *Different to the objectives of the present paper, all of these methods, while referred to as..., require the knowledge of...for design and implementation.*
* *The following list summarizes the contributions of the present work.*
* *The other method is an earlier version of the current work, with a different algorithm that consistently underperforms the one we will introduce here as it is shown in the Results section.*
* *The game introduced herein is a...game for which...solutions are sought.*

3) This + Summary Noun

The pattern *This/These + summary noun* is a good way to establish connection with previous sentence. It avoids repetition as well as makes the sentence compact.

* *We develop a...architecture utilizing...knowledge to... This approach leverages...to provide...and...through...*
* *...will increase sevenfold between...(year) and...(year), reaching...per month by the end of...(year), and...will account for over x% of the total... This trend will cause a...due to...*
* *...is extended to include...and... This development improves performance and boosts the...properties of the algorithm, meaning that...is possible.*
* *However, such a...application makes...capable of satisfying the requirements of...a formidable challenge. This difficulty has led to the...and, sometimes, ... for...*
* *..., ...and...are just few of the performance metrics that 5G networks are expected to boost when deployed. This game changer relies on...such as...or...*
* *While..., these...systems are limited to... This limitation can cause...when...and consequently affects...*

2.5 Stating the Outline of the Article

In some journals, there is a Move about the overall structure of the article in the end of the Introduction. Here are some examples:

* *In this article, we first revisit..., originally cast in...framework, through... descriptions. Next, we show that this result can be used to get a... Concluding remarks are given in Section VII.*
* *This article is structured as follows. Section 2 reviews relevant works in the literature. Section 3 presents our vision and architecture for...in a...context. We then propose schemes for...(Section 4) and...(Section 5). In Section 6, we... The process of..., is described in Section 7...experiments on the performance of the overall...system follow in Section 8. We conclude the article in Section 9.*
* *The remainder/rest of this paper is organized as follows. Section 2 summarizes/reviews... Section 3 describes... Section 4 illustrates... Section 5 introduces... Section 6 presents... Finally, Section 7 concludes the paper.*
* *The remainder of this paper is organized as follows. The system model of...is described in Section II, including...and... Three conventional...methods are introduced in Section III, including... Following a discussion on the key issues when conducting the conventional...methods in..., the novel two-stage method is proposed in Section IV. An analysis of...for the proposed method is given in Section IV. Simulation results are presented in Section IV. Finally, conclusions are drawn in Section VII.*

In the corpus, some verbs that are often used in this part are: *address, consider, detail, design, discuss, describe, develop, evaluate, illustrate, present, propose, provide, show, utilize,* etc.

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Exercises

I. Please identify the moves and specific steps in the following Introduction and comment on them.

Excerpt	Comment
Unlike the previous generation of mobile networks, 5G systems, are expected to rely on both the advancement of physical infrastructures represented by the introduction of Millimeter waves, massive MIMO, full duplex, beamforming, and small cells; as well as the emergence of SDN and NFV. By introducing the logical infrastructure abstraction, the 5G mobile networks will revamp modern network infrastructures using SDN and NFV as key enabling technologies towards softwarized networks. Network Softwarization is the core concept supporting the 5G's use cases, i.e., enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low Latency Communications (uRLLC), and massive Machine Type Communication (mMTC), reducing both the Capital Expenditures (CAPEX) and the OPEX of the service provider, while keeping the deployment schema simple. Network Softwarization can enable high performance improvements by offering the flexibility and modularity that are required to create multiple overlying networks. These softwarized networks' mechanisms give place to a new concept dubbed Network Slicing. Meanwhile, the Third Generation Partnership Project (3GPP), in its Releases 15 and 16, introduced a service-oriented 5G core network (5GCN) that entirely relies on NFs, which increases the need for autonomous mechanisms to deploy and manage NS through operating multiple Service Function Chains (SFC) that will dynamically steer the network traffic and flows across multiple logical and physical infrastructures. For instance, a given user has a network slice that consists of two SFCs: The first one is used to handle the control plane part by steering the traffic through the Access and Mobility Management Function (AMF) and the Session Management Function (SMF) which are equivalent to the MME, PDN-Gateway Control plane (P-GWCP), and Serving-Gateway Control plane (S-GWCP) in the 4G system after the control and user plane separation of EPC nodes (CUPS). The second SFC will ensure the reliability of the data plane by steering the data flows from the AMF to the Data Network (DN) passing by the User plane Function (UPF) which represents the P-GW User plane (P-GWUP) and the S-GW User plane (S-GWUP) in the CUPS architecture.	

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(Continued)

Excerpt	Comment
As the standards development organizations (SDOs), i.e., the Next Generation Mobile Network Alliance (NGMN), 3GPP, and International Telecommunication Union Telecommunication Standardization Sector (ITU-T), are instantiating network slices that contain one or more SFCs, each SFC composed by a set of NFs running inside either a logical node or a physical node. To enable this emerging approach, many NFs may require being traversed in a certain strict order, leveraging on the flexibility of NFV, Mobile Network Operators (MNOs) can deploy any particular slice type honoring its real-time requirements. However, this flexible management can lead to a huge number of active nodes in the network infrastructure that are scarcely used, which leads to an inefficient network slicing deployment. Based on these observations, the contributions of this paper are: ● The introduction of a new architecture in compliance with the ETSI-NFV model and the 3GPP specifications to create a fine-grained NS; ● The formulation of a Mixed Integer Linear Programming (MILP) to achieve an efficient cross-domain network slicing deployment regardless the underlying topologies (both the VNF layer and the physical layer) while satisfying all constraints and the specifications requested by the end-users or a given vertical's application; ● The design and evaluation of a heuristic algorithm to overcome the exponential runtime and allow a quick decision-making capability. The remainder of this paper is organized as follows. Section 2 summarizes the fundamental background topics and related research works. Section 3 describes the proposed architecture and our network model. Section 4 illustrates the problem formulation and describes our proposed framework solution. Section 5 introduces the proposed heuristic for the reduction of the exponential runtime. Section 6 presents the performance evaluation and our results analysis. Finally, Section 7 concludes the paper.	

(Addad, R. A., Bagaa, M., Taleb, T., Dutra, D. L. C. & Flinck, H. 2019. Optimization model for cross-domain network slices in 5G networks. *IEEE Transactions on Mobile Computing*, *19*(5): 1156–1169.)

II. Please try to weaken the statements by adding probability and usuality.

1. Flexibility comes at a cost of robustness, especially when automated parameter estimation is involved.

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2. It is a problem in various fields that one runs into a series of tasks that appear to be highly related to each other, yet applying the optimal machine learning solution of one problem to other results in poor performance.

3. In the context of secure control, attack detection and resilience schemes are divided in data driven and knowledge-based approaches.

4. We test the hypothesis that DL construct feature extractors that are more appropriate than selected adhoc features picked via automatic selection.

5. Answers to this question have a major practical impact especially in those situations where identifying a process model can be difficult and time consuming.

6. This difficulty has led to the proliferation of different and incompatible proposals for the practical realization of IoT systems.

7. However, acquiring these parameters is troublesome and costly.

8. Some of these agents are unreliable, and therefore the consensus process needs to be reliant.

9. An observed sequence of patterns conveys a meaning to the observer, whereby independent fragments of this sequence is hard to decipher in isolation.

10. Assuming robust deep learning is achieved, it is possible to train such a hierarchical network on a large set of observations and later extract signals from this network to a relatively simple classification engine for the purpose of robust pattern recognition.

III. Fill in each of the blanks with a summary noun to make the two sentences logically connected.

1. In statistics and data analysis, one typically proceeds from data presented in the form of real numbers or categorical values, implicitly assuming the underlying measurement process to be precise and exact. In many cases, however, this _____ is clearly not warranted.

2. We shall now introduce three categories of prediction problems, all of key relevance to the operations and management of commercial mobile wireless networks. This _____ is not meant to be exhaustive, although vast majority of problems we have encountered fall into one of these categories.

3. Many machine learning techniques are tied to a series of hyper-parameters and/or selection of sub-components that need to be tuned. This _____ can broadly be defined as the algorithm configuration problem.

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4. In the context of formation control, most of the proposed approaches are based on the notion of navigation function, which is constructed from the geometric information on the considered topology and then employed to define gradient descent control laws. This _____ has been recently extended to the multi-agent scenario, both in a centralized and decentralized implementation.

5. Any successful attack on CPS may jeopardize critical infrastructure and people's lives and properties, even threaten national security. In 2010, Stuxnet malware launched a devastating attack on Iranian uranium enrichment facilities. This _____ raised a great deal of attention to CPS security in recent years.

6. Although there is not yet a formal and widely accepted definition of "Smart City", the final aim is to make a better use of the public resources, increasing the quality of the services offered to the citizens, while reducing the operational costs of the public administrations. This _____ can be pursued by the deployment of an urban IoT.

7. During the first three decades of research, the fuzzy logic community has more focused on topics in the realm of knowledge and information processing, such as control and approximate reasoning, and less on analyzing and learning from data. This _____ started to change in the recent past, which has been characterized by a shift from largely knowledge-based to strongly data-driven fuzzy modeling.

8. Comprehensibility was defined as the learning algorithm ability for encoding its model in such a way that it may be inspected and understood by humans. This _____ narrows the focus to the model itself.

9. Baseline PI is extended to include an appropriate combination of PI task selection and soft-max task selection. This _____ improves performance and boosts the exploratory properties of the algorithm, meaning that escape from local minima is possible.

10. We define a matrix-valued function, for each agent, which is similar in spirit to the definition of a standard navigation function. This _____ is modified by the presence of additional dynamics and the resulting value functions are smooth, hence yielding smooth control laws.

IV. Please combine the two sentences by a *v-ing* clause.

1. The application of the IoT paradigm to the Smart City is particularly attractive to local and regional administrations that may become the early adopters of such technologies. This application acts as catalyzers for the adoption of the IoT paradigm on a wider scale.

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2. These two modules exploit different sets of relations and different model knowledge to perform detection. They compensate each other's vulnerabilities, and reduce the number of attacks that are stealthy.

3. Recent neuroscience findings have provided insight into the principles governing information representation in the mammalian brain. This leads to new ideas for designing systems that represent information.

4. In the past, these systems were standalone and isolated from the world. This makes them unsusceptible to external malicious attacks.

5. A blockchain contains a set of blocks, and every block contains a hash of the previous block. This creates a chain of blocks from the genesis block to the current block.

6. To the best of the authors' knowledge, this is the first time deep learning is introduced to the domain of psychophysiology. This yields efficient computational models of affect.

7. A simultaneous proliferation of high-value connected devices makes the IoT a desirable attack surface, and drives security-related resource requirements. This demands high-powered computation—lest a platform become unfavorable for mission-critical applications.

8. They successfully managed to learn decoding rules with high accuracy using only a fraction of the training trials required by the earlier approaches. This allows subjects to communicate consistently with a computer in a single session.

9. The study compares DL against ad-hoc feature extraction on physiological signals, used broadly in the AC literature. It shows that DL yields models of equal or significantly higher accuracy when a single signal is used as model input.

10. Batches of random experiences are drawn from the buffer and used for updates. This forces the network to generalize beyond what it is currently doing in the environment.

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Chapter 3
Describing Methods

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3.1 Lead-in

What make a good experimental procedure? Mark your answer with a √.

Have you included a description and size for all experimental and control groups?	
Have you included a step-by-step list of all procedures?	
Have you described how to change the independent variable and how to measure that change?	
Have you explained how to measure the resulting change in the dependent variable or variables?	
Have you explained how the controlled variables will be maintained at a constant value?	
Have you specified how many times you intend to repeat the experiment (should be at least three times), and is that number of repetitions sufficient to give you reliable data?	
Can another individual duplicate the experiment based on the experimental procedure you have written?	
If you are doing an engineering or programming project, have you completed several preliminary designs?	

(Retrieved from Science Buddies Organization website.)

The section of Methods deals with what we did or how we did it (Boxman & Boxman, 2020). It is an explicit bridge between literature review and the Results section. It describes the progression of procedure steps and provides sufficient details for replication studies (Cotos et al., 2017). To be specific, it describes in detail how the research is conducted, what experimental apparatus are needed, how to set up the apparatus, what the experimental procedures are, what materials are used, and how to develop the model or how to derive the model equations.

A descriptive model of methods is adopted in this book. Cotos et al.'s (2017) Demonstrating Rigour and Credibility model (for short DRaC) is adjusted to better describe the Methods section in IEEE journals. This model consists of three basic moves and several steps within each move:

- **Move 1: Contextualizing study methods**

  Step 1 Stating the purpose of the method

  Step 2 Referencing previous works

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Step 3 Identifying the methodological approach

- **Move 2: Describing the study**

Step 1 Rationalizing your method

Step 2 Describing the data

Step 3 Describing experimental/study procedures

- **Move 3: Establishing credibility**

3.2 Contextualizing Study Methods

You can begin your Methods section by providing necessary background information for the research method, setting the scene for experimental procedure details and explaining the procedures (Cotos et al., 2017).

3.2.1 Stating the Purpose of the Method

Instead of directly elaborating on how the research is conducted with the specific experiment, apparatus or methods, authors usually can briefly introduce the section by stating the "overview of the purpose of the method and the overall principle by which it works" (Boxman & Boxman, 2020, p. 34).

The following excerpt is the introductory part of the Methods section.

Excerpt	Comment
① In this section, we discuss the control design technique proposed to solve the multi-agent collision avoidance problem. ② Since Nash equilibria for the differential game introduced in Problem 2 cannot be easily obtained, a systematic method for constructing feedback control laws, which satisfy partial differential inequalities (PDIs) (instead of equations), leading to ea-Nash (instead of Nash) equilibria, is provided. ③ The method requires only the solution of matrix algebraic inequalities, which is provided in closed-form. ④ It is shown that the constructive design methodology, which leads to approximate solutions of the differential game in Problem 2, yields a solution to the original Problem 1.	Sentence ① is an overview of what the authors do in this section. Sentences ② and ③ explain in detail how the method works. Then, the last sentence briefly states the feasibility of the method used.

(Mylvaganam, T., Sassano, M. & Astolfi, A. 2017. A differential game approach to multi-agent collision avoidance. *IEEE Transactions on Automatic Control*, *62*(8): 4229–4235.)

There are some other patterns of writing an introductory part of a Methods section. Some are brief, for example:

Excerpt	Comment
III. Implementation ① We developed a proof of concept (PoC) implementation of the decentralized access control system in order to test and evaluate it. ② The following section provides additional details about our implementation, in particular regarding the IoT devices, management hub, and the blockchain network.	Sentence ① directly points out what system the authors developed in the methodology part and its purpose. Sentence ② provides an overview of the Methods section.

(Novo, O. 2018. Blockchain meets IoT: An architecture for scalable access management in IoT. *IEEE Internet of Things Journal*, *5*(2): 1184–1195.)

Some syntactic patterns to begin a Methods section by stating the purpose are shown in the following:

* *In this section, we discuss how...can be used to get...algorithms.*
* *In this section we describe the proposed...model and discuss its characteristics.*
* *This section is an overview of our system with a...description. Later sections develop further details.*
* *This section provides information regarding the test material used, test settings, and logistics.*
* *In this section, we present our proposed scheme in details that comprise V1-ing, V2-ing, ...and Vn-ing.*
* *Our system follows the...approach: It first..., then..., and finally... The main steps are the following...*
* *This section describes...for solving..., and introduces a technique for...*
* *In this paper, we present a...method that takes... For simplicity we explain the method for the case of... Later on, we will show how to handle as well... The main steps of our method can be outlined as follows...*
* *In this section, we demonstrate how...techniques can be used to... We also show how...and...can be combined to achieve greater playing performance. Finally, we describe an attempt to...by means of..., which—albeit eventually failing—inspired us to investigate..., which will be reported in Section IV.*
* *In the present section we describe the evaluation design for our challenge tasks. Before this, we describe the requirements gathering process that we conducted, and the considerations that fed into our final designs.*
* *In this section we show how to directly estimate... Moreover, we show how this can be formulated as a...problem for which the...solution can be computed efficiently.*
* *This section provides the preliminary details about..., followed by the working of the proposed...framework for...in...*

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* *This section is devoted to developing a...procedure to infer the system parameters, based on which, we show how to design...and prove that... Throughout the section, we make the following assumptions...*
* *In general, a conventional system for..., depicted in Figure x, consists of three main steps: x, y, and z, and it contains the following methods...*
* *In Section III-A, we present the underlying idea of...and provide an intuitive explanation why... Section III-B then includes a more rigorous mathematical description. In Section III-C, we discuss Z and in Section III-D the computational complexity.*
* *For...we introduce three conventional...methods: A, B, and C. The process of those methods is elaborated in this section, while their respective drawbacks when applied to a hybrid network are discussed in Section IV-A.*
* *The set of...protocols are referred to as..., which has the following tasks: (i) resolving...; (ii) performing...; (iii) decoding metadata and data; and (iv) interacting with... Its operation has to be designed according to the...requirements and to the...patterns of the supported services. In this section, we consider several...options for...services.*
* *The...problem is very dependent on...since it is a requirement for... The model used in this paper should take into account the...aspects of... Here, we present an augmented mathematical model of...for the development of a...system. Section IV-A develops a...model along with its...dynamics, and Section IV-B introduces a...model used for the development of...*

3.2.2 Referencing Previous Works

You can also situate some aspects of your method in the literature by means of citations, footnotes, and some relatively detailed descriptions of methods in important studies (Cotos et al., 2017). If the article is a review of a specific field, the Methods section can also begin by reviewing previous literature and/or indicating its development in future. For example:

Excerpt	Comment
① Artificial Immune Systems (AIS) emerged in the 1990s as a new branch in Computational Intelligence (CI). ② A number of AIS models exist, and they are used in pattern recognition, fault detection, computer security, and a variety of other applications researchers are exploring in the field of science and engineering [reference]. ③ Although the AIS research has been gaining its momentum, the changes in the fundamental methodologies have not been dramatic. ④ Among various mechanisms in the biological immune system that are explored as AISs, negative selection, immune network model and clonal selection are still the most discussed models [reference].	Sentence ① introduces the model by stating its origin. Sentence ② introduces its application. Then, Sentence ③ acknowledges the achievement of the method as well as states its status quo. Sentence ④ specifies the situation brought about in the previous sentence by presenting the most discussed models.

(Dasgupta, D. 2006. Advances in artificial immune systems. *IEEE Computational Intelligence Magazine*, *1*(4): 40–49.)

For an original research article, the reference of related previous works is to facilitate the understanding of the current method.

Excerpt	Comment
① In this work we built on the multi-scale fusion principles to propose a single image underwater dehazing solution. ② Image fusion has shown utility in several applications such as image compositing, multispectral video enhancement, defogging, and HDR imaging. ③ Here, we aim for a simple and fast approach that is able to increase the scene visibility in a wide range of underwater videos and images. ④ Similar to [23] and [54], our framework builds on a set of inputs and weight maps derived from a single original image. ⑤ In contrast to [23] and [54] however, those ones are specifically chosen in order to take the best out of the white-balancing method introduced in the previous section. ⑥ In particular, as depicted in Fig.1, a pair of inputs is introduced to respectively enhance the color contrast and the edge sharpness of the white-balanced image, and the weight maps are defined to preserve the qualities and reject the defaults of those inputs, i.e., to overcome the artifacts induced by the light propagation limitation in underwater medium.	Sentence ① presents the overview of the purpose of the method as well as the overall principles by which it works. Sentences ② and ③ explain the application of this method and its advantages and purpose. Sentences ④ and ⑤ compare and contrast the current approach with and to the previous ones, and propose the framework of the current research. Sentence ⑥ states the overview of the method with a figure.
⑦ This multi-scale fusion significantly differs from our previous fusion-based underwater dehazing approach published at IEEE CVPR. ⑧ To derive the inputs from the original image, our initial CVPR algorithm did assume that the backscattering component (due to the artificial light that hits the water particles and is then reflected back to the camera) has a reduced influence. ⑨ This assumption is generally valid for underwater scenes decently illuminated by natural light, but fails in more challenging illumination scenarios, as revealed by Fig. 11 in the results section. ⑩ In contrast, this paper does not rely on the optical model and proposes an alternative definition of inputs and weights to deal with severely degraded scenes. ⑪ As depicted in Fig. 8 and detailed below, our underwater dehazing technique consists in three main steps: inputs derivation from the white balanced underwater image, weight maps definition, and multi-scale fusion of the inputs and weight maps.	Sentence ⑦ points out the novelty the current method has compared with the authors' previous method. Sentences ⑧ and ⑨ then describe the assumption of their previous methods, and also evaluate its positive and negative sides. Accordingly, Sentence ⑩ proposes the current method that can remedy the previous ones. Sentence ⑪ briefly introduces the steps that the current method takes.

(Ancuti, C. O., Ancuti, C., De Vleeschouwer, C. & Bekaert, P. 2018. Color balance and fusion for underwater image enhancement. *IEEE Transactions on Image Processing*, *27*(1): 379–393.)

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Some syntactic patterns to build the current method in the context of the accepted methods in the field are shown in the following:

* *In [reference], we have presented... Even though...has proven its capability in..., there are cases that... // ...is a real-world challenge that is quite common in... In [reference] and [reference], we have investigated...using...and...models for... However, in this paper, we have improved our...by adding the following elements.*
* *In this paper, ...is computed by employing...method we have introduced in [reference], which stems from the concept of... The main concept of...is...in order to obtain an improved...*
* *Our...scheme is an extension of...methods that has a larger flexibility [reference]. It also partitions a frame into...which... However, in contrast to..., binary splits into blocks of unequal size are supported. More precisely, ...*
* *Different...systems have been proposed in the past to...[reference]. Nowadays, most of the...are...systems, in which...*
* *...represent...characterized by...In [reference], ...was defined as...In this work, we extend the...by adding explicit process descriptors.*
* *In this section, we propose a...that enables... While...is traditionally formulated as..., it would be based on...and therefore lack... In contrast, we propose to represent...using...that characterize... We will show that such a...is essential to guaranteeing some desirable properties for saliency detection and shape matching.*
* *In this section, the...model will be obtained with the use of a...strategy. In particular, a...will be used since such a strategy has been shown to provide better...properties of the system than its relative degree one equivalent.*
* *The developed...incorporates all the benefits from state-of-the-art...techniques of both the...and... Before we outline the architecture and behavior of..., we briefly introduce the mentioned...and motivate our selection of adequate candidate tools.*
* *To conduct our experiments, it was necessary to prepare a large-scale...dataset that contains... The...dataset has been used in...contexts. However, ... Therefore, this database does not fit our...problem setting, wherein... In this study, we built a...dataset collected by running a...application called...for about two years.*
* *Due to the identified trends in...regarding...and hence..., ...will be identified and analyzed in this section, coming from both industry as well as research environments.*
* *...is a...algorithm designed to handle large-scale datasets. // ...learns a set of rules following the...paradigm first used in...in the...system. This...paradigm generates...in which..., using a...to... Hence, ...is a rule. Once a rule is learnt, it is added to the rule set and the training set is filtered by removing all the examples covered by this rule. The...process generally stops when the whole training set is covered. However, the*

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> *stopping criteria changes when using a default rule as detailed in Section 3.1. In the rest of the section, we only describe the aspects about...that are relevant to this work. For a full description of the algorithm, please see...*

3.2.3 Identifying the Methodological Approach

You can also specify "the approach or research design with brevity or elaboration", and "describe the setting" (Cotos et al., 2017, p. 97). For example, you explain the preparation for the experiment, experimental procedures or the setting up of the apparatus, or introduce the research subjects or participants.

Excerpt	Comment
① An experiment is designed to study mobile users' behavior and to develop a statistical model for the orientation of mobile devices that act as the receiver for wireless communication systems. ② During the experiment, 40 participants were asked to use their cellphones normally that create 222 datasets for orientation. ③ They were asked to use the cellphone in both portrait and landscape modes for one minute. ④ The orientation data is measured for both sitting and mobile users. ⑤ In the experimental measurement, the application Physics Toolbox Sensor Suite has been used as it can provide instantaneous rotation angles α, β and γ. ⑥ This application can be running in the background while the participants can perform activities that require data connection, e.g., browsing or watching streaming videos. ⑦ Below is a summary of the experimental setup: ● Activities while sitting: 1) Browsing twice in portrait mode, 2) Watching streaming videos twice in landscape mode, ● Activities while walking following a certain path: 1) Browsing in portrait mode, 2) Watching streaming videos in landscape mode. The path that the participants took was a straight corridor with dimensions of 40 m × 1.5 m. The participants were asked to walk down the corridor once. We note that the shape of the test area should not affect the experimental results and the model for the elevation angle as it mostly depends on the posture and physical attributes of typical users rather than the environment. This has been confirmed with sets of uncontrolled data collections from participants using their device in different environments.	Sentence ① states the purpose of the experiment. Sentences ② and ③ introduce how the experiment was conducted by a certain number of participants. Sentences ④ and ⑤ explain how the data is measured. Sentence ⑥ provides some supplementary information about the measurement of data. Sentence ⑦ sends a signal of the summary of the experimental setup. The rest of the paragraph provides some supplementary information about the participants.

(Soltani, M. D., Purwita, A. A., Zeng, Z., Haas, H. & Safari, M. 2018. Modeling the random orientation of mobile devices: Measurement, analysis and LiFi use case. *IEEE Transactions on Communications*, *67*(3): 2157–2172.)

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Some similar structures can also be used:

* *In this paper we apply different selection criteria to identify...that will be used by... The use of...allows us to apply the selection algorithm directly over...in the...domain, hence... // ...can be performed according to different parameters, such as... Our main focus is on...based on..., since our analysis is mostly based on...*
* *To take...into account, it is necessary to... [characteristics of part of the method]. Hence, the proposed method determines..., which falls into three categories: A, B and C. Users in the first two categories are only granted access to a certain network. These users are handed over within the same network when needed. The third category allows...to... [conditions for the third category]. Based on the above categories, a...problem is formulated in this section. To..., a novel algorithm based on...is also proposed.*
* *We describe a...method that...and yields... The framework for extracting this information is presented, along with a multiresolution approach. We assume..., and...are known or extracted from a previous characterization step. The...is used to obtain...information for... Here, we describe... Our method assumes that..., and we explore this assumption in Section III-C. By exploiting this information as prior knowledge, ...is achieved.*

3.3 Describing the Study

This move is the main part of the methodology and is usually obligatory for any discipline. You need to describe "all the specifics of the study, focusing on what was done in the experimental procedure prior to data analysis and clarifying conditions, treatments, controls, data, tools, in-process judgements, etc." (Cotos et al., 2017, p. 97). You can arrange this part according to some logical order, for example, in the order in which the experiment is conducted or the different parameters considered in the method.

Based on the different specific procedures of the method, this part can be divided into different sub-sections, and you need to give each one a title to keep your readers aware of where they are. You should try to "use informative subheadings to help organize and present" your material and method by topic (Pechenik, 2016, p. 156). Here, "informative" means that you should be specific to provide enough information for your readers to understand the subsection. For example:

Informative	Uninformative
A. State Feedback Design and Data-Based Parametrization of All Stabilizing Controllers	A. Design and Parameters
B. Linear Quadratic Regulation	B. Experiment

3.3.1 Rationalizing Your Method

Before getting in touch with how your research is conducted, you can explain why the particular method is adopted with the following sentence structures.

* *The chosen...technology for our...was... We developed... We chose...since...*
* *Since...were used for..., we generated...models for..., as well as for...*
* *Since...is critical in..., we first apply our...technique to... This step aims at v-ing...by v-ing... [description of the function of this step]. As a result, to obtain our first input we perform...*
* *In order to..., ...must be estimated. To further..., ...can also be estimated.*
* *In order to analyse...and compare its performance with...we use...*
* *Our motivation was to...to... Our focus was on..., since... We also wished to... We decided to...*
* *Given the results stated in..., in order to design a...architecture, it is necessary either to..., or... To address the latter, ...could be added, although this may not be possible depending on the application.*
* *In the... problem, ...is given. The goal is to... In more formal terms, the goal is to find a Hamiltonian tour of minimal length on a fully connected graph.*
* *The X method has been widely used for solving...problems. Before comparing our proposed methods with the X method, this section summarizes the X method.*
* *In this section, based on the different characteristics between...and...in terms of..., we propose a...method for... The main contribution of this section is three-fold: i) analyse the key issues when...; ii) formulate the...process as a two-stage problem, which firstly determines...and then performs...; and iii) apply...to the first stage to... Regarding the second stage, a...method, such as the...and..., is applicable.*

3.3.2 Describing the Data

You can inform your readers about “the process of collecting, sampling, or selecting primary or secondary data”, and present “the characteristics of the data” (Cotos et al., 2017, p. 98). The sentence structures can be used are as the following.

* *We denote a...as...with...*
* *We consider that..., denoted as..., that is atomic and cannot be divided into subtasks. Each... is characterized by a tuple of two parameters,..., in which... specifies..., and...specifies...*

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* *In our case, we consider only the per-sample energy cost of acquiring sensor data from...and...*
* *The system to be controlled is open-loop unstable. The...procedure is implemented in MATLAB. We generate the data with...and by using...*
* *In this paper, we developed a real-world testbed that... We have conducted...to gather realistic datasets containing...*
* *In Section..., the measured data are...and..., and the starting point is to express the...and...in terms of the...data. Here, we show how similar arguments can be used when only input/output data are accessible.*
* *For our experiments, we consider a...environment in the form of...*
* *In a...method, ...denoted by..., selects all the...pixels found at...pixels from the current pixel. More exactly, ...is of size...and it is used as the...for the...model of the...method.*
* *To conduct our experiments, it was necessary to prepare a large-scale...dataset that contains...and...The...dataset [reference] has been used in...contexts [reference]. However,... Therefore, this database does not fit our personalization problem setting, wherein...*

3.3.3 Describing Experimental/Study Procedures

You can illustrate how the experiment is completed step by step, and provide detailed description of the actions and their sequence (Cotos et al., 2017). For example,

Excerpt	Comment
A. Proxy Model ① The first step in developing a proxy is to select a system model. ② The accuracy and inputs to this model determine the performance of the data proxy. ③ For illustration purposes, we apply the vehicle motion model from Kumar et al. (2013). ④ The car is modeled as a unicycle with the constraint that it moves along a trajectory with no slip. ⑤ A Kalman filter is applied to estimate the location and the distance traveled by the vehicle (called system states here). ⑥ These estimates are performed at a baseline frequency while the model allows GpS and OBD speed measurements to be incorporated at varying frequencies in the estimation model. ⑦ Additionally, a scaling and bias correction are applied to accelerometer measurements for improved estimation accuracy. ⑧ To collect data, a vehicle was driven in a loop while recording information at the reference 10 Hz from a GpS device, an accelerometer, and an OBD interface. ⑨ We identified an optimal reference trajectory using fully sampled data run through our tuned Kalman filter. ⑩ We then iterated filtering using differing down sampling rates for OBD and GpS and calculated the costs and QoDs for each run, as described in the following sections.	This sub-section begins with an introduction of the specific step in Sentence ① and the characteristics of the model in Sentence ②. Sentence ③ explains the model this research adopts, followed by Sentence ④ to Sentence ⑧, which specify the procedures of the operation of this model. Sentences ⑨ and ⑩ then briefly describe how the authors processed the data obtained, connecting the following section.

(Siegel, J. E., Kumar, S. & Sarma, S. E. 2017. The future Internet of Things: Secure, efficient, and model-based. *IEEE Internet of Things Journal*, *5*(4): 2386–2398.)

You can also use the following sentence structures.

* *This section describes...models that we used for... For the...problem, the following assumptions are made.*
* *A...channel is considered, where at the beginning of each time slot, a...is generated and stays fixed throughout that time slot.*
* *Following the law of iterated expectations, for target dimensions..., we obtain the predictive mean...with...*
* *In the following, the computation of...is considered. For simplicity, only...is considered for..., and the result is later generalized to...*
* *In the experiments reported later, we use...*
* *The experiments were done on...desktop with Intel... We used...and..., which is derived from...*
* *In this section, a procedure to systematically construct a set of dynamic strategies solving the...instead of the...is presented. The method, introduced in..., relies on the notion of...solution and a dynamic extension..., which is common to all agents.*
* *We define a…as…function that is guaranteed to…by... In this and the following subsections, we will analyze the properties of...module of... Note that, given that..., we consider...at... Hence, let us define...for clarity of exposition.*
* *First, we discuss the effect of the...parameter...upon the proposed... Second, we study the effect of the...factor...upon the proposed... Third, we discuss the effect of the...upon the proposed...*
* *In this subsection, we will present the complete algorithm in a...form. After that, the...scheme will be introduced in detail.*
* *We model the...problem as a game between... Let...denote..., each corresponding to a... The...is discretized into a finite set of... The information collection environment is then represented as..., where... The time is also assumed to be discretized into time steps. Next, we extend the model to incorporate...*
* *In the proposed approach, a...routine is integrated into the...algorithm and an X is constructed around the main program. Within the X different values of...are trialed until the best solution is obtained.*
* *In experiment set A, ...were used to create different...and...tasks were trialed with... In experiment set B, ...were used and...tasks were trialed with...values of... Each problem was solved using..., the...algorithm, and...extension.*
* *The...tests were carried out for four categories of...: A, B, C and D. The details of the test sequences are provided in Tables X and Y. The sequences are selected from different sources and have different...characteristics, which leads to different behavior of...algorithms. This is the first formal test of...standards where a wide range of...has been evaluated.*

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3.4 Establishing Credibility

In this move, you can deliver information about the quality of analysis and imply that the study procedure results in valid and credible findings. You can do this with the following sentence structures.

* *We will show that the combined use of the two modules in...has advantages in terms of...*
* *In both scenarios, the...network grants all the requests to all the resources. In addition, the tests in both scenarios were performed with a different number of... Every test was measured...times, for...each time, to calculate the average values and the number of...ranged from...to... Furthermore, the second scenario achieves a steady throughput at...requests per...during all the tests. In this scenario, all the...request the resource information from a single...device and, as a result, the...limits the whole performance of this scenario.*
* *In the previous sections, we have considered...formulations based on... Besides their simplicity, one of the main reasons for resorting to such formulations is that... In this section, we exemplify this point by considering..., as well as the problem of..., which are both situations where...can be challenging.*
* *It has been proven that the proposed...scheme using the...model of...drives...to a specified vicinity of... This is an important property, since the ability to...illustrates... with respect to...*
* *It has been demonstrated that the proposed...scheme limits the error of...in the...mode. Furthermore, since..., ...implies that the new strategy ensures... The advantage of the new approach will be further highlighted in...in the next section.*
* *The proposed algorithm and...streams have been designed to enable... The algorithm in Fig. x can be parallelized as follows. First, ... Next, ... Most importantly, ... In addition, due to..., the results can be... We have implemented this using...for...architectures.*
* *We subsequently show that...is powerful enough to provide...that significantly outperforms several state-of-the-art...models. Since the existing features are robust enough, we focus our work on...that exploits the capabilities of these features for effective...*
* *To determine if..., [reference] assume that... Unfortunately, such approach is not very accurate. Additionally, ...also depends on... We therefore suggest a better measure by...As long as..., ...in (algorithm) holds. If..., on the other hand, the...no longer holds and...might be necessary, or...must be performed in...domain, see Section x.*

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* *We have already proven that... Therefore, we conclude that (algorithm A) implies (algorithm B). In order to obtain..., one may wish to... Therefore, it is reasonable to establish conditions ensuring that... For that purpose, in the last theorem, we determine the...ensuring that... We can notice from (algorithm C) that this implies...*
* *In this paper, the…parameter and the…factor are selected to lie within the ranges...and...respectively based on the above discussions. The...parameter ranges are specific to...presented in this paper, and perhaps other parameter ranges are more appropriate in other situations. Fortunately, our experience has indicated that...with the suggested parameter ranges exhibit good estimation performance in many contexts.*
* *The drawback of the...approach is that... As discussed above, ... This is especially critical for...as it may...*

3.5 Figure Description

Methodology is usually accompanied with figure illustration, which constitutes an important part in the Methods section.

Figure description can be carried out with three steps:

(1) Overview of the purpose of the model/experiment/apparatus...and the overall principle by which it works (typically 1–2 sentences); and

(2) Description of the principal parts according to some logical order, i.e., spatial arrangement (e.g., top to bottom, left to right, center to outside) or functional arrangement (e.g., in the order in which the parts operate or process material or information, from the beginning to the end); and

(3) Functional description, detailing how the parts work together, preferably in the order in which the parts operate (Boxman & Boxman, 2020, p. 34).

3.5.1 Overview of the Purpose of the Model/Experiment/Apparatus and the Overall Principle by Which It Works

With a few sentences, you can briefly summarize the information shown in the figure. In this step, you need to explicitly point out which figure you are describing to guide your readers. For example, *Figure 1 is...*

You can use sentences with active voice like *Fig. x + reporting verb + noun phrase / that clause*. Here are some examples:

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* *Fig. x shows the results of the two scenarios.*
* *Fig. x displays/reveals that...*
* *Fig. x shows that for different..., ...remains valid.*
* *Fig. x demonstrates the procedure for v-ing + object...*
* *Fig. x illustrates a scheme that aims to...*
* *Fix. x indicates a...diagram of the proposed scheme.*
* *Fig. x presents a simplified view of...frameworks and shows how...*
* *Fig. x presents a...system, which is comprised of three steps:...*
* *Fig. x depicts the architecture overview suggested in this paper. We have divided the architecture into three layers, as it... The...layer consists of... In this layer, [description of the function of this layer]. The...layer consists of a set of... [description of the function of this layer]. The...layer consists of a set of..., e.g... [description of the function of this layer]. It is noticed that... For instance, ... In the following work, ...is considered, while...was not studied. However, the proposed solution can be also used to...if...*

You can also use sentences with passive voice like *The...is shown in Fig. x*. Notice that in English the passive forms are just as appropriate as the active forms (Swales & Feak, 2012).

* *The...are represented in Fig. x.*
* *The...diagram of...is shown in Fig. x.*
* *The results for...are depicted in Fig. x.*
* *This...technique is illustrated in Fig. x.*
* *A visualization of the...is given in Fig. x.*
* *An overview of the proposed...schemes for...can be seen in Fig. x.*
* *An overview of...and...methodologies is illustrated in Fig. x.*
* *An overview of the...methodologies is illustrated in Fig. x. There are four stages involved in the proposed method, namely, A, B, C and D. In A stage, there are two types of...data, that is, train and test...data. During the...phase... Subsequently, ... Finally, ...*
* *The proposed model is depicted in Fig. x, in which...are assumed to be...*
* *A...model at...GHz for the...environment using...with...is displayed in Fig. x.*
* *The...of the proposed...is given in Fig. 1, and the functional details of each of the...are described as follows.*
* *Illustrated in Fig. x is the...*
* *We assume a...described in Fig. x.*
* *We build the main blocks of our...on the...introduced in [reference] and illustrated in*

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Fig. x.

* *We refer to this as a...method, and it is demonstrated in Fig. x.*
* *It is believed that a...in [reference] and shown in Fig. x may achieve...*
* *In Fig. 4, the top five important features in our dataset along with...are shown.*

You can also locate the figure with an *as clause* or a *prepositional phrase*. For example:

* *As shown in Fig. x, a...is selected for...depending on...*
* *As shown in Fig. x, we first extract...and then...*
* *As depicted in Fig. x, ...is introduced to...*
* *As illustrated in Fig. x, we start with...*
* *This module consists of two phases: ...and...as depicted in Fig. x.*
* *We propose a...to...as depicted in Fig. x.*
* *We consider a...system as illustrated in Fig. x, in which...is equipped with...to provide...*
* *According to Fig. x, in order to..., ...is first divided into...*
* *In Fig. x, we assume/illustrate that...*
* *In Fig. x, we illustrate three typical cases that can...*
* *We propose the...scheme of...whose...diagram is shown in Fig. x.*

3.5.2 Description of the Principal Parts of the Figure According to Some Logical Order

You need to explain, in a few sentences, the organization or main parts of your figure to help your readers understand it. The following sentense structures could be helpful:

* *The...of a...module can be seen in Fig. x. While this...is rated for..., it utilizes... Each...is composed of a...and a...operating at..., connected to... The...is operated using... There is a...with a... The...and...are independently controlled by respective...*
* *The...can be seen in Fig. x. The...is designed for...utilizing a... The X is comprised of a...connected to a..., followed by a...with...structure at the primary side, and a...on the secondary side. The X also has an additional... from a...that...*
* *To illustrate the main concepts of this section, we assume a...as pictured in Fig. 6. A...is equipped with a...that consists of a very large number of...while the...are equipped with one or possible small number of...*
* *Additionally, Fig. x shows that... As can be seen in the first...columns of Fig. x, using the...based on..., ...yields poor estimates. In contrast, by simply applying...on...we obtain comparable and even better estimates than the...techniques of...*

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* *As depicted in Fig. x and detailed below, our...technique consists in three main steps: A, B, and C. A. Since..., we first apply our...technique to... This step aims at... In..., ...suffers from...since... As a result, to obtain our first input we perform a... // ...aims at...and is relevant since...tend to... B. ...are used during...in such a way that... They are thus defined based on... C. ...*
* *As can be seen in Fig. x, the...modules integrated with...and...were able to... At each time step, ...would then...and... Upon completion of...timestep, ...would... This allows...to react to...by..., by..., and by... according to... After..., ...would then... until..., allowing...to..., i.e., ...*
* *Fig. x shows a small sample of... To guarantee..., each timestep is signaled by... Using..., ...is able to..., to be represented by... In the example shown...are instantiated at... Similarly...is able to...*
* *Fig. x shows... As can be seen..., which are represented as..., are exactly the same as provided by... The...also shows...*
* *Fig. x presents the...system, which is comprised of three steps: A, B and C. In general, based on..., the...system outputs..., which indicates... Here four parameters are considered as input: a, b, c, and d. Taking...deployment in Fig. y as an example, the...adjacent to...are... The...reflects...A...means... Consequently, this...will...if... The activity of...is defined as...*
* *Fig. x features the comparison between...and... In Fig. x, the left Y-axis represents the number of..., the right Y-axis shows..., and the X-axis shows the number of...in the proposed architecture. For the optimal solution, the number of...represented by the pentagon shape increases linearly from...to...when the number of...increases. It is noticed that the number of...follows a...logic which means that... The mean number of...is...with a standard deviation of... Meanwhile, the...showed as a hexagonal shape increases exponentially when... The...shows that the number of..., represented by the circle shape, increases from...to...when...is reached. The mean number of...is...with a standard deviation of... Concurrently, the..., portrayed by the star shape, increases linearly from…to… The linear regression parameters are…and…, as a and b, respectively, for the solution cost of our set of experiments.*

3.5.3 Functional Description

Figure description often consists of two parts: caption and textual description. In the caption, you can briefly describe the main information delivered by the figure, while in the textual description, you need to specifically explain the functions of the figure.

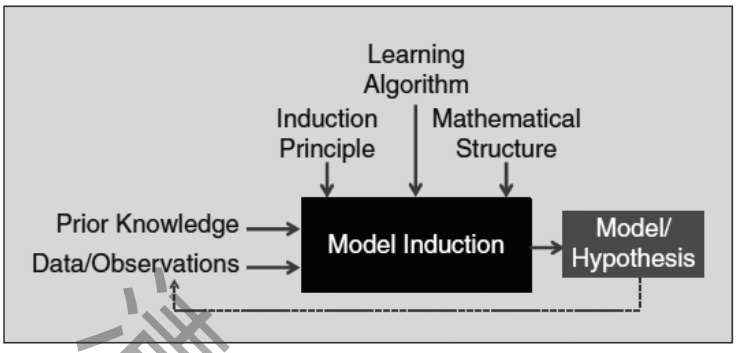

Fig. 3. Schematic presentation of the induction process (with possible feedback cycles) and its "ingredients": Model induction is realized by a learning algorithm that implements an induction principle and operates on the set of properly preprocessed data. Additional background knowledge is incorporated in various ways.

Excerpt	Comment
① As shown in Fig. 3, a typical model induction process requires several "ingredients".	Sentence ① is the overview of Fig. 3.
② In addition to the (training) data D itself, some sort of prior knowledge K is always needed—without any prior knowledge, data is meaningless and learning impossible. ③ In particular, such knowledge is needed to specify a suitable *hypothesis space* H, i.e., a restricted class of candidate models (hypotheses) h. ④ The task of a learning algorithm A essentially consists of choosing a candidate $h \in$ H that appears most promising in light of the data D. ⑤ Mathematically, a learning algorithm, or learner for short, can thus be thought of as a mapping D→H, where D is the sample space (the set of all data sets D the learner may encounter as input of the induction process). ⑥ This mapping is based on an underlying induction principle, such as maximum likelihood estimation or empirical risk minimization.	The main part of the figure description illustrates how this model works. The description starts from the input of the model at the left of the figure (Sentence ②), and then emphasizes the importance of the prior knowledge for model hypothesis at the right (Sentence ③), followed by explanation of how the learning algorithm works at the top of the figure (Sentences ④, ⑤ and ⑥).

(Couso, I., Borgelt, C., Hullermeier, E. & Kruse, R. 2019. Fuzzy sets in data analysis: From statistical foundations to machine learning. *IEEE Computational Intelligence Magazine*, *14*(1): 31–44.)

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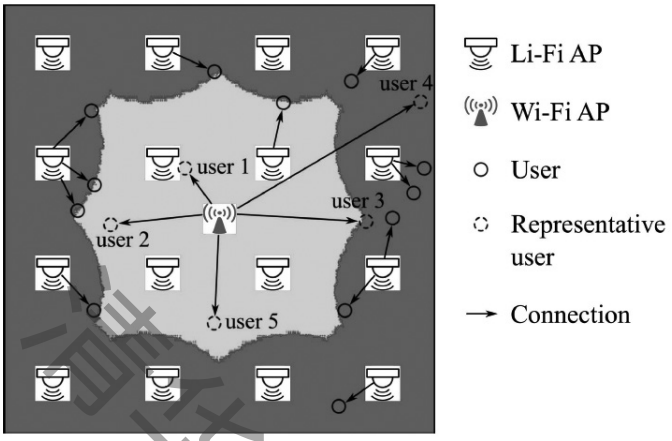
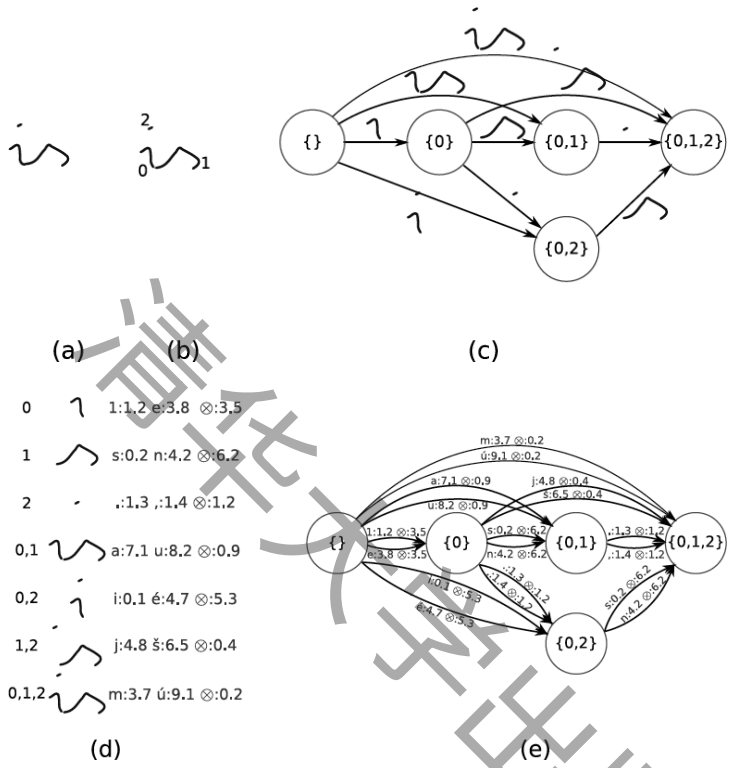


Fig. 3. Representative users for APS in a hybrid Li-Fi and Wi-Fi network.

Excerpt	Comment
① Fig. 3 demonstrates some representative users. Due to the presence of ICI in the Li-Fi network, cell-centre users (e.g., user 1) obtain a much higher SINR and thus a much higher spectrum efficiency than cell-edge users (e.g., user 2). Note that both user 1 and 2 would be connected to Wi-Fi if the SSS is applied. To reach the same data rate, user 2 requires more resource than user 1 if they are both switched to Li-Fi. Hence assigning user 2 to Wi-Fi is better than assigning user 1, though user 1 receives a stronger Wi-Fi signal than user 2 does. User 3 is in a situation similar to user 2, but locates in the field where the Wi-Fi SNR is lower than the Li-Fi SNR. In other words, user 3 is connected to Li-Fi when using the SSS method. Because of receiving a lower Wi-Fi SNR, user 3 has a lower priority than user 2 to use the Wi-Fi resource. However, not all of the Li-Fi cell-edge users should be switched to Wi-Fi. When a user experiences a very weak Wi-Fi signal (e.g., user 4), it would consume a substantial quantity of Wi-Fi resource. Therefore, this user is better to stay in the Li-Fi network in order to avoid draining the Wi-Fi resource. Another case is when the Li-Fi APs adjacent to a user are not in service (e.g., user 5). In this case, the user receives slight interference from distant Li-Fi APs, and thus is better to be served by Li-Fi so as to offload traffic from Wi-Fi.	Sentence ① summarizes the main information this figure provides. The rest of the figure description is developed in sequential order of how each user is connected to Wi-Fi or Li-Fi under different conditions.

(Wu, X., Safari, M. & Haas, H. 2017. Access point selection for hybrid Li-Fi and Wi-Fi networks. *IEEE Transactions on Communications*, *65*(12): 5375–5385.)



Caption	Comment
Fig. 3. Lattice creation: On the input ink (a), we determine cut points and create three segments (b). From the segments, we create a segmentation lattice (c) by grouping adjacent segments in character hypotheses. The character hypotheses are classified (d) and the lattice is labeled (e).	Overview of the figure and the main steps of lattice creation from (a) to the (e).
Excerpt	**Comment**
① Starting from the segmentation lattice (Fig. 3c), we create a multi-graph by adding edges for each potential label for each character hypothesis (Fig. 3e). ② These edges are assigned the classification result for the character hypotheses (Fig. 3d) as a label and the score for that label from the classifier as a cost which is later linearly combined with the other feature functions. ③ The garbage class is treated specially: Each edge is assigned an additional garbage feature function with a value corresponding to the classifier score for the garbage class.	The main part of the figure explains how to operate the lattice step by step, from segmentation to adding edges and then to assigning the edges classification result.

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(Continued)

④ For each character hypothesis we consider the top 20 classification results, thus the labeled lattice will have 20 times the edges as the segmentation lattice and the same set of nodes.	Sentence ④ explains how to get the lattice for each character.

(Keysers, D., Deselaers, T., Rowley, H. A., Wang, L. L. & Carbune, V. 2016. Multi-language online handwriting recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *39*(6): 1180–1194.)

3.6 Language Focus

Passive voice is found being frequently used to describe a process in the Methods section. The focus of process description is usually not on the agent (the person who performs the action), but instead, it is on "explaining how something is done" (Swales & Feak, 2012, p. 120).

Excerpt	Comment
① An experiment is designed to study mobile users' behavior and to develop a statistical model for the orientation of mobile devices that act as the receiver for wireless communication systems. ② During the experiment, 40 participants were asked to use their cellphones normally that create 222 datasets for orientation. ③ They were asked to use the cellphone in both portrait and landscape modes for one minute. ④ The orientation data is measured for both sitting and mobile users. ⑤ In the experimental measurement, the application Physics Toolbox Sensor Suite has been used as it can provide instantaneous rotation angles, α, β and γ. ⑥ This application can be run in the background while the participants can perform activities that ALG distribution.	This description of an experiment consists of six sentences, each of which is about one step in the experimental procedure and is in passive voice. The focus of each sentence is on how the step is carried out, rather than who carries out the experiment.

(Continued)

Excerpt	Comment
① We design an experiment to study mobile users' behavior and to develop a statistical model for the orientation of mobile devices that act as the receiver for wireless communication systems. ② During the experiment, we asked 40 participants to use their cellphones normally that create 222 datasets for orientation. ③ We asked them to use the cellphone in both portrait and landscape modes for one minute. ④ We measure the orientation data for both sitting and mobile users. ⑤ In the experimental measurement, we have used the application Physics Toolbox Sensor Suite as it can provide instantaneous rotation angles, α, β and γ. ⑥ We can run this application in the background while the participants can perform activities that ALG distribution.	Compare this description with the above one. In this active voice version of experimental description, the repetition of the agent "we" does not provide any new information to the readers, because the readers are aware of who carries out the experiment, no matter whether he/she is made explicit in the text or not.

(Soltani, M. D., Purwita, A. A., Zeng, Z., Haas, H. & Safari, M. 2018. Modeling the random orientation of mobile devices: Measurement, analysis and LiFi use case. *IEEE Transactions on Communications*, *67*(3): 2157–2172.)

While reading literature, you may find that not all the process description is made of passive voice sentences. Sometimes, both active voice and passive voice are used.

Excerpt	Comment
① First, the handover cost caused by light-path blockages is considered. ② Users in the category "WiFi only" are not affected by light-path blockages, since they are always served by WiFi. ③ As for the category "LiFi only", data transmission is not available during blockages. ④ Users in the category "LiFi/WiFi" will experience one VHO when a light-path blockage occurs and another VHO when the blockage disappears. ⑤ The VHO overhead is denoted by T_{vho}. ⑥ Let k denote the type of network access. ⑦ The proportion of time that is available for LiFi to serve user u is denoted by $T_{k,u}^{LiFi}$, and regarding WiFi it is denoted by $T_{k,u}^{WiFi}$. ⑧ For different types of network access, $T_{k,u}^{LiFi}$ and $T_{k,u}^{WiFi}$ iare expressed as: ... ⑨ The average throughput achieved by user u is denoted by $\overline{R}_u$, and it can be calculated as follows: ...	Sentences ①, ②, ⑤, ⑦, ⑧ and ⑨ adopt passive voice. Sentence ④ is the only sentence in active voice, because "users" are the focus of this sentence. They are not explicit in the context if omitted.

(Wu, X. & Haas, H. 2019. Load balancing for hybrid LiFi and WiFi networks: To tackle user mobility and light-path blockage. *IEEE Transactions on Communications*, *68*(3): 1675–1683.)

Exercises

I. Please distinguish the three steps in this figure description and summarize the main information of each step.

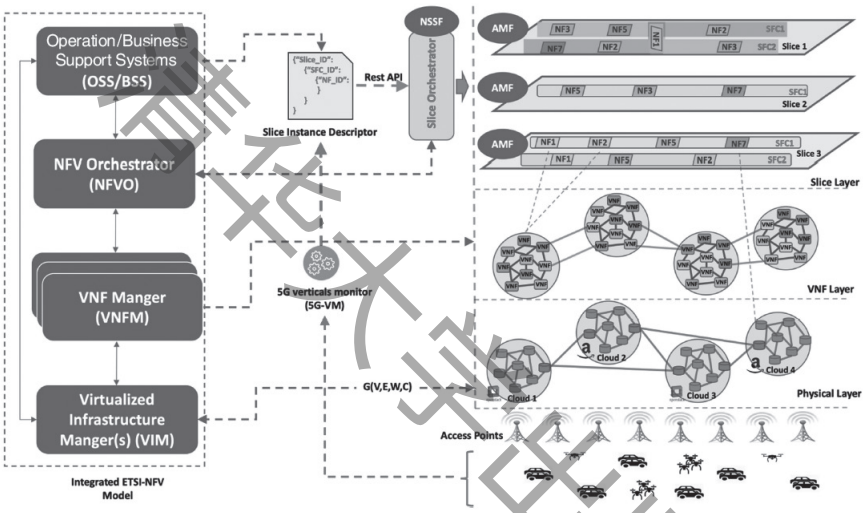

Fig. 1. Global architecture of the proposed solution.

Excerpt	Comment
Fig. 1 depicts the architecture overview suggested in this paper. We have divided the architecture into three layers, as it integrates the ETSI-NFV model and the 3GPP entities to enable the monitoring, selection and creation process of the virtual instances. The physical layer consists of a set of servers and routers. In this layer, the servers are grouped into a set of data centers that communicate between themselves through the physical network. A set of routers would be used as connectors for connecting different data centers. In the NFV model, this layer refers to the NFV infrastructure (NFVI) and would be controlled by the Virtualized Infrastructure Manager (VIM) presented in the same figure. The VNF layer consists of a set of virtual network functions (VNFs) created on top of the servers. Each VNF is dedicated to one or many functionalities during the forwarding of different data traffics. The VNF layer is managed by the VNF Manager (VNFM) that ensures the life-cycle management of all VNF instances spreading over multiple administrative domains. The slice layer, which runs on top of the VNF layer, consists of a set of slices that are dedicated to different services, e.g., health-care and connected cars. The traffic in each slice is routed thanks to service function chaining (SFC), where each traffic in the slice would be forwarded using a predefined order. Each slice is formed by ingress, egress nodes, as	

(Continued)

Excerpt	Comment
well as a set of intermediate nodes. At the reception of different packets at the ingress node, which is also called classifier, the SFC of those packets would be identified, and then the traffic would be forwarded according to that specified SFC. It is noticed that the AMF is considered the classifier in the 3GPP standardization as it is the shared entity between the control plane and the data plane. For instance, in the case of connected car management that belong to the URLLC category, a slice can be comprised of more than one SFC inside a given network infrastructure. While the first SFC could be dedicated to the monitoring and control plane information, the second SFC could be used for applying different management actions i.e., the data plane. In the following work, only the core network, (CN) part is considered, while the radio part was not studied. However, the proposed solution can be also used to deploy RAN slices or RAN/CN slices if the RAN part is an NF on top of the cloud/data-center.	

(Addad, R. A., Bagaa, M., Taleb, T., Dutra, D. L. C. & Flinck, H. 2019. Optimization model for cross-domain network slices in 5G networks. *IEEE Transactions on Mobile Computing*, *19*(5): 1156–1169.)

II. Please distinguish the three moves in this excerpt from the Methods section. This text contains both active and passive voice patterns. Are all of them the right choices?

Excerpt	Comment
In this section the desired evolution of the disturbance-free model (5) will be obtained with the use of a reaching law-based control strategy. In particular, we used a generalization of Gao's seminal reaching law for the case of relative degree two sliding variables since such a strategy has been shown to provide better dynamical properties of the system than its relative degree one equivalent [32]. The considered reaching law is expressed in the following way (12) where $s_m(k)$ is the relative degree two sliding variable (8) and $\varepsilon>0$, $1>q>0$ are the design parameters. The objective of this strategy is to drive the system representative point to a narrow vicinity of the sliding hyperplane and to ensure that the hyperplane is crossed in each step. We obtain the control signal which satisfies these properties by substituting (10) into the left-hand side of reaching law (12) and solving the obtained equation for $u_m(k)$. Then, the control signal has the following form (13) In formerly published literature [32] several advantageous properties of reaching law (12) have been proven. Two of those properties will now be quoted.	

(Latosinski, P. & Bartoszewicz, A. 2020. Model reference DSMC with a relative degree two switching variable. *IEEE Transactions on Automatic Control*. *66*(4): 1749–1755.)

Chapter 4
Reporting Results

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4.1 Lead-in

Answer the following questions.

1. What do you expect to find in the Results section?

2. Do you think the Results section should include the unexpected results?

3. How do you think the Results section should be structured?

A majority of people would like to read the Results section before deciding whether to read the whole article. This is because the Results section is the core of a research article, and all the other sections help explain the results. In the Introduction, the authors provide background information, indicate a research gap in the field and propose research questions or hypotheses that are expected to be answered by the research, and then the Methods section explains what or how the authors do to get the results, which are subsequently presented in the Results section and interpreted and explained in the Discussion section.

The Results section summarizes and reports what you have obtained and observed (Boxman & Boxman, 2020) through the methods mentioned in Chapter 3. It is expected to describe the findings in an objective way.

Despite that this book follows IMRD model, we should be aware that not all journals are strictly structured like this. Some journals would integrate the Methods section and Results section or Results section and Discussion section. For amateur researchers, it is suggested that they fully understand the differences between the Results and Discussion sections and can use the moves and steps in these two sections with flexibility.

In some IEEE journals, the Results section and the Discussion section seem alike at first glance, both with subsections stating the results, figures and tables reporting the statistics, and algorithms proving theorems. However, these two sections serve different functions. The Results section is relatively more objective; to be specific, it mainly serves to report what we have obtained and observed, while the Discussion section tends to focus more on the interpretation of the results.

The key skill for a clear Results section is to “decide what results are representative, and then to organize them in a sequence that highlights the answers to the aims, hypotheses or questions that you set yourself at the beginning of the paper” (Wallwork, 2011, p. 233). The

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Results section is usually structured in a logical sequence, such as a chronological sequence of the results got from the previous method, or a hierarchical order. A hierarchically ordered section places the results according to their relative salience, such as from general to specific, whole to part, and so on (van Dijk, 1977).

Based on Basturkmen (2009), Glasman-Deal (2009), Kanoksilapatham (2005; 2015) and Wallwork (2011), a Results section in IEEE journals can be composed of three basic moves, and there are a few steps within each move:

- **Move 1: Contextualizing results**

  Step 1 Providing background information

  Step 2 Listing procedures or methodological techniques

  Step 3 Stating research questions or hypothesis

  Step 4 Describing aims and purposes

  Step 5 Referring to previous research

  Step 6 Summarizing main results

- **Move 2: Reporting results (obligatory)**

  Results shown by figures or tables.

- **Move 3: Summarizing results**

  Step 1 Instantiating results

  Step 2 Invalidating results

4.2 Contextualizing Results

In the beginning of the Results section, you can state the overview of the research purposes, questions, hypotheses or methods. By briefly reviewing what you have done in the previous sections, you are getting prepared to fill the research gap and solve the research problems with solid statistics or evidence.

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4.2.1 Providing Background Information

You can provide some background information about your methods in the beginning of the Results section. For example,

Excerpt	Comments
① We perform Monte-Carlo simulations to evaluate the proposed techniques. ② The one-stage nML detector is based on Algorithm 1 with a termination threshold and step size $k = 0.01$. For the two-stage nML detector, we let the constant $c = 1.3$ in (38). ③ We first consider the single cell scenario to compare detector performance. ④ Then we take the multicell scenario into account.	The authors review the methodology and some parameters used in the research in Sentences ① and ②. Sentences ③ and ④ briefly introduce the two scenario that will be presented in the Results section.

(Choi, J., Mo, J. & Heath, R. W. 2016. Near maximum-likelihood detector and channel estimator for uplink multiuser massive MIMO systems with one-bit ADCs. *IEEE Transactions on Communications*, *64*(5): 2005–2018.)

The following sentences can help you to write a brief beginning of the Results section:

* *In this section, we discuss the performance of...through a series of experiments conducted with...data whereby... We first investigate... Then, we investigate...and... using...*
* *In this section, we present the experimental framework used to test our approach and the corresponding results. First, we analyze... Then, we present...*
* *We perform...simulations to evaluate the proposed techniques. The...detector is based on Algorithm x with... For the...detector, we let... We first consider the...scenario to compare... Then we take the...into account.*
* *In this section, we first perform a comprehensive validation of our...approach introduced in Section x. Then, we compare our...technique with the existing specialized...techniques. Finally, we prove the utility of our approach for applications such as...and...*
* *In order to verify the properties of the proposed..., an inventory system with...were performed.*

4.2.2 Listing Procedures or Methodological Techniques

You can also provide detailed information about the apparatus, experimental parameters that are important for your readers to re-generate the experiment and results.

Excerpt	Comments
Experimental Results We now evaluate our illumination, albedo and surface height estimation methods on both synthetic and real data. We implement our methods in Matlab and run experiments on a MacBook Pro 2.7 GHz with 16 GB RAM. To construct and solve the linear system of equations required to estimate surface height takes around 1 second. The alternating optimisation to estimate illumination also takes around 1 second. Albedo estimation is the most computationally expensive part of our method, with the nonlinear optimisation taking around 20 seconds.	After building models for estimating surface height from a single polarization image by a large sparse system of linear equations in the previous few sections, the Results section describes the devices used to conduct the experiments. The first paragraph provides details about the parameters to re-generate the experimental results.
For synthetic data, we render images of the Stanford bunny with a physically-based reflectance model appropriate for smooth dielectrics (Fig. 6a). For diffuse reflectance we use the Wolff model. For specular reflectance we use Fresnel-modulated perfect mirror reflection. We vary the light source direction over and We simulate the effect of polarisation according to (3), (6) and (43) with varying polariser angle, add Gaussian noise of standard deviation, saturate and quantise to 8 bits. Illumination is modelled as a dense aggregate of 1,000 point sources, distributed around **s**, and we aggregate the polarisation fields over these sources. We estimate a polarisation image for each noise/illumination condition and use this as input.	Then in the second paragraph the authors describe several different models used for different data.
In order to evaluate our method on real world images, we capture two datasets using a Canon EOS-1D X with an Edmund Optics glass linear polarising filter. The first dataset is captured in a dark room using a Lowel Prolight. We experiment with both known and unknown lighting. For known lighting, the approximate position of the light source is measured and to calibrate for unknown light source intensity and surface albedo, we use the method in Section 5.4 to compute the length of the light source vector, fixing its direction to the measured one. The second dataset is captured outdoors on a sunny day using natural illumination.	In the last paragraph, the authors describe how they verify their method. Through these three steps, we would expect to find whether the results can prove their models in the following section.

(Smith, W. A., Ramamoorthi, R. & Tozza, S. 2018. Height-from-polarisation with unknown lighting or albedo. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *41*(12): 2875–2888.)

We can use the following sentences to list the procedures.

* *In this section we present the numerical results obtained through... For comparison to..., we assume a...scheme where...*
* *The methodology presented in Sections III and IV was implemented to... The experimental setup is based on... Using..., we were able to...// ...were preprocessed using... The machine was studied as a...by considering... The model was developed using a combination of...and...described in Fig. x. The validity of the model was evaluated by...*
* *In Sections II and III, we have assumed that... However, ... Fortunately, state-of-the-art...present a...which is... Consequently, assuming...does not significantly bias the estimation performance. Should the...be..., ...can still be applied using...on...*
* *In the research, three different test categories comprised by different types of content were defined: The...category, consisting of...and...content, the... category and the...category. Moreover, two sets of...were defined. A x case, denoted as x set 1, and a y case, denoted as y set 2. For the x case, ... For the y case, ... Our model was tested against two anchors, the first one being the...anchor and the second one being the...anchor.*
* *All the scripting for the model has been done using...running on Intel...CPU...GHz with...GB RAM. The details about the datasets employed, performance parameters and the existing state-of-the-art models are given below.*
* *We evaluated our...method on... We first defined...as described below (see Section x-1) and tested various features extracted from...as described further below (see Section x-2) before conducting our main experiments.*
* *We now evaluate our...and...methods on both synthetic and real data. We implement our methods in Matlab and run experiments on...(device). To construct and solve the...equations required to...// ...is the most computationally expensive part of our method, with the...taking around...seconds.*
* *For the experiments presented in this section we used a selection of data sets with... Among the data sets used are the...data set [reference], data sets of randomly sampled data of different dimensionality, data sets of...features of different sizes obtained by sampling from the...data set as well as a data set of...features extracted from...*
* *Firstly, to characterize the...of our proposed...solution obtained using Algorithm x, we compare its performance with the optimal solution obtained by the...method, and then with the three other described baselines. Since the...method..., it is...; hence, we carry out the comparison... We randomly generate...*
* *Several...experiments have been performed...(condition) to collect estimate...parameters and to compare the results from the simulation. The experiments include the following parameters...*

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4.2.3 Stating Research Questions or Hypotheses

You can restate the research questions or hypotheses you have raised in the Introduction. The following sentence structures can help you to organize this step.

> * *Since our model is data-driven and..., and given the abundance of datasets, we wanted to answer questions such as..., ..., and... As a result, we performed experiments on...number different datasets, explained in Section x, which enabled us to understand our model in depth.*
> * *Typically, the first question considered when dealing with...concerns...*
> * *Our hypothesis is that...can be tackled by... Moreover, ...could help obtain better results by... More experimentation is needed to validate these hypotheses.*

4.2.4 Describing Aims and Purposes

You can also restate the aims or purposes of your research in the beginning of the Results section to keep reminding your readers of what you are doing and why you are doing so. The following sentence structures can be signals to your readers about what you are going to present.

> * *Our final purpose is to obtain a...that... We compared our method with previous methods that can...[references]. We used...to train..., and...to evaluate...performance. We determined...as the...value of...in (algorithm) by 2-fold cross-validation. All the...methods used in our comparison used...as an initial state.*
> * *The objective was to..., i.e., to... To solve..., we used... The covariance x of the initial state was...allowing each angle to be off by about y degree.*
> * *The goal of our experiments is to validate the theory, by showing that..., and that by adapting...to...we can better exploit architectures of... To this end, we first compare...with...on several standard benchmark datasets using different networks architecture, and highlight a few key properties.*
> * *To test the effect of the...to model the...as in (algorithm x) in Section x, we compare the results of the...solution to calculate...using the...expression versus using the...expression of...*
> * *To investigate the performance of the proposed framework presented in Section x, ...have been conducted using...software, i.e...*

4.2.5 Referring to Previous Research

You can bring about your results by briefly comparing or contrasting with previous research, for example:

> * *Many papers have shown that...[references]// ...is a difficult task, one of the main*

challenges being the impossibility of...For example, ...// ...is even more problematic for...used in [references]. When dealing with..., possible solutions include...

* *...has been used in the literature with good results [references], however, it can be challenging to... In...we used the approach of...*
* *...is used in a large number of both research and industry projects (e.g., [references]) and is widely used in..., in part due to...// ...also is used by other well-known open-source projects, such as...[references].*
* *While...give insight into..., they usually do not provide guidance to practitioners for... More relevant for practical applications are research efforts that aim at...[references] have shown that...*

4.2.6 Summarizing Main Results

It is also a good choice to summarize the main results at the beginning of the Results section.

Excerpt	Comment
We demonstrated the data proxy's utility in maximizing data richness and reducing resource use in the context of our IoT architecture by optimizing the QoD for a target cost and optimizing the cost for a target QoD. Further, we showed that the optimal sampling arrangement varies with sensor costs and QoD type.	The authors briefly introduce what they have done and what results they have obtained.

(Siegel, J. E., Kumar, S. & Sarma, S. E. 2017. The future Internet of Things: Secure, efficient, and model-based. *IEEE Internet of Things Journal*, *5*(4): 2386–2398.)

You can refer to the following sentences to summarize your results.

* *This section presents the results of the experimental evaluation of the proposed...detection model across different case studies.*
* *This section summarizes the...test results. It also provides an analysis with a focus on a comparison with the...test results.*
* *In this section, we present the numerical results of our algorithms detecting...in Section x-C.*
* *We demonstrated the utility of...in...in the context of our...architecture by... Further, we showed that...*
* *In this section we show...achieved with different...when... In particular we compare our results with the performances we achieve: a) with...and b) with...*
* *In this section, the parameters of...models are computed using... Subsequently, we present experimental and simulation results to show...*
* *In this section we are going to analyze the results obtained with our approach by comparing them with an exhaustive experimentation to determine... In the exhaustive search we used...*
* *This section is divided into 3 different parts. First, we describe how we... Second, we*

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compare our approach with...methods. Third, we evaluate the performance of...

* *To better show the potential of...we perform... We first evaluate the...in Section x-A. Afterwards in Section x-B we discuss the..., the...and the throughput performance in... Finally, in Section x-C, we consider the scenario of...*
* *In the following, we demonstrate the advantages of...and...based on... In particular, we evaluate the effects of...// ...is analyzed in two scenarios: a...versus a... The...results clearly outline...*
* *In this section we will extensively evaluate our...algorithm. We both compare it to other...methods, as well as evaluate the effect of important design and parameter choices. We use three datasets for evaluation...*
* *...results are presented to evaluate the performance of our proposed...strategy, referred to as...*
* *In this section, we first validate our...results using...simulations. We consider a network with... In Fig. x, we plot the...for the...scheme. We observe that... Also note that Fig. x matches with our...illustration of...in Fig. y, which plots the...in Theorem x, and the...in Theorem y.*

4.3 Reporting Results

Reporting what you have found is the main function of the Results section. It is the only obligatory move in this section (Williams, 1999), as it states the main findings or results that this research has revolved around.

The results are usually organized from general to specific. You can make a claim about the overall results in the beginning, and illustrate the specific results one by one. You can also start from the most important findings or the results that underlie or lead to the more important ones (Glasman-Deal, 2009).

Usually, you can just state your results directly, or you can use some cue words or sentences to remind your readers as the following.

Excerpt	Comment
Two illustrative examples are presented in this section. In both cases the differential game corresponding to the problem associated with the agents is solved using Theorem 2 and for the collision avoidance functions (6) the parameter c=1 has been used.	The authors simply present the main findings of the two examples.

(Mylvaganam, T., Sassano, M. & Astolfi, A. 2017. A differential game approach to multi-agent collision avoidance. *IEEE Transactions on Automatic Control*, *62*(8): 4229–4235.)

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* *Results show...*

* *This section provides performance results for... Individual results for the new features of..., and...are first reported. Then, ...and...are compared as a whole with respect to..., and... This is done by comparing a realization of..., and a model of... In this model, ...has been extended in a straightforward manner to deal with...*

4.3.1 Results Shown by Figures or Tables

The results are usually presented in the form of figures or tables. You need to describe these figures or tables by summarizing the main information, indicating changes, or making comparison and contrast.

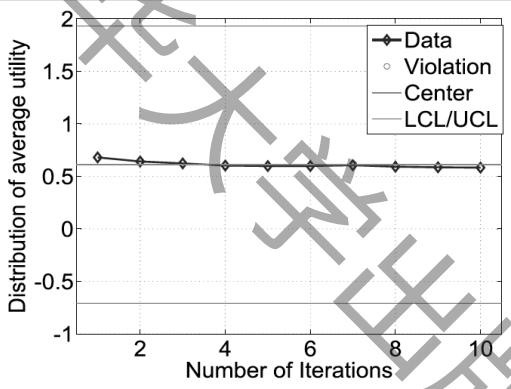

Fig. 10. Normalized average utility of the associations for D = 50.

Excerpt	Comment
①Fig. 10 shows the control chart of the utility distribution of the associations in the proposed AHP based matching approach, where the utility is well-balanced, and there is no violation, and the normalized average utility of the associations at each iteration is close to the central line. ②At each iteration, the IoT device density at each Fog device increases and when the IoT device density is much lower, the performance gain in terms of utility is quite higher than the average line and tends to upper control limit (UCL). ③As the IoT device density in the network increases (i.e., $\|D\|$) the normalized average utility per Fog device slimly tends toward lower control limit (LCL) which is expected due to externalities. ④However, none of the distributions violates the upper (UCL) and lower control limit (LCL) despite the negative effect of externalities at higher IoT device density.	Sentence ① is a summary of the key information in Fig. 10. Sentences ② and ③ describe how the different schemes change according to the number of iterations. The description focuses on the trends of changes. Sentence ④ is the interpretation of the results. It also serves as a summary of the results.

(Abedin, S. F., Alam, M. G. R., Kazmi, S. A., Tran, N. H., Niyato, D. & Hong, C. S. 2018. Resource allocation for ultra-reliable and enhanced mobile broadband IoT applications in fog network. *IEEE Transactions on Communications*, *67*(1): 489–502.)

The beginning of a figure/table description usually contains "a location element and a brief summary of what can be found in a visual display of information" (Swales & Feak, 2012, p. 147). For example, *Table x summarizes the results of different schemes with different variables*.

A location element can guide your readers through reading, especially when they need to combine your text with the visual display. The first sentence in a figure description serves as an orientation as well as an overview of the figure.

Excerpt	Comment

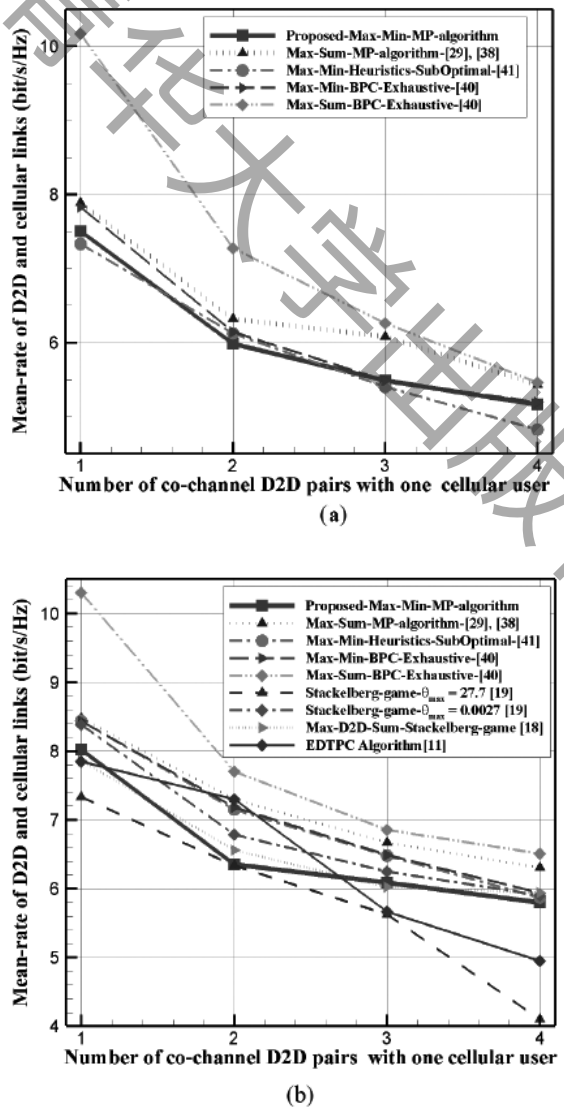

Fig. 4. Mean-rate in terms of the number of co-channel D2D pairs for TDU=2, 4 per RDU. (a) For TDU=2. (b) For TDU=4.

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(Continued)

Excerpt	Comment
① The results are depicted in Fig. 4 in terms of the number of co-channels D2D pairs with cellular user and 2 and 4 TDUs for each RDU. ② Clearly, the system mean-rate decreases by increasing the number of co-channels D2D pairs. ③ Since the interference of D2D users imposed on the performance of cellular users is limited and QoS requirements provided by the cellular users are met, increasing the number of D2D pairs maximizes the spectral efficiency and consequently the network sum-rate. ④ Moreover, increasing the number of TDUs for each RDU in order to make more choices, increases the network mean-rate as well. ⑤ As a general rule, the achieved mean-rate of the proposed max-min MP algorithm is less than that of the max-sum MP algorithm and the max-sum BPC exhaustive search. ⑥ However, it converges to the result of the max-sum algorithm by increasing the number of co-channels D2D pairs with a smaller slope compared to the max-sum algorithm. ⑦ The reason is that the purpose of the max-sum problem is to maximize the sum-rate of the whole network and it does not concern individual users, while the max-min problem searches the best answer for the case all users' rates satisfy a minimum value constraint and that value would be maximized. ⑧ Consequently, the performance of both algorithms leads to the same result by increasing the number of active users. ⑨ On the other hand, the proposed MP algorithm achieves 90% of the max-min BPC exhaustive search performance in the worst case and about 97% in the best case by reducing the order of complexity from $O(N^4L^N\log(NL))$ to $O(N^2L2K^2))$. ⑩ It almost achieved 100% of the max-min heuristics algorithm in the best case and 92% in the worst case by reducing the order of complexity from $O(N^3L^3)$ to $O(N^2L^2K^2)$. ⑪ Both of these compared algorithms are binary while the proposed algorithm works on K-ary values. ⑫ Therefore, in the average 6.5% loss is negligible compared to the above-mentioned complexity reduction that the proposed algorithm attains in comparison with the centralized schemes. ⑬ In comparison with the two other distributed game-theoretic schemes, it is clear that the performance of our proposed scheme is close to both works in [18] and [19].	Sentence ① contains a location element and a summary of the figure. Sentence ② presents the most significant result, and it begins with "clearly" as a signal. Next, an explanation of this result is given in Sentences ③ and ④. Sentence ⑤ moves to another aspect of the results by stating a general rule, followed by some supplementary information in Sentence ⑥. Then, this result is explained in Sentence ⑦, which leads to further results in Sentence ⑧. Sentence ⑨ is signaled by "on the other hand", which indicates a different aspect of the results. Then Sentence ⑩ provides more details, followed by an inference in Sentences ⑪ and ⑫. Sentence ⑬ makes a comparison of the proposed scheme with other schemes and makes a claim about the result.

(Continued)

Excerpt	Comment
⑭ However, the convergence of our proposed scheme is guaranteed and the power allocation is fair, compared to the two other schemes; these schemes try to keep the performance of some users near to the QoS level and this leads to achieving a Nash-equilibrium point which is far from the optimality. ⑮ The other challenge of these schemes is the determination of the optimal pricing factor. ⑯ The EDTPC algorithm proposed in [11] also has almost the same performance compared to the proposed max-min MP algorithm, while it is more sensitive to the number of co-channel users and minimum SINR threshold.	In Sentence ⑭, the authors make a positive evaluation about their proposed scheme after the detailed description above. Then, this claim is supported by the evaluation of other schemes in Sentences ⑮ and ⑯.

(Rashed, S. K., Asvadi, R., Rajabi, S., Ghorashi, S. A. & Martini, M. G. 2020. Power allocation for D2D communications using max-min message-passing algorithm. *IEEE Transactions on Vehicular Technology*, *69*(8): 8443–8458.)

From the above examples we can see that a figure description has a clear structure like this: general→specific→general. In the beginning, a location statement and summary of the main findings or the key information in the figure is necessary. This is the most general claim made through the observation of the figure, and needs to be supported and expanded with details in the following sentences. While developing the claim, details about the data are needed. These details are organized according to some logical orders such as cause and effect, compare and contrast, etc. More structures of figure description can be found in the following sentences:

* *Results for...and...tasks are summarized in Tables x and y, respectively.*
* *Table x shows...for each method, and we highlight in bold the best-A and best-B method between...and..., and between...and... A sample visual result is shown in Fig. x.*
* *The results in Table x illustrate. // ...is added...with a...that... For..., we input... The... can handle..., which... It outperforms...on..., whether...*
* *The...presented in the previous sections is summarized in Table x in terms of...for the...configurations.*
* *For..., we use...for...// ...is simulated and added to...before running it through a...method. // ...results are reported in Table x.*
* *The performance of...is tested by...(method). Table x compares...and... cases. Positive numbers show... For the...configuration, ...shows an average...gain of x%. Since...is applied only to..., the gains are lower for the configurations that... For..., the gain is y%, and for..., which..., the gain is z%.*

* *The…are summarized in Fig. x. These results clearly demonstrate…, as well as...This...is due to... This might raise the question of..., on the other hand... We will use this question as an example of how to take the presented...one step further, ...*
* *In order to examine the impact of..., we measured... This measure is often used in the context of...as it describes... Figs. xa and xb show the results of this evaluation for...and..., respectively.*
* *Fig. x shows... As expected, ... Increasing...does not change... Thus, it may not be necessarily suitable to..., as it does not directly improve...while it may degrade... Fig. x also shows that... Therefore, ...*
* *Fig. x depicts..., where the number of...is...and the number of...is... The...is growing exponentially where... Therefore, we consider a...for comparing our proposed approach with...*
* *Fig. x shows our...results, the...values, along with...results. The...is created by fusing the...with the... The fusion is carried out by...step and... As in practical scenarios, the...outputs are clipped to..., as are the... Our results better remove...compared with..., and details are better reconstructed over the...content. We note that, at...levels, there is a...effect, which creates... These are created by..., but are more salient in our result...as it is... The higher..., the larger... This makes...vary from...to..., randomly, and causes..., rather than a linear one, which is modeled by...*
* *The...results for each category of...are shown in Fig. x in the form of... The...are also plotted on the same graph using a second vertical axis. Note that the scales for the two vertical axes in these plots are independently selected, and thus no direct connection between the...and...plots are demonstrated.*
* *The results are depicted in terms of...and...in Figs. x(a) and x(b), respectively. It is clear that... In Fig. x(a), a...relation is seen between... and... However, by increasing..., ...decreases. Thus, the trade-off between...and...is obvious in Fig. x(a). On the other hand, the results confirm the fair performance of the proposed...algorithm which... The fairness performance is better compared to...which... In Fig. x(b), the difference between...and...increases with... This result shows the effect of...in the context of...*

Usually, you will have more than one figure or table that should be arranged in the most logical order for your readers, and each figure or table should contain some key findings and the supportive details. The results should be able to support your hypothesis or answer your research questions you raised in the Introduction (Wallwork, 2011). Then you can leave the other results in the next subsection.

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4.4 Summarizing Results

Apart from the obligatory report of main findings, you can also interpret your results with more details.

4.4.1 Instantiating Results

You can point out what your findings have proven, how they support your hypotheses or answer your research questions, with the following sentences.

* *We have assessed..., showing that... In addition, we have been able to...by... This hints in the direction that our design requirement for parallelization is met.*
* *In Section x, we show that..., for some..., such that the...is achieved. The proof of this result involved proving that... In practice, for..., we have to decide on a tradeoff between...and... In particular, we can..., and then...*
* *The robustness of the proposed...is verified in two different scenarios, namely, ...and...*
* *Our approach achieves a good performance in terms of...*
* *First, we discuss the effect of...upon the proposed... On the one hand, if..., ... On the other hand, if..., ... In this paper, the...parameter is selected to lie within the range..., and the proposed...with...has essentially consistent estimation performance and higher estimation accuracy than existing..., as shown in the later simulation. Second, we study the effect of the...upon the proposed...*
* *In this paper, the…parameter and the…factor are selected to lie within the ranges...and...respectively based on the above discussions. The recommendations regarding parameter ranges are specific to the...study presented in this paper, and perhaps other parameter ranges are more appropriate in other situations. Fortunately, our experience has indicated that the proposed...with the suggested parameter ranges exhibit good estimation performance in many contexts.*
* *The losses caused by...in...scenarios are almost negligible, as we can see in Fig. x. In particular the figure shows that the...approach is characterized by...for..., but it starts to achieve similar or better performances than the...for both...and... If we apply the...according to the...approach, then performances increase greatly for both algorithms, arriving to almost optimal performances with the...*
* *It can be clearly seen that the difference in...and...between...and...is small. On..., this gap is further reduced and the performance is approximately the same. Moreover, the...increases the computational complexity for... It is worth noting that...*
* *Our analysis in this paper is based on...assumption. To better understand the utility of*

this..., we compare the...with...whereby...

* *As for all...methods, the predominant cause of failure is...in the form of..., since... This issue is amplified since... In contrast, ...allows to..., and thereby...*
* *We explain this behavior as follows: Assuming that..., ...is required to... However, when..., for example, leads to.... Therefore, ... Effectively, ...and...goes hand in hand with...*
* *We have seen that both...methods have pros and cons... // ...requires more computational resources than..., but... The reason why...did not reliably succeed in...is that..., which is largely a result of..., an example of which is given in Fig. x.*

4.4.2 Invalidating Results

Sometimes, you would get results that are out of your expectation or you may have encountered some difficulties or problems. How to deal with the unexpected results or problems is also one part of results interpretation. You are not supposed to just ignore those unwanted results or problems unless you are sure that they are insignificant. Failing to mention those unexpected results or problems may suggest that you are not professional enough in the field to identify and explain those results. In addition, mentioning them provides you an essential element in the Discussion section: directions or suggestions for future research (Glasman-Deal, 2009).

You can use the following sentences to justify your explanation about the results.

* *As discussed in Section x, the different...specifications, e.g., ...and..., may have a direct impact on... Indeed, as previously mentioned, different...may change how the...is perceived and introduce different... Thus, it is critical that during...experiments, researchers specify both the...and the... Moreover, there is still a lack of...studies that allow researchers to better understand the impact of the...features on the...assessment.*
* *Results presented for the…models in the previous subsections were obtained employing… The performances of…are reported in Table x…does not fail but consistently performs worse than... This suggests that... The results do not provide enough evidence for... This might suggest that... Note that... might affect...as well, thus, ...*
* *As shown in Fig. x, neither...nor...perform well, because the former ignores...and the latter fail to...*
* *From the visual results in Fig. x, we see that…do not manage to generate convincing...results about... These models fail to...*
* *One interesting aspect to notice in Table x is that for problems with..., the heuristic seems to fail when...*
* *We have not observed significant..., likely due to...*
* *The proposed...model will fail when...*

4.5 Language Focus

4.5.1 Dealing with Graphs

In most cases, IEEE journal articles present their results in figures, graphs and tables. We can use both nouns and verbs to describe the changes, and also use some adjectives and adverbs to modify the extent and speed of the changes.

1) Describing Changes

One important element that can be visualized is the trends, such as the changes of results or the effects of changing different variables on the results. Different expressions to describe changes can be seen in the following sentences:

* *The rate of...increases by increasing...*
* *Fig. x shows that increasing...may increase/decrease...probability, depending on...*
* *For..., increasing...improves...*
* *If we apply..., then performances increase greatly for...*
* *With every (1 m/s) increase in speed, the gap between the proposed method and...increases by about x%.*
* *The results plotted in Fig. x show clearly that...increases linearly along with...*
* *As...increases, ...become more (comparative)...*
* *The further we increase..., the larger is the performance gap between...and...*
* *We observed that, by reducing..., we increase...*
* *Additionally, if we increase the number of..., then we get...as can be seen from Fig. x.*
* *Fig. x. presents the improvements in…as the number of…are increased in the proposed...scheme. It is shown that with this increase, the number of...increases and this also provides a better...due to...*
* *We observe that...also follow the similar trend, i.e., they increase with...and decrease with...*
* *When...increases from...to...in the case of..., ...drops from...to... Meanwhile, ...has a decrease of x% in..., and...has a decrease of y%.*
* *The (green) dots in Fig. x show...; they decline almost linearly relative to...*
* *This...is expected to continue to decline as...*
* *As shown in Fig. x, ...suddenly drops when..., which indicates...*
* *We also observe significant jumps in...when...*
* *The increasing..., combined with..., leads to an increase in terms of...*
* *Noteworthy is the steep increase in...*

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* *The rate of...is smaller than...*
* *Fig. x plots...and shows a monotonic increase of...*
* *For..., we see a polynomial increase of...*
* *The slight increase of...is expected due to...*
* *Fig. x shows the estimated..., confirming the drop in...*

2) Describing Extent of Change

You can also use some adjectives and adverbs to describe the extent of changes, for example:

* *Given that the field has seen significant advances in the last years, we do think it is more meaningful to report..., which...*
* *For..., increasing the density of...might lead to a significant decline of...*
* *The top plot in Fig. x shows that a substantial decrease in...is experienced by ...*
* *As can be seen in Fig. x, for..., ...do not introduce a significant degradation in quality, while...is observed.*
* *We also observe significant jumps in...when...*
* *After sufficient number of samples, there is no further significant reduction in the gap between...and...*
* *This also explains the huge increase in...by...*
* *Noteworthy is the steep increase in... for..., illustrating that...*
* *From the figure, we can see that...provides substantial gains over...*
* *This causes a very slight decrease in...because...*
* *In Fig. x, we observe a very small increase in...*
* *We see the biggest increase in the average...scores when...*
* *When...is too large, it prevents...from..., jeopardizing...and causing a drastic increase in error.*
* *For..., we see a polynomial increase of...in...*
* *As shown in Fig. x, the proposed method can significantly increase...over..., especially for...*
* *With our default search set..., ...nearly always succeeds for..., then drops sharply to...*
* *It is evident from the figure that...considerably reduces...*
* *...considerably improves...*
* *...started from x and largely increased as...*
* *In..., using...could dramatically increase...with minimal loss in...*
* *The...error of the...model parameters decrease monotonically with the number of...in Fig. x.*

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3) Describing Speed of Change

You can also use some adjectives and adverbs to describe the speed of changes, for example:

* *It is worth noticing how...obtained by...rapidly decrease with the number of users in the scenario, because of...*
* *As shown in Fig. x, ...suddenly drops when...is from x to y, which indicates...*
* *...size was extended progressively from x to y, and for each scenario...were gradually increased from x% to y%.*
* *It is seen from... that the effect of...on is gradually reduced as...increases.*
* *The results plotted in Fig. x show clearly that...increases linearly along with the number of...*
* *We proposed a...strategy to gently change the...process.*
* *This may be considered a moderate loss when compared to...*
* *The effect of...may be modeled as a slow large-scale fading effect since...*
* *Regarding..., we observe a quick increase concerning...*
* *...allows a steady reduction in...and enables...*

4) Describing Approximation in Changes

Sometimes we can use approximation expressions to describe values, numbers that are not an integer or close to a certain number.

* *...is nearly constant above x, showing that...*
* *Table x shows that on average, the...method reduces...rate by approximately x%.*
* *Compared with..., ...of our scheme is approximately x%–y% lower.*
* *Our scheme shows approximately the same performance as...and is up to x% better than...*
* *We find that the...approaches achieve accuracies nearly identical to those achieved by..., showing that...*
* *...almost triples the run times shown in Fig. x.*
* *Performance was even better for..., where almost a quarter of...*
* *For..., ...and...have almost the same performance at (condition)...*
* *The data convincingly show that the...is achieving...that is at least x%.*
* *For..., a value close to x indicates...*
* *For..., the...effect degrades the...performance by about x dB.*
* *...made the...swing in a radius of about x cm.*
* *The covariance x of the initial state was...allowing each angle to be off by about y degree.*

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* *...achieved about x percent success on average.*
* *Both...yield predictors of...with accuracies over x%.*
* *We construct…feature data set by randomly sampling a data set of over x million...features extracted from...*
* *As can be seen, ...ratios in the...scenarios always remained under a tolerable x% loss, which means...*
* *Where there are more than x users, the proposed method achieves the highest throughput.*
* *Comparing to Fig. x, where the...is less than about..., the...from Fig. y is about...*
* *It is advisable to divide...into groups of..., each with fewer than x...*

4.5.2 Compare and Contrast

While reporting results, we always need to compare and contrast either with previous research, or within your results.

* *We present...tests on different...datasets, and compare the results of...and of...*
* *Compared to..., ...was faster when using a...approach.*
* *We compare in Figure x the...obtained using our...scheme (Figure x-a) and the other methods (Figure x-b, c, d).*
* *If we compare the reported results to the results in Table x, we see that most methods achieve consistently higher...as...gets smaller. // ...is very competitive and achieves clearly the best performance among all tested methods for the...task.*
* *In terms of..., the results are similar as in the previous section: The...architecture results in..., while the...contribute towards...when measured through...*
* *As seen in Table x, our...approach improves the...at...level starting from..., which includes... Comparing…and…, we also note with our approach an improvement of... We outperform...by an average of...with our version trained on...levels and we perform...when... Comparing the results of...and of...in Table x, for..., we see that... The improvement of...is consistent with that obtained in our...experiment in Table y.*
* *The...allows all methods to perform significantly better in terms of...on...compared with...*
* *In Fig. x, a comparison between...and the proposed...is illustrated when...*
* *Similarly, ...can be...along similar lines.*
* *The proposed method is also compared with the existing methods which handle...in Table x. It can be seen that the...model outperforms other methods for...// ...and... methods solve only...issue. This is why, not applicable (N/A) is mentioned in table for 0.1 amount of uncertainty.*

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* *One of the key advantages of x as compared with y is that... This is due to the fact that..., while y just...*
* *While the result of the previous section shows that the proposed...provides..., it is only compared against...and thus does not... To this end, we compare the performance of...against...which work as follows: (i)..., and (ii)...*
* *The predicted...from the proposed method are compared with...using three evaluation indices..., ...and...*
* *In this section, we validate that our...method is more effective at...compared with..., and that our...further improves the performance via...*
* *Unlike...that works on..., ...and...using...and in the...domain respectively. We...for a fair comparison.*
* *Fig. x shows that our method produces more accurate...than a, b and c. It is interesting to see that our method achieves equally good quantitative results with..., but...leads to...*
* *Fig. x shows that our...method achieves higher correspondence accuracy compared with...and...on the...testing set. The consistent improvement from...to...indicates that...*
* *Furthermore, comparing Figs. x and y, we notice that...are significantly...than... This shows that our strategy...*
* *Fig. y compares...and... This figure shows that the results are more...due to... Note that...*
* *We compare the...model with...state-of-the-art...models, i.e... [references]. Since some of these models were introduced for...problems, we retrain all models on the...dataset and use open-source implementations of the authors (where available) for a fair comparison.*
* *To highlight the benefits of our...approach over...methods we also consider the...measurements used in Fig. x and compare our approach to the classical...method (see details in [reference]). This approach is chosen as it is the best...method which... Although the comparison could have been performed using...and more advanced methods, the competing methods would have led to significantly higher...costs. To apply the..., we first...*

4.5.3 Describing Sequences

To make sure that your readers could follow your description of methods and also compare their results with yours, you should be able to precisely describe the time and order sequence of what you did and found (Glasman-Deal, 2009). You can use the following sentence structures.

* *At the beginning of..., the proposed...algorithm runs...*

* *The average...between...and...is relatively close at the beginning when...*
* *X reduces Y. Y is then...*
* *In particular, we can set..., and then compute...*
* *The master server...and then...*
* *A...study was first mentioned in [reference] and then presented in [reference].*
* *First, these sensors are placed at... Subsequently, these sensors are moved to...*
* *The...dataset is customary used for... only after...*
* *After...was detected, ...was used to...*
* *The effects of...became noticeable after...*
* *The initial work on...has been driven by..., with the aim of showing that... After this initial phase...*
* *With time, ...degraded and as soon as it reached..., ...was initiated.*
* *...operation starts as soon as...is over.*
* *In particular, it is interesting to notice how...is accomplished while providing at the same time higher efficiencies.*
* *...was computed for...prior to starting...*
* *...is presented in Fig. x, where initially the...value was...*
* *For..., we assume... Later, we evaluate...*
* *...can store energy...and later deliver it to...*
* *The...is significant when... Meanwhile, ...indicate that...*
* *Lastly, when we apply...we can see that...*

4.5.4 Describing Frequency

When reporting a result, it is also important to indicate how often it occurs. Without a frequency modifier, your readers may not be able to evaluate your results appropriately if they lack information about how often a particular result occurs (Glasman-Deal, 2009). Some frequency expressions can be seen in the following sentence structures.

* *...is shown to always act as...*
* *From Fig. x, we can observe that...always performs the best, and that...*
* *We observe in..., transmission between various...still usually succeeds at distances up to...*
* *In the design of..., ...often plays an important role.*
* *With every x m/s increase in speed, the...gap between the proposed method and...increases by about x%.*
* *The...signal could be changed every x m/s.*
* *The benefit of the proposed method becomes greater when...occur more frequently.*

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* *While providing reasonably...results, ...produces only...among all tested models. This result is expected and is observed regularly in [reference] with...methods.*
* *Table x summarizes...commonly found in...*
* *It is shown that...is generally lower than...*
* *The performance of...is generally good even where...*
* *The success rate was approximately x%; ...was sometimes impossible due to...*
* *Considering..., where...conditions are dynamically changing due to..., where...will be initiated every now and then following...*
* *While the effect is hardly visible to..., it has a severe impact on...*
* *For..., the...model never ranks worse than second, but is overall close to the runner up, the...model, in this experiment.*
* *The data convincingly show that...is achieving...that is at least x%.*

4.5.5 Describing Quantity

The interpretation of numbers in figures or tables depends on how you see them. Your attitude towards the numbers affects how your readers view the results. For example, if you say "As can be seen from Fig. x, results show 20% improvement in the performance", you can interpret this improvement as either a strong result "as much as 20% improvement" or a weak result "only 20% improvement" (Glasman-Deal, 2009, p. 103). You can use the following sentence structures to describe quantity.

* *Image x contains a great amount of...details.*
* *We can see that...and yet provide a considerable benefit in terms of...*
* *Without..., although...gradually..., the...have relatively lower...and considerable higher...*
* *Results show a considerable improvement between the original method and after applying...*
* *In Fig. x we can see how... selects a number of beams that...*
* *In this scenario, a number of..., each..., are added to...to support...*
* *To study any of the scenario, we generate a large number of instances with all the parameters randomly chosen.*
* *If x is too small, a large quantity of information about...is lost, which also degrades the performance of...*
* *It can be seen that with a small and moderate number of...the number of... grows linearly but less than the number of...*
* *The...improvement for...systems with...is considerably less marked than for an ideal...*
* *The...exhibits abrupt changes between small and large values, which reflect...*

* *The small error confirms...*
* *The results show a substantial effect for..., and a noticeable effect for..., see Fig. x.*
* *To evaluate the weakness of the...model, we examine in Fig. x a few example...that...*
* *In...experiments, ...algorithm produced the best solution in only about x% of the problems compared to y% for...*
* *The improvement is significant when there are only x% or y%...but remains noticeable when there are more.*
* *The...in the figure shows an example of a...that..., resulting in very little difference in...*
* *For..., all...samples used for training...were utilized for..., and accuracy changed very little.*
* *To this end, we first compare...using..., and highlight a few key properties.*
* *The...is generally measured by a...index that integrates all the possible sources of...into a single or a few values.*

4.5.6 Highlight Your Finding

When you intend to emphasize the importance of your results, or to confirm the contribution of your research, you can use the following phrases to highlight your findings.

* *Our method yields a significant benefit over the current...method.*
* *This is a significant finding, which opens a new area of...*
* *The new approach got significant improvement on...*
* *Another important observation from Fig. x, Fig. y and Fig. z is that...*
* *The first important observation is that...*
* *This result clearly confirms the usefulness of the proposed approach in terms of...*
* *These results clearly demonstrate the...impact...had on...*
* *As expected, we can clearly observe...*
* *We can clearly see that..., as shown in Table x.*
* *It can be clearly seen that the results of our method...*
* *This result is expected, as...thus...*
* *As expected, ...increases...by...*
* *As expected, ...performs significantly better with..., in particular compared to...*
* *As we expected to observe, when...the best results are obtained using...*
* *Not that we observed...*

4.5.7 Impersonal Style

When reporting results, Mohammadi, et al. (2020) use the following expressions.

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1. Meanwhile, we compute horizontal and vertical correlation coefficients for each image.

2. In Fig. 5, the histograms of BCLs for the four images are illustrated employing the block size of 4×4.

3. Fig. 6c shows the histogram of the marked encrypted image has more fluctuation than the encrypted one; however, it depicts the uniform distribution generally.

Sentence 1 makes the agent of the action explicit by using a pronoun "we", while both Sentences 2 and 3 use an impersonal style, with either a passive voice or an inanimate subject. "This usage may either reflect the author's wish to remain in the background and let his results speak for themselves, and/or because he is following his journal's requirements" (Wallwork, 2011, p. 238). This impersonal style is more likely to show objectivity in the interpretation of results.

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Exercises

I. Please identify the moves and steps used in the beginning of the Results section in each of the following excerpts and underline the signalling sentences. Make comments about the functions of the sentences.

Excerpt 1	Comments
We train and test our system on a PC with an Intel Core i7-6700 k CPU, 16 GB RAM, and one Nvidia GTX 1080 graphics card with 8 GB memory. The average time cost of each training iteration is 0.25 s on GPU, and it takes 1.4 hours for 20,000 iterations to complete the whole training process. Given a reasonably large mesh from the SCAPE dataset (12,500 vertices, 24,998 triangles), it takes 26.4 s to compute the raw SH descriptors from the mesh on CPU, 0.09 s to compute the distance metric on GPU, 0.06 s to compute the saliency map on GPU, and 163.4 s to compute 30 saliency-induced embeddings from the metric on CPU. The method of [25] takes about 235.2 s for shape matching on CPU.	

(Hu, S., Shum, H. P., Aslam, N., Li, F. W. & Liang, X. 2019. A unified deep metric representation for mesh saliency detection and non-rigid shape matching. *IEEE Transactions on Multimedia*, *22*(9): 2278–2292.)

Excerpt 2	Comments
The visual quality of classical images and videos is generally measured by a global quality index that (ideally) integrates all the possible sources of distortion into a single or a few values. However, as aforementioned, the sources of distortions in 360-degree videos are numerous and quite different, and their combination into a global index is far from trivial. Table I summarizes the different types of distortions commonly found in 360-degree video. We broadly categorize them as: *spatial*, i.e., those related to still image compression and can appear in both images and videos; *temporal*, i.e., those related to the temporal evolution of images and appear only on video; *stereoscopic*, i.e., those related to binocular vision; and *navigation*, i.e., those that only appear while the user navigates through the scene. The ultimate way to assess the 360-degree visual quality is through subjective tests. Such tests, however, are time consuming and expensive. Thus, objective metrics have been proposed for omnidirectional video in the past few years. However, it is quite challenging to capture all the effects that impact the QoE of 360-degree videos, and much work remains to be done in this area, in particular, with regards to perceptually optimized metrics.	

(Roberto, G. D. A., Birkbeck, N., De Simone, F., Janatra, I., Adsumilli, B. & Frossard, P. 2019. Visual distortions in 360° videos. *IEEE Transactions on Circuits and Systems for Video Technology*, *30*(8): 2524–2537.)

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II. Please identify the moves and steps in the description of the results shown in the figures and underline the signalling sentences. Make comments about the functions of the sentences.

TABLE VII
SUMMARY OF ROW COMMUNICATION FOR SET A

Statistic	CBBA	PI	Soft max
% solved	6.25	90.63	100.00
% best solutions	0.00	9.38	93.75
Θ	0	N/A	3
Mean σ	–	–	2.83
Max σ	–	–	8.43

σ represents the % improvement in solution fitness when soft max selection is used. Θ represents the number of additional problems solved.

Excerpt	Comments
① Table VII summarizes metadata for experiment set A using row communication, and Tables VIII and IX repeat these statistics for mesh and hybrid communication. ② In these tables, σ is the percentage improvement of the soft-max variant when compared to the solution generated by the baseline, and θ is the number of additional problems that each algorithm could solve (i.e., the number unsolvable by the baseline but solvable by the algorithm in question). ③ In calculating the percentage of problems solved, the number of problems was taken as 32, as 4 problems could not be solved by any method in any of the tests. ④ The data are also depicted as a bar chart in Fig. 4 for ease of comparison. ⑤ Note that if the sum of the percentages of best solutions is greater than 100% it is because two algorithms generated the same best solution.	

(Whitbrook, A., Meng, Q. & Chuang, P. 2018. Reliable, distributed scheduling and rescheduling for time-critical, multiagent systems. *IEEE Transactions on Automation Science and Engineering*, *15*(2): 732–747.)

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III. Fill the following gaps of the excerpts with appropriate words provided in the boxes below.

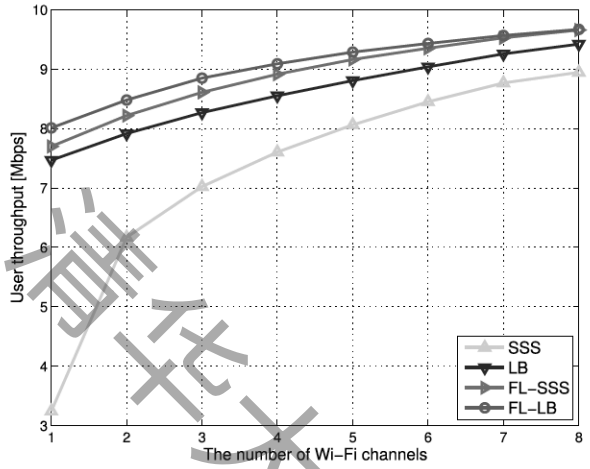
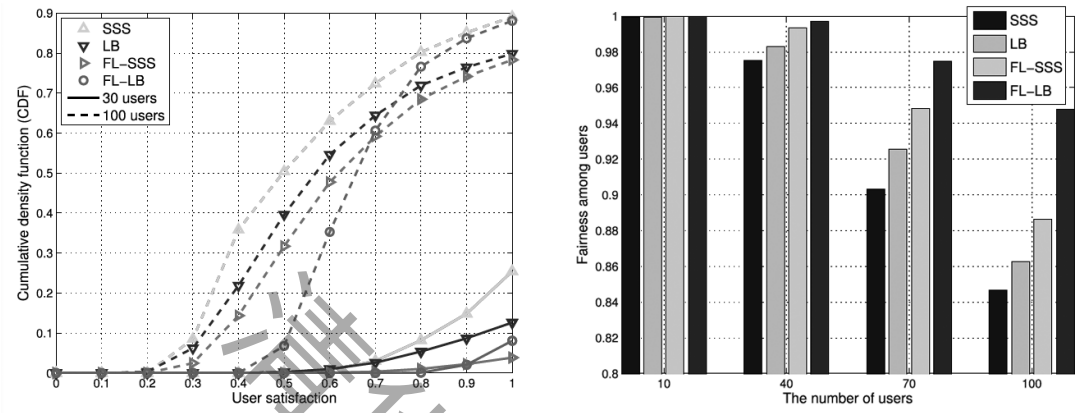


Fig. 11. User's throughput versus the number of Wi-Fi channels ($N_u = 60$).

increases	reduced	smaller	approaches
decreases	compromised	affected	decreases

Excerpt 1

As shown in Fig. 11, in general, the users' throughput _____ when the number of Wi-Fi channels is reduced. Among all the methods, the performance of the SSS _____ the most significantly. This is because the SSS assigns users to Wi-Fi regardless of its capacity and availability. Thus, when the Wi-Fi capacity is _____, the performance of those Wi-Fi users is severely _____. Unlike the SSS, the other methods have the ability to balance the loads between Li-Fi and Wi-Fi, and thus are less _____ by a reduced number of Wi-Fi channels. In addition, as the number of Wi-Fi channels _____, the performance of the FL-SSS gradually _____ that of the FL-LB. The reason for this trend is that when more users are migrated to Wi-Fi, the gap between using the LB and SSS in Li-Fi becomes _____.



(a) Satisfaction (b) Fairness

Fig. 9. System performance versus the number of users ($\bar{R}$ = 10 Mbps).

decreasing	increase	slower	increased to
achieves	cross point	decreases	improve

Excerpt 2

Fig. 9 presents the users' satisfaction and fairness of various methods when the average required data rate is 10 Mbps. As shown in Fig. 9(a), the proposed method can significantly the users' satisfaction over the SSS and LB, especially for a large number of users. When 30 users are present, using the SSS can meet the data requirements for only 74.6% of the users. This value is _____ 87.4% by employing the LB instead of the SSS. When using the FL-SSS and FL-LB, the proportion of satisfied users is 96.1% and 91.9%, respectively. Note that there is a between the curves of the FL-SSS and FL-LB. This is because using the LB in the proposed method can _____ the performance of deeply-unsatisfied users, by _____ the number of satisfied users. In Fig. 9(b), the fairness among users is shown for different numbers of users. Two outcomes are observed: i) the fairness of all methods equals 1 given a small number of users; ii) as the number of users increases, the fairness _____ for all methods, but the fairness of the FL-LB decreases much _____ than that of the other methods. At the fairness of the FL-LB _____ 0.95, while the remaining methods have a fairness below 0.9.

(Wu, X., Safari, M., & Haas, H. 2017. Access point selection for hybrid Li-Fi and Wi-Fi networks. *IEEE Transactions on Communications*, *65*(12): 5375–5385.)

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Chapter 5
Discussing Findings

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5.1 Lead-in

Before commencing writing the Discussion section, one should consider the following questions:

1. What did you expect to find?

2. What is the basis of your assumptions?

3. What have you actually found?

4. Do your results conform to your expectations? If yes, how? If no, why?

5. How would you compare your results with the previous research?

6. How would you explain the unexpected results?

7. Is there any limitation of your research?

8. How would you further improve the research?

Unlike the Results section, which objectively reports the information you get after doing an experiment or conducting a research procedure, the Discussion section probes into the results to explain what these results indicate and their relation with previous research. For novice researchers, the Discussion section may be the most difficult section, as it requires the authors to be able to evaluate the results with accurate judgements and to put forward arguments based on the knowledge of extensive reading and discussion.

Adjusted from Glasman-Deal (2009), Swales (1990), Kanoksilapatham (2015) and consolidated by the corpus, here are some basic moves and steps that can help us in composing a well arguable discussion.

- **Move 1: Revisiting previous sections (summarizing/revisiting general or key results)**

  Step 1 Revisiting the introduction

  Step 2 Revisiting the methodology

  Step 3 Revisiting the results

- **Move 2: Consolidating results**

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Step 1 Reporting results

Step 2 Comparing results

Step 3 Evaluating results

- **Move 3: Stating limitations and future research**

5.2 Revisiting Previous Sections

To begin the Discussion, you can review what has been stated in the previous sections as a reminder to the reader. You can start by reviewing the Introduction, the Method or the Results. It depends on which part of the research you think is the most important for the Discussion.

5.2.1 Revisiting the Introduction

You can introduce the Discussion by reviewing the main moves in the Introduction, the background of your research, the existing research gap and the purpose of your research.

Excerpt	Comment
① Deep learning models have often achieved increasing success due to the availability of massive datasets and expanding model depth and parameterisation. ② However, in practice factors like memory and computational time during training and testing are important factors to consider when choosing a model from a large bank of models. ③ Training time becomes an important consideration particularly when the performance gain is not commensurate with increased training time as shown in our experiments. ④ Test time memory and computational load are important to deploy models on specialised embedded devices, for example, in AR applications. ⑤ From an overall efficiency viewpoint, we feel less attention has been paid to smaller and more memory, time efficient models for real-time applications such as road scene understanding and AR. ⑥ This was the primary motivation behind the proposal of SegNet, which is significantly smaller and faster than other competing architectures, but which we have shown to be efficient for tasks such as road scene understanding.	The authors revisit the Introduction of the paper. They begin by introducing the background of the research in Sentence ①. They focus on the important factors to consider in experiment and application in the next three sentences. Then, in Sentence ⑤ they point out the research gap that needs to be addressed. The last sentence in the first paragraph summarizes the previous few sentences as a reminder of the motivation of the model and describes its application.

(Badrinarayanan, V., Kendall, A. & Cipolla, R. 2017. SegNet: A deep convolutional encoder-decoder architecture for image segmentation. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *39*(12): 2481–2495.)

5.2.2 Revisiting the Methodology

If the novelty of your research lies most in your method, you can also begin your Discussion section by reminding your readers of the purpose of your research and how you have achieved it.

Excerpt	Comment
① In this paper we have discussed the principles of wireless access for Ultra-Reliable Low-Latency Communication (URLLC). ② We have used a communication-theoretic framework to provide discussion on the fundamental tradeoffs. ③ This was followed by elaboration on the important elements in access protocols. ④ Two specific technologies were considered in the context of ultra-reliable communication, massive MIMO and multi-connectivity (interface diversity). ⑤ We have also touched upon the important question about the proper statistical methodology for designing and assessing ultra-reliable communication. ⑥ However, there are also important challenges that were not treated in the paper and out of them we would like to single out the problem of design of short-length codes for URLLC, a topic treated in [83], [84].	In Sentence ①, the authors restate the main purpose of the research as an overall review of the article. In Sentence ②, the authors review the framework used in the research, and explain the important elements in access protocols in Sentences ③ and then list the technologies used in Sentence ④. Sentence ⑤ states the methodology used in the research. Then the authors describe the limitations of the current research.
Here we reiterate the role of Machine Learning (ML) techniques in measuring and ensuring ultra-reliability. The knowledge of the environment in which ultra-reliable connectivity takes place is crucial for guaranteeing high levels of reliability, but also for applying methods to achieve this reliability. As the simplest example, knowing the coherence bandwidth in a given Industry 4.0 setting will lead to a proper selection of the allocated frequency resources. Getting knowledge about the environment requires data-driven technique and ML methods, while it introduces training cost. We believe that one of the main next frontiers in URLLC is proper formulation of the reliability challenge as well as methods to solve it based on ML techniques. Finally, as an important next step, the community needs to address the issue of coupling high reliability with low latency, as it is done in the context of 5G. Relaxing the latency requirements towards a long term, e.g., beyond 10 or 50 ms, opens the design space for solutions that have good system level characteristics, such as coexistence with the other 5G services, or exhibit a higher energy efficiency. It should also be noted	The second paragraph of the Discussion elaborates the methodology with details about the parameters by giving a simple example. And the authors show the contribution of the research.

(Continued)

Excerpt	Comment
that the latency requirements on the wireless link can be reduced by adopting a holistic system design. For example, requiring 1 ms from the wireless link, while allowing source compression procedures that introduce much larger delay, is certainly not the optimal approach. Hence, one is tempted to define new research problems related to joint source-channel coding and protocol design that are suited to meet end-to-end latency and reliability requirements.	In the last paragraph, the authors suggest the specific areas or research questions that can be addressed in future work.

(Popovski, P., Stefanović, Č., Nielsen, J. J., De Carvalho, E., Angjelichinoski, M., Trillingsgaard, K. F. & Bana, A. S. 2019. Wireless access in ultra-reliable low-latency communication (URLLC). *IEEE Transactions on Communications*, *67*(8): 5783–5801.)

5.2.3 Revisiting the Results

You can also begin your Discussion by reviewing the main findings of the Results section.

Excerpt	Comment
① We have shown that temporal fluorescence data can be used to precisely localize a set of point fluorescent emitters in a homogeneous heavily scattering environment. ② For an inhomogeneous domain, the background scattering parameters could be estimated from prior measurements using established reconstruction methods. ③ If substantial background signal is present (from tissue autofluorescence, for example), it could be subtracted from the measured data in a calibration step, or incorporated into the forward model, (11), through the addition of a background source term. ④ We assumed a fixed and known fluorescence lifetime for all reporters. ⑤ While this may be appropriate for some applications, if there should be variations in lifetime because of the local (chemical) environment, lifetime could be estimated along with position, in a revised interpretation of the cost function in (16).	The authors begin the Discussion section by summarizing the main finding of the research in Sentence ①. And they then add more details in Sentences ② to ⑤.

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(Continued)

Excerpt	Comment
⑥ We have analyzed several requirements of being able to successfully detect and localize fluorescent emitters. ⑦ Appendix B develops a method for detecting individual emitters during a temporal scan, and its success depends on the yield, η, as well as the SNR. ⑧ For this detection method to work, fluorescent emissions must be separated in time by at least the window duration, w, a requirement that is explored in Section III-C. ⑨ It is important to note that this requirement for a separation in time places an implicit constraint on the sampling period. ⑩ Namely, the sampling period must be short enough so as to not hide this existing temporal separation. ⑪ Furthermore, for such emitters to be fully distinguishable, their spatial locations must be separated by at least the localization uncertainty described in Section IV-A, otherwise, while they may be detectable, they will be mistaken for the same emitter. ⑫ If all of these conditions are met, then all fluorescent emitters will be detectable and distinguishable from one another. ⑬ In the case where the same emitter is localized several times because its light is emitted at multiple delays separated by at least the window length, the emitter could be identified through calculation of its localization uncertainty.	In the second paragraph, the authors briefly summarizes the methodology part in Sentence ⑥, and provides details about how they get the results in Sentences ⑦ and ⑧. The rest of the sentences discuss how their method and results would be applicable.

(Bentz, B. Z., Lin, D., Patel, J. A. & Webb, K. J. 2019. Multiresolution localization with temporal scanning for super-resolution diffuse optical imaging of fluorescence. *IEEE Transactions on Image Processing*, *29*: 830–842.)

The following sentence structures can be used to revisit the previous sections.

* *We first evaluate the accuracy of the proposed... We then study the effects of...on...as well as...efficiency to...*
* *Before concluding, we wish to draw some reflections out from the above results and from our experience of managing..., and to offer some recommendations for future...*
* *Before concluding our paper, we discuss challenges for future work that need to be overcome in order to make...methods for...a practical component of operations and management of...*
* *We proposed a reasonable solution for... For..., our...calculate...; therefore, ... This calculation increases linearly according to... Therefore...*

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* *We have shed some light on...: (1) a...model with...and (2) ... We focused on...: ...for... and...for... More...methods are conceivable to account for..., for instance. However, even with our current set-up, ...can...*
* *We have introduced a framework for..., both across...and across..., that works across...and requires fewer...than other state-of-the-art methods for..., representing an effective combination of...and...*
* *We have exploited... In our proposed scheme, we have selected..., therefore, the algorithm we employ can be considered as a...one. To give further insight into..., we show...*
* *In order to gain further insights into..., we use the theory of...to help us. We start with a brief introduction to...and a review of pertinent results. In this work, we assume that... We now describe...*
* *We proposed a reasonable solution for...(summary of key results). An important assumption of...is that... If..., ...does not work. Thus, we assume... Therefore...*
* *The framework discussed in this paper has already been successfully applied to a number of different use cases in the context of... For instance, ... In this section, we describe...*
* *We use the results derived for...to evaluate... The main objective is to demonstrate how... The analytical results here are supported further by the numerical results in section x.*
* *In this paper, we have discussed the principles of... We have used a...framework to provide discussion on... This was followed by elaboration on... Two specific technologies were considered in the context of... We have also touched upon the important question about...methodology for... Here we reiterate the role of...in...*
* *...enable... Adopting this paradigm proposed by..., we have shown...*

5.3 Consolidating Results

This is the main part of the discussion, which reveals the authors' perception of the results. It is also the most difficult part, as the perspective of the discussion of results can reflect the authors' understanding of the field; i.e., whether they are able to interpret the results from an appropriate point of view, whether they can compare or contrast their results with the most relevant ones in literature, and what conclusions they can draw from the explanation and comparison.

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5.3.1 Reporting Results

The authors should be able to make a claim about the most important findings and develop their argumentation with the detailed explanations and examples.

Excerpt	Comment
① The tradeoff between solution quality and run-time efficiency is an important factor in both sets of experiments, and a key consideration is that the soft-max variant is not as efficient as the baseline in terms of execution time. ② This matters more for shorter mission times such as those considered in experiment set A, where the maximum mission time is 2000 s (about half an hour), and mean rescue times are at about 280 s (about four and a half minutes). ③ In these problems, any saving in mean rescue time offered by the soft-max variant is counter-balanced by run-time losses. ④ For example, if there is a 4% saving in mean rescue time, this equates to about 11 s for each task. If there are 28 tasks, the total saving is 308 s or about 5 min. ⑤ However, if the search algorithm takes 5 min to run, then any gain is eliminated. ⑥ For smaller time scale problems, this means that it is important to terminate the algorithm execution early or limit the search space some other way as m increases, even if this means missing fitter solutions. ⑦ However, for more realistic larger-scale problems, for example, problems with a maximum mission time in terms of days and mean rescue start times in terms of hours, the algorithm's initial run-time efficiency is not as important and thus has much less impact on overall mean rescue time. ⑧ In these cases, it would be possible to examine a wider range of the spectrum of possible τ values to be certain of finding the optimal or near-optimal solution without compromising the effectiveness or efficiency of the mission. ⑨ In addition, a possible application is to reserve use of the soft-max module only for cases where baseline PI fails to solve. ⑩ These experiments have illustrated that PI is much more effective than CBBA in solving both lower dimensioned problems with tight constraints and higher dimensioned problems with more relaxed constraints. ⑪ They have also demonstrated that PI's performance can be enhanced easily by making some adjustments to the action-selection mechanism within the task removal and task inclusion phases of the algorithm.	In Sentence ①, the authors point out an important factor that can influence the results. Then, they explain the effect of the factor in different situations in detail from Sentence ③ to Sentence ⑦, in which specific examples and results are given to illustrate the authors' claim in Sentence ①. In Sentences ⑧ and ⑨, after presenting the key findings of different problems, the authors give suggestions about how to get the best solution and possible application of the model. In the last paragraph, the authors claim the values of the results.

(Whitbrook, A., Meng, Q. & Chung, P. W. 2017. Reliable, distributed scheduling and rescheduling for time-critical, multiagent systems. *IEEE Transactions on Automation Science and Engineering*, *15*(2): 732–747.)

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The Discussion section is also heavily embedded with figures and tables, according to which, the interpretation of results can follow a structure like this:

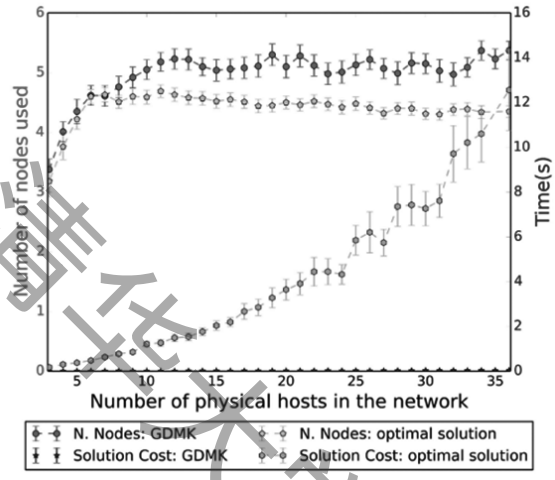

Fig. 5. Varying the number of physical hosts from 1 to 36.

Excerpt	Comment
① The experiment in Fig. 5 shows how the underlying topologies impact both the optimal solution (OCNSD) and the proposed heuristic (GDMK). ② We vary the number of physical hosts belonging to the physical layer in our proposed architecture while fixing the number of network slices, SFCs, NFs. ③ Concerning the optimal solution, the first observation that we can draw from this figure is that the number of used nodes, represented by the pentagon shape, stagnates in 5, even when increasing the number of physical hosts 5 fold. ④ Moreover, we clearly observe the exponential behavior of the computational time, expressed by the hexagon shape, which allow us to conclude that when we increase the number of underlying nodes, the number of links between those nodes increases due to the higher density of nodes in our network which will raise the probability of deployment of the network slices causing by the same time the exponential growth in the computational time (optimal solution search always best options). ⑤ For the heuristic solution, the same stagnation in terms of the number of used nodes, represented by the circle shape, is observed with a higher number of the used nodes (6 for the heuristic instead of 5 for the optimal solution). ⑥ However, the computational time for the heuristic solution is linear and has the following linear regression samples 0.0096 and 0.00099, as α and β, respectively.	Sentence ① locates the description to Fig.5 and summarizes the main information of the figure. Sentence ② explains how the authors get the results in this figure. Sentence ③ states the first observation from the figure. Sentence ④ describes another observation, followed by the interpretation of the results. Sentence ⑤ states another observation with supportive details.

(Addad, R. A., Bagaa, M., Taleb, T., Dutra, D. L. C. & Flinck, H. 2019. Optimization model for cross-domain network slices in 5G networks. *IEEE Transactions on Mobile Computing*, *19*(5): 1156–1169.)

More sentence patterns to report the results are as follows.

* *The...plays a key role in... When..., ...be...*
* *Through our discussions and experimental evaluation, we have demonstrated the effectiveness of...for...*
* *Adopting this paradigm proposed by [reference], we have shown the existence of a...systems that allows us to ...*
* *To apply these theorems, we first make the following observation about...*
* *To illustrate the effect of...on..., Fig. x shows...on...*
* *In all three cases shown in Fig. x, the x for each deployment decreases rapidly with increasing...*
* *It is clear from our experiments and other independent benchmarks [references] that...*
* *The heuristic explanation for the...model lies in the fact that... There are multiple possible...that can lead to the same set of measurement data. For example, assume...is... This would result in..., so... would be impossible.*
* *There are three major types of...encountered in... The first two deal with..., and the third deals with...*
* *In this section, we discuss the...technique proposed to solve the...problem. Since...for the...introduced in Problem x cannot be easily obtained, a systematic method for..., which..., leading to...is provided. The method requires..., which... It is shown that the...methodology, which leads to approximate solutions of...in Problem x, yields a solution to...*

5.3.2 Comparing Results

To consolidate your results, sometimes you need to compare them with other research.

Excerpt	Comment
① The effectiveness of the proposed method will now be verified by means of a simulation example. ② In particular, we will conduct comparison of the proposed model reference scheme using reaching law (12) with the one introduced in [33] where Gao's classic reaching law is used instead. ③ It will be shown that the new strategy can successfully be applied to a plant with unmatched disturbance and that it ensures better system robustness than its relative degree one equivalent.	Sentence ① states the purpose of the Discussion. Sentence ② explains how the effectiveness of the method will be evaluated. Sentence ③ presents the result of the comparison.

(Latosiński, P. & Bartoszewicz, A. 2020. Model reference DSMC with a relative degree two switching variable. *IEEE Transactions on Automatic Control*, *66*(4): 1749–1755.)

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Excerpt	Comment
① We compare our method to Matching Pursuit, and extensions to that method do exist, one being Orthogonal Matching Pursuit (OMP). ② Rather than calculating basis function weights once, OMP recalculates them upon every iteration, thereby mitigating error accumulation. ③ Taking inspiration from OMP, we could reduce potential error accumulation in the estimated ηk by recalculating all of their values upon each successive detection of a fluorescent emitter. ④ Other super-resolution methods have been developed for improving the spatial resolution beyond the diffraction limit in microscopy. ⑤ Fundamentally, imaging methods can surpass resolution limits with the addition of prior information to compensate for the information that is lost due to attenuation or randomization of the signal. ⑥ For example, structured illumination microscopy (SIM) breaks the resolution limit through spatial modulation of the excitation light, and can be further improved by leveraging the nonlinear dependence of the fluorescent emission rate in the saturation regime. ⑦ Stimulated emission depletion (STED) forms a smaller effective point spread function (PSF) by saturating fluorophores at the periphery of the focal point. ⑧ Other techniques such as photo activated localization microscopy (PALM), fluorescence PALM (fPALM), and stochastic optical reconstruction microscopy (STORM) are able to localize switchable fluorescent molecules by distinguishing the emission between their fluorescent and non-fluorescent states. ⑨ These are all super-resolution methods that achieve position information beyond that directly represented by the point spread function. ⑩ The shared use of temporal switching of fluorescence states influorescent molecules makes our method analogous to PALM, fPALM, and STORM. ⑪ However,our incorporation of a forward model, such as the coupled diffusion model for scattered light we use here, allows imaging through scatter. ⑫ Moreover,our super-resolution imaging methodcan be applied to a wider variety of applications that employ forward models, such as photoacoustic tomography, electrical impedance tomography, and microwave imaging.	The authors compare their method to another one, and point out the mechanism of the compared method in the first two sentences. Then, they explain what they can benefit from the comparison. They describe other relevant methods with examples in Sentence ④ to Sentence ⑧. Sentence ⑨ summarizes the previously mentioned methods, and Sentence ⑩ relates the methods to the authors' method. In the following two sentences, the advantages of the authors' method are highlighted through comparison.

(Bentz, B. Z., Lin, D., Patel, J. A. & Webb, K. J. 2019. Multiresolution localization with temporal scanning for super-resolution diffuse optical imaging of fluorescence. *IEEE Transactions on Image Processing, 29*: 830–842.)

To indicate the comparison, you can use the following sentence patterns.

* *We compare our method to..., and extensions to that method do exist, one being...*
* *Results of this comparison are illustrated by the following three figures depicting..., ...and...*
* *Additionally, a numerical comparison of...for both strategies has been conducted using two criteria:...and...*
* *An interesting point of comparison is provided by similar challenges run via... such as...*
* *To give further insight into..., we show the comparison of...and the proposed...in Fig. x.*
* *The effectiveness of the proposed method will now be verified by means of a...example. In particular, we will conduct comparison of the proposed... scheme using...with the one introduced in [reference] where...is used instead.*
* *A comparison with state-of-the-art...algorithms has shown that, in most of the considered situations, ...outperforms its competitors.*
* *These…are examined and compared with…in this database. A…algorithm is implemented wherein...is compared with...in the database.*
* *The results of extensive testing of the...algorithm have validated its architecture and demonstrated benefits compared with...*
* *Comparing this scheme with the...scheme, it is clear that the...scheme is easier to implement.*
* *Previous work in...focuses on...such that..., here referred to as... In contrast, our method treats...as...whose...*
* *First, this paper focuses on creating a...to define...rules of the...system. The...are defined creating... In contrast, the work in [reference] creates a different...for...*
* *To the best of our knowledge, the only previous work related to our solution is [reference], which describes a...framework called… However, there are several differences between the work in [reference] and ours. First, ...*
* *The effectiveness of the proposed method will now be verified by means of… In particular, we will conduct comparison of the proposed model reference scheme using...with the one introduced in... It will be shown that...*
* *Although the various...paradigms may be...from different aspects of the problem, they can be decomposed into the x components depicted in Fig. x. We discuss them one by one.*
* *The usual approach to show the usefulness of a new...technique is to apply it to a number of different problems and to compare its performance with that of already available techniques. In the case of..., this type of research initially consisted of testing the algorithms on the...*

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To show the advantages of your research, you can use sentence patterns like the following.

* *We have shed some light on... We focused on... More expressive representations and...methods are conceivable to account for..., for instance. However, ...*
* *The...framework is not shown in the figure since it is not yet... As the figure shows, our approach brought better results than the existing ones.*
* *More recently, a...designed for the challenging...was shown to be competitive with state-of-the-art...algorithms [references], while at the same time offering better...*
* *This method works better than...both in...case and after...period.*
* *There are also instances in which...that do actually contribute to..., and we have shown that...is robust to...*
* *Previous work has shown that...is useful in... [references]. The...is a close approximation to...that results from...as a...process, a common assumption for...*
* *Although the various...paradigms may be motivated and derived from different aspects of the problem, they can be decomposed into the five components depicted in Fig. x. We discuss them one by one.*
* *…have often achieved increasing success due to… However, in practice factors like…and…are important factors to consider when…// …becomes an important consideration particularly when...as shown in our experiments. From an overall viewpoint, we feel less attention has been paid to..., ...and... This was the primary motivation behind the proposal of..., which is significantly...than other competing architectures, but which we have shown to be efficient for tasks such as...*
* *Comparing the proposed...approach to...suggests that... In order to evaluate this observation in a...context, the architecture of the...was modified by... This amounts to... When tested on..., the... model achieves..., whereas the original architecture achieves... The same experiment on...shows a similar result as the...model obtains..., compared to... obtained by the...model. To test whether...leads to..., the models trained on...are additionally tested on... The...model achieves a...of..., and is outperformed by the original architecture with a...of... The differences are rather small, but it shows that the deeper and more complex model does lead to a more accurate prediction. However, when...is important, small improvements might not justify the...increase in the number of parameters.*

5.3.3 Evaluating Results

The evaluation of the results usually takes a few sentences to show the contribution or significance of the research.

* *This...approach has some advantages.*
* *One of the key aspects of the proposed framework is..., which has a strong impact on...*
* *Our approach achieves a good performance in terms of...// ...achieves good...results, with significantly more/less...than... (see Fig. x for example).*
* *As mentioned in Sections II and III, one important property of the method is that, ... In this work, the method has been implemented using..., leading to an average processing time of...per...*
* *This figure illustrates the importance of studying...for..., as it helps..., which could be implemented in practice.*
* *Even though the proposed methods outperform comparable methods, is still far from being satisfactory. Despite..., ... Thus, ...has the same shortcomings as...*
* *The remarkably better performance of…implies the importance of… Since…, considering...leads to...while other...models are focused only on...such as...*
* *This is a significant finding, which opens a new area of..., in which...can be traded off to achieve better performance. For instance, ...*
* *For the analysis of the results, we will first apply a...test [reference] to determine if there are significant differences between...and...*
* *The obtained results were good for scenarios where...*
* *The...results on...are reported in the right half of Table x. For these..., the...hypothesis is very clearly rejected as there is a growing performance gap between...and our... The...generalizes better to..., even performing close to optimal up to... The further..., the larger is the performance gap between...and... Although both...perform well for..., the...clearly outperforms on...*
* *The findings made based on the...results are also supported by...reported in Table x. ...results in the best overall performance in terms of...and... While providing reasonably convincing...results, ...produces only average...and even results in the lowest...among all tested models on... This result is expected and is observed regularly in the literature [reference] with… methods.// …and…improve upon…in terms of…, but are less competitive in comparison to the top performers of this experiment.*
* *One of...benefits is...by explicitly incorporating...into planning and control.// …, however, does not take...into account. Instead, ... On the other hand, ...*

5.4 Stating Limitations and Future Research

In the end of a research article, you usually need to state the limitations of your research and then propose directions for future improvement and research accordingly. If some of the results are out of your expectation, you can also provide possible explanations so as to make improvement in future.

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Excerpt	Comment
Even though the results obtained are more than encouraging with respect to the applicability and efficacy of DL for affective modeling, there are a number of research directions that should be considered in future research. While the Maze-Ball game dataset includes key components for affective modeling and is representative of a typical affective modeling scenario, our PDLv approach needs to be tested on diverse datasets. The reduced size of the dataset limited the number of features that could be learned. Currently, deep architectures are widely used to extract thousands of features from large datasets, which yields models that outperform other state-of-the-art classification or regression methods (e.g., [27]). We expect that the application of DL to model affect in large physiological datasets would show larger improvements with respect to statistical features and provide new insights on the relationship between physiology and affect. Moreover, to be able to demonstrate robustness of the algorithm, more and dissimilar modalities of user input need to be considered, and different domains (beyond games) need to be explored. To that end, different approaches to multimodal fusion in conjunction with DL need to be investigated. The accuracies obtained across different affective states and modalities of user input, however, already provide sufficient evidence that the method would generalize well in dissimilar domains and modalities.	The authors acknowledge the encouraging results obtained in the previous section, and then point out the future research directions. Then, they elaborate on the points that could be further developed in future.
The paper did not provide a thorough analysis of the impact of feature selection to the efficiency of DL as the focus was put on feature extraction. To that end, more feature selection methods will need to be investigated and compared to SFS. While ad-hoc feature performances might be improved with more advanced FS methods, such as genetic search based FS, the obtained results already show that DL matches and even beats a rather effective and popular FS mechanism without the use of feature selection in several experiments. Although in this paper we have compared DL to a complete and representative set of ad-hoc features, a wider set of features could be explored in future work. For instance, heart rate variability features derived from the Fourier transformation of BVP (see [33]) could be included in the comparison. However, it is expected that CNNs would be able to extract relevant frequency-based features as their successful application in other domains already demonstrates (e.g., music sample classification). Furthermore, other automatic feature extraction methods, such as principal component analysis, which is common in domains, such as	In the second paragraph, the authors first explain why the paper did not provide a thorough analysis, and then point out how some features of their model could be improved in future.

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(Continued)

Excerpt	Comment
image classification, will be explored for psycho-physiological modeling and compared to DL in this domain.	
Despite the good results reported in this paper on the skin conductance and blood volume pulse signals, we expect that certain well-designed ad-hoc features can still outperform automatically learned features. Within playing behavioral attributes, for example, the final score of a game—which is highly correlated to reported fun in games—may not be captured by convolutional networks, which tend to find patterns that are invariant with respect to the position in the signal. Such an ad-hoc feature, however, may carry information of high predictive power for particular affective states. We argue that DL is expected to be of limited use in low resolution signals (e.g., player score over time) which could generate well-defined feature spaces for affective modeling.	The authors make another claim about future research in detail.
An advantage of ad-hoc extracted statistical features resides in the simplicity to interpret the physical properties of the signal as they are usually based on simple statistical metrics. Therefore, prediction models trained on statistical features can be analyzed with low effort providing insights in affective phenomena. Artificial neural networks have traditionally been considered as black boxes that oppose their high prediction power to a more difficult interpretation of what has been learned by the model. We have shown, however, that appropriate visualization tools can ease the interpretation of neural-network based features. Moreover, learned features derived from DL architectures may define data-based extracted patterns, which could lead to the advancement of our understanding of emotion manifestations via physiology (and beyond). Finally, while DL can automatically provide a more complete and appropriate set of features when compared to adhoc feature extraction, parameter tuning is a necessary phase in (and a limitation of) the training process. This paper introduced a number of CNN topologies that performed well on the SC and BVP signals while empirical results showed that, in general, the performance of the CNN topologies is not affected significantly by parameter tuning. Future work, however, would aim to further test the sensitivity of CNN topologies and parameter sets as well as the generality of the extracted features across physiological datasets, reducing the experimentation effort required for future applications of DL to psychophysiology.	By showing the advantage of the current research, the authors make suggestions for future research. Finally, the authors summarize the main contributions and results of the research and propose future research direction.

(Martinez, H. P., Bengio, Y. & Yannakakis, G. N. 2013. Learning deep physiological models of affect. *IEEE Computational Intelligence Magazine*, *8*(2): 20–33.)

You can use the following sentences to state limitations of the current research.

* *Though the proposed...method appears to work well across datasets, it has some undesirable features. One such characteristic of the proposed...method is...*
* *We think the...has still limitations. The...can deal with the difference of...between...and... However, the...cannot cope with...because... How to take newness of records into account is left to the future work.*
* *Our...also has difficulty on..., that is, ... When using..., we have to... Although this process can be done in..., the calculation cost is high especially when ...*
* *A second problematic result of using...is..., as...*
* *An important choice we had to make when...was... Many of these architectures have used...to..., but this makes it difficult to... Instead, we chose to... However, we note that this approach cannot...in achieving a particular result. This is mainly due to the fact that... Acknowledging these shortcomings, our hope is that this...analysis complements other benchmarks [references] and reveals...in different well known architectures.*

You can use the following sentences to indicate possible future research directions.

* *Even though the results obtained are more than encouraging with respect to..., there are a number of research directions that should be considered in future research.*
* *Before concluding our paper, we discuss challenges for future work that need to be overcome in order to...*
* *Further work may determine an appropriate criterion to... For practical application, however, we found no obvious trend as to... Our suggestion with this method would be to...*
* *One possible future direction is to specify our priors as samples from a...process and attempt to take advantage of any...because...[reference], as has been shown to be effective in...[reference]. It is also interesting to note that..., which suggests that... Further work with this approach in...should prove to be very interesting.*
* *For the future, we would like to exploit our understanding of...architectures gathered from our analysis to design more efficient architectures for real-time applications.*
* *Further work with this approach in...or...should prove to be very interesting.*
* *It is also instructive to look at the correlation between…and… It allows us to study...using...*
* *For the future, we would like to exploit our understanding of...to design more efficient architectures for real-time applications. We are also interested in...*
* *Although there are studies analyzing the influence of...on...systematically [references], we are not aware of any unified framework to study... However, albeit being a promising*

framework, a fair comparison, e.g., to the...[reference] would require an analysis of...

* *Hence, while the proposed...offers..., the difference here is less significant for a larger volume. However, our framework could be further improved in several ways. An option would be to... The proposed framework could also be combined with the...approach proposed in [reference] to perform..., which demonstrates... We expect that...would further improve the performance of the method while...as demonstrated in Section x. These extensions are to be addressed in future works.*

5.5 Language Focus

5.5.1 Moderating a Claim

While discussing the results, the authors' attitude is often reflected by the claim. In order to appropriately show the strength of the claim, some rhetoric can be used.

1) Polarity and Modality

One of the most effective ways to moderate a claim is to add different degrees of probability and usuality by using modal verbs, such as *will, can, may*; or adverbs, such as *always, usually, probably*, or both together, such as *will probably, may possibly* (Halliday & Matthiessen, 2014). For detailed explanation, please see Section 2.3.5. Here are some examples with modal verbs or adverbs or both to show moderated claims.

* *The...<u>can be</u> envisioned as a...system, where each layer provides different types of... for..., ...and...*
* *Imaging <u>can be expected to be</u> more accurate in areas where...than in areas where ...*
* *Since...are ubiquitous in systems and control, we expect that our approach <u>could lead to</u>...solutions to many other control problems.*
* *...<u>may also prove</u> a useful addition to make...for general purposes as in... [reference].*
* *Doing...and using...<u>may be beneficial to</u> improve...accuracy.*
* *... <u>would likely be</u> coupled with..., which could be an additional driving force for...*
* *When..., ...<u>are likely to fail</u> to...*
* *While there is no clear rule as to when it <u>might be necessary</u>, we can easily see <u>a possible explanation for</u> this problem when considering the...method itself.*

2) Distance

Distance means "removing yourself from a strong and possibly unjustified claim" (Swales & Feak, 2012, p. 160). For example:

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* *...may seem too trivial, yet the advantage of a fixed model is that...*
* *...tend to reduce...and hence...*
* *Though the proposed...method appears to work well across datasets, it has some undesirable features.*
* *A comparison with state-of-the-art routing algorithms has shown that, in most of the considered situations, ...outperforms its competitors.*
* *Even if this system is a simple application of the..., it still involves a number of different devices and...technologies, thus being representative of most of the critical issues that need to be taken care of when designing...*
* *Common to many of these applications is that the best performing...algorithms make intensive use of...*
* *In...problems, some variables have a stochastic nature.*
* *The algorithm was able to solve some problems that failed using...*
* *Apart from the...problems, for which the main focus was put on..., the... problem was the first...problem tackled by...algorithms.*

3) Cause and Effect

While discussing findings, cause-and-effect statements are often used. These statements can take different forms, such as adverbial phrases, verbs, or conjunctions. It is found in the corpus that conjunctions are the most used and verbs are the least.

* *As a result, even though the...technology provides..., ...are not part of the...network and have to rely their...on...*
* *As a result of this study on the current state of...solution for..., several key trends have been identified that could shape the future of...solutions.*
* *As a result, our method is complementary to...methods.*
* *However, the...cannot cope with...because...*
* *As..., ...outperforms...because..., and...*
* *Fundamentally, ...methods can surpass resolution limits with the addition of prior information to compensate for...that is...due to...*
* *However, due to...and..., their...are different.*
* *Furthermore, when..., the...information is more concentrated on... This is due to the...function that is...*
* *In fact, a significant change of..., whether...or..., can lead to...that would not normally happen for...with...*
* *...features derived from...architectures may define...patterns, which could lead to the advancement of our understanding of...via...*

* *The separate implementation of...and...results in..., due to...devices required in..., as well as...*
* *However, in practice we found... The other option is to use...method, which results in a...that...*
* *The...is a close approximation to...that results from..., a common assumption for...*

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Exercises

I. Please try to use some modifications, such as *could, can, may, might, should, probably, possible, sometimes, seem, appear, some, etc.*, to soften the claims.

1. Taking inspiration from OMP, we reduce potential error accumulation in the estimated nk by recalculating all of their values upon each successive detection of a fluorescent emitter.

2. Our super-resolution imaging method is applied to a wider variety of applications that employ forward models.

3. Each node publishes its own features and data by running a CoAP server, though this feature is not yet implemented in the testbed.

4. The proxy logic is extended to better support monitoring applications and limit the amount of traffic injected into the IoT peripheral network.

5. Examining the readings of the other sensors in the same time interval, we note a sharp decrease of light intensity and temperature, and an increase in humidity.

6. Several applications with different performance requirements require access to the same piece of information at the same time.

7. The reduction in resource requirements allow sensing and connectivity to migrate into very low-power wearable devices, reducing the cost and complexity of contemporary health-aware clothing.

8. When the target appearance changes gradually the prediction succeeds.

9. All the methods presented here perform better if prior knowledge had been incorporated into choosing the feature space.

10. In passive (data-only) systems, sensors fail, connections drop, or a proxy's model is proven inaccurate or incomplete.

II. Please try to rewrite the following statements by using appropriate verbs, adverbs or conjunctions to indicate the cause-and-effect relations.

1. The IoT devices could be part of different management domains during their lifetimes. That information would be spread among many nodes making it difficult to audit and track it.

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2. Public lighting operators will be equipped with mobile devices that can locate the streetlight that requires intervention, issue actuation commands directly to the IoT node connected to the lamp, and signal the result of the intervention to the central system that can track every single lamppost. Public lighting operators optimize the maintenance plan.

3. The SPC cannot cope with the concept change within a user. The SPC does not have any mechanism to forget old records.

4. The work represents an important extension to the baseline as real missions take place in dynamically changing environments where the SA is subject to alter rapidly. Task allocation strategies must be able to adjust to new data and recompute new solutions in real time.

5. It is possible to specify a list of resources that need to be monitored. The server can autonomously update the entries in a cache related to those devices.

6. An approach based on hierarchical reinforcement learning (HRL) was chosen. It is a promising approach to expand traditional RL methods to work with more difficult and complex tasks.

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Chapter 6
Writing Abstract

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6.1 Lead-in

Can you categorize the following phrases into different groups? And what is your standard of categorization?

1. This paper focuses on...

2. ...has become a promising topic in...

3. This paper proposes a...scheme to...

4. We present an algorithm for...in order to...

5. This paper aims to investigate...

6. First, we determine..., and then...

7. Adopting a...method, a...is proposed to...

8. We address this issue by adopting a...approach.

9. It is shown that...

10. The computational results reveal that...

The abstract provides an overview of the article. It summarizes each section of the article and with an emphasis on main findings.

Generally, the abstract consists of four parts that are consistent with the main parts of the article: Introduction, Methods, Results and Discussion. However, the abstract usually has a certain word limit, ranging from 150 to 300 words. In this case, to present the most distinctive contribution of the article, the abstract can omit the Introduction part and combine the Methods and Results, thus leaving space for the Discussion.

The Moves in an abstract can be identified as the following.

- **Move 1: Introducing research topic**

  Step 1 Indicating the research background

  Step 2 Presenting the purpose of the research or summarizing the research

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- **Move 2: Describing the research method**
- **Move 3: Summarizing the research results**
- **Move 4: Presenting the research conclusions**

6.2 Introducing Research Topic

The abstract usually begins with introducing the background of the research. It can describe the problem existing in a certain field, the significance of the current research or the purpose of the research.

6.2.1 Indicating the Research Background

In the beginning of an abstract, we can use the following sentences to indicate the research background.

* *...often present a...architecture, requiring... This leads to... Motivated by this..., in this paper we present a...scheme to provide...for...*

* *This paper addresses two main problems with...approaches—...and...*

* *Some methods developed in...make use of...// ...may also be exploited in...; this has become a research interest in recent years because of the development of...and a need for...This paper presents a...that employs...*

* *This paper proposes a novel approach for...*

* *We present a...for... This...is suitable for...applications in which...are acquired at a fast rate.*

* *Due to the..., the...keeps varying with time depending on...conditions. Moreover, the varying...conditions could also lead to... These factors affect...and cause... Hence, it is important to...so that...can be... However, ... is challenging as it is determined by...*

* *This paper describes...in...specification and the driving motivations behind its design.*

* *In this paper, we describe a...design that enables a higher...than the...standard.*

* *The...standard has been developed with the main goal of providing significantly improved...compared with its predecessors.*

* *...and...are emergent signals being used in many areas, such as...and... In particular, for...applications, they allow...in which the user can... Current approaches for..., however, present many open technical challenges and... Some of the...are specific to the...and often differ from those encountered in classical...*

* *...and...are an emerging technology for... This...combines...and...techniques. While a... network can improve..., it also challenges...due to...*

* *Combining...and..., ...and...are recently proposed to improve... Meanwhile, ...becomes a challenging issue due to...// ...and...further complicate..., since the decision for...is non-trivial. These issues are managed separately in most conventional methods, which might cause...and... A few studies address these issues jointly for...but...*
* *...is a...solution for... Unlike conventional...systems, the...is not isotropic, meaning that... However, due to the lack of a proper model for..., many studies have assumed that... In this paper, a novel model for...based on...has been proposed.*
* *In...systems, it may not be power efficient to have...for...*
* *In recent years, in order to provide a better quality of service (QoS) to..., ... has shifted toward... However, ...is limited and it is essential to efficiently bind...with...*
* *The future...will feature... The coupling of...and...in...use cases makes...very challenging, in terms of...and of...*
* *...consists of...It is especially practical as...when...*
* *One of the main challenges in...using...is... This...also prevents...using existing techniques.*
* *...reconstructs... A crucial step in...is..., which resolves a...structure from...by...*
* *...has piqued researchers interests in...networks. // ..., in such systems is of paramount importance.*
* *Recently, many efforts have been made to develop...for..., as well as for... Because...are often not feasible, ...is strongly demanded for...*
* *It is now commonly agreed that...// ...will also have an impact on...// ...will open the door to... In this new context, how to...and how to...become fundamental problems that need to be solved.*
* *...enables... While...become widespread in the market, the...technology is yet limited in...*
* *While...and...are two closely related and fundamental tasks in..., previous methods approach them..., failing to... In view of the existing gap between... and..., we propose to solve them together using a...*
* *The continuous development and usage of...have contributed to the exponential growth of... In this context, ...plays a critical role in...such as..., ..., and... Thus, a...paradigm for...is highly desired to meet the increasing...requirements.*
* *Bridging the gap between...and...has not yet been accomplished on a large scale. // ...is a promising way to do this.*
* *...has been a promising direction in...for more than a decade since... However, ...approaches typically require..., which is a practical limitation in real systems, such as ..., where...can be impractical and time consuming.*
* *...is an emerging paradigm that provides...to..., enabling...*

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6.2.2 Presenting the Purpose of the Research or Summarizing the Research

We can also present the purpose of the research or summarize the research in the beginning of an abstract, by using the following sentence structures.

* *In this paper, a...for...model with...matrices is proposed.*
* *This paper considers the problem of...in order to optimally detect...in a...system, under the assumption that...*
* *We introduce the concept of a...contraction metric, extending...to...*
* *We propose a...scheme which combines the advantages of...and...*
* *…can be defined by…, …, and… In this work, we present a hybrid model of...combining..., ..., and...*
* *...have experienced a continuous increase in relevance for..., because of... In this work, we introduce a new...scheme that exploits a combination of the concepts of...and...to provide near-optimal performances with ...*
* *In this paper, a...for...systems is proposed where..., i.e., ...*
* *In this paper, a...strategy based on...is introduced.*
* *In this paper, we formulate a joint...and...problem in the...network, considering the evergrowing demand of...imposed by...*
* *The...offers excellent opportunities to...due to... This paper presents experimental measurements and...models for..., using...*
* *This paper aims to provide a broad perspective on..., as well as the principles used in building...*
* *In this paper, we present an algorithm for...using...*
* *In this paper we address the problem of...from...*
* *A...method is presented to determine...*
* *To..., ...are introduced into... The...and...can lead to..., as well as... Such...will affect...and consequently... Therefore, research into objective methods for...has received attention in recent years. In this paper, we proposed a... for...based on a...scheme.*
* *To stimulate research in this field we conducted a public research challenge: ...*

6.3 Describing the Research Method

Then, we need to briefly describe the research method used in the research. The following sentence structures are useful.

* *An approximation of this…based on…is proposed and the accuracy of this*

approximation is confirmed by... Moreover, the statistics of...are calculated and...is modeled as a random process. The influence of...on...has been evaluated. Finally, a...model is proposed by considering... The performance of...is assessed on...and it is shown that it is important to take...into account.

* *The exhaustive search over all the possible...is relaxed to formulate a...problem. Then, the...problem is converted into a...problem which can be efficiently solved. Using the solution, the...can perform... To further improve...performance, we also develop a...that exploits...*
* *First, we determine the priority of different...by enforcing the analytical framework using... Using..., we then formulate a...game to initiate... Subsequently, we consider...in the...game that occurs due to...and solve the...problem by applying...*
* *More than...were measured across...bands to yield...*
* *Adopting a...approach, a...model is constructed to capture...and a...scheme based on...is proposed, yielding a...algorithm able to...*
* *We present a...method that deals with... In particular, given..., our method is able to...*
* *We approach this task with...and propose a novel...model that incorporates... The model consists of two main parts: 1)..., and 2)... Different from most competing...techniques that..., our network uses... This characteristic allows us to apply...*
* *We formulate the...problem over...and...jointly. The...is updated using..., while the...are updated through...*
* *In particular, we consider a...network under...model, in which... We derive...for... We propose a...scheme, which nearly achieves...*
* *First, we compute...for the proposed...scheme, based on... We also derive... Next, ...is estimated using...methods in the presence of... We highlight that...*
* *…models are investigated based on…// …are derived, which are used to…// …is discussed, and...is used to...*
* *We address this issue by developing an analytical framework based on... We focus on... We analytically derive... We then investigate..., and develop... We extend... and evaluate its utility.*
* *Due to the diversity of..., …are taken into account to develop… The features are designed by considering..., ..., and... The...features are then...*
* *Thus, with the view to enhance..., a...scheme for...in the context of...is proposed. It consists of the following two modules: 1) ..., and 2) ...*

6.4 Summarizing the Research Results

In the abstract, we should also present the main results of our research. We can use the

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following sentence structures.

* *It is shown that...can be modeled either based on...or... In addition, a...expression is obtained for...based on...*
* *The proposed…eliminates undesirable…, and ensures that… This approach guarantees..., and ensures that...*
* *The simulation results illustrate the stability of the user association and efficiency of resource allocation with higher utility gain.*
* *...models with respect to...using...are provided herein, and are shown to simplify..., while allowing researchers to... A new...framework, shown to..., is presented for use in..., using...*
* *The performance of the proposed method is assessed using a series of experiments conducted with...and the results obtained pave the way to...*
* *In contrast to what has been speculated in the literature, we show that... Our results also show that...*
* *Results show that by jointly learning from...and..., ...improves..., which is especially obvious for..., such as... At the same time, ...improves...*
* *Simulation results show that our...performs closely to the optimal solution and that it significantly improves...over traditional approaches.*
* *By modeling...as one of the state variables, ...can be estimated, which is further corrected by...method. The...parameters from experimental results are integrated in the model, and simulation results are validated by experiment.*
* *The simulation results show that the proposed...approach is effective for many... scenarios, and...provides...performance and maintains good...*
* *It is shown that, for..., ...results in a reduction of...in...as compared to...and nearly the same…as… In addition, we show that…achieves better performance in all studied...conditions, as compared with other techniques. It is also shown to efficiently work for any configuration of...and..., even for the case of...*
* *Computer simulation results reveal that our...algorithm and novel...solution provide not only a superior...performance but also an increase in...compared to the ordinary... approach.*
* *The…of the proposed method is analyzed and numerical results confirm that the proposed scheme outperforms alternative algorithms in terms of..., while...*
* *Applying these methods to...has the potential to...while simultaneously improving user experience.*
* *Experiments in...show that…results in higher...than either of its two independent components and other state-of-the-art...*

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* *Results on...reveal that...outperforms...as it yields significantly more accurate affective models. Moreover, it appears that...meets and even outperforms affective models that..., for several of the scenarios examined. As the...method is...and applicable to..., the key findings of the paper suggest that...*

6.5 Presenting the Research Conclusions

We can also state the research conclusions in the abstract by using the following sentence structures.

* *Models presented here offer side-by-side comparisons of..., and the results and models are useful for...of future...systems.*
* *The results presented here may assist researchers in analyzing and simulating...that will rely on...*
* *Our approach improves... It also improves state-of-the-art...performance on...*
* *Our extensive qualitative and quantitative evaluation reveals that... Our validation also proves that..., and improves..., such as...and...*
* *Our method is based on... This allows us to model a...that will... The method is...and the results... It outperforms the state-of-the-art...and according to several metrics, and can handle...*
* *We evaluate the proposed approach on...and...databases as well as...database and show superior performance to state-of-the-art...and...methods. Finally, cross-database evaluation shows a high ability to..., indicating...*
* *The proposed...model is able to...and produces convincing results for... We rigorously evaluate the proposed model on..., and report superior performance compared to the existing state-of-the-art.*
* *Numerical results demonstrate the feasibility and performance of our approach compared to...*
* *We prove here…and introduce…to improve… Although, we demonstrate our augmentation on...alone, in general it may be applied to any...algorithm that relies on...*
* *Our analysis makes use of the theory of..., and develops...by... Simulation results verify our analysis, and throw up interesting open problems.*
* *In a...study, we demonstrate its advantages and the need for... With our developed methodology, we can advance the state-of-the-art in...and provide means to...*
* *The effectiveness of the...model is demonstrated using... The model parameters are estimated using...*

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* *The contributions of this paper include: (i) an analytical model for..., (ii) the analysis of..., and (iii) the design of...*
* *The validation tests on...reveal the superior performance of the proposed approach compared to the competing metrics.*
* *Finally, the proposed scheme has been experimentally evaluated on...and...to prove its effectiveness and efficiency in terms of...and...for...*
* *To conduct realistic experiments, we made use of... Experimental results show that our proposed method significantly outperforms existing methods.*
* *The experiments show that the presented approach significantly outperforms state-of-the-art methods in...settings, both in terms of...and...*
* *Compared to state-of-the art...our...method achieves... We demonstrate its applicability to...in...and...tasks.*
* *Our experiments validate the theoretical intuitions behind our method, and we find that...achieves a comparable or better performance than..., especially on..., since it can...*
* *We describe and analyze the various improvements we applied to our own...and show the resulting performance in...*
* *We demonstrate that...can be evaluated objectively by... We find that in the evaluation practice... The analysis provides objective insight into the strengths and weaknesses of...*
* *Future trends in...are identified based on industry examples and academic research.*
* *Finally, future...strategies and functionalities in...infrastructures are addressed, and global...trends are summarized.*
* *We also discuss key challenges for future work, especially with the focus on... for...in mobile wireless networks.*

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Exercises

I. Below is a random list of sentences of the abstract from a research article. Please identify the move of each sentence and determine the correct order of the sentences.

① The proposed architecture relies on a Luenberger observer together with a bank of Unknown-Intput Observers (UIOs) at each subsystem, providing attack detection capabilities.

② Our analysis shows that some classes of attacks cannot be detected using either module independently; rather, by exploiting both modules simultaneously, we are able to improve the detection properties of the diagnostic tool as a whole.

③ Theoretical results are backed up by simulations, where our method is applied to a realistic model of a low-voltage DC microgrid under attack.

④ We describe the architecture and analyze conditions under which attacks are guaranteed to be detected, and, conversely, when they are stealthy.

⑤ DC microgrids often present a hierarchical control architecture, requiring integration of communication layers.

⑥ Motivated by this application, in this paper we present a distributed monitoring scheme to provide attack-detection capabilities for linear Large-Scale Systems.

⑦ This leads to the possibility of malicious attackers disrupting the overall system.

(Gallo, A. J., Turan, M. S., Boem, F., Parisini, T. & Ferrari-Trecate, G. 2020. A distributed cyber-attack detection scheme with application to DC microgrids. *IEEE Transactions on Automatic Control*, *65*(9): 3800–3815.)

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Keys to Exercises

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Chapter 2 Introducing Background

I.

Excerpt	Comment
Unlike the previous generation of mobile networks, 5G systems, are expected to rely on both the advancement of physical infrastructures represented by the introduction of Millimeter waves, massive MIMO, full duplex, beamforming, and small cells; as well as the emergence of SDN and NFV. By introducing the logical infrastructure abstraction, the 5G mobile networks will revamp modern network infrastructures using SDN and NFV as key enabling technologies towards softwarized networks. Network Softwarization is the core concept supporting the 5G's use cases, i.e., enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low Latency Communications (uRLLC), and massive Machine Type Communication (mMTC), reducing both the Capital Expenditures (CAPEX) and the OPEX of the service provider, while keeping the deployment schema simple. Network Softwarization can enable high performance improvements by offering the flexibility and modularity that are required to create multiple overlying networks. These softwarized networks' mechanisms give place to a new concept dubbed Network Slicing. Meanwhile, the Third Generation Partnership Project (3GPP), in its Releases 15 and 16, introduced a service-oriented 5G core network (5GCN) that entirely relies on NFs, which increases the need for autonomous mechanisms to deploy and manage NS through operating multiple Service Function Chains (SFC) that will dynamically steer the network traffic and flows across multiple logicaland physical infrastructures. For instance, a given userhas a network slice that consists of two SFCs:	The authors establish the research territory by claiming the centrality of 5G systems on the basis of development of physical infrastructures and the emergence of SDN and NFV. Then, they review some previous literature.

(Continued)

Excerpt	Comment
The first one is used to handle the control plane part by steering the traffic through the Access and Mobility Management Function (AMF) and the Session Management Function (SMF) which are equivalent to the MME, PDN-Gateway Control plane (P-GWCP), and Serving-Gateway Control plane (S-GWCP) in the 4G system after the control and user plane separation of EPC nodes (CUPS).	
The second SFC will ensure the reliability of the data plane by steering the data flows from the AMF to the Data Network (DN) passing by the User plane Function (UPF) which represents the P-GW User plane (P-GWUP) and the S-GW User plane (S-GWUP) in the CUPS architecture.	
As the standards development organizations (SDOs), i.e., the Next Generation Mobile Network Alliance (NGMN), 3GPP, and International Telecommunication Union Telecommunication Standardization Sector (ITU-T), are instantiating network slices that contain one or more SFCs, each SFC composed by a set of NFs running inside either a logical node or a physical node. To enable this emerging approach, many NFs may require being traversed in a certain strict order, leveraging on the flexibility of NFV, Mobile Network Operators (MNOs) can deploy any particular slice type honoring its real-time requirements. However, this flexible management can lead to a huge number of active nodes in the network infrastructure that are scarcely used, which leads to an inefficient network slicing deployment. Based on these observations, the contributions of this paper are:	The authors establish the niche with a counter-claim. Then, the niche is occupied by indicating the main contributions of the paper.
The introduction of a new architecture in compliance with the ETSI-NFV model and the 3GPP specifications to create a fine-grained NS; The formulation of a Mixed Integer Linear Programming (MILP) to achieve an efficient cross-domain network slicing deployment regardless the underlying topologies (both the VNF layer and the physical layer) while satisfying all constraints and the specifications requested by the end-users or a given vertical's application; The design and evaluation of a heuristic algorithm to overcome the exponential runtime and allow a quick decision-making capability.	
The remainder of this paper is organized as follows. Section 2 summarizes the fundamental background topics and related research works. Section 3 describes the proposed architecture and our network model. Section 4 illustrates the problem formulation and describes our proposed framework solution. Section 5 introduces the proposed heuristic for the reduction of the exponential runtime. Section 6 presents the performance evaluation and our results analysis. Finally, Section 7 concludes the paper.	Lastly, the outline of the article is stated.

II.

1. Flexibility *always* comes at a cost of robustness, especially when automated parameter estimation is involved.

2. It is *often* a problem in various fields that one runs into a series of tasks that appear to be highly related to each other, yet applying the optimal machine learning solution of one problem to other results in poor performance.

3. In the context of secure control, attack detection and resilience schemes *can be often* divided in data driven and knowledge-based approaches.

4. We test the hypothesis that DL *could* construct feature extractors that are more appropriate than selected adhoc features picked via automatic selection.

5. Answers to this question *could* have a major practical impact especially in those situations where identifying a process model *can be* difficult and time consuming.

6. This difficulty has led to the proliferation of different and, *sometimes*, incompatible proposals for the practical realization of IoT systems.

7. However, acquiring these parameters *may be* troublesome and costly.

8. Some of these agents *may be* unreliable, and therefore the consensus process needs to be reliant.

9. An observed sequence of patterns often conveys a meaning to the observer, whereby independent fragments of this sequence *would be* hard to decipher in isolation.

10. Assuming robust deep learning is achieved, it *would be* possible to train such a hierarchical network on a large set of observations and later extract signals from this network to a relatively simple classification engine for the purpose of robust pattern recognition.

III.

1. In statistics and data analysis, one typically proceeds from data presented in the form of real numbers or categorical values, implicitly assuming the underlying measurement process to be precise and exact. In many cases, however, this *assumption* is clearly not warranted.

2. We shall now introduce three categories of prediction problems, all of key relevance to the operations and management of commercial mobile wireless networks. This *categorization* is

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not meant to be exhaustive, although vast majority of problems we have encountered fall into one of these categories.

3. Many machine learning techniques are tied to a series of hyper-parameters and/or selection of sub-components that need to be tuned. This *challenge* can broadly be defined as the algorithm configuration problem.

4. In the context of formation control, most of the proposed approaches are based on the notion of navigation function, which is constructed from the geometric information on the considered topology and then employed to define gradient descent control laws. This *concept* has been recently extended to the multi-agent scenario, both in a centralized and decentralized implementation.

5. Any successful attack on CPS may jeopardize critical infrastructure and people's lives and properties, even threaten national security. In 2010, Stuxnet malware launched a devastating attack on Iranian uranium enrichment facilities. This *incident* raised a great deal of attention to CPS security in recent years.

6. Although there is not yet a formal and widely accepted definition of "Smart City", the final aim is to make a better use of the public resources, increasing the quality of the services offered to the citizens, while reducing the operational costs of the public administrations. This *objective* can be pursued by the deployment of an urban IoT.

7. During the first three decades of research, the fuzzy logic community has more focused on topics in the realm of knowledge and information processing, such as control and approximate reasoning, and less on analyzing and learning from data. This *focus* started to change in the recent past, which has been characterized by a shift from largely knowledge-based to strongly data-driven fuzzy modeling.

8. Comprehensibility was defined as the learning algorithm ability for encoding its model in such a way that it may be inspected and understood by humans. This *definition* narrows the focus to the model itself.

9. Baseline PI is extended to include an appropriate combination of PI task selection and soft-max task selection. This *development* improves performance and boosts the exploratory properties of the algorithm, meaning that escape from local minima is possible.

10. We define a matrix-valued function, for each agent, which is similar in spirit to the definition of a standard navigation function. This *function* is modified by the presence of

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additional dynamics and the resulting value functions are smooth, hence yielding smooth control laws.

IV.

1. The application of the IoT paradigm to the Smart City is particularly attractive to local and regional administrations that may become the early adopters of such technologies, *thus acting* as catalyzers for the adoption of the IoT paradigm on a wider scale.

2. These two modules exploit different sets of relations and different model knowledge to perform detection, *thus compensating* each other's vulnerabilities, and reducing the number of attacks that are stealthy.

3. Recent neuroscience findings have provided insight into the principles governing information representation in the mammalian brain, *leading to* new ideas for designing systems that represent information.

4. In the past, these systems were standalone and isolated from the world, *making* them unsusceptible to external malicious attacks.

5. A blockchain contains a set of blocks, and every block contains a hash of the previous block, *creating* a chain of blocks from the genesis block to the current block.

6. To the best of the authors' knowledge, this is the first-time deep learning is introduced to the domain of psychophysiology, *yielding* efficient computational models of affect.

7. A simultaneous proliferation of high-value connected devices makes the IoT a desirable attack surface, and drives security-related resource requirements, *demanding* high-powered computation—lest a platform become unfavorable for mission-critical applications.

8. They successfully managed to learn decoding rules with high accuracy using only a fraction of the training trials required by the earlier approaches, *allowing* subjects to communicate consistently with a computer in a single session.

9. The study compares DL against ad-hoc feature extraction on physiological signals, used broadly in the AC literature, *showing* that DL yields models of equal or significantly higher accuracy when a single signal is used as model input.

10. Batches of random experiences are drawn from the buffer and used for updates, *forcing* the network to generalize beyond what it is currently doing in the environment.

Chapter 3 Describing Methods

I.

Excerpt	Comment
Fig. 1 depicts the architecture overview suggested in this paper. We have divided the architecture into three layers, as it integrates the ETSI-NFV model and the 3GPP entities to enable the monitoring, selection and creation process of the virtual instances. The physical layer consists of a set of servers and routers. In this layer, the servers are grouped into a set of data centers that communicate between themselves through the physical network. A set of routers would be used as connectors for connecting different data centers. In the NFV model, this layer refers to the NFV infrastructure (NFVI) and would be controlled by the Virtualized Infrastructure Manager (VIM) presented in the same figure. The VNF layer consists of a set of virtual network functions (VNFs) created on top of the servers. Each VNF is dedicated to one or many functionalities during the forwarding of different data traffics. The VNF layer is managed by the VNF Manager (VNFM) that ensures the life-cycle management of all VNF instances spreading over multiple administrative domains. The slice layer, which runs on top of the VNF layer, consists of a set of slices that are dedicated to different services, e.g., health-care and connected cars. The traffic in each slice is routed thanks to service function chaining (SFC), where each traffic in the slice would be forwarded using a predefined order. Each slice is formed by ingress, egress nodes, as well as a set of intermediate nodes. At the reception of different packets at the ingress node, which is also called classifier, the SFC of those packets would be identified, and then the traffic would be forwarded according to that specified SFC. It is noticed that the AMF is considered the classifier in the 3GPP standardization as it is the shared entity between the control plane and the data plane. For instance, in the case of connected car management that belong to the URLLC category, a slice can be comprised of more than one SFC inside a given network infrastructure. While the first SFC could be dedicated to the monitoring and control plane information, the second SFC could be used for applying different management actions i.e., the data plane. In the following work, only the core network, (CN) part is considered, while the radio part was not studied. However, the proposed solution can be also used to deploy RAN slices or RAN/CN slices if the RAN part is an NF on top of the cloud/data-center.	The first sentence presents an overview of the principle by which the model works. Then, the authors briefly describe the principal parts of the figure. Lastly, the underlined sentences explain how the figure works.

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II.

Excerpt	Comment
In this section the desired evolution of the disturbance-free model (5) will be obtained with the use of a reaching law-based control strategy. In particular, we used a generalization of Gao's seminal reaching law for the case of relative degree two sliding variables since such a strategy has been shown to provide better dynamical properties of the system than its relative degree one equivalent [32]. The considered reaching law is expressed in the following way(12) where $s_m(k)$ is the relative degree two sliding variable (8) $\varepsilon>0$, $1>q>0$ and are the design parameters. The objective of this strategy is to drive the system representative point to an arrow vicinity of the sliding hyperplane and to ensure that the hyperplane is crossed in each step. We obtain the control signal which satisfies these properties by substituting (10) into the left hand side of reaching law (12) and solving the obtained equation for $u_m(k)$. Then, the control signal has the following form (13). In formerly published literature [32] several advantageous properties of reaching law (12) have been proven. Two of those properties will now be quoted.	In the beginning of this section, the authors state the purpose of the method. Then they briefly review previous work, which serves as theoretical basis of the method. Lastly, they explain how their strategy works in detail.

Chapter 4 Reporting Results

I.

Excerpt 1	Comment
We train and test our system on a PC with an Intel Core i7-6700 k CPU, 16 GB RAM, and one Nvidia GTX 1080 graphics card with 8 GB memory. The average time cost of each training iteration is 0.25 s on GPU, and it takes 1.4 hours for 20,000 iterations to complete the whole training process. Given a reasonably large mesh from the SCAPE dataset (12,500 vertices, 24,998 triangles), it takes 26.4 s to compute the raw SH descriptors from the mesh on CPU, 0.09 s to compute the distance metric on GPU, 0.06 s to compute the saliency map on GPU, and 163.4 s to compute 30 saliency-induced embeddings from the metric on CPU. The method of [25] takes about 235.2 s for shape matching on CPU.	The authors refer back to the methodology by adding details of the apparatus and parameters, in order to help that are important for readers to re-generate the experiment.

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(Continued)

Excerpt 2	Comment
The visual quality of classical images and videos is generally measured by a global quality index that (ideally) integrates all the possible sources of distortion into a single or a few values. However, as aforementioned, the sources of distortions in 360-degree videos are numerous and quite different, and their combination into a global index is far from trivial.	The authors contextualize the results by providing background information about the method used.
Table II summarizes the different types of distortions commonly found in 360-degree video. We broadly categorize them as: *spatial*, i.e., those related to still image compression and can appear in both images and videos; *temporal*, i.e., those related to the temporal evolution of images and appear only on video; *stereoscopic*, i.e., those related to binocular vision; and *navigation*, i.e., those that only appear while the user navigates through the scene.	Then, they report the results with a table, and describe the main categories of results in the table.
The ultimate way to assess the 360-degree visual quality is through subjective tests. Such tests, however, are time consuming and expensive. Thus, objective metrics have been proposed for omnidirectional video in the past few years. However, it is quite challenging to capture all the effects that impact the QoE of 360-degree videos, and much work remains to be done in this area, in particular, with regards to perceptually optimized metrics.	After summarizing the main results, the authors point out a direction for further research.

II.

Excerpt	Comment
① Table VII summarizes metadata for experiment set A using row communication, and Tables VIII and IX repeat these statistics for mesh and hybrid communication. ② In these tables, σ is the percentage improvement of the soft-max variant when compared to the solution generated by the baseline, and θ is the number of additional problems that each algorithm could solve (i.e., the number unsolvable by the baseline but solvable by the algorithm in question). ③ In calculating the percentage of problems solved, the number of problems was taken as 32, as 4 problems could not be solved by any method in any of the tests. ④ The data are also	Sentence ① is a summary statement about the table. Sentences ② highlights the parameters in the table. Sentence ③ provides some supplementary information about the results in the table, followed by a reference to Figure 4 for details.

(Continued)

Excerpt	Comment
depicted as a bar chart in Fig. 4 for ease of comparison. ⑤ Note that if the sum of the percentages of best solutions is greater than 100% it is because two algorithms generated the same best solution.	Sentence ⑤ explains how some numbers are obtained in the table.

III.

Excerpt 1

As shown in Fig. 11, in general, the users' throughput decreases when the number of Wi-Fi channels is reduced. Among all the methods, the performance of the SSS decreases the most significantly. This is because the SSS assigns users to Wi-Fi regardless of its capacity and availability. Thus, when the Wi-Fi capacity is reduced, the performance of those Wi-Fi users is severely compromised. Unlike the SSS, the other methods have the ability to balance the loads between Li-Fi and Wi-Fi, and thus are less affected by a reduced number of Wi-Fi channels. In addition, as the number of Wi-Fi channels increases, the performance of the FL-SSS gradually approaches that of the FL-LB. The reason for this trend is that when more users are migrated to Wi-Fi, the gap between using the LB and SSS in Li-Fi becomes smaller.

Excerpt 2

Fig. 9 presents the users' satisfaction and fairness of various methods when the average required data rate is 10 Mbps. As shown in Fig. 9(a), the proposed method can significantly increase the users' satisfaction over the SSS and LB, especially for a large number of users. When 30 users are present, using the SSS can meet the data requirements for only 74.6% of the users. This value is increased to 87.4%by employing the LB instead of the SSS. When using the FL-SSS and FL-LB, the proportion of satisfied users is 96.1% and 91.9%, respectively. Note that there is across point between the curves of the FL-SSS and FL-LB. This is because using the LB in the proposed method can improve the performance of deeply-unsatisfied users, by decreasing the number of satisfied users. In Fig. 9(b), the fairness among users is shown for different numbers of users. Two outcomes are observed: i) the fairness of all methods equals 1 given a small number of users; ii) as the number of users increases, the fairness decreases for all methods, but the fairness of the FL-LB decreases much slower than that of the other methods. At the fairness of the FL-LB achieves 0.95, while the remaining methods have a fairness below 0.9.

Chapter 5 Discussing Findings

I.

1. Taking inspiration from OMP, we *could* reduce potential error accumulation in the estimated nk by recalculating all of their values upon each successive detection of a fluorescent emitter.

2. Our super-resolution imaging method *can be* applied to a wider variety of applications that employ forward models.

3. Each node *might* publish its own features and data by running a CoAP server, though this feature is not yet implemented in the testbed.

4. The proxy logic *can be extended* to better support monitoring applications and limit the amount of traffic injected into the IoT peripheral network.

5. Examining the readings of the other sensors in the same time interval, we *can* note a sharp decrease of light intensity and temperature, and an increase in humidity.

6. Several applications with different performance requirements *may* require access to the same piece of information at the same time.

7. The reduction in resource requirements *would* allow sensing and connectivity to migrate into very low-power wearable devices, reducing the cost and complexity of contemporary health-aware clothing

8. When the target appearance changes gradually the prediction *is more likely to* succeed.

9. *It is likely that* all the methods presented here would perform better if prior knowledge had been incorporated into choosing the feature space.

10. In passive (data-only) systems, sensors *can* fail, connections *can* drop, or a proxy's model *might be proven* inaccurate or incomplete.

II.

1. *Since* the IoT devices could be part of different management domains during their lifetimes, that information would be spread among many nodes making it difficult to audit and track it.

2. Public lighting operators will be equipped with mobile devices that can locate the streetlight that requires intervention, issue actuation commands directly to the IoT node connected to the lamp, and signal the result of the intervention to the central system that can track every

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single lamppost and, *hence*, optimize the maintenance plan.

3. The SPC cannot cope with the concept change within a user *because* it does not have any mechanism to forget old records.

4. The work represents an important extension to the baseline as real missions take place in dynamically changing environments where the SA is subject to alter rapidly. Task allocation strategies must *therefore* be able to adjust to new data and recompute new solutions in real time.

5. It is possible to specify a list of resources that need to be monitored, *so that* the server can autonomously update the entries in a cache related to those devices.

6. An approach based on hierarchical reinforcement learning (HRL) was chosen, *as* it is a promising approach to expand traditional RL methods to work with more difficult and complex tasks.

Chapter 6 Writing Abstract

Lead-in

Sentences 1 and 2 introduce the research background. Sentences 3, 4 and 5 state the purpose of the research. Sentences 6, 7 and 8 describe the methods of the research. Sentence 9 shows the results, and Sentence 10 discusses the results.

Exercises

Order: ⑤ ⑦ ⑥ ① ④ ② ③

Sentences ⑤ and ⑦ indicate the research background. Sentence ⑥ presents the purpose of the research. Sentences ① and ④ describe the research method. Sentence ② shows the research results. Sentence ③ presents the research conclusion.

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内 容 简 介

本书共六章，围绕摘要、引言、研究方法、研究结果、讨论与结论、语料库操作等主题展开，选取计算机学科领域重要国际期刊的学术论文为素材进行编撰，直击学术英语写作的难点问题，旨在助力计算机相关专业方向的研究生和从业人员提升其学术论文写作能力。本书遵循“讲”“学”“用”三位一体原则，融合知识讲解、案例呈现和配套练习，旨在营造较强的学习代入感。其中，配套练习包括选择填空、句子排序、段落修改、简答等多种题型，既能强化语言表达和体裁结构方面的知识点，又能帮助学生掌握学术英语写作要点。

本书适合高等院校计算机专业的硕博研究生使用，也可供广大学术英语爱好者参考使用。

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总　　序

2020 年 11 月，教育部新文科建设工作组发布的《新文科建设宣言》指出："文科教育融合发展需要新文科。新科技和产业革命浪潮奔腾而至，社会问题日益综合化复杂化，应对新变化、解决复杂问题亟需跨学科专业的知识整合，推动融合发展是新文科建设的必然选择。进一步打破学科专业壁垒，推动文科专业之间深度融通、文科与理工农医交叉融合，融入现代信息技术赋能文科教育，实现自我的革故鼎新，新文科建设势在必行。"学科英语是外语学科和专业学科相互交叉、彼此融合的产物，符合国家"新文科"建设的时代愿景。开辟外语学科建设的全新思路，是当前外语教学改革的重要突破方向。

"中国科学院大学研究生教材系列"将切实满足特定专业学生群体的英语学习需求作为教材编写的重要依据，充分考虑到具体学习者群体的学习目标和学习诉求，具有以实际应用为导向的根本特质。该系列教材不仅关注教材编写前期的需求分析，同时重视教材试用阶段使用者的实际反馈，因为我们认为，直面使用者反馈是确定教材价值的关键一环，是重新审视学习者需求的宝贵机会，更是反复改进教材质量的可靠抓手。

"中国科学院大学研究生教材系列"融入现代信息技术，运用语料库的数据处理方法，整理归纳学科英语的语言特点和语篇特征。语料库方法可以十分客观快捷地捕捉学术语篇中的词汇、短语、搭配、语块、句子结构等语言层面的使用规律，正在成为学术和学科英语研究领域新近涌现的热点之一。然而，语料库技术运用于教材编写的尝试却寥寥无几，该系列教材无疑为语料库方法运用于教材编写做出了开创性的贡献。语料库的运用不仅能够呈现自然学术语境中真实的语言使用，更为重要的是，能够引导学习者建立适合自己微观研究方向的专业文献语料库，并将其作为未来学术生涯的开端以及追随学术生命成长过程的见证。学科英语语料库一方面可以成为研究者文献阅读经历不断累积的记录，另一方面也可能成为研究者写作不竭的灵感源泉和他们未来指导学生进行

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专业写作的宝贵财富。基于学科英语语料库的教材建设在“授人以鱼”的同时也在“授人以渔”，而学习者也会因此获得“授人以渔”的能力。

我们正处在一个教育变革的时代。新的时代呼唤符合国家发展需求的教育理念和新颖实用的教学方法，同时也鼓励教师队伍努力探索新型的教材编写模式。“中国科学院大学研究生教材系列”积极响应时代的要求，是国家“新文科”建设指导思想下的勇敢尝试。

该系列教材的出版得到中国科学院大学教材出版中心资助，在此表示感谢。

高　原

2022 年 5 月

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前　言

近年来，随着学术英语教学的普及，各类面向特定学科的专门用途学术英语教材已为广大学生熟悉和认可。但囿于篇幅所限，这类教材通常聚焦听、说、读、写、译等学术技能，未能凸显具有学科特色的学术用语，如学术词汇、学术搭配、学术句式等；也难以涵盖特定学科学术语料的分析方法，如创建学术词表的方法、检索学术词汇搭配或句式语法的方法等。但这些内容却是学生提升学术英语水平和自主学习能力所必须掌握的。

《学科英语写作教程：计算机》的编写初衷即在于此。它以计算机学科一区和二区期刊的研究论文为语料，采用语料库方法，为学生梳理具有学科代表性和权威性、凸显本专业特色的学术用语。本书遵循“一书两用”的编写方案，既提供从词汇到句子的真实语料用于查询和应用，又提供论文结构的样文讲解和学术语料的分析讲解便于学生自主学习。因此，本书具有专业针对性，适用于拥有计算机专业知识背景或对计算机专业学术论文写作感兴趣的硕博研究生和英语爱好者。

本书共六章，前五章聚焦学术英语论文的体裁结构，每章由概念解读、元素分解、语步精解、短语句式和写作反思五个板块构成；第六章则讲解学术语料库的分析方法。这六章又可分为两大模块：学术论文构件模块（第一章至第五章）和语料库工具操作教程模块（第六章）。

学术论文构件模块提供写作范例、学术短语和学术句式。该模块以学术论文的体裁结构，即摘要（Abstract）、引言（Introduction）、研究方法（Research Methods）、研究结果（Research Results）和讨论与结论（Discussion and Conclusion）为单元设计，分析和讲解学术样文、学术短语和学术句式。所有样文均经过精心挑选，体现计算机专业学术论文的典型语步。为帮助学生快速了解和准确掌握这些语步，编者在样文中配以序号对语步进行区分，并简明扼要讲解各语步的主要功能。学术短语和学术句式则与这些语步相呼应，呈现各语步最为常见的惯用表达。学术短语以名词、动词和介词短语为主，学

术句式以“主 + 谓 + 宾 + 补 / 状”结构、并列句和从句结构为主，涵盖计算机专业学生需要掌握的大部分短语和句式。因此，这些学术短语和学术句式能帮助学生在规范学术用语的同时，理解它们和体裁结构之间的关系，从而掌握计算机专业学术论文的写作框架和各语步对应的语言表达。

语料库工具操作模块主要围绕学生自主学习学术英语写作的三大难题展开，即哪些是学术词汇、如何使用搭配词和如何检查语法，同时包含创建词表、查询搭配词和核对短语语法在内的三项主题内容。每项主题均包括工具讲解和步骤讲解，语言言简意赅，并配以图例展示操作和分析过程，使学生容易理解操作方法、把握语料分析要点，从而实现自主学习的目的。

鉴于编者水平有限，疏漏之处在所难免，恳请读者批评指正。

钱玉彬
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Chapter 1
Abstract

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"We can only see a short distance ahead, but we can see plenty there that needs to be done."

Alan Turing

1.1 Definition

The Abstract section is like a mini version of the whole paper with a concise statement of its main content. It functions to help readers capture the full picture of the research without reading the full paper. In other words, information in the Abstract section corresponds to the complete paper, but it is highly compressed, having generally between 150 and 250 words. However, the requirements of international academic journals both within and across disciplines may vary to some extent, so it is necessary to check the guidelines of the journal before submission.

1.2 Components

Although short in length, the Abstract section provides information of vital importance for both journal reviewers and readers, and therefore it needs to be taken seriously. To be more specific, during the review stage of the paper, the journal editor, based on the reading of the Abstract section, may conduct an initial evaluation with regard to its suitability for inclusion in the journal, and make a further decision on whether to proceed with peer review; peer reviewers would also like to give priority to the Abstract section and develop a first impression of the entire paper according to the writing. In fact, an open secret is that many desk rejects are attributed to a poorly written Abstract section—it tends to reduce reviewers' interest in reading while elevating the risk of rejection. In the process of paper retrieval and dissemination, the Abstract section is usually the only part of the full paper that is accessible online for free; thereby, it always attracts the most attention from readers, serving as the main basis for them to determine whether to read and pay for the remaining parts of the paper.

The guidelines for writing the Abstract section in most academic journals are mainly limited to content rather than format, and usually require the descriptions of research background, purpose, methods, results, and conclusions. In the practical writing of an Abstract section, the following tips deserve much attention:

- Stay neat and avoid being long-winded, especially for the first sentence. The writing style of the Abstract section often reflects the overall writing style of the paper. A lengthy Abstract section will obscure key information, and even lead readers to anticipate that the entire paper is unclear as redundant information will continue to be piled up, thereby reducing the attraction of the paper. An appropriate way of writing

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is to present only the core points expected by the journal or concentrate on the main content of the paper, and avoid details such as examples. Besides, it is necessary to keep wording and phrasing concise and remove repetition and rhetoric.

- Avoid starting with non-critical information. As the Abstract section is limited in length, the core points of the paper should be promoted in the limited space as much as possible. Especially at the very beginning of the Abstract section, background information that is irrelevant or weakly associated with the main topic should not be involved. Otherwise, it will distract readers' attention from the main topic while squeezing the space. An appropriate way of writing is to start the Abstract section with the use of keywords and proceed with the writing by reducing the use of non-keywords.

- Avoid the misuse of tense and voice. Ambiguity caused by tense and voice is a common problem found in inexperienced Abstract writings. For example, a mixed use of the present tense and passive voice may appear without a distinction between the research conducted by the writer and by others, but it may be a nightmare to readers. A common way of writing is to combine the first-person pronouns and past tense when describing the writer's own work, and use the third-person pronouns and present tense to represent others' research.

- Explain the reasons for the research. In order to impress readers, the Abstract section not only clarifies what research has been carried out, but also brings readers to the research rationale. By and large, it is better to involve some background information that highlights the necessity and importance of the research in the first three sentences of the Abstract section.

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1.3 Structure

The Abstract section can be usually divided into five structural components (or moves), which are research background, research purposes, research methods, research results, and research conclusions.

- **Move 1:** Research background, outlining the importance and necessity of the research topic, and illustrating the problems, gaps, challenges, or shortcomings in prior research.

- **Move 2:** Research purposes, presenting the research goal.

- **Move 3:** Research methods, outlining the study design and research procedures to carry out the research, as well as the data, tools, devices, programs, algorithms, or models used.

- **Move 4:** Research results, summarizing the major findings and achievements of the research.
- **Move 5:** Research conclusions, presenting the significance and implication of the research.

Case Study One

Excerpt (Fawzi et al., 2015)	**Moves**
① Classifiers based on sparse representations have recently been shown to provide excellent results in many visual recognition and classification tasks. ② However, the high cost of computing sparse representations at test time is a major obstacle that limits the applicability of these methods in large-scale problems, or in scenarios where computational power is restricted. ③ We consider in this paper a simple yet efficient alternative to sparse coding for feature extraction. ④ We study a classification scheme that applies the soft-thresholding non-linear mapping in a dictionary, followed by a linear classifier. ⑤ A novel supervised dictionary learning algorithm tailored for this low complexity classification architecture is proposed. ⑥ The dictionary learning problem which jointly learns the dictionary and linear classifier is cast as a difference of convex (DC) program and solved efficiently with an iterative DC solver. ⑦ We conduct experiments on several datasets and show that our learning algorithm that leverages the structure of the classification problem outperforms generic learning procedures. ⑧ Our simple classifier based on soft-thresholding also competes with the recent sparse coding classifiers, when the dictionary is learned appropriately. ⑨ The adopted classification scheme further requires less computational time at the testing stage, compared to other classifiers. ⑩ The proposed scheme shows the potential of the adequately trained soft-thresholding mapping for classification and paves the way towards the development of very efficient classification methods for vision problems.	**Move 1: Research background** Sentence ①: Importance of the research topic Sentence ②: Problems, gaps, challenges, or shortcomings in prior research **Move 2: Research purposes** Sentence ③: Goal of the research **Move 3: Research methods** Sentence ④: Study design and research procedures Sentences ⑤⑥: Data, tools, devices, programs, algorithms, or models **Move 4: Research results** Sentences ⑦–⑨: Major findings and achievements of the research **Move 5: Research conclusions** Sentence ⑩: Significance and implication of the research

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Case Study Two

Excerpt (Adewoyin et al., 2021)	**Moves**
① Climate models (CM) are used to evaluate the impact of climate change on the risk of floods and heavy precipitation events. ② However, these numerical simulators produce outputs with low spatial resolution that exhibit difficulties representing precipitation events accurately. ③ This is mainly due to computational limitations on the spatial resolution used when simulating multi-scale weather dynamics in the atmosphere. ④ To improve the prediction of high resolution precipitation, we apply a deep learning (DL) approach using input data from a reanalysis product, that is comparable to a climate model's output, but can be directly related to precipitation observations at a given time and location. ⑤ Further, our input excludes local precipitation, but includes model fields (weather variables) that are more predictable and generalizable than local precipitation. ⑥ To this end, we present TRU-Net (Temporal Recurrent U-Net), an encoder-decoder model featuring a novel 2D cross attention mechanism between contiguous convolutional-recurrent layers to effectively model multi-scale spatio-temporal weather processes. ⑦ We also propose a non-stochastic variant of the conditional-continuous (CC) loss function to capture the zero-skewed patterns of rainfall. ⑧ Experiments show that our models, trained with our CC loss, consistently attain lower RMSE and MAE scores than a DL model prevalent in precipitation downscaling and outperform a state-of-the-art dynamical weather model. ⑨ Moreover, by evaluating the performance of our model under various data formulation strategies, for the training and test sets, we show that there is enough data for our deep learning approach to output robust, high-quality results across seasons and varying regions.	**Move 1: Research background** Sentence ①: Importance of the research topic Sentences ②③: Problems, gaps, challenges, or shortcomings in prior research **Move 2: Research purposes** Sentence ④: Goal of the research **Move 3: Research methods** Sentences ④–⑦: Study design and research procedures **Move 4: Research results** Sentences ⑧⑨: Major findings and achievements of the research **Move 5: Research conclusions** [Not appear] Significance and implication of the research

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1.4 Phrases and Sentences in Moves

Move 1: Research Background

A. Outlining the importance and necessity of the research topic

- Typical collocations

* *a critical issue*
* *a crucial aspect*
* *a key problem*
* *a pivotal/vital/essential/important role*
* *a problematic field*
* *a prominent part*
* *a valuable/interesting topic*
* *all-important status*
* *be widely studied*
* *significant research*
* *worthwhile work*

- Typical sentences

* *Because X* ***occupies a broad range of frequencies****, some redundant components are introduced…*
* *Currently, X, Y, and Z are* ***attracting significant attention from*** *researchers…*
* *These proposed models have now* ***become essential tools for*** *use in all stages of system development and* ***are reported to be particularly important for*** *CBM…*
* *With a profusion of network applications, X* ***plays a crucial role in*** *network…*
* *X and Y* ***are significant and increasing causes of*** *mortality and morbidity…*
* *X and Y* ***are two important issues in*** *Z where various statistical and machine learning techniques have been employed to develop prediction models.*
* *X* ***is an important aspect of*** *fostering effective ways to self-regulate these experiences…*
* *X* ***is an important part of*** *different focus-related applications such as autofocus, focus stacking, and depth estimation…*
* *X* ***is one of the major security concerns****…*
* *X* ***is reconstructed by*** *the KinectFusion…*

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* *X, one of the major exponents of the third generation of artificial neural networks,* ***has not been thoroughly studied as*** *an online learning approach…*
* *X* ***plays a critical role in*** *a variety of data-centric applications…*
* *X* ***protects the runtime integrity of*** *MapReduce applications…*

B. Illustrating the problems, gaps, challenges, or shortcomings in prior research

- Typical collocations

* *a challenging condition/problem/scenario/task/topic*
* *a defect/limitation in*
* *bridge/minimize/narrow the gap (between)*
* *demand of*
* *insufficient knowledge/performance/research/study*
* *lack/paucity/short of*
* *limited application/data/discussion/number/size*

- Typical sentences

* *A number of studies have shown that…However, important questions regarding X* ***remain unanswered****.*
* *Currently, X* ***is the only option for*** *detailed player monitoring in Y…*
* *Despite decades of research on X, Y* ***has been less than satisfactory****.*
* ***Few attempts have been made to*** *investigate the role of X in the field of Y.*
* ***Few studies in the field of*** *X* ***have sought to*** *examine Y…*
* *However, in a large-scale wireless network such as a wireless mesh network, X* ***has not been fully investigated****…*
* *However,* ***most works only focused on*** *applying specific feature selection methods over either X or Y…*
* *However, obtaining meaningful information from large volumes of raw data* ***represents a significant challenge****…*
* *However, the research community* ***is still constrained by the lack of*** *a comprehensive dataset, and* ***there exists no insightful understanding of*** *mobile ransomware in the wild.*
* *However, the type of data in the real world* ***is usually mixed****, i.e., there are both numeric and categorical attributes together…*
* *However, the use of current thermometers in circadian rhythm monitoring* ***is impractical in daily life****.*
* *However, this assumption* ***is not valid for*** *those images with serious intensity inhomogeneity,*

which inevitably leads to poor segmentation performance of existing models.

* *Previous research in the field of X* ***has been largely restricted to*** *Y.*
* *The high cost of X* ***is a major obstacle****…*
* ***The key challenge of*** *deriving transmission capacity is to characterize the aggregate interference of X…*
* ***The lack of*** *a reliable automatic monitoring system* ***impedes investigations about*** *the risk factors of overuse injuries…*
* *The resulting lack of stationarity in the distribution of the produced data* ***calls for efficient and scalable algorithms for*** *X to such changes.*
* *To the best of our knowledge,* ***no forensic technique has yet been invented*** *to identify whether an image is colorized.*
* *X has been thought of largely as a relay nucleus, and its intrinsic connectivity* ***has not been incorporated in significant detail****, in any model thus far…*
* *X* ***has not been previously studied and compared with each other extensively****…*
* *X is an important area of enquiry; however,* ***relatively little is known about*** *Y.*

Move 2: Research Purposes

Presenting the research goal

- Typical collocations

* *aim/attempt/intend/try to*
* *an aim/goal/objective/purpose of*
* *an overall aim (of)*
* *be aimed at*
* *be concerned with*
* *be demonstrated/conducted/presented/proposed/studied (to)*
* *explore the link/relationship (between)*
* *focus/operate on*
* *gain insight(s) into*
* *highlight the issue (of)*
* *look at (how)*
* *offer/undertake an analysis (of)*
* *provide data/information on/about*
* *seek to*
* *set out to*

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- Typical sentences

* *A new X scheme **is proposed to** solve the variational problem…*
* *In this paper, we **focus on** MapReduce, a popular big data computing framework…*
* *In this paper, we **present a novel framework for** X…*
* *In this paper, we **present a novel** Spatial Contextual Super-pixel **Model for**…*
* *In this paper, we **propose a novel** transformation-based **method for**…*
* *In this paper, we **propose an** attribute-aware encrypted traffic **classification**…*
* *In this study, we **analyze and compare** the discrimination capability of…*
* *In this work, we **present an experimental study** comparing X and Y using Z.*
* *In this work, we **present an** unobtrusive automatic monitoring **system for**…*
* ***One of the central claims of this study is** that…*
* ***Our goal is to** find X which captures the intrinsic structure from the data itself…*
* ***Our main goal is/was to** gain a better understanding of X.*
* ***Part of the aim of this project is to** develop software that is compatible with…*
* ***The aim of this paper is to** study several strategies for X in variational optical flow methods…*
* ***The goal of this work is to** present a computational model for contour detection…*
* ***The objective of the paper is to** introduce a non-invasive diagnosis procedure for…*
* ***The objective of this study is twofold**. The first is to…, the second is to…*
* *The study **is conducted to** examine the effect of…*
* *The study **uses** X **to** generate a numeric equivalent from mixed datasets…*
* *This paper **describes a study to** test the accuracy of a method that…*
* *This paper **develops a novel approach to** find the PS plane in…*
* *This paper **presents** an integrated interval fuzzy logic approach **that**…*
* *This study **attempts to** establish the connection between X and Y.*
* *This study systematically reviews the data for…, **aiming to** provide…*
* ***To enable** the analytical calculation, X for the proposed mechanisms **are acquired**…*
* ***To increase** the diversity of application fingerprints, we **develop** a new…*
* ***To solve** this leakage problem, in this study, we **propose** using X **that** occupies the same frequency ranges as the original signals to improve Y…*
* *We **aim to** assess the financial health of enterprises and individuals…*
* *We **build** X **that** controls a robotic arm by solving inverse kinematics in…*
* *We **explore** X **to** build a neural architecture that controls a robotic arm by…*
* *We **propose a** combined deep and handcrafted visual **feature**…*
* *We **propose a** self-organizing neural **architecture for**…*
* *We **propose an** accurate plane-finding **solution based on**…*

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* *We **study a** classification **scheme that** applies…*
* *We **suggest a** novel spatially continuous **approach for**…*
* *We **try to develop a new method by** incorporating…*
* ***With an aim to** detect the manipulation of digital images…*
* *X **is studied in this paper for** a full duplex wireless network…*

Move 3: Research Methods

Outlining the study design and research procedures, as well as the data, tools, devices, programs, algorithms, or models used

- Typical collocations

* *a characteristic/feature/property of*
* *a combination of*
* *a variety/volume/number/quantity of*
* *an adaptation/adoption of*
* *be based on*
* *be categorized/classified into*
* *be commonly used (to)*
* *be composed/consisted of*
* *be defined/formulated as*
* *be drawn from*
* *be gathered through*
* *be referred/restricted to*
* *by means of*
* *compare with*
* *conduct experiments (to)*
* *cost of*
* *depend on*
* *instead of*

- Typical sentences

* ***A classification is formulated as a solution of** finding the maximum posterior…*
* ***A law is proposed to** provide the finite L2-gain property…*
* ***A model encodes** the probabilistic mapping between…*
* ***A number of feature measurements are extracted from** the available images…*
* ***A robot is trained to** find the shortest path to…*

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* ***Algorithm tailored for*** *this low complexity classification architecture* ***is proposed****…*
* ***An estimation is proposed for*** *the learning procedure of model parameters…*
* ***Data is abstracted into*** *a set of symbolic time intervals…*
* ***Data is collected in*** *a cafeteria under normal eating conditions…*
* ***Data is combined in this way for*** *the calculation of…*
* ***Data is given labels to*** *guide the procedure of clustering…*
* ***Data is segmented into*** *a set of super-pixels with strong homogeneous texture…*
* ***Detector is utilized for*** *the identification of structural defects in concrete…*
* ***Experimental texts are presented*** *in order to illustrate the effectiveness of…*
* ***Micro-aggregation is performed*** *on the equivalent dataset…*
* ***Samples are considered to*** *model the level of uncertainty…*
* ***Simulations are conducted to*** *demonstrate the effectiveness of…*
* *The accuracy* ***is maintained for*** *a failure analysis of FRC beams under…*
* ***The algorithm is based on*** *a structured-light technique…*
* ***The approach includes*** *a semi-discrete method in modeling…*
* ***The approach is compared with*** *a type-1 FLS in real-world…*
* ***The approach is proposed to*** *guarantee the stability of the balance controller…*
* ***The approach is to*** *identify the relationship of…*
* ***The approach is used to*** *model the pile and its surrounding soil…*
* ***The device is composed of*** *an omnidirectional mobility unit…*
* ***The device is employed to*** *model the network topology as…*
* ***The device is used as*** *a constraint in the proposed RF framework to…*
* ***The device is utilized for*** *the identification of structural defects in…*
* ***The function is exploited to*** *replace the point-wise approximation method…*
* ***The method helps to*** *achieve the trade-off between…*
* ***The method is combined with*** *a new energy functional for…*
* ***The method is composed of*** *a set of semantic poses…*
* ***The method is used in order to*** *perform an efficient focus sampling…*
* ***The model is constructed with*** *a learner and a teacher who…*
* ***The model is evaluated in*** *both simulation and physical robots…*
* ***The model is to characterize*** *the likelihood of an observed visual frame…*
* *The proposed* ***models were optimized in the sense of****…*
* ***The solution verifies*** *the runtime integrity of MapReduce applications…*
* *We* ***apply the*** *soft thresholding non-linear* ***mapping in*** *a dictionary…*
* *We* ***define a model of*** *a probabilistic process of collecting corrections to…*
* *We* ***perform a pilot study with 14 subjects to*** *evaluate the performance of…*
* *We* ***perform a user study to*** *evaluate the quality of the mesh models…*

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* *We **suggest a novel approach based on** the variational framework…*
* *X **is acquired with a method of** polarization diffraction imaging flow cytometry…*
* *X **is defined in** the standard of the discontinuous reception mechanism in…*
* *X **is generated from** a sequence of hidden visual poses…*
* *X **is produced in the form of** fast streams, which are further affected by…*
* *X **is produced on the surface of** the pile, depending strongly on the…*
* *X **is provided in the form of** the true object pose…*

Move 4: Research Results

Presenting the major findings and achievements of the research

- Typical collocations

* *a general picture*
* *a significant correlation (between)*
* *be assessed/determined by*
* *be capable of*
* *be consistent with*
* *be derived/obtained (from)*
* *demonstrate/reveal/suggest the existence of*
* *effect/evidence/proof of*
* *interesting findings*
* *lead to*
* *overall findings*
* *result from/in*
* *support for*

- Typical sentences

* *Analytical results **show that** under the same network density, the distribution of X in Y **is more dispersed than** that in Z…*
* *Experimental evaluations on several public real-world datasets **show that** X significantly improves accuracy **compared to** Y…*
* *Experimental results **demonstrate that** both proposed methods **exhibit** a decent performance **against** multiple state-of-the-art colorization approaches…*
* *Experimental results on a classification task using two action benchmark datasets **show that** our model **is competitive with** state-of-the-art methods…*
* *Experimental results **show that** the proposed method **attains a better trade-off***

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***between** X **and** Y **in comparison with** the traditional methods…*

* *Extensive evaluation results **show that** the proposed method can **improve the classification accuracy by** 29% on the average **compared with** the state-of-the-art Markov-based method…*
* *Extensive experimental results **show that** the proposed method **not only** achieves state-of-the-art nodule suspiciousness classification performance, **but also** effectively characterizes nodule semantic attributes.*
* *Numerical results **show that** the performance of the element **is superior to** that of X element…*
* *Our results **highlight** the role of X as a major control hub, and **provide** a mechanistic account **for** its control function…*
* *Results of this paper **show that** X and Y **affect** the HRV analysis outcome…*
* *Results **were positive** and X provided a maximum accuracy of 86.9% for binary detection of stress in the real-world.*
* *The effect **was observed in** the subpopulation of X…*
* *The experimental results **show that** our approach can **represent** the semantic relationship of the given entities effectively…*
* *The experimental results **show that** X can effectively **detect** encrypting ransomware **with** high accuracy and acceptable runtime performance…*
* *The experimental results **show that** X can half the manpower while decreasing back muscle activities, **revealing** the potential health benefits for older staff…*
* *The method **fixes** the total number of types of X…*
* *The model **confirms** the likelihood of X…*
* *The proposed method **achieves** the state-of-the-art result without X…*
* *The results **show that** X **are less stable than** the Alzheimer's disease ones…*
* *The results **show that** X **occurs after** a reasonable number of interactions…*
* *The study **shows that** our learning algorithm that leverages the structure of the classification problem **outperforms** generic learning procedures…*
* *This phenomenon **was found associated with** the prevention of X…*
* *Various simulations **demonstrate the effectiveness of** the proposed approach…*
* *We **show that**: (1) X and Y tasks **are rather unrelated**; and (2) the Z distributions (for both X and Y tasks) **have a direct impact on** the observed system performance…*
* *We **show through computer simulations that** our architecture generalizes well, achieves accurate, fast, and smooth arm movements, and is robust in the face of X.*
* *We successfully **show that** these two proposed mechanisms can **exhibit much more flexibility than** the closely related mechanisms in the literature.*

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Move 5: Research Conclusions

Summarizing the significance and implication of the research

- Typical collocations

* *an efficacy/importance/implication/significance of*
* *an importance/insight for*
* *be of assistance/interest to*
* *be used to*
* *contribute to*
* *establish a framework (for/of)*
* *extend knowledge (of)*
* *improve predictions (of)*
* *increase the understanding (of)*
* *provide a basis (for)*
* *provide insight(s) (into)*
* *represent a breakthrough*
* *the first study (to)*

- Typical sentences

* *Our findings **provide evidence for** the utility of X for the detection of atherosclerotic changes.*
* *Our results **indicate that** X complements Y by Z and improves accuracy in certain medical image classification problems…*
* *Our study **sheds light on** how the choice of X affects the performance of Y…*
* *The approach **significantly expands** the varsity of X…*
* *The findings **provide the largest evidence to date that** the method produces a reliable automated measure of intake during X…*
* *The proposed scheme **shows the potential of** the adequately trained soft-thresholding mapping for classification and **paves the way towards** the development of very efficient classification methods for vision problems.*
* *The results **encourage us for further studies in this field**…*
* *The study can **provide useful suggestions for** contour detection algorithm in computer vision, and may also **contribute to** understanding contrast influence and feature representation in non-classical receptive field inhibition.*
* *The substantial performance margin between established methods and our deep neural network indicates that deep learning **has the potential to** extend the boundaries of X.*

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* *These results **suggest that** X data **provides a new platform for** rapid and label-free classification of single cells with high and consistent accuracy.*
* *This, in turn, **could facilitate more clinical studies based on** X…*
* *This method **suggests a unique regularization term** based on…*
* *This model **can be considered as a development of** the recently…*
* *This result **implies that** X alone **cannot ensure** scalable full duplex wireless networking…*
* *Using X as a signal preprocessing method instead of Y or Z **can significantly improve** classification accuracy and **reduce** calculation time, which **indicates that** X is **a powerful** spectral decomposition **method**…*
* *We **believe that** these achievements **can make** X **broadly applicable in** consumer and robotics domains.*
* *X **shows the promising signs of** high precision and handling in small spaces with its one-step "parallel-parking" ability.*

1.5 Checking the Writing Quality

The following is a useful checklist for assessing the quality of your Abstract section:

- Do I carefully read the guidelines for authors of the journal to be submitted, and organize the Abstract section as required?
- Do I cover the major content of the paper in the Abstract section, especially the research background, purposes, methods, results, and conclusions?
- Is the information stated in the Abstract section consistent with the full paper? Is there any contradiction?
- Do I provide any information that is irrelevant or weakly related to the research topic at the very beginning of the Abstract section?
- Does the Abstract section avoid using misleading words like "attempt" and "try", and avoid making bold statements beginning with "This is the first"?
- Can I shorten the Abstract section a bit more? If the length is reduced to two-thirds, will any key information get lost?
- Are tense and voice used correctly? Will they make it difficult for readers to distinguish the research of others from the research of my own?

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- Do I use keywords that represent the topic of the full paper in the Abstract section? Are they clear enough in meanings? Do they highlight the merits of my research?
- Do I invite others to proofread the Abstract section? Can they understand its content and identify the necessity and importance of the research as I do?

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Exercises

I. Resad the following two Abstract sections and analyze the structures by matching each sentence with the corresponding move. Note that sentences and moves do not necessarily follow a one-to-one correspondence. Instead, one sentence may involve multiple moves, or multiple sentences are enclosed in a single move.

Excerpt 1 (Hájek, 2018)	**Moves**
① Automated textual analysis of firm-related documents has become an important decision support tool for stock market investors.	Sentence ①: _____
② Previous studies tended to adopt either dictionary-based or machine learning approaches.	Sentence ②: _____
③ Nevertheless, little is known about their concurrent use.	Sentence ③: _____
④ Here, we use the combination of financial indicators, readability, sentiment categories, and bag-of-words (BoW) to increase prediction accuracy.	Sentence ④: _____
⑤ This paper aims to extract both sentiment and BoW information from the annual reports of U.S. firms.	Sentence ⑤: _____
⑥ The sentiment analysis is based on two commonly used dictionaries, namely a general dictionary Diction 7.0 and a finance-specific dictionary proposed by Loughran and McDonald.	Sentence ⑥: _____
⑦ The BoW are selected according to their tf-idf.	Sentence ⑦: _____
⑧ We combine these features with financial indicators to predict abnormal stock returns using a multilayer perceptron neural network with dropout regularization and rectified linear units.	Sentence ⑧: _____
⑨ We show that this method performs similarly as naive Bayes and outperforms other machine learning algorithms (support vector machine, C4.5 decision tree, and *k*-nearest neighbor classifier) in predicting positive/negative abnormal stock returns in terms of ROC.	Sentence ⑨: _____
⑩ We also show that the quality of the prediction significantly increased when using the correlation-based feature selection of BoW.	Sentence ⑩: _____
⑪ This prediction performance is robust to industry categorization and event window.	Sentence ⑪: _____

Excerpt 2 (Shen et al., 2017)	**Moves**
① With a profusion of network applications, traffic classification plays a crucial role in network management and policy-based security control.	Sentence ①: _____
② The widely used encryption transmission protocols, such as the secure socket layer / transport layer security (SSL/TLS) protocols, lead to	Sentence ②: _____

(Continued)

Excerpt 2 (Shen et al., 2017)	**Moves**
the failure of traditional payload-based classification methods. ③ Existing methods for encrypted traffic classification cannot achieve high discrimination accuracy for applications with similar fingerprints.	Sentence ③: _____
④ In this paper, we propose an attribute-aware encrypted traffic classification method based on the second-order Markov Chains.	Sentence ④: _____
⑤ We start by exploring approaches that can further improve the performance of existing methods in terms of discrimination accuracy, and make promising observations that the application attribute bigram, which consists of the certificate packet length and the first application data size in SSL/TLS sessions, contributes to application discrimination.	Sentence ⑤: _____
⑥ To increase the diversity of application fingerprints, we develop a new method by incorporating the attribute bigrams into the second-order homogeneous Markov Chains.	Sentence ⑥: _____
⑦ Extensive evaluation results show that the proposed method can improve the classification accuracy by 29% on the average compared with the state-of-the-art Markov-based method.	Sentence ⑦: _____

II. Read the following two Abstracts sections and shorten them as required.

1. Reduce the abstract to less than 150 words.

The purpose of this paper is to design and validate a desktop virtual reality (VR) system, for presentation and assessment of volumetric data, based on commercially off-the-shelf hardware as an alternative to a fully immersive CAVE-like I-Space VR system. We designed a desktop VR system, using a three-dimensional (3D) monitor and a six degrees-of-freedom tracking system. A personal computer uses the V-Scope (Erasmus MC, Rotterdam, The Netherlands) volume-rendering application, developed for the I-Space, to create a hologram of volumetric data. Inter- and intra-observer reliability for crown-rump length and embryonic volume measurements are investigated using Bland-Altman plots and intraclass correlation coefficients. Time required for the measurements was recorded. Comparing the I-Space and the desktop VR system, the mean difference for crown-rump length is −0.34% (limits of agreement −2.58–1.89, ±2.24%) and for embryonic volume −0.92% (limits of agreement −6.97–5.13, ±6.05%). Intra- and interobserver intraclass correlation coefficients of the desktop VR system were all > 0.99. Measurement times were longer on the desktop VR system compared with the I-Space, but the differences were not statistically significant. A user-friendly

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desktop VR system can be put together using commercially off-the-shelf hardware at an acceptable price. This system provides a valid and reliable method for embryonic length and volume measurements and can be used in clinical practice. (213 words, Baken et al., 2015)

2. Reduce the abstract to less than 250 words.

In the past decade, several local region-based level set models have been proposed to segment images with intensity inhomogeneity. In general, these models are designed based on one assumption, i.e., intensity inhomogeneity is slowly varying in the image domain. However, this assumption is not valid for those images with serious intensity inhomogeneity, which inevitably leads to poor segmentation performance of existing models. In this paper, we propose a novel level set method named as polynomial piecewise constant approximation (PPCA) to well segment images with serious intensity inhomogeneity. The basic idea of the PPCA method is to transform the original image to a piecewise constant image so as to make piecewise constant segmentation criterion become applicable. Specially, we firstly define an initial objective function with some constraint conditions to transform the original image. Then, in order to obtain desirable piecewise constant image and highlight the anti-noise performance, the PPCA method is used to realize the dual constraint relaxation for objective function. The dual constraint relaxation reflects in two parts: On one hand, the objective function based on local region is exploited to replace the pointwise approximation method; on the other hand, considering the variance of local intensity distribution and the reliability of polynomial approximation, we utilize a Gaussian pyramid convolution strategy to devise polynomial fitting. The PPCA method relaxes the constraint condition of the objective function

so that the piecewise constant image is easily approximated. According to the piecewise constant segmentation criterion, we obtain the partial differential equation based on polynomial piecewise constant approximation. Finally, we utilize the level set method to construct the energy functional. The visual and quantitative experimental results demonstrate that the proposed PPCA method can yield better results than existing classical local models for segmenting images with serious intensity inhomogeneity. (293 words, Min et al., 2018)

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Chapter 2
Introduction

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"Simplicity is a prerequisite for reliability."

Edsger Dijkstra

2.1 Definition

As the first part of the main body of a research paper, the Introduction section aims to guide readers into the research topic and help them understand the reasons, facts, and conditions of the research. The writing of the Introduction section generally comes last, following the other parts of the body. Such a writing order may ensure that the content of the Introduction section can be revised in real time according to the dynamics of research results and conclusions, thus keeping the writing consistent throughout the full paper.

2.2 Components

The content of the Introduction section is more flexible, not as regular as the Abstract section. However, its common components usually involve the research background, previous studies, research gap in literature, research questions, research purposes, research methods, and research significance. There is no "statutory requirement" for the length of the Introduction section, and a useful strategy is to adjust the length accordingly with reference to the published papers in the journal to be submitted. An interesting fact is that, however, an overlong Introduction section often indicates a low innovation of the research—writers tend to increase the length of the Introduction section, as a strategy, to conceal the fact that they have little new to share in the rest of the paper. In the practical writing of an Introduction section, the following tips deserve much attention.

- The Introduction section is not equal to the Abstract section or its restatement. Since there are some overlaps between the Introduction section and the Abstract section, it is usual to see that some introductions are just duplicates of the abstracts with exactly the same words, or substitutes of the abstracts where words and sentences have undergone paraphrases without obvious changes in content. This way of writing does not treat the Introduction section as a separate section from the Abstract section, which is obviously undesirable. Compared with the Abstract section, the Introduction section describes the research background more meticulously in order to better introduce the topic of the paper. It also takes up certain space to review the status of research in the same field to help readers understand how the research questions, hypotheses, and ideas come into being.

- The description of previous studies is not equivalent to a literature review. Although it is necessary for an introduction to trace studies previously conducted in the same field, the writing itself is not the same as a literature review—it is not necessary to extensively

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and systematically characterize the research status and trends, but only enumerates the most directly related studies on the topic under focus, and integrates and summarizes their core views and research results, so as to inform readers of the necessity and/or significance to carry out the research.

- Avoid details that are already well-known in the discipline. For readers in the same academic community, some information, such as familiar terminologies, concepts, theories, and methods, are comparable to common sense, which can be easily and precisely understood without a lengthy explanation. If an introduction contains too many details of this kind, readers are likely to skim the content without paying attention to details, thereby running the risk of neglecting words and sentences that are important to understand the full paper. Therefore, reducing the proverbial information and cutting unnecessary details may be good ways for improving the clarity and concision of the Introduction section. It is also helpful in bringing forward the information that is new to readers and in this way it can attract their attention.

- Navigate the sections of a research paper clearly and logically in the description of its writing structure. Some introductions tend to end with a short illustration of the paper's writing structure in order to provide navigation for readers. Note that these descriptions must be clear and effective. Otherwise, they will fail to fulfill a guiding function, and will also leave readers with an impression that the structure of the paper is chaotic. It is advised to match the navigation keywords with the headings for sections of the paper. For example, if the paper follows an explicit IMRD structure, then the navigation keywords could be "Introduction", "Methods", "Results", and "Conclusions" which correspond to the heading of each section. Besides, it is also a good way to use the title of each section directly as the navigation keywords.

2.3 Structure

The Introduction section can be divided into three structural components (or moves):

- **Move 1:** Establish the research territory. It aims to describe the academic and social background, necessity, and importance of the research topic, and review the major prior studies in the field (Note: It is common to exclude a literature review unless the writer prefers to synthesize previous studies in a separate section "Related Works").

- **Move 2:** Establish a niche. It aims to describe the deficiencies and/or expandability of previous studies.

- **Move 3:** Occupy the niche. It aims to describe the research purposes, problems, or hypotheses of the paper, outline the main research methods, results, and significance of the paper, and explain the structure of the paper.

Case Study One

Excerpt (Hájek, 2018)	**Moves**
① The past decade has seen the rapid development of textual analysis of many financial problems, such as the modeling of abnormal stock returns, volatility modeling, liquidity, market-to-book ratio, fraud detection, and financial distress prediction…	**Move 1: Establish the research territory**
② In recent literature reviews, two general approaches have been used to analyze firm-related text: dictionary-based and machine learning. ③ The former approach calculates overall word categories (positive, negative, certainty, etc.) based on the frequency of words chosen by financial experts, thus addressing the context specific nature of financial vocabulary better than using general dictionaries such as Harvard IV-4…	Sentence ①: Research background, necessity, and importance of the research topic Sentences ②③: Review of the major prior studies
④ The aim of this paper is to predict abnormal stock returns using the analysis of text in the annual reports of U.S. firms. ⑤ Most studies in the field tended to focus on either dictionary-based or machine learning approaches, paying little attention to their synergistic effects.	**Move 2: Establish a niche** Sentence ⑤: Deficiencies and/or expandability of previous studies
⑥ Here, we use the combination of financial indicators, word categories, and bag-of-words (BoW) to increase prediction accuracy. ⑦ First, adopting the approach of prior studies, we employ predefined dictionaries to show the effect of sentiment (tone) on abnormal stock returns. ⑧ We show that the chosen word categories displayed in the annual reports negatively affect abnormal stock returns…	**Move 3: Occupy the niche** Sentence ④: Research purposes, problems, or hypotheses of the paper Sentences ⑥⑦: Research methods of the paper Sentence ⑧: Research results of the paper
⑨ This paper is a significantly extended version of (Hájek & Bohacova, 2016). ⑩ The previous version was limited to banking industry, whereas here we use a more recent dataset for a wide range of industries. ⑪ The extension further includes an in-depth literature review and an experimental analysis of the combined effects of general and finance-specific dictionaries…	Sentences ⑨–⑪: Research significance of the paper
⑫ The remainder of this paper is organized in the following way. ⑬ Section 2 outlines finance-specific aspects of textual analysis and provides a review of the relevant literature investigating the relationship between textual analysis and stock return prediction…	Sentences ⑫⑬: Writing structure of the paper

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Case Study Two

Excerpt (Liberman et al., 2020)	**Moves**
① Most classical planning languages are first-order. ② Standard formalisms like PDDL and ADL, for example, are first-order. ③ One major reason for using a first-order language over a propositional one is that variables can be used to describe actions compactly. ④ For instance, in the PDDL description of BlocksWorld, the action schema stack (X, Y) uses variables X and Y to represent generic blocks and state the preconditions and effects of all actions of the form: "put block X on top of block Y". ⑤ This is possible because the action of stacking block A on block B has the same type of effects as the action of stacking block C on D; only the names of the blocks are different…	**Move 1: Establish the research territory** Sentences ①–⑦: Research background, necessity, and importance of the research topic
⑥ Dynamic Epistemic Logic (DEL) has proved to be a very expressive framework for epistemic planning, i.e., planning explicitly involved knowledge or belief. ⑦ DEL uses the language of propositional epistemic logic to describe the knowledge or belief held by a community of agents… ⑧ However, as action models are based on the propositional epistemic language, propositional DEL cannot achieve the generality of action schemas. ⑨ Variablized, general descriptions are not possible, so one action model is required for each action. ⑩ Hence, while propositional DEL adds a great deal of expressivity to planning, this comes at a cost in terms of representational succinctness.	**Move 2: Establish a niche** Sentences ⑧–⑩: Deficiencies and/or expandability of previous studies
⑪ This paper presents a DEL-based epistemic planning framework built on epistemic term-modal logic. ⑫ The underlying language is first-order and includes modalities indexed by first-order terms. ⑬ Examples of formulas include K_c on (A, B) (agent c knows that block A is on block B), $K_c \exists x$ on (x, B) (c knows that there is a block on top of B), and $\forall y K_y \exists x$ on (x, B) (all agents know that there is a block on top of B)…	**Move 3: Occupy the niche** Sentences ⑪–⑬: Research methods of the paper Sentence ⑭: Research results of the paper Sentences ⑮⑯: Research significance of the paper Sentences ⑰–⑲: Writing structure of the paper
⑭ In addition to higher-order knowledge expressions, the first-order apparatus of epistemic term-modal logic allows for domain descriptions in terms of objects and relations, as well as abstract reasoning via variables and quantification… ⑮ We consider the development of this epistemic planning framework our first main contribution. ⑯ Our second main contribution is the development of term-modal logic, its dynamic extension and the metatheory for both… ⑰ The paper progresses as follows. ⑱ Section 2 presents "Selective Communication" used as a running example of epistemic planning. ⑲ Section 3 presents term-modal logical languages and Section 4 defines state representations…	

2.4 Phrases and Sentences in Moves

Move 1: Establish the Research Territory

A. Describing the background, necessity, and importance of the research topic

- Typical collocations

* *a finite element/method*
* *a new/novel/state-of-art method/approach/scheme/momentum/framework*
* *a problem about/for/in/of/with*
* *a renewed interest in*
* *advance in*
* *ahead of the filed*
* *an emerging research area*
* *be designed/devoted to*
* *be extensively studied (to/for)*
* *be well/widely known as/for*
* *become increasingly interested in*
* *best performance/selection/parameter*
* *have/play a role in*

- Typical sentences

* ***A particularly important class of*** *transformation models in X is diffeomorphic transformation that produces Y…*
* ***According to*** *the global declaration for Parkinson's disease, 6.3 million people suffer from it worldwide.*
* *Among the techniques, X* ***produces a meaningful image from****…*
* *Due to the demanding need for efficient X methods in many database applications,* ***significant research effort has been devoted to*** *developing new X methods…*
* *Due to the fact that X, Y* ***is an important and urgent issue****…*
* *In recent years, X* ***has been widely and successfully exploited for*** *image segmentation, in which the evolving contour is driven by the partial differential equation until the convergence…*
* *In reviewing the literature,* ***no data was found on*** *the association between X and Y.*
* *In the past several decades, the X method, a well-established and powerful numerical procedure,* ***has been successfully used in many fields of*** *engineering…*

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* *Longitudinal analysis of X* ***is an emerging area*** *linking medical image computing and neurology.*
* *Over the past few years, X* ***has become a popular input device in*** *depth map acquisition for human pose recognition…*
* *Reliably classifying the types of X in natural roadside video data* ***is important for*** *many real-world applications, such as road risk assessment and identification, and vegetation growth monitoring and management.*
* *Since the introduction of the concept of X, it* ***has developed into a subfield of*** *network coding with a wide following…*
* *The ability to determine X* ***is vitally important****…*
* *The advent of X* ***is propelled by the need for*** *a better understanding of…*
* *The increasing use and availability of longitudinal electronic data* ***presents a significant opportunity to*** *discover X…*
* ***The indispensable role of*** *X* ***has resulted in*** *a proliferation of digital images in electronic biomedical publications.*
* *The limited depth-of-field of cameras* ***is a well-known issue in*** *computer vision.*
* *The modeling of X to predict the life span of cracked structures* ***is full of challenges and difficulties****.*
* *The preservation of X* ***is a traditional problem in*** *variational optical flow methods, for which a reliable solution does not exist.*
* *The rapid proliferation of X technologies* ***has increased both the ease with*** *which images can be manipulated* ***and the difficulty in*** *distinguishing between altered and natural images…*
* ***The recent decade has witnessed the emergence of*** *huge volumes of high dimensional information produced by X.*
* *The robust recognition of X* ***represents a crucial component underlying*** *social cognition…*
* ***The usefulness of*** *X* ***has been illustrated through*** *its applications in…*
* *Therefore,* ***the necessity to develop*** *X* ***increases rapidly****…*
* *Unfortunately, the research community* ***is constrained by the lack of****…*
* *When X is not fixed in a finite time,* ***it is difficult to say that****…*
* *With the increasing number of applications based on fast arriving information flows and applied to real scenarios, X* ***has become a paramount issue for*** *online learning environments.*
* ***With the rapid development of*** *X driven by…*
* *Within this area of investigation, a number of studies* ***have set out to*** *explore X.*
* *X and Y* ***are two current*** *global health* ***priorities****…*

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* *X's applications usually **will be executed on** the cluster consisting of a number of hosts…*
* *X is an evolutionarily conserved group of subcortical nuclei, which **has long been implicated in** action selection…*
* *X is **becoming ubiquitous in** healthcare provision addressing screening, diagnostics…*
* *X by recognition of image patterns **is of fundamental interest and can have wide applications** in life science and clinics…*
* *X **has been successfully applied in the field of** sensor fusion, such as…*
* *X **has been successfully employed to** solve many control problems…*
* *X **has been widely recognized that** the order of constraints has…*
* *X **has widely established itself in** the literature and practice as a platform for demonstrating various control strategies.*
* *X **has become the technology of choice in** diverse applications today, from automotive and aviation to robotics, gaming, and consumer electronics.*
* *X **has evolved with** the advent of web-scale services…*
* *X in computer vision research **has made head and body pose estimation possible** even when pedestrians are captured at prohibitively low-resolution by distant cameras in public spaces.*
* *X **is a core technique in** machine learning and artificial intelligence.*
* *X **is a highly challenging as well as an important task in many domains**, such as information security, in which classification can be used for malware detection…*
* *X **is a problem-solving strategy** that uses prior experience to understand and solve new problems.*
* *X **is a well-studied problem in** computer vision.*
* *X **is an efficient tool to** produce…*
* *X **is an important data pre-processing step of** knowledge discovery in databases…*
* *X **is based on** the classical architecture of…*
* *X **is commonly used as** a proxy of the activity of…*
* *X **is essential to** access a variety of physiological data…*
* *X **is important to** ensure a proper diagnosis of…*
* *X **is one of the most active research topics in** computer vision due to its wide range of applications in smart video surveillance, human computer interaction, robotics, health care, etc.*
* *X **is one of the most important structural materials** but weak in tension…*
* *X **is recently emerged in** the context of classification…*
* *X **is very critical in** enterprise risk management, especially for financial institutions.*

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* *X **leads to a growing number of** patients and a reduction of young labors, which stresses the healthcare system in hospital.*
* *X **plays a key role in** assuring the adequacy of manufactured components, and **has been a core research area** for many years.*
* *X **serves as an intermediate step in** knowledge extraction from unstructured texts, which plays an important role in automatic knowledge base construction.*
* *X that contains rich structure information about the contents of scenes **is an important feature in** many visual tasks such as object recognition, geometric reconstruction, and motion analysis.*
* *X, which **has been used in a broad range of applications**, has also applications in…*

B. Summarizing the major prior studies

- Typical collocations

* *a number of evidence/investigations/studies*
* *an enormous/large amount (of)*
* *be conducted (in)*
* *be extensively studied (by)*
* *be generally accepted*
* *be largely overlooked (by)*
* *considerable attention/research*
* *provide evidence (for)*
* *to date*

- Typical sentences

* ***A number of studies have postulated** a convergence between X and Y.*
* *After the seminal work of X, **many works have emerged to solve this problem**. **Earlier solutions rely on** directional information to steer the regularization according to image structures. **In this line, and more recently**, some methods combine…*
* ***All these prior researches are based on** the recursive relations of…*
* ***Ample evidence exists to suggest** a connection between X and Y.*
* ***As shown in several previous comparative studies**, there is no single index structure that works efficiently across a variety of applications…*
* ***As** X **reported**, large disagreements are often observed among human workers in specifying pairwise constraints…*
* ***Existing models have dealt with** a variety of aspects of…*
* ***In an interesting work by** X, the authors investigated…*

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* ***In previous studies on*** *X,* ***different variables have been found to*** *be related to…*
* ***In recent studies****, the filter and wrapper-based feature selection methods have been widely used for bankruptcy prediction and credit scoring…*
* *In recent years,* ***researchers have become increasingly interested in****…*
* ***In the literature****, many supervised machine learning (or classification) techniques have been used for financial distress prediction…*
* ***It has been demonstrated in*** *X that a high intake of Y results in damage to…*
* ***It has been proved that*** *X generated through Y will form a group of Z.*
* ***It is now well established from a variety of studies that****…*
* *Over the years,* ***an enormous amount of research has been carried out in an attempt to****…*
* ***Previous studies have failed to demonstrate any support for*** *the X hypothesis.*
* ***Recent pose estimation algorithms have been shown to*** *be robust to facial appearance variations (X; Y), and can also learn with little training data by exploiting anatomic constraints (Z)…*
* ***Recent studies increasingly propose*** *the use of temporal abstraction as a pre-processing stage and the use of time-intervals mining for feature extraction…*
* ***Recently****, the mobile two-wheeled inverted pendulum (MTWIP)* ***has gained increasing interest*** *(X; Y; Z)…*
* ***Several algorithms have been proposed in the literature for*** *X…*
* ***Several computational models have been developed****, examining their roles in action selection (X; Y; Z)…*
* ***Several*** *effective region-based level set* ***models*** *(X; Y)* ***have been proposed based on*** *the intensity homogeneity assumption…*
* ***Some important works*** *related to meshfree methods* ***are known in the literatures*** *as Element-Free Galerkin (EFG) method (X), reproducing kernel particle method (RKPM) (Y), stable particle methods (Z)…*
* *The discovery of grid cells in the rat's medial entorhinal cortex (MEC)* ***was first published by*** *X, which suggested that...Y* ***presented findings that****...For a review of the multi-scale representation of space, we* ***refer the readers to*** *Z…*
* ***The earliest attempt in this regard is*** *X…*
* *The inhibitory mechanisms* ***have inspired many efforts to*** *deal with computer vision problems such as contour detection (X), edge enhancement (Y), and object detection (Z)…*
* ***There are approaches using robust theories to*** *design…*
* ***There is a large number of published studies that*** *describe the link between X and Y.*
* ***These researches are focused on*** *the development of…*
* *This aggregate ensemble framework is a hybrid approach* ***applied by prior research*** *(X; Y; Z)…*

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* *This approach **has been taken in some other studies of**...*
* *This idea **was first proposed in** 1945 **by** X, with the notion of...*
* *This issue **is addressed in the literature** X...*
* ***Through an extensive review of the literature at the time**, X and Y proposed that the cognitive map laid within the brain's hippocampus...*
* *What we know about X **is largely based upon experimental studies that** investigate...*
* *With the aim of making fuzzy control rules easier, a learning-control scheme, which is termed adaptive fuzzy control, **was proposed in the literature** (X)...*
* *X **develops a model of** the hippocampus to explore...*
* *X **further improved upon this approach by**...*
* *X **has been described by** a sequence of...*
* *X **has been developed in the past decades** according to...*
* *X **has been well studied** in the fields of...*
* *X **is reported to be** a...*

Move 2: Establish a Niche

Pointing out the deficiencies and/or expandability of previous studies

- Typical collocations

* *a large/wide gap between*
* *a problem persists/remains/about/for/of/with*
* *drawback of/to*
* *extension of*
* *have difficulty (in)*
* *in the absence of / absence from*
* *it is difficult to do*
* *lack of*

- Typical sentences

* ***A drawback of** this method **is that**...*
* ***Although** computationally efficient, X **relies on** expensive...*
* ***Although** many methods have been presented in the literature for the detection of X, the detection of X **requires** specific processing...*
* ***Although** pre-processing of X can help extract relevant sequences, the X analysis of Y **can take several hours**. This great effort **is unacceptable**, especially for a consistent*

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long-term monitoring of athletes…

* ***Although*** *several hybrid methods exist that search for X, competence enhancement and competence preservation methods* ***can be combined to*** *achieve the same objectives as hybrid methods…*
* ***Although*** *the increase in computing power in recent years has made this type of analysis more feasible, they* ***cannot always conclusively determine*** *X…*
* ***Although*** *there have been many theoretical studies on X, there have been relatively* ***few experimental and implementation efforts****…*
* ***Although*** *these approaches provide interesting results in some applications, X* ***cannot be adapted easily to other cases****…*
* ***Although*** *X and its variants are widely used, they* ***suffer from inadequate ability to*** *characterize images and* ***lack of*** *robust structures upon visual words…*
* ***Although*** *X and Y allow one porter to move, they* ***have key design limitations****…*
* ***Although*** *X has been an active research area in machine learning,* ***little effort has been made in respect of*** *Y research…*
* ***Despite*** *the major advantages of X,* ***its use is not widespread and is still fairly uncommon****…*
* ***Despite*** *these recent important contributions,* ***there are still two problems that are not addressed*** *in these X models mentioned above…*
* ***However****, acquiring the necessary statistics about X currently* ***requires cumbersome manual video analysis****…*
* ***However****,* ***few*** *of them* ***incorporate some aspects of*** *X…*
* ***However****,* ***it is cumbersome to*** *thoroughly evaluate X…*
* ***However****, it is known that X* ***runs potential risks****…*
* ***However****,* ***it is not enough to*** *distinguish X from Y…*
* ***However****,* ***its use is limited in*** *individuals with medical contraindications. In addition, measurements* ***may be influenced by*** *fluid intake…*
* ***However****, most existing X for mobile inverted pendulums* ***only considered*** *balance control…*
* ***However****,* ***no previous studies have attempted to employ*** *X for the assessment of circadian body temperature rhythm in daily life…*
* ***However****, promoting and monitoring X* ***remains a significant challenge in****…*
* ***However****, such a design* ***can only be used for*** *X…*
* ***However****, the results of X* ***still exist large gaps****…*
* ***However****, their work* ***did not include a comprehensive evaluation of*** *X and results were obtained with data containing* ***only*** *one serve type…*
* ***However****,* ***there is no single*** *X that works efficiently across a variety of applications…*

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* ***However***, *these tools rely upon self-report and* ***have a number of limitations***, *including X and Y…*
* ***However***, *this* ***cannot directly predict*** *X and* ***can only indicate*** *the type of structural response that occurs at a given load…*
* ***However***, *X* ***becomes the main burden for*** *training CNNs efficiently since they involve more computational costs…*
* ***However***, *X has been found to* ***be a risk factor for*** *cardiac arrhythmia and a significant feature of morbidity and mortality…*
* ***However***, *X* ***is invasive and laborious*** *because it involves plasma or saliva sampling…*
* ***However***, *X* ***is only addressed in*** *a small number of studies…*
* ***However***, *X* ***is too slow to be used in*** *an online setting, and* ***prone to getting stuck in*** *local minima as a result of its gradient-based learning algorithm…*
* ***It is challenging to*** *develop a real-time system on X…*
* *Modeling of X,* ***however***, ***is often limited to*** *the finite element analysis framework…*
* ***No method has yet been developed to*** *detect X…*
* ***Novel data-driven techniques are required to…***
* ***One of the key challenges is to*** *develop techniques to deal with X…*
* ***Only a very short exposure is used for*** *X…*
* *Previous comparative studies* ***have not adequately considered these factors****…*
* ***The difficulty of*** *X* ***is*** *caused by a large range of…*
* *The parameter of this scale* ***is difficult to be well defined for*** *X…*
* ***There are still two problems that are not addressed in*** *X…*
* ***There exists no insightful understanding of*** *X…*
* *X* ***does not naturally represen****t temporal sequence inputs, although past work has explored extensions of X that support temporal sequence processing…*
* *X* ***has not been autonomously employed as****…*
* *X must be synchronized onto a common timeline.* ***This is a significant problem****…*

Move 3: Occupy the Niche

A. Describing the research purposes

- Typical collocations

* *address the issue (of)*
* *approach/attempt/point/seek/try to*
* *be aimed at*
* *be commissioned by*

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* *be concerned with*
* *be conducted/designed/presented/proposed/undertaken (to)*
* *be driven by*
* *broaden/expand/determine the scope of*
* *center/focus/report on*
* *cope/deal with*
* *for the purpose/sake of*
* *in an attempt to*
* *in order to*
* *on purpose*
* *provide an overview (of)*
* *with an aim to*

- Typical sentences

* *A machine learning method based on X* ***has been developed to*** *detect…*
* ***Aiming at*** *the two problems presented above, we* ***present a contour detection model****…*
* ***In order to*** *achieve a steady state response, we* ***propose*** *X…*
* *In this paper, we* ***aim to*** *address this new problem by providing feasible solutions…*
* *In this paper, we* ***present a first attempt / a unified framework to****…*
* ***One purpose of this study was to*** *assess the extent to which these factors were…*
* ***Our main goal is to*** *understand the mechanisms underlying…*
* *Our work* ***is the first attempt to*** *introduce…*
* ***The aim is to*** *filter out unrepresentative features from a given dataset…*
* ***The goal of this paper is to*** *identify the characteristics of X through the method of Y.*
* ***The objective of this investigation is to*** *alleviate/build/describe/design/examine/record…*
* ***The purpose of this study is not to*** *conduct a comprehensive evaluation of all existing multi-dimensional indexing structures.* ***Rather****, we choose X that is the most commonly employed spatial indexing structure in the database community…*
* *This research examines the emerging role of X in the context of Y* ***with an aim to****…*
* ***This study attempts to*** *establish the connection between X and Y.*
* ***This study sets out to*** *assess the importance of X in Y.*
* ***To address*** *the above challenges,* ***this paper proposes*** *X…*
* ***To address*** *the issue of X, we* ***have defined in this paper an objective protocol to*** *find the parasagittal plane…*

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* ***To realize*** *X, we* ***design****…*
* ***To verify*** *the effectiveness of our method, we* ***conduct****…*
* *We* ***adopt an*** *X* ***architecture to model****…*
* *We* ***designed and implemented a new method to*** *measure the stability of…*
* *We* ***develop a technique to*** *judge…*
* *We* ***introduce an approach to*** *guarantee…*
* *We* ***revisit*** *X* ***and incorporate it to*** *guide the process of…*
* *We* ***use*** *X* ***to*** *address these limitations of Y…*
* *X* ***was designed to*** *find…*

B. Describing the research questions or hypotheses

- Typical collocations

* *a central hypothesis/issue/question*
* *address/answer/raise the question(s)*
* *against/support/test the hypothesis (that)*
* *be highlighted/tested*

- Typical sentences

* ***Following questions are addressed/raised****…*
* ***One key question is how to*** *extract robust and effective features that take into account both X and Y…*
* ***Our working hypothesis is that*** *X can also benefit from different scales of representation…*
* ***Research questions are as follows****…*
* ***The hypothesis is that*** *X would magnify mapping errors…*
* ***The key question we are asking here is whether*** *it is possible for X to arrive at a vector in the joint angle space…*
* ***The question we seek to answer in this paper is how*** *X and Y are correlated…*
* ***The research question of this study is to*** *examine the potential value of X…*
* *We* ***hypothesize that*** *Xs are more unstable than those based on neurological data…*
* *We* ***question if*** *the use of X achieves more reliable and consistent results…*

C. Characterizing the research methods

- Typical collocations

* *adoption/application of*

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* *algorithm/characteristic/property/design/determination/form/implementation/presence/model of*
* *an amount/type/series/variety/multitude/range of*
* *analytical technique/method*
* *approach/framework/information for*
* *be achieved/characterized by*
* *be adapted/adopted/designed/developed/employed/enforced/proposed/utilized to*
* *be assessed/represented by*
* *be based on*
* *be classified/integrated into*
* *be compared to/with*
* *be dependent on*
* *be derived/drawn/obtained from*
* *be designed for/to*
* *be measured with*
* *be regarded as*
* *be used as/for/to*
* *classification/combination/ingredient/sequence of*
* *collect/gather data*
* *complexity/degree/detail/level of*
* *conform/convert to*
* *consist of*
* *cope/deal with*
* *depend/rely on*
* *longitudinal/qualitative/quantitative dataset*
* *research approach/instrument/method/methodology/tool*

- Typical sentences

* ***An improved method*** *based on X* ***was proposed to*** *alleviate the reconstruction problem by adding and subtracting Y…*
* ***As the third step****, we* ***build a*** *real-time detection* ***system****, called X…*
* ***Based on*** *the above analysis, we* ***propose an unified framework for*** *relation classification by jointly learning X and Y…*
* ***Based on*** *X,* ***a new aggregate interference model is developed****…*
* *By contrast,* ***our method derives*** *Euler–Lagrange equation* ***based on*** *X…*
* *Different from prior work, we* ***employ*** *X* ***as the primary handle for*** *discovering Y…*

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* ***Each model contains two modules***, *X and Y…*
* *ESNNs* ***are based on the principles of*** *X and Y…*
* *In more details, we* ***consider in this paper the following simple two-step procedure for*** *classification.*
* *In response to this, we* ***use*** *X* ***to address*** *these limitations of pairwise constraints…*
* ***In the first step***, *we* ***perform a comprehensive measurement of****…*
* *In this paper, we* ***address*** *these theoretical and practical* ***issues*** *associated with non-stationary parameterization* ***by employing*** *X and Y…*
* *In this paper, we* ***propose*** *the use of a machine learning approach* ***by using*** *X* ***that*** *has the ability to identify patterns from a training dataset…*
* *In this paper, we* ***use*** *X* ***as*** *a study case and propose runtime integrity audition…*
* *In this study, we* ***used both simulation signals and real-world data to*** *verify the effectiveness of X compared with traditional Y and Z methods…*
* *Inspired by the DSA algorithm, we* ***designed and implemented a new method to*** *measure the stability of PPINs based on X function…*
* *Our model* ***exploits the relationship of*** *X and Y…*
* *Our model* ***focuses on*** *X that takes place while the rat is in motion…*
* *Our work* ***considers*** *X model so that the relationship between capacity gain and physical layer parameters can be studied…*
* ***The analytical model is based on*** *the assumption that,…*
* *The assignment of the records to clusters in X* ***is applied for*** *aggregation…*
* *The constraint condition of objective function* ***is extended from****…*
* *The expression data used* ***is derived from****…*
* ***The first phase in the process***, *in which the time point series are abstracted into X…*
* ***The hybrid method is based on*** *combining X and Y by exploiting different evaluation criteria in different search stages…*
* *The input* ***is represented by****…*
* *The method* ***is instantiated in****…*
* *The proposed model* ***simplified the training process by*** *replacing X with Y…*
* *The supervised training procedure* ***comprises two stages****.*
* *The transmission capacity of a full duplex wireless network* ***is*** *then* ***derived based on*** *X…*
* *This assisted signal* ***is combined with*** *the original input data before X is applied…*
* *This method* ***provides a numerical procedure for****…*
* *To achieve this, we* ***associate*** *X in the network* ***with*** *a state that is directly related to the level of expression of the corresponding gene…*
* *We* ***adopt*** *X* ***to*** *model the sub-sentence between given entities instead of modeling the*

whole sentence…

* *We **applied** X **to** surround suppression models in which an adaptive end inhibition is realized based on the information extracted at two different spatial scales.*
* *We **based our study on** the biological role of X, and **contrast the roles of** the small, medium, and large place fields represented across Y…*
* *We **built on** the original model and **used the methodologies developed therein to** assess them…*
* *We **design** X **to** distinguish the user interface differences between benign applications and ransomware samples…*
* *We **devise a simple but effective criterion to** measure the clustering accuracy, with no need of retraining a classifier.*
* *We **investigate the index performance** associated with X methods…*
* *We **present a model** for spatial cognition based on the multi-scale organization of X…*
* *X **acquired on** the axial view can provide a solution to…*
* *X **is applied to** compensate for the elastic solution and to approximate deformation…*
* *X **is classified into** a high risk or low risk group…*
* *X **is collected in** an evidential model of the object…*
* *X **is considered as** a cluster/continuum/development of…*
* *X **is created in** a meshless analysis framework developed from…*

D. Summarizing the major research findings

- Typical collocations

* *account for*
* *act/depend/rely on*
* *appear in*
* *associate with*
* *be considered as*
* *be determined by*
* *be different/originated from*
* *be discussed/found in*
* *be generated/supported by*
* *be interpreted as*
* *be opposed/owing/prone/proved/sensitive/subject/susceptible to*
* *be responsible for*
* *be shown in*
* *clearly indicate*

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* *correspond/lead/tend to*
* *distribution/justification of*
* *emerge from*
* *function/occur in*
* *in conclusion*
* *probability of*
* *result from/in*

- Typical sentences

* ***An exact result is derived from*** *the capacity gain achieved by X…*
* ***An interesting side finding was that****…*
* *Dispensable role of X* ***has resulted in****…*
* *Furthermore, X* ***is represented by*** *a local refinement of element size…*
* *In our 2,721 ransomware samples, we* ***find that*** *X blackmails users by encrypting files…*
* ***It is expected that*** *the major difference from X is…*
* ***It shows that*** *X, when coupled with Y, can often achieve results comparable to…*
* *Our analysis* ***reveals that*** *X and Y emerged in an SSL/TLS session can be regarded as critical features for traffic classification.*
* *Our experiments based on the above criteria* ***reveal several interesting points****…*
* *Our findings* ***are consistent with*** *previous results showing…*
* *Our findings* ***are not generalizable*** *beyond the subset examined.*
* ***The classification result is achieved*** *as follows…*
* *The experiment* ***proved that*** *X was as accurate as a more sophisticated magnetic sensor in tracking the relevant motion pattern…*
* *The investigation of X* ***has implied that****…*
* ***The most obvious finding to emerge from the analysis is that****…*
* ***The principal findings of this research are that****…*
* *The proposed method can well* ***solve the approximation problem for*** *those images with serious intensity inhomogeneity.*
* *The research presented here* ***confirms that****…*
* *The results of this experiment* ***show no clear-cut pattern of****…*
* *The results* ***yielded no statistically significant relationships between*** *X* ***and*** *Y.*
* *The solution to this problem* ***is expressed by*** *X that…*
* *There were* ***small but significant negative correlations between*** *X* ***and*** *Y.*
* *This finding broadly* ***supports the work of other studies*** *in this area linking X with Y.*
* *This finding* ***is congruent with*** *the work of Appel (2017), which/who…*
* *Typically, each input pattern* ***is regularized by*** *X…*

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* *We **demonstrate that** our approach leads to X accuracies, which are as good as Y…*
* *We **found** a common set of X and Y **that** were apparently deregulated in opposing directions in cancers and neurological disorders…*
* *We **observe that** X and their corresponding natural images exhibit statistical differences…*

E. Outlining the research significance

- Typical collocations

* *add/contribute to*
* *be capable of*
* *be effective in*
* *be of interest to*
* *be suitable for*
* *cast/throw/shed light on*
* *contribution/efficiency/efficacy/functionality/usability of*
* *enhance/expand/further the understanding (of)*
* *establish/provide/offer a framework (for)*
* *extend the knowledge (of)*
* *main/major/key strength (of)*
* *prove to be*
* *provide a new understanding (of)*
* *provide evidence (for)*
* *provide insight(s) into*
* *serve as a base (for)*
* *the first study (of)*
* *the only investigation (into)*

- Typical sentences

* *Compared with the non-real-time mode, the X mode **is more efficient**…*
* *It showed that **significant improvements** in energy efficiency and robustness **can be achieved with**…*
* *Methods are expected to be able to **lead to more robust** classifications automatically adaptive to the nature of the testing image…*
* *Our classifier **provides comparable or better classification accuracy** than sparse coding schemes…*
* *Our experimental evaluation **is significantly extended with the use of**…*
* *Our method **has several advantages over** the existing level set methods for*

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segmenting images with serious intensity inhomogeneity, which are presented as follows.

* ***The advantage of the proposal is that*** *it can effectively…*
* ***The contribution of our work can be summarized*** *as follows:…*
* *The following are the* ***additional contributions of this work*** *compared to the earlier version.*
* *The* ***main contributions of the current paper can be summed up*** *as follows: (i)…*
* *The* ***new contributions are****, on the one hand, Xs. On the other hand, Ys.* ***Other contributions are*** *Z…*
* *The present study has gone some way towards* ***enhancing our understanding of****…*
* *The present study has* ***shed contemporary light on*** *the contentious issue of…*
* *These findings* ***add to*** *a growing body of literature on…*
* *This research has demonstrated,* ***for the first time****, that…*
* *This study is* ***an extension of*** *our previous semiautomatic approach with a number of* ***important improvements*** *outlined in the following…*
* *This work* ***may contribute to*** *understanding contrast influence on inhibitory behavior and feature representation of surround suppression.*
* *To our knowledge, the work reported here* ***is the first attempt to*** *build X that controls stable arm reaching movements based on Y…*
* *To the best of our knowledge, this* ***is the first paper that*** *introduces X in encrypted traffic classification…*
* *We* ***are the first to*** *design and demonstrate X that…*
* *We* ***extend*** *X* ***by*** *leveraging a new application attribute…*
* *We show that X* ***is not only useful in*** *the depth measurement,* ***but also useful for*** *capturing shading cues of a scene…*
* *X can be considered/regarded as* ***a development/extension/improvement of*** *Y…*
* *X* ***is able to supply*** *the 3D locations of the markers…*

F. Explaining the writing structure of the paper

- Typical collocations

* *as follows*
* *be composed of*
* *be divided/subdivided into*
* *be followed by*
* *be structured/organized (in)*
* *be summarized as*

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* *begin by*
* *consist in/of*
* *description/outline/remainder of*
* *overall structure (of)*
* *the following section/paragraph*

- Typical sentences

* *...**is presented in Section X** which **is followed by**...*
* ***In Section X**, a description of the problem **is provided**...*
* ***In the following**, we **give a quick overview of** the challenges and our solutions to...*
* ***Section X presents**..., and **Section Y provides**...*
* *Some conclusions **are drawn in the last section**...*
* ***The outline of this paper is as follows**: **Section 2 introduces**...**Section 3 presents**... **Section 4 gives**... Linear test problems **are solved in Section 5**. Some conclusions **are drawn in the last section**.*
* ***The paper is organized as follows**: **Section 2 presents**...**In Section 3**, we evaluate... Finally, we summarize the results and draw conclusions **in Section 4**.*
* ***The remainder of this paper is organized as follows**: **Section 2 introduces**... **Section 3 presents**..., and **Section 4 presents**...Experimental results **are given in Section 5**. **Section 6 discusses** some extensions of...**Section 7 summarizes** related works. **Section 8 concludes** this paper.*
* ***The remainder of this study is shown below**. **Section II presents**...**Section III illustrates**...Experimental results **are given in Section IV** and some discussions on the results of this paper **are presented in Section V**. Finally, we conclude this paper **in Section VI**.*
* ***The rest of the paper is arranged as follows**. **Section 2 gives an overview of**... **In Section 3**, we...**In Section 4**, we...Methods **are described in Section 5**, and experimental results **are presented in Section 6**. **Section 7 includes** the discussion and conclusions.*
* ***The rest of the paper is organized as follows**. **In Section II**, we present a framework to detect...**Section III introduces**...**Section IV outlines** the experimental setup used within this framework and **Section V reports** the quantitative evaluation. Discussion and conclusions **are given in Sections VI and VII, respectively**.*
* ***The rest of this paper is organized as follows**. **In the next section**, we highlight...**In Section 3**, we formulate...**Section 4 then presents**...**In Section 5**, we perform...and **Section 6 finally gathers** a number of important observations on...*

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* ***The rest of this paper is organized as follows****. We summarize the related work and describe our motivation* ***in Section II and Section III****,* ***respectively****. The modeling process of our method for X* ***is presented in Section IV****, which* ***is followed by*** *Y* ***in Section V****.* ***Section VI exhibits*** *the evaluation results. After a brief discussion* ***in Section VII****, we conclude this paper* ***in Section VIII****.*
* ***The structure of this paper is organized as follows****:* ***Section 1 above has explained*** *the rationale of this investigation, and the importance of careful design of experimental test specimens has been highlighted.* ***In Section 2****, a new method is proposed for...****In Section 3****, a description of the problem is provided…****Section 4 presents*** *the obtained results of…Finally,* ***in Section 5****, ...is chosen based on the obtained results* ***in Section 4****. The paper concludes with a discussion of...*
* ***This paper is organized as follows****.* ***In Section II****, we provide…* ***Section III describes****…****In Section IV****, the methods used in the paper for...are presented.* ***In Section V****, the obtained experimental results are presented…****Section VI is dedicated to*** *discussions related to…*
* ***This paper is structured as follows****.* ***Section 2 introduces*** *the related work; then we illustrate the problem definition, derive objective function, and provide the corresponding solutions* ***in Section 3****. Several extensions are given* ***in Section 4****.* ***Section 5 demonstrates*** *our experimental results on several benchmark datasets. Finally, we draw the conclusion* ***in Section 6****.*

2.5 Checking the Writing Quality

The following is a useful checklist for assessing the quality of your Introduction section:

- Is the Introduction section almost the same as the Abstract section? Or does it complement the Abstract section by providing details?
- Compared to the remaining text, does the Introduction section take too much proportion? Does it contain any information that is too familiar to the academic community?
- Does my description of the research background closely fit the topic of the paper? Is it a foreshadowing of the research goals of the paper?
- Does my description of the research results of other authors directly hit the topic of the paper? Is it a brief summary of major previous studies or a systematic literature review?
- Do I explain the reasons and goals of my research? Do I clearly state the research

questions? Do I clarify the proposed research methods?

- Is my description concise enough to keep readers' attention to the key information? Is it clear enough to let readers have a full understanding of the ideas and overall framework of the paper?
- Is the use of tense correct? Is the present tense used to describe the research background and previous studies? Is there a switch between tenses, especially the past tense, present tense, and future tense, to describe the significance of my research?

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Exercises

I. Use your own corpus to retrieve the suitable words or phrases of particular part of speech as required. Select one word or phrase from the retrievals that can best fit in each blank.

- Adjective

1. Decision trees are _____ classifiers, but are outperformed in many problem domains by other classifiers, such as support vector machines, Bayesian networks, and random forests.

2. Many _____ algorithms have been developed for pattern mining.

3. Since then, many studies focused on developing _____ approaches for sequence similarities.

- Verb

4. We _____ different relevant notions to extended fuzzy logic theoretically and mathematically from the stands of sets and systems.

5. This paper _____ that the facial attributes-based supervision can effectively enhance the capability of a face detection network in handling severe occlusions.

6. This paper _____ a review of previous studies in the following ways.

7. This paper _____ the literature in several ways…The rest of the paper is _____ as follows.

- Article + adjective + noun

8. Diversity is _____ because no one learning architecture (or group of architectures) performs optimally on all datasets.

9. Bayesian networks, also known as belief networks, are _____ for representing uncertainty in artificial intelligence.

10. Shape theory has been _____ in many fields from computer vision to biological and medical applications.

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- Adjective + noun + verb

11. _____ that such information can reduce household energy consumption by 14% on average.

12. _____ that the coded multicasting opportunities exploited in the caching problems exist in the data shuffling of distributed computing frameworks.

II. Read the following Introduction section and then complete the tasks.

① Today, some organizations and governments attempt to publish their collected data for scientific and commercial purposes. ② There are serious concerns about the privacy of data respondents when their data is published. ③ Privacy Preserving Data Publishing (PPDP) is a research area that tries to overcome these concerns by altering data such that it stays useful while the privacy of respondents is preserved. ④ There is a trade-off in PPDP between data utility and privacy. ⑤ As the risk of a privacy breach decreases, the information loss is increased.

⑥ There are several computational privacy models proposed in the literature (Samarati, 2001; Jiang & Clifton, 2006; Li et al., 2007; Machanavajjhala et al., 2007). ⑦ Each model has some requirements that if satisfied, a degree of privacy is preserved for data respondents. ⑧ A basic privacy model is *k*-anonymity that states: Each release of data must be such that every combination of quasi-identifiers can be indistinctly matched to at least *k* respondents (Samarati, 2001).

⑨ Microaggregation is the most commonly used mechanism to satisfy *k*-anonymity that operates on the set of quasi-identifier attributes of a dataset and contains two steps: (1) partitioning (clustering)—partition data records into clusters of size at least *k*; and (2) aggregation—replace each record with its cluster centroid. ⑩ Thus, each combination of quasi-identifiers in the published data is repeated at least *k* times, so the dataset is called *k*-anonymous. ⑪ Microaggregation is naturally designed for numerical data. ⑫ Some authors have extended microaggregation for categorical and mixed datasets (Domingo-Ferrer & Torra 2005; Li et al., 2006; Martínez et al., 2012; Han et al., 2014).

⑬ Oganian & Domingo-Ferrer (2001) show that finding the optimal microaggregation is NP-Hard for multivariate datasets. ⑭ Several heuristic algorithms are proposed in the literature for microaggregation of multivariate datasets and all of them attempt to make trade-off between data utility and privacy (Domingo-Ferrer & Torra, 2005; Laszlo & Mukherjee, 2005; Domingo-Ferrer et al., 2006; Kokolakis & Fouskakis, 2009).

⑮ When the data is not entirely numerical, two techniques must be accomplished to enable microaggregation, one to calculate the distance between records and another to find

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the center of records. ⑯ This issue is addressed in the literature (Bai et al., 2011; Martínez et al., 2012; Torra, 2004; Abril et al., 2010b). ⑰ For example, Domingo-Ferrer & Torra (2005) proposed MDAV-generic as an extension to MDAV algorithm for microaggregation of ordinal, nominal, and numeric data.

⑱ In this paper, we propose transformation based microaggregation (TBM), a novel method for microaggregation of large mixed datasets. ⑲ First, TBM transforms mixed dataset T into a numerical equivalent T^n using Multidimensional Scaling (Alpaydin, 2010), such that the relative distances between records of T are preserved in T^n. ⑳ Next, the partitioning step is performed on T^n using one of the two proposed partition algorithms: NFPN and QNM. ㉑ Finally, the assignment of the records to clusters in T^n is applied on T for aggregation ㉒ TBM is an efficient microaggregation technique for anonymizing large mixed datasets. ㉓ Experimental results show that although the proposed method partitions the transformed data instead of the original one, it achieves more data utility than the related works. ㉔ Moreover, TBM attains a better trade-off point between data utility and privacy compared with previous works.

㉕ The remainder of this paper is organized as follows. ㉖ Section 2 presents required basic concepts. ㉗ Section 3 has a glance on the literature of microaggregation algorithms and in particular microaggregation of categorical and mixed data. ㉘ The proposed TBM method is described in Section 4. ㉙ The experimental results are shown in Section 5. ㉚ Section 6 analyzes the proposed method. ㉛ Finally, the conclusion and future works are presented in Section 7. (Salari et al., 2017)

1. The following table tabulates the components in the Introduction section. Match these components with the sentences of the text above and put the sentence numbers in the right table cell.

Moves	Steps	Sentence Number(s)
Move 1: Establish the territory	Describe the background, necessity, and importance of the research topic	
	Summarize the major prior studies	
Move 2: Establish a niche	Point out the deficiencies of previous studies	
	Point out the expandability of previous studies	
Move 3: Occupy the niche	Describe the research purposes	
	Describe the research questions or hypotheses	
	Characterize the research methods	
	Summarize the major research findings	
	Outline the research significance and value	
	Explain the writing structure	

2. Once you have finished Task 1, figure out which steps do not appear in this Introduction section. Are they compulsory components in the field of computer science?

3. How are tenses used in this Introduction section? Do they need to be refined?

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Chapter 3
Research Methods

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"We know the past but cannot control it. We control the future but cannot know it."

Claude Elwood Shannon

3.1 Definition

The Research Methods section, usually under a variety of headings with indicative words such as method, approach, data, preliminaries, experiment, and validation, is undoubtedly the most important section in the field of computer science. It mainly describes the research procedures, data, instruments, devices, and measures used to achieve the research purposes, and serves as an instruction with the necessary information on how to repeat the research and reproduce its results. It is generally believed that the Research Methods section represents a series of mature ideas that the authors are quite familiar with before starting a research; thus, its writing is relatively easy, usually ahead of other sections.

3.2 Components

The content of the Research Methods section is very flexible and varies from journal to journal. In the field of computer science, materials, technical design, research procedures, variables, and data analysis are generally elucidated. In the practical writing of a Research Methods section, the following tips deserve much attention:

- Avoid ambiguity caused by misuse of tense. The tenses commonly used in this section are the simple present tense and the simple past tense, which needs to be further determined according to research fields, journal requirements, and specific scenarios. Generally speaking, the simple past tense is used to describe a series of historical actions at different stages of the research, from its preparation to its implementation in particular; the simple present tense is applied to explicate standard methods, i.e., methods that are widely acknowledged and used in the research community, and it is also used to introduce objective reality like software, portals, tools, models, and devices.
- Avoid stereotyped writing, but change the strategy in accordance with the originality of a research method. To be more specific, if a research method is partially original, then elucidate what improvement and innovation have been added to the prior method and cite the prior method with in-text references. If a research method is a direct imitation, then add the source of the method to guide readers through details. If a research method is brand new, consider writing another paper dedicated to its originality.
- Avoid the user manual style. When writing this section, some authors tend to describe

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each step sentence by sentence, with intervals of semicolons or dots, making it like a technical manual. Such a manual alike style may undermine the integrity of writing so much that it is difficult to paint the full picture of research methods in a systematic way. In fact, a better way of writing is to describe two actions in one sentence (except for particularly complicated actions); do not use semicolons too often but use ordinal numerals and conjunctions to link each sentence in an orderly manner.

- Avoid placing ordinal numerals in the middle or at the end of a sentence. Ordinal numerals are often used to describe research steps. They can be placed at the beginning, the middle, or the end of a sentence, but different positions will affect the reading experience. In general, the vocabulary at the very beginning of a sentence is easier to recognize because it conforms to reading habits. Therefore, placing ordinal numerals at the head of a sentence may be more reader-friendly, as it enhances the recognition of research steps and helps readers to figure out the sequence of research actions more quickly.

3.3 Structure

The Research Methods section generally includes six structural components (or moves), including overview, materials, technical design, research procedures, variables, and data analysis. Compared with the Abstract and Introduction sections, the writing of moves in the Research Methods section is far more flexible: Except for Move 1 which always comes first, other moves do not follow a fixed writing order and they may often appear in a mixture as well.

- **Move 1:** Overview is the overall summary and statement of the research methods. Note that the research objectives, questions, and hypotheses may be mentioned here if they are not included in the previous Introduction section; a review of basics of related research methods may also appear here.
- **Move 2:** Materials explain the prerequisites for conducting the research, such as data sources, programming software, operating systems, equipment, devices, and instruments.
- **Move 3:** Technical design details the models, programs, algorithms, and strategies that implement the research.
- **Move 4:** Research procedures describe the phases and actions involved in the research from development to implementation.

- **Move 5:** Variables describe the factors or features that are dynamic and variational, and express the abstract concepts of values.
- **Move 6:** Data analysis elucidates the process of extracting useful information from research data and forming conclusions.

Case Study One

Excerpt (Kautz et al., 2017)	**Moves**
① In this section, the pipeline for the automatic activity recognition in beach volleyball is described. ② First, the employed hardware is specified and the conducted study is outlined… ③ Second, a method for detecting relevant events from the raw data stream is presented….	**Move 1: Overview** Sentences ①–③: Overall summary and statement of the research methods
④ For data acquisition, sensor units with Bosch BMA280 tri-axis acceleration sensors were used. ⑤ Since low power consumption is an important aspect in wearable sensing, the sensors were configured to operate in low-power mode…	**Move 2: Materials** Sentences ④⑤: Prerequisites for conducting the research, such as data sources, programming software, operating systems, equipment, devices, and instruments
⑥ In the voting approach, the predicted class c for an event x was obtained as the weighted vote of the predictions ci from the $V = 5$ base classifiers: $$c(x) = \arg\max_{c} \sum_{i=l}^{v} wi \bullet ci(x)$$ ⑦ The weights wi of the base classifiers were the classification accuracies of the corresponding classifiers on the training data…	**Move 3: Technical design** Sentences ⑥⑦: Details of the models, programs, algorithms, and strategies that implement the research
⑧ In this layer, we applied 8 kernels for filtering each of the 3 accelerometer signals… ⑨ Subsequently, the filtered output of the first convolutional layer was transformed non-linearly using ReLUs… ⑩ The output of the ReLUs was then compressed using temporal max-pooling… ⑪ After the temporal max-pooling, we applied a second convolutional layer… ⑫ Following the two convolutional layers, fully-connected layers I and II were added…	**Move 4: Research procedures** Sentences ⑧–⑭, ⑱: Phases and actions involved in the research from development to implementation
⑬ For the training of the network, the training data was randomly split into mini-batches containing 200 detected events each. ⑭ To improve the robustness and generalization abilities of the DCNN, zero-mean Gaussian noise was added to the input signals during the training process. ⑮ The SD of	

(Continued)

Excerpt (Kautz et al., 2017)	**Moves**
the noise was set to 4.5 m/s^2… ⑯ The learning rate was set to 10^{-3}. ⑰ The other hyperparameters for the optimization were set to $\beta_1 = 0.9$, $\beta_2 = 0.999$, and $\varepsilon = 10^{-8}$…	**Move 5: Variables** Sentences ⑮–⑰: Factors or features that are dynamic and variational, and the abstract concepts of values
⑱ In each training step, the average cross entropy of all mini-batch elements was minimized. ⑲ Since for each training step only the elements of the current mini-batch instead of the complete training set were evaluated, the objective function (i.e., the average cross entropy) was stochastic… ⑳ The training was stopped, if the classification performance on a validation dataset stopped increasing…	**Move 6: Data analysis** Sentences ⑲⑳: Process of extracting useful information from research data and forming conclusions

Case Study Two

Excerpt (Fermüller et al., 2018)	**Moves**
3. Our Approach ① In this section, we first review the basics of Recurrent Neural Networks (RNNs) and the Long Short-Term Memory (LSTM) model. ② Then, we describe the specific algorithms for prediction of actions and forces used in our approach.	**Move 1: Overview** Sentences ①②, ⑧–⑩: Overall summary and statement of the research methods
3.1 Recurrent Neural Networks ③ Recurrent Neural Networks have long been used for modeling temporal sequences. ④ The recurrent connections are feedback loops in the unfolded network, and because of these connections, RNNs are suitable for modeling time series with strong non-linear dynamics and long-time correlations… ⑤ The traditional RNN is hard to train due to the so called vanishing gradient problem, i.e., the weight updates computed via error back propagation through time may become very small… ⑥ Meanwhile, the output gate o_t controls how much of the memory should be transferred to the hidden state. ⑦ These mechanisms allow LSTM networks to learn temporal dynamics with long-time constants…	Sentences ③–⑦: Review of basics of related methods **Move 2: Materials** Sentences ⑮, ⑱–㉒: Prerequisites for conducting the research, such as data sources, programming software, operating systems, equipment, devices, and instruments **Move 3: Technical design** Sentences ⑪–⑭, ⑯⑰: Details of the models, programs, algorithms, and strategies that implement the research
3.2 RNN for action prediction ⑧ In this section, we describe our proposed model for action prediction. ⑨ We focus on manipulation actions where	

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(Continued)

Excerpt (Fermüller et al., 2018)	**Moves**
a person manipulates an object using a single hand. ⑩ Given a video sequence of a manipulation action, the goal is to generate a sequence of belief distributions over the predicted actions while watching the video…	**Move 4: Research procedures** [Not explicit]: Phases and actions involved in the research from development to implementation
Visual representation: ⑪ The visual information most essential for manipulation actions comes from the pose and movement of the hands, while the body movements are less important. ⑫ Therefore, we track the hand using a mean-shift-based tracker, and use cropped image patches centered on the hand… ⑬ We project each patch through a pretrained CNN model (shown in Figure 3)…	
Action prediction: ⑭ In our model, the LSTM is trained using as input a sequence of feature vectors $x = \{x_1, x_2, \ldots, x_T\}$ and the action labels $y \in [1, N]$…	**Move 5: Variables** Sentences ⑭, ⑯⑰: Factors or features that are dynamic and variational, and the abstract concepts of values
4. Data Collection	
4.1 A device for capturing finger forces during manipulation actions	
⑮ We made a force sensing device with four force sensors attached directly to four fingers: the thumb, the pointer, the middle, and the ring finger (see Figure 4a)…	
⑯ The raw sensor outputs are voltages, from which we derived the forces perpendicular to the sensor surfaces as: $$F = 4.448 * \left(C_1 * \frac{V_{out}}{V_{in} - V_{out}} - C_2 \right),$$ where V_{out} is the sensor measurement. ⑰ V_{in}, C_1, and C_2 are fixed constants of the system…	
4.2 Manipulation datasets	
⑱ Two datasets were collected. ⑲ The first dataset contains videos of people performing dexterous actions on various objects. ⑳ The focus was to have different actions (with significant variation) on the same object… ㉑ The second dataset contains simultaneously recorded video and force data streams, but it has fewer objects. ㉒ It was used to	

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(Continued)

Excerpt (Fermüller et al., 2018)	**Moves**
evaluate our approach of hand force estimation. 4.2.1 Manipulation Action Dataset (MAD) ㉓ We asked five subjects to perform a number of actions with five objects, namely cup, stone, sponge, spoon, and knife. ㉔ Each object was manipulated in five different actions with five repetitions, resulting in a total of 625 action samples… 4.2.2 Hand Actions with Force Dataset (HAF) ㉕ To solve the problem of synchronization, we asked subjects to wear the force sensing device on their right hand, leave their left hand bare, and then perform the same action with both hands, with one hand mirroring the other (see Figure 4b for the setting)…	**Move 6: Data analysis** Sentences ㉓–㉕: Process of extracting useful information from research data and forming conclusions

3.4 Phrases and Sentences in Moves

Move 1: Overview

A. Presenting the overall summary and statement of the research methods

- Typical collocations

* *a variety of methods/steps*
* *adopt/correspond to*
* *be applied/conducted/used to*
* *be carried out (to)*
* *be defined/depicted in*
* *be denoted by*
* *be performed using*
* *be proposed by/to*
* *be widely used (to)*
* *consist of*
* *context/direction/overview of*
* *depend/rely on*
* *empirical/full/general picture*

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* *the following steps*
* *the most common method/procedure*

- Typical sentences

* ***A common way to*** *measure the contrast is to…*
* *Analysis* ***was based on the conceptual framework proposed by*** *Smith et al. (2002).*
* ***Generally****, X* ***is a*** *local region approximation* ***method*** *based on Y…*
* ***In the proposed method****, it is assumed that…*
* *In this study, inspired by X, we* ***propose*** *Y, in which…*
* *Instead of employing X,* ***our approach focuses on*** *Y…*
* ***More precisely****, we* ***utilize*** *X* ***to****…*
* ***Our algorithm is inspired on*** *the definition of X…*
* ***Our architecture consists of*** *a series of Xs for processing body actions from pose-motion features…*
* ***Our architecture uses*** *X* ***to****…*
* ***Our cost function is composed of*** *X…*
* ***Our prototype device for*** *epipolar time-of-fight imaging* ***uses*** *X* ***for*** *illumination and Y with an adjustable region of interest for imaging…*
* ***Our strategy is motivated by*** *the idea that…*
* ***Our technique is related to*** *both X and Y under concept drift…*
* ***The architecture for the model was based on*** *X…*
* *The first approach that was employed for X* ***was similar to the methods described in previous publications****…*
* ***The framework of method mainly contains*** *X and Y…*
* ***The implementation of the algorithms*** *described in this section* ***was based on*** *X…*
* *The methodological approach taken in this study* ***is a mixed methodology based on****…*
* ***The new model introduces a novel idea****, where X is considered as…*
* ***The overall workflow of our solution is depicted*** *in Figure 4…*
* *The proposed fiber reinforced concrete modeling framework* ***adopts*** *X* ***for****…*
* *The synthesis of X* ***was applied according to*** *the procedure of John et al. (2013).*
* ***The theorem for the analysis is based on*** *X…*
* ***The two steps are summarized as*** *X in this section…*
* *This investigation* ***utilized time-series data from*** *X* ***to*** *assess…*
* ***This method approach defines*** *X…*
* ***This paper proposes a concept that utilizes*** *X and Y in a novel combination that allows the design of an experimental testing program for low cycle fatigue crack initiation.*

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* ***This section introduces the framework of*** *the proposed X…*
* *This study* ***employed*** *X* ***to*** *investigate the impact of…*
* *To measure this divergence, we* ***have explored*** *X* ***that*** *measures…*
* *To obtain the goal, X* ***is employed in this paper****…*
* *We* ***adopted an approach based on*** *X, a method that allows…*
* *We* ***chose*** *a dry version of X* ***as*** *our testbed for the navigation model…*
* *We* ***defined*** *performance from a computational perspective* ***based on*** *X…*
* *We* ***evaluate*** *the performance of the classifiers and the detectors using X…*
* *We* ***introduce*** *X* ***to****…*
* *We* ***model the relation between*** *X* ***and*** *Y* ***by using*** *Z…*
* *We* ***propose a method based on*** *X* ***to*** *model message type transitions in SSL/TLS sessions for each specific application…*
* *X* ***is a well-known measure for****…*
* *X* ***is a widely used method to*** *overcome this problem…*
* *X* ***is a widespread technique in****…*
* *X* ***is an index structure based on*** *Y…*
* *X* ***is applied in*** *this paper for…*
* *X* ***is defined as*** *a ratio of…*
* *X* ***is used for*** *the computational analyses performed in this investigation…*
* *X* ***is used in*** *both registration and metric approximation algorithm…*
* *X* ***provides an available approach to****…*

B. Describing the research objectives, questions, and hypotheses

- Typical collocations

* *a goal/purpose/resolution/scope of*
* *aim/according/difficult/expect/need/tend/try to*
* *center at/on*
* *classification problem*
* *consistent with*
* *suit for/to*

- Typical sentences

* *During training, weights are adjusted* ***in order to****…*
* *Feature extraction* ***aims to*** *extract X to distinguish the appearance of different object categories.*
* *Given a training and validation set, we* ***expect to*** *tune well the above parameters,* ***in***

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order to *achieve high accuracy and reliability, despite dataset complexity…*

* *Given the lung nodule CT images,* ***our goal is to*** *discover X and thus to capture Y…*
* *TD4C is a supervised learning method in which the discretization cutoffs are chosen* ***so as to*** *abstract X…*
* ***The aim is to*** *determine a set of positions, where X is the total number of focus samples.*
* ***The aim of*** *classification* ***is to*** *predict action labels from unseen action samples…*
* *The algorithm* ***is designed for*** *X and* ***requires*** *control over Y…*
* *The algorithm* ***is used to*** *evaluate/parametrize/test X…*
* ***The goal of*** *the ground truth process* ***was to*** *identify X, Y, and Z…*
* ***The major computational issue is*** *how to compute X efficiently…*
* ***The objective of*** *the method* ***is to*** *…*
* *The research* ***is driven by the hypothesis that*** *…*
* ***To achieve the goal of*** *X, we introduce the function execution audition algorithm to audit the execution integrity of a given function invocation.*
* ***To assess*** *X, two evaluation metrics are used…*

Move 2: Materials

Explaining the prerequisites for conducting the research, such as data sources, programming software, operating systems, equipment, devices, and instruments

- Typical collocations

* *a characteristic/complexity/component/detail/dimensionality/form/nature/pattern/property of*
* *a classification/combination/description of*
* *a degree/distribution/length/level/matrix/percentage/quality/range/ratio of*
* *an amount/list/number/series/set/subset/variety of*
* *an effectiveness/feasibility/position/representation of*
* *associate with*
* *be capable/composed of*
* *be characterized by*
* *be considered/defined/determined/represented as*
* *be different/drawn/sourced from*
* *be proportional/similar to*
* *be used/utilized/undertaken to*
* *belong to*

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* *center/focus on*
* *come from*
* *compare to/with*
* *consist of*
* *differences between*
* *range from…to*
* *training data/dataset/sample/set*

- Typical sentences

* *Data including X and Y **was collected from** 231 participants at the Charles Sturt University Diabetes Complications Screening Initiative…*
* *Different datasets **are provided by** X and Y…*
* *It **is defined as** the following equation where…*
* *It **is defined in the way that**…*
* *Raw experimental data for X datasets **was downloaded from**…*
* *The **data collection** exercises **included** a total of twenty-one participants, thirteen females and eight males, with an age range from 25 to 57…*
* *The data **is designed with the aid of**…*
* *The data used in this study **was obtained from**…*
* *The datasets used in this study **are balanced**…*
* *The equilibrium equation **is expressed in terms of**…*
* *The first (Dataset A), **consists of**…, and similarly the second (Dataset B) and the third (Dataset C) of 29,999 and 42,329 cases, respectively…*
* *The image data of X acquired in the first group **was divided into** a training dataset and a test dataset…*
* *The learning task **is characterized by** X…*
* *The material **is treated as** a system, and thus…*
* *The size of this data structure **is bounded by**…*
* *The training data **was sampled randomly** in each modality, where the spatial difference and joint angle difference data **are** then **normalized to** unit lengths…*
* *The unknown flow **is classified as** X…*
* *Thousands of X datasets **are available in** public databases, each **containing** a description of the corresponding biomedical origin of the sample…*
* ***Total usable data include** 271 participants, 518 courses with a range of 1–4, and average of 1.8 courses per participant…*
* *Tri-axial acceleration data **was recorded from** 30 subjects (11 female, 19 male)*

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during beach volleyball training…

* *Two datasets **are constructed for**…*
* *X is a small and low-power wireless sensing device **equipped with**…*
* *X **is cached in** the motor output filter…*
* *X **is shared by** all elastic threads and **is protected by**…*
* *X **was chosen from**…*
* *X **was trained with the data from** 25 subjects in each fold…*

Move 3: Technical Design

Detailing the models, programs, algorithms, and strategies that implement the research

- Typical collocations

* *an algorithm for*
* *an approach to*
* *be adopted in*
* *be applied/developed/undertaken/used/utilized (to)*
* *be based on*
* *be collected/employed using*
* *be measured/modeled/modulated/performed/predicted by*
* *behavior/detection/function of*
* *depend on*
* *feature vector*
* *function to*
* *learning algorithm*
* *machine learning*
* *make use of*
* *neural network*
* *orthogonal matrix*
* *pass through*
* *provide a novel approach (to)*
* *provide quantitative data (from)*
* *take the form of*
* *the nearest neighbors*

- Typical sentences

* *A convolutional neural network **was used as a benchmark to** test the efficacy of X…*

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* *A cross-sectional study **was undertaken to** explore the potential relationship between X and Y.*
* *A defocused image can **be computed as/by** X…*
* *A set of superpixel seeds with low confidence **is selected from** all superpixels by X…*
* *A thread of fiber with length of 60 mm **is embedded in** the concrete matrix…*
* *An X algorithm **is applied to** estimate the network parameters and structure…*
* *Each cluster **is represented by** X to characterize…*
* *Each image **was processed by** the X software to store in a square matrix…*
* *Each target's body region **is determined as** X…*
* *Frequently, 15 **is used as** a pointwise score for…*
* *Given a specific value of k, **a straightforward way to assess** the classification accuracy is X.*
* *In both cases, X **determines the conservative behavior of**…*
* *In convolution layer, we **use** X **to** represent…*
* *In Formula 11, X **means the probability that**…*
* *In particular, the BSN **was formed by** X…*
* *In practice, X **can be calculated as** the percentage of Y…*
* *Its performance and its position and velocity in the feature space **are acquired by** X…*
* *Let the group of mean-subtracted features **be denoted by** X where…*
* *Neural growth in the learning algorithm **is modulated by** X…*
* *Our solution **consists of** three modules:…*
* *Raw EMG data **was recorded with** a BioRadio 150™ (Great Lakes Neuro Technologies) with sampling frequency 960 Hz…*
* *Subjects **were divided into** six groups according to X and Y…*
* *Successful transmission occurs if the received signal interference plus noise ratio (SINR) is larger than a threshold T, which **is determined according to** X…*
* *Target feet positions **are estimated with** X…*
* *The 3D orientation of the Shimmer device **is estimated through** X…*
* *The activation level of each node **is determined by** X…*
* *The activity detection **was evaluated in** X…*
* *The damage pattern **is uniformly distributed in** X…*
* *The distance between X and Y **is estimated through/via/by**…*
* *The equation of motion at an arbitrary time step **can be written as** X…*
* *The feature extraction **is based on** X, a common technique applied in noise modeling…*
* *The feature selection **was performed with** the X approach based on…*
* *The finite element software package, X **is used for** the computational analyses…*

* *The key idea of the algorithm is to* ***sort data by*** *X…*
* *The kinematic analysis* ***was carried out in a comparative way****, considering a Y system and a Z system…*
* *The last network GSTS* ***is equipped with*** *an associative learning mechanism to…*
* *The model* ***establishes the relationship between*** *X* ***and*** *Y…*
* *The neurophysiological evidence* ***is expressed as*** *the equation where…*
* *The parameter X* ***determines*** *the ellipticity of the receptive field…*
* *The raw ECG data* ***has been filtered using*** *X filter, with a cut-off frequency between 0.5 Hz and 200 Hz and a passband ripple of 1 dB…*
* *The self-consistency of the model* ***can be measured by/from/through*** *X…*
* *The transmission capacity* ***is given by*** *the equation where…*
* *These settings* ***were chosen as a method to*** *identify missed peaks and false positives that…*
* *This study* ***utilized clustering techniques to*** *identify…*
* *Three features* ***were extracted on a basis of*** *X…*
* *Two poses of the training set* ***can be distinguished under*** *X…*
* *Unlike X which* ***is distributed over*** *the whole spectrum, Y* ***can be set to****…*
* *Using X, the constrained local approximation* ***can be constructed/described/expressed/represented as****…*
* *We* ***define*** *X* ***as*** *Y* ***to*** *quantify this phenomenon…*
* *We* ***have the equation where*** *X is regarded as the total uncertainty…*
* *We* ***measure*** *the contour saliency* ***in the following way****…*
* *We* ***performed*** *X* ***to*** *ensure that every volume is included in testing…*
* *We* ***proceeded with*** *our research approach by implementing three different experiments. The first experiment* ***was done for****…The second experiment* ***was done for****…The third experiment* ***dealt with****…*
* *X* ***applies*** *the conditional BBNR rule* ***to*** *examine…*
* *X for the same function in the same task* ***is stored in*** *the same invoke/branch log file…*
* *X* ***is a factor that*** *determines the size/value of the circle…*
* *X* ***is an effective tool for*** *describing human textural perception…*
* *X* ***is built from*** *the set of likelihoods as described in Section III…*
* *X* ***is calculated to*** *evaluate the accuracy of the method…*
* *X* ***is often adopted as*** *a baseline scheme…*
* *X* ***is often utilized to*** *measure the homogeneity…*
* *X* ***is placed on*** *the front end of the bed at a sample frequency…*
* *X* ***is stored in*** *an in-memory heap structure…*

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Move 4: Research Procedures

Describing the phases and actions involved in the research from development to implementation

- Typical collocations

* *along with*
* *an implementation/phase/process/sequence of*
* *append/continue/lead to*
* *as described (in)*
* *as follows*
* *be achieved/followed/generated by*
* *be carried out (to)*
* *be categorized/classified/divided/grouped into*
* *be employed/required to*
* *be illustrated in*
* *be obtained as*
* *be prior/subject to*
* *follow the analysis/treatment (of)*
* *follow the correction (for)*
* *following/further steps*
* *follow-up phase*
* *initial/next stage*
* *lead to*
* *on the arrival/completion of*
* *once completed/finished*
* *rely on*
* *start from/in/with*
* *step in/into*

- Typical sentences

* *A grid system is adopted to compute X;* ***then*** *Y employs trilinear interpolation algorithm on grids.*
* ***After that****, we give a design overview followed by the detailed description.*
* ***After*** *the determination of X, a total of 17 GLCM parameters were obtained, which were combined with image pixel intensity parameters.*
* ***At each time step****, the forward hidden layer will compute a hidden representation…*

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* ***At the beginning***, *the encryption key used was hard-coded inside the binary as plain text…*
* ***During the fiber-pull out stage***, *the fiber force is described by / determined as…*
* ***Each partition*** *is recursively divided in the same way using…*
* ***Each training set*** *is further sampled for the training and validation subsets to train the method.*
* ***Every time*** *a new sample arrives in the stream, the neural encoding is performed for the samples.*
* ***First***, *each feature selection method is executed over the training set.* ***Next***, *the selected features are used as the new training set to…*
* ***For each bite*** *labeled by one rater, X was searched for a corresponding bite from the second rater…*
* ***For each*** *SSL/TLS* ***session*** *of a specific application, the handshake process is followed by…*
* ***If*** *the upper bound on the accuracy of a case calls below the inactivation threshold puma, it is deactivated from future reasoning…*
* ***In each phase***, *the input and output logs are stored in an input log file and an output log file, respectively.*
* ***In each scale***, *we compute each increment and the final optical flow is obtained as an accumulative value for all increments…*
* ***In each side***, *an artificial marker was placed for the robot to…*
* *In our implementation, we* ***firstly*** *prune item pairs…And* ***then****…*
* ***In the first stage***, *the training images are convolved with…*
* ***In the first step***, *strategy data reduction is carried out* ***every time*** *the neuron repository is full.*
* ***In the minimization process***, *the function X is initialized by the solution of…*
* ***In the presence of obstacles***, *subsequent turns are made until a forward motion can be carried out.*
* ***In the second step***, *contextual superpixel classification is performed to…*
* *It prevents a case from being deleted in the current round and will be cleared* ***at the beginning of the next round****…*
* *On the other hand,* ***when*** *a rough mesh is obtained from a single depth map…*
* ***Once*** *an evidential model has been learned from the available training set, it can be used to estimate…*
* *The architecture undergoes* ***multiple time steps***, *each of which is a discrete time…*
* *The backward recursion is derived based on* ***the next transition in****…*
* *The calculation of the plastic and total strain range is performed through* ***the first stage of****…*

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* ***The first step*** *is to divide each dataset into the training and testing sets by 10-fold cross validation.*
* ***The following procedure of*** *X is proposed in the present work…*
* ***The handshake process*** *is followed by…*
* ***The new peak*** *was then inserted into the empty row underneath the flagged peak.*
* ***The next stage*** *required features to be extracted from this data.*
* ***The next step*** *is to compute the crack propagation angle based on the information of…*
* *The proposed deep architecture is composed of* ***two distinct processing streams*** *for X…*
* *The value of X can be set fixed,* ***whenever*** *a new sample arrives, it is stored in the memory and the oldest one is discarded.*
* ***These sequences*** *are filtered with a window size of three frames to reduce the effect of X.*
* ***This procedure*** *is repeated until all partitions contain no more than f points.*
* ***This process*** *is repeated until a root node is created.*
* *Training of the architecture is divided into* ***three stages****.*
* *Two groups of markers namely a and b were examined as a potential* ***two-stage*** *screening for X.*
* *We* ***further*** *relax the constraint by…*
* *We* ***start*** *by introducing…We* ***then*** *explain…****In the next section****, we present a rigorous evaluation of our discretization method in several different medical domains.*

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Move 5: Variables

Describing the factors or features that are dynamic and variational, and expressing the abstract concepts of values

- Typical collocations

* *a calculation/degree/duration/estimation/frequency/means/number/parameter/probability/value of*
* *a change/coordinate/correlation/deviation/performance/presence of*
* *additional/control/dependent/endogenous/exogenous/extraneous/independent variable*
* *be bounded/determined/expressed/replaced by*
* *be close/connected/equivalent/opposed/prone/sensitive/up to*
* *be expressed in*

* *be noticeable for*
* *consider/pertain/tend to*
* *critical/demographic/contributory/driving/key/main/major factor*
* *depend/rely on*
* *descriptive/predicative data*
* *differences between*
* *mean/median value*
* *multivariate/normal/univariate distribution*
* *probability distribution*
* *residual stress*
* *statistical analysis/test*

- Typical sentences

* ***A new value is chosen based on*** *the maximum distance of item pairs in the heap…*
* ***A zero-value*** *weight function indicates the bond between X and Y is disengaged.*
* *All the data was smoothed* ***using a Gaussian-weighted window of*** *width 1s and* ***standard deviation of*** *2s.*
* *An image is assumed to* ***have its pixel values normalized in the range*** *[X, Y]…*
* *As the salience is increased for a particular channel, its output decreases and approaches* ***selection threshold****…*
* *As X* ***cannot be greater than*** *the number of training samples, such a discounting factor also* ***considers limited size of*** *the training set.*
* ***By adjusting*** *X* ***of each vertex****, the position of each vertex is iteratively updated.*
* *During the simulation, the mathematical relationships* ***among*** *X* ***variable values*** *can be derived based on the semantics of each simulated statement.*
* *Each end node maintains* ***two variables****, X and Y,* ***for RTT estimation****.*
* *For DADRX-m with* ***a smaller value of m selected from*** *the feasible set, some state changes are prohibited.*
* *For each time instant k,* ***a number of feature values are computed from*** *the region of interest in each training image.*
* ***For each variable atom that*** *the learner has encountered in a unique teacher meaning, there is a decision tree that determines…*
* *If a corresponding byte was found within the window but* ***one or more of the variables did not match****, then the byte was reviewed by a third rater who judged* ***which variable values were correct****.*
* *If the sample label is not present in L,* ***a new column*** *in H* ***is created and initialized***

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to *X and Y, whereas if the input sample is not labeled, then H is not updated.*

* *In atemporal problems, supervised discretization is often performed for classification purposes when* ***the variables' values are continuous****…*
* *In conventional cameras, the overall resolution is* ***a function of two variables****: X and the Y.*
* *Let X be the set of time series of* ***a temporal variable distributed within*** *the Y classes throughout all of the entities.*
* *Note that the inequalities in A* ***are LMIs of variables*** *X, Y, and Z, from which the controller can be easily solved.*
* *Once* ***the optimal variables are determined****, X and Y can be obtained using the above change of variables.*
* ***Our choices of enabled*** *X* ***values are determined empirically*** *so that each source of inputs has approximately equal contribution to the net input.*
* *Our method has an advantage to optimize only* ***a single variable*** *X* ***for*** *each vertex.*
* ***Parameters*** *X,* ***taking on values in*** *0, 1, are relative strengths that gate inputs from different sources.*
* ***Rather than using a value specified by*** *a user, it* ***uses a value that is determined by****…*
* ***The adaptive mean and standard deviation values*** *corresponding to each RR-interval* ***were calculated adaptively*** *from the filtered sequence.*
* *The branch log records* ***the variable values involved in*** *the condition of the branch statement.*
* ***The cost ratio between false negatives and false positives was varied in*** *a leave-one-subject-out validated grid search.*
* ***The damage variable****, X,* ***is described as*** *a function of equivalent strain…*
* ***The dependent variable*** *is X, whereas* ***the independent variable*** *is Y…*
* ***The distribution of the variables*** *was non-Gaussian as ascertained by the Chi-square goodness of fit test.*
* ***The error on the validation set*** *will normally decrease during the initial phase of training, as does the error on the training set.*
* *The forward recursion based on the* ***predicted probability*** *is determined by…*
* ***The highest value among all classes is an indicator of*** *the class that X most likely belongs to…*
* ***The number of clusters*** *X* ***is set here to a fixed value for*** *each feature space.*
* ***The ranges of the above variables are given in*** *Table I.*
* ***The relationship among the variables is illustrated in*** *Fig. 8.*
* *The sensor* ***allows the ROI to be changed with*** *every sensor readout.*

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* ***The size of** X **is determined by**…*
* ***The variable** s, **that is the sign of** the components of w, **essentially encodes** the "classes" of the different atoms.*
* ***Those binary numbers are then concatenated to** form an 8-bit-coded integer, which takes a value from the set.*
* *To this end, **two constraints based on** the stereo configuration **may be added to** our model.*
* *We also **have a countable number of variables** (**A variable atom is an expression** formed by applying a predicate symbol to **the correct number of variables** as arguments…).*
* *We define our partition model using a threshold level t where G is a Gaussian **with standard deviation of** 0.1 and denotes the convolution operator.*
* *We **measured the** X **and** Y **values across** dopamine levels and **plotted them against** Z.*
* *We **search this value from** 1 **to** 60, and plot the variation of classification accuracy on the validation set in Fig. 7.*
* *We **set** X **to different values**, and keep other parameters unchanged…*
* *We **used a very small value to** merge two clusters and verified empirically that **values from** X **to** Y **are suitable to** our purpose.*
* *When a gate is enabled, it **takes on a positive value to** allow the corresponding input activity to affect…*
* *When a neuron is fired, the age of the connections from the neuron to its topological neighbors **is set to** 0, while the age of the rest of the connections **is increased by a value of** 1…*
* *When copying each node, leaf nodes are packed to **variable size records**, leaving only a small amount of space to allow for updates.*
* *X and Y **indicate the mean value** and half of the extent of variation of rhythm in one cycle, respectively.*
* *X has to be updated due to **the possible change of variable values**.*
* *Xs are primitive operations on **variables that do not include** Y; **the value of** Y **will be changed** after the execution of Z.*

Move 6: Data Analysis

Elucidating the process of extracting useful information from research data and forming conclusions

- Typical collocations

* *account for*

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* *an approximation/data/derivative/distance/evaluation/output/position/strength of*
* *assume to*
* *be able/equal/subject to*
* *be calculated/computed/expressed as*
* *be captured/collected/gathered/measured/performed/plotted using*
* *be obtained/represented by*
* *compare to/with*
* *cross validation*
* *cut off*
* *extend/lead/reduce to*
* *feature extraction/space*
* *hidden layer*
* *obtain/originate from*
* *search for*
* *standard deviation*
* *with respect to*

- Typical sentences

* *A motor output at each iteration X* ***is computed by*** *Y based on…*
* *An accuracy of classification X* ***is defined to measure*** *the outcomes of classifier prediction against the ground truth established by…*
* *An independent t-test* ***was carried out*** *on each of the variables to determine whether…*
* *Based on the central limit theorem, the PSF for incoherent polychromatic illumination* ***is often approximated as*** *an X…*
* *By X, we* ***are able to verify*** *the integrity of…*
* *Correlations between X and Y* ***were negative and statistically significant****.*
* *Dataset X* ***was used to construct*** *the networks for Datasets Y and Z that were used in all of our experiments.*
* *Each acquired ECG segment* ***was denoised by*** *a combination of X and Y.*
* *Each cluster* ***was represented by*** *a Gaussian distribution to characterize…*
* *Each item pair in the priority queue* ***is evaluated based on****…*
* *Each memory pool* ***is structured as*** *arrays of identically sized objects.*
* *Each of the attributes* ***is normalized into*** *the range from 0 to 1.*
* *Each target X* ***is characterized by*** *a time-dependent triplet Y.*
* *False intervals* ***were replaced by*** *X…*

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* *Following the Ambrosio and Tortorelli convergence framework, the discontinuity set X* ***can be approximated by*** *Y…*
* *In testing, the system* ***essentially determines*** *how likely a testing sequence of X* ***is associated with*** *Y.*
* *In that case, every sample X* ***is characterized by*** *a different combination of feature clusters.*
* *In this case, an additional parameter sets the maximum number of iterations* ***performed by*** *the search algorithm.*
* *It should be noted that all system uncertainties* ***are attenuated by****…*
* *Non-parametric Kruskal-Wallis test* ***is implemented for*** *these distributions of different study groups.*
* *Salience* ***was represented as*** *a scalar value at the input with one salience per channel…*
* *Significance levels* ***were set at*** *the 1% level using the t-test.*
* *Since these two devices have similar configuration, we* ***chose*** *X* ***as a baseline to*** *show the effectiveness of…*
* *The 3D orientation of the Shimmer device* ***is estimated through****…*
* *The average prediction accuracy* ***is obtained by*** *the equation X and is based on Type I error.*
* *The dataset comprises three separate tables, all of which* ***are normalized to*** *3NF.*
* *The divergence score* ***is calculated based on*** *X.*
* *The fitness of a network* ***is evaluated using*** *X among all the individuals' outputs.*
* *The integrity of X* ***is verified by*** *the input audition of the current phase…*
* *The laser light* ***is directed at*** *X that…*
* *The mass and damping coefficients* ***are chosen to obtain*** *the steady-state solutions in a manner that…*
* *The mean score for the two trials* ***was subjected to*** *multivariate analysis of variance to determine…*
* *The objective function of X* ***is estimated in*** *a predefined and limited range so that it can be used to…*
* *The overall performance of the system* ***is evaluated by*** *X…*
* *The RR-intervals* ***are normalized by*** *X…*
* *The staying probability of X* ***is updated through*** *the equation…*
* *The three presented classifiers (namely NCC, kNN, and SVM)* ***have been run on both original data****…*
* *To validate the effectiveness of the radiometric calibration step, we* ***provide an additional experiment****…*

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* *Two estimation techniques, X and Y,* ***were used to estimate*** *the daily core body temperature.*
* *Using this function, the activation X* ***can be interpreted as*** *Y…*
* *We* ***temporarily trust*** *the integrity of X and* ***use it to verify*** *the integrity of the execution.*
* *X* ***calculates*** *the varying residual stress, associated with the elastic solution where Y is the cycle number.*
* *X* ***is defined to measure*** *the outcome of…*
* *X* ***is used to predict*** *the outcome of…*
* *X* ***is used to produce*** *an incident beam of 52 nm in wavelength…*
* *X* ***is used to quantify*** *the mechanism…*
* *X* ***is used to test*** *the performance of the prediction model…*

3.5 Checking the Writing Quality

The following is a useful checklist for assessing the quality of your Research Methods section:

- Does the Research Methods section provide necessary details, including materials, technical design, research procedures, variables, and data analysis? Do I explain the research actions involved to carry out the research?
- Do I explain the reasons for choosing particular material, e.g., its advantages and necessity?
- Is my description concise and clear? Are unnecessary semicolons used? Can readers understand my train of thoughts and replicate the methods?
- Do I inform readers of the basis of my research methods with necessary in-text references? Do I avoid detailed explanations of the research methods that are not original?
- Is the number of actions described in the sentences appropriate, i.e., approximately two to three in each sentence? Are these sentences listed and stacked like those in a user manual?
- Do I arrange the content in a way that suits reading habits, such as describing the research procedures in a chronological order and avoiding frequent backreferences in the paper?

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- Do I follow the writing instructions of the target journal regarding how to present numbers, formulas, symbols, etc.?
- Is the use of tense correct? Do I use the simple past tense to describe the actions during the research, and the simple present tense to describe the standard methods, scientific facts, and objective reality?

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Exercises

Read the following Research Methods section and then answer the questions.

We describe the components of our model, and give examples drawn from the primary domain we have used to guide the development of the model.

A situation is composed of some objects and some of their properties and relations. These are not intended to be an exhaustive description of the state of the world, but to pick out some aspects of it that are of joint interest to the teacher and the learner. We assume that these objects, properties, and relations are recognizable to both the teacher and the learner from the outset. A situation is represented as a set of ground atoms over some constants (denoting objects) and predicates (giving properties of the objects and relations between them). For example, a situation s_1 consisting of a big purple circle to the left of a big red star is represented by the following set of ground atoms:

$$s_1 = \{bi1(t_1), pu1(t_1), ci1(t_1), le2(t_1, t_2), bi1(t_2), re1(t_2), st1(t_2)\}.$$

Here, the two objects are represented by the constants t_1 and t_2, and the unary predicates are big (*bi1*), purple (*pu1*), circle (*ci1*), red (*re1*), and star (*st1*), and the sole binary predicate is the relation of one object being to the left of another (*le2*). The teacher and the learner each have access to this representation of the situation.

Formally, we have a finite set P of predicate symbols, each of a specific arity (number of arguments), where the arity is appended to the name of the predicate. We also have a countable set of constant symbols t_1, t_2, …, which are used to represent distinct objects. A ground atom is an expression formed by applying a predicate symbol to the correct number of constant symbols as arguments, for example, $re1(t_1)$ or $ab2(t_2, t_1)$.

We also have a countable number of variables x_1, x_2, …A variable atom is an expression formed by applying a predicate symbol to the correct number of variables as arguments, for example, $re1(x_2)$ or $le2(x_4, x_3)$. A meaning is a finite sequence of variable atoms. Note that the atoms do not contain constants, and the order in which they appear is significant. Examples of meanings are as follows:

$$m_1 = (st1(x_1))$$

$$m_2 = (st1(x_1), le2(x_2, x_1), pu1(x_2), ci1(x_2))$$

$$m_3 = (bi1(x_1))$$

$$m_4 = (pu1(x_1), ci1(x_2))$$

A meaning is supported in a situation if there exists a support witness, that is, a mapping of its variables to distinct objects in the situation such that the image under the mapping of each atom in the meaning appears in the situation. If a meaning is supported in a situation by a unique support witness, then it is denoting in the situation.

The meaning m_1 is supported in the situation s_1 via the witness $x_1 \rightarrow t_2$, the meaning m_2 is supported in the situation s_1 via the witness $x_1 \rightarrow t_2$, $x_2 \rightarrow t_1$, and the meaning m_3 is supported in the situation s_1 by either the witness $x_1 \rightarrow t_1$ or the witness $x_1 \rightarrow t_2$. The meaning m_4 is not supported in the situation s_1 because any support witness must map the variables x_1 and x_2 to distinct objects. Meanings m_1 and m_2 are denoting in the situation s_1, but meaning m_3 is not; intuitively, the predicate *bi1* by itself could refer to either object. We assume that both the teacher and the learner can determine whether a meaning is denoting in a situation.

We also have a finite alphabet W of words. An utterance is a finite sequence of words, for example, “the star” or “the star to the right of the purple circle or star of circle small the green”. The target language is the set containing every utterance such that there exists some situation in which the teacher could produce that utterance. In our example, this includes utterances like “the star” or “the triangle to the right of the purple circle” but not “star of circle small the green”. We assume each utterance in the target language is assigned a unique meaning; in our examples, a finite state transducer is used both to recognize utterances in the target language and to assign them meanings.

1. What is this excerpt about? Summarize the main idea of each paragraph.
2. Do the paragraphs correspond to the structural moves of the Research Methods section? Point out the correspondence between paragraphs and moves.
3. What is possibly going to follow the last paragraph based on the information flow?
4. What is the major tense in this excerpt? Why is this tense used?
5. What is the major voice in this excerpt? Why is this voice used?

Chapter 4
Research Results

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"Everyday life is like programming. If you love something, you can put beauty into it."

Donald Knuth

4.1 Definition

The Research Results section lays out the major findings of data analysis, with responses to the research questions, hypotheses, and goals raised in the Introduction (or the Research Methods sometimes) section in the corresponding order. In addition to be entitled as "Research Results", this section may also appear under the heading "Experimental Study", "Experimental Results", or "Results". Another point to mention is that the Research Results section can be either an individual part or (in some cases) combined with the Discussion and Conclusion section. No matter whether it is separated or combined, the Research Results section is different from the Discussion and Conclusion section in terms of function: The latter is an abstraction and extension of the former, usually generalizing the research findings to a much broader context with a shorter length and a more universal meaning. The decision on whether to write a separate Research Results section is largely dependent upon the target journal's preference and conventions.

4.2 Components

The Research Results section only reports findings that are representative and directly pointing to the research questions. In general, it often starts with a brief review of the research objectives and/or methods, proceeds with a description of the representative data and its analysis results in conjunction with tables and figures, and finally arrives at a summary of the research findings and their significance. In the practical writing of a Research Results section, the following tips deserve much attention:

- Be targeted and avoid being exhaustive. It should be kept in mind that readers are not interested in all the findings but the most typical ones that are targeted at research questions. Therefore, there should be a trade-off when reporting research findings. As for the findings not reported yet but maybe significant enough to raise concerns, they can be discussed as a future direction or a research implication, placed at the end of the paper.
- Maintain objective with moderate comments. Compared with other disciplines, especially humanities and social sciences, computer science attaches more attention to the rigorous and unbiased description of facts; thus the objective and formal writing style is more favored by reviewers. The most frequently used strategy to improve objectivity is to use passive voice and few first-person pronouns. Nonetheless, objectivity does not mean a complete divorce from the writer's own opinions. In fact,

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comments from the writer often render readers a certain sense of reading immersion, enhancing their reading interest. Therefore, when reporting research findings, especially their attributes, values, and meanings, it is favorable for the writer, with a fine tuning of lexical items, to express certain degree of (dis)agreement and attitude.

- Avoid the misuse of tense. A confusion in tense often offends against the reading experience to a large extent. For example, it is a nightmare for readers if a frequent shift between the simple past tense, simple present tense, and present perfect tense appears in a single paragraph, because they may struggle at that time to puzzle out which tense is describing the findings of the paper itself. Therefore, a much-preferred writing strategy is to keep tense consistent (with few exceptions): Use the simple present tense or the simple past tense to report research findings, and the simple present tense to explain tables and figures.

- Visualize complex results and differentiate visualization from text description. Some research results are so complicated with multilayered discoveries and sophisticated output that they can hardly be described in words only. In this case, visualizing the results by tables and figures is an ideal alternative to text description as it improves the efficiency of information transmission in a much clearer and more concise manner. However, note that visualization and text description are two completely different elements: Visualization displays information, while text description explains the information. In other words, visualization is about "what it is" question, while text description clarifies "why it is" question.

- Make the titles of tables and figures concise, and avoid complete sentences. The title of a table or figure in an academic paper mainly serves as a reminder, that is, telling readers what research results it is displaying, rather than explaining details such as what the results are, and what their trends and meanings are. Therefore, the title of a table or figure is often compact and succinct, usually named by a phrase which is self-evident to show the relationship between the content and the research results. In addition, there is no need to describe the chart type in the title, such as "Histogram representing changes in..." where the "Histogram" is obviously redundant.

4.3 Structure

The Research Results section generally contains three structural components (or moves), namely introducing results, explicating results, and summarizing results:

- **Move 1:** Introducing results is an overview of the relevant background before reporting

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specific findings, usually including a brief review of the research purposes and / or prior studies, a reiteration or complement to key research methods, and sometimes an overview of the section with a short summary of research findings as well.

- **Move 2:** Explicating results describes details of the research findings, usually including tables and figures where those findings are visualized, key and conspicuous research findings with or without explanations, and comparison and evaluation of research findings.

- **Move 3:** Summarizing results is not common in research papers in computer science. This move synthesizes the pieces of research findings organically to form a narrative summary. It also comments upon these findings with regard to their problems, enlightenment, and implication.

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Case Study One

Excerpt (Harding & Milner, 2017)	**Moves**
① This section presents experiments that examine acoustic feature estimation in noisy conditions and under speaker variability. ② Experiments first use a speaker-dependent database to examine specifically the effectiveness of noise adaptation. ③ This database contains 579 phonetically balanced sentences for training and 246 for testing (130,000 test vectors) spoken by a female U.S. English speaker, each with a duration of between 5 and 9 seconds…	**Move 1: Introducing results** [Not appear] Brief review of research purposes and/or prior studies Sentence ①: Overview of the section Sentences ②–⑦, ⑯, ㉑–㉓: Reiteration or complement to key research methods
④ The audio was sampled at 8 kHz and tests carried out in white noise, babble noise, and destroyer operations room noise, added at SNRs between –5 dB and +15 dB as an aim of the work is robustness in high noise levels…	
5.1 Fundamental frequency estimation	
⑤ Fundamental frequency error, E_{f0}, is measured as $$E_{fo} = \frac{1}{N_V}\sum_{i=1}^{N}\left(\frac{\left\lvert \hat{f}_{oi} - f_{oi}\right\rvert}{f_{oi}}\right)\times 100\,\% \quad \forall f_{oi} > 0$$ where $\hat{f}_{oi}$ and f_{oi} are the estimated and reference fundamental frequencies for the ith voiced frame respectively, and N_V is the number of voiced frames. ⑥ To avoid analysis being affected by voicing errors, E_{f0} is measured on only frames classified as voiced.	

(Continued)

Excerpt (Harding & Milner, 2017)	**Moves**
5.1.1 Speaker dependent	
⑦ Speaker-dependent tests first examine the effect of the number of filterbank channels and the number of mixture components in the GMM… ⑧ Fig. 4 shows E_{f0} in white noise at an SNR of 10 dB… ⑨ Increasing the filterbank from 16 to 32 channels reduces error but beyond that no further reduction is observed. ⑩ Similar patterns of results were obtained at other SNRs and noises… ⑪ Fig. 5 shows E_{f0} in white, babble, and destroyer noises at SNRs from −5 dB to +15 dB for clean trained models, models trained and tested under the same noise conditions, and models adapted to noise. ⑫ E_{f0} was 2.1% in clean conditions. ⑬ For comparison, the performance of the ETSI XAFE (ETSI, 2003), YIN (de Cheveigné & Kawahara, 2002), PEFAC (Gonzalez & Brookes, 2014), and parametric fast NLS (Nielsen et al., 2016) methods are also shown… ⑭ In fact, estimates from these comparative methods were consistently worse than the proposed method. ⑮ We did examine whether accuracy could be improved by applying speech enhancement prior to f_0 estimation but found this to reduce performance which we attribute to distortion introduced, particularly at lower SNRs.	**Move 2: Explicating results** Sentences ⑧ ⑪ ⑰ ㉔ ㉗: Tables and figures where research findings are visualized Sentences ⑨ ⑩ ⑫ ⑱ ㉕ ㉘: Key and conspicuous research findings with or without explanations Sentences ⑬–⑮, ⑲ ⑳ ㉖: Comparison and evaluation of research findings
5.1.2 Speaker independent ⑯ For speaker-independent estimation, noise adaptation is identical to that for speaker-dependent models, and speaker adaptation is also used to adjust the statistics of the model to the speaker under test. ⑰ Fig. 6 shows E_{f0} for clean trained models, models adapted to noise, and then models adapted to speaker and noise. ⑱ E_{f0} in clean conditions was 3.8%… ⑲ In comparison, YIN and PEFAC are effective in white noise, with errors just higher than adapted models, but less so in the non-stationary noises. ⑳ NLS is even more effective in white noise, achieving lower errors than YIN and PEFAC, but slightly higher than adapted models, and is also less accurate in babble and destroyer noises…	**Move 3: Summarizing results** [Not appear]

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(Continued)

Excerpt (Harding & Milner, 2017)	**Moves**
5.2 Voicing classification ㉑ Voicing classification error, E_V, is measured as $$E_V = \frac{N_{\bar{V}\|V} + N_{\overline{UV}\|UV} + N_{\overline{NS}\|NS}}{N_T} \times 100\ \%\ ,$$ where $N_{\bar{V}\|V} + N_{\overline{UV}\|UV}$ *and* $N_{\overline{NS}\|NS}$ are the number of voiced, unvoiced, and non-speech frames classified incorrectly and N_T is the total number of frames under test. 5.2.1 Speaker dependent ㉒ An initial test, similar to that for fundamental frequency estimation in Section 5.1.1, investigated the effect of the size of filterbank and the number of mixture components. ㉓ E_V was minimized with 8 channels and 16 mixture components and beyond these values the error remained unchanged… ㉔ Fig. 7 shows speaker-dependent voicing error in white, babble, and destroyer noises at SNRs from −5 dB to +15 dB for clean trained models, matched models, and models adapted to noise. ㉕ Voicing error in clean conditions is 4.5%. ㉖ For comparison, voicing error is shown for XAFE and PEFAC which have E_V of 6.1% and 10.8% in clean conditions… 5.2.2 Speaker independent ㉗ Fig. 8 shows E_V for speaker-independent testing in white, babble, and destroyer noises using clean trained models, noise adapted models, and noise and speaker adapted models. ㉘ In clean conditions, E_V is 7.1% with clean speaker-independent models, which reduces to 6.3% when adapted to the speaker under test…	

Case Study Two

Excerpt (Appel et al., 2017)	**Moves**
① In the method proposed by Appel et al. (2016), when the sentiment lexicon did not contain the necessary terms/words to produce a classification output when processing a given sentence, there were only two possible paths to follow: add terms to the lexicon (offline process), or use the services of a	**Move 1: Introducing results** Sentences ①⑩: Brief review of research purposes and/or prior studies

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(Continued)

Excerpt (Appel et al., 2017)	**Moves**
word-frequency dictionary (online process) that is computationally costly to build… ② Experimental results are reported in this section regarding the performance of the alternative path proposed in this paper based on the cross-ratio uninorm operator.	Sentence ②: Overview of the section
5.1 Datasets utilized	
③ We make use of the Movie Review Dataset provided by Pang and Lee and available at http://www.cs.cornell.edu/people/pabo/movie-review-data/. ⑤ In addition, we utilize a dataset containing Twitter data, *Sentiment140*, which is available at http://help.sentiment140.com/for-students.	Sentences ③–⑤: Reiteration or complement to key research methods
5.2 Results for the application of cross-ratio uninorm aggregation to test datasets	**Move 2: Explicating results**
⑥ In order to assess the validity of the alternative path based on the cross-ratio uninorm proposed in this article, experiments were carried out to compare: • The cross-ratio uninorm performance as an aggregation tool of the classification output when applying the NB and ME algorithms against the performance achieved using the arithmetic mean aggregation… • The performance of the cross-ratio uninorm implementation in the HSC lexicon-based method against the performances of the HSC lexicon-based method…	Sentences ⑥⑪: Tables and figures where research findings are visualized [Not appear] Key and conspicuous research findings with or without explanations
5.2.1 Cross-ratio uninorm against two other possible techniques	
⑦ Tables 1 and 2 show comparative results of the cross-ratio uninorm aggregation the classification outputs when applying the NB and ME algorithms against two methods: the arithmetic mean, and the classification outputs obtained by using the word-frequency dictionary described in… ⑧ In this comparison, the cross-ratio uninorm (NB & ME) comes ahead of algorithms in all four performance indicators. ⑨ Particularly, the recall indicator (how many of the true positives sentences were found) displayed by the cross-ratio uninorm is the highest of all by a significant margin.	Sentences ⑦–⑨, ⑫–⑮: Comparison and evaluation of research findings

(Continued)

Excerpt (Appel et al., 2017)	**Moves**
5.2.2 Cross-ratio uninorm as an enhancer of our hybrid method ⑩ In the hybrid model we presented in Appel et al. (2016), we did show that during the first pass of the proposed hybrid algorithm, there were sentences that could not be classified as the sentiment lexicon did not count with the required terms/words in order to produce a classification outcome… ⑪ The next step in our experimental phase is to study and analyze the performance of the cross-ratio uninorm (NB & ME) when embedded in our HSC method… ⑫ The obtained results are presented in Table 3 (for Movie Review Dataset) and Table 4 (for Twitter Dataset). ⑬ We see that the cross-ratio uninorm approach performs second-best in the group, achieving results that are very close to those attained by HSC with word-addition enabled (only 2% below in accuracy and precision)… ⑭ We repeated the same experiment using the Twitter Dataset this time, obtaining the results presented in Table 4, which basically confirms the previous results and analysis. ⑮ We can say with confidence that the alternative option when the lexicon cannot offer a solution based on the cross-ratio uninorm constitutes an excellent alternative at a very low cost, both computationally and people-wise.	**Move 3: Summarizing results** [Not appear]

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4.4 Phrases and Sentences in Moves

Move 1: Introducing Results

A. Briefly reviewing the research purposes

- Typical collocations

* *a purpose of/to*
* *address the issue (of)*
* *aim at/to*
* *an objective of*

* *an overall aim (of)*
* *attempt/seek/tend to*
* *be concerned with*
* *be highlighted in*
* *be motivated by*
* *be provided by/in*
* *be compared/designed/developed/referred/undertaken/used to*
* *critically review*
* *discuss the role (of)*
* *explore the link (between)*
* *focus/operate on*
* *for the purpose of*
* *in order to*
* *main/major/primary goal*
* *offer/provide an analysis (of)*
* *set out to*
* *with respect to*

- Typical sentences

* ***An initial objective of*** *the project* ***was to*** *identify…*
* *Given an ever-increasing load on the foreground applications,* ***the goal is to*** *determine X…*
* ***In an attempt to*** *visualize the differences of the performance between the balanced and imbalanced training sets, we calculate X…*
* *In this investigation,* ***the aim was to*** *assess…*
* *Instead of relying on the complex program analysis technique,* ***our approach utilizes layout analysis to*** *determine X…*
* *Our algorithm learns a discriminative dictionary* ***whose goal is to****…*
* ***Our objective here was not to*** *generate high absolute classification values,* ***but rather to****…*
* ***The aim of this study was to*** *develop a better understanding of…*
* *The focus measure* ***aims at*** *estimating the focus level of X…*
* *The focus sampling scheme proposed in Section. 3.4 is applied to X* ***in order to****…*
* ***The main purpose of*** *the current study* ***was to*** *determine…*
* ***The objective of*** *autofocus* ***is to*** *determine X in order to bring an observed object into focus…*
* *The present study* ***was intended to*** *determine the effect of…*

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* ***The second aim of*** *this study* ***was to*** *investigate the effects of…*
* ***The use of*** *X* ***is to*** *avoid the possible bias on individual datasets…*
* *This obeys the nature of X, which* ***aims to*** *uncover…*
* *This project* ***was undertaken to*** *design X and evaluate Y.*
* *This prospective study* ***was designed to*** *investigate the use of…*
* *This study* ***attempted to*** *establish the connection between X and Y.*
* *This study was conducted* ***in purpose of*** *investigating…*
* *We* ***conduct a study to*** *analyze the impact of…*
* *We* ***sought to*** *demonstrate an alternative feature extraction pipeline that…*
* *We use the results from Section 5.3 to derive a resource configuration policy framework,* ***whose purpose is to*** *determine X…*

B. Briefly reviewing prior studies

- Typical collocations

* *a detailed/thorough/influential/widely-accepted account (of)*
* *be associated with*
* *be carried out (by)*
* *be cited in*
* *be claimed by/in*
* *be demonstrated/explored/investigated/performed/presented/proposed/provided/studied by*
* *be described/provided in*
* *be generally believed*
* *be known as*
* *be mentioned by/in*
* *be reported by/in*
* *most cited study*
* *previous work*
* *prior study*
* *recent/substantial research*
* *systematic review/study*

- Typical sentences

* *A good summary of the classification of X* ***has been provided in the work of****…*
* ***A number of studies have postulated*** *a convergence between X, Y, and Z.*
* *In 2015, John and Torch* ***were the first of many investigators to*** *demonstrate that…*

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* ***In a randomized controlled study of*** *X, Smith (2012) reported that…*
* ***In previous studies on*** *X, different variables have been found to be related to…*
* *It enriches X as described* ***in the previous work****…*
* ***It has been demonstrated*** *that a high intake of X results in damage to…*
* *It is noteworthy to mention that the best results of X we are aware of on these datasets* ***are achieved by*** *Mairal et al. (2008).*
* ***It is now well established from a variety of studies*** *that…*
* ***Motivated by the recent progress in*** *X, we implement…*
* *Multiple foreground cosegmentation* ***was first proposed by*** *Kim et al. (2012).*
* ***One of the most cited studies is that*** *of X who investigates…*
* ***One well-known study that is often cited in research on*** *X* ***is that*** *of Palov (2016), who found that…*
* *Our results outperform the overall accuracy* ***reported by*** *Jung et al. (2015).*
* ***Similar to the process described by*** *Korczynski et al. (2014), the ground truth is derived in two steps.*
* *Slender beam test shown in Fig. 7 is a straight cantilever beam* ***proposed by*** *MacNeal & Harder (1985).*
* *The analytical solution of SIFs for such a structure* ***is given by*** *Ewalds & Wanhill (1989).*
* ***The first systematic study of*** *X* ***was reported by*** *Jonson et al. (2002).*
* *The innovative and seminal work of Smith (2012)* ***pioneered a new approach to*** *examining X.*
* *The reaction between X and Y* ***was first reported by*** *Appel in 1916.*
* *The X dataset is a subset of the original dataset* ***created by*** *Taylor et al. (2016).*
* *There are* ***a large number of published studies*** *(e.g., Smith, 2001) that describe the link between X and Y.*
* *There are* ***a number of large cross-sectional studies*** *which suggest that…*
* *This example* ***has been studied by*** *Leonel & Venturini (2011)…*
* *X* ***has been widely used for*** *the computer vision community…*
* *X* ***was proposed and analyzed by*** *Liu et al. (2010).*

C. Reiterating or complementing key research methods

- Typical collocations

* *a new/novel method for/of/to*
* *according to*
* *an applicability/implementation/method/set/size of*

* *be adopted/measured (by)*
* *be based on*
* *be equipped with*
* *be extracted from*
* *be randomly selected*
* *be traditional applied/employed/used*
* *be widely used by*
* *consist of*
* *current method (of)*
* *experimental approach/set-up (to)*
* *feature selection*
* *offer an effective way (of/to)*
* *perform in*
* *previously mentioned/reported*
* *proposed algorithm/method*
* *provide a means (of)*

- Typical sentences

* *A possible comparison **can be performed by** X...*
* *A second model **was built for** the right view only, with X feature spaces...*
* *Any tampering that results in X **will be detected by**...*
* *As in LAST, we set X and **use the same initialization strategy**...*
* *At high connection counts, the working set of this workload **is dominated by** X...*
* ***Based on** this observation, we **defined the threshold for** the feature selection as...*
* ***By the above four steps**, we **alternatively update** X, Y, and Z and **repeat** the process until...*
* ***By Theorem 1**, we **transfer the problem into** an X clustering problem...*
* ***During the cross validation**, in each iteration, X **was repeated on** the relevant dataset to...*
* ***Each fold in turn is considered as** a testing set, with the remaining nine folds acting as the training set...*
* *Each of X, Y, and Z **is equally divided into** a training set and a testing set.*
* ***Each time we perform** X **to** roughly select 50% of the traces to...*
* ***For each input** image patch of size 128 × 128 × 3, we **concatenated** the output of the tenth layer into...*
* ***For each sample**, we **recorded** the number of X which labels it as...*

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* ***For each test target***, *X* ***is run for*** *a maximum of 1,000 iterations to…*
* ***For every part***, *a specific number* ***is generated from*** *X…*
* ***For the classification experiments***, *determining X* ***was used as*** *the classification target…*
* ***For the LEGS experiment***, *we* ***built a model with*** *X…*
* *Here, we* ***use an exhaustive search for*** *the optimal assignment to find the solution…*
* *Hippocampal shapes* ***are rigidly aligned to*** *the template by X…*
* ***In both variations***, *visual pose sequences* ***are generated through*** *X…*
* ***In our implementation***, *we* ***apply*** *several optimizations* ***to****…*
* ***In this empirical study***, *we* ***performed a statistical analysis to*** *evaluate…*
* *Instead of assigning background to the remainder directly, X* ***is introduced as*** *a background threshold…*
* *Instead of relying on X, our approach* ***utilizes layout analysis to****…*
* *Network throughput* ***is maximized by*** *optimizing X…*
* *Note that about half of the instances* ***were recorded by*** *X…*
* *Note that the natural images and the fake colorized images* ***are defined as*** *X…*
* *Our algorithm* ***runs on*** *a desktop with a quad-core Intel processor and 8 GB RAM…*
* *Our approaches* ***are based on*** *a single model…*
* *Our experimental set-up* ***consists of*** *X and Y.*
* *SOB* ***outperforms*** *the other methods in terms of the mean values of three metrics, which* ***confirms*** *the effectiveness by introducing X…*
* *Subjects* ***were required to*** *perform the actions three times based on X…*
* *The 1,000 spatial targets* ***used for*** *testing* ***are generated by*** *X…*
* *The algorithm parameters* ***were originally determined*** *using data recorded in a laboratory setting…*
* *The algorithm* ***uses an*** *X* ***approach to*** *find…*
* *The centroids* ***are computed by*** *X, whose denominator represents…*
* *The evaluation* ***is based on*** *a user-independent model that…*
* *The flow speed of the cells* ***carried by*** *the core fluid* ***was controlled by*** *X…*
* *The learning procedure* ***is equipped with*** *a test mode, in which…*
* *The mesh distortion* ***is controlled by*** *an X parameter…*
* *The neural architecture* ***is trained using data generated by*** *X…*
* *The parameter X* ***is chosen by*** *X in…*
* *The pathway thus influences selection* ***by setting*** *X…*
* *The proposed meshless FRC model* ***is validated by*** *X…*
* *The ranked weights and features* ***were plotted and eliminated based on*** *X…*
* *The research question here* ***focused on*** *X…*
* *The saliency prior* ***is obtained by*** *conducting the X model…*

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* *The solution **is to calculate** X, and **run** Y **to**…*
* *The step size **is chosen through** a cross-validation procedure…*
* *The SVM classifier with X **was applied to** each of the three test datasets to…*
* *The training and test of X classifiers **were performed with** the same computer **used to calculate** Y parameters…*
* *The weight of each base classifier **is calculated by** X…*
* *This algorithm **uses** X **to** find the average contribution of…*
* ***To address** this problem, we **provide an approximation of** false positives **for** X…*
* ***To answer** the research questions, we **ran** X **with** 10-fold cross validation…*
* ***To answer** the various research questions, we **ran a set of evaluation with** X…*
* ***To capture** a majority of nodule morphology, X **was set to**…*
* ***To demonstrate** the efficiency of each of the algorithms compared, we **list** the average training time required by X…*
* ***To evaluate** how NEFCS performs in a different application domain, we **conduct a comparison on** an X dataset…*
* ***To evaluate** the ability of our approach, we **apply** X **to** the commonly used synthetic benchmark…*
* ***To evaluate** the discrepancy among X, we **further ran**…*
* ***To evaluate** the efficacy of the proposed method, **four experiments were conducted** including…*
* ***To examine** the convergence of X, three discrete models with regular grids **are constructed**…*
* ***To examine** the correspondence in X, we **compared**…*
* ***To explore** this hypothesis, we **calculated** the amount of motion of…*
* ***To measure** the accuracy of the estimates produced by different evidential models, we **acquired** X…*
* ***To measure** the difference with sub-sample resolution, we **leverage** X…*
* ***To measure** the quality of X, we **invited** five individuals **to** select…*
* ***To measure** the structural difference in X and Y, we **computed** the degree of Z…*
* *We **build the dictionary by** merging X…*
* *We **choose this number of data symbols to** ensure…*
* *We **compared** the performance of X **against** related approaches for…*
* *We **constructed** the fully-trained DCNN **based on** X…*
* *We **control** the duration of time slot to emulate X…*
* *We **divide** the dataset **into** ten stratified divisions or folds…*
* *We **enriched** the ground truth by annotating both the head and body samples using X…*
* *We **evaluate** our MC-CNN performance **by** measuring X…*

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* *We **learn** a separate dictionary and a binary linear classifier **by** solving X…*
* *We **measured** the classification performance of the resulting induced classifiers **based on** X…*
* *We **perform** X **against** different parameters…*
* *We **performed** X **to** evaluate the effectiveness of…*
* *We **predefined** an exclusive API database **by utilizing** the machine learning algorithm proposed by Rasthofer et al. (2017).*
* *We **present a comparative study on** X and Y…*
* *We **provided an additional comparison with** the X method proposed by Han et al. (2013).*
* *We **selected** X in the regression analysis and **extended** Y that provided the smallest mean RMSE…*
* *We **set the value of** the regularization parameter to X, as it was found empirically to be a good choice…*
* *We **use** X **to evaluate** the effectiveness of…*
* *We **use** X **to measure** the overall CPU utilization…*
* *We **use** X **to place** a selected load on…*
* *We **use** X **to refine** the 3D model…*
* *We **used** X **to drive** the USRP hardware, and Y **to develop** the full protocol stack…*
* *We **used** X **to implement** the SVM classification, and Y **was used as** the support vector classifier…*
* *We **want to restrict** X and focus each case's contribution on Y…*
* *X and Y datasets **were used to** evaluate the representativeness of salient frames…*
* *X **is adopted for** the physical patch on the computational boundary…*
* *X **is constructed as** the action descriptor for classification…*
* *X **is employed to** test the compensative capability of…*
* *X **was adopted to** project the metric matrix onto…*
* *X **was conducted on** MSRC-12 and Combined-17 datasets to…*
* *X **was designed to** quantify nodule malignancy uncertainty by applying the model of…*

Move 2: Explicating Results

A. Positioning tables and figures where research findings are visualized

- Typical collocations

* *as presented/shown in*
* *be described/highlighted/illustrated/mentioned/presented/reported/seen/shown in*
* *be followed by*

* *be seen from*
* *focus on figure/table*
* *from the figure/table*
* *look at the figure/table*
* *the table/figure contains/displays/illustrates/presents/provides/reveals/shows*

- Typical sentences

* *A comparison with X for the two datasets* ***is presented in Table 1****…*
* *Accuracies of X* ***were shown in Table 1****…*
* *As can be seen in the mean results* ***displayed in Fig. 1****…*
* ***As illustrated in Fig. 1****, X provides the higher detection rates…*
* ***As seen in Fig. 1****, as the number of visual poses* ***increases****, X is improved significantly…*
* ***As shown in Fig. 1****, X* ***produces better segmentation results than*** *Y…*
* ***Based on Fig. 1****, the transmission capacity ratio between X and Y* ***is revealed in Fig. 2****…*
* *Convergence of the relative errors in X* ***given in Fig. 1****…*
* *Distributions of approximation errors for X* ***are plotted in Fig. 1****…*
* ***Fig. 1 shows*** *the number of steps needed to reach the goal for X…*
* ***In Table 1****, it shows X…*
* ***In the first column of every table****, we present X…*
* ***In the table****, actions are numbered and their names are shown…*
* ***In these graphics****, X is depicted with a blue line…*
* ***In this experiment****, the initial arm position as well as the target is again the same as* ***used in Fig. 1****…*
* *It can be seen that X yields satisfactory segmentation results* ***as shown in the red contours of Column 5 of Fig. 1****…*
* *The accurate allocation of X* ***is demonstrated in Fig. 1****…*
* *The classification results* ***are reported in Fig. 1****…*
* *The convergence curves* ***are schematically depicted in Fig. 1****…*
* *The error measures for X and Y methods* ***are summarized in Table 1*** *against the suggested approach…*
* *The final level set function* ***as shown in the last column of Fig. 1*** *is smooth…*
* ***The last column shows*** *the percentage of the total number of X…*
* *The mean results across all of the datasets,* ***as displayed in Fig. 1****, demonstrate that…*
* *The normalized confusion matrices for X* ***are depicted in Fig. 1****…*
* *The positive impact of X* ***can be noted from Table 1****…*
* *The robust results of X* ***are shown in the last row of Fig. 1****…*

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* *The values **are listed in Table 1** for comparison…*
* *The values of X **are collected in Fig. 1**…*
* *Three best performing SVM classifiers with three largest values of X **are marked in Fig. 1**…*
* *X **can be found at Table 1**…*
* *X **is separately shown from the first column to the last column of Fig. 1**…*
* *X remained the same **as described in Table 1**…*

B. Reporting key and conspicuous research findings, with or without explanations

- Typical collocations

* *a deviation/distribution/duration/effect/exception/level/performance/probability/result/value/variance/variety of*
* *account for*
* *as follows*
* *be associated with*
* *be categorized into*
* *be close/(un)likely to*
* *be composed of*
* *be defined/regarded as*
* *be dominated/represented by*
* *be uniformly distributed*
* *be unsuitable for*
* *consist of*
* *cross validation*
* *experimental result*
* *focus/rely on*
* *lead to*
* *overall accuracy*
* *result from/in*
* *serve as*
* *statistically significant*
* *with regard/respect to*

- Typical sentences

* *A first look at the results in this table **reveals that**…*
* ***Accordingly**, the stability of X under study **is affected in the same way as** the stability of Y…*
* ***Although** there is no significant improvement over X, Y **shows** a significant*

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improvement on…

* ***Based on*** *the above results, we can* ***draw a conclusion that****…*
* ***Compared to*** *X, the number of distance computations and disk accesses* ***is increased by****…*
* *Each result is the mean of 200 evaluation runs,* ***due to*** *X…*
* ***For*** *both datasets, the overall accuracy* ***shows*** *a slight decrease for up to 40% of corrupted labels.*
* ***For*** *this part, value X* ***suggests*** *the existence of…*
* ***From*** *the spatial trajectory, X* ***does not greatly affect*** *the smoothness of the trajectory…*
* ***Here****, X* ***denotes*** *the total probability associated with the response delay…*
* ***It can be concluded that*** *the X algorithm has a performance comparable to that of…*
* ***It can be observed/found that*** *the functions of X have different behaviors in the two tasks…*
* ***It can be seen from the tables/figures that…***
* ***It can be seen that*** *for most scenarios, the performance of our method shows a positive relevance with the percentage of side information.*
* ***It is clear that*** *the theoretical model underestimates the location of…*
* ***It is evident that*** *X does not amplify the noise of the state measurement…*
* *Occlusion labeling errors in the map set* ***are caused by*** *X…*
* *Our experiments* ***yield*** *an overall accuracy of 98.7%, which is a very competitive result with respect to the state of the art…*
* ***Since*** *our prior results were based on X, in this section, we* ***extended to****…*
* *The curve* ***proves*** *the fraction of the total number of general forms that…*
* *The histograms* ***are displayed*** *on the same scale and convincingly* ***show*** *the advantage of X…*
* *The low accuracy* ***is expected*** *since…*
* *The number of neurons created in each layer* ***is driven by*** *X…*
* *The results* ***reveal*** *a significant improvement over X at a confidence level of 95%…*
* *The results* ***suggest*** *an alternative way of estimating X…*
* *The shortest computation time for the class prediction* ***was achieved with*** *X…*
* *The stable outcomes* ***can be explained that****…*
* *These comparative experiments* ***are the results of*** *training the model with…*
* ***This is explained by the fact that*** *the proposed method covers the focusing range with the minimum number of focus samples…*
* *This slight difference, however,* ***does not essentially influence*** *the performance of these models* ***because****…*
* *We* ***conclude that*** *X exhibits a visible advantage over Y* ***because****…*

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* *We **see** a significant increase in X when Y is utilized along with positional information…*
* *X and Y are especially important **because of**…*
* *X **can be observed from** the frequency distribution of the original signal…*

C. Comparing and evaluating research findings

- Typical collocations

* *an advantage/distinction/evaluation/superiority of*
* *ascribe/attribute/belong/correspond/oppose/relate to*
* *be analogous/comparable/easy/equivalent/insensitive to*
* *be compared to/with*
* *be consistent with*
* *be different from*
* *be driven by*
* *best performance*
* *comparison of/to/with*
* *compete with*
* *depend on*
* *differ from*
* *effect on/of*
* *in comparison with*
* *significant differences (between)*

- Typical sentences

* *A separate Wilcoxon signed-rank test **comparing** X **and** Y **reports a significant improvement in**…*
* *Although **there is no significant improvement over** X, Y **shows a significant improvement on**…*
* ***Compared with** the state-of-the-art method, the overall improvement of X is about…*
* ***Comparisons are made with respect to** existing Markovian-based models such as…*
* *However, it is rather unfair to **make a straight comparison**, because…*
* ***In contrast**, the calibrated model overcomes the dependency on X…*
* *In the Hepatitis classification task, using the set of three abstract temporal relations **was better than** using the set of seven relations…*
* *It can be seen that, X **outperforms** others in general, and **improves** the average accuracy of 2.5 % to the second best…*

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* *It is noticeable that the proposed X method* ***is capable of*** *predicting…*
* *It suggests that the use of simple centroid-based classification algorithms* ***will be likely to fail****…*
* *Our proposal* ***is more effective in*** *reducing meaningless edges engendering from texture fields* ***than*** *X…*
* ***The best results*** *are achieved with X which corresponds to typical values described in the literature…*
* *The choice of the threshold is* ***a trade-off between*** *the completeness of X* ***and*** *the removal of Y…*
* ***The comparison of*** *the proposed X* ***with*** *the other methods is reported in various combinations of the three features…*
* *The evaluated disparity maps reveal that discontinuities* ***are better preserved by*** *X…*
* *The image representations learned by X* ***produced more accurate classification than*** *Y…*
* ***The only difference is that*** *the relative speed-up of X* ***is slightly higher*** *with 8D skewed data* ***than*** *that with uniform data…*
* *The performance of X* ***is worse than*** *Y, and performance* ***degrades further*** *with higher dimensional datasets…*
* *The region that is marked with the red box* ***shows less reliable results than****…*
* *The regression model* ***gave no significant difference in*** *X estimation performance between males and females…*
* *The results for X* ***are consistent with*** *those published in Y…*
* ***There is a significant difference*** *between X with balanced and imbalanced datasets…*
* *This experiment* ***confirms the superiority of*** *our learning algorithm* ***over*** *X…*
* *Those dipoles induced by X* ***have much higher contribution to*** *light signals* ***than*** *Y…*
* *Using the X method* ***resulted in slightly worse performance than*** *using the rest of the Y methods.*
* *We* ***compare*** *our results* ***with*** *X and another recent ensemble approach for handling concept drift…*
* *We* ***compare*** *X* ***to*** *baseline classification techniques described in the previous section, as well as to sparse coding-based methods…*
* *We* ***make a comparison with*** *the original work of…*
* *We observe that the CPU utilization at the relay* ***is larger than*** *that at end nodes…*
* *X* ***achieves the best*** *overall accuracy, followed by Y and Z…*
* *X combined with Y or Z* ***provided better performance in****…*
* *X* ***is better than*** *Y, which means that extracting the keyword information in the sub-sentence* ***is more effective than****…*

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* *X learned in a single network* ***had comparable or even better representative capability than*** *Y…*

Move 3: Summarizing Results

A. Synthesizing research findings to form a narrative summary

- Typical collocations

* *a brief outline/overview (of)*
* *a conclusion/review/summary of*
* *a general/overall picture of*
* *findings indicate/show (that)*
* *general findings*
* *in conclusion/summary*
* *overall results*
* *so far*
* *sum up*
* *taken together*
* *to conclude/summarize*

- Typical sentences

* ***Altogether****, in all cases, the algorithm achieves a good estimation of…*
* ***Collectively****, these findings outline a critical role for…*
* ***From the above*** *simulations,* ***it can be summarized that****…*
* ***Generally****, we demonstrate the effectiveness of X in nodule subtlety prediction…*
* ***In summary****, our supervised learning algorithm, specifically tailored for the soft-thresholding encoder, provides significant improvement over…*
* *It* ***can be concluded that*** *the global stress field of…*
* ***On average****, the shortest computation time for the class prediction was…*
* ***Overall****, these results indicate that…*
* ***Taken together****, these results suggest that there is an association between X and Y.*
* ***The overall*** *classification percentages, as well as, the confusion matrices are presented…*
* *There are* ***in general*** *20 semantic poses parsed from…*
* ***Together****, these findings provide important insights into the…*
* *Two important themes emerge from the results* ***discussed so far****…*
* *What emerges from the results* ***reported here*** *is that…*

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B. Describing the problems of research findings

- Typical collocations

* *be constrained/limited/unlikely to*
* *be incapable of*
* *be limited by/to*
* *be only valid for*
* *be poorly matched*
* *be problematic in*
* *be statistically abnormal*
* *be unable to*
* *be worth noting*
* *certain disadvantage/drawback/weakness*
* *deficiency/impact/lack/limitation of*
* *even though*
* *major/main problem*
* *obvious difficulty*
* *over-reliance on*
* *potential bias (for)*
* *principle/serious limitation*
* *underestimate the prevalence (of)*

- Typical sentences

* *A full discussion of X lies* ***beyond the scope of*** *this study.*
* ***A major weakness*** *with this study is that* ***there was no control for*** *X.*
* *Although the study has successfully demonstrated that…, it* ***has certain limitations in terms of****…*
* *As for X,* ***it is not possible to*** *obtain a theoretical model…*
* *Because different algorithms result in different levels of accuracy and storage requirements,* ***it is difficult to****…*
* *Due to* ***practical constraints****, this paper* ***cannot provide a comprehensive review of****…*
* *In this case, X* ***fails to****…*
* ***It is impractical to*** *examine the whole case-base for X…*
* *It is possible that these results* ***might be biased*** *because of…*
* *It should be noted that the transmission capacity in this case* ***does not meet the need of****…*
* ***One of the limitations*** *with this explanation* ***is that*** *it does not explain why…*

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* *The extra execution time required by X* ***implies a possible limitation of*** *our proposed algorithm in…*
* *The findings in this report* ***are subject to at least three limitations****. First,…*
* *The lack of X in the sample* ***adds further caution regarding*** *the generalizability of these findings.*
* *The number of atoms required to encode the positive class* ***might not be sufficient****…*
* *The paper* ***suffers from*** *the use of* ***poorly matched controls****.*
* *The present study* ***was subject to*** *a number of potential* ***methodological weaknesses****.*
* ***The principal limitation of*** *this analysis* ***was*** *the variance in the design of…*
* *The responses relating to X* ***were subjective*** *and* ***were*** *therefore* ***susceptible to recall bias****.*
* *The saliency detection method* ***only*** *provides X; thus we may need to…*
* ***There are certain problems*** *with the use of focus groups. One of these is that* ***there is less****…*
* *We also notice that the DF scheme* ***required much more training to****…*
* *While X uses a disjoint decomposition of spaces,* ***the main drawback of*** *X* ***is that****…*
* *With a small sample size,* ***caution must be applied****, as the findings* ***might not be transferable to****…*
* *X* ***is a trivial problem*** *in our system…*
* *X* ***is an undesirable pathway for****…*

C. Illustrating the enlightenment and implication of research findings

- Typical collocations

* *achievement/contribution/effectiveness/efficacy/implication/indication of*
* *add/expect to*
* *be of value (to)*
* *be suggestive of*
* *be suitable for*
* *cast doubt on*
* *continue/contribute to*
* *deal with*
* *further explore/investigate*
* *further step towards*
* *future direction/investigation/study/research/work*
* *lay the foundation (for)*
* *provide a base (for)*

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* *provide support (for)*

- Typical sentences

* *A further study with more focus on X* ***is therefore suggested****.*
* *A number of* ***possible future studies*** *using the same experimental set-up are apparent.*
* ***An implication of*** *these findings* ***is that*** *both X and Y should be carefully considered when…*
* ***Another possible area of future research*** *would be to investigate why…*
* *As a result of these investigations, suggestions* ***were identified for future research****.*
* *Determining the impacts of X on Y* ***is important for the future of****…*
* ***Further research could also be conducted to*** *determine the effectiveness of…*
* ***Further research is needed to*** *better understand the underlying causes of…*
* ***Further work is required to*** *establish the viability of…*
* ***Future research will have to*** *ascertain the veracity of…*
* ***In further research****, the use of the data as X could be a means of…*
* ***In future work****, they can be considered for a more accurate and rigorous defocus model…*
* ***It is necessary for future work to*** *perform additional experiments to deal with…*
* *It is suggested that the association of these factors* ***is investigated in future studies****.*
* ***More research is required to*** *develop a deeper understanding of the relationships between X and Y.*
* ***One possible implication of*** *this* ***is that****…*
* *The findings can* ***contribute to a better understanding of****…*
* *The findings presented in this thesis* ***add to our understanding of****…*
* *The results of this research* ***support the view that****…*
* *These findings* ***have significant implications for*** *the understanding of how…*
* *These findings* ***provide a solid evidence base for****…*
* *These findings* ***provide some support for*** *the conceptual premise that…*
* *These initial results* ***are suggestive of*** *a link between X and Y.*
* *We* ***plan in future to*** *adopt a multi-threaded implementation to accelerate this phase…*
* *We would* ***expect to*** *collect more nodule samples to further improve and validate the stability of the proposed approach…*

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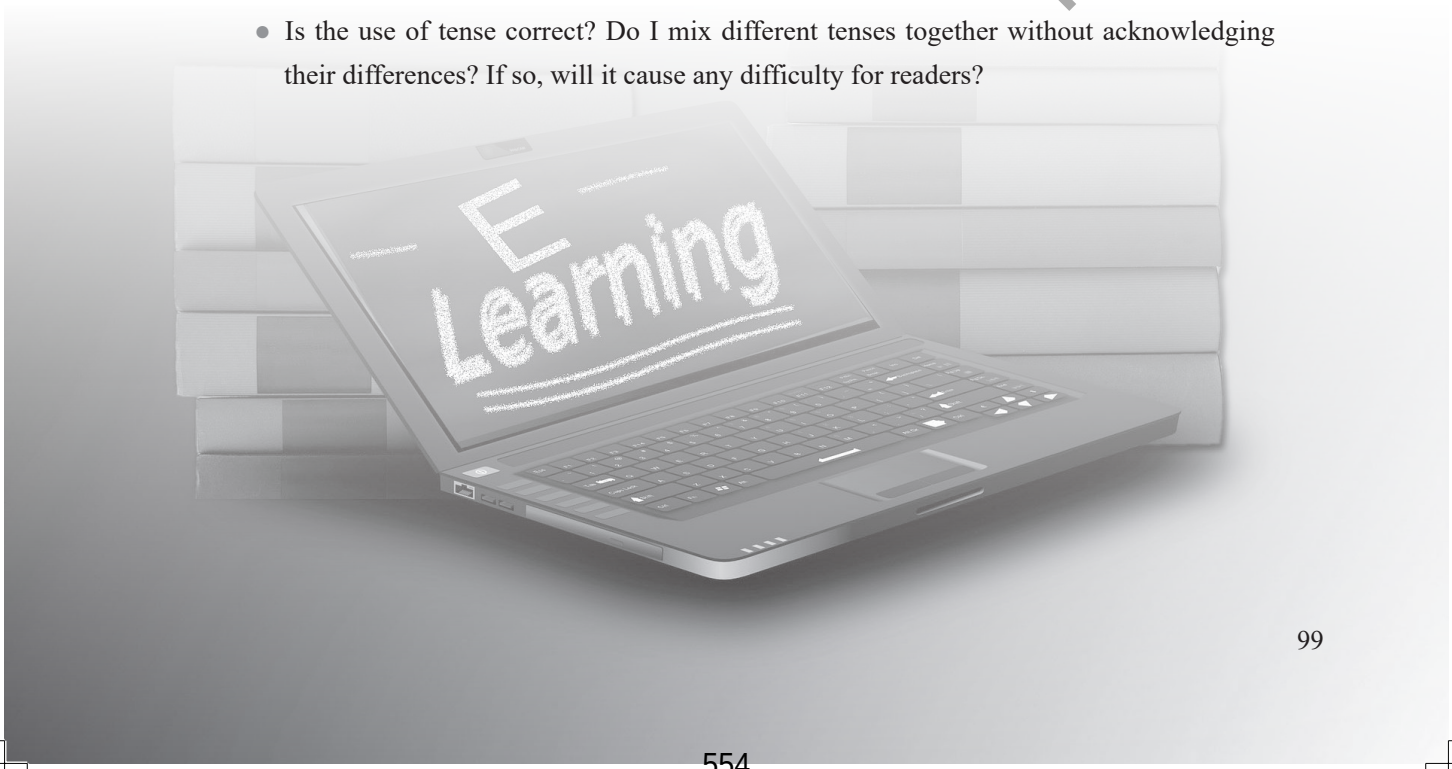
4.5 Checking the Writing Quality

The following is a useful checklist for assessing the quality of your Research Results section:

- Is my writing clear and concise enough for reviewers and readers to fully understand the research findings?
- Do I need to review my research goals and research methods before reporting the research results?
- Do I mix the Research Results section with the Discussion and Conclusion section? Can I clarify their differences and tell them apart?
- Do I attend to all research findings and every detail of them? If so, is it necessary? Will readers be interested?
- Do I report the most appealing research findings to readers? Do I prepare to summarize these findings in the following Discussion and Conclusion section so as to keep my writing consistent?
- Do I add any interpretation and evaluation when reporting the research findings? Are they moderate and appropriate?
- Do I use tables and figures to visualize complex results? Is the information expressed by them the same with text descriptions?
- Is the use of tense correct? Do I mix different tenses together without acknowledging their differences? If so, will it cause any difficulty for readers?



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Exercises

Read the following Research Results section carefully and then answer the questions.

The autoencoder was pretrained for 300 epochs, with each epoch using 256K domains randomly sampled from the Alexa Top 1M, and a batch size of 128. Pretraining required roughly 14 hours on a single NVIDIA Titan X GPU. Subsequent to pretraining, in each adversarial round, we generated 12,800 adversarial samples against the detector. Each round required roughly 7 minutes on the GPU. Results from the training are detailed in the following subsections.

A. Autoencoder Results

Given a domain as input, the autoencoder produces a multinomial distribution over the possible characters (outcomes), from which a domain can be sampled. For example, a few domains sampled from the output of the autoencoder given the input (with TLD removed) are shown in Table II.

Table II A few domains sampled from the output of the DeepDGA autoencoder (with TLDs removed)

```
   biogartenversand --> bidegerafernrnps
           metapack --> mdtkhrhk
       diaboliclabs --> dirinoyslhns
homehealthsollution --> tsntneyerasyeeaenne
        mousebreath --> metbrslamtl
      newinventions --> nataiirsfsdos
          wonderbox --> weonkimwb
        tara-china --> tun-mos-gi
             gobuu --> caxfx
           keeyword --> kaxioawy
           kandidco --> kauircae
   toaster-schwerin --> teztoylabr-bs-st
```

The autoencoder does not reconstruct perfectly the input, which can be ascribed to the stochastic sampling of the multinomial distributions to choose each domain character via independent draws, and insufficient model capacity (e.g., heavy model bias) to express all character combinations of domains in the Alexa Top 1M. However, since we actually don't want to generate domain names in the Alexa Top 1M, but rather names from the same (or similar) generative distribution, the reconstructions are wholly adequate.

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B. GAN Results

Figure 3 displays Receiver Operating Characteristic (ROC) curves of a random forest classifier after each of four adversarial rounds. The classifier is trained on DeepDGA generated domains as malicious and the Alexa Top 10K as benign. Results are based on 10-fold cross-validation. The ROC curves demonstrate that performance of the random forest classifier degrades with the number of adversarial rounds with an apparent asymptote after three rounds. This degradation is due to the GAN's ability to generate domains that create confusion for the classifier. Training on these domains will allow us to harden the classifier to blind spots to increase performance of a DGA detector. All subsequent experiments in this paper will be based on three adversarial rounds due to decreasing utility after three rounds…

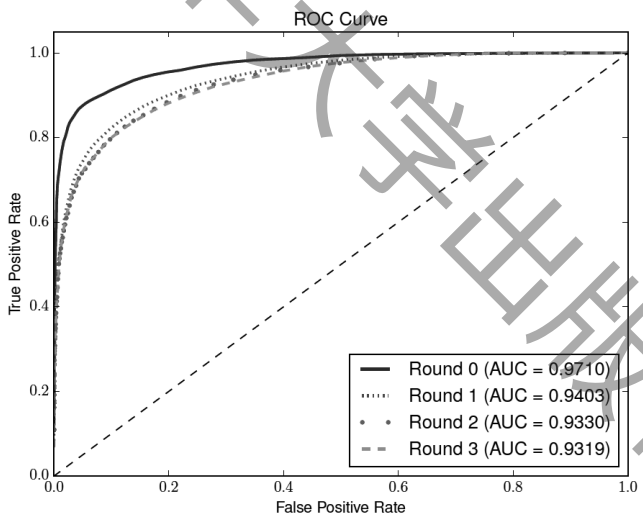

Figure 3 ROC curves for random forest classifier trained on DeepDGA vs. Alexa Top 10K averaged over 10-fold crossvalidation

Note: DeepDGA becomes increasingly more difficult for the random forest classifier to detect with each round of adversarial training up to three rounds. (Subsequent rounds don't produce substantial AUC reduction.)

Compared to other character-based DGAs, DeepDGA shows significant improvement in its ability to produce domains that are undetectable by a DGA classifier… (Anderson et al., 2016)

1. Analyze the structure of this excerpt according to the structural components involved in the Research Results section.

2. Illustrate how the writers present the details of the research findings in this excerpt, including the ways of introducing tables and figures where research findings are visualized, characterizing key findings, and comparing and evaluating findings.

3. How do you think about the captions of Table II and Figure 3 in this excerpt? Are there any overlaps between these captions and text descriptions?

4. What is the function of Table II and Figure 3 in this excerpt? Can they be improved?

5. What are the main tense and voice used in this excerpt? How do they differ from those in other Research Methods sections?

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Chapter 5
Discussion and Conclusion

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"You don't understand anything until you learn it more than one way."

Marvin Minsky

5.1 Definition

The Discussion and Conclusion section is the last section of a research paper. Depending upon journal conventions and writing habits, some papers divide this section into two separate parts: One is entitled Discussion, and the other is Research Conclusion. The Discussion part mainly compares the research findings of the paper with others, explains why and how the paper surpasses previous research, and reflects on the niche the paper has not yet occupied. By contrast, the Research Conclusion part highlights the significance of the paper, usually informing readers of what its contributions to the praxis and research in the professional field are, how its findings solve the problems of previous studies, what impacts the results bring forward on future, and whether the results can be extended to a broader context. Instead of maintaining a physical separation, some journals and authors would prefer to integrate the Discussion part into the Conclusion part under the unified title "Research Conclusion" or "Conclusion(s)". In either case, this section does not mean to simply repeat the information mentioned in the previous Research Results section, but brings readers new information.

5.2 Components

The Discussion and Conclusion section is often regarded as the finishing touch of a research paper, and it is also the section that many readers prefer to read before the main text. Due to the importance, its content needs to be summative with key information highlighted. A common practice is to feature the research findings of the paper which are distinctive from previous studies, review the research objectives and methods, sum up the new discoveries and innovations, and expound on the implication for related research and the practical applications in industry. In the practical writing of a Discussion and Conclusion section, the following tips deserve much attention:

- The Discussion and Conclusion section is not the same as the Abstract section. Although the two sections have many similarities regarding the content, their functions are completely different. The Abstract section functions like an advertisement that aims to attract readership and promote the paper; thus it focuses on the reporting of essential research findings. The Discussion and Conclusion section, on the other hand, reads like a reading note, aiming to remind readers of the key information and important value of the paper. As a result, in addition to summarizing the research findings, the section of Discussion and Conclusion is much more informative, usually accompanied by the

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significance and implication of the research.

- A conclusion is not a list of the research results but their abstraction and refinement. Starting from the research results, a conclusion can be drawn from the following aspects: the connections and differences between the results and the cardinal principles and concepts, the comparison between the results and those of previous research, the theoretical and methodological significance of the results, and their practical applications, possible limitations, and drawbacks.

- It is advised to acknowledge any limitations that may undermine the research and provide possible solutions. When there is negligence in the research methods or potential defects in the research results, it is an appropriate strategy to be frank about any problems and offer details for justification. The strategy may alleviate the negativity found in the research itself and somehow increase the stringency and credibility of the research; after all, science is not always perfect. Do not just make a claim to improve the research and solve the problems in the future without any explanations. It is a plausible way to provide solutions with some specific ideas and methods so that readers, especially reviewers of the paper, can recognize the authors' reflections.

- Key information is usually placed at the beginning of the sentence rather than at the end. For readers, their attention is mostly paid to the beginning of the sentence so that they can locate the key information of the section quickly and decide whether to read the rest parts of the full text. Therefore, putting the key information at the beginning of the sentence is in line with the reading habits of readers, making it easier for them to capture the core points. Besides, the better the reading experience is, the more impressed the readers are, especially the reviewers.

- The use of tense is flexible but follows some rules. The tense in the section of Discussion and Conclusion, compared with other sections, is assumed to be the most variable and complex. If the author is not clear about the occasions for the usage of each tense, he/she is likely to misuse the tense and thus increase reading difficulties. Generally speaking, the present perfect tense is used to describe the actions completed during the process of writing (such as "We have described a method to..."), the simple past tense is used to describe the behaviors at the stages of research (such as "This method was used to..."), the simple present tense is used to discuss the significance, implication, recommendation, and limitation of the research (such as "One limitation is that the success of TBM depends on…"), and the simple future tense is used to describe the future prospects of the research (such as "In the future, we will study how to extend our work to…").

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5.3 Structure

The section of Discussion and Conclusion usually consists of three structural components (or moves), including brief review, summary with discussion, and concluding remarks.

- **Move 1:** Brief review is the prologue of this section, which often reasserts the research background, objectives, questions, hypotheses, and main research methods.
- **Move 2:** Summary with discussion is the synthesis and refinement of the research results, which is also the key of the entire section. It usually summarizes the most important research findings, explains their contributing factors and mechanisms, and comments on and interprets their uniqueness and significance.
- **Move 3:** Concluding remarks mainly describe the limitations and implications of the research and extend future research directions.

Case Study One

Excerpt (Ramirez-Gallego et al., 2017)	**Moves**
① Case-base editing is an important aspect of CBM research that adopts an instance selection approach for handling concept drift. ② Editing the case-base properly can continuously tune a case-based learner according to concept drift.	**Move 1: Brief review** Sentences ①②: Reassertion of the research background, objectives, questions, and hypotheses
③ In this paper, we first present a competence enhancement method—NEFCS, to prevent noise from being included and to quickly adapt the case-base according to concept drift by the safe removal of obsolete cases. ④ Instead of blindly trusting all the most recent cases, NEFCS incorporates a concept drift detection method to differentiate the treatment on new cases based on whether there is concept drift…	Sentences ③④: Review of the main research methods **Move 2: Summary with discussion** Sentence ⑤: Summary of the important research findings [Not appear] Explaining the contributing factors and mechanisms of research findings
⑤ Several interesting findings have been revealed through our experiments: (1) FISH2 is not suitable for static tasks, because it forces to take into account the time factor whether or not concept drift occurs… ⑥ From this research, we conclude that: (1) differentiating new cases according to drift	Sentence ⑥: Comments and interpretations of the uniqueness and significance of research findings

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(Continued)

Excerpt (Ramirez-Gallego et al., 2017)	**Moves**
detection is better than retaining or discarding all new cases indiscriminately; (2) a competence-guided, controllable, and conservative method is preferable to a non-competence-guided, uncontrollable, and unbalanced method of conducting competence preservation for time-varying tasks…	**Move 3: Concluding remarks** [Not appear] Illustration of the research limitations
⑦ Instead of either retaining or removing a case completely, our next attempt will target the discovery of a fuzzy case weighting schema which will better balance the decision as to whether a case is noisy or whether it represents a novel concept.	Sentence ⑦: Extension of future research directions
⑧ In addition, it would be interesting to consider our work in relation to the machine learning field, and to discover whether it is possible to plug our instance selection technique into other learning models.	Sentence ⑧: Description of the research implications

Case Study Two

Excerpt (Kouvaros & Lomuscio, 2016)	**Moves**
① With the deployment of systems based on MAS-architectures, there has been a growing interest in their verification. ② Considerable progress has been made in model checking MAS against specifications based on temporal, epistemic, deontic, and strategic properties. ③ Open-source implementations based on efficient symbolic approaches have been put forward and compared. ④ While this work has proven to be valuable, it is limited to scenarios where the number of components is known at design time. ⑤ This is not a realistic assumption in certain MAS where the number of components cannot be known before deployment. ⑥ A typical case is robotic swarms, whereby the properties of the swarm need to hold irrespective of how many robots are present in the system and should hold even if some of the robots develop a fault and leave the system.	**Move 1: Brief review** Sentences ①–⑥: Reassertion of the research background, objectives, questions, and hypotheses
⑦ In this paper, we put forward a methodology to solve the parameterized model checking problem for MAS in a	Sentence ⑦: Review of the main research methods

(Continued)

Excerpt (Kouvaros & Lomuscio, 2016)	**Moves**
number of noteworthy classes of PIIS. ⑧ As we showed, this enabled us to give a methodology for the cut-off identification of a given parametric system…	**Move 2: Summary with discussion**
⑨ Table 2 summarizes the theoretical results obtained. ⑩ Since the PMCP is in general undecidable, no complete results can be established in general… ⑪ Incompleteness for the SMR and the SGS classes follows in the absence of an agent-environment simulation between the templates since in this case the techniques cannot assess the correctness of a given specification. ⑫ In contrast, we can always assess the correctness of a specification on SFE systems. ⑬ This level of confidence, which follows from the decidability result of Corollary 7.6, comes with considerable limitations on the range of systems that the technique can be applied to. ⑭ For instance, the result cannot be applied to any scenario where the agents evolve in any other way other than lock-step evolution…	Sentences ⑧–⑩: Summary of the important research findings [Not appear] Explaining the contributing factors and mechanisms of research findings Sentences ⑪ ⑫: Comments and interpretations of the uniqueness and significance of research findings **Move 3: Concluding remarks** Sentences ⑬ ⑭: Illustration of the research limitations
⑮ In future work, we plan to explore other methodologies, including counter-abstraction for obtaining cut-offs for even wider classes of systems. ⑯ Furthermore, we believe the technique here put forward can serve as an ideal stepping stone to verify open MAS where the agents can dynamically join or leave the system at runtime…	Sentences ⑮ ⑯: Extension of future research directions [Not appear] Description of the research implications

5.4 Phrases and Sentences in Moves

Move 1: Brief Review

A. Reasserting the research background, objectives, questions, and hypotheses

- Typical collocations

* *an aim/goal/objective/purpose of*
* *as discussed/mentioned/reported in*
* *address the question/issue*
* *aim at/to*

* *attempt/try/seek to*
* *be designed/undertaken to*
* *concatenation of*
* *concentrate on/upon*
* *focus on*
* *make references to*
* *provide evidence (for/to)*
* *set out to*
* *with respect to*

- Typical sentences

* *All of the studies **reviewed so far have supported** the hypothesis that…*
* ***Another objective of this study was to** optimize X with respect to…*
* ***As mentioned in** previous sections, **the aim of this study was to** investigate the relationship between X and Y.*
* ***In order to** illustrate the effectiveness of ESE module we proposed, we compare X…*
* *In principle, the task **is to** determine…*
* *In this paper, we **aimed to** address a new problem in the field of X.*
* *In this study, a compensative-control law **is proposed to** integrate X into Y.*
* *Much of the **current literature on** X pays particular attention to…*
* *Our study **focused on** the use of X…*
* ***Previous research has indicated** potential associations between X, Y, and Z.*
* ***Previous studies have clearly proved that** there is a relationship between X and Y.*
* ***Previous studies have provided** robust evidence for the X hypothesis.*
* ***Returning to the question** posed at the beginning of this study, it is now possible to state that…*
* ***Several attempts**, **as described in** the related work, **have been made to** determine…*
* *Simulations **are conducted to** demonstrate the effectiveness of the proposed design.*
* ***The main motivation of this study is to** investigate X…*
* *The methodology of classification **was designed to** test X…*
* ***The primary goal of this study was to** assess the accuracy of…*
* ***The purpose of the current study was to** determine…*
* *The X hypothesis **has been questioned** on the basis of some experimental findings.*
* *This research **was intended to** identify the elements that impact X.*
* *This study **has examined** the factors which are thought to contribute to…*
* *This study **set out to** evaluate a new method of measuring…*

* *We **have described a method to** radiometrically calibrate X…*
* *We **presented an automatic method to** detect X…*
* ***With respect to the** first **research question**, it was found that…*
* *X and Y are compared **for the purpose of** direct comparison among mechanisms.*
* *X **has been carried out to** assess the performance of pattern recognition and machine learning algorithms.*

B. Reviewing the major research methods

- Typical collocations

* *accord with*
* *an adoption/analog/annotation/application/framework/model of*
* *anonymized data*
* *approach for/to*
* *authoritative/longitudinal dataset*
* *backward/temporal variable*
* *be adapted/adopted/applied/employed/followed/used to*
* *be devised as*
* *be extracted from*
* *be obtained by/from*
* *be suitable for/to*
* *bottom up*
* *candidate selection*
* *conceptual framework*
* *evidential model*
* *feature extraction*
* *in accordance with*
* *learning algorithm*
* *meta study*
* *neural network*

- Typical sentences

* *All the methods **run on** the same machine with 12 GB memory and a 6-core Intel Xeon CPU.*
* ***Based on this mechanism**, X **is proposed to** enhance the ability of…*
* *Both X and Y **are included to** demonstrate the effect that…*
* ***Data has been labeled using** X that has been obtained…*

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* *Discrete cracks **were modeled by** a set of bond relationships between X and Y.*
* ***Following a complete** low cycle X **analysis**, a design load of 270 MPa has been selected…*
* *For an application with a delay constraint, **the optimal value of** X **can be obtained by** choosing X…*
* *NEFCS **incorporates** X **to** differentiate the treatment on new cases.*
* ***Once** analyzing the impact of applying DRTs to OeSNN, we **proceed by** analyzing the set of experiments with X…*
* *Semantic information might **allow us to** tackle the problem of scalability by reducing the amount of data X must consider.*
* *Specifically, for self-organizing networks, catastrophic interference **is modulated by** X.*
* *The evaluation **is performed on** the online detection of…*
* *The form of the family of mappings actually modeled **is determined by** X.*
* *The heel elevation **was measured through** X.*
* *The partition step of micro-aggregation **is performed on** the equivalent dataset…*
* *The query processing performance of indices **is affected by** X.*
* *This **is achieved through the use of** X.*
* *This paper **introduces** a motorized bed mover that **can be applied to** current manual stretcher to build…*
* *This paper **proposes a new approach for** X **in**…*
* *This paper **proposes a novel framework to** jointly estimate X.*
* ***To assess** the sparsity of the learned representation, we **compute** X…*
* *We **allow** X **with** different configurations **to** perform the task of relation classification.*
* *We **developed a prototype system** called X based on the idea of Y.*
* *We **have adapted** X **to** be used on online data streams by…*
* *We **introduced** X **to** tackle the challenging problem of lung nodule malignancy suspiciousness classification.*
* *We **set up** X **to** model the sub-sentence between the given two entities.*
* *We **synthesize** the Pareto frontier **by** combining X and Y.*
* *We **use** X **to** extract the semantic properties of entities based on different contextual words.*
* *We **verified this by** running X…*
* *X **adopted in this paper can be seen as**…*
* *X **builds a** compact classification **model on the basis of** the training data.*
* *X **conducted in this paper is an information-theoretic approach** in which no collision awareness is considered.*
* *X **employs a statistical approach for** textural characterization of an input image.*

* *X **generates a numerical equivalent for** the original data, **using** multi-dimensional scaling.*
* *X **has been carried out to assess** the performance of pattern recognition and machine learning algorithms.*
* *X **has been proposed as a technique for** the design of an experimental testing program.*
* *X **includes** a parameter Y that defines the minimum time between bites…*
* *X **is applied on** the original dataset for aggregation **to** produce the anonymized data.*
* *X **is defined in** a spatially continuous setting, providing an inherent subpixel evaluation.*
* *X **is designed to** detect the typical amount of motion.*
* *X **is employed during** the later stages of movement…*
* *X **is introduced into** the compensative-control law to guarantee a better control performance.*
* *X **is performed to** calculate the number of cycles.*
* *X **is used for** the detection of TIRPs in the classification phase.*
* *X **is used to** maximize the variance of projection of each layer.*
* *X **seems an attractive processing strategy to** make the implementation of the proposed automatic detection algorithm…*
* *X **was used as** a training set to perform a grid search over several parameters.*

Move 2: Summary with Discussion

A. Summarizing the major research findings

- Typical collocations

* *a classification/distribution/snapshot/overview of*
* *apart/aside from*
* *be capable of*
* *be gained by*
* *concluding remark*
* *consist of*
* *converge of/to*
* *decline in*
* *decouple from*
* *experimental/promising result*
* *in conclusion/summary*

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* *in general*
* *result from/in*
* *statistically significant*
* *succeed in*
* *to conclude/summarize*

- Typical sentences

* *According to the experiments, we* ***found that*** *the processing efficiency of X is improved by computing the polynomial in each iteration.*
* ***Evaluation results confirm that*** *we can detect X with high accuracy.*
* ***Experimental evaluations indicate that*** *X achieves over 90% accuracy on a cropped region dataset.*
* *From the results in Fig. 6,* ***it can be concluded that*** *X has a performance comparable to…*
* *In light of X,* ***conclusions can be drawn from****…*
* *In our view,* ***there are*** *three* ***conclusive answers to*** *these contentions.*
* ***In summary****, these results show that…*
* *In this study, X* ***is found sufficient to*** *predict the behavior of…*
* ***It can be observed that*** *X has different behaviors in the two tasks.*
* ***It can be seen that*** *X only occurs between the loads of…*
* ***It is noticed that*** *X needs adding additional nodes, which increases the size of the global stiffness matrix.*
* ***It shows that*** *X produces rather complex…*
* ***It was found that*** *high classification rates of more than 90% were achieved with the same classifiers and similar features.*
* ***It was shown that*** *X has frequency responses similar to those of…*
* ***More detailed results were found in*** *the current study by considering…*
* ***Our work reveals*** *an interesting structure of the optimization problem for X that…*
* *The relevance of X* ***is clearly supported by*** *the current findings.*
* *The work* ***generates*** *a numerical equivalent for the original data, using multidimensional scaling…*
* *These representation methods* ***were shown to have*** *an added value, when compared with the default X method…*
* *These values* ***are*** *approximately similar with the ones* ***found in this study for*** *not only X but also for Y…*
* *X* ***is revealed as*** *a novel source of theta oscillations.*
* *X, Y, and Z* ***emerged as*** *reliable predictors of…*

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B. Explaining the contributing factors and mechanisms of research findings

- Typical collocations

* *account for*
* *association with*
* *attribute/ascribe/owe to*
* *be associated with*
* *be close/consistent/due to*
* *be depicted as*
* *be emitted by*
* *be suitable for*
* *because of*
* *complexity/determinant/indication/justification of*
* *contributory/driving/key/predictive/underlying factor*
* *demand for*
* *depend on*
* *effect on/upon*
* *emerge from/in*
* *impact on/upon*
* *justify empirically*
* *key aspect/component/driver/indicator/ingredient/part (of)*
* *offer/provide an explanation (for)*

- Typical sentences

* ***A number of factors play a key role in*** *determining the effects of…*
* ***A possible explanation for*** *these findings* ***may be*** *the lack of…*
* *An increase in network entropy* ***was seen to be associated with*** *X…*
* ***Another factor to consider*** *here* ***is the role of*** *X, which is known to generate…*
* ***Another possible alternative explanation of*** *the findings is that they* ***are due to****…*
* *As far as the delay is concerned, a larger X makes the corresponding delay lower because the probability* ***associated with*** *X becomes smaller.*
* ***Because*** *X captures a single line at a time, it* ***allows*** *a depth camera* ***to*** *have most of the robustness of…*
* *It is difficult to explain this result, but it* ***might be related to****…*
* *It is possible that these unmeasured variables could* ***account for*** *some aspects of the results.*
* ***It is supported by the fact that*** *X shows an increasing tendency to default to this behavior.*

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* *KB definitions are not available in each domain, especially* ***when confronted with*** *X...*
* ***One explanation for*** *this* ***is that*** *X is commonly the lowest in the signals recorded from the ankle due to Y.*
* ***One possible interpretation of*** *these results* ***would be that*** *X implies a general deregulation of cell growth, resulting in Y.*
* *Overfitting* ***was partly caused by*** *X that was fitted based on the training data.*
* ***Several factors could explain*** *this observation. Firstly,...*
* *So far,* ***two factors have been identified as*** *being potentially important: X and Y.*
* *The query processing performance of X* ***is significantly affected by*** *Y.*
* ***The reason is that*** *X is regarded as an attractive solution for massive data streams.*
* *The results obtained* ***can be taken as an indication of*** *X towards a less stable state.*
* *These cases were only seen in stepwise models and were not observed in the final model,* ***indicating that*** *they were* ***due to*** *X.*
* *These* ***confirm that*** *X undergoes a reversed plasticity response at an applied load of this magnitude.*
* *These relationships* ***may partly be explained by****...*
* *This could* ***mean that*** *the policies are automatically updated in the presence of X.*
* *This possibility* ***is corroborated by*** *the suggestion that X is collected from Y.*
* *This result* ***may be explained by*** *the fact that...*
* *This* ***suggests*** *there is no sense to perform PW analysis* ***due to*** *X.*
* *We believe that* ***the reason behind these results is that*** *the quasi-dyadic structure is enforced by X.*
* *X and Y have been identified as* ***the major reasons for*** *the increase of...*
* *X is* ***a significant contributory factor to*** *the development of...*

C. Commenting on and interpreting the uniqueness and significance of research findings

- Typical collocations

* *add to*
* *agree/compete with*
* *be akin/preferable/similar to*
* *be consistent with*
* *be different from*
* *be of interest to*
* *be useful in*
* *comparative outlook*

* *contribute to*
* *edge over*
* *enhance/further the understanding (of)*
* *extend the knowledge (of)*
* *for the first time*
* *gain insights*
* *help to*
* *key/main strength*
* *make predictions about*
* *provide a basis (for)*
* *provide insight(s) into*
* *shed light on*
* *the first study of/to*

- Typical sentences

* *31% of* ***improvement can be gained by*** *X* ***as compared to*** *Y.*
* *A comparison of ensemble performance* ***shows a clear advantage for*** *X* ***over*** *Y.*
* *A simple heuristic choice of this parameter was shown to* ***provide very good results in the experiments, compared to*** *X.*
* *According to the figure, as X increases, Y* ***wastes much more information compared with*** *Z.*
* *Although each method behaves very differently based on the dataset, our proposed approach* ***constantly reports good overall accuracy across the datasets****.*
* ***As compared to*** *X, it can* ***achieve additional capacity gain through*** *interference nullifying and interference alignment.*
* ***Compared to*** *sudden concept drift, X* ***is believed to be more suitable for*** *gradual concept drift.*
* *For the classification, we* ***compared*** *five different classification algorithms that were* ***successfully*** *used in similar studies…*
* *It* ***has richer*** *approximation* ***qualities compared to*** *X and hence…*
* *Our model* ***offers a significant improvement over*** *existing models based mainly on orientation features.*
* *Our work* ***has improved upon*** *this* ***by*** *achieving a maximum accuracy of 86.9%.*
* *The classification accuracy with feature selection* ***was consistently lower compared with*** *the experiments with the complete feature set.*
* *The computation time for X* ***was increased by*** *a factor of approximately 75* ***compared***

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to Y…

* ***The demonstrated effectiveness of** using only three relations **greatly reduces** the computational complexity of…*
* *The experiments confirm that the method **overcomes the main limitation of** current anonymization algorithms for large mixed datasets.*
* *The joint use of deep and handcrafted features, **showed a** 4.5% **decline in accuracy when compared with** the 9.2% reduction with a fully-trained X.*
* *The method seems to be **a balanced mechanism as compared with** X and Y.*
* *The naive Bayes classifier combined with feature selection can **significantly outperform** the baseline method in most cases.*
* *The present X element **gives much better results comparable to** Y and Z elements.*
* *The proposed learning algorithm **has several advantages compared with** X…*
* *The query processing performance of X **is significantly affected by** the index construction methods, while Y **is relatively less affected by** the index construction method.*
* *The results **have verified the efficacy of** the proposed method…*
* *These values **are approximately similar with** the ones found in this study.*
* *Various simulations are conducted to **demonstrate the effectiveness of** the proposed design.*
* *X achieves Y of 83.1%, which **is the best result when compared with** other variations…*
* *X and Y **have comparable delays** if the packet arrival rate **is** equal to or **higher than** 45 packets per second.*
* *X and Y **render a degraded performance when compared with** Z…*
* *X **is compared with** Y so as to further **testify the superiority of** acceleration algorithm.*
* *X **performed substantially higher compared with** Y…*
* *X **was superior to** the unsupervised methods **compared with** Y and slightly **better than** Z.*

Move 3: Concluding Remarks

A. Narrating the research implications

- Typical collocations

* *an advantage/breadth of*
* *be accessible/available to*
* *be indicative/suggestive of*

* *be needed to*
* *broad/strong recommendation*
* *compensate for*
* *continue/contribute/point to*
* *desire/plan for*
* *future direction/practice/research/study/work*
* *implication for/of*
* *in need of*
* *possible area/field*
* *practical/theoretical implication*
* *provide insights for*
* *seem to suggest*

- Typical sentences

* ***A possible/reasonable approach to tackle this issue could be to**…*
* ***An implication of these findings is that** both X and Y should be taken into account when…*
* ***An interesting line of enquiry** would label the data based on either psychophysiology or driving conditions and compare those results with the subjective labels.*
* *Considerably, **more work in future will need to** be done to determine the effect of…*
* *Formulation and optimization scheme proposed in this approach **can be extended to** X…*
* ***Further investigation and experimentation into** X is strongly recommended.*
* *Furthermore, modeling **suggests that** the increase in X is characteristic of Y…*
* ***Future studies on** the current topic are therefore recommended.*
* ***It is implied that** the X modeling may potentially improve the computational accuracy by…*
* *It **proved that** X can represent the semantic properties of the given entities effectively.*
* *It **reveals that** X is able to retain the knowledge with a reduced number of output neurons.*
* ***More future research using** X method **is needed to**…*
* *Our model **suggests** a possible explanation for X…*
* *Our work **reveals** an interesting structure of the optimization problem for X.*
* *The findings from these studies **recommend that** X can have an effect on…*
* ***The implication is that** X cannot be modeled as a simple uniform relay nucleus.*
* *The issue of X is an intriguing one which could be usefully explored **in further research**.*

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* *These results **demonstrate** the importance of choosing a suitable feature selection for X.*
* *This benefit may **have implications for** X as the repeated experience of stress can induce Y.*
* *This **implies that** the chosen dataset may have a positive impact on the performance of X after performing feature selection.*
* *This would be a fruitful area **for further work**.*
* *To develop a full picture of X, **additional studies are needed to** examine…*
* *We expect that the X method **has the potential to** be translated from a research novelty into a powerful tool for Y.*

B. Explaining the research limitations

- Typical collocations

* *an absence/lack/limitation/risk/scarcity/shortcoming of*
* *be impossible to*
* *be impractical in*
* *be inappropriate for*
* *be inconsistent with*
* *be isolated in*
* *be sensitive/subject to*
* *beyond the scope (of)*
* *confront with*
* *fail to*
* *imbalance between*
* *incomplete model*
* *incongruity in*
* *inconsistent cluster*
* *limited room (for)*
* *maximization problem*
* *prominent failure*

- Typical sentences

* ***A major problem with** this model was that…*
* ***A number of limitations** need to be noted regarding the present study.*
* ***A weakness of** this approach is that it requires a tremendous effort in labeling the ground truth…*

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* ***Although*** *our method can help to reduce the impact of the confusing relation, it still* ***needs further improvement for*** *the class of…*
* ***An issue that was not addressed in*** *this study was whether X related Y to…*
* ***Another potential limitation of*** *X is its susceptibility to false positives caused by…*
* ***As a limitation of*** *our work, we assume X which makes our results error-prone to specular highlight…*
* ***Despite*** *the promising results,* ***there are some limitations*** *in the study.*
* *Finally,* ***a number of important weaknesses*** *need to be considered. First,…*
* ***However, a difficulty of*** *the proposed method is its dependency on the accuracy…*
* ***However****, as observed by Hovsepian et al. (2015), we are still* ***lacking*** *a well-validated stress model that can be used for managing stress in the natural environment.*
* ***However****, both X and Y* ***are still less accurate than*** *Z…*
* ***However****, the application of the proposed system* ***was not tested in****…*
* ***However****, the database used in this study* ***is highly imbalanced****…*
* ***However, the limitations of*** *X become evident in the most challenging contexts…*
* ***However****, this approach* ***has significant limitations for*** *X…*
* *It is still possible that behaviors in free-living environments could affect the accuracy of the method in ways that* ***could not be captured*** *in this study.*
* ***One of the limitations with*** *the findings is that they do not take X into account.*
* ***One of the problems with*** *the algorithm the researchers used to measure X was that…*
* ***Several limitations on*** *this study need to be acknowledged.*
* *The current model of X* ***suffers from certain weaknesses*** *that hinder its ability to…*
* *The current study* ***is constrained/limited by*** *the relatively small sample.*
* ***The main weakness of*** *this study was the lack/paucity of…*
* *The present investigation* ***was not specifically designed to*** *evaluate factors related to…*
* ***There is still room left for*** *improving our approach to handle complex cases…*
* *These effects* ***have not explicitly been modeled*** *in this work with acceptable results…*
* *These rates* ***raise a limitation for*** *evaluating accuracy measures of continuous methods…*
* *This study* ***suffers from certain ambiguities*** *at the conceptual level.*

C. Extending future research directions

- Typical collocations

* *advocate for*
* *be advisable to*
* *be inspired by*

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* *be recommended/suggested (to)*
* *continue/plan to*
* *deserve further research*
* *for/in future*
* *future direction/practice/research/study/work*
* *further development/investigation/understanding (of)*
* *possible area/direction*

- Typical sentences

* *A sensitivity analysis **may be performed to** study the effect of various X models.*
* *Additional principles that play a role in lifelong learning such as X and Y in the development of Z **will be subject to future research**.*
* *All these issues remain to be investigated in a real-time system **in future**.*
* *Although it is difficult to conclude the best feature selection for the financial distress prediction problems, several feature selection methods that can provide relatively better performances **can be recommended for future research**.*
* ***An interesting future direction** would be to explore the effects of X…*
* *Based on the aforementioned results and observations, X and Y **are strongly recommended for use in** Z.*
* *Customization of X for mixed data anonymization can be considered as **a research direction**.*
* *Developing more accurate mixed distances can be also investigated **in future work**.*
* *For the proposed procedure to update the parameters of X, there are still **some issues to be addressed further**.*
* ***Further experimental and theoretical work is needed to** assess the extent to which X is required for Y.*
* *Furthermore, **it is possible that** similar methods, oriented towards the classification performance, can be used for X.*
* ***Future efforts** can be invested in several research lines…*
* ***Future studies** should examine the algorithm's accuracy in these types of situations…*
* ***Future work directions** include the evaluation of our method with larger-scale datasets…*
* ***In the future**, X will be applied in a hospital environment to investigate its performance…*
* *Inspired by the recent successes of deep learning models applied to computer vision tasks, **another future research direction** will be X.*
* *Instead of either retaining or removing a case completely, our **next attempt** will target*

the discovery of X.

* ***It is advisable to*** *incorporate an X algorithm to select a subset of different features for each object to create class-specific features.*
* *More work is required with our model to explore these possibilities, but the model provides a basis for doing so* ***in future simulations****.*
* ***One possibility*** *would be to try a simple model of X* ***in future****.*
* ***One way to possibly improve*** *X would be to detect Y…*
* *Our* ***future research activities*** *include the application of the proposed approach to the analysis task of X.*
* *The design of an experimental testing program with the inclusion of extended hold times in the cyclic loading condition, as well as TMF loading, will be the focus of* ***future investigations****.*
* *The detailed design of the procedure to update the parameters of X and the deep analysis for the issues mentioned in Remarks 1 and 2* ***deserve further studies*** *and* ***serve as our future work****.*
* *The proposed method* ***can be extended in a number of ways to*** *improve its robustness* ***in future****…*
* *This paper is only a preliminary investigation, and there are many directions that* ***require further exploration****.*
* *To be meaningful, this work* ***needs to be investigated*** *on the experimental front…*
* *We believe that incorporating semantics is crucial for* ***future search engines****.*
* *We believe that with* ***future optimizations****, X can adapt to new variants of ransomware.*
* *We* ***intend to*** *experiment with such a measure* ***in the future plan****…*
* *We* ***plan to*** *increase the level of details of our X model…*
* *X clearly has a massive influence on the striatum and when more data is available on its connectivity, it must be incorporated* ***in future models****…*

5.5 Checking the Writing Quality

The following is a useful checklist for assessing the quality of your Discussion and Conclusion section:

- Do I review the research objectives and methods in limited space?
- Is there a match between the brief review in this section and the research background in the previous Introduction section? Is there any conflict or inconsistency?

- Do I compare my research findings with those of previous studies? Do I explain the uniqueness and advantages of my research? Do I interpret the contributing factors and/or mechanism of my research findings on the shoulder of prior studies?
- Are my comments on previous studies reasonable and well-founded? Are the reasons sufficient?
- Is key information placed at the beginning of the sentence? Can readers easily recognize it in each sentence?
- Does the discussion reflect or relate to the research topic? Does it contain any irrelevant or redundant information?
- Is the conclusion an exact repetition or paraphrase of the Abstract section? (If the length of the two sections is similar, then their content is likely to be identical.)
- Is the conclusion just a summary or restatement of the Research Results section? Has it accounted for the relationship between research findings and research questions?
- Does the conclusion clarify the research contributions? Do these explanations exaggerate facts or are they short of evidence?
- Do I faithfully inform readers of the problems, deficiencies, and challenges of my research? Do I provide possible solutions and suggestions to deal with the research limitations?
- Do I describe the implication of my research and its impact on future works? Do I end the writing with any future research direction?
- Is the tense used consistently? Do I use the present perfect tense to describe the actions completed during the writing, the simple past tense to describe the behaviors taking place during the research, the simple present tense to describe the uniqueness, significance, and limitations of my research, and the simple future tense to describe the future research?

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Exercises

I. Check whether the following statements are true or false. Write T for true and F for false.

1. Compared with the Research Results section, the content of the Discussion and Conclusion section is much broader and more abstract.

2. The Discussion and Conclusion section is a synthesis and refinement of research results, with a highlight of research significance and contributions.

3. The Discussion and Conclusion section often shows diagrams to present details.

4. The Discussion and Conclusion section usually discusses the research results not reported in the previous sections.

5. The boundary between a discussion and a conclusion is often blurred. It is necessary to decide whether to separate or merge them according to journal requirements and preferences.

6. The biggest difference between a discussion and a conclusion is whether to summarize the research results.

7. No matter whether to separate the discussion from the conclusion, it is necessary to summarize what has been achieved by the research.

8. The Discussion and Conclusion section shares considerable similarities with the Abstract section in terms of both content and function: The former is no more than a repetition and extension of the latter.

II. Read the following Discussion and Conclusion section carefully and then answer the questions.

① A strong relationship between textual information extracted from annual reports and abnormal stock return has been reported in the literature. ② This study set out with the aim of assessing the synergistic effects of sentiment analysis and machine learning approach in predicting abnormal stock returns. ③ The results of this study indicate that machine learning approaches using BoW provide more accurate predictions than the aggregate indicators of sentiment categories. ④ However, the elimination of irrelevant and redundant features seems

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to be critical in the BoW approach. ⑤ Moreover, the combination of sentiment analysis and machine learning approach showed an increase in ROC accuracy compared with the pure machine learning approach. ⑥ On the one hand, this increase was not significant, suggesting that BoW sufficiently incorporate sentiment-related terms. ⑦ On the other hand, we demonstrated that this combination outperformed the SMF model that ignores the evaluation of sentiment.

⑧ It is plausible that a number of limitations may have influenced the results obtained. ⑨ Similar to most previous studies, the sample used in this study was limited to major U.S. stock exchanges. ⑩ Although the sample can be considered representative of the North America region and similar to the Europe region, recent empirical evidence suggests that other regions' stock markets exhibit specific behavior, such as Japan. ⑪ Moreover, this study has only investigated a limited time period. ⑫ In the year 2013, major U.S. stock exchanges returned to growth, including a more optimistic investor sentiment compared with previous years. ⑬ This trend has remained to the present day, suggesting that the proposed model may perform well for a longer period of time. ⑭ However, caution must be applied, as managers begin to be aware of the importance of their comments on investors' behavior. ⑮ Substantially, more experiments should therefore be conducted to generalize our findings.

⑯ Another important finding was that NN with dropout regularization and rectified linear units performed particularly well on this prediction task, suggesting that this method may be well suited for text classification tasks working with sparse high-dimensional data. ⑰ Therefore, further research should be done to investigate the use of this NN model in related text classification tasks. ⑱ Future research should also concentrate on different feature selection procedures, especially for high-dimensional imbalanced data. ⑲ Furthermore, a future study investigating the syntactic structure and additional semantic features of firm-related text documents would be interesting. ⑳ In fact, alternative NN structures such as convolutional NNs, have recently been proposed to model sentiment specific word embedding. ㉑ Moreover, further research might explore the role of tone dispersion within managerial comments as this has been identified as an important indicator of current and future corporate financial performance. ㉒ Finally, the current study was limited by the use of financial fundamental indicators. ㉓ Future research should therefore concentrate on the investigation of technical analysis in conjunction with the linguistic features of firm-related documents. (Hájek, 2018)

1. The following table tabulates the components in the structure of the Discussion and Conclusion section. Match these components with the sentences of the excerpt above and put the sentence numbers in the right cells.

Moves	Steps	Sentence Number(s)
Moves 1: Brief review	Reassert the research background, objectives, questions, and hypotheses	
	Review the major research methods	
Moves 2: Summary with discussion	Summarize the major research findings	
	Explain the contributing factors and mechanisms of research findings	
	Comment on and interpret the uniqueness and significance of research findings	
Moves 3: Concluding remarks	Explain the research limitations	
	Narrate the research implications	
	Extend the future research directions	

2. What tenses have been used? In what case are they used?

3. Compared with the Abstract section of the same article (see Excerpt 1 in Chapter 2), how is the content of this section different from and connected with the Abstract section?

III. The following sentences are drawn from Fawzi et al. (2015). Put these sentences in an appropriate order to develop a logical conclusion.

A. The proposed LAST classifier has also been shown to compete with recent discriminative sparse coding techniques in handwritten digits classification experiments.

B. We have proposed a supervised learning algorithm tailored for the soft thresholding-based classifier.

C. The proposed algorithm (LAST), which leverages the DC structure, significantly outperforms stochastic gradient descent in all our experiments.

D. Our method moreover compares favorably to other standard techniques as linear, RBF kernel, or nearest neighbor classifiers.

E. The learning problem, which jointly estimates a discriminative dictionary D and a classifier hyperplane w, is cast as a DC problem and solved efficiently with an iterative

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algorithm.

F. Furthermore, the resulting classifier consistently leads to better results than the unsupervised sparse coding classifier.

G. We should mention that, while the sparse coding encoder features some form of competition between the different atoms in the dictionary (often referred to as "explaining-away" [Gregor & LeCun, 2010]), our encoder acts on the different atoms independently.

H. Despite its simple behavior, our scheme is competitive when the dictionary and classifier parameters are learned in a suitable manner.

Order: _____

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Chapter 6
Manual for Using Corpora

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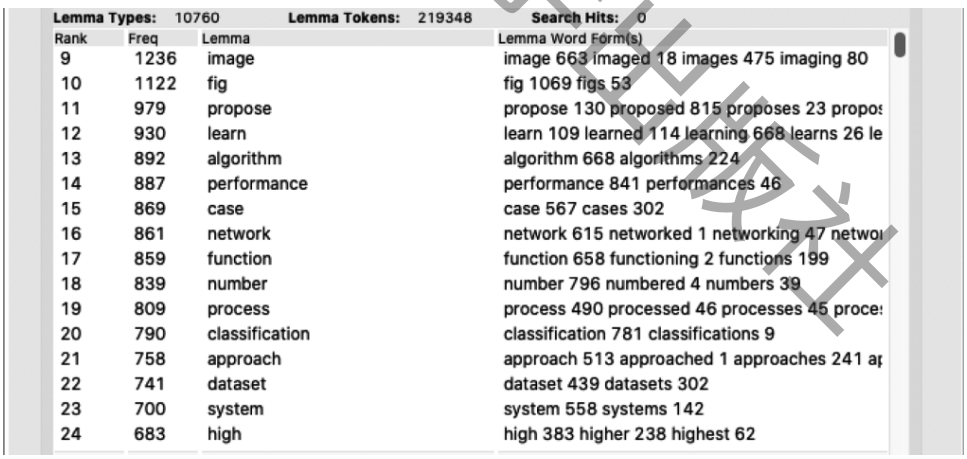
"When something is such a creative medium as the Web, the limits to it are our imagination."

Tim Berners-Lee

This chapter is a brief manual on the operation of corpus tools, designed to equip students with simple corpus analysis methods to build the skill of discovering academic knowledge from a corpus on their own, even without the help of a teacher. The following contains three main topics, explaining in turn how to generate an academic word list, retrieve academic collocations, and check grammatical patterns.

6.1 Generating a Word List

A word list, also known as a word frequency list, collects all words in the corpus along with their corresponding frequencies. An academic word list is then the glossary of word entries retained after removing function words, which helps readers quickly identify frequently-used vocabulary in an academic field and thus facilitates their learning and acquisition of professional lexis. As shown in Figure 6.1, the words "image", "propose", "algorithm", "performance", and others are high-frequency academic words in the area of image processing technology.



Lemma Types: 10760 Lemma Tokens: 219348 Search Hits: 0

Rank	Freq	Lemma	Lemma Word Form(s)
9	1236	image	image 663 imaged 18 images 475 imaging 80
10	1122	fig	fig 1069 figs 53
11	979	propose	propose 130 proposed 815 proposes 23 propos
12	930	learn	learn 109 learned 114 learning 668 learns 26 le
13	892	algorithm	algorithm 668 algorithms 224
14	887	performance	performance 841 performances 46
15	869	case	case 567 cases 302
16	861	network	network 615 networked 1 networking 47 networ
17	859	function	function 658 functioning 2 functions 199
18	839	number	number 796 numbered 4 numbers 39
19	809	process	process 490 processed 46 processes 45 proces
20	790	classification	classification 781 classifications 9
21	758	approach	approach 513 approached 1 approaches 241 ap
22	741	dataset	dataset 439 datasets 302
23	700	system	system 558 systems 142
24	683	high	high 383 higher 238 highest 62

Figure 6.1 Demo of an academic word list

The concordancer AntConc (free at the Laurence Anthony's website) can easily be operated to produce a list of general words, and on this basis, generate an academic word list by eliminating function words and performing lemmatization. There are mainly four steps involved in order to yield such an academic word list.

Step 1: Clean up texts

Messy texts would reduce the accuracy of words' retrieval and their statistics, and also lead to errors and malfunctions of part-of-speech tagging. To clean up messy texts usually means to

cut down the noise in text formatting, special characters and symbols, pictures and formulas, and extra space and paragraphs. Since the process of text cleaning is a basic technique in the field of computer technology and application, it is not repeated here.

Step 2: Import the texts

Find and import the cleaned text files through the "Open File(s)" or "Open Dir..." option under the "File" menu at the top left of AntConc. Return to the home screen, and switch to the interface of "Word List" (see Figure 6.2).

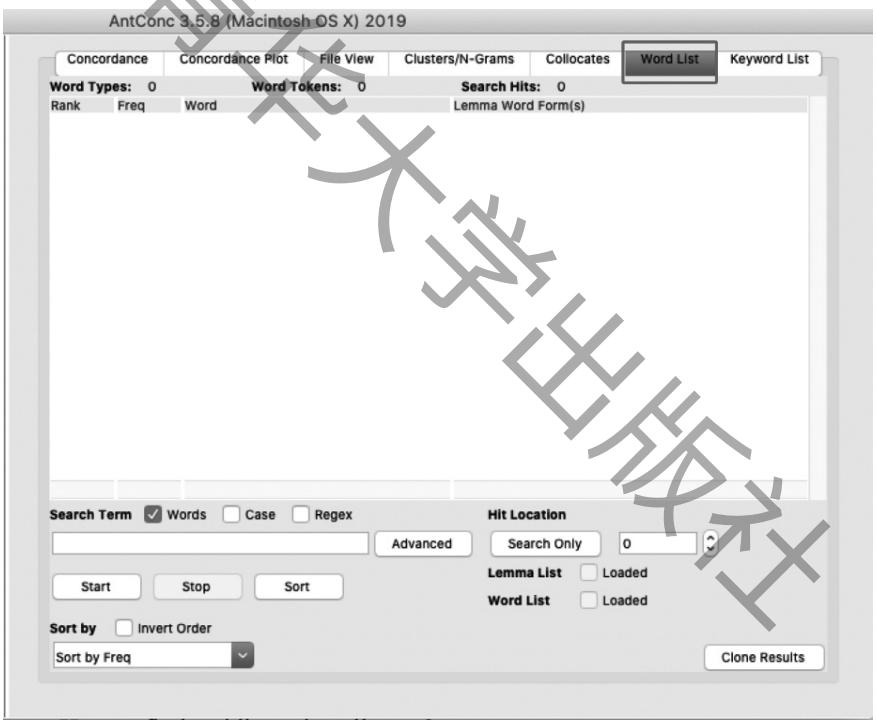


Figure 6.2 "Word List" interface in AntConc

Step 3: Load in the lists of stop words and lemmas

Stop words are a pre-prepared collection of words (mostly function words) that are meaningless to vocabulary learning, while a lemma list is used to classify and merge words with the same roots for the purpose of conciseness and readability. It is necessary to load in the lists of both stop words and lemmas before building an academic word list that is useful and neat. The operation goes through the following steps: Click the "Settings", "Tool Preference" menus in turn at the top of the AntConc; open the dialogue box as shown in Figure 6.3; click the "Word List" under "Category" on the left side of the dialogue box; then find the "Lemma

List" on its right side; and click "Open" to load in the lemma list. Once finished, locate the "Word List Range", select "Use a stoplist below", and then click "Open" to load in the stop words. Finally, click "Apply" at the bottom right of the dialogue box.

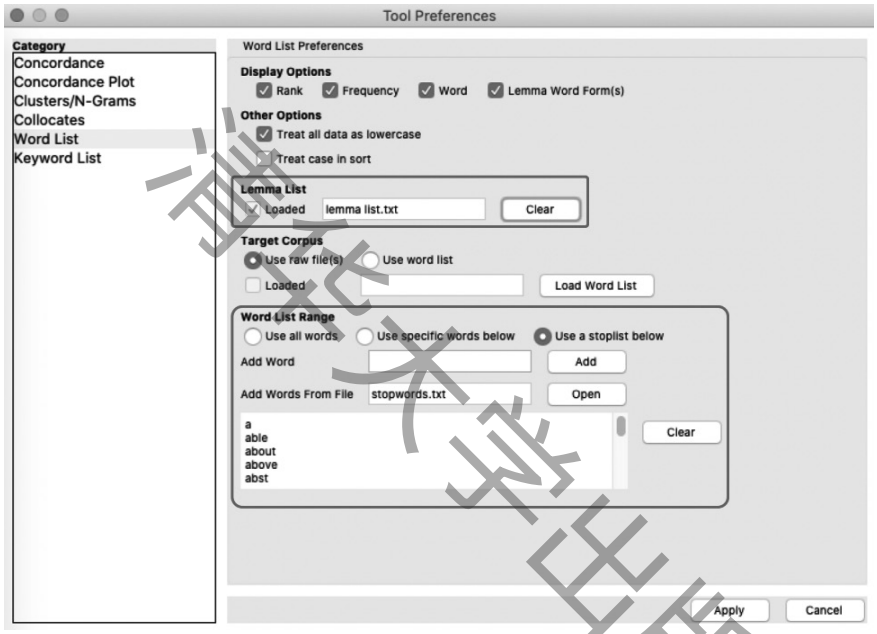


Figure 6.3 Settings of stoplist and lemma list

Step 4: Generate the academic word list

Turn back to the home interface of AntConc, and simply click the "Start" at the bottom to generate the word list (see Figure 6.4). By clicking "Clone Results", the word list would be displayed in a pop-up box, which can be copied and saved to somewhere else in a computer.

6.2 Enquiring Word Collocates

As for any concordancer, the word for search is called the node or center word, while the words on the node's left and right sides are named the collocates; the range of the distance between the node and its collocates is called span. Attributed to the hypotactic language, English words always present a specific companion relationship, indicating an underlying but conventional combination between a node and its collocates. Such a relationship correlates with the language idiomaticity, which, therefore, is fairly important for natural expressions in academic writing. There are four major steps to search for collocates using AntConc.

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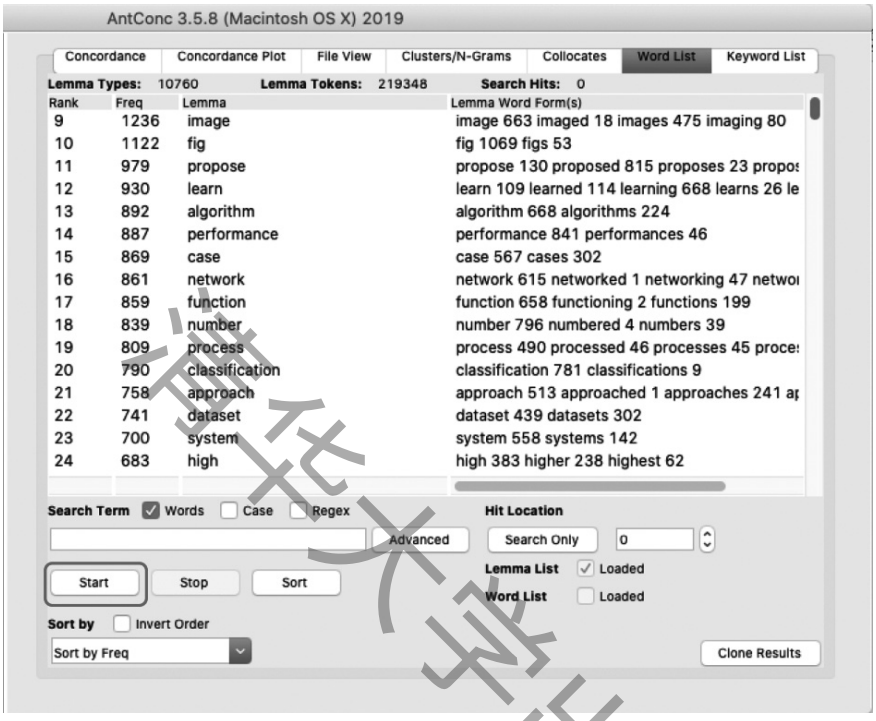

Figure 6.4 Result of a word list

Step 1: Clean up texts

It is the same as the first step in Section 6.1.

Step 2: Import the texts

Load in the cleaned texts through the “Open File(s)” or “Open Dir...” option under the “File” menu at the top left of AntConc. Return to the home screen, and switch to the “Collocates” interface (see Figure 6.5).

Step 3: Adjust the span

Adjust the window span to locate the positions of the collocates relative to the node. For example, in Figure 6.6, using the “Window Span” panel, we set the positions of the left and right collocates to 0 and 1 respectively, which means that only the immediate right collocates of the center word will be the targets for retrieval.

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Figure 6.5 “Collocates” interface in AntConc

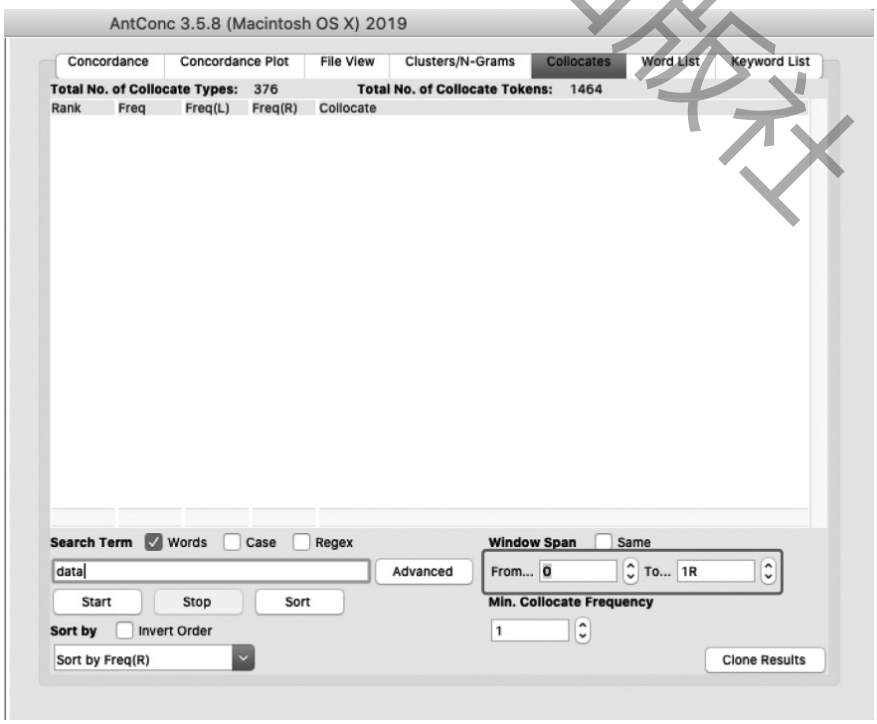

Figure 6.6 Span setting

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Step 4: Generate the collocates

Put the node in the search box, and click "Start" to begin searching (see Figure 6.7). After generating the list of collocates, select the sorting method from the drop-down box at the bottom of the interface, and then click "Sort" to rank the results.

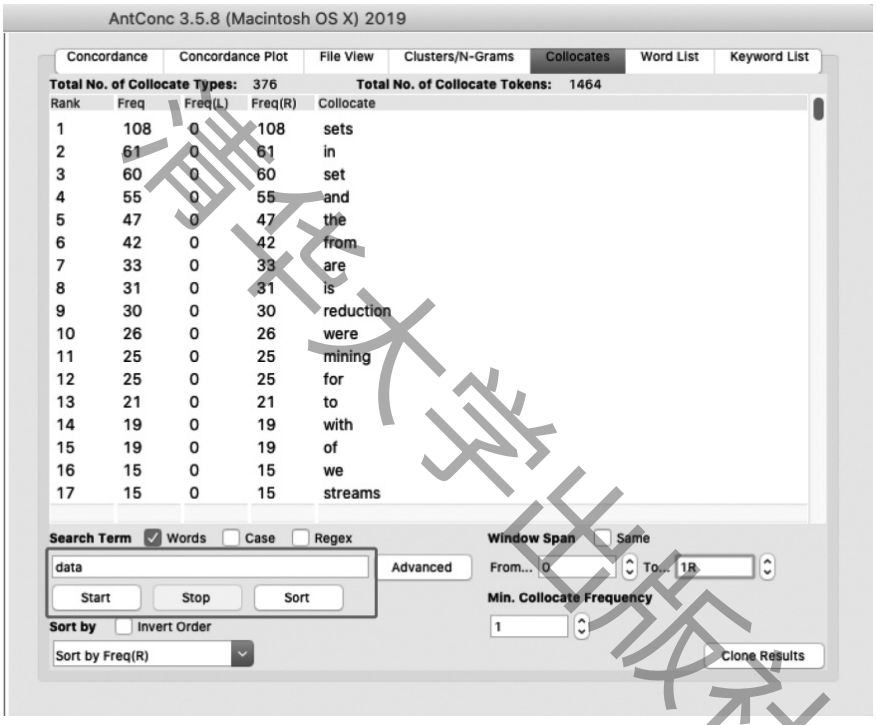

Figure 6.7 Search for collocates

6.3 Checking Grammatical Patterns

A grammatical pattern here refers to not only a word or phrase of a certain part of speech (POS), but also a specific syntactic structure. In the concordancer, grammatical patterns can be retrieved with the help of wildcards or regular expressions, helping readers to learn a vocabulary of a particular part of speech and check usage of a specific syntactic structure. The steps of retrieving grammar patterns mainly include the following five steps.

Step 1: Clean up texts

Refer to the first step in Section 6.1.

Step 2: Tag the texts' part of speech

POS tagging means to automatically label the part of speech of all words in a text or texts according to the co-texts of words. Tools for tagging POS can be rule-, stochastic-, and neural-based. Here, we use TreeTagger, a free annotation tool designed by the Institute of Computational Linguistics, University of Stuttgart, Germany. The accuracy rate of the English POS marked by TreeTagger is between 96% and 97%.

First, open the main interface of TreeTagger (see Figure 6.8), find the "File" menu at the upper left corner, and click the "Open File(s)" or "Open Dir..." option to import the cleaned texts. Then, turn back to the main interface, find the "Choose a language", "Input text encoding", and "Output format" options at the top, and select the language type, character encoding, and annotation format corresponding to the texts respectively. Finally, click "Run Tagger" at the top right of the main interface to execute the tagging.

Figure 6.8 Interface of TreeTagger

Step 3: Import the annotated texts into the concordancer

Find the annotated texts through the "Open File(s)" or "Open Dir..." option under the "File" menu at the top left of AntConc. Back on the main software page, switch to the interface of "Concordance", and tick the "Regex" check box (see Figure 6.9).

Step 4 (Optional): Hide tags

This step can hide POS tags to make the search results clearer and more concise. Readers can decide whether to perform this step according to their needs: Click the "Settings–Global Settings" menu at the top of the AntConc, and open the dialog box shown in Figure 6.10. Click "Tags" under "Category" on the left side of the dialogue box, and then find "Tag settings" on

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the right side. There are three options: “Show tags”, “Hide tags”, and “Hide tags (Search in Conc/Plot/File View)”. They function to reserve POS tagging, hide POS tagging (cannot be retrieved), and hide POS tagging (can be retrieved) respectively. Here, we select “Hide tags (Search in Conc/Plot/File View)” to ensure that POS tags can be both retrieved and hidden in the retrieval results.

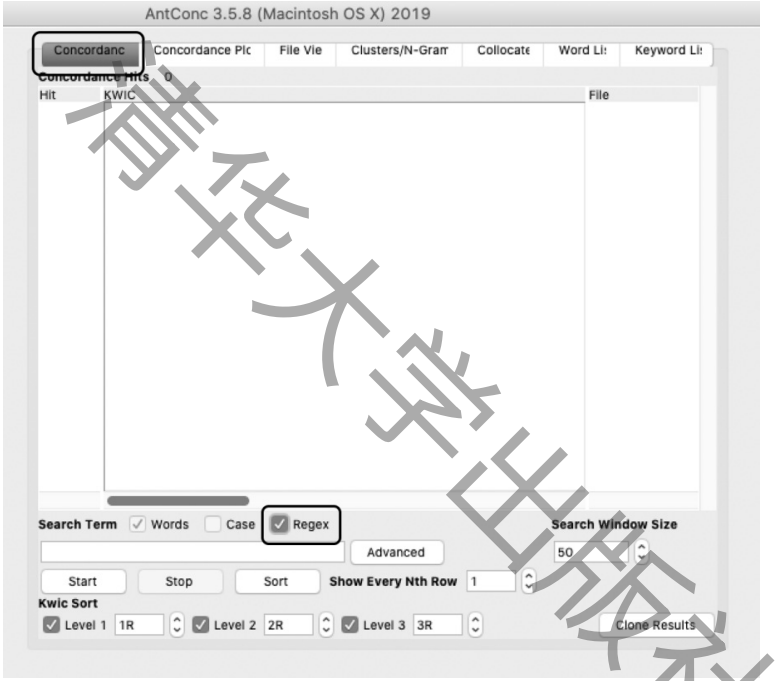

Figure 6.9 “Concordance” interface in AntConc

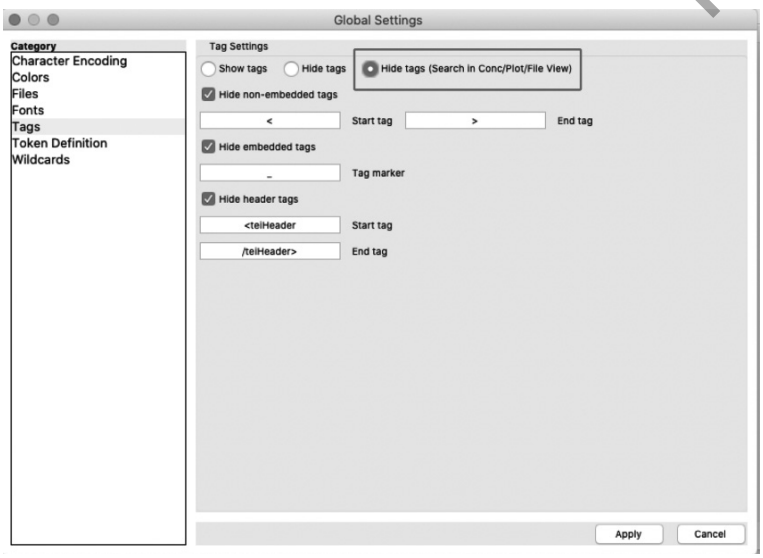

Figure 6.10 Tag settings

Step 5: Search for the pattern

Use regular expressions to search for words, word combinations, or even syntactic structures of a particular POS. As shown in Figure 6.11, if you want to search for the usage of passive voice, put "\S+_VB\w*\s\S+_VVN" in the search box, and then click "Start". In this way, all concordance lines that conform to this syntax structure will be generated.

The results' layout can be modified by the control panels "Search Window Size" and "Kwic Sort" (see Figure 6.11). "Search Window Size" manages the length of all concordances; the bigger the size number, the longer the concordance lines. "Kwic Sort" is used to display the output's order. Here, "Level 1", "Level 2", and "Level 3" mean the items and priority of sorting.

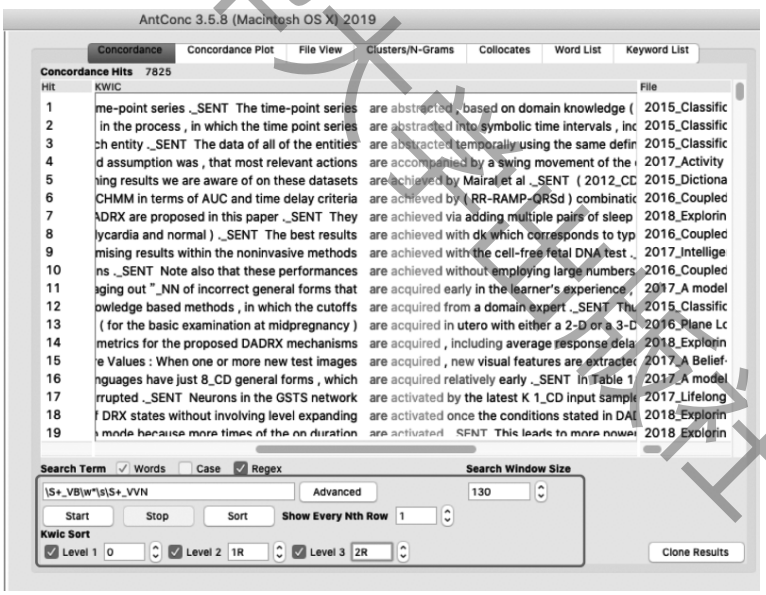

Figure 6.11 Search for grammatical patterns

In addition to retrieving sentences of passive voice, a similar approach can be used to search for sentences of any interest (e.g., conditional sentences, complex sentences, etc.), as well as combinations of vocabulary and grammar (e.g., a combination of any adjective and the word "modal", a combination of two sequent nouns, etc.). With POS annotation of the corpus texts and certain knowledge of regular expressions, a corpus is able to offer almost any academic knowledge that you want, and will be a very powerful helper when you are at a loss for writing.

Exercises

Compile a mini corpus, usually larger than 100,000 words, with articles drawn from your own research field. Follow the instructions in this chapter to analyze the corpus and complete the following tasks.

1. Build an academic word list containing at least 100 content words and fill the words in the table below along with the requested information.

Frequency	Words	Meaning
…	…	…

2. Some expressions in the following sentences are uncommon or even incorrect in academic writing. Follow the example to underline the problematic expressions, and then use the corpus to verify your judgments and make corrections.

Sentences	Verification	Correction
e.g., This study is the first attempt to address the following fundamental question.	No hits found in the corpus.	To our best knowledge, this study is the first that addresses the following fundamental question.
We propose, therefore, to look at the other side of the coin.		
It is eye-catching that the importance of each device was different in every year of data collection.		
They were assayed using commercial kits, as found elsewhere.		

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(Continued)

Sentences	Verification	Correction
This argument holds, a fortiori, in the development of meaning, where the reduction of the number of predicate symbols in the situation is an explicit objective.		
We should point out that not all the variables of the database have been used for all the cluster analysis.		
However, it should be highlighted that the employment of ABC scale compared to the use of the criteria described by Smith et al. (2020) did not modify the prevalence of ABC cases in this new study.		
Special reference needs to be made to the role of TP. The TP concentration is commonly used for the evaluation of the transfer of passive immunity.		
All conditions should be conscientiously tested in order to find any discrepancies.		
Their approach provides an easy, encouraging, and promising way to test the model.		
Marked differences were found in quality and quantity of the results. A similar problem was absent in the robotic fields.		
In conclusion, X seems to be not influenced by both Y and Z.		
Note, however, that, in this simple case, the additional memory requirements amount to a single bit.		
An interesting difference in the expression level was observed for ABC1-2.		

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3. Find some sentences from your corpus that match the requested sentence patterns listed in the table below.

Sentence Patterns	Sentences
there be…	e.g., The proof is that *there is* a decreasing proportion of legitimate e-mail from May to July for dataset 1.
as + adjective/adverb	
although…, noun/pronoun	
between…and…	
verb + adverb	
noun + verb + adjective	

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Keys to Exercises

Chapter 1

I.

Excerpt 1: Sentences ①②③: Move 1

Sentences ④⑤: Move 2

Sentences ⑥⑦⑧: Move 3

Sentences ⑨⑩: Move 4

Sentence ⑪: Move 5

Excerpt 2: Sentences ①②③: Move 1

Sentences ④⑥: Move 2

Sentences ⑤⑥: Move 3

Sentence ⑦: Move 4

II.

1. This paper aims to design and validate a desktop virtual reality (VR) system, for presentation and assessment of volumetric data, based on commercially off-the-shelf hardware as an alternative to a fully immersive CAVE-like I-Space VR system. We designed a desktop VR system, using a three-dimensional (3D) monitor and a six degrees-of-freedom tracking system. A personal computer uses the V-Scope volume-rendering application, developed for the I-Space, to create a hologram of volumetric data. Results showed that, between I-Space and the desktop VR system, the mean difference for crown-rump length is –0.34% and for embryonic volume –0.92%. Besides, measurement times were longer on the desktop VR system, but not statistically significant. A user-friendly desktop VR system can be put together using commercially off-the-shelf hardware at an acceptable price. This system provides a valid and reliable method for embryonic length and volume measurements and can be used in clinical practice.

2. Several local region-based level set models have been proposed to segment images with intensity inhomogeneity. However, these models are generally based on the assumption

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that intensity inhomogeneity is slowly varying in the image domain, which is invalid for images with serious intensity inhomogeneity and thus leads to poor segmentation performance. In this paper, we propose a novel level set method named a polynomial piecewise constant approximation (PPCA) to segment images with serious intensity inhomogeneity. The basic idea of the PPCA is to transform the original image into a piecewise constant image to make the piecewise constant segmentation criterion applicable. We firstly define an initial objective function with constraint conditions to transform the original image, and then use the PPCA to realize the dual constraint relaxation for the objective function. The dual constraint relaxation is reflected in two aspects: (1) the objective function based on local region is exploited to replace the pointwise approximation method; (2) a Gaussian pyramid convolution strategy is used to devise polynomial fitting given the variance of local intensity distribution and the reliability of polynomial approximation. The PPCA relaxes the constraint condition of the objective function, thereby approximating the piecewise constant image easily. According to the piecewise constant segmentation criterion, we obtain the partial differential equation based on polynomial piecewise constant approximation. Finally, we utilize the level set method to construct the energy functional. Experimental results demonstrate that the PPCA can yield better results than classical local models for segmenting images with serious intensity inhomogeneity.

Chapter 2

I.

Open. Suggested answers are as follow.

1. non-linear/useful/tree-based

2. graph-based/efficient/genetic

3. image-based/ANN-based/fuzzy-control

4. add/introduce/refer

5. describes/proposes/reports

6. extends/introduces/provides

7. presents/reviews/summarizes; arranged/organized/structured

8. a non-uniform action / a non-standard dataset

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9. an efficient model / a common approach

10. a well-known theorem / a systematic framework

11. Temporal abstraction shows / Existing algorithm mentioned

12. Prior studies show / Extensive evidence proves

II.

1.

Moves	Steps	Sentence Number(s)
Move 1: Establish the territory	Describe the background, necessity, and importance of the research topic	①–⑤
	Summarize major previous studies	⑥–⑰
Move 2: Establish a niche	Point out the deficiencies of previous studies	/
	Point out the expandability of previous studies	/
Move 3: Occupy the niche	Describe the research purposes	⑱
	Describe the research question or hypothesis	/
	Characterize the research methods	⑲–㉒
	Summarize the major research findings	㉓
	Outline the research significance and value	㉔
	Explain the writing structure	㉕–㉛

2. Both the two steps in Move 2 and the step "Describe the research question or hypothesis" in Move 3 are not found in this paper. Generally, Move 2 is compulsory with few exceptions in the field of computer science.

3. Tthe present tense dominates in this Introduction section. The description of the research procedures is suggested to follow the past tense as it presents "what the author did during the research" before the writing.

Chapter 3

1. This excerpt is mainly about the components involved in the model. Paragraph 1 is an overview of the model. Paragraph 2 is about the situation the model depends upon. Paragraph 3 describes the objects and predicates that represent the situation. Paragraph 4 explains the symbols that represent objects and arguments. Paragraph 5 presents the variables that construct arguments and meanings. Paragraph 6 explains the formation

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of meaning. Paragraph 7 details the development of meanings through symbols and variables. Paragraph 8 defines the utterance.

2. Paragraph 1 gives a general picture of the model, thus matching Move 1 “Overview”. Paragraphs 2 to 5 describe the details of the model, including its situation, objects, and the development of meaning and utterance. Therefore, these paragraphs match Move 3 “Technical design”. Paragraphs 6 to 8 describe the variables that express the abstract concepts of values, thereby matching Move 5 “Variables”.

3. The last paragraph defines the utterance along with several examples, but it does not build a close relation with the model. Therefore, if another paragraph follows, it may explain how an utterance is denoting in the situation s_1 as defined in previous paragraphs, and how it assigns meanings to m_1 and m_2.

4. Simple present tense is mainly used in this excerpt. It is used when: (1) defining a term such as a situation, atom, and utterance; (2) explaining the components of the model, including symbols, variables, and values; (3) offering examples.

5. Passive voice is mainly used in this excerpt. It is usually used by convention to describe the depersonalized information. The passive structure allows readers to omit the agent (usually “I” or “we”), placing the emphasis on the model itself (instead of the human intervention) and the components that construct the model.

Chapter 4

1. Paragraph 1 reiterates the key research methods previously mentioned in the paper; as a result, it matches Move 1 “Introducing results”. Paragraphs 2 to 4 elucidate the research findings from the autoencoder and the GAN, and Paragraph 5 makes a comparison between different models; thus, these four paragraphs match Move 2 “Explicating results”.

2. Tables and figures are part of the presentation of the results, offering detailed information that would be difficult to describe in verbal language. They are both used to explain something or some relations between two or more things, and are used to show all the collected data in an accessible way, helping make dense information easily available to readers at possibly one glance.

3. Table II and Figure 3 include a brief description of the results being presented and other necessary information in a caption or title. Table captions go above the table, and figure captions go below the figure. It is common to see an overlap between figure captions

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and text descriptions in the field of computer science, particularly in the areas of image processing.

4. Table II and Figure 3 are used to provide a visual presentation of important information for readers. As a convention that a table includes a set of data (numbers or texts) arranged in rows or columns, Table II in this excerpt can be improved in terms of its layout and forms of data. The current form of Figure 3 is acceptable, but the note under its legend is usually placed in the body as a footnote or endnote.

5. As for this excerpt, present tense is preferred to direct readers to a specific table or figure, or key findings. The voice is mixed when referring to a table or figure, but the active voice dominates when this excerpt highlights or interprets the results.

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Chapter 5

I. 1–4 TTFF 5–8 TFTF

II.

1.

Moves	Steps	Sentence Number(s)
Move 1: Brief review	Reassert the research background, objectives, questions, and hypotheses	① ②
	Review the major research methods	/
Move 2: Summary with discussion	Summarize the major research findings	③ ⑯
	Explain the contributing factors and mechanisms of research findings	/
	Comment on and interpret the uniqueness and significance of research findings	④–⑦, ⑯
Move 3: Concluding remarks	Explain the research limitations	⑧–⑮, ㉒
	Narrate the research implications	/
	Extend the future research directions	⑰–㉑, ㉓

2. The verb tenses used in this section are comparatively complex. Past tense, present tense, future tense, or modal auxiliaries are employed according to the types of information contents. At the beginning of this section, the elements referring to the research purpose, and the summary of and comments on research findings tend to be presented in the simple past tense, whereas the present tense is preferred for a general statement. Modal

auxiliaries and the future tense are mostly used to emphasize the direction for future studies.

3. The Abstract section functions like an advertisement that aims to attract readership and promote the article; thus it focuses on the reporting of essential research findings. The Discussion and Conclusion section reads like a reading note, aiming to remind readers of the key information and important value of the article. As a result, in addition to summarizing the research findings, the section of Discussion and Conclusion is much more informative, accompanied by the research significance, implications, and future research directions.

III. BECFDAGH

Chapter 6

1. Omitted.

2.

Sentences	Possible Correction
We propose, therefore, to look at the other side of the coin.	We thus propose a different viewpoint / an alternative approach.
It is eye-catching that the importance of each device was different in every year of data collection.	The importance of each device was different in each year of data collection.
They were assayed using commercial kits, as found elsewhere.	They were assayed using commercial kits, as reported/mentioned in Section 2.1.
This argument holds, a fortiori, in the development of meaning, where the reduction of the number of predicate symbols in the situation is an explicit objective.	This is even more true that in the development of meaning, where the reduction of the number of predicate symbols in the situation is an explicit objective.
We should point out that not all the variables of the database have been used for all the cluster analysis.	Not all the variables of the database have been used for all the cluster analysis.
However, it should be highlighted that the employment of ABC scale compared to the use of the criteria described by Smith et al. (2020) did not modify the prevalence of ABC cases in this new study.	However, our use of the ABC scale rather than the XYZ scale described by Smith et al. (2020) did not modify the prevalence of ABC cases.

(Continued)

Sentences	Possible Correction
Special reference needs to be made to the role of TP. The TP concentration is commonly used for the evaluation of the transfer of passive immunity.	TP plays a key role. The TP concentration is commonly used for the evaluation of the transfer of passive immunity.
All conditions should be conscientiously tested in order to find any discrepancies.	All conditions should be tested in order to find any discrepancies.
Their approach provides an easy, encouraging and promising way to test the model.	Their approach provides an easy way to test the model.
Marked differences were found in quality and quantity of the results. A similar problem was absent in the robotic fields.	Marked differences were found in the quality and quantity of the results. There was no such problem in the robotic fields.
In conclusion, X seems to be not influenced by both Y and Z.	In conclusion, X does not seem to be influenced by either Y or Z.
Note, however, that, in this simple case, the additional memory requirements amount to a single bit.	However, in this simple case, the additional memory requirements amount to a single bit.
An interesting difference in the expression level was observed for ABC1-2.	A fundamental/significant difference in the expression level was observed for ABC1-2.

3.

Sentence Patterns	Possible Sentences
there be…	As we recall from Section 6, *there are* nine possible descriptors to use in order to create the input vectors.
	The nodes of the graph correspond to words and predicate symbols, and *there is* an undirected edge between every pair of nodes.
as + adjective/ adverb	The basic idea is to develop a system able to get an evaluation of the motor status of a patient *as close as possible* to the evaluation of neurologists when they apply semiquantitative evaluation scale.
	Notice that when the robot is in a specific continuous state, more than one cluster may be active simultaneously, the same way *as more than* one place cell might be firing simultaneously.
	The security model is *as strong as* conventional kernel-based networking stacks, a feature that is missing from all recently proposed user-level stacks.

陆军装甲兵学院

(Continued)

Sentence Patterns	Possible Sentences
although…, noun/pronoun	*Although* ransomware also focuses on private files which are valuable for users, *it* makes the choice automatically and never reminds users which files have been encrypted.
	Although they allow for a high data reduction rate while preserving the model accuracy, *edition-based PS techniques* are usually the slowest ones due to their greedy search procedures.
	Although past work has explored extensions of SOMs that support temporal sequence processing, *conventional SOMs* do not naturally represent temporal sequence inputs.
between…and…	Comparisons of transmission capacity *between* a full duplex network *and* a half duplex network reveal that the capacity gain from full duplex communications is limited due to severe aggregate interference.
	A new phenomenon was observed in which the usual monotonic relationship *between* input to the basal ganglia *and* its output within an action "channel" was, under some circumstances, reversed.
	Slipping effects *between* pile *and* soil are not taken into account: They are insignificant.
verb + adverb	The combination of RPE and ESE can *bring about* 10 points of improvement when compared with using RPE1 alone and can also be better than using RPE alone.
	The strategy turns into a route navigation (Redish, 1999) one, in which the simulated robot *went forward* until it reached a wall, and turned and repeated the action, as seen in Fig. 9.
	Although BoF and its variants *are used widely*, they suffer from inadequate ability to characterize images and lack of robust structures upon visual words.
noun + verb + adjective	*This paper addresses various challenges* arising from implementing and integrating these elements.
	Different entities have different dependencies on their contextual words. Some entities' property may be reflected by the former (next) one word, and some may be reflected by the former (next) two words or more.
	The proposed FRC *model is capable* of distributing the tension force by means of fiber links embedded in concrete such that the concrete member does not fail by localized damage or a stress concentration.

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中国科学院大学研究生教材系列

学科英语写作教程：材料科学

Writing a Research Paper in Materials Science

总主编◎高　原　张红晖

主　编◎崔雅琼

清华大学出版社

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·北京·

内 容 简 介

本教材基于语料库编写，共分为八章，从学术与思辨的视角介绍了材料科学研究论文的基本结构、语言特点与写作方法，总结了撰写学术论文的常用词汇、短语和句型，辅以新颖、多样、丰富的课后练习，帮助学生巩固学习成果，提高自主学习能力和学术写作能力。

本教材还提供了材料科学专用词汇表和常用词汇搭配表等拓展学习资源，读者可登录ftp://ftp.tup.tsing hua.edu.cn./ 下载使用。本教材既可作为学术英语写作教材，也可作为学术论文写作的参考工具书。

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总　　序

2020 年 11 月，教育部新文科建设工作组发布的《新文科建设宣言》指出："文科教育融合发展需要新文科。新科技和产业革命浪潮奔腾而至，社会问题日益综合化复杂化，应对新变化、解决复杂问题亟需跨学科专业的知识整合，推动融合发展是新文科建设的必然选择。进一步打破学科专业壁垒，推动文科专业之间深度融通、文科与理工农医交叉融合，融入现代信息技术赋能文科教育，实现自我的革故鼎新，新文科建设势在必行。"学科英语是外语学科和专业学科相互交叉、彼此融合的产物，符合国家"新文科"建设的时代愿景。开辟外语学科建设的全新思路，是当前外语教学改革的重要突破方向。

"中国科学院大学研究生教材系列"将切实满足特定专业学生群体的英语学习需求作为教材编写的重要依据，充分考虑到具体学习者群体的学习目标和学习诉求，具有以实际应用为导向的根本特质。该系列教材不仅关注教材编写前期的需求分析，同时重视教材试用阶段使用者的实际反馈，因为我们认为，直面使用者反馈是确定教材价值的关键一环，是重新审视学习者需求的宝贵机会，更是反复改进教材质量的可靠抓手。

"中国科学院大学研究生教材系列"融入现代信息技术，运用语料库的数据处理方法，整理归纳学科英语的语言特点和语篇特征。语料库方法可以十分客观快捷地捕捉学术语篇中的词汇、短语、搭配、语块、句子结构等语言层面的使用规律，正在成为学术和学科英语研究领域新近涌现的热点之一。然而，语料库技术运用于教材编写的尝试却寥寥无几，该系列教材无疑为语料库方法运用于教材编写做出了开创性的贡献。语料库的运用不仅能够呈现自然学术语境中真实的语言使用，更为重要的是，能够引导学习者建立适合自己微观研究方向的专业文献语料库，并将其作为未来学术生涯的开端以及追随学术生命成长过程的见证。学科英语语料库一方面可以成为研究者文献阅读经历不断累积的记录，另一方面也可能成为研究者写作不竭的灵感源泉和他们未来指导学生进行

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专业写作的宝贵财富。基于学科英语语料库的教材建设在“授人以鱼”的同时也在“授人以渔”，而学习者也会因此获得“授人以渔”的能力。

我们正处在一个教育变革的时代。新的时代呼唤符合国家发展需求的教育理念和新颖实用的教学方法，同时也鼓励教师队伍努力探索新型的教材编写模式。“中国科学院大学研究生教材系列”积极响应时代的要求，是国家“新文科”建设指导思想下的勇敢尝试。

该系列教材的出版得到中国科学院大学教材出版中心资助，在此表示感谢。

高　原

2022 年 5 月

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前　言

随着我国“双一流”高校和学科建设的开展，高校学生面临着用英语发表学术论文的压力。然而，我国目前的英语教育侧重于培养学生的一般语言技能，而非在学术背景下的语言使用。编者在编写本教材之前开展了一项学术英语需求调查。调查显示，大多数学生缺乏系统的学术英语训练，这使得他们在使用英语撰写学术论文方面感到非常吃力。学生普遍表示，由于难以有效而准确地表达研究内容，他们倾向于依赖机器翻译和语言服务来撰写英语学术论文。然而，目前的机器翻译存在诸多问题，如语言表达生硬、无法准确地表达研究者的实际想法等，而现有的语言服务则局限在语言的校对和润色上，服务提供者可能并不熟悉特定研究领域的写作惯例，从而无法从更高层次给予研究者帮助和建议。培养研究者独立的学术英语写作技能不仅符合当前我国英语教育改革的培养目标，也有助于科研人员融入国际科学界，为我国学术强国的建设助一臂之力。

研究论文大多遵循比较传统的结构：标题—摘要—引言—研究方法—结果—讨论—结论。虽然这种结构适用于大多数学科的研究论文，但在特定研究领域有一些细微的变化和不同。特定学科的学术写作所使用的词汇和语法相对固定，而且各有侧重。因此，对于母语并非英语的学生和科技工作者来说，了解特定学科领域论文的结构、词汇和常用句型，可以有效地帮助他们掌握该领域的学术写作技能。《学科英语写作教程：材料科学》旨在为从事材料科学及相关研究领域的学术英语学习者和实践者提供写作资源和支持。

本教材共分为八章，第一章主要介绍材料科学研究论文中的基本结构和特点。第二章至第六章分别是关于文章引言（Introduction）、研究方法（Methods）、结果（Results）、讨论（Discussion）以及标题和摘要（Abstract and Title）等部分的写作。第七章分析了材料科学论文中语言的特点，第八章从思辨视角对学术论文的写作进行了总结。在每章中，编者还根据 Swales（1990）和 Hyland（2000）总结的研究论文的主要语步总结了撰写该部分常用的短语和句型。本教材的教学目标明确、结构合理、范式统一，每章的内容都遵循章节导入、重点讲解、文本分析、总结归纳的编写顺序，教材体系科学合

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理、循序渐进。每章的最后会有一个复习清单和“记忆口诀”，帮助学习者系统地复习本章要点。教材的配套资源中还提供了提取自语料库的材料科学专用词汇表（Materials Science Word List）和常用副词—动词搭配表（Adverb-Verb Collocations）。编者鼓励学习者通读本教材，完成每一项练习任务，以便更好地理解材料科学的学术写作。编者还强烈建议学习者在写作实践中使用本教材中的词汇、短语和句型，并举一反三；同时通过自主阅读，积累更多的论文写作表达方式。

本教材的编写基于真实学术语料，具有科学性。本教材提供的词汇、短语和句型均提取自新近发表在 SCI 期刊（例如，*Acta Materialia, Current Opinion in Solid State & Materials Science, Materials Today, Advanced Materials, Advanced Functional Materials* 等）上的百余篇材料科学研究论文及由北京外国语大学开发的 50 万字的材料科学论文语料库（CQPweb-MatDEAP）。这些句型和表达方式经过编者筛选、提取并整合后，在使用上具有通用性，学习者可以根据自身需求合理使用。

本教材兼具思想性。编者引用了一些中国科学家发表的具有较大国际影响力的期刊论文，体现了我国科学工作者为推动人类科技进步做出的贡献，彰显了我国学者在国际学术界的话语权。

本教材是一本易于上手的学术写作指南，既有理论指导，又提供大量实用的学习资源，更有实操性很强的技巧、方法和策略，旨在帮助材料科学及相关研究领域的学习者和科研工作者提高学术写作能力。本教材的内容主要来源于期刊论文，具有一定难度，因此主要面向英语语言能力处于中等及以上水平的材料科学相关专业的学生、科研工作者或相关领域的学术英语教师。

鉴于编者水平有限，如有疏漏和错误之处，恳请广大同仁和读者批评指正。

编　者

2022 年 6 月

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Chapter 1
Introducing Materials Science Articles

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field:

1. How many sections are usually included in a research paper? What are they?
2. What is the purpose of each section?
3. In your opinion, which section is the most challenging to write? Which section is the easiest to write?

1.1 Article Structure

As you may have noticed, a materials science research article generally follows the conventional IMRD structure, namely, Introduction, Methods, Results, and Discussion. Beyond that, it also contains a title, an abstract, several keywords, a conclusion, and supplementary information.

1.1.1 A Concise and Informative Title

The title of a materials science paper is concise but informative. It usually contains the research purpose and key findings of the study. For example, in the title "Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins", we can see that the researchers' purpose is to develop a new pressure sensor based on certain microstructures that are tunable, ultrasensitive, and flexible, and this sensor can be used for electronic skins. It is important to remember that the use of abbreviations and complete sentences in titles is discouraged.

1.1.2 Abstract

The length of an abstract of a materials science paper is usually from 150 to 200 words, unstructured (i.e., no subtitles). The abstract should state the main purpose of the study, the methods used, the main results, and the key conclusion.

1.1.3 Keywords

Like in other research articles, authors need to provide 4 to 6 keywords, which can best summarize the main idea of the study or can be used for indexing purpose. Effective keywords include abbreviations or phrases that may not appear in the title or abstract and that link the work to wider fields of research.

1.1.4 Main Body

The main body of a research article describes the original research, and is typically divided into the following sections:

- **Introduction:** This section provides a concise, up-to-date description of the background to give readers enough context to understand the research being presented and its significance. This section also provides an effective literature review, a specified research gap, a clearly stated research purpose, and a summary of the main results.

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- **Materials and Methods:** This section is sometimes also called "Experimental" or "Procedure", and some journals require the authors to place this part at the end of the research article. In this section, techniques, materials and equipment are described in great detail to show the credibility and validity of the study and to allow readers to replicate the study. Methods that are identical to the published procedures should still be summarized in brief, and the paper should include a citation to the original work.

- **Results and Discussion:** In materials science papers, the Results section is often presented together with the Discussion section. This section presents data or measurements related to answering the central research questions. The Discussion section often involves interpreting the results, comparing the results with previous findings, pointing out the implications of the results, considering their significance, and grounding them into a wider context to make contributions to the field. These two sections are, however, sometimes separated.

- **Conclusion:** A research paper is often ended with a Conclusion section, which states the main conclusions drawn from the research. Authors may also suggest future research directions in this section.

Figure 1.1 presents the overall structure of a materials science paper.

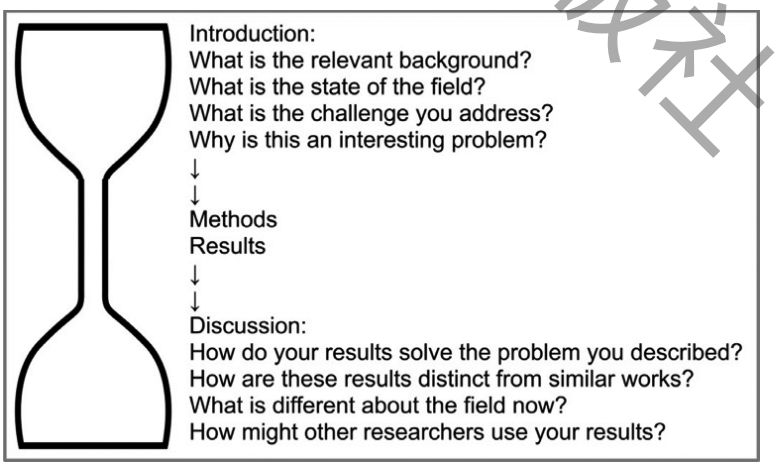

Figure 1.1 The hourglass figure of a scientific manuscript, going from general, to specific, and back to general again, with potential questions to be addressed [Retrieved from Editorial (2019). How to write a compelling (materials) science paper. *Materialia, 6*.]

Other sections include "Acknowledgements", which lists people who contribute to the work but who are not named as authors and funding sources that support the research; and "Supplementary Information", which describes additional information omitted from the main body.

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1.2 Article Content

It should be noted that a well-organized research article is full of repetitions. As you may have noticed, the keywords of the study may appear in the title, the abstract, the Introduction, and the Conclusion for multiple times. The frequent occurrences of the keywords not only remind readers of the core information in this study but also make the article more logical and coherent. For example, in an article titled "Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins", the keywords include *tunable*, *ultrasensitive*, *pressure sensor*, *wrinkled microstructures,* and *electronic skins*, which repeat the key information presented in the title. The abstract also begins with the following information: "Flexible pressure sensors play an important role in electronic skins (E-Skins), which mimic the mechanical forces sensing properties of human skin. A rational design for a pressure sensor with adjustable characteristics is in high demand for different application scenarios. Here, we present tunable, ultrasensitive, and flexible pressure sensors based on compressible wrinkled microstructures." It is clear that the keywords are also repeated in the abstract.

As shown in Figure 1.1, a well-written materials science article is like a hourglass in which the Introduction and Discussion sections are tightly connected through the Methods and Results sections. To be more specific, while the Introduction starts from general background information to the specific research topic, the Discussion starts with the results of this specific topic and extends to a broader scholarly context to highlight the significance of the study. For instance, a research article in materials science often focuses on fabricating a new material or improving a given material's performance to solve a real-life problem. In this case, authors usually start the article with the significance of a research field, followed by a statement of the problem at the current stage, then point out the need for more research to solve the problem, and then propose a new method or approach that can be used to prepare a new material or improve a given materials' performance. The Discussion section, on the other hand, starts with the study itself, demonstrating what has been found in the experiments. Then, authors illustrate how the results could contribute to the broad problem or concern that is raised at the beginning of the article and call for future research.

This chapter simply gives you a general idea of what a research article in materials science should be like. Chapter 2 to Chapter 6 will be devoted to each section respectively, with further details explained.

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1.3 Academic Notes

Before moving next, we would like to say something about how to keep effective academic notes while reading. Writing academic notes helps researchers keep track of relevant literature and form research ideas. Therefore, when taking notes, it is important to distinguish facts from opinions. Facts in this case refer to what a particular study has found, including research method and results. Such information, together with the research purpose, constitutes the main idea of a study. Opinions, on the other hand, are what you think about these findings and results, mainly including your own comments or critiques on a given study. The "facts" that you have recorded in your notes can help you derive new research ideas based on what has been found in previous literature, playing an important role in writing the literature review.

Academic notes can take a variety of forms. Here, we would like to introduce two methods: drawing mind maps and writing summaries.

When reading or writing academic papers, you can draw a mind map. This will not only help you grasp the main idea of a research article and better remember the key information, but also benefit your writing in organizing the paper and synthesizing information from various sources. Figure 1.2 gives you a rough idea of what a mind map looks like, and you can draw mind maps or outlines of your own style.

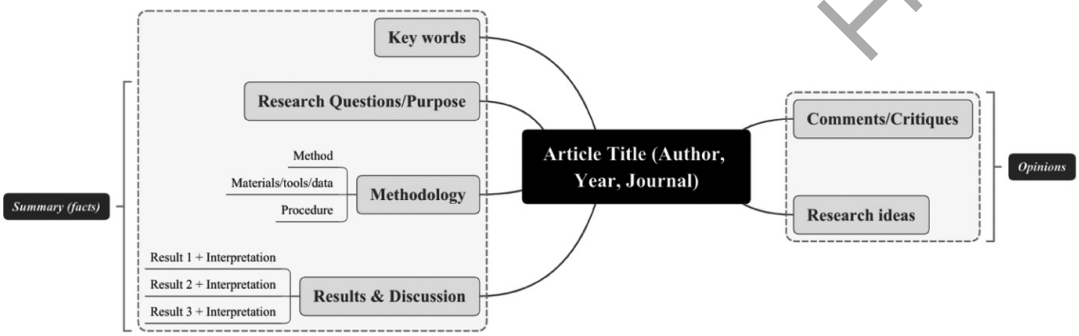

Figure 1.2 Sample mind map

You can also use the following templates to write a summary that captures the main idea of a research paper.

1. Using a(n) _____ (research method/approach), this study/research/work investigated/explored/studied _____ (research purpose/questions/hypotheses). Analyses of data showed that: (1)_____; (2)_____; (3)_____.

2. Adopting a(n) _____ (research method/approach) to investigate/explore/study _____ (research purpose/questions/hypotheses), this study/research found that: (1)_____; (2)_____; (3)_____.

The following rhyme summarizes the main points discussed in this chapter.

论文结构

学术论文有结构，IMRD 不可少。

论文标题很重要，简短概括观点明。

摘要代言最后写，复制粘贴要避免。

引言部分定基调，从宽到窄渐聚焦。

研究方法要具体，可复制性很重要。

研究结果本领大，学术成就全靠它。

讨论结果有依据，由小及大解问题。

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Exercises

I. Read one research paper that you are interested in and try to think about the following questions.

1. How is this paper structured?

2. What sections are included in this paper? How are they named?

3. What kind of information is included in each section?

4. Try to draw a mind map or an outline to illustrate the paper structure and the main idea.

II. Try to summarize the main idea of the paper that you selected in Exercise 1 by using one of the templates introduced in Section 1.3.

III. Decide which section of a research paper the following sentences are most likely to appear in and underline the parts that help you judge.

A. Introduction	B. Methods	C. Results	D. Discussion

_____ 1. Self-powered Nanosystems and stretchable/transparent actuators have been recently demonstrated, but the power sources lack high flexibility and high-density integration.

_____ 2. The amorphous nature of metallic glasses was characterized using DSC (Perkin Elmer Diamond DSC) and XRD (Rigaku Smartlab).

_____ 3. In order to escape the property-processability trade-off, in this paper we combine both of the two above strategies, applying a new processing route (FFF-based 3D printing) to a unique material class (BMGs).

_____ 4. Mechanical characterization was carried out to evaluate the effect of the printing process on the mechanical properties of BMGs.

_____ 5. This suggests that highly formable BMGs can be readily printed under practical conditions even with 0.5mm diameter nozzles, whereas medium range formable BMGs with 0.5–1mm nozzles, and the less formable BMGs only with 2mm nozzles.

_____ 6. In addition to the "thermal conduction path" theory to explain the improvement of thermal conductivity, the synergistic effect of composite fillers was also an important reason to improve the thermal conductivity of composite films.

_____ 7. However, the conventional PI also has the defect of poor thermal conductivity, and it cannot dissipate heat in time when it is used as electronic package or electronic device, which seriously affects the performance and service life of the device.

_____ 8. In particular, capacitive pressure sensors, which transduce mechanical strain into a capacitance change, have attracted much attention because of the advantages of the simple governing equation, low power consumption, and negligible temperature fluctuations.

_____ 9. As expected, there is a nearly linear relationship between them.

_____ 10. The base agent and curing agent of PDMS (Sylgard 184, Dow Corning) were mixed at a weight ratio of 10:1, which was well blended and deaerated via a planetary centrifugal mixer (Thinky, AR-100) for 15 min.

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Chapter 2
Writing the Introduction Section

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field.

1. Is an Introduction the same as a literature review?
2. How does an Introduction usually start?
3. What information is included in an Introduction?
4. With what information does an Introduction end?
5. How are verb tenses and voices used in an Introduction?

2.1 General Introduction

The purpose of an Introduction is to create a research space (i.e., "CARS," Swales, 1990; Swales & Feak, 2012). The CARS model can help to (1) begin the writing process; (2) understand how an Introduction sets the stage for the rest of the paper; and (3) assess how the Introduction fits within the larger scope of the present study. The model proposes three "moves", accompanied by specific "steps" within each move, generally reflecting the development of an effective Introduction of a research paper. These "moves" and "steps" can be used as a roadmap for the reading of research articles and also a template for writing the Introduction of your materials science papers so that you can present your arguments more clearly and convincingly.

Authors may start the Introduction by describing the problem to be solved or the aim of a study, but this is not how most research papers begin. As suggested by many journal editors working in the field of materials science, a scientific manuscript should be shaped like an hourglass (see Figure 1.1). It should start general at the beginning, become more specific in the middle, and then become more general again in the end. Therefore, the Introduction should go from general to specific and is the place for contextualizing the topic and the study. Authors must explain why this research topic is interesting and meaningful. Correspondingly, the Discussion should go from specific to general, and is the place for contextualizing the results that were obtained from the study. Authors must explain why the results are significant by comparing their results with those of the related studies and suggesting their implications.

The CARS model follows such a format to start an Introduction. Next, we will explain the CARS model in greater detail, use the CARS model to analyze an Introduction section of a materials science paper, and introduce some useful expressions in each move. The expressions were all extracted from authentic materials science research papers.

2.1.1 Move 1: Establishing a Research Territory / the Situation

In this move, authors set the context for the research, providing necessary background on the research topic. This is generally accomplished by demonstrating that a general area of research is important, critical, interesting, relevant, or worthy of investigation and by pointing out what the current literature fails to address so that further efforts are needed. This move includes one or more of the following steps:

- **Step 1:** Claiming importance. In this step, authors often highlight the importance of a general topic dealt with in the current paper with specific reasons, such as "Thermal stability is one of the important properties for the composites in processing and application because…"

- **Step 2:** Making topic generalizations. In this step, authors make statements about the current knowledge, practices, or problems of a specific subfield of the general topic mentioned in Step 1.

- **Step 3:** Reviewing previous research. In this step, authors organize and incorporate what has been found on the topic presented in Step 2 by writing "Several studies have suggested that…" This way of organizing and incorporating previous literature is known as *synthesizing*, the basis of writing a literature review. To organize multiple literature sources in a logical way, different structures can be adopted, which can be summarized as "4C": Climactic order (i.e., literature is organized from introducing the general background to focusing on a specific focus), Chronological structure (i.e., literature is organized in a time order), Comparison and Contrast, and Classification (高原、于华、姜文东，2019).

2.1.2 Move 2: Identifying a Niche or a Gap

In this move, authors may argue that there is an open "niche" or gap in the existing literature, a space that needs to be filled through additional research. The niche can be established in one of the four ways, which can be summarized in four letters—UCAS:

- **a:** Question-raising, meaning something in the current literature is unclear (U). The authors ask questions about previous research or identify a problem in prior research, suggesting that additional research needs to be done to clarify certain aspects by writing, for example, "While X has been established in previous studies, these findings raise a number of questions, including…". Authors can also challenge earlier research by writing "While X is believed to be accurate, a close examination demonstrates X to be flawed".

- **b:** Indicating a controversy, meaning the findings regarding a certain topic in the current literature is controversial (C).

- **c:** Continuing a tradition, meaning something needs to be added (A) to the current literature. The authors present the research as an extension of the existing research by writing, for instance, "Earlier studies seemed to suggest X. To verify this finding, more work is needed."

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- **d:** Indicating a gap, meaning something is scarce (S) or limited in the current literature.

It should be noted that the literature review and research gap do not necessarily follow a linear sequence in which previous findings are thoroughly reviewed and then research gaps are identified. Rather, they are often presented in an alternating pattern in which they occur in pairs so that more previous findings may be reviewed after one research gap is presented, and followed by another research gap. However, a research gap should always be based on the literature review, narrowing the scope of the paper to the topic investigated in the present research.

2.1.3 Move 3: Occupying That Niche

In this move, authors turn the "niche" identified in Move 2 into the research space that they will fill; that is, authors demonstrate how they will substantiate the counter-claim made, fill the gap identified, answer the question(s) raised, or continue the research tradition. This move can be achieved in several steps, which are described below:

- **Step 1a:** Outlining purposes. The authors indicate the main purpose(s) of the current study and answers the "so what" question by writing "The present research aims to..."
- **Step 1b:** Announcing present research. The authors describe what the research is going to do or accomplish by writing "Here we report the results of the application of…" or "In this paper, we develop an effective way to…" This step is more commonly adopted in materials science papers.
- **Step 2:** Announcing main findings. The authors present the main results or conclusions of their research by writing "It was found that…", "Aside from X, Y is demonstrated", or "Furthermore, the results clearly show that…"

2.2 Verb Tense

As you may have noticed from the examples above, different verb tenses are used in writing the Introduction section, namely, simple present tense, simple past tense, and present perfect tense. In English, verb tenses often denote meaning. Therefore, appropriate verb tenses should be used by writers to convey specific meanings.

2.2.1 Simple Present Tense

The simple present tense is used in materials science papers to present common sense knowledge and widely accepted facts. In the Introduction section, the research background is usually written in simple present tense because it often presents a broad concept or widely

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accepted phenomenon on which the present study is based. In the following examples, you may find that when presenting well-accepted factual knowledge, authors often use simple present tense (i.e., the boldfaced parts):

1. Electronic skins (E-skins) ***emulate*** *the human sophisticated somatosensory system by transducing physiological signals into electrical signals and* ***has*** *great application potential in intelligence robots, biomimetic prosthetics, health monitoring, and various wearable devices. As an essential component of E-skin, pressure sensors* ***mimic*** *the human skin's perception of pressure. There* ***are*** *different types of sensory receptors with varied size, shape, number, and distribution to realize different characteristics of pressure perception in different areas of skin. For example, the skin on the fingers and the skin on the body* ***possess*** *different range of receptive field and sensitivity. To mimic the pressure-sensing properties of human skin, pressure sensors with different sensitivities and pressure ranges* ***are*** *essential for different application scenarios and functions. Realizing controllable structures to achieve a tunable sensitivity and pressure range* ***provides*** *a solution.*

2. Generally, elastomers ***are adopted*** *as dielectric materials for their great elasticity and compressibility, which strongly affects the sensitivity and working range of a capacitive sensor. However, the viscoelastic nature of elastomers usually* ***results in*** *significant hysteresis and long relaxation times.*

2.2.2 Simple Past Tense

Simple past tense is often used to refer to specific studies or particular findings, as shown in the following examples:

1. Recently, our group ***reported*** *a nonflammable electrolyte for sodium batteries with fluoro-substituted ether.*

2. Perez-Bergquist et al. ***found*** *that Young's modulus and nanoindentation hardness both decreased by 20% from the centre to the surface, which indicates a gradient rejuvenated amorphous structure (GRAS) from the interior to the irradiated surfaces. A similar experimental study conducted by Bian et al. also* ***revealed*** *an irradiation dosage-dependent softening, which is associated with the change of the glassy structures by increasing the free volume content.*

3. For example, staggered microstructures inspired from bones ***were printed*** *with a multi-material printer, realizing over 10 times increase in fracture energy under static tensile loading. Similar methods* ***were used*** *to study the role of osteon shape, interfacial waviness, and mineral bridges, uncovering the design motifs of biomaterials.*

In Examples 1 and 2, the authors refer to specific studies (e.g., "our group", "Perez-Bergquist et al.", and "Bian et al."), and in Example 3, the authors refer to specific methods adopted in previous studies (e.g., "staggered microstructures inspired from bones", and "similar methods").

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In these cases, simple past tense is often used. In addition, the last part of the Introduction section usually summarizes the research method and key findings of the present research. In this part, past tense is often used, as shown in the following examples:

4. Guided by the experimental results and the basic principle, hollow structures ***were introduced*** *in the wrinkled microstructure to further reduce the elastic resistance, resulting in an ultrahigh sensitivity of 14.268 kPa^{-1}.*

5. In addition, the pressure sensor ***demonstrated*** *a quite low detectable pressure limit (1.5 Pa), a fast response time (<50 ms, which was comparable with the temporal resolution of human skin), and an excellent cycling stability (10,000 cycles at 0.15 kPa). The capability of monitoring the respiratory rate and recognizing different words* ***was demonstrated*** *by adhering the sensor onto the chest and throat, respectively, showing its promising application potential for disease diagnosis and prosthetics.*

2.2.3 Present Perfect Tense

Present perfect tense in the Introduction section is to indicate the current status of a research inquiry. The subject of the sentence is often an area of study, as shown in the following examples:

1. Recently, pressure sensors based on piezoresistivity, capacitance, or piezoelectricity, or integrated with a field-effect transistor structure ***have demonstrated*** *high sensitivity and great flexibility. In particular, capacitive pressure sensors, which transduce mechanical strain into a capacitance change,* ***have attracted*** *much attention because of the advantages of the simple governing equation, low power consumption, and negligible temperature fluctuations.*

2. To improve the performance, constructing elastomers with a porous structure ***has been conducted*** *to reduce the viscoelastic behavior and to further enhance the compressibility. Additionally, elastomers with a regularly or irregularly microstructured surface* ***have been fabricated*** *with an adjustable morphology for sensitivity and/or working range modifications.*

2.3 Sample Analysis

In this section, we will analyze a sample Introduction taken from a research article titled "Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins" to illustrate what has been covered so far. For ease of reference, the sentences are numbered.

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Title: Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins	
Excerpts	**Comments**
① Electronic skins (E-skins) emulate the human sophisticated somatosensory system by transducing physiological signals into electrical signals and has great application potential in intelligence robots, biomimetic prosthetics, health monitoring, and various wearable devices.	**Move 1: Establishing a Research Territory** ***Step 1: Claiming Importance*** Sentence ① provides a general background of the research topic (i.e., electronic skins) and highlights its significant application potential in many areas. Simple present tense is used in this sentence.
② As an essential component of E-skin, pressure sensors mimic the human skin's perception of pressure. ③ There are different types of sensory receptors with varied size, shape, number, and distribution to realize different characteristics of pressure perception in different areas of skin. ④ For example, the skin on the fingers and the skin on the body possess different range of receptive field and sensitivity. ⑤ To mimic the pressure-sensing properties of human skin, pressure sensors with different sensitivities and pressure ranges are essential for different application scenarios and functions. ⑥ Realizing controllable structures to achieve a tunable sensitivity and pressure range provides a solution.	***Step 2: Making Topic Generalization*** In Sentences ②–⑥, the authors make statements about the current knowledge on pressure sensor, an essential component of electronic skin, pointing to the significance of controllable underlying structures to realize tunable sensitivity and pressure ranges for electronic skin to achieve various applications and functions. In this step, the authors narrow down the discussions from electronic skins to pressure sensors. Again, simple present tense is used.
⑦ Recently, pressure sensors based on piezoresistivity [citation], capacitance [citation], or piezoelectricity [citation], or integrated with a field-effect transistor structure [citation] have demonstrated high sensitivity and great flexibility. ⑧ In particular, capacitive pressure sensors, which transduce mechanical strain into a capacitance change, have attracted much attention because of the advantages of the simple governing equation [citation], low power consumption [citation], and negligible temperature fluctuations [citation].	***Step 3: Reviewing Previous Research*** In Sentences ⑦–⑧, the authors synthesize what has been done to realize controllable structures in previous research, such as pressure sensors based on piezoresistivity, capacitance, and piezoelectricity, etc. Present perfect tense is used to introduce previous research. In addition, when reviewing previous findings, the authors adopt a classification order to organize previous findings. Specifically, the previous works cited in this literature review are categorized based on different structures

(Continued)

Excerpts	Comments
	that have been realized in others' studies. This way of organizing and incorporating previous literature is known as *synthesizing*, the basis of writing a literature review. After displaying a variety of structures, authors focus specifically on the capacitive pressure sensors with Sentence ⑧. When introducing the advantages of capacitive pressure sensors, the authors also adopt a classification order to combine relevant findings and list the advantages in a logical way. Again, the discussion is narrowed down to the underlying structures to make desired pressure sensors.
⑨ Generally, elastomers are adopted as dielectric materials for their great elasticity and compressibility, which strongly affects the sensitivity and working range of a capacitive sensor. ⑩ However, the viscoelastic nature of elastomers usually results in significant hysteresis and long relaxation times. ⑪ To improve the performance, constructing elastomers with a porous structure has been conducted to reduce the viscoelastic behavior and to further enhance the compressibility. ⑫ Additionally, elastomers with a regularly or irregularly microstructured surface have been fabricated with an adjustable morphology for sensitivity and/or working range modifications. ⑬ However, they either require a high cost, complicated manufacturing process, or possess less controllability.	**Move 2: Identifying a Research Gap** The authors address the research gap by raising their concerns about using elastomers as dielectric materials in making the capacitive sensor. In Sentence ⑩, the authors use "However" to signal the research gap that points out the problems associated with using elastomers. The authors further review an improved elastomers with a porous structure to overcome the above-mentioned problems in Sentences ⑪ and ⑫, then raise another question about this method in Sentence ⑬. Obviously, the authors review the previous research and present the research gap in an alternating pattern, progressively pointing to the present research.
⑭ Here, we report a tunable, ultrasensitive and flexible capacitive pressure sensor based on a wrinkled polydimethylsiloxane (PDMS) microstructure via a feasible low-cost fabrication approach. ⑮ The wrinkled microstructure is replicated from a reusable PDMS mold fabricated by releasing a prestretched PDMS film treated with ultraviolet ozone (UVO).	**Move 3: Occupying the Research Niche** ***Step 1: Announcing the Present Study*** The authors occupy the niche by announcing the present research in Sentence ⑭, and briefly summarize the research method adopted in Sentence ⑮. Simple present tense is used.

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(Continued)

Excerpts	Comments
⑯ The sensitivity and working range of the sensor can be tuned independently through geometry modifications of the PDMS microstructure by adjusting the PDMS mold in a well-controlled manner. ⑰ Guided by the experimental results and the basic principle, hollow structures were introduced in the wrinkled microstructure to further reduce the elastic resistance, resulting in an ultrahigh sensitivity of 14.268 kPa^{-1}. ⑱ In addition, the pressure sensor demonstrated a quite low detectable pressure limit (1.5 Pa), a fast response time (<50 ms, which was comparable with the temporal resolution of human skin), and an excellent cycling stability (10,000 cycles at 0.15 kPa). ⑲ The capability of monitoring the respiratory rate and recognizing different words was demonstrated by adhering the sensor onto the chest and throat, respectively, showing its promising application potential for disease diagnosis and prosthetics.	***Step 2: Announcing Main Findings*** As the last part of the Introduction section, the authors present the main findings from their research, providing a synopsis of the main idea of their study. As seen, simple past tense is used in this step.

Figure 2.1 schematically illustrate the overall structure of the sample Introduction analyzed.

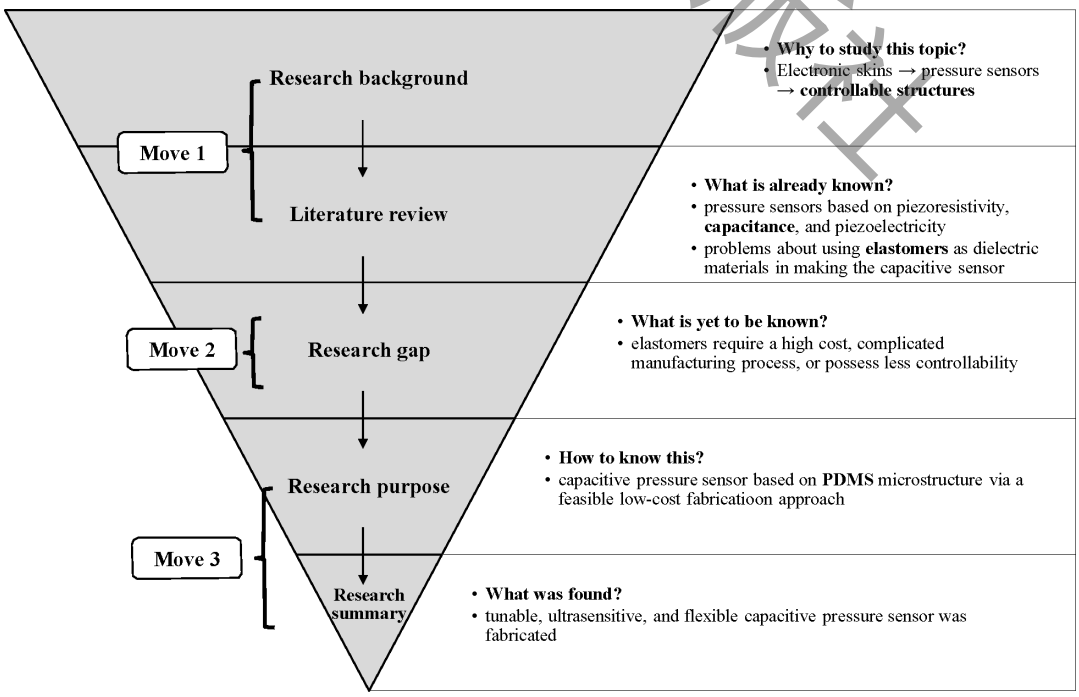

Figure. 2.1 An illustration of the structure of the sample Introduction

As shown in the sample analysis, materials science papers follow a rather conventional way of organizing and presenting information. As shown in Figure 2.1, the article first starts with a general concept (i.e., electronic skins) and then narrows down to one specific topic in this area (i.e., pressure sensors). Then, relevant previous studies are reviewed to show what has been done to realize controllable structures to make effective pressure sensors. According to this body of research, capacitive pressure sensors (i.e., capacitance-based pressure sensors) have been shown to have some advantages. In a recent study, elastomers were adopted as dielectric materials to make capacitive sensor, but the outcomes are unsatisfactory (e.g., high cost, complicated manufacturing process, less controllability), which serves the research gap of this study (Move 2). In Move 3, the authors summarize their methods and findings.

Notably, this Introduction forms a funnel shape, with more general information presented first and followed by more specific information within the general topic. By tracing the bolded texts in Figure 2.1 (i.e., controllable structures → capacitive pressure sensors → elastomers → PDMS), we get to know what the research focus of the present study is. In addition, each step is always built upon the previous step, making the information logically connected.

To conclude, the Introduction section shows readers the quickest route to get into the present study without providing additional irrelevant information about the research.

2.4 Useful Expressions

In this section, useful expressions in each move and step are provided.

Move 1: Establishing a Research Territory

Step 1: Claiming Importance

* *In recent years, researchers have become increasingly interested in X.*
* *X is emerging as a promising technology that may revolutionize our future life.*
* *A primary concern of…is X.*
* *X is a key issue/factor/aspect in…*
* *X is a key feature/element/indicator/component/determinant/mechanism of…*
* *X faces inherent safety concerns due to…*
* *X attracts much experimental research effort due to its fundamental and technological importance.*
* *X has been / is widely used in…*

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* *A central issue in…is the validity/application/commercialization of X.*
* *X is critical/fundamental for…due to…*
* *X is an important/ideal component in…, and plays a key role in…*
* *X are crucial components of…used in a wide range of…, including…*
* *…is increasingly recognized as a serious, worldwide…concern.*
* *With the increasing demands of…for applications like…, technologies that can…have been investigated intensively in recent years.*
* *X and Y are highlighted to be one of the major global problems for modern society.*
* *Along with the development of emerging technologies and products such as…, X is becoming necessary.*
* *In recent years, X have received increasing interests for their extensive application potentials in the fields of…*
* *As a promising…technology, X shows merits of…, compared to other…technologies.*

The following table summarizes more expressions to highlight the importance of a topic.

X	*plays a(n)*	*key* *vital* *major* *crucial* *central* *essential* *important* *significant* *fundamental*	*role in*	*reducing…* *preventing…* *addressing the issue of…* *the transmission of…* *the development of…* *the fabrication of…* *the application of…*

Step 2: Making Topic Generalizations

* *This leads to a proliferation of studies that…*
* *Recent developments in the field of…have led to an interest in…*
* *Extensive works focus on…*
* *The role of X in…has received increased attention in…*
* *As one of the emerging…materials, X has attracted much attention due to…*
* *Several theoretical models have been proposed to describe how…*
* *The complexity of…and variation in…raise questions of considerable interest for…*
* *X has been extensively researched/widely studied due to…*
* *It is now generally accepted that…*
* *There is a growing body of literature recognizing the importance of…*

* *Recent work/research on X suggests that...*
* *Recently, it has been suggested/demonstrated/shown that...*
* *Recent research on X has made great strides towards...*
* *Recently, advances have been made in...*
* *Up to now, various techniques have been used to prepare X.*
* *One core challenge is to provide…for these…components without sacrifice of…*
* *How to use…efficiently has become a popular research topic.*
* *X, such as…, are receiving intensive attention due to…*
* *For this reason, …is highly desirable.*
* *X still depends on the traditional chemical battery, which carries risks to…*
* *Enhancing the performance of X also confronts challenges to the existing framework of X.*
* *X presents a promising application in areas such as…*

Step 3: Reviewing Previous Research

A. Making transitions to the literature review

* *Considerable evidence has supported/suggested that…*
* *Much research has been devoted to…*
* *Empirical studies have examined/investigated…[research topic]*
* *Research on X has highlighted/suggested/reported/shown that…[research results]*
* *Previous/several studies of X have identified…*
* *Research on X has highlighted/suggested that…*
* *There exists a vast body of research on X.*
* *A number of recent studies have examined / looked into the role of…in…*
* *Recent studies have addressed the issue of…*
* *Previous studies have examined/investigated the impact/effects of…on…*
* *A growing body of research has investigated…*
* *A great deal of previous research into X has focused on…*
* *A considerable amount of research has been published on X. These studies…*
* *To date / Thus far / Up to now, several studies have reported that…*
* *Only in the past ten years / two decades have studies of X directly addressed…[research topic]*
* *In previous studies, great efforts have been made to improve…*
* *Due to its importance in industrial applications, the relationship between X and Y upon…has been intensively studied by both theoretical and experimental research.*
* *Many modified methods, such as…, have been used to improve…, and to increase*

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thermal conductivity of the composites.

The following table summarizes more expressions to make transitions to the literature review.

Recently,	*there has been*	*growing scholarly attention on…*
More recently,		*a growing/increasing interest in…*
In recent years,		*extensive research on…*
		increased emphasis on…
		growing recognition of…
		a growing number of publications focusing on…
		a great focus placed upon…

B. Reviewing specific studies

* *[citation] showed/illustrated/found/demonstrated/concluded/discussed/reported that…*
* *According to [citation],…*
* *In [citation], researchers adopted a…approach to…*
* *[citation]'s investigation/discussion/observation of X illustrates that…*
* *[citation] believes / proposes / points out / argues that...*
* *[citation] attributes...to...*
* *As reported / demonstrated / showed / revealed / pointed out by [citation], …*
* *In a recent study by [citation], …*
* *Similar findings were / have been reported by [citation].*
* *Similarly, [citation] found that...*
* *..., which is similar to the [citation]'s results/findings.*
* *Additional support for this explanation/point comes from [citation].*
* *An alternative approach/method, suggested by [citation], is...*
* *[citation] was one of the first to examine X.*
* *[citation] performed the first study that…*
* *X was first reported by [citation] in [year].*
* *By far, the most detailed/thorough/complete/influential/systematic study of X is the work of [citation].*
* *[citation]'s seminal work on…is particularly relevant.*
* *We previously reported that…*
* *Recently, our group reported…*
* *[citation] has shown advantages of…, which renders as a potential solution to…*

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* *Recently, X has been synthesized for the first time since being proposed as a(n)…60 years ago.*
* *Very recently, X has been the subject of several studies: [citation 1] observed that…, whereas [citation 2] showed that…*

C. Commenting on previous studies

* *Current research seems to indicate that…*
* *It has been noted/argued/shown/assumed/reported/suggested/established that…*
* *From these studies, it is clear that...*
* *This is an interesting finding because it...*
* *Taken together, these studies indicate that…*
* *Overall, these studies highlight the need for…*
* *The evidence presented here suggests/illustrates that…*

Move 2: Identifying a Niche or a Gap

a: Question-raising

* *The disadvantage of this approach is that...*
* *One of the main obstacles to…is…*
* *…is a major problem in…*
* *One of the greatest challenges is…*
* *Despite its effectiveness in…, X has a number of problems.*
* *There is an urgent need to address the safety problems caused by…*
* *Despite its safety and efficacy, ...suffers from several major drawbacks: First,…; Second,…*
* *Despite the progress made in…, there is increasing concern over…*
* *The study makes several / a number of important contributions to..., but…*
* *Although much important work has been carried out on X, a number of questions remain.*
* *Although considerable progress has been made in..., many important issues remain unexplored/unresolved/unaddressed.*
* *The enhancement of X is mainly restricted by two issues. The first one is…, and the other is…*
* *Although there are many reports on…, most are restricted to…*
* *Previous published studies are limited in…*
* *What remains unclear/unknown, however, is why/how/whether…*
* *Therefore, it remains an open question what/whether/how/why…*

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* *The findings suggest that this approach might be less effective when…*
* *The results should be treated with caution.*
* *The existing literature on X fails to consider the impact of… / the reason for… / several key aspects of… / the possible effects of… / the underlying causes of…*
* *Most of the work performed on X ignores the possibility that…*
* *The practical application of X imposes a challenging requirement to improve…, which is closely related to…*
* *X is a relatively facile method that is widely adopted, which can…However, the acquired…are not stable and are restricted to…*
* *However, …have very high…but low…, which limits their practical applications.*
* *From the above analysis, it was known that increasing X was at the cost of Y. To improve this point,…*
* *Results from [citation] indicate that…, but it is questionable whether…*
* *It is difficult to predict a priori whether X would lead to…*
* *Previous research/studies/results lacked…*
* *Previous research/studies neglected/overestimated/underestimated/overlooked the role/importance/issue of X.*
* *The evidence points to…However, the role of X is still inadequately understood.*
* *The mechanism by which...is unknown/not well understood.*
* *Although efforts have been spent on improving these weaknesses, the efficient and effective method has yet to be developed.*
* *[citation]'s main assumption that...is problematic.*
* *...is not yet clearly/completely/well understood.*
* *Previous research in the field of…has been restricted to…*
* *Existing research has largely focused on X, but has failed to explore Y.*

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The following table summarizes more expressions to raise questions to previous studies.

The extent to which	*X affects Y* *X influences Y* *X determines Y* *X is related to Y* *X plays a role in Y* *X contributes to Y* *X benefits from Y*	*is (still)* *remains*	*unclear.* *unknown.* *poorly understood.* *not yet fully/clearly/completely understood.*

b: Indicating a controversy

* *These studies have emphasized…, as opposed to [citation].*

* *While there is a general agreement on…, there is considerable disagreement on…*
* *There is little agreement on the causes of X.*
* *Although it is widely accepted that…, …remains controversial.*
* *This contrasts with [citation] who found that...*
* *In contrast, a study of... found/reported/showed that...*
* *However, this interpretation has recently been challenged.*
* *Although earlier work/results suggested that..., subsequent studies have shown that...*
* *Controversy remains regarding...*
* *Other researchers have also called for...*
* *The evidence for...is inconclusive.*
* *These results are unsatisfactory/controversial because…*

c: Continuing a Tradition

* *To re-examine/revisit the long-standing issue of / the long-standing question that…*
* *Building on earlier research, we…*
* *X merits further study/investigation.*
* *X deserves further consideration.*
* *X is worth examining more closely.*
* *The issues warrant further discussion.*
* *X is worth exploring further.*
* *X has not yet been fully addressed.*
* *X deserves more research attention.*

d: Indicating a Gap

* *However, little work/research has focused on / investigated / be conducted on...*
* *However, few studies/investigations have focused on / attempted to / studied…*
* *There is limited research investigating…*
* *Little is known about…*
* *Few attempts have been made to investigate the role of X in…*
* *However, few studies/attempts/researchers have…*
* *However, research on…for X is seldom conducted.*
* *Few studies have addressed…*
* *Up to now, little attention has been paid to the role of X in…*
* *Despite/In spite of…, little is known about…*
* *Although considerable research has been devoted to X, less attention has been paid to Y.*
* *While there has been a great deal of research on X, very few studies…*

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* *There is as yet no clear evidence of / consensus on…*
* *Research in this area has been limited...*
* *While/Although some research has been performed on…, the mechanism by which… has not been established.*
* *The effect of X on Y has not been examined in detail.*
* *To date, however, these has been no/little clear/reliable/empirical proof/support/evidence that…*

Move 3: Occupying That Niche

Step 1a: Outlining Purposes

* *This study was carried out / conducted / undertaken to examine / investigate / determine…*
* *To examine/explore the relationship/link between X and Y, we…*
* *This paper provides data / detailed information on…*
* *The (primary) aim of this paper is to analyze the effects of… / examine the way in which… / evaluate the rationale behind…*
* *A major goal of this study is to extend the utilization of a recently developed procedure for X.*
* *An objective/goal/purpose/aim of this study is to investigate/determine the effect of… / evaluate the effectiveness of… / identify the characteristics of… / assess the impact of X on Y / discuss the extent to which…*
* *This study aimed to / sought to / set out to explore/determine whether…*
* *Our primary objective in this paper is to provide…*
* *Our main goal is/was to gain a better understanding of the mechanism underlying…*
* *The main purpose of the experiment reported was to…*
* *This paper aims at giving a comprehensive review of the available information about X, with special focus on…*
* *With the aforementioned background, the focus/aim of the present work is twofold: (1)… and (2)…*
* *Therefore, it is necessary to synthesize…materials with novel structures in order to develop and broaden the applications of…*

Step 1b: Announcing Present Research

* *Here, X and Y were fabricated/prepared using…*
* *We examined the role of X in…*
* *To verify the role of X in…, we…*

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* *To directly observe…, we…*
* *This paper provides findings from…*
* *…simulation has been conducted to clarify…*
* *We now report the interaction between…*
* *In this paper, we give preliminary results for…*
* *In the present study/work, we proposed a series of solutions for… / analyzed… / successfully prepared… / tested the hypothesis that… / directly observed… / simulated… / controlled…*
* *X was carried out to improve Y and therefore the output performances of Z.*
* *Here, we report on a practical, ultraflexible X, which can…*
* *To develop a…method to enhance…, X with features of…is proposed in this work.*
* *X combined with Y were performed to reveal the…process.*
* *…were carried out to validate and interpret the experimental observations.*
* *We used X solutions of varying concentrations as the dealloying medium, and found that…*
* *This study presents a successful synthesis and formation mechanism of X, consisting of…*
* *To improve this point, X was used as…to achieve the same level of thermal conductivity.*
* *The surface of X was modified with Y to investigate whether it had a positive effect on the improvement of…*
* *Using…techniques, detailed analyses have been performed to assess…*
* *A series of PI composites with X and Y particles were prepared by…*
* *The thermal conductivity and insulating property of the X composites with different Y contents were investigated.*
* *So in this work, X was introduced to functionalize the surface of Y to enhance…*
* *In this study, conventional TEM characterization was applied in…condition to compare…*
* *Therefore, in this work, a series of Xs were prepared by…*
* *X was observed and analyzed by X equipped on a Y.*

Step 2: Announcing Main Findings

* *The mechanical energy of…was successfully converted into electricity by…*
* *X was demonstrated to…without extra…*

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* *In this paper, we demonstrated a(n)… that consists of…, which can be used to simultaneously harvest mechanical thermal.*
* *…are successfully demonstrated/prepared/fabricated using…*
* *By X, …can be achieved through…*
* *With rationally designed structure, this device can achieve…, which has potentials to be further evaluated in the future, presenting a promising strategy to greatly enhance… for practical applications.*
* *It was found/observed that…*
* *In this study, we reformulate…and incorporate them into…, investigating the effect of X on Y.*

2.5 Checklist for Writing the Introduction Section

Swales (1990) pointed out some common pitfalls when writing the Introduction section: (1) containing unnecessary background or repetitive information; (2) exaggerating the importance of the present study; (3) providing no context for the study to be grounded; and (4) not focusing on a clear and compelling research question or hypothesis. The following checklist may be beneficial to check your Introduction after writing this section:

- Have you stated the topic and the purpose of the research clearly, concisely, and logically?
- Does the Introduction effectively introduce the research focus by providing enough background information or reviewed all the relevant literature?
- Have you expressed everything as concisely and briefly as you can?
- Have you given enough background information and reviewed all the relevant literature?
- Does the Introduction effectively follow the CARS model?
- Are appropriate verb tenses are used?

Before writing your Introduction, you can also make an outline to organize your thoughts. Figure 2.2 gives you an idea of how to make such an outline.

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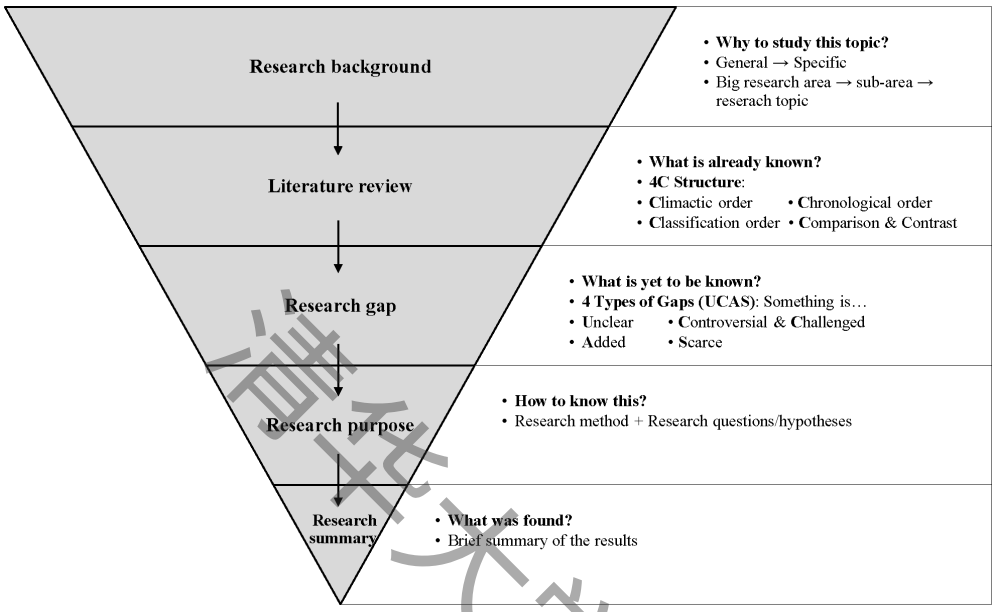

Figure 2.2 A sample outline for writing the Introduction section

The following rhyme summarizes the essence of the Introduction section, and you can refer to it when reviewing this chapter.

引言

引言是位领路人，指引方向到正文。

引言细分五步走，研究背景做开头。

先说学科大领域，逐步聚焦到论题。

文献回顾很重要，善用结构重条理。

研究空白定基调，研究目的紧随行。

最后再把结论说，研究意义是点睛。

引言写作靠思辨，论点论据要分清。

研究问题是论点，前人研究为论据。

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Exercises

I. Follow the CARS model to analyze the following Introduction section taken from a paper titled "Nonflammable Electrolyte for Safer Non-aqueous Sodium Batteries" and fill in the blanks with relevant information.

Title: Nonflammable Electrolyte for Safer Non-aqueous Sodium Batteries	
Excerpts	**Comments**
① Sodium batteries, with abundant sodium sources (2.64 wt% in the earth's crust) and low standard potential (-2.71 V), have been considered as low-cost alternatives to lithium-ion batteries for large-scale electric storage applications.	**Move 1:** _____ ***Step 1:*** _____ **Analysis:** _____
② The current sodium batteries are composite of flammable, voltage-sensitive carbonate-based electrolytes and highly reactive electrodes, which might cause serious hazards such as fire and explosion under abuse-testing conditions, for example punch, heat, crash, etc. ③ Safety concerns are the key hindrance in the further application of sodium batteries. ④ Dahn's group has studied the reactivity of carbonate electrolyte with oxide cathodes and carbon-based anodes using Accelerating Rate Calorimetry: Their results showed that the exothermic reactions with carbonate electrolytes start at 115 ℃ for $Na_{0.35}CoO_2$[3] and 120 ℃ for Na_xC.[4] ⑤ To solve these problems, introducing flame-retarding additives may be the most economic and efficient way.	***Step 2:*** _____ **Analysis:** _____
⑥ A large number of flame-retarding additives have been included in nonflammable electrolytes for lithium batteries since the first report by Wang et al. using trimethyl phosphate in 2001. ⑦ Among these additives, phosphazene-based additives are reported to have the best flame-retarding efficiency and electrochemical compatibility. ⑧ It has been reported recently by Xia that only 5 wt% PFPN addition can make the electrolyte totally nonflammable. ⑨ However, research on flame-retarding additives for sodium batteries is seldom conducted. ⑩ Recently, our group reported a nonflammable electrolyte for sodium batteries with fluoro-substituted ether.	***Step 3:*** _____ **Analysis:** _____

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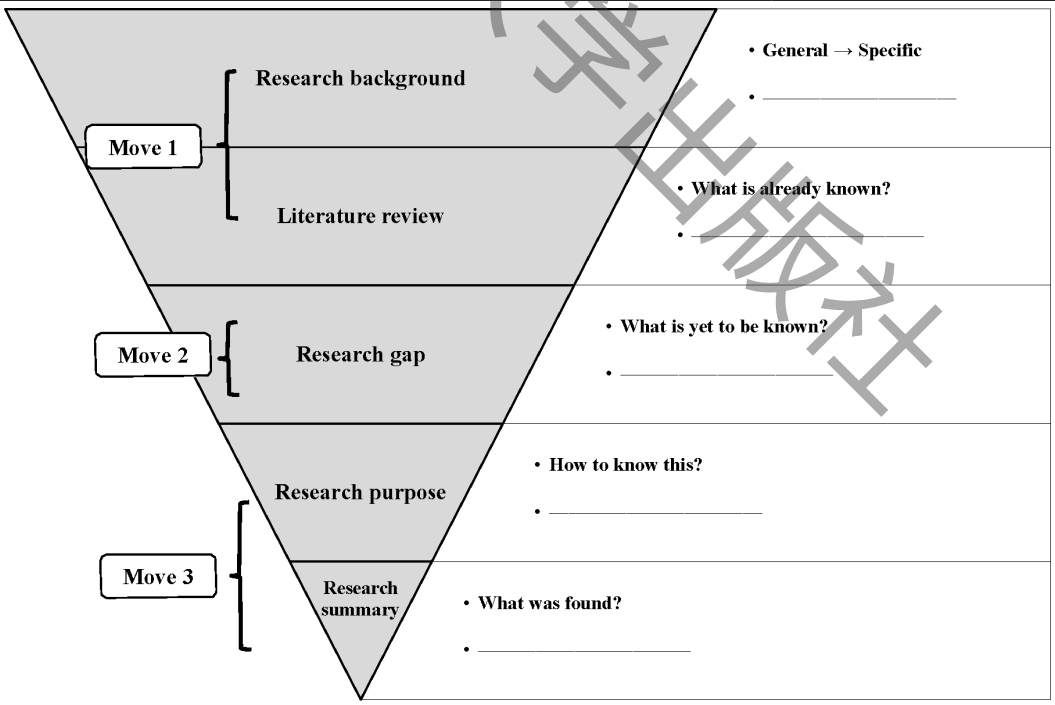
(Continued)

Excerpts	Comments
⑪ However, the ionic conductivity of the ether-based electrolyte is relatively low (～0.5 mS cm^{-1}), which restricts its practical application.	**Move 2:** _____ **Analysis:** _____
⑫ Based on the previous studies, ethoxy(pentafluoro)cyclotriphosphazene (EFPN) was selected as a flame-retarding additive for sodium batteries due to its high boiling point (125 ℃), low viscosity (1.25 mPa s at 25 ℃) and high flame-retarding efficiency.	**Move 3:** _____ ***Step 1:*** _____ **Analysis:** _____
⑬ It was found that EFPN-containing electrolyte was stable towards sodium and only 5% EFPN addition caused the common sodium electrolyte to become nonflammable. ⑭ Moreover, the cyclability of both the acetylene black (AB) anode and the $Na_{0.44}MnO_2$ cathode were improved.	***Step 2:*** _____ **Analysis:** _____



II. Follow the CARS model and reorganize the following scrambled sentences into the correct order.

A. Besides, transmission electron microscopy (TEM) indicated that the solid-phase reaction at high temperature contributed to the threading dislocation reduction by allowing the columnar AlN to recrystallize. The surface morphology transformed from high-density

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island structure to step-and-terrace morphology. X-ray photoelectron spectroscopy (XPS) measurement indicated that the thermal annealing process decreased O and C impurities on film surface.

B. It is expected that the application of sputtered AlN template can significantly reduce the epitaxial growth cost in MOCVD or MBE. However, the sputtering technique suffers from high-density threading dislocations in AlN, limiting performance of UV devices. Hence, improving the crystalline quality of sputtered AlN is essential.

C. Thermal annealing is an important approach to improve crystal quality of AlN. Defect reduction in MBE- and MOCVD-grown AlN by high-temperature thermal annealing has been reported. Kar et al. found that the morphology, crystallinity and electrical properties of sputtered AlN film were improved by post-deposition annealing at 400–800 °C in nitrogen ambient. Miyake et al. have studied the annealing of thin sputtered AlN films at 1500–1750 °C in N_2 and the full widths at half maximum of the (0002)- and (1012)-plane X-ray rocking curves (XRCs) were improved to 49 and 287 arcsec, respectively.

D. Despite impressive crystal quality and surface morphology improvements, details on surface compound composition, film strain and optical transmissivity of the annealed AlN films, which have great influence on the epitaxial device performance, have not been clearly discussed in that article.

E. Recently, Susilo et al. obtained 268-nm DUV LEDs grown on thermal-annealed sputtered AlN on sapphire. Our group also realized AlGaN-based UV LEDs on sputtered AlN on sapphire, without AlN regrown by MOCVD.

F. AlN is one kind of indispensable semiconductor materials for deep ultraviolet (DUV) photoelectronic devices and high-power electronic devices due to its ultra-wide band gap, high break down voltage and high thermal conductivity.

G. In this paper, we performed comprehensive study on the thermal annealing of sputtered AlN film in N_2, including crystal quality, dislocation distribution, surface morphology and compound composition, film strain, and optical transmission. The full widths at half maximum (FWHM) of the (0002)- and (1012)-plane XRCs remarkably reduced after annealing as same as mentioned by other groups.

H. Furthermore, we found that the recrystallization process changed the film strain from tensile to compressive stress. The optical transmissivities did not decrease after annealing, and the band edge slopes increased, providing further evidence of improved crystal quality.

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I. Up to now, various techniques have been used to prepare AlN films, such as metalorganic chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE), hydride vapor phase epitaxy and reactive magnetron sputtering. Among them, reactive magnetron sputtering is an attractive low-cost technique to grow large-scale AlN films. Bulk and surface acoustic wave devices based on sputtered AlN films are currently commercially available.

Your answer: _____

III. Fill in the blanks with the appropriate forms of verbs based on what you have learned in Section 2.3.

Polyimides (PIs) (1) _____ (show) excellent thermal stability compared with other engineering plastics. Therefore, PIs (2) _____ (be) expected to be used as TIMs for high-temperature applications. Research on thermal conductive filler/PI composites can be found in the literature, but only a few studies (3) _____ (focus on) PI composites compared with epoxy resins. Ceramic fillers have shown relatively low levels of electrical conductivity, which is appropriate for use in electrical insulation. Among them, hexagonal boron nitride (hBN) (4) _____ (gain) much attention due to a high level of TC and chemical stability. Only a limited number of studies on the effective TC for hBN/PI composites (5) _____ (report) thus far. Li and Hsu (6) _____ (investigate) the effect that different sizes of mixed hBN fillers exert on the effective TC of the hBN/PI composites.

The effective TCs of hBN/PI composites and a mixture of (hBN + aluminum nitride)/PI composites (7) _____ (investigate) by Kuo et al. In that case, PI synthesized from 2,2-bis(3-amino-4-hydroxyphenyl) hexa-fluoropropane and 4,4'-oxydiphthalic dianhydride that could be dissolved in tetrahydrofuran was used, and the fillers were mixed directly with the PI rather than with a polyamic acid (PAA) of a precursor of PI. Recently, Yang et al. (8) _____ (modify) the surface properties of hBN using a silane coupling agent to improve the interfacial affinity between the hBN and the PI matrix to enhance the effective TC. Diaham et al. also (9) _____ (investigate) the effective TCs of BN/PI composites using 120 nm of hBN and 40 nm of wurtzite type BN. They also (10) _____ (perform) a theoretical study using four types of well-known thermal conductive models, which are referred to as the Bruggeman and Hamilton-Crosser models.

IV. Follow the CARS model and make an outline of the Introduction section of the research project that you are currently working on.

Chapter 3
Writing the Methods Section

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field.

1. What is the Methods section often titled?
2. How is the Methods section structured?
3. What information is included in this section?
4. What languages and expressions can be used to connect information?
5. How are verb tenses and voices used in this section?

3.1 General Introduction

The Methods section serves as a main part of a research paper in which authors describe what has been done and how it was done in their study. Many researchers tend to write this part first because this part objectively describes what has been done in the experiment and can be written during the process of the research.

As you may have noticed, the title of this section varies in different disciplines and in different journals. It is sometimes called *Methodology*, or it can be called *Materials and Methods, Experiments/Experimental,* or *Procedure* in materials science papers. The position of this section also varies across disciplines and journals. For some papers, the Methods section appears immediately after the Introduction; for others, this section may appear at the very end of a research paper. There are also journals that require authors to include this section as Supplementary Materials. Most journals include an submission guidelines for authors in which the editors clearly describe what are expected in each section and how the paper should be formatted. You can also refer to the recently published articles in your target journal to get an idea of what are expected in this section.

The purpose of including a Methods section in a research paper is to show the credibility and validity of the current research and to allow other researchers to replicate the results. Therefore, the Methods section should contain clear, sufficient details for readers to understand **what** has been done, **how** it was done, **where** it was done, and **why** it was done. A detailed description of the study process, such as the apparatus, materials, and procedures, can also let readers evaluate the credibility of the study, understand the method and judge if the results and conclusions based on the methodology are reliable and valid.

In many other disciplines, the Methods section usually starts with an overview of the study context and methodology; however, in materials science papers, it is a common practice to begin the Methods section by describing the data collection procedures and materials. In this section, authors need to describe the precise details of the study, focusing on what was done in the experimental procedure and clarifying conditions, treatments, materials, data, devices, and some justification, if necessary. Authors need to provide specific information about the materials (e.g., quantities, temperatures, treatment duration, sequence, conditions, locations, and sizes). Thus, this section mainly fulfills a descriptive goal, including key information necessary for potential replication and validity justification.

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Materials science papers often divide the Methods section into sub-sections, each of which deals with one specific procedure, with the procedure being the title of the sub-section, such as "Equal Channel Angular Pressing (ECAP) and Multi-directional Forging (MDF)", "Materials Preparation", "Sample Characterization", "Strain Measurements", and "Tensile Relaxation Test".

3.1.1 Describing the Materials

It is necessary to present the characteristics of the materials. By means of general or specific descriptions (e.g., units of measurement, scales, physical properties), authors can clarify which aspects of the materials may influence methodological decisions or experimental outcomes. If you are unsure of how many details should be provided, it is better to give slightly too much information than too little. This is because by the time you write up your research, you will probably have repeated your experiments many times, so you are very familiar with the materials, quantities, equipment, software, the sequence or steps in the procedure and the time taken for each step. Because of this familiarity, specific details may seem obvious to you, but those details may not be obvious to readers. If you want others to be able to replicate your results, you should include every specification and detail. For example, the following sentence describes the properties of Alloy 600 by introducing its heat number, manufacturer, supplier, and the chemical composition because these characteristics of the sample are important for the study and may influence the experimental results:

- *The material used in this study was Alloy 600 (Heat no. 93510) manufactured by B&W Tubular Products Division and supplied by Westinghouse. The material was provided in the low temperature mill-annealed condition and the chemical composition is reported in Table 1 (the following table).*

Chemical composition (wt%) for Alloy 600 used in this study.

Heat no.	C	Mn	S	P	Si	Cr	Ni	Cu	Co	Al	Ti	Fe
93510	0.047	0.23	0.002	0.005	0.30	15.42	74.43	0.01	0.057	0.19	0.34	8.94

There are a variety of strategies to provide additional information of a certain material or procedure. For instance, "of" can be used to describe the properties of certain material, such as thickness, volume, or concentration. For example, we can say "10 nm of Ti", "5 mol of X solution", or "75% of the ether". We can also use participles to serve as the modifying element to provide additional information, such as "UVO-treated" in "UVO-treated PET substrates". Another strategy is to use a relative clause. Using an adverbial adjunct, such as "using a PET mask" can also provide additional information. In addition, we can put additional information in parentheses. Additional information can also be presented in figures or tables.

3.1.2 Describing Experimental/Study Procedures

This step illustrates exactly how experimental steps were conducted, outlining what was done in the study in a step-by-step manner and therefore providing detailed descriptions of various actions and their sequence. When introducing the experimental procedure, authors often follow a chronological sequence in which time markers are often used to connect different actions. For example, in the following sentence, the experiment procedure is described in a step-by-step manner through the use of "and" to connect different actions.

- *Five grams of BN (AlN) and 100ml ethanol solution were poured into a three-necked flask, and 0.5 g of a silane coupling agent KH550 was added to it and stirred in a constant temperature water bath at 80 °C for 2–3 h.*

This step also usually starts with explaining the purpose of a given procedure.

- *To obtain the work function of the prepared thin films, a series of Kelvin Probe Force Microscopy (KPFM) measurements were performed using an atomic force microscope (Dimension ICON, Bruker Co., USA), and the temperature of each sample was maintained at 37 °C (incubator temperature) using a heating stage.*
- *To understand how the antimicrobial effect of this newly developed thin film occurs in an in vivo condition, additional in vitro experiments were performed to investigate the interactions between the bacteria and VO_2.*

However, for highly conventional research procedures in certain areas, you can follow how other researchers describe those procedures without giving too many details, but citations are often required.

3.1.3 Describing Tools Used to Obtain Data

This step explains the nature, composition, and/or origin of the devices used in the study. Devices may include instruments, recording or measuring equipment, and/or observation tools. For experimental devices purchased from a third party, information such as the model, manufacturer, and origin should be provided; for tools that are specifically developed for a study, a detailed description of the functions of the tools is necessary. Such descriptions enable other researchers not only to replicate the study but also to judge the credibility of the study. For instance, in "The chemical composition and chemical state were studied by X-ray photoelectron spectroscopy (XPS; Thermo Scientific Escalab 250Xi, US) with Al K^{a} (1486.6 eV) illumination", the model, manufacturer, and setting of the spectroscopy are provided; in "A scanning electron microscope (XL 30 S-FEG, FEI Co., USA,

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10 kV) and a Raman spectrometer (Renishaw 1000NR) using an argon-ion laser (514 nm) were used to characterize as-prepared patterned Si electrode", the model, manufacturer, and setting of the experimental devices are also provided.

3.1.4 Obtaining the Data

This step informs readers of the process of collecting, sampling, or selecting data. For example, in "Sensor resistance and capacitance measurements were recorded on an Agilent (E4980A) Precision LCR meter with custom LabVIEW programs, and sensor currents were measured on a Keithley 4200 SC", sensor resistance and capacitance measurements are two types of data that were obtained through experiments; and in "A field-emission scanning electron microscope (SEM; HITACHI S- 4800, Japan) was used to observe the surface morphology of samples VO_2, VO–W1, VO–W2, and VO–W3", the surface morphology of samples is one type of data obtained in the study.

3.1.5 Describing the Experimental Environment

The experimental environment often serves as an important factor that may influence the results, so it is necessary to report the experiment conditions when writing the Methods section. For example, in "The HCF fatigue tests were conducted at both 25 ^{o}C and 200 ± 2 ^{o}C in a helium cryogenic environment", the temperature of the environment in which the study was conducted is specified; and in "Before deposition, the vacuum chamber was evacuated to a pressure of 7.0×10^{-5}Pa. Argon was filled with a pressure of 0.5 Pa", the pressure of the vacuum chamber is specified.

3.1.6 Justifying Experiment Decisions

Many writers believe that the Methods section is just an objective description of what was done; in fact, there is a strong communicative component which lies in the justification of a certain choice. When describing your materials and methods, you need to communicate not only what you did but also why you did it. Justification enables readers to trust the choices you made. It indicates with what purpose specific experimental steps were completed and uses explanation to justify certain decisions related to your materials, data, tools, or procedures. For example, in "A low pressure super-heated H_2-steam environment was used as a surrogate for a PWR primary water environment as it has the benefit of providing good control of the oxidizing potential with respect to the Ni/NiO transition", the authors explain, by using "as", why such an environment was used in the experiment; and in "This tensile tester is available at the DiffAbs beamline of the synchrotron radiation facility SOLEIL. It comprises four independent motors and four load sensors that allow to perform tensile tests with different (and not necessarily constant) load ratios", the choice is justified by explaining the function of the tensile tester. If

you fail to provide justification for what you did, then readers may not accept the validity of your choices, and this will eventually affect how they evaluate your paper.

Another way to justify the experiment decisions is to cite previous studies.

- *In fact, the surface finish and the final roughness have been shown to strongly influence the SCC susceptibility [citation] and to affect the oxide evolution [citation].*

3.2 Verb Tense

As you may have noticed from the examples above, simple past tense and passive voice are commonly used in the Methods section. This is because when writing the Methods, writers are mainly describing something that happened in the past and readers are more interested in what has been done instead of who did the work. However, if you write about a standard, conventionalized procedure or introduce the properties of certain chemicals and materials, simple present tense can be used. Nevertheless, there are certain disciplines and journals that prefer simple present tense when describing the research procedure. You can refer to the author guidelines or the recently published papers for reference.

3.2.1 Simple Past Tense

Simple past tense is used to describe what has been done (i.e., materials and tools used, data obtained) and how the research was done (i.e., the research procedure), as shown in the following examples:

1. First, the Kapton HN film (DuPont) ***was cleaned by*** *ultra-sonication with acetone, alcohol, and deionized water for 10 min,* ***dried by*** *N_2 flow,* ***and cured*** *in an oven at 80 °C for 4 h.*

2. The material used in this study ***was*** *Alloy 600 (Heat no. 93510) manufactured by B&W Tubular Products Division and supplied by Westinghouse.*

3. The experiments ***used*** *cp-Ti (ASTM grade 2) that has a single a-phase hexagonal close-packed (hcp) crystal structure in as-received condition.*

As you may have noticed from Example 3, there is a mixed use of verb tense: While *use* is written in simple past tense *used*, *have* is written in its simple present tense *has*. This is because the relative clause introduced by *that* describes the physical property of cp-Ti which is a fact and is true across conditions. In this case, simple present tense is used.

3.2.2 Simple Present Tense

4. The chemical composition (wt. %) of the cp-Ti ***is*** *Fe 0.28%; C 0.08%; N 0.03%; H 0.015%, O 0.25% and Ti in balance.*

5. To gain a better understanding about the grain growth behaviour of UFG cp-Ti under HCF fatigue loading, a suitable experimental technique ***is required****.*

6. A low pressure super-heated H_2-steam environment ***was used*** *as a surrogate for a PWR primary water environment as it* ***has*** *the benefit of providing good control of the oxidizing potential with respect to the Ni/NiO transition. The oxidizing potential of the system, and hence the oxygen partial pressure, can be modified by changing the ratio between the steam partial pressure over the hydrogen partial pressure. The environmental conditions in the H_2-steam environment can be described by a parameter R, which* ***is*** *the ratio between dissociation pressure at the Ni/NiO transition ($p_{O2\ Ni/NiO}$) and the p_{O2} in the system. Consequently, for $R > 1$ the Ni* ***is*** *stable, for $R < 1$ the NiO* ***is*** *stable.*

7. The fabrication process of the ultraflexible 3D-TENG ***includes*** *the developing of ultraflexible 3D printer, material preparation (composite resins), 3D modeling (3D MAX), printing setup (for instance, a size of 3.5 cm × 3.5 cm × 3.5 cm, 3D printing of composite resin II part will need 180 g of composite resin II and 10 min of build times), 3D printing and integration assembly. According to the fabrication process as shown in Supplementary Fig.1d, the ultraflexible 3D-TENG* ***was successful assembled****.*

8. The schematic of the hybrid 3D printing system plan ***is*** *shown in Fig. 1.*

9. Supplementary Fig. 3 ***demonstrates*** *our printing capabilities of complex 3D-structure designs by comparing the final 3D printed ultraflexible parts.*

Example 4 describes the components of cp-Ti, which is a fact; therefore, simple present tense is used. Example 5 justifies an experiment decision by explaining the purpose of a certain step; therefore, simple present tense is used. Example 6 also presents mixed use of the verb tense: Except for the first verb *use*, which is written in its simple past tense, the other verbs are all in simple present tense. This is because the first clause "A low pressure super-heated H_2-steam environment was used as a surrogate for a PWR primary water environment" talks about the environment of the experiment at hand, while the clause introduced by *as* serves the function of justifying the rationale of using low pressure super-heated H_2-stream environment, which is a general truth. The rest of the paragraph describes a model on which this study was based. It is also common to use simple present tense when explaining equations. Similarly, Example 7 uses both the simple present tense and simple past tense. The first sentence introduces a conventional research process to fabricate ultraflexible 3D-TENG; therefore, simple present tense is used. By comparison, the second sentence uses simple past tense to describe the specific experiment. Examples 8 and 9 present another scenario in which simple

present tense is used; that is, when locating the table or figure in the text.

To summarize, when referring to specific steps taken in an experiment, simple past tense is often used, while when describing a fact or a standard procedure, simple present tense is preferred.

You may also have noticed that researchers tend to write about materials and methods in passive voice. These verb forms emphasize the action rather than the doer of the action. There has been a trend to use active verbs as much as possible because this makes the writing more direct and less wordy, as shown in the following examples:

*10. To check the stability of our device, **we performed** repetitive tests to load-unload a pressure of 0.25 kPa on the device for 10,000 cycles.*

*11. **We conducted** a GMR characteristic measurement of as-fabricated $[Co/Cu]_{50}$ multilayers at room temperature.*

3.3 Cohesion

When writing about the research procedure, a chronological sequence should be followed so that each step is precisely described. Therefore, logical connectors that denote a sequential relationship are often used in this section.

One strategy is to use relative clauses to indicate that a certain step is taken after a previously taken step. For example, in “The base agent and curing agent of PDMS (Sylgard 184, Dow Corning) were mixed at a weight ratio of 10:1, which was well blended and deaerated via a planetary centrifugal mixer (Thinky, AR-100) for 15 min”, the relative clause introduced by *which* describes another two actions that were taken. Another strategy is to use time sequence markers such as “before”, “after”, “prior to”, “until”, or “when” to link different action verbs. The third strategy is to use logical connectors such as “subsequently”, “then”, “next”, or “on the following day” to move onto the next step. Sometimes, we can also use “to do” structure to introduce the next step. You may refer to the useful expressions in this chapter for commonly used connection words; you may also refer to Chapter 7 (7.2.2 Accuracy), which discusses various strategies to achieve cohesion in academic writing.

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3.4 Sample Analysis

Title: Nonflammable Electrolyte for Safer Non-aqueous Sodium Batteries	
Excerpts	**Comments**
Experimental Section ***Microstructure Mold Fabrication***. ① The base agent and curing agent of PDMS (Sylgard 184, Dow Corning) were mixed at a weight ratio of 10:1, which was well blended and deaerated via a planetary centrifugal mixer (Thinky, AR-100) for 15 min.	This section is labeled as "Experimental Section". As seen from the subtitles, there are four sub-sections: Microstructure Mold Fabrication, Pressure Sensor Fabrication, Fabrication of the Hollow Structure, and Characterization of the Pressure Sensor, with each sub-section dealing with one specific procedure. In the sub-section of Microstructure Mold Fabrication, there are 4 sentences. Sentence ① talks about the preparation of the base agent and curing agent of PDMS, in which the product model and producing company are provided in parentheses, and the weight ratio of the mixture is specified as 10:1. In addition, the device used to blend and deaerate the mixture is introduced, and the blending duration is specified. Simple past tense and passive voice are used.
② Then, the mixture was spin-coated at 500 rpm for 60 s on a PET substrate and was cured at 80 °C for 3 h. ③ After curing, the cured PDMS film (thickness: ～100 μm) was peeled-off from PET and stretched uniaxially on a strain stage, followed by UVO exposure.	Sentences ②–③ used simple past tense and passive voice to continue talking about how to treat the mixture: spin-coating, curing, peeling off, stretching, and UVO exposure. Notably, when describing the procedure, those sentences explain a series of actions in a chronological sequence, and give details of the experimental conditions, such as the revolutions per minute (500 rpm), revolution duration (60 s), the location of the spin-coating (PET substrate), the curing temperature (80 ℃) and duration (3 h), and thickness of the cured PDMS film (～100 μm). Another issue is that when describing the process, logical connectors such as "then", "after", and "followed by" are used to connect the actions, making the writing logical and coherent. The use of logical connectors is a common strategy to link research actions when describing the research procedure.

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(Continued)

Excerpts	Comments
④ Finally, the wrinkled microstructure was generated on the PDMS surface after releasing the applied pre-strain.	Through the use of "finally" and "after", Sentence ④ signals the last step in fabricating the microstructure mold: releasing the applied pre-strain.
Pressure Sensor Fabrication. ⑤ First, 10 nm of Ti and 50 nm of Au were deposited on UVO-treated PET substrates to form flexible electrodes using a PET mask, which was fabricated by a laser cutting machine (Universal Laser Systems, PLS 6MW).	Sentence ⑤ describes the first step in fabricating the pressure sensor—depositing Ti and Au to form flexible electrodes. As shown in this sentence, the thicknesses of Ti and Au are respectively specified, and the name and model of the laser cutting machine are also provided.
⑥ The base agent and curing agent of PDMS were mixed at a weight ratio of 10:1 and were spin-coated at 3,000 rpm for 60 s on the electrode-patterned PET substrates after blending and deaeration.	Sentence ⑥ presents similar information as Sentence ②, describing how the base agent and curing agent of PDMS were treated with specific details. We need to note that a series of actions are linked with logical connectors like "and" and "after".
⑦ After curing at room temperature for 24 h, the PDMS presented a semisolid state. ⑧ The microstructure mold was placed on the PDMS-coated PET substrate. ⑨ A pressure of 500 Pa was applied to clamp the entire stack and remove the residual air. ⑩ Then, the stack was baked at 80 °C for 6 h. ⑪ The microstructured PDMS with the reversed wrinkle pattern was generated after peeling off the mold.	Sentences ⑦–⑧ describe the preparation of the microstructure mold. As shown in the excerpt, the PDMS was cured for 24 hours and was applied to the PET substrate. The microstructure mold was then placed on the PET substrate. "The entire stack" in Sentence ⑨ refers to the above-mentioned microstructure mold and PET substrate. Sentences ⑨–⑪ describe the subsequent steps in generating the microstructured PDMS. In Sentence ⑩, "then" is used to indicate the next step.
⑫ Finally, another PET substrate with Ti/Au electrodes was added on with an orientation orthogonal to the Ti/Au electrodes on the bottom PET substrate, forming 4 × 4 sensor arrays.	The last step in fabricating the pressure sensor is signaled by "finally" in Sentence ⑫. In this sentence, a participle structure "forming 4 × 4 sensor arrays" is used to provide additional information (i.e., the size) of the sensor arrays.

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(Continued)

Excerpts	Comments
Fabrication of the Hollow Structure. ⑬ Different densities for the hollow structure can be obtained via two approaches as follows.	The third part in the Methods section describes how to fabricate the hollow structure. Sentence ⑬ serves as the topic sentence, introducing the two approaches that can be used to obtain different densities for the hollow structure.
⑭ Changing the precuring condition: The PDMS film that was spin-coated on the PET substrate was precured at room temperature for different times (at least for 12 h) to obtain different curing degrees. ⑮ Then, a micropatterned mold was placed on top. ⑯ The entire stack was clamped at a pressure of 500 Pa and was baked at 80 °C for 10 h.	Sentences ⑭–⑯ describe the first approach—changing the precuring condition—in which a detailed description of the procedure is provided. In addition, Sentence ⑭ describes three actions: spin-coat, precure, and obtain different curing degrees. It should be noted that these three actions are connected in different ways to show the experimental sequence. "Spin-coat" appears in a relative clause introduced by "that" to show that this action has been completed, while "precure" appears in the main clause, and is connected with "to do" construction (i.e., to obtain) to denote the next action.
⑰ Changing the applied pressure: The PDMS film that was spin-coated on the PET substrate was precured at room temperature for 18 h. ⑱ Then, a micropatterned mold was placed on top. ⑲ The entire stack was clamped at different pressures and was baked at 80 °C for 10 h. ⑳ The micropatterned mold used here was fabricated with an exposure time of 6 h and a pre-strain of 50%.	Sentences ⑰–⑳ describe the second approach—changing the applied pressure. Here, a detailed explanation of the procedure is provided, including the specific experimental conditions.
Characterization of the Pressure Sensor. ㉑ The capacitance of the pressure sensor was measured by using an Agilent 4294A Precision Impedance Analyzer. ㉒ A universal high-performance motion controller (XPS-Q8) and force gauge (Handpi, HP-5) were used to apply the pressure.	The last part in the Methods section describes how to characterize the pressure sensor. Sentence ㉑ introduces the tool (i.e., Agilent 4294A Precision Impedance Analyzer) used to measure the capacitan-ce of the pressure sensor, and by providing the model of the devices, Sentence ㉒ specifies the tools (i.e., motion controller and force gauge) used to apply the pressure.

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As shown in the sample analysis, materials science papers tend to present the Methods section in a quite straightforward way, by directly describing the tools, materials, and research procedures adopted in the present study. A typical research process description features the sequence of "preparation/fabrication–characterization" of novel materials to verify their improved functions. The preparation/fabrication process may be influenced by the experimental environment in which the study was conducted; therefore, a detailed description of the material properties and study conditions is of great significance. A variety of measures are characterized by experimental tools; therefore, a description of the manufacturer information, mechanisms and functions of the tools is also necessary.

Different from the Introduction section which generally follows a funnel shape, the Methods section is written in a chronological sequence to explain the specific procedures. To show the experimental steps, a series of verbs are often used to describe each step in a coherent way, and these verbs are often used in simple past tense and passive voice.

To conclude, the Methods section allows readers to clearly know what has been done and allows them to judge the validity of the study and to replicate the experiment.

3.5 Useful Expressions

In this section, useful expressions in each step are provided with examples.

Describing the Materials

* *X (model, company, city, country) was used as the template materials.*
* *X was obtained/purchased from...*
* *X was used in this study to perform...*
* *The materials included / consisted of / comprised of / was taken from / was drawn from…*
* *The apparatus consists of / is made up of / is composed of / is based on...*
* *The device was designed / developed / set up in order to...*
* *X incorporates / makes use of…*

Describing the Data

* *X was obtained by…and is shown in Fig. 3.*
* *X analysis was used to test/predict/confirm Y.*
* *Changes in X were calculated/compared using...*
* *The correlation/difference between X and Y was tested.*
* *The data were obtained/collected using X.*

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* *...was observed with X.*
* *All samples were carefully/thoroughly checked for...*
* *X has been measured in three different ways.*
* *The height of X was obtained from the expression: $h = h_m/\sin a$, where h_m is…, a is…*

Describing the Experimental Tool

* *Data were collected using a high spectral resolution X.*
* *The data were collected and recorded on X.*
* *The system was connected to / attached to / covered with / integrated into / embedded onto / aligned with / positioned on / equipped with...*
* *X was analyzed using…*
* *To evaluate/assess…, X was used.*
* *...was carried out / performed / analyzed / calculated / observed / determined using X.*

The following table summarizes expressions that can be used to describe the locations of the experimental tools.

be below/above	*be horizontal/vertical*	*be coupled (onto)*
be parallel with	*be placed/located/positioned/embedded (in)*	*be connected (to)*
be on the right/left (to)	*be mounted (on)*	*be surrounded (by)*
be in the front/back	*be aligned (with)*	*be covered (with/by)*
be at the upper/lower level	*be attached to*	*be on top of*

Describing the Research Purpose

* *In order to investigate…, X was taken/adopted/performed.*
* *To better understand how...*
* *To address the possibility of...*
* *X was conducted with the intention of…*
* *The process was repeated three times in order to...*
* *(In order) to test/analyze/characterize/measure/assess/identify/understand/investigate/study…*
* *To determine/check/verify/determine whether...*
* *To ensure homogeneous material, sample was flipped…times.*

Other verbs that are often used to state the research purpose include: *allow, avoid, compensate for, confirm, enable, enhance, facilitate, guarantee, identify, improve, increase,*

limit, minimize, maximize, obtain, prevent, reduce, remove, validate.

You can also use the expressions in the following table to describe the research method with the research purpose.

X was	*used to* *applied to* *adopted to* *proposed to* *performed to* *designed to* *employed to* *developed to* *introduced to*	*assess…* *analyze…* *test…* *identify…* *characterize…* *measure…* *help understand how…* *determine…* *evaluate…* *collect…* *investigate…* *examine whether…* *prepare…* *fabricate…* *synthesize…* *obtain…*

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Describing the Process/Procedure/Sequence

* *X was recovered and stored overnight at [temperature].*
* *X was gradually/slowly/rapidly/gently heated.*
* *X was harvested, washed, and (then) transferred to…*
* *By partitioning the array, all the Xs could be identified.*
* *X was placed in…, covered with...*
* *X was removed from Y and placed in…*
* *The solution was washed three times with deionized water.*
* *The X were gently mixed at room temperature for...*
* *To begin this process, ...*
* *Initially,…*
* *X was performed prior to/before the XPS measurement to obtain…*
* *After X was obtained, Y was prepared by different imidization temperatures.*
* *After cooled to room temperature, X was achieved.*
* *After curing, X was peeled-off from PET and stretched uniaxially on a strain stage,*

followed by UVO exposure.

* *The process was repeated until X is simulated.*
* *Then, it reached a maximum of…at a UVO exposure time of…and subsequently decreased when the UVO exposure time was further increased.*
* *Then, X was…*
* *Finally, …*
* *X was collected/tested/characterized/assessed during the first/initial step.*
* *The levels were thus/consequently/therefore set at...*
* *The resulting Xs were then...*
* *X was used to characterize…*
* *The final/resulting solutions contained…*

Justifying Experimental Decisions

* *The advantage of using X was that…*
* *…, allowing…*
* *…, which avoided problems of…*
* *Because…, X was used to…*
* *By doing..., we were able to…*
* *This method represents a valuable/innovative alternative to...*
* *As (previously) described/explained/reported/suggested/proposed by/in [citation],…* [*by* and *of* are usually followed by the name of the researcher or research team, e.g., by Zhang, and *in* is usually followed by the work e.g., in Zhang et al. (2003)].
* *Our procedure is a clear improvement/advance on current methods.*
* *This solution improves/enhances/furthers/advances previous methods by...*
* *This method/model/system was chosen because it is one of the most practical/feasible/economic ways to...*
* *To date, various methods have been developed to measure X.*
* *In this study, we followed [citation] by using X to…*
* *We used reliable/innovative techniques based on the recommendations of...*
* *Xs were prepared as described by / as suggested by / according to / following [citation].*
* *This apparatus has several/many features/characteristics.*

The verbs below are highly frequent in the Methods section of materials science papers.

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was adapted	*was collected*	*was incorporated*	*was removed*
was added	*was combined*	*was installed*	*was repeated*
was adopted	*was constructed*	*was isolated*	*was sampled*
was adjusted	*was converted into*	*was located*	*was scored*
was analyzed	*was designed*	*was maximized*	*was selected*
was applied	*was determined by*	*was measured*	*was separated*
was arranged	*was eliminated*	*was minimized*	*was simulated*
was assembled	*was employed*	*was modified*	*was substituted*
was attached	*was estimated*	*was obtained*	*was rinsed*
was calculated	*was exposed to*	*was optimized*	*was transferred to*
was calibrated	*was extracted*	*was positioned*	*was treated*
was carried out	*was filtered*	*was prepared*	*was utilized*
was characterized	*was formulated*	*was recorded*	

3.6 Checklist for Writing the Methods Section

You can refer to the following checklist for writing the Methods section of your paper.

- Is your experiment design appropriate for answering the research questions?
- Is your research methodology credible and valid?
- Did you describe your research methods in a way that your experiment can be replicated by other researchers? Are enough details given?
- Did you describe your study in a chronological order?
- Are the experimental steps logically connected?
- Did you justify your use of unconventional methods in the study?
- Are the verb tenses and voices appropriately used in your paper?

Figure 3.1 summarizes the main points discussed in this chapter.

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What	● Which reserach method was used? ● What are the materials/tools/data? ● What are the variables?
Where	● Where was the experimental carried out?
How	● How was the experiment carried out?
Why	● Why was certain step/measure taken?

Figure 3.1 A summary of the Methods section

The following rhyme summarizes the essence of the Methods section, and you can refer to it when reviewing the content of this chapter.

研究方法

研究方法不可少，描述过程学问高。

研究价值可评估，复制结果也需要。

有时放在引言后，有时文章末尾找。

研究对象和场所，变量设备和环境。

研究过程和数据，描述说明要详尽。

语言准确又客观，顺序安排需考虑。

过去时态被动式，衔接用语要牢记。

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Exercises

I. Follow the steps introduced in this chapter and analyze the following Methods section taken from a paper by filling in the blanks.

Title: Three-dimensional Ultraflexible Triboelectric Nanogenerator Made by 3D Printing	
Excerpts	**Comments**
2. Experimental Section ***2.1 The Structure and Fabrication Process of the Ultraflexible 3D-TENG*** ① Printing was performed using an UV curing 3D printer [citation] comprised of automatic pressure injecting device, ink extrusion and UV curing system, precision positioning platform, PC and hardware/software control system, as schematically illustrated in Fig. 1a.	This section is labeled as _____. The first part of this section describes _____, which can be seen from the sub-section title. As the title implies, the authors will talk about two things in this part: _____ and _____. Written in _____ tense, Sentence ① introduces _____. In this sentence, previous studies that have used this tool are cited to increase the credibility of this experimental decision.
② The schematic of the hybrid 3D printing system plan is shown in Supplementary Fig. 1. ③ This is a new method of hybrid 3D printing for producing ultraflexible parts, in which the liquid photopolymer resins and support materials are directly printed by using a single manufacturing process within an integrated platform [citation]. ④ Printed parts with additive internal supporting structure are intended to keep high accuracy of ultraflexible printed parts and shape unchanged, and then the internal supporting structure is removed by corrosive reagents without affecting other parts. ⑤ Finally, the ultraflexible parts are obtained to act as the electrification materials of TENGs (Fig. 1b).	Sentences ②–⑤ use _____ tense to describe the schematic of the UV curing 3D printer because this is how the hybrid 3D printing system generally works. Sentence ② locates a figure which shows the schematic of the tool and Sentences ③–⑤ _____. As shown in the excerpt, passive voice is generally used.

(Continued)

Excerpts	Comments
⑥ Supplementary Fig. 3 demonstrates our printing capabilities of complex 3D-structure designs by comparing the final 3D printed ultraflexible parts. ⑦ The SEM analysis about the micro-morphology of the ultraflexible printed parts shows that the UV curing forms a layer-upon-layer structure along the printing direction as the object is fully realized (Fig. 1c).	Sentences ⑥–⑦ also use _____ tense to validate the capabilities of the UV curing 3D printer by analyzing the printed parts. An "SEM analysis" is specified and additional information is provided in the figures. This part also explains _____; therefore, simple present tense is used.
⑧ In this approach, digital light processing UV curing system was used to partially set the extruded resins and provide the high accuracy (i.e., < 10 μm), allowing a designed performance of ultraflexible part relevant to application requirements. ⑨ The ultraflexible 3D-TENG uses printed resin parts and ionic hydrogel as the electrification material and electrode, respectively, which together make up one columnar array of triboelectric interfaces. ⑩ Its structure and assembly process are schematically illustrated in Fig. 1d and Supplementary Fig. 5 and the ultraflexibility test are presented in Fig. 1e and Supplementary Video 1.	Sentence ⑧ uses _____ tense to give details of "this approach". The participle "allowing a designed performance of ultraflexible part relevant to application requirements" serves as a justification. Sentence ⑨ explains _____. The function of Sentence ⑩ is to locate the figures which display the structure and assembly process of the triboelectric interfaces to provide additional information; therefore, simple present tense is used.
2.2 Methods and Materials ⑪ Hybrid 3D printing system is comprised of automatic pressure injecting system, ink extrusion and UV curing system, precision positioning platform, PC and hardware/software control system. ⑫ The UV curing ink (liquid photopolymer resin) was prepared based on acrylate oligomer (～70 wt%), acroleic acid (～25 wt%), photoinitiator (～2 wt%), reactive diluents and additives (～3 wt%). ⑬ The composite resins I and II were prepared by mixing the UV curing ink base and different masses of acrylonitrile butadiene styrene powder,	Sentences ①–⑩ describe the structure, so the next part mainly deals with the fabrication process of the 3D-TENG. Sentence ⑪ mainly introduces _____. Because this sentence describes the components of the system, _____ tense is used.

(Continued)

Excerpts	Comments
1:1.5 and 1:2 by weight, and then 3D printing was carried out. ⑭ The PAAm-LiCl hydrogel was prepared according to the method reported previously. ⑮ Briefly, acrylamide powder was added into LiCl (8 M) aqueous solution. ⑯ Subsequently, N, N'-me-thylenebisacrylamide, ammonium persulfate, and N, N, N', N'-tetra-methylethylenediamine (Sigma-Aldrich) were dissolved in the solution consecutively. ⑰ The solution was then transferred into a cylindrical array of glass mold and treated in an oven at 45 °C for 3 h to form the PAAm-LiCl hydrogel.	Sentences ⑫–⑰ detail the process of ____ _____. Notably, logical connectors such as _____ are used to indicate the sequence of the process. _____ voice is mostly used when describing their process.
⑱ The fabrication process of the ultraflexible 3D-TENG includes the developing of ultraflexible 3D printer, material preparation (composite resins), 3D modeling (3D MAX), printing setup (for instance, a size of 3.5 cm × 3.5 cm × 3.5 cm, 3D printing of composite resin II part will need 180 g of composite resin II and 345 g of Supporting material and 10 min of build times), 3D printing and integration assembly. ⑲ According to the fabrication process as shown in Supplementary Fig. 1d, the ultraflexible 3D-TENG was successful assembled. ⑳ Finally, the copper wire was attached to the hydrogel for electrical connection.	Sentence ⑱ introduces the general process of fabricating the ultraflexible 3D-TENG; therefore, _____ tense is used. Sentences ⑲–⑳ refer to this specific experiment; therefore, simple past tense is used.
㉑ The morphology of the nanostructured rubber surface was characterized by a field emission scanning electron microscope (Hitachi SU8020). ㉒ The electrical output signals (voltage, charge, and current) of the ultraflexible 3D-TENGs were measured by a programmable electrometer (Keithley, part no. 6517B) and data acquisition card. ㉓ A linear motor (LinMot E1100) was used to form alternative motions and drive the device to contact and separate for quantified measurement. ㉔ In addition, the data were collected and recorded by computer-controlled measurement software written in LabVIEW.	The last part mainly deals with the data obtained from the experiment and the tools used to obtain the data. Sentence ㉑ introduces _____ to characterize the morphology of the surface. Sentence ㉒ describes _____ to measure the electrical output signals. Sentence ㉓ mentions _____ to treat the data. Sentence ㉔ describes the measurement software to _____. _____ tense and _____ voice are frequently used.

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II. The following sentences are taken from a Methods section of a research paper explaining the preparation of SiCNWs-GSs hybrids. Reorganize these scrambled sentences into the correct order. Pay attention to the textual cohesion.

A. The growth of SiC nanowires on the graphene sheets surface was carried out by a simple heat-treatment process.

B. The as-milled powders were first set in a graphite crucible and then placed in the vacuum induction furnace that was pumped to abase pressure of about 10^{-3} Pa.

C. In the typical experiments, 0.2 g GSs, 0.4 g silicon powders and 0.6 g reduced Fe powders were mixed with a ball-milling process for 12 h.

D. For purification of nanomaterials, the as-prepared samples were dispersed in the deionized water with ultrasonically vibration.

E. The extra silicon powders and Fe particles were deposited in the bottom.

F. Then, the upper layer suspension was taken out to filter and dry to obtain the SiCNWs-GSs.

G. After the growth process, the furnace was switched off and the sample cooled down at room temperature.

H. Afterward, the furnace was heated from room temperature to 1,300 °C and maintained for reaction for 90 min under a total pressure of about 10^{-3} Pa.

I. Repeat these two steps 3 times to obtain the pure SiCNWs-GSs.

J. Finally, the resulting nanofillers was dried overnight in vacuum for 80 °C.

Your answer: A–____–____–____–____–D–____–____–I–J

III. Fill in the blanks with the appropriate forms of verbs based on what you have learned in Section 3.3.

Passage 1

Textile samples (1) _____(glue) onto glass cover slips with double sided adhesive tape and (2) _____(place) on a custom built tilting table. A syringe (3) _____(mount) above the tilting table with a fixed needle to a substrate distance of 1 cm. The syringe (4) _____(position) in a way that a drop falling

from the needle would contact the substrate 2 cm from the bottom end of the sample. Two needles with inner diameters of 130 mm (Hamilton #90531) and 250 mm (Krüss #NE 43) (5) _____(use) to produce water drops with volumes of 5±0.3 and 13±0.3 μL, respectively. To control the volume of the drops released from the needle, a drop of 4.5 or 12.5 μL volume (6)_____ (produce) at the needle tip using the automated syringe control of an OCA 20 contact angle system (Dataphysics). The drop (7) _____(expand) in steps of 0.1 μL until it detached from the needle.

Passage 2

The coupons samples (1) _____(characterize) after exposure to H_2-steam environment with a range of conventional and advanced analytical microscopy techniques. A Zeiss Sigma field emission gun (FEG)–scanning electron microscope (SEM) (2) _____(equip) with an Oxford Instruments X-Max 150 silicon drift detector (SDD) for energy dispersive X-Ray (EDX) spectrum imaging and microanalysis and an Aztec analysis system (3)_____ (use) to analyze the surface of the coupon samples after exposure to H_2-steam environment. The In-lens, secondary electron (SE), and annular backscattered electron (BSE) detectors (4) _____(use) at low accelerating voltage (3–5 kV) to analyze the surface of the coupons, with particular emphasis on the oxide morphology in the vicinity of the grain boundaries. A Zeiss Merlin FEG-SEM equipped with two Oxford Instruments X-Max 150 Silicon Drift Detector (SSD) and an Oxford Instruments X-Max Extreme 100 windowless SDD for low voltage EDX spectrum imaging, and an Aztec analysis system for qualitative chemical analysis (5) _____(use) at low voltages to assess the composition after the high temperature H_2-steam exposure. FIB cross-sections (6)_____(prepare) from selected grain boundaries using a FEI Helios 660 and a FEI Quanta 3D Dual Beam SEM/FIB. Twenty FIB cross sections (7) _____(evaluate) from each sample in order to assess the extent of PIO penetration along the newly migrated GB. In order to study the DIGM effect on the morphology of the PIO, specific geometrical parameters of the migrated region, such as the depth (d), the width (w) and the area, (8) _____(measure) for over 50 grain boundaries on the SE-FIB cross sections by using the Fiji ImageJ software (version 2.0). The FEI Helios 660 FIB (9) _____(use) to prepare six electron-transparent lift-out specimens for further analytical electron microscopy (AEM) analyses. TEM characterization (10)_____(perform) using an FEI Tecnai T20 LaB6 analytical TEM/STEM operated at 200 kV and equipped with an Oxford Instruments X-Max 80 TLE SDD and Aztec analysis system, and a Philips CM20 TEM operated at 200 kV. Discrete STEM-EDX “spot” analyses (11)_____(perform) to analyze the local compositional variation along grain boundaries oriented parallel to the incident electron beam. These EDX spectra (12) _____(quantify)

using the Aztec software (version 4.0) with theoretical "k-factors". More detailed analyses (13)_____(perform) using an FEI Talos F200 analytical FEG-S/TEM equipped with Super X (4 SDDs) for STEM-EDX spectrum imaging and microanalysis. The STEM-EDX spectrum image data acquisition (14) _____(perform) with a dwell time of 200 ms for a total live time of 30 min and whit a pixel size equal to 1.328 nm. STEM-EDX Spectrum Image (SI) datasets (15) _____(analyze) using Thermo Fisher Scientific Velox software (version 2.4).

IV. Improve the following process description sentences by adding a time adverbial. a linking passive or -*ed* participle.

1. Single particles impacted and adhered to the substrate. Then the power feed rate during deposition was lowered.
2. The particles were deformed. Then these particles were dissected to measure these dimensions using a FEI Quanta 3D Dual Beam instrument.
3. Precession electron diffraction (PED) is a TEM-based technique. The PED was performed on the thin foils via a NanoMegas ASTAR platform using a precession angle of 0.3° and a step size of 20–25 nm.
4. The base agent and curing agent of PDMS (Sylgard 184, Dow Corning) were mixed at a weight ratio of 10:1. The solution was then well blended and deaerated via a planetary centrifugal mixer (Thinky, AR-100) for 15 min.
5. SST polymer with HTV silicone rubber (MVQ 110-2) and BPO were homogeneously blended by a two-roll miller (Taihu Rubber Machinery Inc., China, Type XK-160). The commercially available thermochromic fillers (bought from Shenzheng Bianse Chemical Technology Co., Ltd, China) were then added.

V. The following methods describe four ways to remove tarnish from stainless steel jewelry. Choose one method and convert the steps into a coherent paragraph that may fit a Methods section in a research paper.

Method 1. Using Baking Soda

Step 1. **Combine baking soda and water to make a cleaning paste.** This method will remove tarnish from your jewelry and can also help you polish it as well. Mix 1 tablespoon (15 mL) of baking soda and 1/2 tablespoon (7.4 mL) of water in a small bowl. Stir the ingredients together with a spoon until the substance forms a paste.

Step 2. **Use a toothbrush to scrub the jewelry with the solution.** Submerge a toothbrush in the baking soda paste and gently scrub down each piece of jewelry. Try to work the toothbrush

into the crevices of the jewelry to make sure you remove all the tarnish, dust, and grime.

Step 3. **Wash off the solution with water and let the jewelry dry.** Run warm water from the faucet over the jewelry to rinse off the baking soda. After that, wipe down each piece with a clean cloth to dry the jewelry. Wait for your jewelry to fully dry before putting it away in storage. To keep the jewelry protected when you store it, keep it in a cool, dry place out of direct sunlight. Try a jewelry holder made out of a soft material.

Method 2. Using Dish Soap

Step 1. **Mix dish soap and hot water to make the solution.** This method is great for removing grime like grease from your jewelry in addition to removing tarnish. Combine 1–3 drops of dish soap with hot water. You don't need an exact measurement for the amount of water you use. Just make sure it will be enough to fully submerge the jewelry. Any standard dish soap will do.

Step 2. **Wet a cloth with the dish soap and water solution.** Choose a soft cloth that won't scratch or damage your jewelry in the cleaning process. Then, dampen the cloth with the solution.

Step 3. **Scrub your jewelry with the cloth.** Clean off any tarnish, dirt, or dust. Use gentle motions to avoid scratching or damaging your jewelry.

Step 4. **Rinse off your jewelry in water and let it dry.** Once you're done scrubbing your jewelry, wash off the cleaning solution with warm water. Then, use a cloth to dry off the jewelry. Once the jewelry is dry, store it away from direct sunlight in a cool, dry place.

Method 3. Using White Vinegar

Step 1. **Combine water and white vinegar to make your solution.** Try out white vinegar to restore the shine in your jewelry in addition to removing any tarnish. Pour 1 cup (240 mL) of warm water and 1 cup (240 mL) of white vinegar into a spray bottle.

Step 2. **Spray the solution onto a cloth to wipe down the jewelry.** Opt for a cloth made of soft material so that it won't scratch the stainless steel. Then, spray the solution on the cloth until it's damp and gently scrub the jewelry. This will clean off any tarnish, dust, or dirt.

Step 3. **Soak the jewelry in the solution as an alternative.** Combine 1 cup (240 mL) of warm water and 1 cup (240 mL) of white vinegar in a bowl. Next, place the jewelry in the solution. Fully submerge each piece and allow them to soak for up to 5 minutes.

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Step 4. **Dry off the jewelry.** To do so, gently rub the jewelry with a clean cloth. Avoid putting the jewelry back in storage until it is fully dry. Store your sparkling clean jewelry in a dry, cool place that is out of direct sunlight.

Method 4. Using Toothpaste

Step 1. **Apply the toothpaste to a wet cloth.** This is a terrific means to polish and remove tarnish from your jewelry with an ingredient you surely have at home. First, wet a cloth with water. After it's fully damp, dab a small amount of toothpaste on the cloth. Use plain toothpaste for this method. Avoid toothpaste with any whitening products in the ingredients, as these can be too hard on your jewelry and damage it.

Step 2. **Scrub your jewelry with the cloth.** Use gentle motions to scrub the surface without leaving any scratches. This will remove any tarnish and grime, and will also help you restore your jewelry's shine.

Step 3. **Rinse the jewelry in warm water.** Do this to wash off the remaining toothpaste. Make sure to rinse off any crevices to make sure you remove all of the toothpaste.

Step 4. **Wipe down the jewelry with a cloth to dry it.** Make sure no water remains before storing your jewelry. Once it's dry, store it out of direct sunlight in a cool, dry location.

VI. Name some strategies to provide additional information when describing the materials and procedures.

VII. Make an outline of the Methods section of the research project that you are currently working on.

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Chapter 4
Writing the Results Section

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field.

1. In what forms are the data presented?
2. How is the Results section titled? "Results" or "Results and Discussion"?
3. What information is often included in this section?
4. What verb tenses are used when reporting the results?

4.1 General Introduction

The Results section is considered to be the most important part of a materials science paper, because this section reports what has been found in the present study. Data are often presented in graphics (e.g., tables and figures) to answer the research questions, and complement the written descriptions of the findings. The title of this section varies in different disciplines and journals. There are two common ways to report results in materials science papers: to describe what was found or observed in the *Results* section and to explain the results in a separate *Discussion* section; or to combine these two sections as *Results and Discussion*. In either case, data are presented in a similar way; the main difference is how much authors interpret their findings. In this book, we separate the Results and Discussion sections; however, when reporting findings in the Results section, authors sometimes briefly comment on the data. This is because data usually do not speak for themselves, and it is the authors' responsibility to make meanings out of the data. Authors can describe their results in numbers or visual graphs, but readers still need to know what these numbers or graphics mean in order to better understand the results. These brief comments can also better guide readers to the Discussion section.

The results need to be clearly stated because it is the results that constitute the new knowledge. The earlier parts of a paper (i.e., Introduction, Methods) aim to tell readers why and how the results are obtained; the later part of the paper (i.e., Discussion) aims to tell readers what these results mean.

When describing results, authors need to first decide what results to include, and then organize them in a sequence that highlights the answers to the research questions indicated in the Introduction section, and in accordance with the procedures described in the Methods section. Generally, the results are organized in sub-sections with headings that indicate the primary focus of each part so that readers can easily locate the relevant results. Within each sub-section, authors tend to report findings in separate paragraphs instead of in a long one. Note that authors need to be honest with their results; authors should not only report good results, but also report those that are not found and those that are contradictory to their hypotheses.

4.1.1 Move 1: Locating the Tables and/or Figures

This move allows authors to indicate where the results can be found. The most common way to begin the Results section is to go directly to the results, often by inviting readers to look at one of the figures or tables, either in the first sentence or very shortly after, as shown in the following examples:

*1. **Figure 2 is** an infrared spectrum of the surface modification of BN and AlN by silane coupling agent KH550.*

*2. **Figure 6 shows** the variation curves of breakdown field strength and volume resistivity of PI composite film with filler content.*

*3. Representative TEM micrographs **are shown in Fig. 2a and c** for MDF and ECAP cp-Ti respectively.*

*4. **Fig. 4a summarizes** the results of longitudinal residual lattice strains derived from lattice parameters for the three in situ HCF fatigue tests.*

*5. The fabrication processes of e-skin **are schematically illustrated in Figure 1**.*

*6. Morphologies of the Al-Cu alloy particles after impact onto the steel substrate **are shown in Fig.2 and Fig. 3**.*

*7. Cracks are observed on the Si columns after 40 cycles in 0.005 V to 2 V **(Figure 4a)**.*

*8. The continuous operation of the ultraflexible 3D-TENG is based on compressive deformation and elastic recovery of the shape **(Fig. 2a)**.*

*9. On the basis of the strong advantages of the ultraflexible 3D-TENG demonstrated above, we develop a smart self-powered system to send out the SOS distress signal in the field **(Fig. 5a)**, only relying on the weak stress from biomechanical motions.*

*10. Unique among metal 3D printing processes, and a major advantage of the introduced 3D printing of BMGs through FFF method is that the entire process can be carried out in air. Thermal and mechanical behavior **(Fig. 4a, b, c, e)** suggest no noticeable effect of the air exposure during fabrication.*

As shown, after the specific figure or table number, there is often an introductory statement that either presents the results to be described (i.e., indicative summary) as in Examples 1–6, or summarizes the general findings (i.e., informative summary), as shown in Examples 7–10. Such introductory statements can often be written as a paraphrase of the titles of the figures or tables.

You may have noticed that Examples 9–10 look a bit different from the others because the descriptions begin with a statement of the advantage of using certain methods. For some materials science papers, the Results section may also begin by briefly introducing the research method and the purpose of using this method, as shown in the following examples:

- *Finally, a portable self-powered system was also developed by integrating two 3D-TENGs with self-building converting/accumulating charge circuit core components for diode-bridge and capacitor. The viability of the charging electronics by biomechanical energy harvesting at compressed states was further evaluated. The relationship between charging voltage and load capacitance at 300 working cycles was measured, and then the charging voltage-time relationship at different load capacitances are shown in Fig. 6e and f, respectively.*

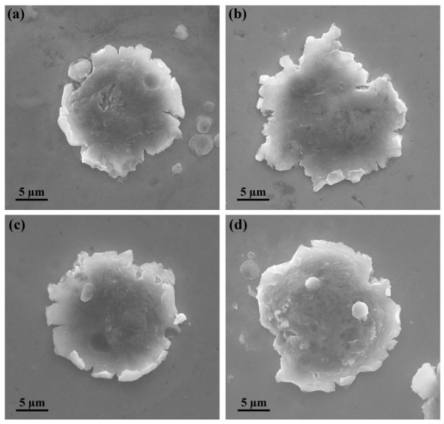
- *In this work, five different mass ratios (SST:PDMS), 100:0, 90:10, 70:30, 50:50, and 0:100, were employed to fabricate mixture polymer with definite dimension. SST polymer shows a typical cold flow feature (Figure 2a) while pure PDMS is incompressible (Figure 2b).*

- *To further mimic the protection as well as tactile sensing properties of e-skin, a drop hammer test device is applied to load/unload the impact excitation. The falling heights and weights are varied according to the experiments. e-skin with the length, width, and thickness of 40 × 15 × 3 mm is fixed on the force transducer, which is further placed on the button of a metal pedestal (Figure 6a).*

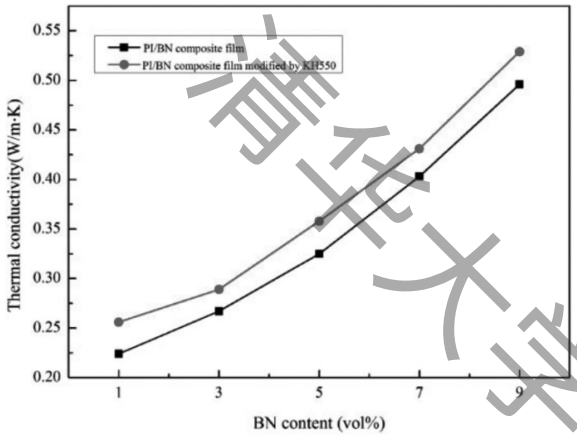
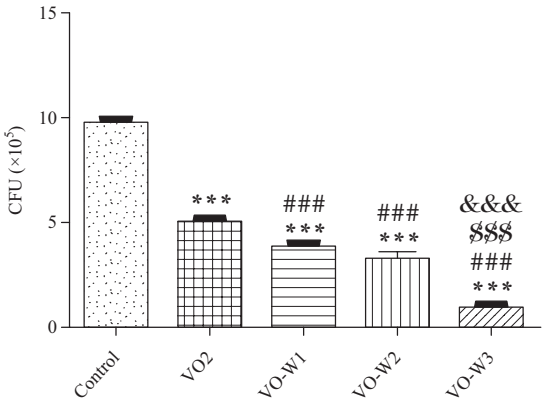
It should be noted that when referring to a figure in the text, the word "Figure" is often abbreviated as "Fig.", while "Table" cannot be abbreviated.

4.1.2 Move 2: Highlighting Specific Findings

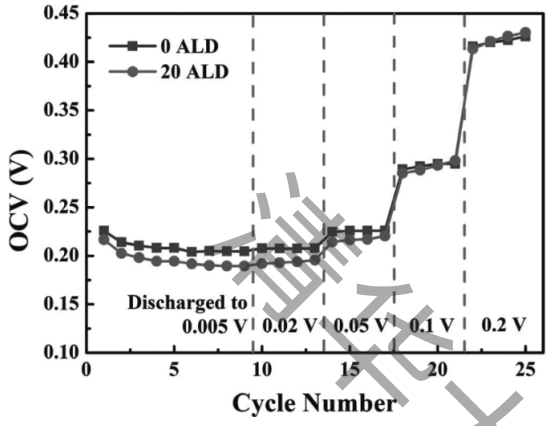
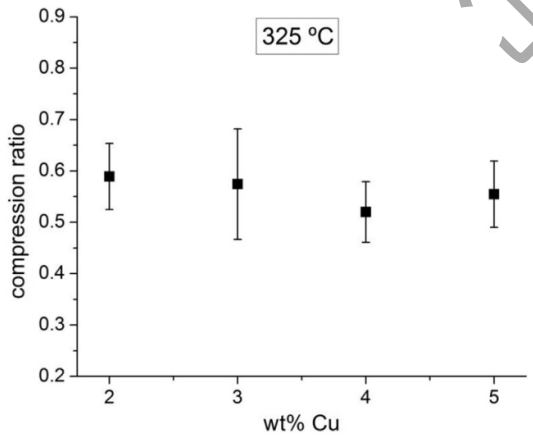
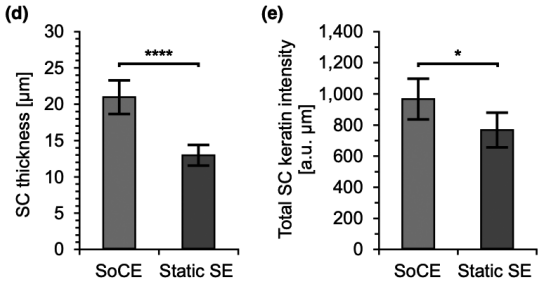
Specific results regarding changes, trends, relationships, effects over time, exact numbers, proportions, interactions, or physical appearance are presented in this move. These results should be closely related to the research questions and are often presented in an order that is from the most important ones to the less important ones. In addition, results in materials science papers should be presented in the same order as the research procedure described in the Methods section. It is also important to note that the written text should further summarize and highlight the main findings in the tables or figures, rather than simply repeat all the information in the graphics.

Figures	Examples
 **Fig. 2.** Secondary electron images of individual deposited particles (top-down view), (a) Al-2Cu, (b) Al-3Cu, (c) Al-4Cu, and (d) Al-5Cu sprayed at 325 °C.	*From the top-down view of deposited Al-Cu particles (Fig. 2), jet-like features were observed in the peripheral region of particles. It should be noted that the jetting features were not continuous around the particle, but instead showed multiple small fractures around the periphery of the impacted particle. No clear, qualitative difference in top-down impact morphology for different Al-Cu compositions was observed. Smaller particles were deposited on the top of some of the particles (e.g. Fig. 2 (d)).*

(Continued)

Figures	Examples
 **Figure 7.** Thermal conductivity of PI/BN composite films with different BN contents. PI: polyimide; BN: boron nitride.	*It can be seen from the figure that the addition of BN significantly increased the thermal conductivity of the PI/BN composite film and was positively related to the content. The thermal conductivity of pure PI was 0.211 W/(m•K). When BN was 1 vol%, the thermal conductivity of the composite film was 0.224 W/(m•K). When the BN content was 5 vol%, the thermal conductivity was increased to 0.325 W/(m•K). The thermal conductivity of the composite film was 0.496 W/(m•K) when 9 vol% BN was added to the PI matrix.* *It can also be seen from Figure 7 that after the surface modification of BN particles by KH550, the thermal conductivity of the PI/BN composite film was greatly improved compared to the unmodified one.*
	*The mean CFU/ml values of Control, VO_2, VO–W1, VO–W2, and VO–W3 were (10^5) as follows: 9.78 ± 0.23, 4.99 ± 0.17, 3.77 ± 0.23, 3.25 ± 0.31, and 0.98 ± 0.11 (Fig. 5c). Compared with the control group, VO_2 exhibited good anti-biofilm properties ($P < 0.001$), and remarkably, W doping further enhanced the anti-biofouling activity ($P < 0.001$). Meanwhile, the promoting effect was conductivity-dependent. Sample VO–W3 can exert a more powerful antimicrobial effect than samples VO–W1 and VO–W2 ($P < 0.001$).*

(Continued)

Figures	Examples
 **Figure 3.** Comparison of the OCVs measured after 5 h relaxation for Li/0-ALD-Si and Li/20-ALD-Si half cells at different states of discharge.	*The 0-ALD-Si electrode shows a higher OCV than the 20-ALD-Si electrode at the discharge state below 50 mV.* *It is also observed that the OCV for the two electrodes are almost the same at the discharge state higher than 0.1 V.*
 **Fig. 4.** Compression ratio as a function of Cu contents of Al-Cu alloys sprayed at 325 °C.	*The average compression ratio from Al-2Cu to Al-5Cu was 0.59 ± 0.06, 0.57 ± 0.11, 0.52 ± 0.06, and 0.55 ± 0.06, respectively (Fig. 4). Generally, the average compression ratio slightly decreased with copper alloy additions from 2–3 wt% Cu to 4–5 wt% Cu. The change in compression ratio with increasing gas temperature was also slight in the given temperature range from 225 °C to 325 °C.*
	*The mean stratum corneum thickness is 1.6-fold greater in the SoCE than in the Static SEs (Fig. 5d). The mean total keratin intensity in the SoCE's stratum corneum is 1.3-fold greater than in the Static SE (Fig. 5e).*

(Continued)

Figures	Examples

Table 1
Spreading angles before and after the ion irradiation of C–SiC coaxial nanotubes from cup-stacked and typical cylindrical MWCNTs.

	Parallel to nanotube length		Perpendicular to nanotube length
	Before irradiation	After irradiation	After irradiation
Cup-stacked MWCNT	52.7 ± 2.7°	31.8 ± 4.5°	25.5 ± 1.9°
Typical cylindrical MWCNT	19.6 ± 3.0°	31.4 ± 7.4°	————————

The spreading angles before and after ion irradiation are shown in Table 1. We found that the spreading angle of the C–SiC coaxial nanotube from typical cylindrical MWCNTs was increased by ion irradiation. However, in the C–SiC coaxial nanotube from cup-stacked MWCNTs, the spreading angle after irradiation was smaller than that it was before.

When reporting a series of results, linking words such as *in addition, also, further* (i.e., to add something) or *in contrast* (i.e., to make comparisons) can be used to make the descriptions more explicit and easier to follow.

4.1.3 Move 3: Commenting on Data

In this move, authors often give brief comments on the results. For example, they can briefly compare the results with the hypothesis or previous findings, explain the possible reasons for the results, or make implications about the data. This move is often combined with Move 2.

- *The capability of monitoring the respiratory rate and recognizing different words was demonstrated by adhering the sensor onto the chest and throat, respectively (**Move 2**), showing its promising application potential for disease diagnosis and prosthetics (**Move 3: making implications**).*

- *In addition, the pressure sensor demonstrated a quite low detectable pressure limit (1.5 Pa), a fast response time (<50 ms) (**Move 2**), which was comparable with the temporal resolution of human skin, and an excellent cycling stability (10,000 cycles at 0.15 kPa) (**Move 3: making comparisons**).*

- *Thermal and mechanical behavior (Fig. 4a, b, c, e) suggest no noticeable effect of the air exposure during fabrication (**Move 3: making implications**). Further, when considering the temperature exposure during the printing process (Fig. 4f) no discoloration can be discerned (**Move 2**), which would be indicative of oxidation (**Move 3: making implications**).*

- *The siloxene SSC device delivered a maximum power density of 272.5 mW cm^{-2}, which is higher than those of other silicon- and carbon-based SSCs (**Move 2**), highlighting their potential for application in energy storage (**Move 3: making implications**).*

- *The aluminum X-ray signal from the interface was much suppressed in intensity compared with the aluminum matrix nearby (**Move 2**). The gallium signal from the aluminum matrix was due to the use of gallium ion beam during the TEM sample preparation (**Move 3: giving explanations**). The relative intensity ratios of oxygen and carbon to aluminum in the interface were quite large (**Move 2**), suggesting that this amorphous region was relatively rich in carbon and oxygen (**Move 3: making implications**).*

- *The mean stratum corneum thickness is 1.6-fold greater in the SoCE than in the Static SEs (Fig. 5d). The mean total keratin intensity in the SoCE's stratum corneum is 1.3-fold greater than in the Static SE (Fig. 5e) (**Move 2**). These findings reinforce the histological observations by quantifying the water and keratin differences, confirming the superior epidermal morphogenesis in dynamically cultured SEs (**Move 3: making implications**).*

4.2 Two Organizations: Sequential Pattern and Alternating Pattern

Authors often organize the above-mentioned moves in two ways: sequential pattern and alternating pattern (李芝，2017). In a sequential pattern, authors present a series of relevant results and provide a general comment in the end; while in an alternating pattern, authors usually present one result and give a brief comment and then present another finding, which is followed by another brief comment (see Figure 4.1, p. 77). The following two examples illustrate the difference between these two patterns.

4.2.1 Sequential Pattern

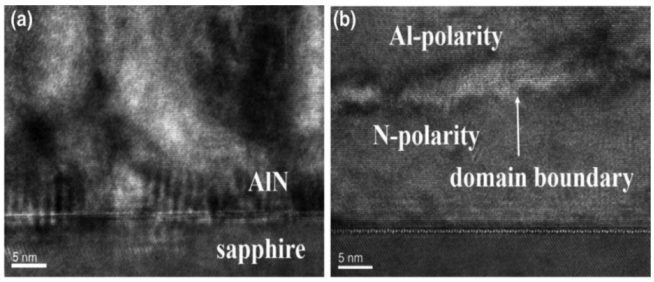


Fig.4 High-resolution TEM images of the 200-nm AlN/sapphire interfaces a before and b after 1650 ℃ annealing

- *Figure 4 shows high-resolution TEM images of the AlN/sapphire interfaces (**Move 1**). Poorly defined dense AlN grains were observed at the AlN/sapphire interface before annealing (**Move 2**). After 1650 °C annealing, the AlN grains recrystallized, and the AlN/sapphire interface turned clearer (**Move 2**). Furthermore, a domain boundary was observed about 15 nm above the AlN/ sapphire interface (**Move 2**). At the initial stage of*

*sputtering, several nanometer AlON film was deposited on the sapphire for better quality sputtered AlN (**Move 2**). Wu et al. reported that AlN on the AlON interlayer was grown with mixed polar, therefore an inversion domain was usually formed in the film. During the annealing process, the N-polar and Al-polar grains recrystallized respectively and left an inversion domain boundary propagated transversely in the AlN layer (**Move 3: giving explanations**).*

4.2.2 Alternating Pattern

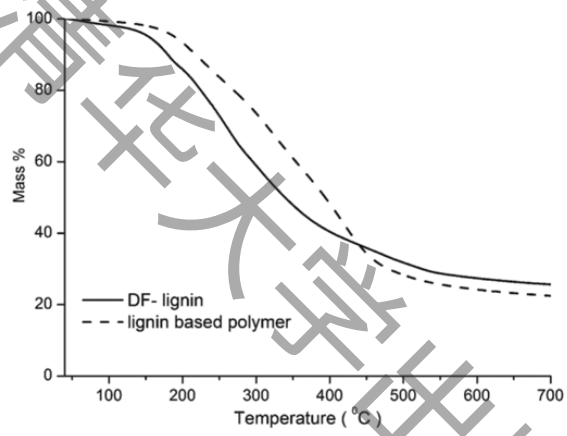


Fig.10 Thermogravimetric analysis of lignin based polyester and DF-lignin.

- *TGA thermograms of DF-lignin and synthesized lignin based polyester are shown in Fig. 10 (**Move 1**). From the TGA data, thermal stability factors including initial decomposition temperature and the temperature of 20% weight loss ($T_{20\%}$) were determined (**Move 1**). The results show that the synthesized lignin based copolymer is thermally stable up to 200 ℃ with T20% = 290 ℃. The initial decomposition temperature of DF-lignin is 180 ℃ and $T_{20\%}$ = 240 ℃ (**Move 2**). These results indicate that the newly formed polymer has a higher thermal stability compared to the starting material DF-lignin. The improved thermal stability suggests the formation of a polymerized product from DF-lignin (**Move 3: making implications**).*

4.3 Figure/Table Titles

Many readers and reviewers tend to skim the text and read the tables or figures directly for the results; titles of the tables or figures, in particular, are often the first place for readers to look at. Therefore, tables or figures should be presented as stand-alone entities that can best summarize the key data, and the titles of tables or figures should be as clear and informative as possible.

Tables are not frequently used in materials science papers. Authors often use tables to

present information or the experimental conditions. Therefore, the titles are often written in the form of a phrase, as shown in the following examples.

- *Table 1. Chemical composition (wt%) for Alloy 600 used in this study.*
- *Table 2. Summary of the experiments performed in the superheated low pressure H_2-steam environment at 480 °C for 210 h.*
- *Table 1. Tensile properties of as-received and severe plastic deformed cp-Ti samples.*

The titles of figures are more complicated, and often contain several elements:

(1) a brief title that summarizes the general information of the figure(s);

(2) details or specific results, sometimes with description of the units and symbols (optional);

(3) for multiple-visual figures, each figure is given a letter (e.g., a, b, c…) to distinguish from the other figures, and each figure is described individually;

(4) additional explanations of the components of the figures (e.g., notes, methods used) (optional).

The following table summarizes some commonly used figure titles.

Example Titles	Comments
Figure 8. Thermal conduction mechanism of PI/BN composite film. PI: polyimide; BN: boron nitride.	The title summarizes general information of Fig. 8 (i.e., thermal conduction mechanism of PI/BN composite) and provides explanatory notes to PI and BN. This type of title is similar to those of tables that are written in phrases and is often used for single-picture figures.
Fig. 8. Grain size distribution of individually deposited Al-2Cu and Al-5Cu particles sprayed at 325 ℃ (PED data).	The title introduces general information of Fig. 8 (i.e., grain size distribution) and specifies the experimental materials (i.e., Al-2Cu and Al-5Cu particles), the condition (i.e., 325 ℃), as well as the data type (i.e., PED data).

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(Continued)

Example Titles	Comments
Fig. 2. Bright-field TEM micrographs and grain size-distribution histogram for two types of UFG cp-Ti processed by MDF method shown in (a) and (b), and ECAP shown in (c) and (d).	The title first summarizes general information of Fig. 2 (i.e., bright-field TEM micrographs and grain size-distribution histogram), and provides additional information regarding the research method (i.e., MDF and ECAP methods) and the materials (i.e., UFG cp-Ti). In addition, letters are assigned to individual figures that present results with different methods. This type of title is often used for multiple-picture figures.
Figure 4. SEM images of (a) a 0-ALD-Si electrode and (b) a 20-ALD-Si electrode in their fully charged state after 40 charge–discharge cycles in the voltage range of 0.005–2 V. (c) A 0-ALD-Si electrode and (d) a 20-ALD-Si electrode in the fully charged state after 100 charge–discharge cycles in the voltage range of 0.23–2 V.	This title presents SEM images for different experimental conditions denoted by letters a–d. This type of title is often used for multiple-picture figures.
Fig. 3. (a) Pawley fitting obtained s gauss as a function of fatigue cycles for all three in situ tests showing the presence of noticeable grain size increase in MDF-1 that was fatigued at 25 °C; (b) and (c) single-peak fitting obtained relative peak intensity changes in MDF-1 for longitudinal and transversal directions, respectively. Note: The different peak intensities were normalized with respect to the initial value at 0 fatigue cycles, except for {0002} grain family where the peak was normalized with respect to the final value at 10^4 cycles.	There is no general introduction of the series of figures in this title, and individual figures are directly introduced. The description for each figure is written in complex phrases that present the main findings of each figure. An additional note is also provided for clarification of the data.
Fig. 8. Evolution of the average PIO as function of the oxidizing condition R (eq. (5)). The data from Molander et al. is also plotted as square root of the initiation time (solid green line and green diamonds) so that the dependence of the time-to-initiation and the PIO as a function of the oxidizing condition can be compared. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)	This title first summarizes the general information in Fig. 8 with a phrase, then additional details are provided for readers to better understand the figures.

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It should be noted that the titles of tables and figures are placed differently; the title of a table is placed above the table, while the figure title is often positioned below the figure.

4.4 Verb Tense

It is a common practice to use simple present tense in Move 1, simple past tense in Move 2, and simple present tense in Move 3, but we recommend authors to refer to the Author Guidelines or the latest published articles of the target journals to get a better sense of how verb tense is used.

4.4.1 Move 1: Simple Present Tense

When locating the tables or figures, simple present tense is often used.

- *The procedure of charging based on these circuits is presented in Fig. 5g.*
- *Fig. 6b shows all the necessary components in the smart lighting shoe, and its digital photograph after formed is shown in Fig. 6c.*
- *Morphologies of the Al-Cu alloy particles after impact onto the steel substrate are shown in Fig. 2 and Fig. 3.*

4.4.2 Move 2: Simple Past Tense

When reporting findings, simple past tense is often used; however, simple present tense is preferred in some disciplines or journals (e.g., *Advanced Materials*).

- *From the top-down view of deposited Al-Cu particles (Fig. 2), jet-like features were observed in the peripheral region of particles. It should be noted that the jetting features were not continuous around the particle, but instead showed multiple small fractures around the periphery of the impacted particle. No clear, qualitative difference in top-down impact morphology for different Al-Cu compositions was observed. Smaller particles were deposited on the top of some of the particles (e.g. Fig. 2 (d)).*
- *The average compression ratio from Al-2Cu to Al-5Cu was 0.59 ± 0.06, 0.57 ± 0.11, 0.52 ± 0.06, and 0.55 ± 0.06, respectively (Fig. 4). Generally, the average compression ratio slightly decreased with copper alloy additions from 2–3 wt% Cu to 4–5 wt% Cu. The change in compression ratio with increasing gas temperature was also slight in the given temperature range from 225 °C to 325 °C.*
- *The steel substrate was much harder than the impacting aluminum alloy particle, and as such, almost no penetration of the particle into the substrate was noted for any of the compositions.*

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- *By optimizing testing circuitry and shield setting, the interference from proximity signals is minimized, leading to a better sensing performance in contact mode.*

4.4.3 Move 3: Simple Present Tense

Although Move 3 is often combined with Move 2 and is often stated in a "-ing" adjunct structure, authors tend to use simple present tense when making comparisons with previous findings or the hypotheses, and use modal auxiliaries when explaining the results or making implications to make their claims less absolute and more plausible (For more information regarding being tentative, refer to Chapter 7).

- *This indicates that the ideal crystal growth could not be achieved by dipping of the seed with a long period after reaching a high temperature. (**Making implications**)*
- *This is consistent with the absence of neutron diffraction peak corresponding to {0002} grain families for both pre- and post- fatigued conditions. (**Making comparisons**)*
- *The ultrafine grains at the interfacial region are very likely formed via dynamic recrystallization, as indicated by the low intragranular misorientation (blue grains) in the GROD maps. (**Giving explanations**)*

4.5 Sample Analysis

Title: Solution Growth of SiC from the Crucible Bottom with Dipping under Unsaturation State of Carbon in Solvent

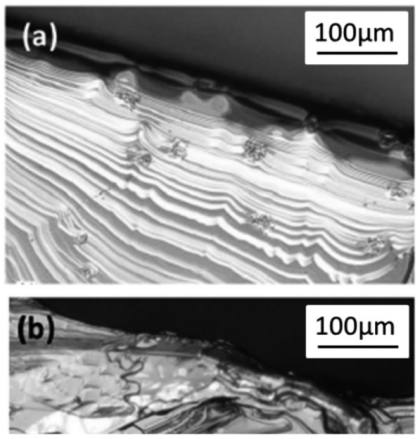

Fig. 2. Optical microscopy image of SiC crystals grown by the TSSG method with the dipping time after reaching 1,800 °C of (a) 15 min, (b) 120 min.

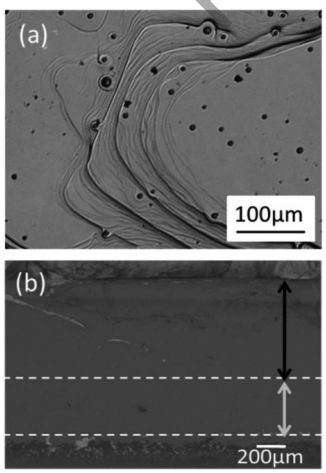

Fig. 3. Optical microscopy image of SiC crystals of (a) growth surface, (b) cross section, grown from the crucible bottom after 2h from the dipping.

Excerpts	Comments
Figure 2(a) and 2(b) shows the optical microscopy images of the periphery of SiC crystals grown by the TSSG method after dipping, with the period after reaching 1,800 ℃ of 15 min and 120 min, respectively.	**Move 1: Locating the results** in Figures 2(a) and 2(b), followed by a summary statement that shows the content of the figures. Notably, the summary statement is a paraphrase of the figure title.
In the case of the period of 15 min, the growth surface was smooth with the step-flow-like curves shown in Fig. 2(a). At the periphery of the grown crystal, the quality was almost the same as that at the center. According to Raman spectroscopy, the polytype of the grown crystal was 4H-SiC.	**Move 2: Highlighting the findings** presented in Figure 2(a). The findings are mainly based on observations and are described in simple past tense.
This indicated that the ideal crystal growth was achieved by dipping the seed in the early stage soon after reaching high temperature.	**Move 3: Commenting on data** presented in Figure 2(a) by indicating the implication of the results.
However, in the case of a period of 120 min, the growth surface was not smooth, especially, it was rough at the periphery as shown in Fig. 2(b). Polycrystallization occurred at the periphery.	**Move 2: Highlighting the findings** presented in Figure 2(b). "However" is used to show the comparisons between the case of 15 min (Fig. 2(a)) and that of 120 min (Fig. 2(b)). Again, the findings are mainly based on observations and are described in simple past tense.
This was proposed to be induced by the adhesion of extra small SiC grains, which had random crystallographic orientations and were formed by the supersaturated carbon in the solvent during the crystal growth. The polytype was mainly 4H-SiC, but the crystal quality was considerably lower than that shown in Fig. 2(a). This indicates that the ideal crystal growth could not be achieved by dipping of the seed with a long period after reaching a high temperature.	**Move 3: Commenting on data** presented in Figure 2(b) by giving possible reasons and making implications.
However, Figure 3(a) and 3(b) shows the optical microscopy images of the growth surface and cross-section of the SiC crystals grown from the crucible bottom at 1,800 ℃, respectively.	**Move 1: Locating the results** in Figures 3(a) and 3(b).

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(Continued)

Excerpts	Comments
The growth surface shown in Fig. 3(a) was observed after removing the residual solvent covering the grown crystal by isotropic etching. Step-flow-like curves morphologies were observed, although spherical-shaped voids existed. According to Raman spectroscopy, the polytype of the grown crystal was 4H-SiC. Such SiC crystals were grown with a smooth interface between the 4H-SiC seed (yellow arrow) and the grown layer (black arrow) as shown in Fig. 3(b). A layer thickness of approximately 500 μm on the 4H-SiC seed was obtained after 2 h from the dipping.	**Move 2: Highlighting the findings** presented in Figures 3(a) and 3(b). These results are presented sequentially through a series of verbs, including "observe", "grow", and "obtain".

Clearly, the results are described logically, figure by figure. For each figure, the three moves are presented in an alternating pattern in which the authors present one major finding and provide a brief comment, and then present another finding, sometimes with comments and sometimes without. This way of presenting findings is very common in materials science papers because there are usually numerous data to be reported. However, only the relevant data should be discussed.

4.6 Useful Expressions

In this section, useful expressions in each step will be provided with examples.

Move 1: Locating the Tables and/or Figures

* *Figure 1 summarizes/presents/describes/shows/demonstrates/illustrates/displays/depicts/lists/details/compares…*
* *Figure 5 schematically illustrates…*
* *Figure 1a is a schematic representation of…*
* *The schematic representation of X is shown in Figure 1.*
* *As shown in Fig. 2, …*
* *[A statement of results] (Fig. 4).*
* *As illustrated/indicated/shown in Fig. 1, …*
* *X can be observed in Fig. 1.*
* *It can be seen in Fig. 7 that…*
* *Fig. 3 shows…, where…(Fig. 3a), and where…(Fig. 3b).*

* *The extent of X and Y for each sample was measured and the results are plotted as function of Z in Fig. 4.*

Move 2: Highlighting Specific Findings

* *This resulted in a significant/moderate increase in…*
* *X decreased/increased/declined with the increase of Y.*
* *X increased as Y increases.*
* *X (significantly) increased/decreased from…to…*
* *X resulted in a significantly increased X, whereas no significant difference between the groups was observed in Y.*
* *X gradually increased with the increase of Y, consistent with an increase in the density of Z.*
* *X was significantly enhanced with the light intensity increased from…to…*
* *…, leading to a significantly increased X.*
* *The conversion of X continuously increased with temperature.*
* *X increased from its initial value over the course of…days and retained 85% of its peak performance after…days.*
* *…were observed in the peripheral region of the particles.*
* *Smaller particles were deposited on the top of the particles.*
* *The degree of X, as quantified by…, did not vary significantly with increasing Y.*
* *X exhibited the lowest/highest compression ratio.*
* *X slightly decreased with Y additions from…to…*
* *The change in X with increasing temperature was also slight in the given temperature range from…to…*
* *The deposited particles were severely deformed, but the deformation was not uniformly distributed.*
* *This increasing level of X was further confirmed by…, in which the blue color suggests…, and green to yellow colors indicate…*
* *Substantial X occurred at the particle/substrate interfaces.*
* *X was clearly revealed by…*
* *X was similar between…and…*
* *X was obtained after 2 h from the dipping.*
* *No significant difference was found/identified/revealed/detected/observed in X.*
* *The effect is particularly strong in X where it leads to long-range correlations in…*
* *The two curves intersect at…*
* *The microstructure consists of X with a mean grain size of…*

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* *For X, there was a measurable grain growth but the degree was much less compared to Y.*
* *The intensity of all the diffraction peaks dropped with a similar proportion.*
* *...reveal a progressive increase in X with..., whereas a limited decrease for Y.*
* *The Gaussian peak width derived from...did not exhibit any clear trend in terms of peak width broadening or shrinking as a function of X.*
* *It is evident that X had a much larger grain size, but the grain size in Y remained unchanged.*
* *X had a grain size increase from...to...as a result of...*
* *When the content of X was low, the filler particles were evenly dispersed in...and the gap between particles was large.*
* *X was uniformly covered with a rough external oxide layer.*
* *The SEM observations revealed that...*
* *After exposure, TEM analysis revealed that X was not straight but deviated laterally by...from its original path into Y.*
* *Under the hypotheses..., it is possible to correlate X with Y via Z as shown in Eq. 1.*
* *X was much harder than the impacting Y.*
* *By optimizing..., X is minimized, leading to a better sensing performance in contact mode.*
* *...was developed by integrating X with Y.*

The following table summarizes some useful adjectives and their corresponding adverbs that can describe the extent of changes.

Adjectives	Adverbs	Adjectives	Adverbs	Adjectives	Adverbs
substantial	substantially	steep	steeply	considerable	considerably
significant	significantly	moderate	moderately	slight	slightly
minimal	minimally	rapid	rapidly	steady	steadily
gradual	gradually	continuous	continuously	constant	constantly

Move 3: Commenting on Data

* *It appears/seems that...*
* *It is (highly) likely/probable/possible that...*
* *It is / may be reasonable to assume that...*
* *The evidence points to the likelihood/probability that...*
* *The evidence suggests/indicates/implies that...*

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* *After reduction, the transcurrents increased with positive voltage gating, indicative of…*
* *X was significantly enhanced from…to…, which was attributed to / due to…*
* *X increased from its initial value over the course of…days and retained 85% of its peak performance after…days, showing…*
* *X was very likely/probably/possibly formed via Y, as indicated by…*
* *X was quite large, suggesting/indicating that…*
* *It is clear/evident that…*
* *As expected, there is/was…*
* *As reported by [citation], …*
* *This could be owing to / due to…*
* *Combining X as shown in Fig. 1 and Y as shown in Fig. 2, the present work provides unambiguous evidence to support that…should play a vital role in…because…*
* *This observation has also been reported in previous studies on X.*
* *X is comparable to Y, confirming Z.*
* *Thus, X did not affect the extent of Y.*
* *Consistent with…, measurements showed a prominent peak at…associated with the strong coupling between X and Y, in sharp contrast to…, which lacks…*

When making comparisons with earlier studies or the research hypothesis, the following expressions can also be used: *be identical to, be consistent with, be comparable with/to, be in line with, contrary to, be inconsistent with, support, provide compelling evidence, corroborate, confirm, prove, reinforce, validate, contradict,* and *verify*.

4.7 Checklist for Writing the Results Section

You can refer to the following checklist for writing the Results section.

- Are the data reported according to your research questions?
- Is there a clear match between the Results and the Methods sections?
- Are the results clearly presented in a logical sequence?
- Are tables and/or figures used to help report the data?
- Are the tables and/or figures clearly presented?
- Are the tables and/or figures stand-alone entities? Are the table/figure titles clear enough to allow readers to understand the research without reading the texts?

- Are the results briefly commented on?
- Are the verb tenses appropriately used?

Figure 4.1 summarizes the main points discussed in this chapter.

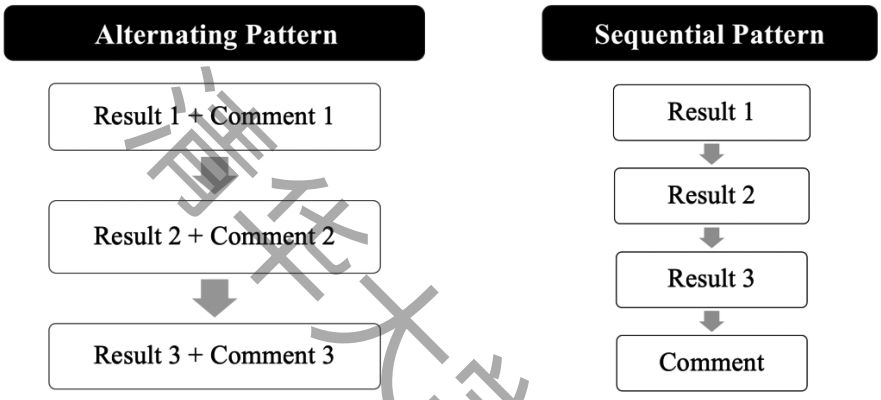

Figure 4.1 A summary of the Results section

The following rhyme summarizes the essence of the Results section.

研究结果

研究结果是核心，报告结果要切题。
数据展示用图表，一目了然效率高。
三大要素两结构，时态使用也讲究。
首先告知图位置，图表概要现在时。
结果描述要客观，简评结果依据足。
描述讨论可交替，先叙再议也可取。
描述多用过去式，讨论多用模糊语。

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Exercises

I. Identify the three moves in the following passage and indicate in which order the three moves are organized.

Figure 2 is an infrared spectrum of the surface modification of BN and AlN by silane coupling agent KH550. It can be seen from Figure 2 that curve (a) is the FTIR diagram of the silane coupling agent KH550, curves (b) and (d) are the FTIR diagrams of the surface modification of the BN and AlN by KH550, and curves (c) and (e) are FTIR patterns of BN particles and AlN particles. According to the infrared spectrum of silane coupling agent KH550, it was found that KH550 had obvious characteristic absorption peaks at 2926.74, 1442.31, 1389.61, and 1072.18 cm^{-1}, and the characteristic peak at 2926.74 cm^{-1} represented the expansion and contraction of C–H bond in $-CH_2$. The vibrations 1442.31, 1389.61, and 1072.18 cm^{-1} corresponded to characteristic peaks of the $Si\text{-}O\text{-}CH_2CH_3$ group. The characteristic peaks of 1370.53 cm^{-1} and 780.16 cm^{-1} represented the stretching vibration peak and bending vibration peak of the BN bond, indicating the existence of BN, and the characteristic peak of 726 cm^{-1} signified the bending vibration of Al-N-Al, which proved the existence of AlN. The curves in the comparison showed that the characteristic absorption peaks of BN and AlN had changed after KH550 surface modification. The BN and AlN curves that had no characteristic absorption peaks at 2926.74 cm^{-1} and 1100.22 cm^{-1} had a weaker characteristic peak, and the characteristic peaks at the 1100.22 cm^{-1} were corresponding to the stretching vibration absorption peak of the Si-O-Si bond. The step proved that KH550 had been successfully connected on the surface of BN and AlN.

II. Match the following research results with appropriate diagrams.

A		B	
C		D	
E		F	
G			

1. The distance between particles decreased. _____

2. The breakdown field strength and volume resistivity of PI/BN composite film decreased first and then increased. _____

3. The composite filler had a more significant decrease in thermal conductivity due to the synergistic effect. _____

4. The distribution of the microhardness values fluctuates because of the effect of this intercalated strip structure in the SZ. _____

5. The dry weight of sucralfate remained unchanged for at least 20 min. _____

6. The interface impedance gradually increased after completely stripping Li. _____

7. NOE measurements showed a prominent peak at 7.79. _____

III. Read the following table and fill in the blanks with the appropriate forms of the given verbs.

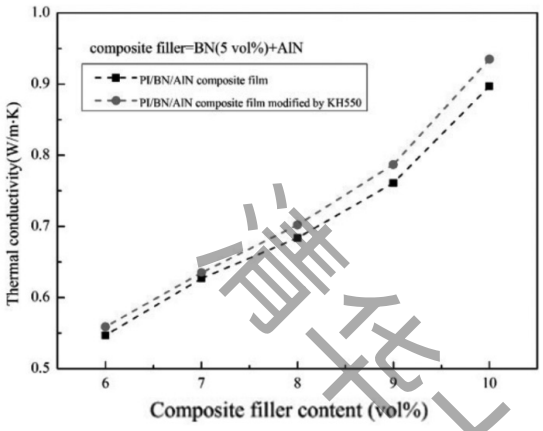
Table 1

The mean value of corrosion current (I_{corr}) and pitting potential (E_b) of the highly polished Co28Cr6Mo disk and SPMK-grafted Co28Cr6Mo disk with 0.9% NaCl and 0.9% NaCl+25% BSA as the electrolytes

Samples	0.9% NaCl		0.9% NaCl+25% BSA	
	Icorr (10-6 A)	Eb (V)	Icorr (10-6 A)	Eb (V)
highly polished Co28Cr6Mo disk	4.51	0.011	1.41	0.002
SPMK-grafted Co28Cr6Mo disk	0.126	0.446	0.096	0.378

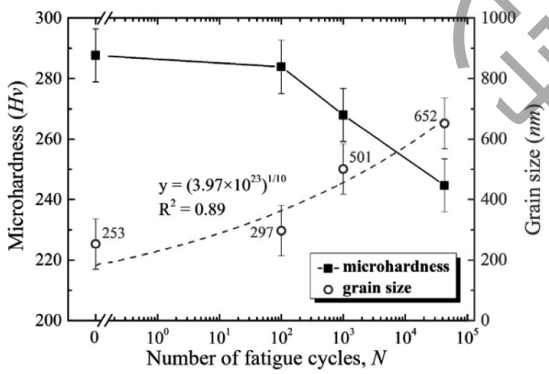
The potentiodynamic polarization curve of the highly polished Co28Cr6Mo disk and the SPMK-grafted Co28Cr6Mo disk in 0.9% NaCl and 0.9% NaCl coupled with 25% BSA (1)_____ (show) in Figure 6, and the Icorr and Eb values of the samples in these two electrolytes (2) _____ (summarize) in Table 1. It is clear from this table that for both 0.9% NaCl and 0.9% NaCl coupled with 25% BSA, Icorr-polished CoCrMo (3) _____ (large) than Icorr-grafted CoCrMo, whilst Eb-polished CoCrMo (4) _____ (small) than Eb-grafted CoCrMo. This result (5) _____ (indicate) that SPMK surface grafting on CoCrMo alloy (6)_____ (reduce) the corrosion rate of the material.

IV. Write the titles of the following figures according to the location statements.



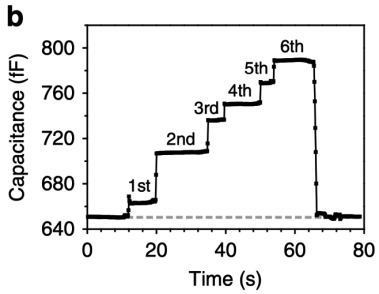
1. Title: _____

Location statement: Figure 9 displays the change curve of thermal conductivity of PI/BN/AlN composite film with the content of composite fillers.



2. Title: _____

Location statement: Fig. 7 presents grain size data (based on TEM micrographs) as well as micro-hardness data as a function of fatigue cycles for MDF-1 (25 ℃).



3. Title: _____

Location statement: Pressure as low as 7.3 ± 1.2 Pa is detected and recorded in real time by the sequential application of six water droplets to the sensor, as shown in Fig. 4b.

Chapter 5
Writing the Discussion Section

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field.

1. How is the Discussion section started?
2. What elements are included in the Discussion section?
3. How are verb tenses used in the Discussion?
4. How do authors highlight the important findings?
5. How is the Discussion section ended?

5.1 General Introduction

Discussions are perhaps the most often neglected part of many papers. As mentioned in Chapter 4, data do not speak for themselves; it is the authors' responsibility to make them meaningful. In other words, authors need to be very clear about the significance of the current study, what new insights have been brought by the current study, how the research questions have been addressed, and what remains to be investigated in future research, and so on.

The title of this section also varies from journal to journal. As noted in Chapter 1, some journals title this section as "Discussion", while some other journals title this part as "Results and Discussion" or "Discussion and Conclusion". In the first two cases, the elements to be included in the Discussion are similar. The Conclusion section, which is out of the scope of this book, is often brief and short, comprising one or two paragraphs highlighting the major contributions of the current study, acknowledging the limitations, or recommending directions for future research.

As you can see from Figure 5.1, the Discussion section forms a reverse shape of the Introduction section. While Introduction usually moves from a general, broad focus to the narrower "report" sections of the paper (i.e., Methods and Results), the Discussion moves away from that narrow section to a wider, more general research area. The Discussion section revisits the points made in the Introduction based on the results of the current study. When authors start the Introduction, they help readers move into the research focus by establishing the significance of the topic, providing background information, reviewing other researchers' work, indicating the need for further investigation, and summarizing the key findings of the current study. Following the reverse pattern, authors often start the Discussion by revisiting the main results of the study, explain how the results can potentially fill the research gap, and end this section by helping readers navigate possible ways to address the problems raised in the Introduction and move forward the research area. Therefore, parts of the Discussion may repeat some elements of the Results section.

Writing the Discussion section is challenging because it involves a lot of critical thinking, which makes it different from the Results section. Showing what the results are is the main function of the Results section, while talking about what they mean is the central function of the Discussion. As illustrated in Figure 5.1, authors need to think about how the evidence from the current study (i.e., Results) and the evidence from previous research (i.e., Literature Review) tell a story together and to make such connections in the Discussion section. It is from these

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connections that authors could draw a conclusion that is meaningful to a broader research field.

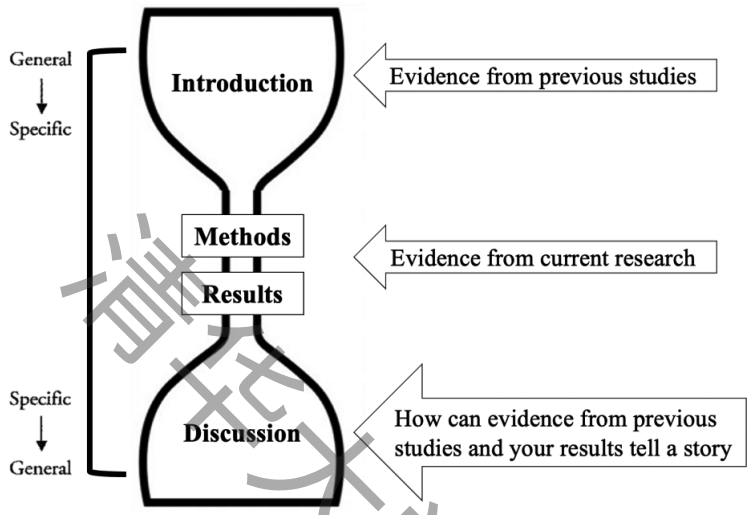

Figure 5.1 The IMRD Structure

5.1.1 Move 1: Revisiting Key Results

This move mainly serves as a reminder that helps readers recall the methods used in the current study and organize the key findings. No new information should be added in this section.

- **Step 1:** Reminding readers of the methods used in the study, sometimes with a statement summarizing the purpose of using certain methods.
- *To determine the mechanism, we first cultured MRSA in vitro to investigate their response to pure and W-doped VO_2 thin films.*
- *Oxidation studies on Alloy 600 SA were performed in low pressure superheated H_2-steam environments at 480 °C for 210 h in order to understand the role of the preferential intergranular oxidation on SCC by using a range of complementary analytical microscopy techniques.*
- *Based on the experimental data from in situ synchrotron X-ray diffraction experiments, the probable plasticity mechanisms occurring in these two films are now discussed.*
- **Step 2:** Summarizing the main results obtained from the current study.
- *Our study introduces a novel organ-on-chip device and a novel SE culture protocol to show that innovative microfluidic design combined with state-of-the-art epithelial tissue culturing can yield significant improvements in the quality and functionality of an*

organotypic skin.

- *In summary, we have demonstrated the capability of W-doped VO_2 thin films to act as functional antifouling coatings.*
- *A portable self-powered temperature sensor or a smart watch is also successfully developed.*

5.1.2 Move 2: Mapping Current Study with Previous Research

In this move, authors discuss relationships or trends and cause-effect relations based on the data obtained from the study. It is also important to compare the results with previous similar research. When discussing the results, authors should refer to specific results either from the current study or from others' work to support these generalizations.

- **Step 1:** Situating your study in the literature. In the literature review, authors provide a picture of the current state of inquiry in a research area. Therefore, in the Discussion section, authors are responsible for explicitly showing readers how and where the present study fits into that picture and in what way it changes or affects the research agenda in this area. For example, the current study may have used a different method to produce similar results; it may confirm the results obtained in a previous study; it may contradict and therefore discredit results obtained in a previous study; it may offer a completely different approach, or it may extend the results and therefore confirm the implications of previous studies. It is important to focus primarily on the literature that has appeared in the Introduction and Methods sections to avoid bringing up new information in the Discussion section.
- *Contrary to other devices developed for skin studies [citation], ours is made of thermoplastics and relies on a one-step thermal bonding fabrication process. Hence, it eliminates potential issues of chemical and biocompatibility associated with polydimethylsiloxane-based microdevices for cell culture [citation] and is amenable to mass production techniques such as injection molding and hot embossing. The use of optically transparent support membranes and PMMA as bulk material [citation], as well as the miniaturized design allow for real-time, non-invasive imaging with lower autofluorescence [citation].*
- *Various studies have demonstrated the contribution of fibroblast density [citation], fibroblast precultivation time [citation]… [a series of factors with citations are omitted here for the sake of brevity]. These factors were also reported to aid to a certain extent in reduction of culture period. However, in addition to the use of exogenous factors, these*

studies also employed fetal bovine serum, hormones and/or growth factor supplements such as triiodothyronine, transforming growth factor-b1, heparin, fibroblast growth factor-b, and platelet-derived growth factor-b. On the contrary, in this study, we reconstructed SEs with superior epidermal morphogenesis, BM maturation, and enhanced barrier functions using culture media devoid of fetal bovine serum and expensive growth factor supplements, and an organ-on-chip system with dynamic perfusion and controlled ventilation.

- *In addition, the specific nano-patterns appearing on the thin-film surfaces may also contribute to the antimicrobial effect. For instance, nickel nanostructures are able to alter the adhesion behaviors of Staphylococcus aureus on material surface. Puckett et al. also investigated the effects of nanorough, nanotubular and nanotextured titanium surfaces against the adhesion of Staphylococcus aureus. It was found that the bacteria unlikely adhered onto the nanorough surfaces, whereas the nanotubular surfaces provided a good environment for bacterial adhesion.*

- **Step 2:** Providing explanations. In this step, authors give possible reasons to their results. It is important to identify the unexpected results and explain what may have caused these results.

- *It was observed from Figure 9 that the thermal conductivity of the composite film increased with the increase of the composite filler content. This phenomenon could be analyzed first by the principle of "thermal conduction path". When the content of filler particles was low, the particles could not contact each other and could not form local heat conduction chain or heat conduction network. As the particle content increased, the local heat conduction network gradually formed and the thermal conductivity gradually increased. If the filler content was further increased, the thermal conduction network became complete and the thermal conductivity was also bound to rise.*

- *Since very small magnitudes of lattice strains were accumulated for {1011} and {2021} grain families at the end of fatigue cycles, it is very unlikely that micro-yielding at these soft oriented grains already occurred in the fatigued MDF-1 cp-Ti. Note both the diffraction peaks corresponding to {1012} and {1013} grain families were not found for the longitudinal bank measurement, due to the deformation texture associated with the severe plastic deformation means. The second reason that helps to rule out the dislocation slip involved grain growth is laid out below.*

- **Step 3:** Making implications. This step allows authors to draw conclusions from the results, or in other words, to explain what these results actually mean in the context of

existing knowledge. These implications may clarify how the results can address the research questions.

- *These results confirm a close relationship between the electrical conductivity (band structure) and antifouling activity of VO_2 thin films.*
- *As evidenced by this study, W doping can effectively modulate the VO_2 phase change initiated by temperature alteration and the thermochromic optical property just comes concomitantly.*
- *A comparison to widely established FFF of thermoplastics, a mature and commercially available technology, suggests a high degree of similarity. It is therefore plausible that many of the engineering challenges that have been solved in thermoplastic FFF can be readily translated to the printing of BMGs.*

5.1.3 Move 3: Highlighting Significance

In this move, authors focus on the achievement or contributions of their work. Positive languages are often used to emphasize the advantages of the current study. Given the practical nature of materials science research, such advantages may include the application of the results in real-world situations, which often corresponds to the research background stated in the Introduction section.

- *Excellent performance of this system could be evidence for the 3D-TENG as a promising power source to be applied in self-powered electronic devices and their controlling.*
- *We believe that on the basis of the ultraflexible 3D-TENG, many kinds of application areas will spring out to make people's life more fascinating.*
- *The ultraflexible 3D-TENG and the new method of hybrid 3D printing are unique and distinct in its fundamental mechanism, which can effectively avoid problems that includes layer-by-layer structures, inconvenient fabrication process and inescapable elastic supporting for reciprocating motions.*
- *Vocalization recognition and respiratory rate monitoring have been demonstrated as examples of human physiology monitoring applications, which shows promising potential for applications in disease diagnosis, prosthetics, and various wearable devices.*

5.1.4 Move 4: Stating Limitations or Recommending for Future Research

Materials science researchers sometimes acknowledge the limitations of their work, but very often frame them as suggestions for future research. This invites the research community

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to improve the status of the current work.

- *However, further investigations are required to finetune the flow rates of media and air toward the development of SoCE with better differentiation and barrier functions similar to normal human skin.*

- *Future work using electron energy loss spectroscopy (EELS) should shed more light onto the composition of these amorphous interface layers.*

- *In the future, integration of the organ-on-chip device with a fluidic control system, an on-stage incubator, and a downstream fraction collector will enable the automation of the culture and testing processes.*

- *Although promising, these existing methods have at least one of several limitations: extended period of functional loss during self-repair; need for manual reassembly; dependency on external or redundant electronics for damage detection and circuit restoration; need for external energy sources such as heat, light or mechanical energy; or dependency on non-ambient conditions such as increased relative humidity or temperature. Overcoming these limitations has the potential to dramatically improve the longevity, performance and functionality of deformable electronic materials.*

5.2 Highlighting and Hedging

Highlighting and hedging are strategies that can strengthen or weaken authors' opinions. They not only show authors' certainty about their results but also show their attitudes toward these results. To illustrate, highlighting expressions allow authors to assert a statement with confidence, while hedging expressions may show authors' cautiousness when interpreting the results by weakening their opinions. However, they are not contradictory skills, a combination of which may achieve different effects when discussing the results. For instance, highlighting can help readers see the significance or major contributions of the study by using eye-catching adjectives and adverbs.

- To show the study's innovation: *innovative, novel, cutting edge, ...*
- To show the study's importance: *important, significant, of central/vital/fundamental importance, ...*
- To show authors' certainty: *clear(ly), obvious(ly), evident(ly), conclusive(ly), definite(ly), ...*

However, to protect authors from accusations that they are too certain about their findings,

tentative languages can be used to soften their claims, especially when interpreting their results or making implications. These tentative languages include adverbs (e.g., *probably, possibly, often, generally, relatively, somewhat,* and *often*), adverbial phrases (e.g., *to a certain extent*), adjectives (e.g., *probable, likely,* and *possible*), tentative verbs (e.g., *tend to, seem, appear, indicate,* and *suggest*), as well as modal auxiliaries (e.g., *can, could, may, would,* and *should*). Tentative languages usually appear most frequently in the Discussion section, as shown in the following paragraph taken from the Discussion section of a paper entitled "High-Cycle-Fatigue Induced Continuous Grain Growth in Ultrafine-Grained Titanium".

- *It is generally* (**adverb**) *agreed that the primary basal {0002}<1120> or prismatic {1010}<1120> slip systems are not capable of accommodating plastic deformation along the c-axis for the hcp α-phase in titanium and its alloys [citation]. Hence either twinning [citation] or <cpa> slip modes operating on the {1011} and {1122} planes are required to ensure full plasticity [citation]. By using in situ synchrotron X-ray diffraction combined with tensile deformation on Tie6Ale4V, it was reported by Stapleton et al. [citation] that {1012} grain family is the first to exhibit micro-yielding, followed by {1011}, {2021} and {1013} grain families. Since very small magnitudes of lattice strains were accumulated for {1011} and {2021} grain families at the end of fatigue cycles, Fig. 4c, it is very unlikely that* (**adjective**) *micro-yielding at these soft oriented grains already occurred in the fatigued MDF-1 cp-Ti. Note both the diffraction peaks corresponding to {1012} and {1013} grain families were not found for the longitudinal bank measurement, due to the deformation texture associated with the severe plastic deformation means. The second reason that helps to rule out the dislocation slip involved grain growth is laid out below. As a consequence of room-temperature HCF fatigue, the grain size increased from 253 nm to 652 nm for MDF-1 (Fig. 5d), this might suggest* (**modal auxiliary + tentative verb**) *that some micro-yielding could have* (**modal auxiliary**) *already occurred due to the continuous material softening as revealed by the hardness drop in Fig. 7. However, for the ECAP cp-Ti that has the initial grain size of 638 nm (Fig. 5f), the elastic limit is 544 MPa (Table 1). This means that even for the post-fatigued MDF-1 having a grain size of 652 nm (similar to the initial grain size of ECAP), the elastic limit should be* (**modal auxiliary**) *much higher than the applied fatigue stress amplitude of 280 MPa. It is thus concluded that the grain growth observed here is very unlikely to be* (**adjective**) *related to the dislocation slip process.*

Apparently, a combination of different hedging strategies are adopted in this passage to soften the authors' claims while leaving room for flexibility in interpreting the results.

5.3 Verb Tense

As in previous chapters, verb tenses used in the Discussion section vary according to its moves and are quite flexible. We believe that based on your experience in reading the previous chapters, you may have had a clearer sense of the use of verb tense in writing research papers. Because authors bring together the results from both the current study and previous research in the Discussion section, the rule of thumb is that when authors describe the specific findings from the current study, simple past tense is more commonly used, while when authors comment on the results by making comparisons or give explanations, simple present tense is preferred. In addition, authors can also express various levels of certainty through the use of modal auxiliaries when they voice their opinions.

5.3.1 Simple Past Tense

When authors summarize the major findings or restate the research methods, simple past tense is often used.

- *SiC crystals were grown by the TSSG method and from the crucible bottom by changing the dipping timing after when the growth temperature was reached.*
- *In this work, a novel e-skin array with multifunctional sensing properties and safeguarding performance was designed by assembling PET film, AgNWs, and hybrid polymer composites. Shear stiffening polymer mixed with small amounts of PDMS was used to prepare the hybrid polymer.*
- *Repeated impacts during cold spray process resulted in a more uniform distribution of deformation in the prior particle interior of the coating compared with that observed in the interior of the single deposited particle.*

When authors present findings from previous literature, simple past tense is often used.

- *Puckett et al. also investigated the effects of nanorough, nanotubular and nanotextured titanium surfaces against the adhesion of Staphylococcus aureus. It was found that the bacteria unlikely adhered onto the nanorough surfaces, whereas the nanotubular surfaces provided a good environment for bacterial adhesion.*

5.3.2 Present Perfect Tense

Present perfect tense is sometimes used when authors summarize the key findings from the current study.

- *Skin-inspired highly stretchable and conformable matrix networks have been fabricated that integrate temperature, strain, humidity, light, magnetic, pressure, and proximity sensors as multifunctional detection matrix.*

- *In summary, we have demonstrated the capability of W-doped VO_2 thin films to act as functional antifouling coatings.*

5.3.3 Simple Present Tense

Simple present tense is often used when authors compare the current results with previous findings or make comments.

- *A direct comparison between a single impacted Al-5Cu particle and an Al-5Cu coating after cold spray shows the importance of subsequent particle impacts after the initial impact. The deformation structure evolves from impacted, single particles to a coating developed from many impacts.*

- *This result suggests that subsequent impact of powder particles plays a key role in developing the deformation structure in the previously-bonded single particles.*

- *These results confirm a close relationship between the electrical conductivity (band structure) and antifouling activity of VO_2 thin films.*

5.3.4 Modal Auxiliaries

Modal auxiliaries are preferred when authors give explanations to the results, make implications, or make recommendations for future work.

- *This skin-inspired SCMN, which features simultaneous multi-stimulus sensing, adjustable sensing range/large-area expandability, and potential high-density 3D integration, can sense the magnitude and location of multi-stimulus sensing in real time, impressively construct a personalized intelligent prosthesis for pressure/temperature sensing, and will likely attract considerable attention for its application to humanoid robotics, new prosthetics, human-machine interfaces, and health-monitoring technologies.*

- *The thermosensation ability of e-skin by varying the colors just like the chameleon epidermis can be used to assess external temperature. Moreover, e-skin with good shear stiffening property can impede external force and absorb nearly 50% of impact energy which presents ideal safeguarding property.*

- *The cold spray literature and the results of the current paper suggest that the nature of*

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the interface between an impacted particle and the substrate may be material-system dependent.

- *In addition, the specific nano-patterns appearing on the thin-film surfaces may also contribute to the antimicrobial effect.*

5.4 Sample Analysis

Title: On the Existence and Origin of Sluggish Diffusion in Chemically Disordered Concentrated Alloys	
Excerpts	**Comments**
Using three atomistic modeling techniques: μs-scale MD, k-ART and conventional lattice kMC, the vacancy diffusion in Ni-Fe alloys has been studied.	The authors restate the methods used in the current study.
The concentration dependence of the diffusivity has found to be non-monotonic. The total tracer diffusion coefficient has minimum near the fcc-lattice site percolation threshold, ~20 at.%Fe. Contrary to intuition and the models considered before, an increase in the concentration of Fe—the faster species in Fe-Ni alloy—leads to a decrease in the total tracer diffusion at concentrations between 0 and ~20 at.%Fe.	The authors revisit one of the results, which contradicts the hypotheses.
This minimum is explained by the effect of Fe atoms on the energy barriers of Ni atom jumps for $C_{Fe} < 20\%$. For $C_{Fe} > 20\%$, vacancy jumps from one Fe site to another with an effective migration energy that decreases with increasing Fe-Fe coordination number. The ratio of partial tracer diffusion coefficients of Fe and Ni atoms, D^*_{Fe}/D^*_{Ni}, obtained by MD for 20 and 50 at.%Fe alloys is equal to 0.8 and 8.0 for 900 K and 0.7 and 7.3 for 1100 K. The latter values are similar to the k-ART predictions of ν_{Fe}/ν_{Ni} (which are 1.0 and 9.5, respectively).	The authors explain the unexpected findings by writing "This minimum is explained by the effect of …".
This confirms that the composition dependences of D^* and D^*_{Fe}/D^*_{Ni} obtained by MD simulations are accurately reproduced by the k-ART which takes into account only local transition states.	The authors make implications of the findings by writing "This confirms that…".

(Continued)

Excerpts	Comments
In addition, the cNEB energies for Ni and Fe atom jumps into a vacancy averaged for each alloy composition and shown in Fig. 4a have been used to calibrate the conventional lattice kMC [citation]. A comparison with the MD and the k-ART data is presented in Fig. 4b. As can be seen, the minimum of D^* at ~20 at.%Fe is reproduced by kMC. The composition-dependent E^a obtained from the Arrhenius treatment of the MD, k-ART and kMC data are presented in Fig. 4c. The three techniques reveal an increase of E^a with increasing C_{Fe} up to the site percolation threshold, and a decrease of E^a for $C_{Fe} > 20\%$.	The authors revisit another result.
This indicates that the diffusion in concentrated alloys can be qualitatively predicted by the kMC using composition dependent transition state energies, which is dramatically faster than both MD and k-ART. This suggests that the site percolation and composition dependence of the activation energy of vacancy migration are the reasons for the non-monotonic $D^*(C_{Fe})$ dependence (see Fig. 1a). The two effects are the underlying driving forces for sluggish diffusion. One can predict that alloys with the largest differences in the vacancy formation energy between different atomic subsystems at a composition near the site percolation threshold will exhibit the strongest effect.	The authors make implications of the result by writing "This indicates that…", "This suggests that", and "One can predict that".
In the conventional theoretical studies of alloy diffusion, the ratio of the exchange frequencies of different species with vacancies is usually taken to be independent of alloy composition. As a result, the correlation factor and the diffusion coefficient both found to increase monotonically with increasing concentration of faster species (see e.g. [citation]). With the same assumption, our lattice kMC calculations reproduce this result (see in Fig. 3). In the present study, the activation barriers for vacancy-atom exchange jumps and the ratio of corresponding frequencies are considered to depend on alloy composition.	The authors situate the current study within the literature by making comparisons with other research.

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(Continued)

Excerpts	Comments
A surprising fact has been revealed, namely that an increase of concentration of faster species (Fe atoms) in fcc Ni-Fe decreases the overall atomic diffusion. The composition dependence of the tracer diffusion coefficient has a minimum near the site percolation threshold for fastest species (see examples in Figs. 1–4). The very existence of the minimum in the diffusion coefficient and its magnitude depends on the alloy composition. In the present calculations, the effect is quite significant. So, the minimum value of the diffusion coefficient at 500 K is found to be about five times lower than in pure Ni.	The authors explain the "surprising" result.
In this study we did not consider the effect of vacancy concentration on the total diffusivity. The vacancy concentration is an important parameter, which also depends on the alloy composition through the vacancy formation energy. Preliminary *ab initio* and classical MD calculations demonstrated that the vacancy formation energies in the Ni-Fe equiatomic alloy and other concentrated solid solutions [citations] vary within a wide range depending on the local atomic configurations. However, detailed investigations of these effects have not yet been performed and accurate estimations of the concentration of mobile vacancies in concentrated alloys with chemically different components is currently impossible. For this reason, in this study we limited ourselves to the effects of composition on a single vacancy migration.	The authors state and justify one limitation of the study by writing "In this study we did not consider the effect of…" and "in this study we limited ourselves to the effects of…".
The effects reported in these diffusion simulations explain why equiatomic fcc alloys of up to four or five components (MEAs and HEAs) tend to demonstrate the best properties [citation]. Indeed, five is about the optimum number of components in the fcc lattices to ensure the absence of site percolation for each component, which maximizes sluggish diffusion. It is interesting that, in the bcc lattices, the site percolation threshold is $p_c \approx$ 25 at.%; hence about four components should be optimal. In general, the CSAs with component concentrations near p_c are more likely to maintain structural stability as a result of their slow microstructure evolution, including component segregation and second phase precipitation.	The authors make implications of the study by combining the above discussed results, tapping into the research focus of this study.

(Continued)

Excerpts	Comments
According to the results presented here the vacancy diffusion and self-diffusion of the fast component—Fe in NiFe—will significantly decrease if the concentration of the fast component element decreases under the percolation threshold, but self-diffusion of the slow component—Ni in NiFe—will increase. This explains why Ni self-diffusion is higher in CoCrFeNiMn than in CoCrFeNi [citation]. The current study also confirms the composition dependence of the activation barrier for vacancy jumps of subcomponents [citation]. It should be emphasized that this composition dependence qualitatively changes the diffusion properties, as the percolation effects alone cannot explain the non-monotonic dependence of diffusivity on the subcomponent concentration.	The authors highlight significant results by writing "The current study also confirms…" and "It should be emphasized that…".
While not in the scope of this work, the optimization of alloy composition to improve other alloy properties, such as minimization of the mobility of interstitial defects to enhance radiation tolerance, may be achievable. For instance, interstitial atoms are also expected to have percolation effects that can be studied in a way similar to vacancies. Such coupled percolation-barrier effect most likely explains why ion-irradiation-induced component segregation is observed at loops and voids in NiFeCrCo, but not in NiFeCrCoMn [citation], as the concentration of the solid solution components reduces from 25% to 20%.	The authors make several implications of the results by pointing out the possibility to improve other alloy properties by optimizing alloy composition.
The physical background put forth here, based on the coupling of percolation and composition-depend barriers in each component sub-system, may reconcile experiments on MEAs and HEAs where sluggish diffusion is observed [citation] and those where it is not [citation]. Moreover, this work provides a design method for controlling atomic transport in CSAs and an effective simulation approach implementing composition-dependent activation energies in kMC simulations, based on DFT calculations of migration barriers. It allows for fast, yet accurate, predictions enabling pre-selection of alloys with potentially desired properties without time-consuming MD modeling and/or expensive experimental examinations. Other, e.g. magnetic, alloy properties can be traced simultaneously within the same computational framework.	The authors highlight the significance of the study.

5.5 Useful Expressions

In this section, useful expressions in each move and step are provided with examples.

Move 1: Summarizing Research Results

* *The current study found that…*
* *These experiments confirmed that…*
* *Another important finding was that…*
* *The present study was designed to determine the effect of…*
* *The most striking/important/significant/interesting/unexpected finding is…*
* *What is surprising is that…*
* *One unanticipated finding was that…*
* *Contrary to expectations, this study found no significant difference between…*
* *In this paper, we investigated/examined/presented/outlined/described…*
* *Surprisingly, X was found to…*
* *Surprisingly, no differences were found in…*
* *One unexpected finding was the extent to which…*
* *The weak association of X with Y is interesting, but not surprising.*

Move 2: Mapping Current Study with Previous Research

Step 1: Situating Your Study in the Literature

A. Listing evidence

* *New evidence has found that…*
* *Studies have shown that…*
* *It is clear from numerous studies that…*
* *Recent research has demonstrated that…*
* *This view is supported by the findings of a recent study, which show a clear link between…*
* *Little evidence has shown that…*
* *[citation] reported/found that…*

B. Comparing results with other studies

* *This finding is consistent with that of [citation] who…*
* *Results in this study corroborates these earlier findings.*

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* *This also confirms our earlier observations which showed that…*
* *This study supports evidence from other research [citations] that…*
* *This finding broadly supports the work of other studies in…*
* *This outcome is contrary to that of [citation] who found…*
* *In contrast to earlier findings, however, no evidence of…was detected.*
* *The yields in this study were high compared to those of other studies.*
* *It was suggested that…[citation]; however, this does not appear to be the case in this study.*
* *These results differ from [citation], but they are broadly consistent with earlier studies.*
* *Although these results differ from some studies [citations], they are consistent with those of…*
* *As [citation] proposed/suggested/found…*
* *Similar films on gold nanoparticles have also been found to be liquid-like.*
* *Previous studies evaluating X observed inconsistent results on whether…*
* *The results of this study challenge [citation]'s assumptions that…*
* *X provides results that are comparable to the existing…research.*
* *The results are inconsistent with those of previous research in that…One possible explanation for this difference is that…*
* *These results further support the idea of… / confirm the association between… / are consistent with data obtained in… / match those observed in earlier studies / are in line with those of previous studies.*
* *These findings are somewhat surprising given the fact that other research shows…*

Step 2: Providing Explanations

* *A possible explanation for this might be…*
* *This result may be explained by…*
* *Several factors could explain this observation. Firstly, …*
* *These relationships may partly be explained by…*
* *This inconsistency may be due to…*
* *The observed increase in X could be attributed to…*
* *This discrepancy could be attributed to / due to / caused by…*
* *Differences between X and Y may have influenced…*
* *These findings may be somewhat limited by…*
* *It is possible/likely/probable that…*
* *These data must be interpreted with caution because…*
* *This interesting/surprising/unexpected finding may be related to… / might be a result of… / could be caused by…*

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It should be noted that words or expressions that denote causal relationships can also be used when explaining the results, such as *stem from, derive from, because of, as a result of, generated, lead to, contribute to, make, be responsible for, promote, result in, as a result, yield, bring about, as a consequence, therefore,* and *consequently*.

Step 3: Making Implications

* *These findings (further) indicate/suggest that…*
* *In general, it seems/appears that…*
* *The value of X suggests that a weak link may exist between…*
* *These results provide further support for the hypothesis that…*
* *These initial results are suggestive of a link between X and Y.*
* *These findings confirm that…*
* *These observations have several/three main implications for research into X.*
* *A further important implication is that…*
* *From these figures, it is clear that the implementation of X does affect the growth rate of Y.*

Move 3: Highlighting Significance

* *This study emphasizes/highlights the importance of…*
* *This finding is of vital importance for researchers.*
* *X plays a special/central/important/major/key/vital role in…*
* *Our results provide compelling evidence that…*
* *Our results provide a clear distinction between X and Y.*
* *These preliminary results demonstrate the feasibility of using X.*
* *X can be applied to a wide range of…*
* *Notwithstanding its limitation, this study suggests that…*
* *X therefore could be used for…*
* *This approach has great potential in areas such as…*
* *This study broadens / challenges / confirms / corroborates / extends / modifies / provides insights into / verifies…*
* *This study is the first step towards enhancing our understanding of…*
* *Our method/technique/approach/procedure could be applied to…*
* *One possible/potential/promising application of our technique would be…*
* *This could potentially lead to…*
* *Taken together, these findings suggest/implicate/highlight the role of X.*
* *Our study provides the framework / a springboard / the basis for a new way to do X.*

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* *X provides a powerful tool/methodology for…*
* *These findings add to a growing body of literature on X.*
* *These findings substantially add to / enhance our understanding of X.*
* *This research sheds new light on / provides new insights into…*
* *The present study fills a gap in the research on…*
* *Understanding the link between X and Y will help…*
* *The importance and originality of this study is that…*
* *The present research explores, for the first time, the effects of X.*
* *This study contributes to this growing area of research by exploring…*
* *Therefore, this study makes a major contribution to research on X by demonstrating…*

Move 4a: Stating Limitations

* *The limitations of this study are…*
* *The findings of this study are restricted to…*
* *This study has addressed only the question of…*
* *It should be noted that this study has been primarily concerned with…*
* *However, the findings fail to imply…*
* *The results of this study cannot be taken as evidence for…*
* *Unfortunately, we are unable to determine from this data…*
* *Despite these promising results, questions remain.*
* *However, the neural mechanisms underlying these effects remain to be determined.*

Move 4b: Recommending Future Research Direction

* *Future work using X should shed more light onto…*
* *Further research should be undertaken to validate these findings.*
* *A further study with more focus on X is therefore suggested.*
* *Future studies on the current topic are therefore recommended.*
* *In future investigations, it might be possible to use a different X in which…*
* *This finding is promising and should be explored with other materials.*
* *Future work should focus on…*
* *Future research is needed to address the following questions.*
* *Further studies are required to determine/examine/evaluate/explore the mechanisms behind/underlying…*
* *An important question for future studies is to determine…*
* *It would be beneficial/useful to…*

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5.6 Checklist for Writing the Discussion Section

You can refer to the following checklist for writing the Discussion section.

- Did your Discussion section move from specific results to general implications?
- Did you connect your findings to those of the previous studies?
- Did you explain your results?
- Did your results or the results of others support your explanations?
- Did you discuss the unexpected results?
- Were the conclusions drawn based on the results obtained in the current study?
- Did you use appropriate languages when summarizing results, explaining your results, or making implications?

Figure 5.2 summarizes the main points discussed in this chapter.

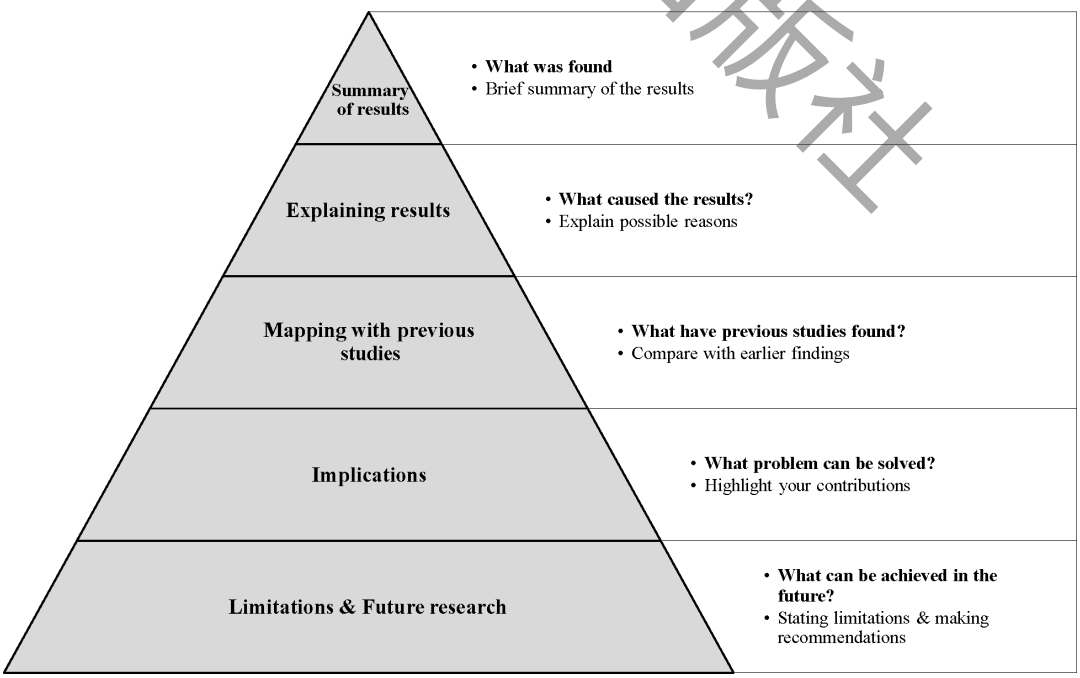

Figure 5.2 A summary of the Discussion section

The following rhyme summarizes the essence of the Discussion section.

结果讨论

结果讨论最难写，夹叙夹议是关键。

数据结果是事实，数据讨论表观点。

只有数据无意义，仅有讨论无依据。

结果原因需解释，数据意义要说明。

假设是否可证明，相比前人可一致？

讨论引言相呼应，由小及大解问题。

观点态度要鲜明，结论谨慎留余地。

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Exercises

I. Identify the moves and steps in the Discussion section of a research paper in your field.

II. Read the following two passages and answer questions.

Passage 1

Sensors constructed on these structures were evaluated. Figure 3f shows that the normalized sensitivity of the device ($S/S_{wrinkle}$), where $S_{wrinkle}$ is the sensitivity obtained from the device with only the wrinkle structures, increased quickly as the area-occupying ratio of the hollow structures increased. The pressure response from the device with the best performance is shown in Figure 3g. It shows an ultrahigh sensitivity of 14.268 kPa^{-1} in the low-pressure region (<0.7 kPa) and 0.032 kPa^{-1} in the high-pressure region (0.7−40 kPa) and a large working range (40 kPa). In particular, the sensitivity was boosted almost one order of magnitude over the one without the hollow structure. Figure 3h shows the sensitivity and pressure range of this device, compared with those of pressure sensors in previous reports [citations]. Obviously, our device exhibits the highest sensitivity and a relatively large pressure range simultaneously. Moreover, our device exhibits an ultralow detectable pressure limit of 1.5 Pa, benefiting from the considerably reduced effective mechanical modulus because of the introduction of hollow structures, as shown in Figure S7.

1. What is the main result of this study?
2. Is the result in this study consistent with previous studies? Underline the expressions indicating the comparison.
3. What is the author's claim in this paragraph? Does the author show any proof for his claim?
4. How does the author explain the results?

Passage 2

It was observed from Figure 9 that the thermal conductivity of the composite film increased with the increase of the composite filler content. This phenomenon could be analyzed first by the principle of "thermal conduction path". When the content of filler particles was low, the particles could not contact each other and could not form local heat conduction chain or heat conduction network. As the particle content increased, the local heat conduction network gradually formed and the thermal conductivity gradually increased. If the filler content was further increased, the thermal conduction network became complete and the thermal conductivity was also bound to rise. In addition to the "thermal conduction path" theory to explain the improvement of thermal conductivity, the synergistic effect of composite fillers

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was also an important reason to improve the thermal conductivity of composite films. The synergistic mechanism was that BN had a certain aspect ratio, which could play a role of bridging and penetrating between AlN fillers. When the content of AlN was low, BN particles could effectively connect multiple AlN particles and form a plurality of heat conduction paths in the matrix, thereby improving the thermal conductivity of the composite film. When the content of AlN was 1 vol%, the thermal conductivity of the composite film was 0.144 W/(m•K) higher than that of the 7 vol% PI/BN composite film, indicating that the synergistic effect played an obvious role. At the same time, it could also reduce the amount of thermal conduction particles to a certain extent. As the AlN content was further increased, the effect of this synergistic effect was more pronounced. After the modification of BN and AlN by silane coupling agent KH550, the thermal conductivity of the composite film was improved compared with the unmodified one, because the silane coupling agent optimized the inorganic–organic interface structure, enhanced the bonding ability between the two, reduced the number of defects between the interfaces, enhanced the phonon transfer, and improved the thermal conductivity of the composite film.

1. What finding is discussed in this passage?
2. What is the purpose of this passage?
3. What are the explanations that the authors have offered?
4. How are these reasons connected? Underline the expressions connecting the possible reasons.

III. The following sentences either interpret experiment results or make implications from the findings. Improve the underlined parts and correct the errors if the statements are too strong or too absolute by using hedging expressions.

1. The orientation difference of the recrystallized microstructure and as-deformed UFG microstructure *is caused by* the anisotropic grain growth behaviour where the {0001} grain family with their c-axis perpendicular to the fatigue load axis grew much faster at the expense of other grain families.
2. In conclusion, patterned silicon electrodes were fabricated by photolithography and RIE technology *for the first time*. It shows stabilized cycling performance and no cracks are observed after the first charge to 2 V. The 20-ALD-Si electrode exhibits *the best* cycling performance compared to the uncoated electrode.
3. As a result, the silicon electrode with ALD coating shows better capacity retention in a long run. It hints that surface coating a well-fabricated, nano-sized, Si-based composite *leads to* a practical anode with high coulombic efficiency and good cycling performance.
4. Considering the easy/exact controllability fabrication process (micron scale) and the common resin materials used, it *will* achieve high flexibility, high precision, large area, and mass production in the future.

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Chapter 6
Writing the Abstract and Title

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Lead-in Questions

Answer the following questions based on your knowledge of research articles in your field.

1. How is the abstract started?
2. What information is included in the abstract? In what order?
3. What information does the title convey?
4. What features can you observe from the title?

6.1 General Introduction

Abstracts are short, informative writings that serve as screening tools or previews for research papers, conference presentations, and other communications. Abstracts are extremely important. Journal editors may decide whether to send the paper for external review based on the abstract. Reviewers will probably read the abstract first before reading other parts of the paper. If they are not attracted by the abstract, they may simply stop reading and reject the paper, rather than wasting their time reading and evaluating the rest of the paper. In fact, a well written abstract is often the sign of a good paper, which will encourage readers to continue reading.

The focus of an abstract (summary vs. results) and its format (with headings vs. without headings) vary across contexts. However, there are generally five moves that appear in an abstract. The length of each move can vary (from a phrase to sentences), and some moves may be omitted depending on the abstract's audience and purpose; however, the sequence of the moves is rather fixed.

6.1.1 Move 1: Introducing Background or Problem

This move mainly deals with what is currently known about the topic under investigation, and what is still unknown, or what needs further exploration. Such statements usually start with an idea, the purpose of the study, a problem or a research gap. Bear in mind that the context setting should not take up more than 20% of the whole abstract.

- *Flexible pressure sensors play an important role in electronic skins (E-Skins), which mimic the mechanical forces sensing properties of human skin* (**a fact**).
- *This present work introduces a new understanding of the precursors events to Stress Corrosion Cracking (SCC) initiation in nuclear power plant components, exploring the role of grain boundary migration and Preferential Intergranular Oxidation (PIO)* (**purpose of the study**).
- *The colonization of microorganisms on material surfaces, or namely biofouling, is a challenging matter in both the medical and marine industries* (**a problem**).
- *Whereas 3D printing of thermoplastics is highly advanced and can readily create complex geometries, 3D printing of metals is still challenging and limited. The origin of this asymmetry in technological maturity is the continuous softening of thermoplastics*

with temperature into a readily formable state, which is absent in conventional metals (**a research gap**).

6.1.2 Move 2: Presenting Research Purpose

This move mainly presents the research purpose, sometimes with justifications.

- *Unlike conventional metals, bulk metallic glasses (BMGs) demonstrate a supercooled liquid region and continuous softening upon heating, analogous to thermoplastics. Here we demonstrate that, in extension of this analogy, BMGs are also amenable to extrusion-based 3D printing through fused filament fabrication (FFF).*
- *Here we present a skin-inspired highly stretchable and conformable matrix network (SCMN) that successfully expands the e-skin sensing functionality including but not limited to temperature, in-plane strain, humidity, light, magnetic field, pressure, and proximity.*
- *A rational design for a pressure sensor with adjustable characteristics is in high demand for different application scenarios. Here, we present tunable, ultrasensitive, and flexible pressure sensors based on compressible wrinkled microstructures.*
- *With the inspiration of the metabolism cascade of microorganisms, this study develops a new antifouling material surface that enables the drainage of extracellular electrons from the electron transfer chain in microbial metabolism, thereby interrupting the energy metabolism and subsequent microbial viability.*

6.1.3 Move 3: Describing Methodology

Sometimes the methods adopted in the current study may be omitted, and sometimes they may be combined with other moves in the abstract.

- *The UFG microstructure was created by equal channel angular pressing (ECAP) and multi-direction forging (MDF).*
- *A series of polyimide (PI) composite films were prepared using PI as matrix and boron nitride (BN) and aluminum nitride (AlN) as the doped phases. The modification of the thermal conductive filler particles was characterized by Fourier transform infrared (FTIR).*
- *A sudden emergence of new continuous graphitic layers in the microstructure were observed by in situ transmission electron microscopy following ion irradiation, where these layers were perpendicular to the nanotube's length direction.*

- *When utilizing the BMGs'supercooled liquid behavior, 3D printing can be realized under similar conditions to those in thermoplastics.*

- *This thought has been realized by tungsten doped vanadium dioxide (VO_2) thin film using customized magnetron-sputtering deposition. The aim of tungsten doping is to tune the semiconductor-to-metal phase change of the VO_2 thin film and then endow the temperature-responsive electrical conductivity (band structure).*

6.1.4 Move 4: Reporting Results

This move briefly reports the main findings from the current study, and so constitutes the most important part in the abstract.

- *The activation parameters show that the films deform mainly by dislocations and give indications about their mean free paths, whereas the Bragg peak positions, widths and areas bring invaluable information on residual stress as well as on some plasticity properties, like dislocation storage inside the grains or grain rotations. For the demonstration, two sputter-deposited nanocrystalline 50 nm-thin films deposited onto stretchable substrates are studied. It is shown that an as-grown sample (at a homologous temperature of 0.22) presents a stress-assisted annealing, thus decreasing its initial defect density, whereas if a thermal annealing (3 h at 200 °C, corresponding to a homologous temperature of 0.35) has been applied to the sample before the tensile test, it deforms by conventional plasticity, and the dislocations are not stored inside the grains. These mechanisms lead to different work-hardening properties.*

- *The SiC crystals in the CeSiC coaxial nanotube became amorphous, also due to the ion irradiation, although the critical amorphization dose was higher than that for bulk SiC. Most remarkably, the carbon layer remained crystalline, even after an irradiation dose higher than 20 dpa (displacement per atom).*

- *The initial step is the microbial adhesion onto the metallic VO_2 film to form the direct microbe–VO_2 physical contact, which leads to the destructive extraction of electrons from the transmembrane protein complex of the respiratory chain (a discharge process); this induces oxidative stress and energy starvation and, eventually, interrupts the microbial membrane function. Finally, the microbial membrane integrity is destroyed, which leads to intracellular matter leakage (electrocution).*

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6.1.5 Move 5: Interpreting Results

This move serves the function of concluding the abstract by explaining how this study has contributed to the field. Researchers sometimes write about the implications or explanations of the results.

- *This work shows how a moderate annealing can have a profound influence on the mechanical behaviour of these thin films.*
- *Due to the similarity between FFF of thermoplastics and BMGs, this method may leverage the technology infrastructure built by the thermoplastic FFF community to rapidly realize and proliferate accessible and practical printing of metals.*
- *This demonstrates that the carbon layer experiences high compression stress during ion irradiation. Thus, the ion irradiation of CeSiC coaxial nanotubes gives rise to a novel development of the microstructure and can be considered as one of the new synthetic processes for making novel carbon nanomaterials.*
- *This study demonstrates that the temperature-dependent VO_2 electrical conductivity or band structure serves as a key factor to modulate the antimicrobial capability of tungsten-doped VO_2 thin film. It is believed that the current findings can provide a new insight for the development of new antifouling surfaces.*

Abstracts in materials science papers should be concise; therefore, you need to avoid mentioning the following information in the abstract:

(1) background information that is too general for your readers;

(2) claims that are not supported in the paper;

(3) terms that are too technical;

(4) definitions of key terms;

(5) mathematical equations;

(6) generic quantifications (e.g., *many, several, few, a wide variety of*) and the use of subjective adjectives (e.g., *innovative, interesting, fundamental*);

(7) unnecessary details;

(8) references to other papers.

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6.2 Verb Tense

The verb tenses used in the abstract are similar to the ones used in the corresponding sections of the article, although in some cases the simple present tense is used throughout the abstract.

When introducing the research background or research problem, simple present tense is often used.

- *Mechanosensation electronics (or electronic skin) consists of mechanically flexible and stretchable sensor networks that can detect and quantify various stimuli to mimic the human somatosensory system, with the sensations of touch, heat/cold, and pain in skin through various sensory receptors and neural pathways.*
- *The colonization of microorganisms on material surfaces, or namely biofouling, is a challenging matter in both the medical and marine industries.*
- *Whereas 3D printing of thermoplastics is highly advanced and can readily create complex geometries, 3D printing of metals is still challenging and limited.*

When presenting the research focus, simple present tense is generally used.

- *With the inspiration of the metabolism cascade of microorganisms, this study develops a new antifouling material surface that enables the drainage of extracellular electrons from the electron transfer chain in microbial metabolism, thereby interrupting the energy metabolism and subsequent microbial viability.*
- *Here we present a skin-inspired highly stretchable and conformable matrix network (SCMN) that successfully expands the e-skin sensing functionality including but not limited to temperature, in-plane strain, humidity, light, magnetic field, pressure, and proximity.*
- *We report here a practical, ultraflexible and three-dimensional TENG (3D-TENG) that is capable of driving conventional electronics by harvesting biomechanical energy.*
- *This present work introduces a new understanding of the precursors events to Stress Corrosion Cracking (SCC) initiation in nuclear power plant components, exploring the role of grain boundary migration and Preferential Intergranular Oxidation (PIO).*

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When describing the research methodology, simple past tense is often used.

- *The cyclic deformation behaviour and microstructural stability of severe plastic deformation processed bulk nanostructured (ultrafine-grained, UFG) commercially pure cp-Ti were investigated by using in situ neutron diffraction combined with R= – 1 high-cycle-fatigue (HCF) loading at room and cryogenic temperatures* (**combining the research focus and the methodology**).

As you may have noticed, the research methodology in materials science paper abstracts is often combined with other elements, connected with "*by + doing*" structure. You can find more examples below:

- *Furthermore, by intentionally introducing hollow structures in the PDMS wrinkles, our pressure sensor exhibits an ultrahigh sensitivity of 14.268 kPa*$^{-1}$ (**combining the research results and the methodology**).

- *Implementing respiratory monitoring and vocalization recognition is realized by attaching the flexible pressure sensor onto the chest and throat, respectively, showing its great application potential for disease diagnosis, monitoring, and other advanced clinical/biological wearable technologies* (**combining the research results and the methodology**).

When briefly reporting the results, simple past tense is often used, and sometimes present perfect is also used.

- *The UFG microstructure was created by equal channel angular pressing (ECAP) and multi-direction forging (MDF). A considerable continuous grain growth was revealed by neutron diffraction for MDF cp-Ti fatigued at 25°C, as opposed to that at 200°C. The same HCF fatigue loading at 25°C only caused very limited grain growth for ECAP cp-Ti. Transmission electron microscopy confirmed the grain growth. Further confirmation of the room-temperature HCF fatigue-induced grain growth was obtained by transmission Kikuchi diffraction based analysis.*

- *In this work, a systematic evaluation of Alloy 600 exposed in low pressure H_2-steam over a range of oxidizing potentials in the vicinity of the Ni/NiO transition has revealed a notable decrease in PIO for conditions more oxidizing than the Ni/NiO transition, whilst local diffusion-induced grain boundary migration occurs irrespective of the oxidizing potential.*

- *A novel hybrid carbon nanomaterial was synthesized by ion irradiation of a CeSiC coaxial nanotube. The hybrid consisted of one-dimensionally stacked graphene nanodisks*

with diameters less than 50 nm and cylindrical multiwalled carbon nanotubes inside an amorphous SiC tubular layer. A sudden emergence of new continuous graphitic layers in the microstructure were observed by in situ transmission electron microscopy following ion irradiation, where these layers were perpendicular to the nanotube's length direction. The SiC crystals in the CeSiC coaxial nanotube became amorphous, also due to the ion irradiation, although the critical amorphization dose was higher than that for bulk SiC. Most remarkably, the carbon layer remained crystalline, even after an irradiation dose higher than 20 dpa (displacement per atom).

For some journals or research areas, simple present tense can also be used.

- *Such TENG is made for the first time by the unique additive manufacturing technology—hybrid UV 3D printing. The TENG is made up of printed composite resin parts and ionic hydrogel as the electrification layer and electrode. A sustainable and decent output of 10.98 W/m^3 (P_v, peak power per unit volume) and 0.65 mC/m^3 (ρ_{sc}, transferred charge per unit volume) are produced under a low triggering frequency of ~1.3 Hz, which is attributed to the Maxwell's displacement current. Meanwhile, a self-powered SOS flickering and buzzing distress signal system, and smart lighting shoes are successfully demonstrated, as well as self-powered portable systems of a temperature sensor or a smart watch.*

- *It is also shown that Al/Ti enrichments that develop along the migrated GBs correlate with the occurrence of PIO when the alloy develops a non-protective external oxide.*

- *Modifying the morphology of polydimethylsiloxane (PDMS) microstructure enables the device to obtain different sensitivities and pressure ranges for different requirements. Furthermore, by intentionally introducing hollow structures in the PDMS wrinkles, our pressure sensor exhibits an ultrahigh sensitivity of 14.268 kPa^{-1}. The elastic microstructure-based capacitive sensor also possesses a very low detectable pressure limit (1.5 Pa), a fast response time (<50 ms), a wide pressure range, and excellent cycling stability. Implementing respiratory monitoring and vocalization recognition is realized by attaching the flexible pressure sensor onto the chest and throat, respectively, showing its great application potential for disease diagnosis, monitoring, and other advanced clinical/biological wearable technologies.*

When interpreting the results, present tense is commonly used.

- *Such results show that these carbon layers possess better resistance against amorphization when subjected to ion irradiation than the SiC layers in the CeSiC coaxial nanotube. The lattice plane spacing of the carbon layer increases up to the point when*

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irradiation damage led to the complete amorphization of SiC crystals, after which it starts to decrease. This demonstrates that the carbon layer experiences high compression stress during ion irradiation. Thus, the ion irradiation of CeSiC coaxial nanotubes gives rise to a novel development of the microstructure and can be considered as one of the new synthetic processes for making novel carbon nanomaterials.

- *Looking forward, this SCMN has broader applications in humanoid robotics, new prosthetics, human–machine interfaces, and health-monitoring technologies.*
- *Our work provides new opportunities for constructing multifunctional self-powered systems toward the applications in realistic environments.*
- *Novel insights into fatigue induced grain growth mechanism in UFG cp-Ti are thus provided: (i) The thermally activated process plays an important role in grain growth during the room-temperature HCF fatigue; (ii) continuous dynamic recrystallisation is responsible for the grain growth and dislocation slip or twinning is not essential to trigger such a grain growth; (iii) the anisotropic grain growth behaviour in {0002} grain family can be reconciled by accepting that these grains accumulated highly stored energy during initial severe plastic deformation and the subsequent recrystallisation nucleation occurred at these highly deformed regions* (the last two verbs are used in simple past tense because these two verbs present the specific results).
- *This study demonstrates that the temperature-dependent VO_2 electrical conductivity or band structure serves as a key factor to modulate the antimicrobial capability of tungsten-doped VO_2 thin film. It is believed that the current findings can provide a new insight for the development of new antifouling surfaces.*

6.3 Features of Materials Science Paper Titles

Like an abstract, the title of a research article tends to be written last although it comes first. As discussed in Chapter 1, a successful title of an article should summarize the main content precisely and concisely so that it will enable the editors and readers to figure out the gist of the article without reading the whole paper. It should also arouse the potential readers' interest so that they will have the desire to read your complete work.

1. *Temperature-Responsive Tungsten Doped Vanadium Dioxide Thin Film Starves Bacteria to Death*
2. *High-Cycle-Fatigue Induced Continuous Grain Growth in Ultrafine-Grained Titanium*
3. *Thermal Conductivity Enhancement of Polyimide Films Filled with BN and AlN Fillers*

4. Three-Dimensional Ultraflexible Triboelectric Nanogenerator Made by 3D Printing

5. Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins

6. Understanding the Role of Diffusion Induced Grain Boundary Migration on the Preferential Intergranular Oxidation Behaviour of Alloy 600 via Advanced Microstructural Characterization

7. Skin-Inspired Highly Stretchable and Conformable Matrix Networks for Multifunctional Sensing

8. Full-Thickness Human Skin-on-Chip with Enhanced Epidermal Morphogenesis and Barrier Function

9. Alumina-Coated Patterned Amorphous Silicon as the Anode for a Lithium-Ion Battery with High Coulombic Efficiency

10. Novel Safeguarding Tactile E-Skins for Monitoring Human Motion Based on SST/PDMS–AgNW–PET Hybrid Structures

11. 3D Printing Metals Like Thermoplastics: Fused Filament Fabrication of Metallic Glasses

12. X-ray Diffraction and Stress Relaxations to Study Thermal and Stress-Assisted Annealings in Nanocrystalline Gold Thin Films

13. Synthesis of Novel Hybrid Carbon Nanomaterials inside Silicon Carbide Nanotubes by Ion Irradiation

14. On the Existence and Origin of Sluggish Diffusion in Chemically Disordered Concentrated Alloys

As seen from the examples above, the titles of materials science papers are mostly a long, informative noun phrase instead of a complete sentence (except the first example). To make the titles informative and at the same time concise, expressions like *a study of, an analysis of, an investigation of*, etc., are often excluded. Although generally a title is not a complete sentence, it has to be grammatically correct.

In materials science papers, some titles may directly state the key findings of the study, or the methods used in the research. Therefore, a good title of a materials science paper should include at least two of the following elements:

(1) topic/area/field of the study;

(2) main findings or final products;

(3) methods of the study;

(4) variables or relationships (optional).

A detailed analysis of the titles is illustrated in the following table.

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Titles	Topic / Research Area	Main Findings / Final Products	Methods	Variables
1. Temperature-Responsive Tungsten Doped Vanadium Dioxide Thin Film Starves Bacteria to Death	vanadium dioxide thin film	starves bacteria to death	doped with tungsten	
2. High-Cycle-Fatigue Induced Continuous Grain Growth in Ultrafine-Grained Titanium	ultrafine-grained titanium	continuous grain growth	high-cycle-fatigue	
3. Thermal Conductivity Enhancement of Polyimide Films Filled with BN and AlN Fillers	polyimide films	enhanced thermal conductivity	filling polyimide films with BN and AlN fillers	
4. Three-Dimensional Ultraflexible Triboelectric Nanogenerator Made by 3D Printing	triboelectric nanogenerator	three-dimensional ultraflexible triboelectric nanogenerator	3D printing	
5. Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins	pressure sensors for electronic skins	pressure sensors are tunable, ultrasensitive, and flexible	based on wrinkled microstructures	
6. Understanding the Role of Diffusion Induced Grain Boundary Migration on the Preferential Intergranular Oxidation Behaviour of Alloy 600 via Advanced Microstructural Characterization	Alloy 600	preferential intergranular oxidation behaviour of Alloy 600	advanced microstructural characterization	diffusion induced grain boundary migration
7. Skin-Inspired Highly Stretchable and Conformable Matrix Networks for Multifunctional Sensing	multifunctional sensing	highly stretchable and conformable matrix networks	skin-inspired	

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(Continued)

Titles	Topic / Research Area	Main Findings / Final Products	Methods	Variables
8. Full-Thickness Human Skin-on-Chip with Enhanced Epidermal Morphogenesis and Barrier Function	human skin-on-chip	full-thickness human skin-on-chip with enhanced epidermal morphogenesis and barrier function		
9. Alumina-Coated Patterned Amorphous Silicon as the Anode for a Lithium-Ion Battery with High Coulombic Efficiency	lithium-ion battery	lithium-ion battery with high coulombic efficiency	using alumina-coated patterned amorphous silicon as the anode	
10. Novel Safeguarding Tactile E-Skins for Monitoring Human Motion Based on SST/PDMS–AgNW–PET Hybrid Structures	novel safeguarding tactile E-skins	monitoring human motion	using SST/PDMS–AgNW–PET hybrid structures	
11. 3D Printing Metals Like Thermoplastics: Fused Filament Fabrication of Metallic Glasses	metallic glasses	3D printing metals like thermoplastics	fused filament fabrication	
12. X-ray Diffraction and Stress Relaxations to Study Thermal and Stress-Assisted Annealings in Nanocrystalline Gold Thin Films	nanocrystalline gold thin films	studying the thermal and stress-assisted annealings in nanocrystalline gold thin films	X-ray diffraction and stress relaxations	
13. Synthesis of Novel Hybrid Carbon Nanomaterials inside Silicon Carbide Nanotubes by Ion Irradiation	hybrid carbon nanomaterials	synthesizing novel hybrid carbon nanomaterials inside silicon carbide nanotubes	ion irradiation	
14. On the Existence and Origin of Sluggish Diffusion in Chemically Disordered Concentrated Alloys	chemically disordered concentrated alloys	the existence and origin of sluggish diffusion		

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As shown in the analysis above, most of the materials science paper titles contain three elements, namely, the topic or research area, the findings or the final product of the study, and the methods or treatments (usually introduced by *with, by, based on*, and *via*) involved in the research, to give readers an overview of the important information in the paper. However, some titles may exclude the methods, and some titles may include the important variables in the study by using expressions like "the role of", "the relationship between" or "the effect of". It is suggested that the most important words in the title, such as the topic of the study, should be fronted to distinguish your article from others. This can be achieved by using a colon or a dash to separate the topic or problem from research methods or solution, as demonstrated in Example 11.

6.4 Sample Analysis

Title: Three-Dimensional Triboelectric Nanogenerator Made by 3D Printing	
Excerpts	**Comments**
Title: Three-Dimensional Triboelectric Nanogenerator Made by 3D Printing	This title is a noun phrase which contains two elements: (1) Topic/area/field of the study: three-dimensional triboelectric nanogenerator (2) Methods of the study: 3D printing These two elements are linked with "by"
Abstract: ① As the fast developments of wearable devices, artificial intelligences and Internet of Things, it is important to explore revolutionary approach and fabrication method for providing flexible and sustainable power sources.	***Move 1: Introducing Background or Problem.*** The authors first introduce the research background (i.e., developments in wearable devices, artificial intelligences and internet of things) and the research topic (i.e., innovative approach and fabrication method for improving power sources). Here, "revolutionary" and "flexible and sustainable" also indicate the research gaps in the current literature.
② We report here a practical, ultraflexible and three-dimensional TENG (3D-TENG) that is capable of driving conventional electronics by harvesting biomechanical energy.	***Move 2: Presenting Research Purpose*** The authors use "here" and the pronoun "we" to pinpoint the research purpose: to generate a new product (i.e., 3D-TENG) which can have better performance.

(Continued)

Excerpt	Comment
③ Such TENG is made for the first time by the unique additive manufacturing technology—hybrid UV 3D printing.	***Move 3: Describing Research Methods.*** The new method (i.e., hybrid UV 3D printing) adopted in this study is its unique contribution, which is introduced by a "—". The significance of this method is also indicated through the authors' use of "be made for the first time" in this sentence.
④ The TENG is made up of printed composite resin parts and ionic hydrogel as the electrification layer and electrode. A sustainable and decent output of 10.98 W/m3 (P_v, peak power per unit volume) and 0.65 mC/m^3 (P_{sc}, transferred charge per unit volume) are produced under a low triggering frequency of ~1.3 Hz, which is attributed to the Maxwell's displacement current. ⑤ Meanwhile, a self-powered SOS flickering and buzzing distress signal system, and smart lighting shoes are successfully demonstrated, as well as self-powered portable systems of a temperature sensor or a smart watch.	***Move 4: Reporting Results*** The authors report the results by first describing the composition of the materials (i.e., be made up of…) and then the functions of the materials (i.e., output data with specific numbers). Sentence ⑤ demonstrates the application results of the new materials.
⑥ Our work provides new opportunities for constructing multifunctional self-powered systems toward the applications in realistic environments.	***Move 5: Interpreting Results*** The authors write "provides new opportunities for" to indicate the significance and the application value of the results.

As shown in the sample analysis, the abstract of a materials science paper follows a rather conventional way of organizing and presenting information. You can view an abstract as a surrogate of your article because it condenses the most important information of your study and may help readers decide if they would like to read the full article. Therefore, it is suggested to write the abstract and title last, because by then you will have been quite familiar with your study and can have a general idea of your research. Another suggestion is that the abstract should be written separately instead of copying texts from the Introduction section.

As you may notice, not every abstract contains all of the five moves mentioned in this chapter, with some moves excluded. For example, for some papers, the abstracts start directly from reporting the findings and interpretations; and for others, no information regarding the research methods is included. However, no matter what moves to include in the abstract, they should follow the specific order and sequence to ensure the logic flow of the abstract. In addition, moves can be combined in the abstract. For instance, the methods and results are often combined, which are often connected with "through", "by", or "via"; results and interpretations can also be combined, which are often linked by "which indicates", "which suggests", or "indicating that", etc.

To conclude, the abstract and title of an article help readers grasp the main idea of a research paper efficiently. It is always a great idea to have your advisors, colleagues, or friends, especially those who are not quite familiar with your work, to read your abstract to make sure that everything mentioned in your abstract can be clearly understood.

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6.5 Useful Expressions

In this section, useful expressions in each move of the Abstract are provided with examples.

Move 1: Introducing Background or Problem

* *A key aspect / primary concern of X is…*
* *X attracts much experimental research effort due to…*
* *X has been / is widely used in…*
* *A central/critical issue in X is…*
* *X is critical/fundamental for…due to/because…*
* *X is an important/ideal component in…, and plays a key role in…*
* *…is increasingly recognized as a serious, worldwide…concern.*
* *Little work/research has focused on / investigated...*
* *Few studies/investigations have focused on / attempted to / studied…*
* *Little is known about…*
* *Although…, X is still challenging/remains a challenge.*
* *While there has been a great deal of research on X, very few studies…*

Move 2: Presenting Research Purpose

* *This study was carried out / conducted / undertaken to examine/investigate/determine…*
* *This study aims to…*
* *The aim of this paper was to investigate/examine…*

* *Here, we demonstrate/present/report a X, which can effectively…*
* *In this paper, we present a…approach to…*
* *In this study, we describe a new model that allows/enables…*
* *In this work, X was prepared/developed by (using)…*

Move 3: Describing Research Methods

* *X was further carried out to improve Y and therefore the output performances of Z.*
* *X can be achieved by/through/via…*
* *…was observed and analyzed by X equipped on a Y.*
* *X was successfully fabricated/prepared/demonstrated/observed by…*
* *X has been conducted to clarify…*
* *X was adopted to…*

Move 4: Reporting Results

* *X was successfully converted into electricity by…*
* *…are successfully demonstrated/prepared/fabricated.*
* *We show here that…*
* *It was found/observed/shown that…*
* *SEM results show that…*
* *X was successfully fabricated/prepared in this study.*

Move 5: Interpreting Results

* *This research sheds new light on / provides new insights into…*
* *This investigation will enhance our understanding of…*
* *This study contributes to this growing area of research by exploring…*
* *Therefore, this study makes a major contribution to research on…by demonstrating…*
* *This technology has a great potential for…*
* *This study provides new opportunities for…*
* *With rationally designed structure, this device can achieve…, which has potentials to be further evaluated in the future, presenting a promising strategy to…for practical applications.*

6.6 Checklist for Writing the Abstract and Title

You can refer to the following checklist for writing the abstract and title.

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- Have you followed the target journal's author guidelines? Have you followed the required structure and style of the journal?
- Does your abstract summarize the main idea of your research, including such moves as the background/problem, purpose, the methods, the results, and the implications?
- Is everything mentioned in the abstract also touched upon in the main text?
- Do the moves in your abstract follow the correct order?
- Is your abstract a stand-alone entity? Have you clearly presented the important information of your study?
- Is your abstract written separately instead of direct copy and paste from the main body of the article?
- Does the title help readers to predict the purposes, research questions, and methods of your paper?

The following rhyme summarizes the main points discussed in this chapter.

摘要和标题

文章摘要和标题，学术论文代言人。
摘要通常分五步，清晰简洁显重点。
研究问题直切入，研究目的要说明。
研究方法和结果，重中之重多笔墨。
结果解释或意义，摘要最后可点明。
摘要最后单独写，文中内容勿照搬。
标题简短不简单，大量信息藏中间。
多用短语少用句，重点突出观点明。

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Exercises

I. Follow the five moves to analyze the following abstracts.

Title: 3D Printing Metals Like Thermoplastics: Fused Filament Fabrication of Metallic Glasses

Abstract 1: Whereas 3D printing of thermoplastics is highly advanced and can readily create complex geometries, 3D printing of metals is still challenging and limited. The origin of this asymmetry in technological maturity is the continuous softening of thermoplastics with temperature into a readily formable state, which is absent in conventional metals. Unlike conventional metals, bulk metallic glasses (BMGs) demonstrate a supercooled liquid region and continuous softening upon heating, analogous to thermoplastics. Here we demonstrate that, in extension of this analogy, BMGs are also amenable to extrusion-based 3D printing through fused filament fabrication (FFF). When utilizing the BMGs' supercooled liquid behavior, 3D printing can be realized under similar conditions to those in thermoplastics. Fully dense and amorphous BMG parts are 3D printed in ambient environmental conditions resulting in high-strength metal parts. Due to the similarity between FFF of thermoplastics and BMGs, this method may leverage the technology infrastructure built by the thermoplastic FFF community to rapidly realize and proliferate accessible and practical printing of metals.

Title: Tunable, Ultrasensitive, and Flexible Pressure Sensors Based on Wrinkled Microstructures for Electronic Skins

Abstract 2: Flexible pressure sensors play an important role in electronic skins (E-skins), which mimic the mechanical forces sensing properties of human skin. A rational design for a pressure sensor with adjustable characteristics is in high demand for different application scenarios. Here, we present tunable, ultrasensitive, and flexible pressure sensors based on compressible wrinkled microstructures. Modifying the morphology of polydimethylsiloxane (PDMS) microstructure enables the device to obtain different sensitivities and pressure ranges for different requirements. Furthermore, by intentionally introducing hollow structures in the PDMS wrinkles, our pressure sensor exhibits an ultrahigh sensitivity of 14.268 kPa^{-1}. The elastic microstructure-based capacitive sensor also possesses a very low detectable pressure limit (1.5 Pa), a fast response time (<50 ms), a wide pressure range, and excellent cycling stability. Implementing respiratory monitoring and vocalization recognition is realized by attaching the flexible pressure sensor onto the chest and throat, respectively, showing its great

application potential for disease diagnosis, monitoring, and other advanced clinical/biological wearable technologies.

II. The following sentences are taken from an abstract of a research paper. Follow the five moves and reorganize these scrambled sentences into correct sequence.

A. Surprisingly, an increase of concentration of faster species (Fe) in face-centered cubic Ni-Fe alloy may decrease the overall atomic diffusion.

B. Concentrated single phase solid solutions, including medium- and high-entropy alloys, represent a new class of materials that have recently attracted significant interest due to exceptional functional and structural properties.

C. A fast method for preselecting materials with potentially desired properties is suggested.

D. Their fascinating properties are mainly attributed to the sluggish atomic-level diffusion and transport, but its controlling mechanisms are largely unknown and there is certain skepticism about its very existence.

E. We argue that this coupled percolation and composition-dependent barriers for vacancy jumps within different subsystems in medium- and high-entropy alloys leads, indeed, to the sluggish diffusion.

F. Consequently, the composition dependence of tracer diffusion coefficient has a minimum near the site percolation threshold, ～20 at.%Fe.

G. By using microsecond-scale molecular dynamics, on-the-fly and conventional kinetic Monte Carlo, we reveal the governing role of percolation effects and composition dependence of the vacancy migration energy in diffusion.

You answer: _____

III. Fill in the following blanks with the appropriate forms of verbs.

Reconstruction of full-thickness skin equivalents with physiologically relevant cellular and matrix architecture (1) _____ (gain) importance as an in vitro tool for basic research, and for the pharmaceutical, toxicological, and cosmetic industries. However, human skin equivalents reconstructed on traditional culture systems (2) _____ (limit) by a weak skin barrier function compared to normal human skin. Probable reasons (3) _____ (include) the lack of mechanical forces and dynamic flow system that provide necessary mechanistic signals and continuous supply and/or drainage of nutrients and metabolites. Here,

we (4) _____ (combine) a fibrin-based dermal matrix with a biomimetic "organ-on-chip" system for the development of human skin equivalents that better (5) _____ (recapitulate) the structure and functionalities of human skin, compared to conventional static culture systems. We (6)_____ (demonstrate) that dynamic perfusion and a fine control of the microenvironment enable improved epidermal morphogenesis and differentiation, and enhanced barrier function. It (7)_____ (be) also shown that integrated 3D culturing and integrity/permeability testing can be conducted directly on the organ-on-chip device owing to the non-contracting properties of the fibrin-based dermal matrix, thus (8) _____ (overcome) the limitations of collagen-based skin equivalents used in conventional cell culture inserts and diffusion cells. With this scalable system, it (9) _____ (be) possible to achieve higher throughput and automation of culture and testing protocols, and deliver low-cost alternatives to animal and clinical studies for drug screening and toxicological applications.

IV. Follow the five moves to analyze an abstract of a research paper in your field.

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Chapter 7
Features of Academic Language

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Lead-in Questions

1. Based on what you have read so far, in your opinion, what are the characteristics of academic English? How is it different from everyday English?

2. Read the following Text A and Text B. Which text is more academically written? How are they different?

Text A

The rapid growth of flexible and multifunctional electronics imposes the challenges on portable power sources that feature in high flexibility. Self-powered Nanosystems and stretchable/transparent actuators have been recently demonstrated, but the power sources lack high flexibility and high-density integration. Since the soft and wearable electronics are widely integrated in clothes and shoes, and some of them are also attached on forced parts of human body, their power sources are supposed to be highly flexible, shape-adaptive, and capable of driving applications ranging from integrated circuits to soft sensor.

Text B

Electronics have developed rapidly and are getting more and more flexible and can serve a lot of functions. This makes making portable power sources difficult because they also need to be very flexible. Some scientists have used nanosystems that can use their own power and some kind of actuators, but they don't work very well because they are not flexible and can't be intensively integrated. As we all know, clothes and shoes often use some soft and flexible electronics, and sometimes we can see these electronics in human body. This means that their power sources should be very flexible and can be used in many applications, such as integrated circuits and soft sensor.

7.1 Syntactic Features of Materials Science Articles

Academic writing can be defined as a process of gathering, organizing, and presenting information to persuade readers of the scientific contributions and to exchange ideas between researchers. One important strategy to present such information effectively is to use academic language accurately and clearly. Generally, academic writing features sentence variety, complexity, objectivity, formality, clarity, conciseness, and tentativeness. Each feature will be discussed in greater detail in this chapter.

This section will mainly be devoted to introducing the sentence types and grammatical features observed in materials science articles. Being aware of these features may help learners better convey information in their papers.

7.1.1 Sentence Variety

In scientific writing, sentence variety is an important indicator of the quality of writing. In materials science articles, most of the sentences are simple sentences, with expanded phrases

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or construction modifying the main clauses. A simple sentence can be very short, consisting of a noun for the subject and a verb for the predicate. Simple sentences can also be expanded by adding additional segments such as infinitive phrases (不定式), gerunds (动名词), participles (分词), or appositive phrases (同位语) at the beginning, middle, or end of the sentence. The following examples show the use of infinitives, gerunds, and participles at the beginning or the end of the sentence to provide additional information:

- *X-ray photoelectron spectroscopy (XPS) analysis was used to detect the group distribution of the SiCNWS-GSs.*
- *To further improve the comprehensive properties of polymer materials, Liang et al. and Tang et al. also adopted the method of surface modification of filler particles to improve the dispersion and binding ability of particles in the matrix.*
- *Using cross-sectional transmission electron microscopy (TEM), Lu et al. demonstrated that defect clusters migrated slower in NiFe than in pure nickel and NiCo at room temperature.*
- *The height of the tan d peak gradually decreased with increasing m-BN particles, indicating the rigidity of composites increased.*
- *When the content of AlN was 1 vol%, the thermal conductivity of the composite film was 0.144 W/(m•K) higher than that of the 7 vol% PI/BN composite film, indicating that the synergistic effect played an obvious role.*
- *This leads to the applied stress transferred from the PI to m-BN fillers.*
- *The surface of PI composite film filled with different BN contents was analyzed by SEM, and the dispersion state of the BN filler particles in the matrix was observed.*
- *The studied region is highlighted as shown in Fig. 1.*

In this way, the main clauses are still simple sentences (i.e., Subject + Verb + Object), but they are expanded by providing more information without adding additional sentences. Nevertheless, complex and compound sentences remain a distinctive feature of scientific papers.

Compound sentences in research articles are often made up of two sentences, as shown in the following examples:

- *The prepared powers were dispersed in ethanol by sonication for 15 min, and some pieces were collected on 200 mesh carbon coated copper grids.*

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- *The volume resistivity of the composite film using BN and AlN as fillers increased first and then decreased with the increase of AlN content and reached the maximum when the volume fraction of AlN is 2%, but the breakdown field strength has been decreasing.*

- *The real-time fast Fourier transform (FFT) of the output data was carried out by using a signal analyzer (SR785), while the vibration speaker was operated at a specific acceleration.*

The most frequently used coordinating conjunctions in materials science articles are *and*, followed by *but* and *while*.

Different from compound sentences, which usually have two sentence subjects connected by a coordinating conjunction, complex sentences usually contain two clauses, with the subordinate clause modifying the main clause. Some commonly used conjunctions include *when, after*, *until,* and *while*, as shown in the following examples:

- *By contrast, when the hybrid fillers contents go up to a higher level (2–7 wt%), the thermal conductivity increases at a higher speed.*

- *When the filling content of BN reached a certain value, there was no gap between the fillers and the particles were agglomerated together, as shown in Figure 4(e).*

- *After the surface modification of the filler particles, the properties of the composite film showed the same trend compared with the unmodified one.*

- *After the PAA-mixed solution was obtained, the PI composite film was prepared by different imidization temperatures.*

- *After the treatment, the h-BN particles were washed with deionized water for several times until the filtered water was neutral, dried at 60 °C under vacuum overnight.*

The adverbial clauses with subordinate conjunction *when, after,* and *until* usually express the cause-effect relations between the clauses and denote the outcomes of the experiment. Other examples also include attributive relative clauses (定语从句), as shown in the following examples:

- *The dispersion of thermal conductive filler particles in the matrix and the bonding between the particles and the matrix were characterized using FEI Sirion200 SEM, which was operated at a voltage of 20.0 kV.*

- *When the loading level of m-BN reached 40%, the thermal conductivity of 0.768 $Wm^{1}K^{1}$*

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was obtained, which was 4.6 times higher than that of pure polyimide.

- *This method can only be used in the fields that do not require high electrical insulation.*

As shown in the examples above, simple sentences are often used in topic sentences because information expressed in simple sentences is usually important and easily understood; complex sentences with subordinate clauses are mainly used to give additional information.

These examples show that scientific writers tend to use a variety of sentence structure to describe their studies because the essence of a good writing is to convey meanings clearly, precisely, and logically, so a combination of using simple sentences and complex sentences is highly recommended as long as they can clearly express what you are trying to say.

7.1.2 Complexity

Academic writing involves sophisticated thinking and reasoning, which requires the use of complex structures, and that is why complexity is a prominent feature of academic writing. Besides what has been mentioned earlier in this chapter, there are several other strategies to achieve complexity in academic writing, namely, nominalization, noun clusters, and adverbs.

***1. Nominalization* (名词化)**

Nouns and noun phrases are often preferred in academic writing because nouns and noun phrases can serve as both the subject and object of a sentence, which gives writers more space to organize and convey their information in a concise and dense way. English is an inflectional language, which means new words can be formed by adding affixes to the base word. The class of the base word may or may not be changed by adding prefixes (adding affixes before a base word), while suffixes will often change the word class. For example, the sentence "This book is easy to read" can be changed into "This book is readable", which is shorter but conveys the same meaning. Similarly, the sentence "This book is popular for its being interesting to read" can be changed into "This book is popular for its readability", in which "being interesting to read" is replaced by one longer word "readability", making the sentence lexically denser. Such lexical density is achieved by adding affixes to the base word. This feature allows us to "create" new words that can increase the lexical density.

This process of transforming a verb or an adjective into a noun or noun phrase is called nominalization, a powerful device for packing and integrating information in fewer words, making the writing more abstract, objective, complex, and concise. Please compare the following two sentences:

a. If the thickness of the lagging is increased, it will reduce the heat losses.

b. An increase in the thickness of the lagging will reduce the heat losses.

In Sentence *a*, there are two clauses and the first clause is a conditional clause introduced by *if*. If we convert the verb *increase* into its noun form, which is also *increase*, this sentence becomes more syntactically complex, containing fewer words, and the meaning of the sentence is more packed and abstract. More examples of nominalized expressions are shown below:

- *While not in the scope of this work, the optimization of alloy composition to improve other alloy properties, such as minimization of the mobility of interstitial defects to enhance radiation tolerance, may be achievable.*
- *In addition, when a microstructured PDMS film is compressed, a reduction in air gap volumes will lead to an increased effective dielectric constant, which further enhances the change rate of capacitance and, thus, the pressure sensitivity.*
- *However, the insertion of lithium ion causes the amorphization of the crystalline silicon and its dramatic volume expansion (>300%) and contraction during Li insertion and extraction lead to the pulverization of the particles and electrical disconnection.*

The following table summarizes the commonly used suffixes to convert verbs and adjectives to nouns.

Suffixes	Examples	Suffixes	Examples
-age	store–storage use–usage	-ing	jog–jogging spell–spelling
-al	try–trial arrive–arrival	-ity (-ty)	uniform–uniformity selective–selectivity certain–certainty necessary–necessity
-ant (-ent)	determine–determinant	-ment	excite–excitement replace–replacement attach–attachment enlarge–enlargement enhance–enhancement manage–management

(Continued)

Suffixes	Examples	Suffixes	Examples
-ation	inform–information organize–organization form–formation transform–transformation determine-determination	-ness	complete–completeness direct–directness
-cy (-ce)	accurate–accuracy resist–resistance	-ship	friend–friendship author–authorship member–membership
-er (-or)	compute–computer write–writer convert–converter	-sis	analyze–analysis synthesize–synthesis hypothesize–hypothesis
-hood	likely–likelihood	-tion (-sion)	combine–combination convert–conversion expand–expansion convert–conversion select–selection conceptualize–conceptualization extend–extension

- **Do Not Over-nominalize: Prefer Verbs to Nouns**

Despite the importance of using nominalization in academic writing, we would like to advise here that we should avoid over-nominalizing. As mentioned above, nominalization can make our writing more abstract, objective, and complex, which is preferred when expressing authors' opinions or comments; however, too many abstract nouns make a sentence heavy to read. Therefore, to achieve sentence variety and to make sentences flow better, verbs and adjectives are more often used when describing an action or a fact, which can also reduce the number of words. Compare the following sentence pairs:

*1a. X was used in **the preparation of** Y.*

*1b. X was used to **prepare** Y.*

*2a. The **separation** of the carbon of the nanotube's inner layer was demonstrated in two regions.*

*2b. The carbon of the nanotube's inner layer was **separated** into two regions.*

*3a. The **observations** of the extensive microstructural developments to the CeSiC coaxial nanotubes before and after ion irradiation were performed by TEM (Model 2100F, JEOL Ltd., Akishima, Japan) operating at 200 kV.*

*3b. The extensive microstructural developments to the CeSiC coaxial nanotubes before and after ion irradiation were **observed by** TEM (Model 2100F, JEOL Ltd., Akishima, Japan) operating at 200 kV.*

*4a. The **evaluation** of this index was carried out by means of X.*

*4b. This index was **evaluated** using X.*

The examples above are taken from the Methods and Results sections in which authors mainly report facts (e.g., experimental actions and results). In this case, we prefer to use the verbs, as shown in sentences *1b*, *2b*, *3b*, and *4b*. Please refer to the following table for more such examples, and we will come back to this point later in this chapter when talking about clarity.

Original Version	Suggested Version
make an analysis	analyze
make a comparison	compare
achieve an improvement	improve
carry out an experiment	investigate/examine
exert an influence	influence
make a prediction	predict
give an explanation	explain
reach a conclusion	conclude
reach a consensus	agree
show an improvement	improve
experience a change	change
provide evidence	prove
exhibit a downward trend	decrease/fall

That said, it is a common practice for science writers to use verbs and nominalized forms alternatively. In other words, we should not over-nominalize, and we should use verbs, adjectives, and nouns appropriately to better convey our thoughts in our writing.

- *Although specific CPKac is sufficient to activate stress or immune responses associated with strong and distinct Ca^{2+} signaling patterns, **activation** of subgroup III CPKac alone*

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did not fully evoke specific nitrate response. Consistent with our findings, it has been suggested that primary nitrate signaling requires the coordination of multiple signalling mechanisms. Our results indicate that nitrate may specify and synergize functionally redundant subgroup III CPKs in NIR-LUC activation. To test the ***specificity and physiological roles*** *of subgroup III CPKs, we examined loss-of-function cpk mutants. (Kun-hsiang Liu et al., 2017)*

In this short passage, we can see that both verbs and nominalized forms are used, with verbs, such as *activate, specify* and *synergize*, being used to describe an action or a change, and the nominalized forms, such as *activation, specificity* and *physiological roles*, being used to introduce a comment or to refer to the previously mentioned actions. Therefore, verbs, adjectives, and nouns often take different roles and serve various functions in academic writing. Because verbs and adjectives are vivid, we tend to use them to describe actions or changes. On the other hand, when we are concerned about the phenomena and to make comments on certain actions or changes, we tend to use nominalized forms. For example, in scientific paper writing, when you first mention an action or a change, you can use the verb form. If you would like to refer back to this action or behavior in the following text, you can nominalize the verb to provide additional comments or explanations, as shown in the following examples:

- *Of course, this series of large-scale hierarchical filters itself constitutes a set of contingent theoretical constraints. But out of this contingency emerges some rather simple patterns.*
- *Unlike conventional metals, bulk metallic glasses (BMGs) demonstrate a supercooled liquid region and continuous softening upon heating, analogous to thermoplastics. Here we demonstrate that, in extension of this analogy, BMGs are also amenable to extrusion-based 3D printing through fused filament fabrication (FFF).*

As shown in the examples above, the first sentences use verbs or adjectives to describe a phenomenon: “contingent” in the first sentence, and “analogous” in the second one. If we want to further comment on these phenomena or behaviors, we can nominalize these verbs or adjectives to summarize the previously mentioned phenomena, such as “this contingency” in the first example, and “this analogy” in the second example.

To summarize, nominalization tends to focus on the conceptualization of a phenomenon and can make our writing more abstract, more formal and more objective, and can allow us to make further comments on the previous information. Despite its importance in academic writing, we should not over-nominalize. We need to use verbs, adjectives, and nominalization appropriately in academic writing.

2. Noun Clusters

In academic writing, noun clusters are often used conventionally in a specific discipline, and some have become fixed phrases. The following noun clusters are examples extracted from our materials science paper corpus for your reference:

absorption spectra	electrode materials	material properties	Raman spectra
boundary conditions	electronic devices	metal ions/oxides	scale bars
carbon fibers	energy levels	microscopy images	SEM/TEM images
carbon materials	fracture surfaces	particle sizes	simulation results
carbon nanotubes	FTIR spectra	perovskite films	slip systems
cathode materials	glass fibers	point defects	starch fluids
charge carriers	grain boundaries/sizes	polarization curves	surface areas
composite material	graphene sheets	polymer chains	transport properties
crystal structures	husk varieties	polymer composites	thermal conductivity
diffraction patterns	hydroxyl groups	quantum dots	volume fractions
diffraction peaks	lattice parameters		

The advantage of using noun clusters is to reduce the number of clauses and make information more packed. However, a noun cluster usually contains no more than two nouns except for technical terms (e.g., "oxygen partial pressure" and "equal channel angular pressing"). If there are more than three nouns in a noun cluster, you may need to consider splitting the cluster by using prepositions such as *of*, *for*, and *in*.

*1a. To further improve the comprehensive **polymer materials properties**,…*
*1b. To further improve the comprehensive **properties of polymer materials**,…*

*2a. A typical approach for **the biomechanical energy harvest** is to employ…*
*2b. A typical approach for **harvesting the biomechanical energy** is to employ…*

*3a. **The charge carriers transport** is limited by ionic diffusion in many battery materials…*
*3b. **The transport of charge carriers** is limited by ionic diffusion in many battery materials…*

3. Position of Adverbs

In spoken English, adverbs are usually placed rather randomly, but in academic writing,

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adverbs are often placed right before the main verbs that they modify, as shown in the following examples:

- *Niwase et al. have reported that graphite was readily amorphized by D or He ion irradiation at a critical dose of less than 1 dpa at room temperatures.*
- *The graphite (002) spots ascribed to the carbon layer in the CeSiC coaxial nanotube from cup-stacked MWCNTs were distinctly maintained, even after an irradiation of 22.3 dpa had been applied to the carbon layer, as shown in Fig. 3(e).*
- *The HR-TEM image in Fig. 3(d) indicates that the basal planes in graphitic shells perpendicular to the nanotube length direction were slightly rippled, thereby demonstrating that the newly produced graphitic shells had a favorable crystallinity.*
- *It has also been reported that high-energy (MeV) ion irradiation of MWCNTs causes nano-compartments with a bamboo-like structure to be clearly formed inside the nanotubes.*
- *Nanoporous metals developed by dealloying binary solid solution alloys such as nanoporous gold (np-Au) from AueAg, nanoporous copper (np-Cu) from CueMn, etc., have been extensively investigated.*
- *However, the results by Langelier et al. clearly showed that the migrated area was only depleted in Cr, thus suggesting that minor chemical differences associated with a specific heat may influence the oxidation behaviour of the alloy in the proximity of the HAGBs.*
- *PIO is considered to be one of the main processes leading to the initiation stage of PWSCC, and despite several decades of research, its role as a "precursor event" is still not fully understood.*

7.1.3 Objectivity

As mentioned earlier, nominalization is a strategy to make our writing more objective. There are two other strategies to achieve objectivity: using passive voice and limiting the use of personal pronouns.

***1. Passive Voice* (被动语态)**

The passive voice form allows writers to create an objective tone in scientific papers. The passive voice is also necessary when the subject of the action is less important than the action itself or the outcomes of the action. Therefore, the passive voice constructions are involved in creating an impersonal tone in scientific writing. In other words, passive voice is used when

we are more interested in "**what** has been done", or "**how** it was done", than in "**who** did this". For example, in the Methodology section, authors describe the detailed study process, materials used, measurements calculated, or techniques adopted. In this case, passive voice is preferred.

- *Two gold thin films have been simultaneously prepared by physical vapor deposition on a 125 mm-thick polyimide substrate (Kapton®) at room temperature.*
- *The graphite (002) spots ascribed to the carbon layer in the CeSiC coaxial nanotube from cup-stacked MWCNTs were distinctly maintained, even after an irradiation of 22.3 dpa had been applied to the carbon layer, as shown in Fig. 3(e).*
- *These coupons were extracted several millimetres away from the external surfaces thus avoiding the possibility of oxide contaminations.*
- *A low pressure super-heated H_2-steam environment was used as a surrogate for a PWR primary water environment as it has the benefit of providing good control of the oxidizing potential with respect to the Ni/NiO transition.*
- *All the tests were conducted at 480 °C for 210 h and full details are reported in Table 2.*
- *CoP nanowire arrays grown on carbon cloth (CoP NWs/CC) were synthesized by the phosphorization of CoOHF nanowire arrays.*

In recent years, however, authors are encouraged to use the active voice in their articles since it is considered to be more direct and less wordy. For example, *we found that…* seems more straightforward than *…was found.* Please compare the following two sentence pairs:

1a. In this study, ***we successfully synthesized*** *the CoP nanowires supported on carbon clothes.*

1b. In this study, the CoP nanowires supported on carbon clothes ***were successfully synthesized****.*

2a. Here, ***we report*** *a practical, ultraflexible three-dimensional TENG (3D-TENG), which can drive or charge common electronics through harvesting energy from human motions.*

2b. Here, a practical, ultraflexible three-dimensional TENG (3D-TENG), which can drive or charge common electronics through harvesting energy from human motions, ***is reported****.*

Clearly, these two pairs of sentences have different focuses: Sentences *1a* and *2a* tend to emphasize the authors' contribution and the significance of their study and are likely to appear in the Introduction and the Conclusion sections. Sentences *1b* and *2b* focus on the outcome of the study, and are likely to appear in the Results section.

Another suggestion concerning this issue is to use *the authors/the researchers found that…* or *we found that…* instead of *I found that…* because people consider "I" to be a bit personal and subjective. The tendency to use the active voice does not mean we should remove the passive completely from our papers. The reason is that the passive can be more effective and appropriate in the Methods section, where readers are more interested in how an experiment was conducted and the specific procedure of the whole research.

2. Limited Use of Personal Pronouns

As you may have noticed, academic papers tend to limit the use of personal pronouns. For example, we may avoid saying "I suggest that…", "I believe that…", or "you can find a pattern in this figure". Alternatively, we tend to use "there + be" structure and "it + be + Adj./V-ed that" structure (e.g., *It is suggested that…*, and *It is believed that…*) to show objectivity in academic writing. These structures are more likely to be used to introduce the research background or facts, report the results, and explain the findings.

- *There are no previous reports of hydride in alumina scales.*
- *In recent years, there has been exciting progress in the development of soft electronics that are capable of self-healing or that can be repaired when damaged to restore electrical functionality.*
- *Before mechanical failure, there is no loss in electrical conductivity (Fig. 4).*
- *There is clear evidence of grain boundary nanoporosity formation resulting from selective oxidation during the IGSCC of Ni alloys in pressurized water reactor (PWR) conditions.*
- *It is known that one-dimensional nanomaterials, such as nanowires, nanorods, and nanotubes possess new properties different from those of their bulk materials due to their intriguing geometries and a nanometer size.*
- *When diffusion impedance has such behavior due to bounded diffusion space in active material, it is referred to as bounded diffusion (BD) impedance throughout this article.*
- *In addition, for porous nanoparticle electrodes, it is assumed that the thickness of the electrode is thin and the electrolyte conductivity is high, so that the model does not account any gradient that may develop along the electrode thickness.*
- *Comparing the estimator values obtained from model (b) and (c), it is found that overlooking the radius distribution in model (b) results in a slight overestimation of* D_{ch}.

- *It is shown that the locally correlated residuals are reduced by accounting for the actual cylindrical geometry of the nanowires in model (b).*
- *Moreover, in nanocrystalline metals, it is well-known that grain boundaries act as dislocation sources and sinks.*
- *It is hoped that the activation volume determination will be a method to characterize macro-scopically the leading plasticity mechanism operating in the material.*
- *It is seen that the residual stress of the as-grown sample is approximately 200 MPa, and that the annealing reduces this value to about zero.*
- *ALD has been shown as an excellent coverage and conformal deposition even on high-aspect-ratio structures, and the thickness of the as-deposited film is precisely controllable due to its self-limiting nature.*
- *It is also observed that the OCV for the two electrodes are almost the same at the discharge state higher than 0.1V.*

However, overusing these structures may sacrifice the conciseness of the sentences. Compare the following sentence pairs:

1a. ***It has been proposed that*** *silicon is a potential material for next-generation lithium-ion batteries to replace the conventional carbon-based anodes due to its high lithium storage capacity of 4,200 mAh g^{-1} to form the $Li_{22}Si_5$ phase at high temperature.*

1b. ***Silicon has been proposed as*** *a potential material for next-generation lithium-ion batteries to replace the conventional carbon-based anodes due to its high lithium storage capacity of 4,200 mAh g^{-1} to form the $Li_{22}Si_5$ phase at high temperature.*

2a. The first fatigue study on NC copper that was processed by inert gas condensation ***was performed by Witney et al.****.*

2b. ***Witney et al. performed*** *the first fatigue study on NC copper that was processed by inert gas condensation.*

3a. This small dispersity implies that virtually all sulfonic layers are accessible to surrounding water; ***there are*** *essentially no sulfonic layers that are isolated from diffusing water.*

3b. This small dispersity implies that virtually all sulfonic layers are accessible to surrounding water; ***no sulfonic layers are isolated*** *from diffusing water.*

As shown in the examples above, sentences *1b*, *2b*, and *3b* are more concise. Therefore, we

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can try to replace the subject in the "there + be" and "it + be + Adj./V-ed that" structures with a concrete noun to make our writing more concise. However, it should be noted that the choice of certain sentence structures also depends on the cohesion and flow in your writing. For example, although sentence *2b* (active voice) is more concise, it is better to use "It was found that…" than "…was found to…" for the next sentence for cohesion purpose.

To summarize, researchers use a variety of syntactic structures to serve different functions. The participle is used primarily as an attribute in preposition or post-position. The gerund functions as an adverbial modifier and as a subject. The infinitive is used to express an adverbial modifier of purpose. It is also used to modify a proceeding noun as an attribute. As for sentence types, the most common are simple sentences extended by infinitive phrases, gerund phrases, and participle phrases. Complex sentences are found to be preferable for describing experimental procedure or for showing the cause-effect relations.

7.2 Language Features: FACT

In this section, we will introduce four features of academic language: formality, accuracy, clarity, and tentativeness (FACT).

7.2.1 Formality

Academic language is formal and follows some general conventions.

1. Avoid Using Contractions and Abbreviations

- *In addition, for porous nanoparticle electrodes, it is assumed that the thickness of the electrode is thin and the electrolyte conductivity is high, so that the model does not account any gradient that may develop along the electrode thickness.*
- *Figure 1a shows the scanning electron microscopy (SEM) image of the as-deposited silicon thin film electrode, which has not been etched, and Figure 1b shows the morphology of patterned silicon electrode.*
- *Thus, the formation of the Ni- and Fe- rich oxides did not affect the extent of DIGM.*
- *It is important to note that DIGM was not present prior into the sample exposure to H_2-steam as reported in Ref. [13], which investigated the same Alloy 600 heat used in this study.*
- *The undulation observed in Fig. 2 is not associated with a uniform migration of the GB*

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in one direction.

- *Therefore, DIGM and the Al/Ti enrichments can be considered to be secondary factors for the occurrence and evolution of PIO because they can support and enhance its evolution, although they do not appear to be rate controlling.*
- *However, this correlation is not feasible because there are no SCC data in H_2-steam and, to the authors' knowledge, there are no systematic investigations of PIO as a function of potential in high temperature hydrogenated water in the literature.*

Whenever you need to use abbreviations, do remember to spell them out the first time they appear in the text.

- *Alloy 600 was widely used for structural components in Pressurised Water Reactors (PWRs), but it was discovered to be susceptible to Primary Water Stress Corrosion Cracking (PWSCC).*
- *Terachi et al. performed oxidation experiment on Alloy 600 coupon samples in high temperature water at 320 ℃ and identified a stable and continuous NiO layer for low levels of the dissolved hydrogen (DH), whereas when the H_2 content was increased (DH 1/4 1.0 ppm), the NiO became less stable and exhibited a needle-like oxide structure.*
- *Silicon carbide (SiC) is one of the crucial wide-bandgap semi-conductors and is also a structural material that can be used under high temperatures. It is known however, that one-dimensional nanomaterials, such as nanowires, nanorods, and nanotubes possess new properties different from those of their bulk materials due to having intriguing geometries and a nanometer size. Hitherto, we have succeeded in synthesizing single-phase SiC nanotubes and CeSiC coaxial nanotubes, in which multiwalled carbon nanotubes (MWCNTs) were coated with a SiC layer by heat treatment of MWCNTs with Si powder in a vacuum. In situ transmission electron microscopy (TEM) was used to observe microstructural developments of single-phase SiC nanotubes under ion irradiation, where the results clearly differed from those of bulk SiC.*

2. Using Lexically Denser Vocabulary

It is advised to use one strong word instead of a phrasal verb (i.e., verb + preposition), which is considered as colloquial and informal, as shown in the following table:

Phrasal Verbs	More Lexically Denser Version
point out	indicate
make up	compose
deal with	address
put together	incorporate, integrate, combine, synthesize
look into	analyze, research, investigate, examine
rule out	eliminate
go on	continue
carry out	conduct, implement
break up	disintegrate

You can refer to Section 7.1.2.1 *Nominalization* for more discussions of lexical density.

7.2.2 Accuracy

Accuracy and precision in academic writing means that each opinion should be accurately expressed and supported by evidence. The logical structure of writing allows readers to follow the text with ease. For example, to accurately and precisely report the study, materials science researchers tend to use adverbs when reporting the results if the adverbs have particular meaning.

- *The atomic percent of Ni, Mn, and Co gradually increase from 0 to 20 nm and almost keep constant from 30 to 120 nm.*
- *Interestingly, it is found that Pc and IFSS slightly increase with the incorporation of graphene to the polymer layer and this trend is most remarkable when PP brushes are attached to graphene.*
- *We then focus on MoS_2BP heterostructure-based logic devices by engineering the partition load and matching, and successfully demonstrate the first tunable ternary inverter, in which both the middle output value and middle region length can be controlled.*

Similarly, researchers also tend to give as many details (e.g., experimental tools, experimental environment or conditions, and research procedures) as possible when describing the research methods.

Another aspect regarding accuracy is how researchers logically and precisely present the study and connect ideas, which is also referred to as textual cohesion. There are generally two types of cohesion: internal cohesion and external cohesion. Compared to external cohesion

which features the explicit use of logical connectors, internal cohesion means that ideas are connected following a flow of information in which old information often comes before new information to contextualize readers. For example, when writing the Introduction section, we need to follow a funnel-shape structure in which new information is generated based on the previously mentioned information. That is, the specific research focus comes from the general research background; the relevant literature is about the research topic; the research gap is identified from the previously reviewed research; the research purpose is presented to solve the problem that hasn't been answered by previous studies; and the research summary presents a possible solution to the research gap. Therefore, each move is built upon the previous one, and each sentence is also built upon the previous sentence to provide new information to move forward the argument. Similarly, when writing about the research procedure, a chronological sequence should be followed so that each step is precisely described.

One key point in keeping the information flow is to write along with the previously mentioned concepts. There are three strategies to achieve the internal cohesion while maintaining the sentence variety: repeating the noun, using a synonym, and using a pronoun. You can use these strategies to refer to a previously mentioned concept and continue bringing new concepts to make your writing flow.

● **Repeating the Noun**

This strategy is quite straightforward, which means to repeat the key concept in the previous sentence when starting the next sentence.

- *The effect is particularly strong in Ni-Fe alloys where it leads to long-range correlations in vacancy jumps. Such long-range correlations between vacancy jumps suppress long-range diffusion due to reduced connectivity of distant regions by vacancy exchange with fast Fe atoms.*

In the following excerpt from an Introduction section in which the key concept is thermal conductivity, the subjects of the new sentences (i.e., "thermal conductive fillers" and "BN") always repeat the key concepts in previous sentences, forming a cohesive chain to make an argument, and "thermal conductivity" is repeated four times.

- *At present, filling thermal conductive particles is one of the main methods to improve the thermal conductivity of polymer materials. Commonly used thermal conductive fillers include metals (copper, aluminum, silver, etc.), inorganic thermal conductive particles (aluminum nitride (AlN), boron nitride (BN), alumina, etc.), and carbon materials (graphite, carbon nanotubes, carbon fibers, etc.). Among them, BN has the*

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characteristics of high thermal conductivity, high electric breakdown strength, low moisture absorption, excellent oxidation resistance, and corrosion resistance and is an ideal filler for preparing a polymer material with high thermal conductivity and good electrical properties. Therefore, BN as a thermal conductive filler to improve the thermal conductivity of materials has become a research hot spot.

Another example comes from the description of research procedure, in which the key words such as "PAA/BN solution", "PI composite film", and "imidization" (亚胺化反应), are repeated several times, and the same word is used to refer to the previously mentioned information to achieve cohesion.

- *The mixture was mechanically stirred at room temperature for 3 h to obtain a uniform PAA/BN (or PAA/BN/AlN) precursor solution. After the PAA-mixed solution was obtained, the PI composite film was prepared by different imidization temperatures. The imidization process of PI film was 80 ℃/60 min, 120 ℃/30 min, 160 ℃/30 min, 200 ℃/30 min, 250 ℃/30 min, 300 ℃/30 min, and 350 ℃/30 min. After the imidization was completed, the film was taken out while the temperature in the oven was naturally cooled to room temperature and PI composite film was obtained.*

The following example comes from the Results section in which key words, such as "wrinkled topography" and "PDMS", are repeated.

- *The optical image in Figure 1b and the inserted scanning electron microscopy (SEM) image present the wrinkled topography of the PDMS surface, showing a uniform and periodic microstructure, which is very beneficial for reducing viscoelastic behavior and improving the sensitivity. To obtain this wrinkled structure, a micropatterned PDMS mold was fabricated first.*

- **Using a Synonym**

A synonym refers to a more general term that can be used to refer back to a previously mentioned noun, sentence or fact, as shown in the following examples:

- *With the continuous advancement of chip technology, integrated electronic devices are gradually developing toward high density, high frequency, fine wiring, and high power of chips. This trend causes more heat to be generated in a limited volume.*

- *The SEM analysis about the micro-morphology of the ultra-flexible printed parts shows that the UV curing forms a layer-upon-layer structure along the printing direction as the*

object is fully realized (Fig. 1c). In this *approach, ...*

- *Here, we report a practical, ultraflexible three-dimensional TENG (3D-TENG), which can drive or charge common electronics through harvesting energy from human motions. More importantly, this device is fabricated by a unique additive manufacturing technology—hybrid 3D printing technique.*

- *All data presented here were cut off at certain values of applied pressure accordingly, where the change in capacitance was negligible (<0.01 pF) when the applied pressure was further increased. The pressure range before this value can be defined as the working range of the pressure sensor.*

- *Indeed, the SCMN could realize a 25-fold (or more) expansion of the sensing area, ranging from the original coverage (16 cm^{-2}) to the expandable size (400 cm^{-2}). Furthermore, this property can be used to define the detection area not only for pressure but also for other external stimuli (e.g., temperature, in-plane strain, proximity, humidity, optical, magnetic field, etc.).*

● Using a Pronoun

- *The ultraflexible 3D-TENG uses printed resin parts and ionic hydrogel as the electrification material and electrode, respectively, which together make up one columnar array of triboelectric interfaces. Its structure and assembly process are schematically illustrated in Fig. 1d.*

- *The DIGM has been observed to be adjacent to and ahead of the PIO and crack tips on samples exposed to the H_2-steam environment or simulated PWR primary water; however, its contribution to the early stages of PWSCC is still not fully understood and at time contradictory.*

- *PIO is considered to be one of the main processes leading to the initiation stage of PWSCC, and despite several decades of research, its role as a "precursor event" is still not fully understood.*

● Logical Connectors

As you may have noticed from the examples above, researchers also tend to use connectors to link ideas to make them more logically connected. In the following example, we can see that the use of logical connectors ("at present", "among them", and "therefore") clearly shows the relationship between the ideas and makes the writing more coherent.

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- *At present, filling thermal conductive particles is one of the main methods to improve the thermal conductivity of polymer materials. Commonly used thermal conductive fillers include metals (copper, aluminum, silver, etc.), inorganic thermal conductive particles (aluminum nitride (AlN), boron nitride (BN), alumina, etc.), and carbon materials (graphite, carbon nanotubes, carbon fibers, etc.). Among them, BN has the characteristics of high thermal conductivity, high electric breakdown strength, low moisture absorption, excellent oxidation resistance, and corrosion resistance and is an ideal filler for preparing a polymer material with high thermal conductivity and good electrical properties. Therefore, BN as a thermal conductive filler to improve the thermal conductivity of materials has become a research hot spot.*

The following table presents some commonly used logical connectors.

Functions	Meanings	Examples
Addition	To add a point or idea to reinforce or support what you have said	*also, furthermore, moreover, in addition, additionally, likewise, similarly, meanwhile,…*
Time Sequence	To connect what you are saying with something you previously said or to describe a procedure step by step in a chronological order	*earlier, previous(ly), before, until, formerly, at present, at this point, at the same time, first, to begin with, to start with, initially, secondly, then, next, finally, eventually, afterwards, later, lastly, subsequently, while, when, in recent years, recently, currently,…*
Cause and Effect	To indicate the cause and/or consequence	**Cause:** *due to, because, because of, since, as,…* **Effect:** *so, therefore, hence, thus, consequently, as a consequence, as a result, for this reason, correspondingly, accordingly,…* (Please note that verbs such as *result from, be caused by, give rise to, affect, influence, determine, generate, bring about, stem from, arise, lead to, originate from, produce, be attributed to, enable,* and *develop* can also denote causal relationship.)
Comparison and Contrast	To compare and contrast ideas	*on the contrary, by comparison, by contrast, in contrast to, on the one hand…on the other hand, while, whereas, compared with, different from, instead, alternatively, conversely, rather than,…*

(Continued)

Functions	Meanings	Examples
Adversative	To show disagreement to previous statement	*although, despite, in spite of, but, however, nevertheless,…*
Illustration	To give examples to illustrate a certain point	*for example, for instance, such as, among them, including…*
Intensification	To emphasize a certain point	*particularly, in particular, especially,…*

7.2.3 Clarity

Clarity refers to expressing ideas clearly without redundant information, which is another feature that distinguishes academic writing from other writing styles.

1. Expressing Your Ideas Concisely

Being concise in your writing means expressing your ideas in as few words as possible. This involves cutting out irrelevant details and avoiding redundancy (i.e., the use of unnecessary words). If your sentences are too "wordy", they are difficult for readers to understand.

Wordy Sentences	More Concise Sentences
We continued our activities in the development of new protocols for group communications.	We have continued to develop new protocols for group communications.
The different materials that contribute to an environmental impact have quantitatively different potential environmental effects.	Different materials have quantitatively different potential environmental impacts.

2. Avoid Using Vague Language

As you may have noticed, the language in academic writing is precise, clear, and specific. To achieve this, you should avoid using vague language in academic writing. The more clearly your vocabulary expresses what you mean, the better the chance your readers will get your points. The word "important" in the following example is a vague expression:

- *Thermal stability is one of the important properties for the composites.*

By using the word "important", we have no idea of why thermal stability is important for the composites. You can strengthen this sentence by substituting "important" with more descriptive words, or by adding specifications, explanations or examples, as shown in the following sentence:

- *Thermal stability is one of the important properties for the composites in processing and*

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application because…

More such examples are shown as follows in which authors provided specific explanations (introduced by *due to, because of, because, since*, *as*, or *in that*, etc.) for why a statement is made for the subject:

- *The transport of charge carriers is limited by ionic diffusion in many battery materials due to the high mobility of electrons.*
- *Silicon has been proposed as a potential material for next-generation lithium-ion batteries to replace the conventional carbon based anodes due to its high lithium storage capacity of 4,200 mAh g^{-1} to form the $Li_{22}Si_5$ phase at high temperature.*
- *Along with the rapid development of science, technology and the worldwide economy, electrical materials have been unable to meet the requirements to dissipate the emitting heat because of their increasing integration.*
- *Unfortunately, the $LaCoO_3$ obtained by the conventional methods usually had low specific surface area, which limits their potential applications as catalysts, since the catalytic activity of metal oxides catalysts is closely related with their surface area.*
- *A low pressure super-heated H_2-steam environment was used as a surrogate for a PWR primary water environment as it has the benefit of providing good control of the oxidizing potential with respect to the Ni/NiO transition.*
- *Various metal oxides such as TiO_2, WO_3, $BiVO_4$, and Fe_2O_3 have been applied, but these materials are limited in that the light absorption band is narrow because of the large band gap, and/or the charge transfer is poor.*

However, it should be noted that for comprehension efficiency, *because* and *due to* are more likely to be used than *since* and *as* when explaining the reasons because *since* and *as* have other meanings (e.g., *since* also means "from a time in the past"; *as* also means "like" or "something happens at the same time") which may mislead readers. It should also be noted that Chinese learners of academic writing like to bring up broad concepts and leave things unexplained. In contrast, experienced scientific writers tend to explain their ideas clearly by giving definitions, providing examples, offering explanations, or simply repeating the ideas in another way. For example, in *Mechanosensation electronics (or Electronic skin, e-skin) consists of mechanically flexible and stretchable sensor networks that can detect and quantify various stimuli to mimic the human somatosensory system, with the sensations of touch, heat/cold, and pain in skin through various sensory receptors and neural pathways*, the authors use a relative clause

introduced by *that* to explain what mechanically flexible and stretchable sensor networks are. This strategy is quite common in scientific writing. Another example can be seen in *We report here a practical, ultraflexible and three-dimensional TENG (3D-TENG) that is capable of driving conventional electronics by harvesting biomechanical energy*.

Excerpts	Comments
① Currently, most studies focus on the RIS behavior of grain boundaries. ② For instance, radiation-induced depletion of Cr at grain boundaries was observed in austenitic stainless steels for decades, and it was widely known as one of the contributing factors to irradiation-assisted stress corrosion cracking (IASCC). ③ Kumar et al. claimed that FeNiMnCr HEA exhibited better resistance against RIS on grain boundaries compared to conventional Fe-20Cr-24Ni alloy citation.	Sentence ① is a topic sentence that summarizes the main idea of this paragraph. However, this sentence is quite broad. In Sentence ②, the authors specifically explain what has been found regarding "the RIS behavior of grain boundaries". Sentence ③ cites one study (Kumar et al.) to illustrate this point.
④ On the other hand, few studies on RIS to the defect clusters have been reported. ⑤ The small scale of defect clusters and low magnitude of RIS around them make the characterization very difficult.	Sentence ④ points out the potential research gap in previous studies, and this sentence is also quite broad and vague. Sentence ⑤ seeks to explain why few studies have been conducted on RIS to the defect clusters.
⑥ Nevertheless, such studies are important because RIS around defect clusters may alter the defect cluster evolution under continued irradiation and thus affect the mechanical properties of the material. ⑦ For example, the austenite structure can be destabilized due to the depletion of Ni in the matrix while Ni atoms segregate to the void/dislocation and/or loop/grain boundaries caused by RIS citation.	Sentence ⑥ points out that such research is necessary by giving specific reasons introduced by *because*, which makes the claim more reasonable and convincing. Sentence ⑦ further gives one specific example to strengthen this claim.

3. Avoid Being Wordy

Expressions like "last but not least", "as far as I am concerned", "in my opinion", and "due to the fact that" are very common in student writing. These unnecessary and unhelpful expressions are examples of clutter language. These expressions are grammatically correct but we should minimize using them because academic writing features conciseness and clarity, which means to use fewer words to express the same meaning. Please compare the following sentence pairs:

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1a. This paper ***provides a review of*** *the basic tenets of stem cell biology study design, using example studies that illustrate the methodologic challenges or that demonstrate* ***successful solutions*** *to the* ***difficulties*** *inherent in biological research.*

1b. This paper ***reviews*** *stem cell biology study design using examples that illustrate specific* ***challenges and solutions****.*

2a. The results ***concerning*** *the accuracy and precision of the method have been shown in the Table 2* ***for three levels*** *(LOQ, 5LOQ, 10LOQ) of salicylaldoxime.*

2b. Table 2 shows the accuracy and precision results for LOQ, 5LOQ, and 10LOQ salicylaldoxime.

3a. Researchers have failed to solve this technical problem due to various ***issues, problems and difficulties****.*

3b. Researchers have failed to solve this technical problem due to various ***issues****.*

As shown in these examples, *1b*, *2b*, and *3b* are better. Although sentences in *1a*, *2a*, and *3a* are grammatically correct, they contain several pieces of unnecessary information. For example, in *1a*, "review" is changed to "provide a review", which is redundant (This point has been discussed earlier in this chapter). Second, those sentences contain some repetitive information. For example, "challenges" and "difficulties" in 1a are the same thing, so we don't need to mention them twice. "Solutions" are used to solve "difficulties", so the use of "difficulties" seems redundant. The same problem appears in Sentence *3a*. Lastly, "successful solutions" is unnecessary because what we can infer from the word "solutions" is that the problem could be successfully solved, which makes the word "successful" redundant here. Similarly, in *2a*, "concerning" and "for three levels" are redundant because they add nothing new in meaning, and this sentence can simply be written as *2b* with these expressions excluded but the meaning unchanged.

In academic writing, authors need to use the simplest but the most accurate, concrete words to express their meanings. That is, authors need to avoid using strings of words with little meanings. Therefore, *last but not least* actually means *lastly*, *in the recent time* can be replaced by *recently*, *as far as women are concerned* can be simply changed to *women believe that*, and *this argument is not connected with the matter in hand* can be simply written as *this argument is irrelevant*.

The following table summarizes some typical clutter languages and provides the alternative versions for your reference.

Clutter Languages	Better Versions
a considerable amount of	much
a majority of	most
a number of	many
a total of X samples	X samples
a small number of	a few
are taken as evidence of	suggest
less frequently occurring	rare
reduce the quantity of	reduce
take into consideration	consider
the observed/obtained data	the data
the employed method	the method
due to the fact that	because
have an effect on	affect
is found to be	is
provide an explanation of	explain
conduct an analysis of	analyze
by means of	by/through/with
for most of the times	often
causal factor	cause
as a consequence of	because
despite the fact that	although
an example of this fact is that	for example
during the course of	during/while
as a matter of fact	in fact/(omit)
as a means of	to
at a rapid rate	rapidly
fewer in number	fewer
first of all	first
for a period of	for
for the purpose of	for

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(Continued)

Clutter Languages	Better Versions
for the reason that	because
at the present time	currently
from the point of view of	for
based on the fact that	because
future plans	plans
given an account of	describe/explain
large/small in size	large/small
quite a large quantity of	much
make preparations for	prepare
red in color	red
make reference to	refer to
needless to say	(omit)
new initiatives	initiatives
not later than	by
on account of	because
on a daily basis	daily
on behalf of	for
owing to the fact that	since/because
place a great emphasis on	stress/emphasize
prior to	before
provided that	if
resultant effect	result
so as to	to
this result would seem to indicate	this result indicates
through the use of	by/with
whether or not	whether
with regard to	regarding/concerning
in an automatic mode	automatically
in a rapid manner	rapidly

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(Continued)

Clutter Languages	Better Versions
from a technical/conceptual perspective	technically/conceptually
It is necessary to use X.	Using X is necessary.
It is possible that inflation will rise.	Inflation may rise.

7.2.4 Tentativeness: Use of Hedging

Researchers generally write in an impersonal style in order to be more objective, precise, and convincing, not too strong or too weak. Although academic writers strive for explicitness and accuracy, nothing can be concluded as absolutely correct; what researchers are trying to do is to get closer to the truth. Therefore, they want to avoid a too-strong commitment to a particular conclusion, so hedging what they say is a way of fulfilling this purpose. Hedging thus refers to not expressing a claim too strongly or too absolutely. Because researchers often express their opinions or claims in the Introduction and Discussion sections, hedging expressions are more likely to appear in these sections of research papers. Too direct and absolute claims may give the impression of over-confidence and may expect criticism from colleagues, as shown in the following two examples.

- *a. Although X has been investigated by many researchers, this is the first attempt to...*
- *b. Our results demonstrate that…, which is caused by…*

These two sentences are considered to be too absolute because they leave no room for doubt by using "the first attempt" in Sentence *a* and "is caused by" in Sentence *b*. For Sentence *a*, no one can be sure that this is the *first* attempt. For Sentence *b*, the researchers are talking about their interpretation of the results that came from their sample, but they cannot be sure that other researchers may have an alternative interpretation or draw different conclusions from a different sample. The following sentences would be better.

- *Although X has been extensively investigated, few studies specifically focused on…*
- *Our results would seem to demonstrate that…, which could be caused by…*

There are several strategies to hedge in academic writing, which can protect writers against being proved wrong while recognizing alternative ideas on the research topic.

● Using Tentative Verbs

Useful verbs for hedging include *seem to, appear to, tend to, suggest, indicate* and *imply*.

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- *As the primary CeO2 nanospheres are formed, they **tend to** aggregate around the as-formed Pt seeds to assemble into self-supported nanospheres, which **should be** favorable for minimizing their total surface energy.*
- *These findings **indicate** that the physical mechanism governing the strength of the DMI in the graphene/Co interface is very different from that in Co/Pt, which is captured by the FertLevy model.*
- *Furthermore, high-quality low-energy electron diffraction (LEED) patterns were obtained, **indicating** a well-ordered surface.*
- *Upon heating to approximately 675 °C, new Bragg peaks began to appear in the PXRD pattern concomitant with a decrease in intensity of the peaks corresponding to $NiBi_3$, **suggesting** the synthesis of a new intermetallic phase.*
- *Based on our analysis, alkyne cages **appear to** be the most likely to produce positive results, followed by imine cages and alkene cages.*

Compared with verbs that often leave no room for doubt, such as *is/are, mean, demonstrate, conclude, confirm, show*, and *prove*, which are often used when presenting facts (e.g., results, or common-sense knowledge), these tentative verbs are used when researchers express opinions (e.g., commenting on results, interpreting data, or making conclusions).

- **Using Modal Verbs**

Using modal verbs is another common way to indicate tentativeness or a lack of certainty, and can thus be used to soften your claims. Commonly used modal verbs include *can, should, may, could,* and *would,* but they denote different certainty levels.

Example	Level of Certainty
It was previously proposed that the DMI **can** be amplified using multilayer structures.	90–100%
Alignment of the layers **should** further improve conductivity.	80%
The discovery of the DMI induced by graphene **may** open up a new area in the field of spintronics.	70%
To capture the diffraction peaks that **could** distinguish the perovskites from the precursors, we used in situ grazing-incidence wide-angle X-ray scattering (GIWAXS).	60%
This indicates that walking pressure **would** not be sufficient to activate the composite in the most vulnerable situation.	60%

● **Using Adverbs**

To protect yourself from accusations that you are too certain about your findings, you can use adverbs and adverbial phrases like *somewhat, generally, rather, quite, relatively*, or *essentially,* adverbs of probability and possibility, such as *probably, likely*, and *possibly*, as well as adverbs of frequency, such as *often, usually, seldom, hardly,* and *sometimes*. These words can help to leave your claim open to other interpretations.

- *We find that Tsp is relatively insensitive to cooling rate above some threshold value of this rate.*
- *Conversely, overdoped cuprates are generally regarded as conventional Fermi liquids possessing no collective electronic order.*
- *However, we demonstrate that the highly frequent small nodules are essentially the same as the large ones.*
- *However, such measurements often probe only interparticle contacts, precluding a fundamental understanding of charge transport.*
- *Moreover, the characteristic peak of the carbon matrix is hardly observed due to the high crystallization degree of* $NiSe_2$.
- *The RPP perovskite devices exhibit extremely low dark current due to its rather insulating nature in the dark, which is the key factor for the high sensitivity of the photodetector.*

● **Using Adjectives**

Commonly used adjectives to soften claims include *likely, probable,* and *possible*. They are often used when explaining the results. However, they vary in their certainty level.

Examples	Level of Certainty
Since the grain boundary Au compositions were similar at the 60 and 1,100 nm locations, it seems highly **unlikely** that the gold enrichment results only from dealloying.	90–100%
Changes were **likely** due to…	80–90%
Because of their lower oxidation states compared to aluminum, it is suggested that their diffusion would be more **probable**.	70–80%
In the first place, slight or no microstrain is measured on pure and monocrystalline Pt/C catalysts, suggesting that structural order is **possible** for this type of material.	60–70%

样张不得出售

The following rhyme summarizes the main points discussed in this chapter.

学术语言

学术语言有特点，日常用语勿照搬。

用词准确忌冗余，正式清晰学术语。

语言连贯有逻辑，连词副词关联语。

句子结构稍复杂，从句状语修饰语。

偏好名词强动词，表达清楚少用字。

被动语态显客观，情态动词示委婉。

词语前后重搭配，表达多样忌单一。

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Exercises

I. Refer to Text A and Text B that appear at the beginning of this chapter. Find the formal expressions in Text A to match with the informal expressions in Text B.

Text A

The rapid growth of flexible and multifunctional electronics imposes the challenges on portable power sources that feature in high flexibility. Self-powered Nanosystems and stretchable/transparent actuators have been recently demonstrated, but the power sources lack high flexibility and high-density integration. Since the soft and wearable electronics are widely integrated in clothes and shoes, and some of them are also attached on forced parts of human body, their power sources are supposed to be highly flexible, shape-adaptive, and capable of driving applications ranging from integrated circuits to soft sensor.

Text B

Electronics have developed rapidly, and are getting more and more flexible and can serve a lot of functions. This makes making portable power sources difficult because they also need to be very flexible. Some scientists have used nanosystems that can use their own power and some kind of actuators, but they don't work very well because they are not flexible and can't be intensively integrated. As we all know, clothes and shoes often use some soft and flexible electronics, and sometimes we can see these electronics in human body. This means that their power sources should be very flexible and can be used in many applications, such as integrated circuits and soft sensor.

Formal	Informal
1.	A. serve a lot of functions
2.	B. makes…difficult
3.	C. very flexible
4.	D. use their own power
5.	E. some kind of actuators
6.	F. don't work very well
7.	G. often use…
8.	H. must be
9.	I. powerful

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II. Compare the following five pairs of sentences. For each pair, choose the sentence that is more academically written. Pay attention to the underlined parts.

1a. XRD patterns of hybrid polymer composites *were analyzed* by an X-ray diffractometer (SmartLab 9 kW).

1b. *We used* an X-ray diffractometer (SmartLab 9 kW) *to analyze* XRD patterns of hybrid polymer composites.

2a. The mixture was *mechanically stirred* at room temperature for 3 h to obtain a uniform PAA/BN (or PAA/BN/AlN) precursor solution.

2b. The mixture was *stirred mechanically* at room temperature for 3 h to obtain a uniform PAA/BN (or PAA/BN/AlN) precursor solution.

3a. The scattered values of the extent of PIO, especially for the samples exposed to the more reducing conditions *might be explained by* the different crystallographic orientations of the two adjacent grains that can induce a stress gradient.

3b. The scattered values of the extent of PIO, especially for the samples exposed to the more reducing conditions *is caused by* the different crystallographic orientations of the two adjacent grains that can induce a stress gradient.

4a. *The preparation of polyamic acid (PAA) was executed by* solution polycondensation between TPE-Q and BPDA in DMAc at room temperature.

4b. *The polyamic acid (PAA) was prepared by* solution polycondensation between TPE-Q and BPDA in DMAc at room temperature.

5a. It is therefore necessary to synthesize those carbon nanomaterials with novel structures *for the purpose of developing and broadening* the applications of carbon nanomaterials.

5b. It is therefore necessary to synthesize those carbon nanomaterials with novel structures *to develop and broaden* the applications of carbon nanomaterials.

III. Choose the appropriate connector for each sentence.

1. The CeSiC coaxial nanotubes from the cylindrical-type MWCNTs had almost the same dimensions, such as their outer and inner diameters, compared to those from cup-stacked

MWCNTs. _____, the thickness of the SiC layer was much larger.

A. Therefore B. However C. In fact D. In addition

2. Therefore, irradiation results in expansion of basal planes in MWCNTs in the radial direction, _____ the length becomes shortened in MWCNTs.

A. despite B. compared with C. although D. while

3. _____ in these studies the skin cells are cultured directly in the microfluidic chip, they do not represent the 3D complexity of human skin.

A. Although B. Because C. Whereas D. So

4. _____ a smaller atomic number (Z) relative to the transition metal ions, Mg^{2+} ions are still able to reflect a certain amount of X-ray, leading to a lowered (003) / (104) ratio in NC-Mg.

A. Despite B. Compared with C. Although D. While

5. In the second set of experiments, samples were removed from the electrolyte and held in air for times ranging from 3 to 180 s before load application, and _____ immersed in water.

A. continuously B. initially C. accordingly D. subsequently

6. The ultraflexible 3D-TENG and the new method of hybrid 3D printing are unique and distinct in its fundamental mechanism, which can effectively avoid problems that includes layer-by-layer structures, inconvenient fabrication process and inescapable elastic supporting for reciprocating motions. _____, this approach demonstrates complicated high-density integration while maintaining high flexibility.

A. Therefore B. Additionally C. However D. Subsequently

VI. Choose the appropriate word to fill in the blanks.

1. In recent literature, silicon nanoparticles, silicon nanowires, and silicon thin films have been _____ (investigated / looked at) as the anode material for Li-ion batteries and the cycling performances were obviously improved

2. These spherical fillers with the diameter in the range of 1–8 μm are _____ (put together / incorporated) into the hybrid polymer.

3. With the increase of BN content, the gap between particles _____ (decreased / underwent a decrease) and the particles gradually became tight.

4. If the heat cannot be exported in time, excessive accumulation will cause the operating

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temperature of the chip to rise, _____ (affecting / exerting an effect on) its normal operation and even burning of electronic components.

5. As expected, such a grain refinement led to _____ (an improvement in / improved) static tensile strength but with some sacrifice in ductility.

6. There is no major difference between SoCEs and static SEs _____ (concerning / with regard to) KRT-10 and filaggrin expression.

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Chapter 8
Conclusion

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Lead-in

In previous chapters, we have walked you through the process of writing a material science paper and discussed strategies to refine your academic language. In this chapter, we will first briefly summarize what has been covered so far, and then try to make connections between individual chapters and put academic writing in a big picture.

8.1 Revisiting Previous Chapters

Let us first look at some common reasons why papers get rejected.

Topic	The paper deals with irrelevant topic or topic of local interest only.	**Introduction**
Newness	The paper offers no new insights into a research field.	
Methodological Soundness	The methods adopted are flawed, insufficiently described, or unjustified.	**Methods**
Data	The methods and results are weak or preliminary.	**Results**
Focus	The topic, objectives and conclusions are not connected.	**Introduction & Discussion**
Style	Texts are unclear, incoherent, and inappropriate.	**Language**

As shown in the table, there are mainly two big problems with rejected manuscripts: writing quality and writing style. Writing quality refers to the study itself and deals with such issues as if the topic is relevant to the target readers, if the paper offers something new in certain research area, if the method is appropriately used, if the study is adequately described, if the results are justified by evidence, and if the study tells a good research story. Writing style, on the other hand, deals more with language issues, such as the use of academic language and conventions. It can be concluded that clear, logical, coherent, focused, good argument and well-structured writing gets the paper published.

In this book, we introduced the IMRD structure (Chapters 2–6) to address the above-mentioned writing quality problems. The moves and steps suggested clearly show how to construct a well-structured and logical materials science paper, and the expressions provided could effectively help to enrich sentence varieties in writings. The writing style issue can be solved by the discussions of the features of academic language in Chapter 7 in which we summarize what distinguishes academic English from general English.

To conclude, a good research article, including a materials science one, should include some characteristics that are summarized as the “7C-Rule”.

Be **c**onsiderate	Write for your audience. Make your writing explicit.
Be **c**reative	Focus on innovative and original research ideas.
Be **c**lear	Keep a clear focus in the paper and present only relevant information.

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(Continued)

Be concise	Use one word instead of two if that word can adequately communicate your meanings.
Be concrete	Use concrete words and avoid abstract and ambiguous expressions.
Be critical	Make a clear distinction between your work and those of others by citing appropriately.
Be confidently uncertain	Hedge when making conclusions, but your results and data should be strong enough to make such conclusions.

8.2 Connecting Different Sections

In previous chapters, we discussed the IMRD structure separately; in this part, we would like to invite you to look at how these separate elements are connected.

Academic writing is all about critical thinking. That is, authors try to use evidence to prove a claim through reasoning. Here, a "claim" refers to the conclusion that the authors make, "evidence" includes the evidence from both others' research (i.e., Introduction) and the present study (i.e., Methods and Results), and the "reasoning" is in nature the process of persuading readers how the previous findings and the present findings tell a story together (i.e., Discussion) and thus move the research area forward (i.e., Conclusion). Therefore, we can clearly see the connections between each move and step across different sections (Figure 8.1).

As shown in Figure 8.1, different components of a logical research article are not separate; instead, they form close connections with others to present a logical, well-organized research story. Notably, the words or information that are often repeated are usually the key words of the study and should be highlighted in the title and abstract.

Finally, we would like to remind you that a good research article always involves great efforts and several rounds of intensive revisions. Don't get frustrated when your first draft looks ugly. The key is to sit down and finish your draft first and take time to revise and refine it later.

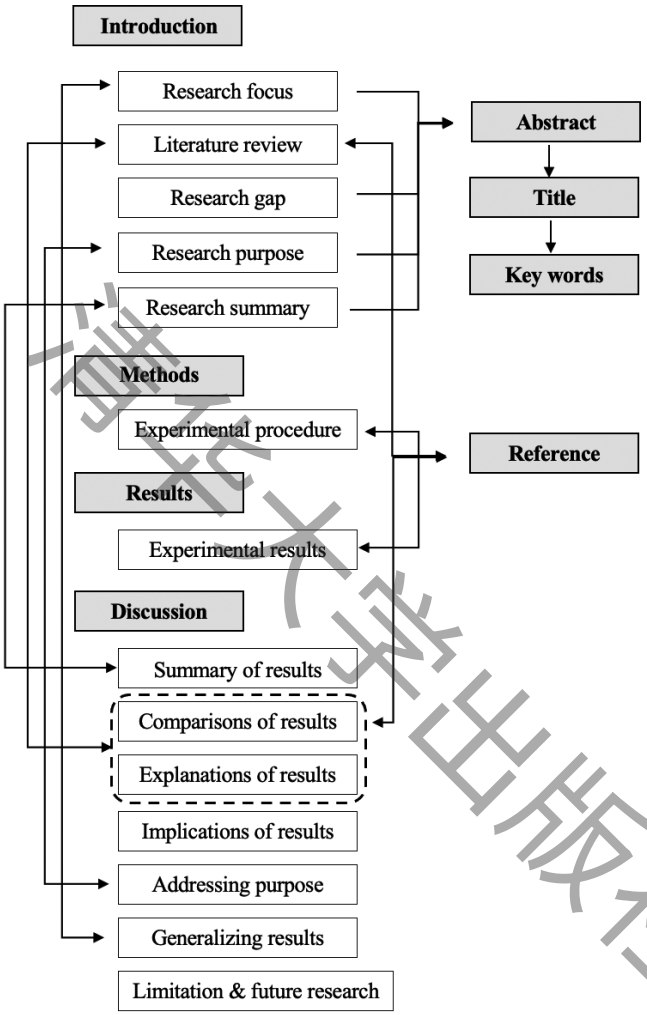

Figure 8.1 A visual representation of the corresponding relationship between each step across sections

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Keys to Exercises

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Chapter 1

I. Answers may vary.

II. Answers may vary.

III.

1. A. “have been recently demonstrated” illustrates review of literature.

2. B. “was characterized using” shows the research method.

3. A. “in order to…, in this paper we combine…” demonstrates the research purpose.

4. B/C. “was carried out to…” shows the research method.

5. C/D. “This suggests that…” indicates the implication of the results.

6. D. “was also an important reason to…” offers an explanation of the results.

7. A. “However” indicates a research gap with “the conventional PI”.

8. A. “have attracted much attention” signals the significance of a research field.

9. C. “As expected, there is a nearly learner relationship between them” shows the result.

10. B. “were mixed…, which was well blended and deaerated via” describes the research procedure.

Chapter 2

I.

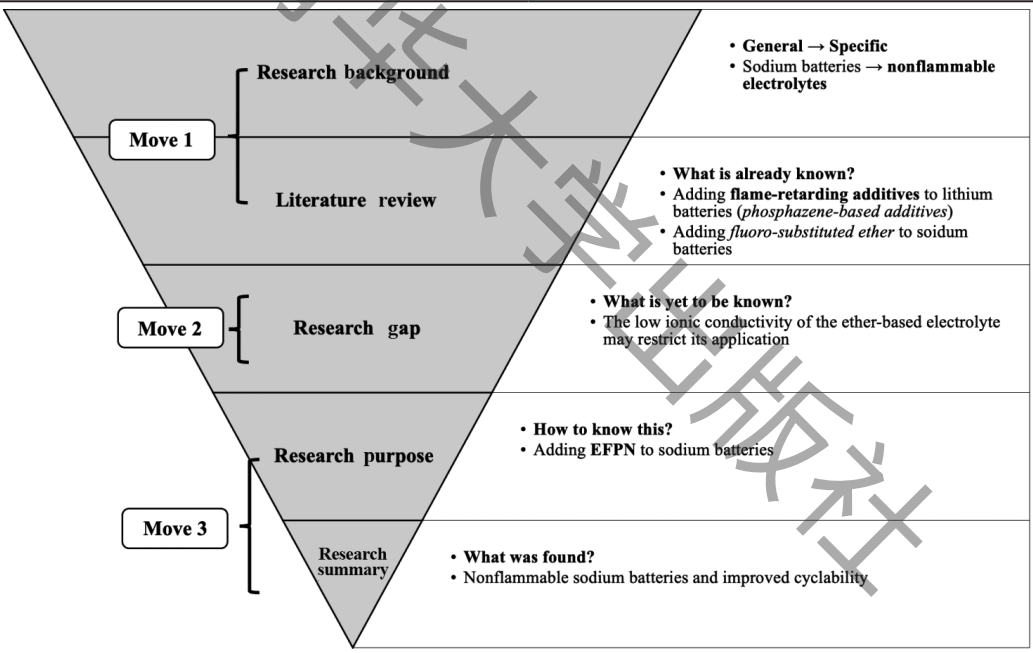
Title: Nonflammable Electrolyte for Safer Non-aqueous Sodium Batteries	
Excerpts	**Comments**
① Sodium batteries, with abundant sodium sources (2.64 wt% in the earth's crust) and low standard potential (-2.71 V), have been considered as low-cost alternatives to lithium ion batteries for large-scale electric storage applications.	**Move 1: To Establish a Research Territory.** ***Step 1: Claiming Importance*** Sentence ① starts with a broad concept—sodium batteries—to familiarize the readers with the research background of this study. By highlighting that sodium batteries "have been considered as low-cost alternatives to lithium-ion batteries for large-scale electric storage applications", the authors emphasize on the importance of this study. Present perfect tense is used.
② The current sodium batteries are composite of flammable, voltage-sensitive carbonate-based electrolytes and highly reactive electrodes, which might cause serious hazards such as fire and explosion under abuse-testing conditions, for example punch, heat, crash, etc. ③ Safety concerns are the key hindrance in the further application of sodium batteries. ④ Dahn's group has studied the reactivity of carbonate electrolyte with oxide cathodes and carbon-based anodes using Accelerating Rate Calorimetry: Their results showed That the exothermic reactions with carbonate electrolytes start at 115 ℃ for $Na0.35CoO_2^3$ and 120 ℃ for Na_xC.[4] ⑤ To solve these problems, introducing flame-retarding additives may be the most economic and efficient way.	***Step 2: Making Topic Generalization*** Sentences ②–③ further generalize the topic and bring up one challenge that hinders the application of sodium batteries; that is, safety issues caused by "flammable, voltage-sensitive carbonate-based electrolytes and highly reactive electrodes". This represents the current knowledge in the field, so simple present tense is used. Sentence ④ cites Dahn's team's work on the reactivity of carbonate electrolyte, and simple past tense and present perfect tense are used. Sentence ⑤ presents a potential solution to this challenge, signaling the research focus of this study.

(Continued)

Excerpts	Comments
⑥ A large number of flame-retarding additives have been included in nonflammable electrolytes for lithium batteries since the first report by Wang et al. using trimethyl phosphate in 2001. ⑦ Among these additives, phosphazene-based additives are reported to have the best flame-retarding efficiency and electrochemical compatibility. ⑧ It has been reported recently by Xia that only 5 wt% PFPN addition can make the electrolyte totally nonflammable. ⑨ However, research on flame-retarding additives for sodium batteries is seldom conducted. ⑩ Recently, our group reported a nonflammable electrolyte for sodium batteries with fluoro-substituted ether.	***Step 3: Reviewing Previous Research*** Sentences ⑥–⑩ review relevant literature on introducing flame-regarding additives to make nonflammable electrolyte for batteries. Sentences ⑥–⑦ summarize previous efforts in introducing flame-retarding additives for lithium batteries and report that phosphazene-based additives have the best effect. Sentence ⑨ points out one research gap that such additives have not be applied to sodium batteries. Sentence ⑩ reports on one recent study which added fluoro-substituted ether to make nonflammable electrolyte for sodium batteries. A combination of simple present tense and present perfect tenses are used.
⑪ However, the ionic conductivity of the ether-based electrolyte is relatively low (～0.5 mS cm^{-1}), which restricts its practical application.	**Move 2: To Identify a Research Gap** Sentence ⑪ raises one problem with the above-mentioned study, that is, the low ionic conductivity of the ether-based electrolyte may restrict its application. Simple present tense is used.
⑫ Based on the previous studies, ethoxy (pentafluoro) cyclotriphosphazene (EFPN) was selected as a flame-retarding additive for sodium batteries due to its high boiling point (125 ℃), low viscosity (1.25 mPa s at 25 ℃) and high flame-retarding efficiency.	**Move 3: To Occupy the Research Niche** ***Step 1: Announcing the present study*** Sentence ⑫ introduces the present study that intends to solve the problem mentioned in Sentence ⑪ by adding EFPN as a flame-retarding additive to sodium batteries. Simple past tense is used.

(Continued)

Excerpts	Comments
⑬ It was found that EFPN-containing electrolyte was stable towards sodium and only 5% EFPN addition caused the common sodium electrolyte to become nonflammable. ⑭ Moreover, the cyclability of both the acetylene black (AB) anode and the Na0.44MnO2 cathode were improved.	***Step 2: Announcing Main Findings Sentences*** ⑬ and ⑭ briefly summarize the main findings from the present study that the EFPN addition demonstrates good results. Simple past tense is used.



II. F–I–B–C–D–E–G–A–H

III.

1. show
2. are
3. (have) focused on
4. has gained
5. have been reported
6. investigated
7. were investigated
8. modified
9. investigated
10. performed

IV. Answers may vary.

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Chapter 3

I.

Title: Three-Dimensional Ultraflexible Triboelectric Nanogenerator Made by 3D Printing	
Excerpts	**Comments**
2. Experimental Section ***2.1 The structure and Fabrication Process of the Ultraflexible 3D-TENG*** ① Printing was performed using an UV curing 3D printer [citation] comprised of automatic pressure injecting device, ink extrusion and UV curing system, precision positioning platform, PC and hardware/software control system, as schematically illustrated in Fig. 1a.	This section is labeled as "Experimental Section". The first part of this section describes the structure and the fabrication process of the ultraflexible 3D-TENG, which can be seen from the sub-section title. As the title implies, the authors will talk about two things in this part: the structure and the fabrication process. Written in simple past tense, Sentence ① introduces the tool used in this experiment to identify the structure of the 3D-TENG, with the components of the tool described in text and the detailed information provided in figures. In this sentence, previous studies that have used this tool are cited to increase the credibility of this experimental decision.
② The schematic of the hybrid 3D printing system plan is shown in Supplementary Fig. 1. ③ This is a new method of hybrid 3D printing for producing ultraflexible parts, in which the liquid photopolymer resins and support materials are directly printed by using a single manufacturing process within an integrated platform [citation]. ④ Printed parts with additive internal supporting structure are intended to keep high accuracy of ultraflexible printed parts and shape unchanged, and then the internal supporting structure is removed by corrosive reagents without affecting other parts. ⑤ Finally, the ultraflexible parts are obtained to act as the electrification materials of TENGs (Fig. 1b).	Sentences ②–⑤ use simple present tense to describe the schematic of the UV curing 3D printer because this is how the hybrid 3D printing system generally works. Sentence ② locates a figure which shows the schematic of the tool and Sentences ③–⑤ provide a detailed explanation on how this machine works. As shown in the excerpt, passive voice is generally used.

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(Continued)

Excerpts	Comments
⑥ Supplementary Fig. 3 demonstrates our printing capabilities of complex 3D-structure designs by comparing the final 3D printed ultraflexible parts. ⑦ The SEM analysis about the micro-morphology of the ultraflexible printed parts shows that the UV curing forms a layer-upon-layer structure along the printing direction as the object is fully realized (Fig. 1c).	Sentences ⑥–⑦ also use simple present tense to validate the capabilities of the UV curing 3D printer by analyzing the printed parts. An "SEM analysis" is specified and additional information is provided in the figures. This part also explains the properties of the machine; therefore, simple present tense is used.
⑧ In this approach, digital light processing UV curing system was used to partially set the extruded resins and provide the high accuracy (i.e., < 10 μm), allowing a designed performance of ultraflexible part relevant to application requirements. ⑨ The ultraflexible 3D-TENG uses printed resin parts and ionic hydrogel as the electrification material and electrode, respectively, which together make up one columnar array of triboelectric interfaces. ⑩ Its structure and assembly process are schematically illustrated in Fig. 1d and Supplementary Fig. 5 and the ultraflexibility test are presented in Fig. 1e and Supplementary Video 1.	Sentence ⑧ uses simple past tense to give details of "this approach". The participle "allowing a designed performance of ultraflexible part relevant to application requirements" serves as a justification. Sentence ⑨ explains a general mechanism of the formation of triboelectric interfaces. The function of Sentence ⑩ is to locate the figures which display the structure and assembly process of the triboelectric interfaces to provide additional information; therefore, simple present tense is used.
2.2 Methods and Materials ⑪ Hybrid 3D printing system is comprised of automatic pressure injecting system, ink extrusion and UV curing system, precision positioning platform, PC and hardware/software control system.	Sentences ①–⑩ describe the structure, so the next part mainly deals with the fabrication process of the 3D-TENG. Sentence ⑪ mainly introduces the device used to prepare the materials. Because this sentence describes the components of the system, simple present tense is used.
⑫ The UV curing ink (liquid photopolymer resin) was prepared based on acrylate oligomer (～70 wt%), acroleic acid (～25 wt%), photoinitiator (～2 wt%), reactive diluents and additives (～3 wt%).	Sentences ⑫–⑰ detail the process of how the materials are prepared through a series of actions.

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(Continued)

Excerpts	Comments
⑬ The composite resins I and II were prepared by mixing the UV curing ink base and different masses of acrylonitrile butadiene styrene powder, 1:1.5 and 1:2 by weight, and then 3D printing was carried out. ⑭ The PAAm-LiCl hydrogel was prepared according to the method reported previously. ⑮ Briefly, acrylamide powder was added into LiCl (8 M) aqueous solution. ⑯ Subsequently, N, N'-methylenebisacrylamide, ammonium persulfate, and N, N, N', N'-tetramethylethylenediamine (Sigma-Aldrich) were dissolved in the solution consecutively. ⑰ The solution was then transferred into a cylindrical array of glass mold and treated in an oven at 45 °C for 3 h to form the PAAm-LiCl hydrogel.	Notably, logical connectors such as "then", "subsequently", "consecutively", and "then" are used to indicate the sequence of the process. Passive voice is mostly used when describing their process.
⑱ The fabrication process of the ultraflexible 3D-TENG includes the developing of ultraflexible 3D printer, material preparation (composite resins), 3D modeling (3D MAX), printing setup (for instance, a size of 3.5 cm × 3.5 cm × 3.5 cm, 3D printing of composite resin II part will need 180 g of composite resin II and 345 g of Supporting material and 10 min of build times), 3D printing and integration assembly. ⑲ According to the fabrication process as shown in Supplementary Fig. 1d, the ultraflexible 3D-TENG was successful assembled. ⑳ Finally, the copper wire was attached to the hydrogel for electrical connection.	Sentence ⑱ introduces the general process of fabricating the ultraflexible 3D-TENG; therefore, simple present tense is used. Sentences ⑲–⑳ refer to this specific experiment; therefore, simple past tense is used.
㉑ The morphology of the nanostructured rubber surface was characterized by a field emission scanning electron microscope (Hitachi SU8020). ㉒ The electrical output signals (voltage, charge, and current) of the ultraflexible 3D-TENGs were measured by a programmable electrometer (Keithley, part no. 6517B) and data acquisition card. ㉓ A linear motor (LinMot E1100) was used to form alternative motions and drive the device to contact and separate for quantified measurement. ㉔ In addition, the data were collected and recorded by computer-controlled measurement software written in LabVIEW.	The last part mainly deals with the data obtained from the experiment and the tools used to obtain the data. Sentence ㉑ introduces the field emission scanning electron microscope to characterize the morphology of the surface. Sentence ㉒ describes the programmable electrometer to measure the electrical output signals. Sentence ㉓ mentions the linear motor to treat the data. Sentence ㉔ describes the measurement software to collect and record data. Simple past tense and passive voice are frequently used.

II. A–C–B–H–G–D–E–F–I–J

III.

Passage 1:

1. were glued	2. placed	3. was mounted	4. was positioned
5. were used	6. was produced	7. expanded	

Passage 2:

1.were characterized	2. was equipped	3. was used	4. were used
5. was used	6. were prepared	7. were evaluated	8. were measured
9. was used	10. was performed	11. were performed	12. were quantified
13. were performed	14. was performed	15. were analyzed	

IV.

1. The powder feed rate during deposition was lowered until single particles impacted and adhered to the substrate.

2. The deformed particles were dissected to measure these dimensions using a FEI Quanta 3D Dual Beam instrument.

3. Precession electron diffraction (PED), a TEM-based technique, was performed on the thin foils via a NanoMegas ASTAR platform using a precession angle of 0.3° and a step size of 20–25 nm.

4. The base agent and curing agent of PDMS (Sylgard 184, Dow Corning) were mixed at a weight ratio of 10:1, which was well blended and deaerated via a planetary centrifugal mixer (Thinky, AR-100) for 15 min.

5. SST polymer with HTV silicone rubber (MVQ 110-2) and BPO were homogeneously blended by a two-roll miller (Taihu Rubber Machinery Inc., China, Type XK-160) followed by addition of the commercially available thermochromic fillers (bought from Shenzheng Bianse Chemical Technology Co., Ltd, China).

V. Answers may vary.

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VI. There are a variety of strategies to provide additional information of certain material or procedure. (1) "of" can be used to describe the properties of certain material, such as thickness, volume, or concentration. For example, we can say "10 nm of Ti", "5 mol of X solution", or "75% of the ether". (2) We can also use participles to serve as the modifying element to provide additional information, such as "UVO-treated" in "UVO-treated PET substrates". (3) Another strategy is to use relative clause, as shown in the last clause introduced by "which". (4) Using an adverbial adjunct, such as "using a PET mask", can also provide additional information. (5) In addition, we can put additional information in parentheses.

VII. Answers may vary.

Chapter 4

I. Figure 2 is an infrared spectrum of the surface modification of BN and AlN by silane coupling agent KH550. It can be seen from Figure 2 that curve (a) is the FTIR diagram of the silane coupling agent KH550, curves (b) and (d) are the FTIR diagrams of the surface modification of the BN and AlN by KH550, and curves (c) and (e) are FTIR patterns of BN particles and AlN particles (**Move 1: locating and summarizing figures**). According to the infrared spectrum of silane coupling agent KH550, it was found that KH550 had obvious characteristic absorption peaks at 2926.74, 1442.31, 1389.61, and 1072.18 cm^{-1}, and the characteristic peak at 2926.74 cm^{-1} represented the expansion and contraction of C–H bond in $-CH_2$. The vibrations 1442.31, 1389.61, and 1072.18 cm^{-1} corresponded to characteristic peaks of the $Si\text{-}O\text{-}CH_2CH_3$ group. The characteristic peaks of 1370.53 cm^{-1} and 780.16 cm^{-1} represented the stretching vibration peak and bending vibration peak of the BN bond (**Move 2: describing figures**), indicating the existence of BN, and the characteristic peak of 726 cm^{-1} signified the bending vibration of Al-N-Al, which proved the existence of AlN (**Move 3: making implications**). The curves in the comparison showed that the characteristic absorption peaks of BN and AlN had changed after KH550 surface modification. The BN and AlN curves that had no characteristic absorption peaks at 2926.74 cm^{-1} and 1100.22 cm^{-1} had a weaker characteristic peak, and the characteristic peaks at the 1100.22 cm^{-1} were corresponding to the stretching vibration absorption peak of the Si-O-Si bond (**Move 2: describing figures**). The step proved that KH550 had been successfully connected on the surface of BN and AlN (**Move 3: making implications**).

The three steps are organized in an alternating sequence.

II.

1. B 2. D 3. E 4. G 5. A 6. C 7. F

III.

1. is shown
2. are summarized
3. was greatly/significantly larger
4. was greatly/significantly smaller
5. indicates
6. could/may reduce

IV.

1. Figure 9. Curves of thermal conductivity of PI/BN/AlN composite films with the content of composite fillers.
2. Fig. 7. Grain growth kinetics in MDF-deformed cp-Ti as a function of fatigue cycles at 25 °C.
3. Fig. 4b. Real-time small-pressure recording during the sequential application of six water droplets to the sensor; the corresponding pressure is 7.3 ± 1.2 Pa.

Chapter 5

I. Answers may vary.

II. Answers may vary.

III.

1. The orientation difference of the recrystallized microstructure and as-deformed UFG microstructure is likely to be a consequence of anisotropic grain growth behaviour where the {0001} grain family with their c-axis perpendicular to the fatigue load axis grew much faster at the expense of other grain families.
2. In conclusion, patterned silicon electrodes were successfully fabricated by photolithography and RIE technology. It shows stabilized cycling performance and no cracks are observed after the first charge to 2 V. The 20-ALD-Si electrode exhibits a remarkably improved cycling performance than the uncoated electrode.
3. As a result, the silicon electrode with ALD coating shows better capacity retention in a long run. It hints that surface coating a well-fabricated, nano-sized, Si-based composite may lead to a practical anode with high coulombic efficiency and good cycling performance.
4. Considering the easy/exact controllability fabrication process (micron scale) and the

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common resin materials used, it could be able to achieve high flexibility, high precision, large area, and mass production in the future.

Chapter 6

I.

Abstract 1: Whereas 3D printing of thermoplastics is highly advanced and can readily create complex geometries, 3D printing of metals is still challenging and limited (**Move 1: Research Background**). The origin of this asymmetry in technological maturity is the continuous softening of thermoplastics with temperature into a readily formable state, which is absent in conventional metals. Unlike conventional metals, bulk metallic glasses (BMGs) demonstrate a supercooled liquid region and continuous softening upon heating, analogous to thermoplastics (**Move 2: Problem**). Here we demonstrate that, in extension of this analogy, BMGs are also amenable to extrusion-based 3D printing through fused filament fabrication (FFF) (**Move 3: Method**). When utilizing the BMGs' supercooled liquid behavior, 3D printing can be realized under similar conditions to those in thermoplastics. Fully dense and amorphous BMG parts are 3D printed in ambient environmental conditions resulting in high-strength metal parts (**Move 4: Results**). Due to the similarity between FFF of thermoplastics and BMGs, this method may leverage the technology infrastructure built by the thermoplastic FFF community to rapidly realize and proliferate accessible and practical printing of metals (**Move 5: Implications**).

Abstract 2: Flexible pressure sensors play an important role in electronic skins (E-skins), which mimic the mechanical forces sensing properties of human skin (**Move 1: Research Background**). A rational design for a pressure sensor with adjustable characteristics is in high demand for different application scenarios (**Move 2: Problem**). Here, we present tunable, ultrasensitive, and flexible pressure sensors based on compressible wrinkled microstructures (**Move 3: Method**). Modifying the morphology of polydimethylsiloxane (PDMS) microstructure enables the device to obtain different sensitivities and pressure ranges for different requirements. Furthermore, by intentionally introducing hollow structures in the PDMS wrinkles, our pressure sensor exhibits an ultrahigh sensitivity of 14.268 kPa^{-1}. The elastic microstructure-based capacitive sensor also possesses a very low detectable pressure limit (1.5 Pa), a fast response time (<50 ms), a wide pressure range, and excellent cycling stability (**Move 4: Results**). Implementing respiratory monitoring and vocalization recognition is realized by attaching the flexible pressure sensor onto the chest and throat, respectively, showing its great application potential for disease diagnosis, monitoring, and other advanced clinical/biological wearable technologies (**Move 5: Implications**).

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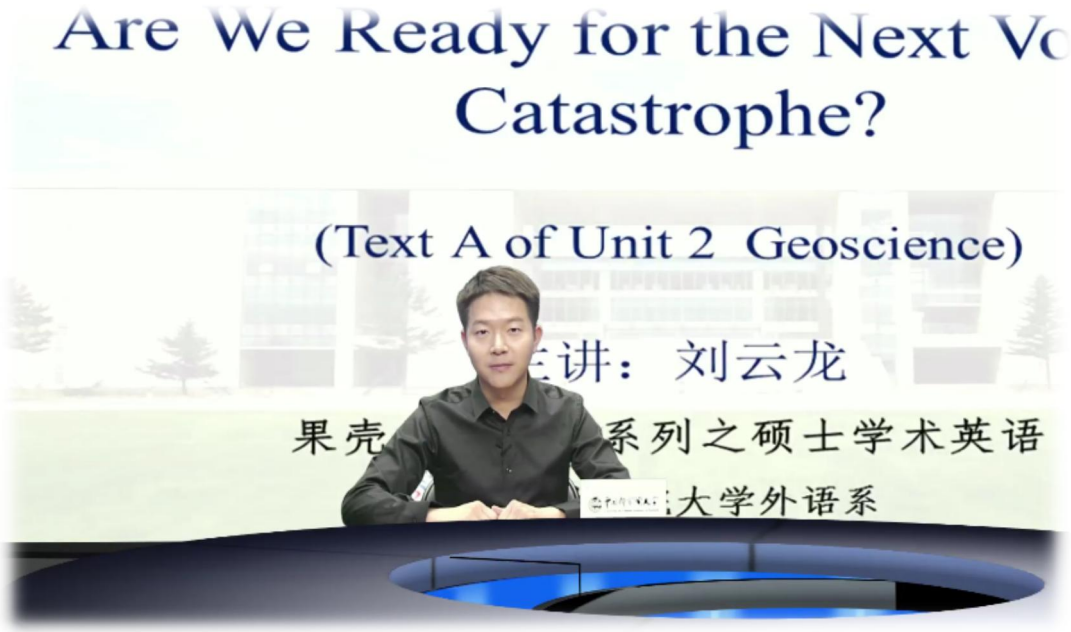
学术英语系列微课（科学家制作）



学术英语系列微课（外语教师制作）

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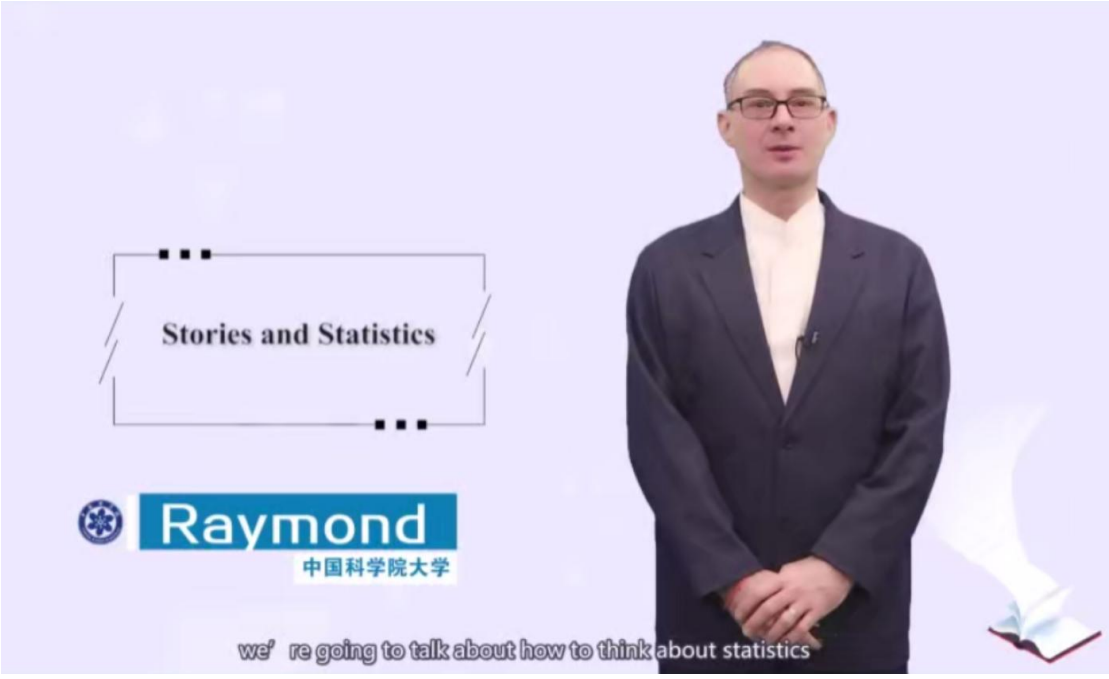

博士学术英语慕课

好消息1

自主学习中心预约平台

主要提供语言文化讲座、语音正音辅导两种辅导形式

外语的语音语调有什么典型特点？说外语时有浓重的口音？如何诊断自己发音中影响表达和理解的症点？期待一口的纯正外语发音？想让自己的外语听起来更自然更舒服？如何准备一个高质量的国际学术会议报告？喜欢外国语言与文学，希望读懂经典作品的内涵和意义？对语言和文化感兴趣，想了解语言和文化的相互影响？

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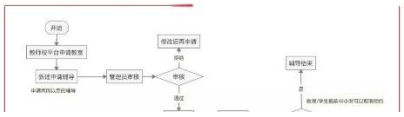
好消息2

学术英语写作中心预约平台

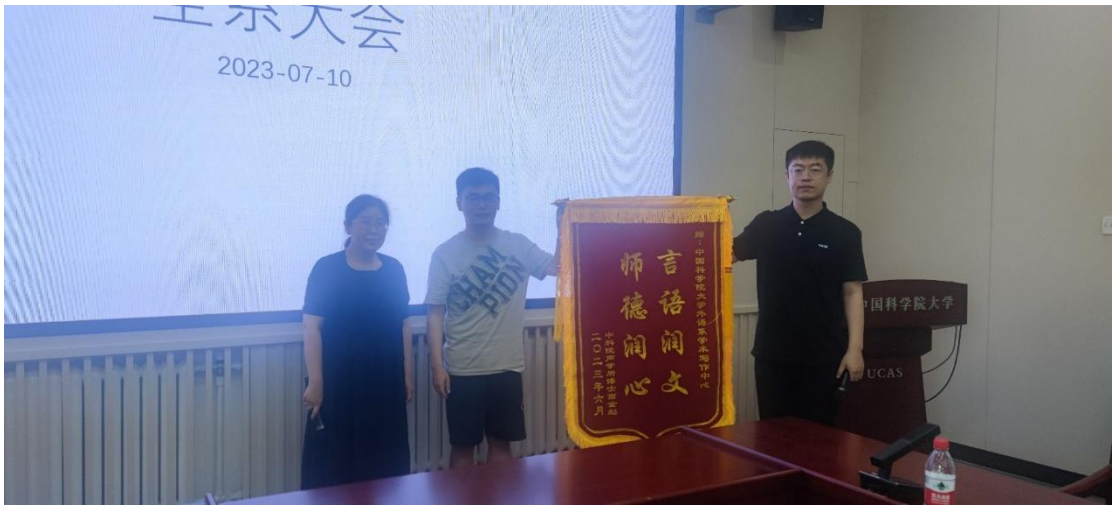
平台整合了我校外语教师资源，将陆续推出针对本、硕、博阶段的各类辅导课程，学生可以根据学习需求预约相应的辅导课程，教师将提供一对一或一对多，针对性及个性化的课程辅导。

学术写作预约平台基于**智能机器批改系统**，整合了**机器批改与人工批改**，并入了教师与学生互评体系，为我校师生提供全方位的线上及线下教学与辅导的全新模式。

系统流程如下图：



自主学习中心和学术写作中心课后辅导预约平台



声学所高金彪同学为学术英语写作中心赠送锦旗
（言语润文 师德润心）

学术英语测评体系材料

深圳先进技术研究院考场

杭州高等研究院考场

南京学院考场

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武汉教育基地考场

京内考场

学术英语机考考点

《硕士学位英语》学术英语机考测验每学年参加人数 1.2 万余人次，慕课学习机考测验 7200 余人分别在京内两个校区 24 个考场（多场次），4 个京外学院（杭高院、南京学院、海洋学院、成都学院），10 余个京外研究所（深圳先进技术研究院、武汉教育基地、沈阳自动化研究所、水生生物研究所、武汉病毒研究所、昆明植物研究所等）同时参加测验。

考生和试卷信息 9.5分

Part I: Vocabulary (已阅)
Part II: Cloze (已阅)
Part III: Translation (已阅)

考生和试卷信息

考生ID:	1000083009	性别:	男
姓名:	201918000936001(曾昌葛)	班级:	英语A+18班（怀）
学院:	高能物理研究所	邮箱:	
考试IP:	117.136.0.177	试卷名称:	Unit 2 预习测验02
进入考试时间:	2019-10-24 08:35:17	交卷时间:	2019-10-24 08:45:05
阅卷时间:	2019-10-30 22:23:26	阅卷老师:	liuyunlong(刘云龙)

随堂线上学术英语测评材料

题库名称	试题数量	题型数量
学术英语考试题库-学术英语-春季学期	39	2
学术英语考试题库-完型-nominalization-春季学期	22	1
学术英语考试题库-完型-opinion markers-秋季学期	21	2
学术英语考试题库-完型-reporting verbs-秋季学期	23	1
学术英语考试题库-完型-hedging-春季学期	21	1
学术英语考试题库-完型-connector-秋季学期	19	2
学术英语考试题库-完型-collocations-春季学期	22	1
学术英语考试题库-学术英语-秋季学期	379	3

学术英语题库建设

学术英语测评中心2023年度为各研究所博士考试命题列表

中国科学院亚热带农业生态研究所
中国科学院南海海洋研究所
中国科学院城市环境研究所
中国科学院自动化研究所
中国科学院高能物理研究所
中国科学院西北高原生物研究所
中国科学院地理科学与资源研究所
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中国科学院空间应用工程与技术中心
中国科学院电工研究所
中国科学院大学公共政策与管理学院
中国科学院科技战略咨询研究院
中国科学院南京地理与湖泊研究所

学术测评中心为研究所命题情况（以 2023 年为例）

学术英语代表性教研论文

以第 1 完成人近几年代表性学术英语论文成果为例：

1. **Gao, Y.** & Cui, Y. 2024. From teacher to teacher researcher: Identity change in the power dynamics of an EAP reform community. *Journal of English for Academic Purpo*ses. 71, https://doi.org/10.1016/j.jeap.2024.101408
2. Jin, Q. & **Gao, Y.** *2024. A rhetorical move-step analysis of graphical abstracts in experimental research articles. *Journal of English for Academic Purposes*. 70, https://doi.org/10.1016/j.jeap.2024.101396
3. Li, Y., **Gao, Y.** * & Lu, X. 2023. Effects of word limit on sentence length and clause length in academic journal article abstracts: A synergetic linguistic perspective. *Journal of Quantitative Linguistics*. http:// doi.org/10.1080/09296174.2023.2263249
4. Wang, J., **Gao, Y.** * & Cui, Y. 2023. Classroom gesture instruction on second language learners' academic presentations: Evidence from Chinese intermediate English learners. *Journal of English for Academic Purposes*. 66, https://doi.org/10.1016/j.jeap.2023.101304
5. Cui, Y., Jin, H. & **Gao, Y.** * 2023. Developing EFL teachers' feedback literacy for research and publication purposes through intra- and inter-disciplinary collaborations: A multiple-case study. *Assessing Writing.* 57, https://doi.org/10.1016/j.asw.2023.100751
6. Zhou, X., **Gao, Y.** * & Lu, X. 2023. Lexical complexity changes in 100 years' academic writing: Evidence from *Nature* biology letters. *Journal of English for Academic Purposes*. 64, https://doi.org/10.1016/j.jeap.2023.101262
7. Yin, S., **Gao, Y.*** & Lu, X. 2023. Diachronic changes in the syntactic complexity of emerging Chinese international publication writers' research article introduction: A rhetorical strategic perspective. *Journal of English for Academic Purposes.* 61, https://doi.org/10.1016/j.jeap.2022.101205
8. **Gao, Y.** & Cui, Y. 2022. Emotional tensions as rewards: An emerging teacher leader's identity construction in EFL textbook development. *TESOL Journal*. http://doi.org/10.1002/tesj.689
9. **Gao, Y.** & Cui, Y. 2022. 'Agree to disagree': Reconciling an English teacher's identity tensions in negotiating an educational reform through a community of practice perspective. *Language Teaching Research*. 1-19, http://doi.org/10.1177/13621688221130125
10. **高原**、于华，2022，国内出版的学术英语教材的现状与前景探究。《中国 ESP 研究》，第 1 期。
11. **Gao, Y.**, & Cui, Y. 2022. Agency as power: An ecological exploration of an emerging language teacher leaders' emotional changes in an educational reform. *Frontiers in Psychology* (13): https://doi.org/10.3389/fpsyg.2022.958260.
12. **Gao, Y.**, & Cui, Y. 2022. English as a foreign language teachers' pedagogical beliefs about teacher roles and their agentic actions amid and after COVID-19: A case study. *RELC Journal*, 53(1).
13. Cui, Y., Liu, Y., Yu, H., & **Gao, Y.*** 2022. Developing English teachers' language assessment literacy in an EAP reform context through test design: A case study. *System*. 109, https://doi.org/10.1016/j.system.2022.102866
14. **Gao, Y.**, & Cui, Y. 2021. To arrive where you are: A metaphorical analysis of teacher identity change in EAP reform. *Teaching and Teacher Education*. *104*, https://doi.org/10.1016/j.tate.2021.103374
15. Yin, S., **Gao, Y.***, & Lu, X. 2021. Syntactic complexity of research article part-genres: Differences between emerging and expert international publication writers. *System*. *97*, https://doi.org/10.1016/j.system.2020.102427
16. **高原**、崔雅琼，2021，英语教师在教学改革中情绪劳动变化轨迹的质性个案研究。《外语教育研究前沿》，第 3 期。

17. **高原**，2021，从对话理论看学术英语教师发展中的身份构建和情感变化。《中国 ESP 研究》，第 1 期。
18. 刘云龙、**高原**，2021，连接学术英语教学大纲与测评——以中国科学院大学学术英语教学改革为例。《外语测试与教学》，第 1 期。

Graphical abstracts article

发件人：

收

Dear Jin (if I may)
Thank you for your article on graphical abstracts in JEAP. I have been able to integrate some of your insights into my research article writing course for PhD students.
Best wishes

Assistant Professor in Applied Linguistics and Language Teaching
Head of English, University of Luxembourg Language Centre
Faculty of Humanities, Education and Social Sciences, Department of Humanities

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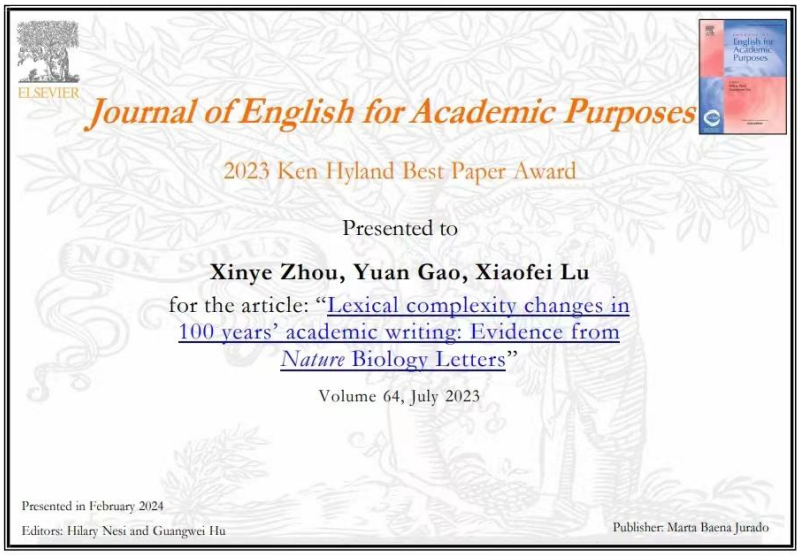
Grand Duchy of Luxembourg

研究成果在国外同行的博士学术英语写作课堂教学实践中的应用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Journal of English for Academic Purposes

2023 Ken Hyland Best Paper Award

Presented to

Xinye Zhou, Yuan Gao, Xiaofei Lu

for the article: "Lexical complexity changes in 100 years' academic writing: Evidence from *Nature* Biology Letters"

Volume 64, July 2023

Presented in February 2024

Editors: Hilary Nesi and Guangwei Hu

Publisher: Marta Baena Jurado

学术英语国际最高荣誉 Ken Hyland Best Paper Award

外语教师情绪劳动研究丨"前沿面对面"直播预告

外研社外语学术科研

2022年04月25日 17:07 听全文

以下文章来源于外语教育研究前沿，作者外语教育研究前沿

外语教育研究前沿

《外语教育研究前沿》由北京...

期刊好文丨英语教师在教学改革中情绪劳动变化轨迹的质性个案研究（文/高原、崔雅琼）

原创 高原、崔雅琼 外语教育研究前沿

2021年09月27日 17:15 1人

提要：教师需要付出情绪劳动，但以往研究较少涉及教学改革中的情绪劳动，更少探讨教学改革中不同的教师身份如何影响教师情绪劳动。本研究基于后结构主义视角和生态系统理论框架，长期跟踪访谈一名教学改革团队管理者和一名普通参与者，揭示教学改革生态系统中拥有不同权力身份的教师个体所付出的情绪劳动差异和变化轨迹。研究发现，管理者和普通参与者在教学改革进程中关注的情绪对象和采取的情绪劳动策略有所不同，管理者倾向于付出更

论文成果多次受到同行推荐

其他支撑材料

学生学术演讲比赛特等奖

中国大学生 5 分钟科研演讲大赛设有 34 个赛区，初赛共收集了 5757 组作品，其中 1228 组作品进入复赛；复赛评选出 72 组进入地区赛，推选出来自 28 所高校共 30 组作品晋级进入全国总决赛，角逐特等奖。选手的演讲题材涉猎广泛。从电子电气、能源、到材料、医药，从社会研究学前教育到艺术设计、文学翻译。展示出新一代科研人的科研热情与精神风貌。

同行前来参加博士学术英语教材研讨会

成立中国科学技术史学会语言、文学与科学专业委员会聚力国内学术英语教研活动。例图为学会活动：2022 年语言、文学与科学前沿论坛、第一届科学话语研究论坛暨 2023 年学术英语教学与测试研讨会。

外语教师和学科导师共同讨论学术英语课程设置

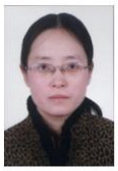
广州能源研究所

动物研究所

国际气候与环境科学中心

青岛生物能源与过程研究所

学术英语写作中心的外语教师深入研究所一线

Topic: 从大陆漂移到板块构造 Speaker: 魏东平 Time: 5月4日（周五）下午三点 Room: 中国科学院大学玉泉路校区人文楼会议室	Topic: 数学学科分类及论文写作基础 Speaker: 申立勇 Time: 2018年4月13日15:00-16:00 Room: 中国科学院大学玉泉路校区人文楼会议室	Topic: 视觉目标检测 Speaker: 叶齐祥 Time: 5月8日（周五）下午三点 Room: 中国科学院大学玉泉路校区人文楼会议室	Topic: 心理学概述 Speaker: 毕鸿燕 Time: 6月1日下午三点 Room: 中国科学院大学玉泉路校区人文楼会议室
			
中国科学院大学地球与行星科学学院教授	中国科学院大学数学科学学院 教授	中国科学院大学电子电气与通信工程学院 教授	中国科学院心理研究所研究员

科学家在外语系交流