BLG596- Bilimsel Araştırma, Etik ve Seminer

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How to Write a Technical Paper…

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Contents

Know your message, and stay on message

As a general rule, your paper needs to convince the audience of three key points: that the problem is **interesting**, that it is **hard**, and that you **solved** it.

If any of these is missing or unclear, the paper will not be compelling. You'll also need to convince your readers that your contributions are novel.

When expressing this, it may be helpful to explain why no one else thought of your approach before, and also to keep in mind how you expect the behavior of readers to change once they appreciate your contributions.

Which details to include

Your purpose is to communicate specific ideas, and everything about your paper should contribute to this goal. If any part of the paper does not do so, then delete or change that part. You must be ruthless in cutting every irrelevant detail, however true it may be. Everything in your paper that does not support your main point distracts from it.

Write for the readers, rather than writing for yourself. In particular, think about what matters to the intended audience, and focus on that. It is not necessarily what you personally find most intriguing.

A common mistake is to focus on what you spent the most time on. Do not write your paper as a chronological narrative of all the things that you tried, and do not devote space in the paper proportionately to the amount of time you spent on each task.

Make the organization and results clear

A paper should communicate the main ideas of your research (such as the techniques and results) early and clearly.

Then, the body of the paper can expand on these points; a reader who understands the structure and big ideas can better appreciate the details. A technical paper is not a joke or a mystery novel. The reader should not encounter any surprises, only deeper explanations of ideas that have already been introduced.

It's particularly irritating when an abstract or introduction states, “We evaluated the relationship between baldness and beekeeping”, with the key results buried pages later. A better abstract would say, “Male beekeepers are 25% more likely to be bald ($p=.04$), but there is no statistically significant correlation for female beekeepers.”

Getting started: overcoming writer's block and procrastination

Some writers are overwhelmed by the emptiness of a blank page or editor buffer, and they have trouble getting started with their writing. Don't worry! Here are some tricks to help you get started. Once you have begun, you will find it relatively easier to revise your notes or first draft. The key idea is to write *something*, and you can improve it later.

Start verbally. Explain what the paper needs to say to another person. After the conversation is over, write down what you just said, focusing on the main points rather than every word you spoke.

Outline. You may not be ready to write full English paragraphs, but you can decide which sections your paper will have and give them descriptive titles. Once you have decided on the section structure, you can write a little outline of each section, which indicates the subsection titles.

Stream-of-consciousness notes. Write down everything that you know, in no particular order and with no particular formatting. Afterward, organize what you wrote thematically, bringing related points together. Eventually, convert it into an outline and proceed as above.

Divide and conquer. Rather than trying to write your entire document, choose some specific part, and write just that part

Re-use. Find other text that you have written on the topic and start from that. An excellent source is your progress reports — you are writing them, aren't you? This can remind you what was hard or interesting, or of points that you might otherwise forget to make.

You must be willing to delete and/or rewrite your notes and early drafts.

Brevity

Be brief. Make every word count. If a word does not support your point, cut it out, because excess verbiage and fluff only make it harder for the reader to appreciate your message. Use shorter and more direct phrases wherever possible.

Make your writing crisp and to the point. Eliminate any text that does not support your point. Here is one way you might go about this; it is time-consuming but extremely effective. **First**, examine each section of the paper in turn and ask what role it serves and whether it contributes to the paper's main point. If not, delete it. **Next**, within each section, examine each paragraph. Ask whether that paragraph has a single point. If not, rewrite the paragraph. **Next**, within each paragraph, examine each sentence. If it does not make a single, clear point that strengthens the paragraph, delete or rewrite it. **Finally**, within each sentence, examine each word, and delete or replace those that do not strengthen their point.

Writing style

Passive voice has no place in technical writing. It obscures who the actor was, what caused it, and when it happened. Use active voice and simple, clear, direct phrasing.

First person is rarely appropriate in technical writing. Never use first person to describe the operation of a program or system. It is confusing to use “we” to mean “the author and the reader” or “the paper” (“In this section, we ...”) or even “the system being described” (“we compute a graph” makes it sound like the authors did it by hand). As a related point, do not anthropomorphize computers: they *hate* it. Anthropomorphism, such as “the program thinks that ...”, is unclear and vague.

Avoid puffery, self-congratulation, and value judgments: give the facts and let the reader judge.

Do not use words like “clearly”, “easily”, “obviously”, and “trivially”, as in “Obviously, this Taylor series sums to π.” If the point is really obvious, then you are just wasting words by pointing it out. And if the point is not obvious to readers who are not intimately familiar with the subject matter the way you are, then you are offending readers by insulting their intelligence, and you are demonstrating your own inability to communicate the intuition.

Writing style

When describing an experiment or some other action that occurred in the past, use *past tense*. For example, the methodology section should not say “We run the program”, but “We ran the program”. However, it would be correct to say “Our methodology was to run the program”, where you are using the infinitive “to run”. When describing the paper itself, use *present tense*. “This paper shows that ...”. The reason for this is that the reader is experiencing the paper in real time; the paper is like a conversation between the authors and the reader.

Avoid gratuitous use of the future tense “will ...”, as in, “switching the red and green wires will cause the bomb to explode”. Instead, use the shorter and more direct “switching the red and green wires causes the bomb to explode”.

Use “previous work” instead of “existing work”. Your work exists, so “existing work” would refer to it as well.

Figures

Use figures! Different people learn in different ways, so you should complement a textual or mathematical presentation with a graphical one. Even for people whose primary learning modality is textual, another presentation of the ideas can clarify, fill gaps, or enable the reader to verify his or her understanding. Figures can also help to illustrate concepts, draw a skimming reader into the text (or at least communicate a key idea to that reader), and make the paper more visually appealing.

It is extremely helpful to give an example to clarify your ideas: this can make concrete in the reader's mind what your technique does (and why it is hard or interesting). A running example used throughout the paper is also helpful in illustrating how your algorithm works, and a single example permits you to amortize the time and space spent explaining the example (and the reader's time in appreciating it). It's harder to find or create a single example that you re-use throughout the paper, but it is worth it.

A figure should stand on its own, containing all the information that is necessary to understand it. Good captions contain multiple sentences; the caption provides context and explanation.

Your code examples should either be real code, or should be close to real code.

Naming

Give each concept in your paper a descriptive name to make it more memorable to readers. Never use terms like “approach 1”, “approach 2”, or “our approach”, and avoid acronyms when possible. If you can't think of a good name, then quite likely you don't really understand the concept. Think harder about it to determine its most important or salient features.

It is better to name a technique (or a paper section, etc.) based on *what* it does rather than *how* it does it.

Use terms consistently and precisely. Avoid “elegant variation”, which uses different terms for the same concept, to avoid boredom on the part of the reader or to emphasize different aspects of the concept. While elegant variation may be appropriate in poems, novels, and some essays, it is not acceptable in technical writing, where you should clearly define terms when they are first introduced, then use them consistently. If you switch wording gratuitously, you will confuse the reader and muddle your point; the reader of a technical paper expects that use of a different term flags a different meaning, and will wonder what subtle difference you are trying to highlight. Thus, don't confuse the reader by substituting “program”, “library”, “component”, “system”, and “artifact”, nor by conflating “technique”, “idea”, “method” and “approach”, nor by switching among “program”, “code”, and “source”. Choose the best word for the concept, and stick with it.

Numbers and Measurements

Digits of precision:

Don't report more digits of precision than the measurement process reliably and reproducibly produces. The 3rd or 4th digit of precision is rarely accurate and generalizable; if you don't have confidence in it, omit it.

Don't report more digits of precision than needed to convey your message. If the difference between 4.13 and 4 will not make a difference in convincing readers, then don't report the extra digits. Reporting extra digits can even distract readers from the larger trends and the big picture. Including an inappropriate number of digits of precision can cast suspicion on all of your results, by giving readers the impression that you are statistically naive.

Use a consistent number of digits of precision. If the measured data are 1.23, 45.67, and 891.23, for example, you might report them as 1.23, 45.7, and 891, or as 1.2, 46, and 890, or as 1, 50, and 900. (An exception is when data are known to sum to a particular value; I would report 93% and 7% rather than either 93% and 7.4% or 90% and 7%. Often it's appropriate to report percentages as whole numbers rather than using the same precision.)

If you do any computations such as ratios, you should internally use the full precision of your actual measurements, but your paper will report only a limited number of digits of precision.

If a measurement is exact, such as a count of items, then it can be acceptable to give the entire number even if it has many digits; by contrast, timings and other inexact measurements should always be reported with a limited number of digits of precision.

Processing Data

Your paper probably includes tables, bibliographies, or other content that is generated from external data. Your paper may also be written in a text formatting language such as LaTeX. In each of these cases, it is necessary to run some external command to create some of the content or to create the final PDF.

All of the steps to create your final paper should be clearly documented — say, in comments or in a notes file that you maintain with the paper — and, preferably, should be automated so that you only have to run one command that collects all the data, creates the tables, and generates the final PDF.

If you document and automate these steps, then you can easily regenerate the paper when needed. This is useful if you re-run experiments or analysis, or if you need to defend your results against a criticism by other researchers. If you leave some steps manual, then you or your colleagues are highly likely to make a mistake (leading to a scientific error) or to be unable to reproduce your results later.

One good way to automate these tasks is by writing a program or creating a script for a build system.

Realated work

A related work section should not only explain what research others have done, but in each case should compare and contrast that to your work and also to other related work. After reading your related work section, a reader should understand the key idea and contribution of each significant piece of related work, how they fit together (what are the common themes or approaches in the research community?), and how your work differs. Don't write a related work section that is just a list of other papers, with a sentence about each one that was lifted from its abstract, and without any critical analysis nor deep comparison to other work.

Unless your approach is a small variation on another technique, it is usually best to defer the related work to the end of the paper. When it comes first, it gives readers the impression that your work is rather derivative. (If this is true, it is your responsibility to convey that clearly; it it is not true, then it's misleading to intimate it.) You need to ensure that readers understand your technique in its entirety, and also understand its relationship to other work; different orders can work in different circumstances.

Just as you should generally explain your technique first, and later show relationships with other work, it is also usually more effective to defer a detailed discussion of limitations to a later section rather than the main description of your technique.

Feedback

Get **feedback**! Finish your paper well in advance, so that you can improve the writing. Even re-reading your own text after being away from it can show you things that you didn't notice. An outside reader can tell you even more.

When readers misunderstand the paper, that is always at least partly the author's fault! Even if you think the readers have missed the point, you will learn how your work can be misinterpreted, and eliminating those ambiguities will improve the paper.

Be considerate to your reviewers, who are spending their time to help you. Here are several ways to do that.

As with submission to conferences, don't waste anyone's time if there are major flaws. Only ask someone to read (a part of) your paper when you think you will learn something new, because you are not aware of serious problems.

Responding to conference reviews

Many conferences provide an author response period: the authors are shown the reviews and are given limited space (say, 500 words) to respond to the reviews, such as by clarifying misunderstandings or answering questions. The author response is sometimes called a “rebuttal”, but I don't like that term because it sets an adversarial tone.

Your paper will only be accepted if there is a champion for the paper: someone who is excited about it and will try to convince the rest of the committee to accept the paper. Your response needs to give ammunition to your champion to overcome objections. If there isn't a champion, then the main goal of your response is to create that champion.

Read the reviews and decide what points you will respond to. You need to focus on the most important and substantive ones.

In your responses, admit your errors forthrightly. Don't ignore or avoid key issues, especially ones that multiple reviewers brought up.

Your response to each point will be one paragraph in your response. Start the paragraph with a brief heading or title about the point. Do not assume that the reviewers remember everything that was written by every reviewer, nor that they will re-read their reviews before reading your response. Organize your responses thematically.

Rejections

If you submit technical papers, you will experience rejection. In some cases, rejection indicates that you should move on and begin a different line of research. In most cases, the reviews offer an opportunity to improve the work, and so you should be very grateful for a rejection! It is much better for your career if a good paper appears at a later date, rather than than a poor paper earlier or a sequence of weak papers.

Even small flaws or omissions in an otherwise good paper may lead to rejection. This is particularly at the elite venues with small acceptance rates, where you should aim your work. Referees are generally people of good will, but different referees at a conference may have different standards, so the luck of the draw in referees is a factor in acceptance.

The **wrong lesson** to learn from rejection is discouragement or a sense of personal failure. Many papers — even papers that later win awards — are rejected at least once. The feedback you receive, and the opportunity to return to your work, will invariably improve your results.

Other resources

- Norman Ramsey's advice, excerpted immediately above.
- "Hints on writing an M.Eng. thesis", by Jeremy Nimmer
- my notes on reviewing a technical paper, which indicate how to recognize — and thus produce — quality work
- my notes on choosing a venue for publication
- my notes on giving a technical talk: a talk has the same goal as a paper, namely to convey technical ideas
- my notes on making a technical poster
- Ronald B. Standler's advice on technical writing
- Dave Patterson's Writing Advice
- Advice on SIGPLAN conference submissions
- *The Elements of Style*, William Strunk Jr. and E. B. White, is classic book on improving your writing. It focuses at a low level, on English usage.
- *Style: Toward Clarity and Grace*, by Joseph M. Williams, is another general-purpose writing guide, with a somewhat higher-level focus than that of Strunk & White.

Questions?