Some Hints to Improve Writing of Technical Papers*

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Abstract

The abstract must summarize the paper, clearly stating the context, the contribution and the main results.[1] *In this paper, I provide a number of hints that should be useful to students in computer science in writing quality technical papers. This paper is reflexive in the sense that it is written following these hints. The hints are provided in terms of rules and form the basis for a simple method for getting started.*

1 Introduction

The introduction must convince the reader that the paper is worth reading, e.g., it addresses an important problem and provides an exciting, solid solution. It is usually structured as follows: context of the paper, precise problem definition, limitations of existing, state-of-the-art solutions (if any), goal of the paper, key ideas, and a short outline.

Context of the paper. In this paper, I am primarily interested in papers in computer science, in particular, the area of information and database systems, because it is an important aspect of our professional life. Not only must we do excellent research, we must also be able to communicate well our results to the professional community. This essentially means writing high-quality technical papers.

Problem definition. Given a good research result, the problem is to come up with a quality technical paper that best presents it. The most common measure for assessing the quality of a technical paper today is its suitability for publication in the best journals or conferences in its area. The intense competition in computer science, as led by the USA, has set high-quality standards that

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[1] I use **bold** font when talking about a paper in general, i.e., at a meta-level, and standard font for this paper.

we must follow. But there are several difficulties that hamper the production of such high-quality papers by junior researchers and Ph. D. students: poor English skills, lack of proper training, and lack of method. There is not much I can do about the two former problems except advising for personal investment (e.g., join a good English class!). This paper addresses the latter problem.

Limitations of existing solutions. The most practical solution is that you [2] produce a first draft and enlist a researcher with good writing skills to improve or entirely rewrite the paper, sometimes even without your own contribution. Although the end result can be an excellent paper that you may not recognize, the main problem is that you will not learn how to produce the paper yourself. Some dedicated researchers may consider the activity of producing a paper as a training job, which essentially means explaining again and again how to transform an unreadable draft into a good paper until you can do it yourself. Although I have always favored the latter solution, I now feel that writing down a number of hints to avoid the most common mistakes should be useful to a larger number of students. A more mundane reason is that it should save us much time and pain.

Goal of the paper. In this paper, my main goal is to provide a number of hints and a simple method for improving the quality of technical papers. This is meant as a guide to get started and I do not claim to be complete or to solve all technical writing problems. I distinguish between the content and the presentation aspects of a paper for which I give hints in terms of numbered rules. These rules are the basis for the method.

Outline of the paper. This paper is organized as follows. Section 2 addresses the content aspects of a paper. Section 3 addresses the presentation aspects. Section 4 tells how to get started with a simple method. Section 5 concludes.

2 Content

The content provides the substance of the paper. It must develop the key idea and result and be organized so that the reader is convinced of its significance and validity. I advise the following rules for producing and organizing the content of a paper.

Rule 1: choose carefully the key idea and hold to it.

The key idea must be clearly stated and identified. Trying to convey too many ideas, even related, may obscure the main idea and confuse the reader. Also, this tends to make the paper longer than need be. Fixing a size limit for the paper, e.g., 20 double-space pages, is a good way

[2] I am now assuming that **you** need to improve your technical writing. Otherwise, you would have thrown this paper away.

to encourage focus.

Rule 2: design a scheme for the paper that best conveys the idea.

This means planning the main elements of the content (formalism, algorithms, examples, etc.) for overall consistency. Appropriate formalism should provide the suitable level of abstraction to avoid being too close to your environment or prototype implementation. This is important to show wider applicability of the result. Similarly, algorithms must be described in a suitable way, e.g., with pseudo-code or graphics, depending on their complexity. However, it is best to avoid low-level languages or over-detailed graphics unless absolutely necessary. Planning a common example to be used consistently throughout the paper is also important.

Rule 3: demonstrate the result.

It is hard to convince a reader without a good demonstration. For a formal paper, theorems with their proofs are necessary. But proofs should be understandable and not too long, e.g., between half-a-page to two-page long. For a system-oriented paper presenting a new technique, simulation or implementation results are more convincing than analytical models. This is much more difficult to do if the contribution is a new architecture and thus there is no general rule. I advise not starting alone with such papers.

3 Presentation

The presentation must ease the task of the reader (understanding the contribution) by relying on organization, brevity and illustration. I advise the following rules for presenting a paper.

Rule 4: organize the paper in suitable units of presentation.

A standard paper is organized in sections, subsections and paragraphs. These units must be self-contained and consistent, i.e., avoid forward and backward references that make reading unpleasant. Sections or subsections contain logically connected paragraphs, each one consisting of a few related sentences that develop one point of interest. The finest granule of writing is therefore the paragraph, which also needs careful organization. A good paper organization is easily assessed by the reasonable number of sections, subsections and paragraphs.

Rule 5: write in a style that is brief, active, precise and simple.

All of us who wish to improve our writing style should use the rules of the excellent book [Strunk79]. Brevity means avoiding unnecessary words and ideas, and thus yields more precise

writing. An active style (e.g., "I propose the following algorithm") is more direct and lively than the passive voice (e.g., "the following algorithm is proposed"). Preciseness implies defining all concepts of interest the first time they appear and always refer to them with the same word. Finally, a simple style is always better for technical writing. Thus, avoid complex sentences by breaking them into simpler, connected ones, use the present tense as much as possible, and avoid too many acronyms. Also avoid complex formalisms unless absolutely necessary.

Rule 6: illustrate with suitable means.

Although the presentation can be well abstracted with a good formalism, illustrations are useful to ease understanding and give focus. Illustrations can be drawings, examples, algorithm descriptions, etc. In all cases, avoid illustrations that are either too simple, e.g., a 2-line algorithm, or two complex, e.g. a 50-line algorithm. Like text, drawings should be brief and precise, avoiding unnecessary coloring and details.

4 How to Get Started

I now propose a simple method to write technical papers using the previous rules. This method proceeds in 5 steps.

a. **Starting.** Make sure you have a real, significant contribution before going to the next step. The best way is to discuss the idea with colleagues or give a talk to get early feed-back.

b. **Planning.** Apply rules 1-4 to produce a detailed outline of the entire paper. This should be a good basis for discussion and improvement before writing.

c. **Writing.** Apply rules 4-6 to write the paper. Start with the abstract and introduction to fix the motivation and structure of the paper. Then write the other sections and finish with the conclusion. Build the bibliography in parallel with writing.

d. **Checking.** Use standard tools (speller, dictionaries, cross-referencing checker, etc.) to correct all mistakes. Failing to do this will be interpreted as unprofessional.

e. **Rewriting.** Circulate the paper internally to get rapid feed-back. Then revise and rewrite according to suggestions.

5 Conclusion

The conclusion must summarize the paper contribution and emphasize the main result. It can also address application of the result and open issues, and give future research directions.

Summary of the paper contribution. In this paper, I provided a number of hints for improving the writing of technical papers. I proposed a few basic rules for producing the content and presentation of a paper.

Main result. I proposed a simple method for writing papers based on these rules.

Application of the result. This method can be used by beginners as a training exercise for writing short reports, approximately the size of this paper. As more experience is gained, the method should be refined and adapted to write longer papers. Ultimately, it applies to a Ph.D. thesis, which is merely a very long paper.

Open issues. The biggest open issue is certainly to come up with excellent research contributions.

Future research directions. Now let us find a good subject for applying the proposed method.

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References

[Strunk79] W. Strunk Jr., E.B. White: *The Elements of Style.* Macmillan, New York, 1979.