Best Practices for Writing Academic Papers
Elements of a Paper

• **Title**  
  What the paper is about

• **Byline/affiliation**  
  Who you are

• **Abstract**  
  Short summary that can stand alone

• **Keywords**  
  Index terms for searching

• **Introduction**  
  The problem, what is known, what is not known, and the objective

• **Materials/methods**  
  What you did

• **Results**  
  What you found

• **Discussion**  
  How you interpret the results

• **Conclusion**  
  Possible implications and the impact

• **Acknowledgements**  
  Who contributed to the work and how

• **References**  
  How to find the works cited
Title

• Tells the reader what the paper is about and encourages people to read the paper
• Will be read more than any other section of the paper
• Should be informative, specific, and concise:
  – Informative: describe the subject of the research, not the results
  – Specific: differentiate your research from others on the subject
  – Concise: no more than 10 to 12 words
Functions of an Abstract

• Summarizes the major points made within the body of the paper
• Helps editors identify key features for indexing and retrieval
• Shows the reader the nature and scope of the paper
• Must be concise and self-contained (no cross-references)
• Between 150 to 250 words
• One paragraph (ideally)
• Write the abstract last to be sure it accurately reflects the content of the paper
Structure of an Abstract

• One or two sentences that state the topic and describe the problem you are tackling (why?)
• One or a few sentences that provide a general picture of the methodological approach (how?)
• A few sentences that describe the main outcomes (“what” was done?)
• One or two sentences that present the conclusion (“where” to?)
Example of an effective abstract

Electromagnetic induction coils are widely used in a variety of applications, many of them safety-critical. The insulation around the wire in an electromagnetic coil accounts for a significant portion of the failures in solenoid-operated valves and in electric motors. This paper presents a method of detecting the degradation of insulation used in low-voltage applications by assessing changes in impedance responses. The results indicate that coil impedance, resolved into resistance and reactance, evolves differently when the coil is subjected to different loading conditions, which reflects insulation degradation signatures due to different failure mechanisms. This method can be used to assess the insulation life of an electromagnetic coil, allowing replacement prior to the formation of harmful shorts or critical coil opens.

119 words
Example of an effective abstract

Degradation of electronic components is typically accompanied by a fractional deviation in their electrical parameters from their nominal values, which leads to parametric faults in electronic circuits. The existing prognostic approaches for detecting electronic component parametric faults emphasize identifying such monotonically deviating parameters and modeling their progression over time. However, in practical applications where the components become a part of the electronic circuits, it might not be feasible to monitor such component-level parameters, and prognostics then becomes a challenge. To address this problem, a health estimation method was developed using a kernel-based machine learning technique that exploits features specific to the circuit-comprising components exhibiting parametric faults, instead of the component-level parameters. The performance of kernel learning depends on the automatic adaptation of hyperparameters to the learning features. Hence, this study first presents an optimization framework for circuit health estimation from learning features using a penalized likelihood function and then solves it using a stochastic filtering method. Extensive evaluations of the data from simulation experiments on a benchmark Sallen–Key filter circuit and a DC–DC converter system demonstrate the ability of the developed method to estimate circuit health without having to monitor the individual component parameters.

196 words
Example of an effective abstract

Accurate battery state of charge (SOC) estimation contributes to establishing a reasonable charging/discharging strategy for battery management systems. It can also prevent serious damage to the battery (pack) caused by over-charging or over-discharging. This work develops a battery SOC estimation method based on a mechanistic model that has low computational cost and acceptable accuracy. The method was expanded from a single cell to a battery pack, and a corresponding charging/discharging control strategy for battery packs was also developed, which can reach a balance between charging depth and charging consuming time. Analysis and assessment of the accuracy and robustness of the developed method for single cells and battery packs indicate that the SOC estimation accuracy is acceptable under various operating conditions and shows potential for applications in electric vehicles.

128 words
An abstract that is too long: Part 1

This paper presents an analysis of the Database of Adverse Event Notifications for Medical Devices (DAEN-Medical Devices), which stores reports of medical devices used in Australia and has been available to the public since 2012. The goal of the paper is to understand how the database works in terms of gathering, processing, and sharing the information as well as presenting conclusions and recommendations to improve the database. The database was compared with the Manufacturer and User Facility Device Experience (MAUDE) database from the United States to identify and evaluate features that may be used for implementation. One observation found was that the database collects information from different sources, like manufacturers or patients, and from different formats, like paper or digital submissions. Due to the multiple origins and formats that are allowed in report submission, duplication of reports of the same adverse event for a medical device may be difficult to detect and could lead to confusion or misinterpretation of the information. Although TGA acknowledges that DAEN-medical devices cannot be used to determine whether a medical device is safe or not, the database can implement improvements to expand data history and achieve more accuracy on the reports stored. It is recommended that adverse events reported to TGA for DAEN-medical devices be submitted online and by manufacturers, sponsors (e.g. pharmaceutical companies, medical device suppliers) and health care practitioners only, to help reduce duplication, any inaccuracy in reporting and increase the amount of technical or medical details. Discontinuing the submission of reports in paper format, will also help reduce the extra work that could be required if such data was to be digitized into DAEN-medical devices. It is also recommended to improve the online search engine by using a more responsive auto search feature that will allow the user to perform a search without restricting the input order. Allowing data to be downloadable would also be a useful feature to implement, especially for research purposes, since the raw data can also be of interest for analysis but would be more manageable if it can be opened with computer software such as excel. Development of a mobile application to report adverse events is also recommended to increase the electronic access for reporting and guarantee constant interaction between the TGA and the entity reporting.

379 words
An abstract that is too long: Part 2

This paper presents an analysis of the Database of Adverse Event Notifications for Medical Devices (DAEN-Medical Devices), which stores reports of medical devices used in Australia and has been available to the public since 2012. The goal of the paper is to understand how the database works in terms of gathering, processing, and sharing the information as well as presenting conclusions and recommendations to improve the database. The database was compared with the Manufacturer and User Facility Device Experience (MAUDE) database from the United States to identify and evaluate features that may be used for implementation. One observation found was that the database collects information from different sources, like manufacturers or patients, and from different formats, like paper or digital submissions. Due to the multiple origins and formats that are allowed in report submission, duplication of reports of the same adverse event for a medical device may be difficult to detect and could lead to confusion or misinterpretation of the information. Although TGA acknowledges that DAEN-medical devices cannot be used to determine whether a medical device is safe or not, the database can implement improvements to expand data history and achieve more accuracy on the reports stored. It is recommended that adverse events reported to TGA for DAEN-medical devices be submitted online and by manufacturers, sponsors (e.g. pharmaceutical companies, medical device suppliers) and health care practitioners only, to help reduce duplication, any inaccuracy in reporting and increase the amount of technical or medical details. Discontinuing the submission of reports in paper format, will also help reduce the extra work that could be required if such data was to be digitized into DAEN-medical devices. It is also recommended to improve the online search engine by using a more responsive auto search feature that will allow the user to perform a search without restricting the input order. Allowing data to be downloadable would also be a useful feature to implement, especially for research purposes, since the raw data can also be of interest for analysis but would be more manageable if it can be opened with computer software such as excel. Development of a mobile application to report adverse events is also recommended to increase the electronic access for reporting and guarantee constant interaction between the TGA and the entity reporting.
An abstract that is too long: Part 3

This paper presents an analysis of the Database of Adverse Event Notifications for Medical Devices (DAEN-Medical Devices), which stores reports of medical devices used in Australia and has been available to the public since 2012. The goal of the paper is to understand how the database works in terms of gathering, processing, and sharing the information as well as presenting conclusions and recommendations to improve the database. The database was compared with the Manufacturer and User Facility Device Experience (MAUDE) database from the United States to identify and evaluate features that may be used for implementation. Due to the multiple origins and formats that are allowed in report submission, duplication of reports of the same adverse event for a medical device may be difficult to detect and could lead to confusion or misinterpretation of the information. It is recommended that adverse events reported to TGA for DAEN-medical devices be submitted online and by manufacturers, sponsors, and health care practitioners only, to help reduce duplication and any inaccuracy in reporting and increase the amount of technical or medical details. Development of a mobile application to report adverse events is also recommended to increase the electronic access for reporting and guarantee constant interaction between the TGA and the entity reporting.

207 words
An abstract that is too brief

Stretchable electronics can offer a new degree of design freedom and products with unprecedented capabilities. This paper focuses on the development and cyclical fatigue studies of a new screen-printable and stretchable conductive ink.

33 words

My comments: This abstract is rather brief and doesn’t describe the breadth of the paper, in my opinion. You could easily add several more sentences, such as How would the ink benefit the SE technology—is there a problem that your research on the ink is helping solve? How does a stretchable ink relate to SE?
Introduction

- Clear statement of the problem or project and why you are studying it
- Background of the problem and the significance, scope, and limits of your work
- Description of what has been done before by citing pertinent literature
- Statement of how your work differs from or is related to previously published work
- Not the same as an abstract, start writing your paper with the Introduction
Materials and Methods

• Provides a clear and complete description for all experimental, analytical, and statistical procedures.

• Organize the section logically, perhaps chronologically, and use specific, informative language.

• An outline can be a valuable tool at this stage. Headings can help you to systematically address each important point that you wish to make.

• Each paragraph should have clear, well thought out points, and should contain only the information needed to make or support that point.

• Fill in each paragraph with more details until you have a coherent argument building toward your final, concluding statement.
Results and Discussion

• The results and discussion sections may be separate or they may be combined.

• The results section should explain or elaborate on your findings by logically summarizing and illustrating relevant data using tables or figures.

• The discussion section should interpret the results clearly, concisely, and logically.
Three Parts of a Strong Conclusion

• Part 1: Introduction
  – 1 paragraph
• Part 2: Synthesis
  – 2 to 3 paragraphs
• Part 3: Outlook
  – 1 paragraph
Part 1: Introduction

• Write 1 introductory paragraph that describes the current situation in industry or academia that your research addresses.
  – Describing the current situation will explain to readers why your research needed to be done.
  – Write clearly.
  – Keep this paragraph short (3 to 4 sentences).
  – Be specific about the current situation; for example, list the specific industry affected, or give a startling example, or list statistics that will grab people’s attention.
Part 1: Introduction: Original Example

• Original introductory paragraph:
  – At room temperature in a high humidity and high sulfur environment, the migration of Ag⁺ could occur. The corrosion products mainly consisted of Ag₂S. If Cu was exposed, Ag and Cu formed galvanic cells. The galvanic reaction occurred in environments that had substantial concentrations of sulfur and sufficient humidity, and subsequently Cu₂S and CuS were formed. As time went on, the edges of the Ag layers formed different corrosion layers with Ag₂S, Cu₂S, and CuS. Most of the Cu was covered, and galvanic corrosion was prevented by Ag₂S and also by some Cu₂S and CuS that had formed previously. This caused the dendrites in the IIL location to be short, even after increased exposure.
Part 1: Introduction: Revised Example

• Revised introductory paragraph:
  – The corrosion of PCBs is a serious concern for manufacturers that use computers in high-sulfur environments. For example, automakers routinely use high-sulfur clay to design new car body concepts. Many automakers have reported that computers used in close proximity to modeling clay have experienced failures due to corrosion. The amount of corrosion seen on the PCBs of these computers is often equal to a harsh Battelle Class IV environment.
Part 2: Synthesis

• In 2 to 3 paragraphs, synthesize your research.
  – Don’t just list what you did.
  – Make a verbal link between your research and your introduction.
    • Use the same “terms” (e.g., sulfur, corrosion, PCBs, automakers, clay) as in the Introduction. Don’t change your terminology. Be consistent.
  – Hit the highlights. Don’t explain every little detail.
    • Mention important or memorable statistics.
    • Be persuasive.
    • Show that your experiment addresses the problem you described in the Introduction.
    • Show how your results relate to the real-world problem you described in the Introduction.
Part 2: Synthesis: Summary vs. Synthesis

• Don’t summarize; synthesize.
  – Summary: Today I went to the store from 10:30 to 11:30 a.m. Then I ate lunch at McDonald’s. I had a hamburger and a soda. Then I went to my friend’s house in Silver Spring. I stayed there for 4 hours and then I came home and ate dinner.
  – Synthesis: I needed to get some food for my party tomorrow, so I went to the store this morning. Then I went over to my friend’s house to help her paint her living room. She just got a new house and she asked me to help her.
Part 2: Synthesis:
Summary vs. Synthesis

- Summaries don’t say which information is important.
  - Was eating lunch at McDonald’s more important than helping your friend paint?
- Summaries don’t explain why you did what you did.
  - A summary doesn’t tell us that you went shopping because you have a party tomorrow night, or that you went to your friend’s house to help her paint.
- Syntheses discriminate between unimportant and important information.
  - The synthesis didn’t mention lunch at McDonald’s.
- Syntheses explain why you did what you did.
  - You went shopping because of the significant reason of a party, not for the common reason that you needed food. And without knowing why you went to your friend’s house, we couldn’t understand your reason for spending all that time there.
Part 2: Synthesis:
Example of a Summary

• This is a summary:
  – Ten PCBs were exposed to high-sulfur environments for 100 hours at 40 ºC and 90% RH. The samples were taken out and examined every 60 minutes. Their corrosion levels were measured. The samples were then placed back in the test chamber and the chamber door was sealed. The PCBs failed after 85 hours.

• Notice:
  – There is irrelevant information:
    • The samples were then placed back in the test chamber and the chamber door was sealed.
  – The reasons for doing this test are not clear.
Part 2: Synthesis: Example of Synthesis

• This is a synthesis:
  – To determine the time to failure of PCBs under high-sulfur environments, 10 PCBs were exposed to high-sulfur environments for 100 hours at 40 °C and 90% RH. The corrosion levels were measured every 60 minutes. The PCBs failed after 85 hours. These results are consistent with reports from several automakers that indicate that their computers that were used in high-sulfur environments regularly failed after three to four days of continuous operation in high-sulfur environments.

• Notice:
  – Irrelevant information deleted, such as that the PCBs were placed back in the test chamber.
  – The reasons for conducting this test are given:
    • To determine the time to failure of PCBs under high-sulfur environments.
    • To explore a problem that automakers regularly experience.
Part 2: Synthesis:
Reminders

• The revised example paragraph has a strong first sentence.
  – It introduces the fact that I am going to spend time describing: the two main failure modes of PCBs in high-sulfur environments.
  – It makes a link between my introductory paragraph and my research synthesis by repeating the main issue: corrosion of PCBs in high sulfur environments.

• Part 2 should be 2 to 3 paragraphs long.
  – Make each paragraph a synthesis of one part of your experiment.
  – Don’t give too much detail. Just give the essentials.
  – Relate the essentials to the original problem given in your introduction.
Part 3: Outlook

• In 1 final paragraph, explain how the world will change (no matter how small the change is) because of your research.
  – Explain in 1 to 3 sentences how your research can be implemented by those in industry and/or academia.
  – Explain in 1 or 2 sentences the positive results that those who implement your ideas can expect to have.
  – Explain in 1 sentence some further areas of research.
Part 3: Outlook: Example

Automakers and other industry members that use computers in high-sulfur environments should limit the exposure of their computers to such environments to prevent corrosion. One way to limit exposure is simply to remove computers from areas where they will be exposed to high amounts of sulfur. In situations where computers must be used in high-sulfur environments, humidity and temperature can be controlled to slow the growth of corrosion. Once implemented, these measures will be able to significantly lower the number of failures of computers in high-sulfur environments. This could save industry the cost of new computers and prevent the loss of data from damaged computers. Further areas of research include measuring the effects of variable distances between computers and sulfur sources, and the growth rates of corrosion on PCBs made of different materials.
3 Parts of a Conclusion

• Part 1: Introduction
  – 1 paragraph of 3 to 4 sentences.
  – Mention real-world problems, statistics, and examples.

• Part 2: Synthesis
  – 2 to 3 paragraphs, each 4-8 sentences long.
  – Use the same “characters” as in the Introduction.
  – Link your experiment and results to the real-world problem described in your Introduction.

• Part 3: Outlook
  – 1 paragraph (4-6 sentences).
  – Describe how the characters in industry/academia that you mentioned in the Introduction can implement your results.
  – Describe the benefits of your results for industry/academia.
  – Mention in 1 sentence some areas for further research.
Figures and Tables

• Know the difference between a figure and a table (and between and a table and a list). A table compares data.

• All figures and tables must be called out and discussed in the text BEFORE they appear.

• Use descriptive captions: place captions above tables; below figures

• If a figure has multiple parts, describe parts in the caption (a, b, c)
Figures and Tables: Word Tools

• Use the Insert caption feature in Word to link the caption to the figure or table.

• Then use the Insert cross-reference feature to link the figure or table callout in the text.

• To update figure and table numbers if you move them, CTRL a, then F9.

• If you have a lot of figures, compress them using Word’s compression feature (under Picture Tools). Remove cropped sections.
Figures and Tables: Quality and Permissions

- Tables must be editable in Word, not a graphic
- Draw your own figures or get permission to use someone else’s figures
- Cite the source of the figure in the caption
  - e.g., Fig. 1 Title of figure. Reprinted with permission from journal name; copyright (year) by (owner of copyright)
- Figures must be able to reproduce well—high resolution needed
- Labels should be the same size and font (Times Roman) as the text
Figure Examples

Problem: Figure is “fuzzy” because it is low resolution.

Problems: Figure is “fuzzy” AND the axis labels are too small. Labels should be the same size as text.
Do’s and Don’ts (1/3)

- Do watch verb tenses. Experiments should be described in the past tense.
- Do quantify adjectives such as low or high, small or large—give examples.
- Don’t use one-sentence paragraphs—expand them or join with the following paragraph.
- Don’t stack headings without at least a paragraph in between.
- Don’t use spaces to move text over. Use tabs rather than multiple spaces—use the tab ruler to set the tabs.
Do’s and Don’ts (2/3)

- Do limit use of bulleted or numbered lists. Use text narration instead.
- Do use the degree symbol ° rather than superscript “o”. You can access it on the Insert menu, then choose the symbol chart.
- Do precede units of measure by a space (e.g., 5 kHz, 10 °C). A nonbreaking space (CTRL-SHIFT-space) is preferable to avoid line breaks between the number and the unit (or be consistent and per the journal style)
- Do use the spelling checker and set the language to U.S. English for the WHOLE document—make sure that the “do not check spelling and grammar” is not selected.
Do’s and Don’ts (3/3)

• Don’t overuse headings, subheadings can often be combined.

• Do limit use of acronyms. Define acronyms when they first appear and give the acronym in parentheses.

• Don’t overuse the term “important” without explaining why something is important.
Formatting

• Check the journal website for the preferred format—there usually are author guidelines for formatting.

• Use the styles tool for all elements. If you style tag your headings, you can see them in the navigation pane, which can act as an outline. You can redefine the built-in style tags.

• Differentiate paragraphs by indenting them or, preferably, adding extra space between paragraphs using the style menu.

• Closer to publication, single-space your paper and use page breaks to avoid widows and orphans (single lines at bottom or top of page/column).

• Repeat table column heads and avoid breaking table rows over two pages (these are options in Word.)
References (1/2)

• Put the reference number [1] following the author you are citing.
• Make sure it’s clear which parts of the narration you are attributing to a particular reference.
• Do not copy text verbatim. Put in your own words OR use quote marks and cite your source.
• Reference list: use author guide from journal to which you are submitting OR use IEEE style:
  • Format consistently, especially journal titles (capitalization).
  • Use Word’s Insert citation tool.
References (2/2)

• Use web sources sparingly.
• Do not use Wikipedia as a source (but look at original sources cited in Wikipedia and use as primary sources)
• Journal articles, and conference papers, and books are preferred.
• Provide more information than URL only, include: author, title, date of publication, access date.

  Not: www.fda.gov.synthesis.pdf

• Access date is helpful, but it also “dates” a reference. Update them closer to publication.
• Include digital object identifier (DOI) if the paper has not been published yet.
Writing Tips

• **Choose words carefully.** Use specific and concise words. When you have something simple to say, say it simply.
  – Examples: *Instead of … Use …*
    - approximately  about
    - commence  begin
    - finalize  finish
    - terminate  end
    - utilize  use

• **Use active verbs and avoid passive verbs.**
  – Example: “This method was recommended by them” is passive, whereas “They recommended this method” is active.

• **Use strong verbs, not nouns:** Put the emphasis of the sentence in the verb, not the noun.
  – Examples: *Instead of … Use the verb …*
    - make an adjustment  adjust
    - make a judgment  judge
    - take into consideration  consider
    - perform an investigation  investigate
Writing Tips

• **Tighten your writing:** Wordy writing bores the reader and makes it harder to understand what you mean.
  
  – Examples (the words in red can be eliminated): *a period of* two months, *during the course of* the experiment, *during the year 2002*, *maximum (minimum) possible*, *past experience*, *plan in advance*, *refer back*, *the color red*, *true facts*, *repeat again*, *already existing*, *different alternatives*, *previous literature*, *completely eliminate*

• Delete words that can’t be quantified when used to modify another word.
  
  – Examples: *quite, really, rather, very, many, few*

• Delete words that don’t add to the understanding of the message:
  
  – Examples: *it is interesting to note that*, *it should be pointed out*, *it is significant that*

• Put the main idea of your sentence into the subject and verb to reduce the number of words. Instead of writing “The purpose of this approach is to allow…”, try writing “This approach allows …”. The main idea is *purpose* but rather *approach*. 
Writing Tips

• Substitute a single word for a wordy phrase:
  – Examples:  
    
    | Instead of                        | Use      |
    |----------------------------------|----------|
    | at the present time              | now      |
    | due to the fact that             | because  |
    | it may be that                   | perhaps  |
    | in the near future               | soon     |
    | prior to the start of            | before   |
    | the first point is               | first    |
    | one of the problems              | one      |
    | on two separate occasions        | twice    |
    | in close agreement with          | agree with |
    | it is obvious that               | obviously|
    | the majority of                  | most     |
Helpful Websites

IEEE Authorship Series: How to Write for Technical Periodicals & Conferences: Guide to the writing process, includes a discussion on ethics. Gives links to other IEEE websites related to writing.


This University of Zurich Plant Science Center website “Guidelines for Writing a Review Article” gives concise descriptions of each element of an article, including function, verb tense, and length
http://ueberfachliche-kompetenzen.ethz.ch/dopraedi/pdfs/Mayer/guidelines_review_article.pdf

Purdue University Online Writing Lab (OWL) is a general resource for research and writing. Covers other publication styles—APA, MLA, and Chicago Manual of Style. Although it’s more aimed at social sciences, there are several good discussions and exercises on how to avoid plagiarizing.
https://owl.english.purdue.edu/owl/