Research papers: Writing tips and top-tier targets

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A s a part of each graduate program study, graduate students need to conduct research in a specific field and, most importantly, publish the results of their work in journals and conference publications. While this might sound easy to some graduate students, it may be the most challenging task for many, specifically those in the early years of their studies. Particularly, students have questions regarding transferring the results of their work from a "report" into a research paper, writing high-quality research papers, and how to choose among the various journals and conference publications in their fields. Very often, many students have good results but they have a difficult time publishing them.

This article aims to address such concerns through discussing different parts of a research paper as well as summarizing some criteria that facilitate choosing the right place for your research paper publication. Moreover, it is worth mentioning that there are many different ways to write high-quality research papers and target top-tier journals and conference publications, and I will discuss an approach based on my experience.

Document your work

Before discussing research papers, it is critical to emphasize the importance of documenting your work. Throughout your research, you may come up with different ideas and solutions. When working on a subject, make a report: document all your ideas, possible solutions, and, of course, the results. This document should also include a summary of the works related to your research on the topic.

A great idea is to write reports using a research paper template [e.g.,

the Association for Computing Machinery (ACM) and the IEEE have some specific templates for their publications]. These documents help when you want to discuss your research progress with your advisor, and they are great resources when you want to start writing your research paper, particularly, when you have time constraints due to an approaching deadline. When your work is properly documented, you can easily use the document to put together different materials into

a few papers. Some useful tips are summarized in the rest of this article to provide effective examples regarding how to write successful research papers.

Finding the right place for publication

Prior to writing and submission, it is always a good idea to know about the journal or the conference publication to which you are submitting. The importance of journals and conferences vary from one field to another. For example, conference publications are more important in computer science, while journal papers are considered to be more important in mechanical and material engineering. But, in general, journal papers are mostly given more attention compared with conference publications, since they always include more information and are more complete. Nevertheless, conferences are critical to present your work and interact with other colleagues in your field, which can lead to a successful collaboration.

In both cases, you need to find the right place to publish your work. If you want your work to be noticed in your community, you may want to monitor where most of the works in your field are being published and target those outlets. When it comes to journal papers, impact factor can give you an idea about the quality of the journal. Impact factor is a measurement of the frequency with which an average article in a journal has been cited in a particular year. The higher the impact factor score, the more highly cited the publicaton.

It is important to be present in leading conferences in your field. Presenting in a top-tier conference can help your work get noticed and sometimes brings collaboration. Google Scholar has an option called *Metrics* that can help you learn more about the quality of the conferences in your field by considering the h5-index related to each conference (the h-index for articles published in the last five complete years in each conference publication).

Selecting a journal or a conference publication also depends on the significance of your contribution in the paper: you need to make sure that the contribution matches the level of the journal or the conference publication to which you are submitting. Also, sometimes due to the tight competition among different research groups, you may consider publishing your work in a lower-ranked journal or conference publication. This can be the case when you want to make sure that you are the first one discussing a novel idea in your community.

Some symposiums and workshops that highly focus on the field of your research can also be good places to publish your work, since they can help improve your visibility in your research community. In the end, as a rule of thumb, follow the highly cited papers in your field to get a good idea of where most of the best papers are published.

No matter which journal or conference publication you choose for publishing your work, it is important to become familiar with the publication prior to writing your paper. Before you start writing, you need to carefully choose the right topics/tracks in the journal or the conference publication of your interest that perfectly matches the field of the paper. Make sure that you use some of the terms in that specific topic/track while writing your paper, particularly in the abstract and the keywords section (see the "Title, Author List, and Keywords" and "Abstract and Introduction" sections). This shows that your work lies within that specific topic/track.

What is a research paper?

Let's discuss the main purpose and different parts of a good research paper. While there are different definitions when it comes to a good research paper, it is all about the story of your work. You want to tell others about the importance of the problem on which you are working, the significance of your work, and your findings. Like any other story, yours should make perfect sense. You need to make it interesting and sound. There should be strong connections among different parts of your story with the ending being extremely important to the reader. Therefore, when you are writing, always think of a perfect and convincing story that you can tell to attract others.

The paper itself includes several important parts, such as a title, a list of authors, keywords, an abstract, an introduction, the main body (i.e., the methodology and technical part), results, conclusions, references, and sometimes, appendices. Before writing, you need to come up with an outline. The outline is like the infrastructure of your paper: you need to determine the different sections and then identify the major topics in each section. A complete outline helps you create a perfect story and can help save a lot of your time: without a good outline, there will be a lot of back and forth revisions when writing your paper. In the following sections, each part of the research paper is briefly described to help you become more familiar with the proper structure of a good research paper.

Title, author list, and keywords

Almost all research papers follow the same template—a title and a list of authors with their affiliations. Choosing a title is very important since it is the first part a reviewer or reader views. A good title should help readers identify the content of the paper and catch their attention. Elaborate on each word of the title throughout the paper; in other words, summarize your work in a few words. Make sure the title is not too long, usually one or two lines are best.

> **Prior to writing and submission, it is always a good idea to know about the journal or the conference publication to which you are submitting.**

The abstract and introduction are the most important parts of any research paper.

The authors list indicates all the people who have contributed to the work as well as their affiliations. Usually, the first author is the one with the most significant contribution, and the last one is the principal investigator (i.e., supervisor) of the team (although this might be slightly different depending on the university and the country). While having a long author list is normal in some fields (e.g., papers that are produced by a large collaboration like those dealing with experiments that involve many people), usually the significance of each author's contribution gets less as the author list grows.

Usually, after the title and the author list, there are some keywords that determine the specific domain of the paper. These keywords should be selected carefully to make sure an interested person/company can easily locate your paper using such keywords. As previously mentioned, these keywords should be selected considering the topic/track in a journal or a conference publication to which the paper is submitted.

Abstract and introduction

The abstract and introduction are the most important parts of any research paper. The abstract is usually a paragraph that briefly summarizes the research problem, your motivation, and your contribution. The most important aspect of the abstract is to make sure that it attracts a person to continue reading your paper.

The introduction further expands the abstract by detailing the background of the problem and its importance in the field, your motivation and solution, and your contribution. Very often, the contribution can be listed with bullet points in the introduction, making it very easy to understand the major contributions of your work. You also need to make a strong and clear connection between the problem definition (e.g., power consumption in an electronic chip) and your contributions (e.g., a novel method to reduce electronic chips power consumption).

The introduction can also include an overview of the advantages of your approach/method in dealing with the problem, as well as summarizing the results and their significance. It is worth mentioning that a good paper starts with an interesting and strong abstract and introduction. As a result, reviewers pay a lot of attention to these two parts when evaluating a research paper.

Related work and methodology

The related work section is mostly necessary for journal papers, while conference papers usually include a short related work section. It includes a summary of the most up-to-date works related to the problem you are addressing in the paper. It also discusses the state of the art with respect to the field of the paper and fairly summarizes the strengths and drawbacks of each related work, while highlighting the major contributions and differences of your paper compared with others. It is important to be realistic and fair while discussing others' work.

After the related work, the paper usually expands the contributions through a detailed methodology. This is the longest part of the paper, discussing different aspects, including problem definition and modeling, different assumptions and techniques, and analyses, among others. As a result, it is the most technical part of the paper. A major problem that often arises is the assumptions: you want to make sure that they are valid and are supported by enough evidence. You are responsible for making sure that all the analyses are correct and sound. In the end, it is always necessary to cite the paper from which you are borrowing a technique or an idea.

Results, conclusion, and references

After discussing the methodology, it is time to look into some results. Whether presenting a simulation or experimental results, it is always important to detail the simulation/experiment setup, including the use of any specific equipment, software, tool, method, or conditions (e.g., temperature). Be realistic when presenting the results, and always compare them with those from some selected related works and under different conditions.

Don't just present the results, but focus on why they are important and describe different aspects and behaviors. The reader should get a clear idea about the different trends and details of the results through reading the text in your manuscript. If some results from your approach are worse than others, explain the reason and further highlight the other aspects in which your approach outperform other works. Quantitatively highlight the importance and advantages of your results compared with other related works (e.g., 40% improvement in the power consumption of electronic chips). Discuss possible overheads and present some ideas and solutions to overcome those concerns.

The conclusion is not only a short summary of your paper, including the problem, motivation, your contribution, and the most important results you obtained in your work, but it should also discuss the scope of the work and how it contributes to the field in a broader sense. Usually, it also discusses future work. It is important to remember that the conclusion is not the abstract, and one should not copy the abstract into the conclusion. The conclusion discusses the results and significance of the work in a broader sense compared with the abstract.

The references are the last part of the manuscript, including a list of other related works cited in the paper. It shows the reader that you

have gone through different works and carefully performed a good literature review. Try to use up-to-date references with a proper format. It is acceptable to cite some of your previous works, but do not overindulge in self-citation.

If you are submitting your paper to a conference that requires blind-review submissions (i.e., the authors should not reveal their identity in the paper when submitting to the conference), be careful when citing your previous work: always refer to the work using the third-person point of view, and avoid citing papers that are not yet published or available to the public. Some papers might also add an appendix at the end, in which the authors can further elaborate on the technical information or analyses that are used in the manuscript.

Keep revising and ask peers

After you finish writing your paper, it is time to make some revisions. Start by reading the paper from the beginning and make sure everything is clear. Put yourself in the shoes of the reader and the reviewer. Then, ask yourself: does the story you are telling in the paper make sense? Is there anything missing in the paper? Is there a clear connection between the highlighted issues and the contributions? Are the analyses correct? Are the assumptions valid? Are the results sufficient and do they support the ideas and claims in the paper? If not, you need to apply the necessary corrections and improvements.

Moreover, carefully scan the paper for possible typos, language errors (grammar mistakes), and misuse of technical words. If you are writing in your nonnative language, have someone who is proficient in that language review your work. Once you are confident about your paper, you can pass it to one of your colleagues from the same group (labmates or advisors) to read it and provide their comments/suggestions. This is very important and highly encouraged: even if you are very confident about the paper, it is important to have someone else's opinion. You may be familiar with your work, but the purpose of writing the paper is to inform others, so the emphasis here is on making sure that the paper makes a complete sense to a person with an outside view.

Presentation, organization, and writing: They all matter

Although research papers need to be technically sound, their presentation and organization are also important. The writing should be easy to follow, without typos and language mistakes. Remember that no matter how good the technical part of the paper, it is the presentation and organization that catches the attention of the reader.

No one likes to read a paper that has boring figures and poor organization. Make sure that the figures are easy to read and are placed on the right page (i.e., close to where they have been cited in the text). Use existing professional software/tools to draw your figures (e.g., Microsoft Visio or Gnuplot, among others). Don't be shy, and use appropriate colors (everyone likes a colorful paper), while making sure you are consistent (e.g., use the same color when plotting power consumption in electronic chips throughout the whole paper). Consider printing your paper and carefully look at the figures to make sure the colors are recognizable and the text in the figures is easy to read.

Finally, when writing your paper, you want to make sure it is easy to understand and follow. Try to make it simple but professional: remember that the main focus is on the technical part, and your job is to make sure the reader can easily understand the content. Also, even if you are a native English speaker, it is always a good idea to have your paper proofread by a professional communication advisor.

Keep writing and reading

The secret to writing high-quality research papers is to keep writing and, most importantly, read others' works. You can always learn from how successful researchers write their papers. For example, choose some papers that have received best paper awards or those that have been largely downloaded or cited, and carefully read them to understand different techniques used by the authors.

In the end, it is always beneficial to discuss your ideas with your advisor and seek his or her opinion regarding writing research papers. Many universities hold useful workshops to discuss writing techniques for research papers, and these are great opportunities to improve your skills.

Read more about it

• M. Nikdast, "Research tips for first-year Ph.D. students," *IEEE Potentials*, vol. 35, no. 3, pp. 18–20, May/June 2016. DOI: 10.1109/MPOT. 2016.2514618.

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Mahdi Nikdast (mnikdast@ieee.org) earned his Ph.D. degree in electronic and computer engineering from The Hong Kong University of Science and Technology in 2013. Since 2014, he has been a postdoctoral fellow in the Department of Computer and Software Engineering at Polytechnique Montréal, Canada.

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