Research Methodology: Lecture 5

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Scientific Writing – I



Good Writing: Why?

- Good writing ensures wider dissemination of the results.
  - The community will not take notice unless you write clearly and forcefully.
- Good writing helps in the review process.
  - The reviewers are more likely to read faster and give a favourable report.
- Good writing gives you a good reputation in the community.
  - As a scientist, people will mostly know you by your writing.
  - If you write well, people will *infer* that you also think well.
- Good writing requires hard thinking.
  - The thinking part does not end with research.
  - Thinking is required from the overall planning stage to the composition of individual sentences.



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Division of the Discussion

- Scientific Writing – I.
  - Macro-level discussion.
  - Structure of the documents.
  - General issues of presentability.
- Scientific Writing – II.
  - Micro-level discussion.
  - Stylistic issues.
  - Examples of bad and good writings.



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What Will be Discussed?

Scientific Writing covers a broad range of documents and subjects. Our focus will be on the following topics.

Type of documents.

- Research papers providing new technical contributions.
  - Journal papers.
  - Conference papers.
- Survey papers and doctoral theses.

Content.

- General mathematical content.
- Algorithms.
- Reporting numerical results.
  - Derived from experimental data.
  - Comparative study.



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Purpose and Readership

Technical papers.

- To report results arising out of research carried out over a period of time.
- Depending on the nature of the results, the intended audience could either be
  - a small group of specialists;
  - or a wide range of researchers;
  - and that affects how you should write your paper.
- Important: The first reading of a paper is by reviewers.
  - So, people often tend to write only for the reviewers.



Purpose and Readership (contd.)

Survey papers.

- Present a unified view of a broad area.
- Readership will also be wide.
- The issue of reviewers still remain.

Thesis.

- Report of research carried out as part of doctoral work.
- In most cases, only the reviewers are the readers.

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Structure: Order of Presentation

- Title.
- Author(s).
- Abstract.
- Key words.
- Introduction.
- Preliminaries/Definitions/Notation.
- Sections on technical matter.
- Conclusion.
- Acknowledgement.
- References/bibliography.
- Appendices.



Structure: Order of Preparation

Very often, the following order is adopted.

- Title.
- Author(s).
- Preliminaries/Definitions/Notation.
- Technical matter including appendices.
- Conclusion.
- Introduction.
- Abstract.
- Key words.
- References are generated automatically (if you are using bibtex).
  - You still need to go through them carefully.
- Author(s).
- Acknowledgement.



Title

- Identifies the work and should be attractive. Sometimes this is framed as a question.
- Usually is not too long.
- Should not suggest things not covered in the work.
- Should not miss out important things which are covered in the work.
- Start with an early title.
  - This gives you time to think about it and choose more appropriate ones.
- Consider the title as the abstract of the abstract.
  - But, it is written earlier than the abstract.



Acknowledgement

- If somebody has helped you, then you should acknowledge it.
  - They are more likely to help you in the future.
- If the help is substantial, then you may also acknowledge it at the appropriate place in the body.
- If comments from an anonymous reviewer has helped you, then mention this.
  - Even if you are submitting to another journal/conference.
- Trying to impress by putting ‘big names’ is not a good idea.
- Note: people named in the acknowledgement may not be asked to review the paper.



Author(s)

These are the people who get the credit!

- You can start with the author list (name and order).
- You can add the author list at the end.
  - At that point, you are sure of who have contributed.

We will discuss the ordering of authors later.



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Key Words

- Key words/index terms/categories/....
- There are two roles.
  - May help in assigning the paper to the proper reviewer.
  - Searches on the key word will return the paper.
- Usually there may be two parts.
  - The first part may have to be chosen from one or more lists provided by the journal or the conference.
  - The second part will be specific to the paper.



Preliminaries/Definitions/Notation

- People generally start writing a paper when they have obtained some results.
  - This means that at this point the basic definitions and terms have been fixed.
- It is useful to draw up a list of notation before starting the technical description.
  - Do not use the same symbol to denote two different things.
  - Do not use two different symbols to denote the same thing.
- If there is a new notion involved, then it is good to precisely write down the definition of that notion before doing anything else.
  - Just giving a formal/precise/rigorous definition is not enough.
  - You need to explain it in plain English and illustrate by examples.
  - This requires a lot of thinking.



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Preliminaries/Definitions/Notation (contd.)

- It is a good practice to write down even standard definitions from memory.
  - At least try to write them in your own words.
  - If you are writing several papers on the same topic, then using exactly the same wordings for the definitions maybe a bit boring.
- Do not overdo definitions.
  - People do not want to read too many definitions. So, read, re-read and cut down on unnecessary definitions and/or notation.
  - Do not over explain standard definitions.
- Choice of notation.
  - Symbols help the reader in following the main description.
  - Too many symbols make the reader spend too much effort in trying to remember what is what.



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The Main Technical Content

- May consist of one or more of the following.
  - Mathematical results (theorems).
  - Algorithms.
  - Comparison to previous work.
- The above suggests a natural division of the paper into sections.
  - Subsections help in further structuring of the description.
  - If a section becomes “too long” then look for ways of dividing it into two (or more) sections.
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Naming of Mathematical Results

- Theorem: a main/important result in the context of the work.
- Lemmas (lemmata): small results which lead up to a theorem.
  - Sometimes a lemma becomes a key step in the proof of several theorems.
- Corollary: a direct consequence of a theorem (and sometimes also of a lemma).
  - The theorem statement may be of a general import while a corollary may be of more specific interest.
  - Sometimes a corollary arises out of a side-effect of the technique used to prove the theorem.
  - Sometimes corollaries are used in the subsequent work.
- Proposition: a “stand-alone” result which is perhaps not important enough to be called a theorem.
  - Nomenclature of proposition is not always very clear.



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Presentation of Theorems

- Explain the motivation for the result before stating the result.
- If the theorem statement is complicated, then explain the different components before getting into the proof.
- If the theorem has interesting consequences, then mention some of them before getting into the proof.
  - This will convince a reader that the theorem and its proof is worth reading.
- If possible, structure the proof into smaller results (lemmas).
  - This helps in verifying and “maintaining” the proof.
  - The lemmas could come earlier or later.
- For long proofs, provide an overall description (intuition) of the proof strategy before getting into the details of the proof.



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Algorithms

- Algorithm description.
- Correctness.
- Complexity: run-time, space, random bits.
- Results of running the algorithm (if applicable).
- Comparison with other algorithms.
  - Theoretical.
  - Practical/result-oriented.



Algorithms (contd.)

- Description.
  - Clearly state the data structures before the algorithm description.
  - Explain the role played by each data structure.
  - Divide into sub-routines.
  - Provide a matching textual description.
  - In the presentation, aim for clarity rather than precision. You can mention optimisation tricks in the text.
  - Describe in plain language the non-trivial core of the algorithm. This will help the reviewer/reader appreciate the novelty of your work.
- Correctness.
  - Proof of termination (unless it is obvious).
  - Proof that the algorithm does what it is supposed to do.
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Algorithms (contd.)

- Complexity.
  - Depending on your algorithm, these may need rigourous proofs.
  - Use of asymptotics depend on the context. For some applications, the constants do matter.
- Results of running the algorithm.
  - These show that you have implemented the algorithm and so it is implementable.
  - Use tables and/or plots.
  - Highlight the novel features of your algorithm. For example, it may be possible to run it on larger inputs.
- Comparison to previous algorithms.
  - Use tables and/or plots.
  - The comparison could be theoretical (like counting multiplications) or experimental (like reporting time in seconds).
  - Mention the hardware and software platform used for comparison.
  - Be fair to the algorithms you are comparing with.



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Comparison to Previous Work

Basis for comparison could be one or more of the following.

- An improved algorithm.
  - Faster/smaller memory/smaller code size/lesser randomness.
  - Comparison may be theoretical and/or experimental.
- An improved theorem.
  - Previous results follow as special cases.
  - Previous results require more conditions and so apply to more restricted situations.
- An improved proof.
  - A new technique is used.
  - The technique applies to other situations.
  - The proof is simpler.
  - The proof is more “elegant”.
- Increased practicability.
  - Provide a real-life scenario which your work covers but is not covered by previous work.



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Appendices

- Results which chronologically belong somewhere in the text, but, placing it there will interrupt the smooth reading of the paper.
- Additional results.
  - A second proof illustrating some other point.
  - A simpler but less efficient algorithm.
- Quick review of basic background material which may not be familiar to the readers in the area.



Introduction

- Motivate the problem.
- Set the context for your work.
- State your contributions.
  - Do not be shy; modesty will not endear you to the reviewers.
  - Do not oversell; being unnecessarily strident will not impress the reviewers.
- State related results.
- The bulk of the bibliography arises from references in the introduction.
  - People like to have their papers referenced; missing out on a reference may ruffle the feathers of a reviewer.
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Introduction: Challenges

- Without some notation you cannot proceed; using too much notation will make the description dense at the beginning itself.
- You need to define a few terms to get started; but, putting a formal and precise definition at the start will scare readers (and reviewers).
- You should try to state your contributions as soon as possible (remember reviewers may not be patient souls); but, without stating some background work you cannot place the results in the proper context.
- You should be providing tabular/graphical comparison; but, you cannot provide too much details.



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Introduction: Meeting Challenges

- There is no definite prescription for achieving the above balance.
- Requires time, patience, effort (in thinking and writing and re-writing) and experience.
- Consciously read papers written by others watching for both flaws and good features.



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- The abstract is the first thing that a reader will read.
- In many cases searches also return the abstract along with the title.
- Abstracts are short and sometimes have word limits.
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- Avoid trying to motivate the problem in the abstract.
- In a condensed form, the challenges in writing the introduction are also present for writing the abstract.



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Conclusion

- A casual reader will often move to the conclusion right after the abstract.
- State limitations of the work and possible ways of overcoming them; state possible open problems; future work which is in progress.
- Is a conclusion compulsory?
  - Some people think that a conclusion should not be a re-statement of the abstract. If you have nothing to say in the conclusion, then do not have one.
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Preparation of a Paper

- May take quite some time.
- Usually goes through several revisions.
- The addition of new material may be accumulative.
- Remember to be critical of your own writing.
- Try to provide reasonable time gaps between successive readings.
  - If your gaps are too short, then your mind will not register the flaws or suggest improvements.
- Try to obtain feedback from colleagues.
  - But, politeness may restrain people from being critical; it may also make people appear more positive than they really are.



Preparation of a Paper

- May take quite some time.
- Usually goes through several revisions.
- The addition of new material may be accumulative.
- Remember to be critical of your own writing.
- Try to provide reasonable time gaps between successive readings.
  - If your gaps are too short, then your mind will not register the flaws or suggest improvements.
- Try to obtain feedback from colleagues.
  - But, politeness may restrain people from being critical; it may also make people appear more positive than they really are.



Conference Papers

A conference is a competition.

- A conference can accept only a certain number of papers; typically, many more will be submitted.
- Conference worthiness can be different from journal worthiness.
  - Something new on a topic of current interest is likely to attract attention. Reviewers may be less concerned about the long term value of the idea.
  - A generalisation, even if non-trivial, may not be of interest to a conference.
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Conference Papers (contd.)

Things to keep in mind.

- Limited space.
  - Do not cut down on the abstract and the references.
  - Do not cut down on the motivation and your contributions.
  - You have to clearly explain the ideas behind a proof or an algorithm.
  - Detailed technical material may be put in an appendix (if allowed), or may have to be omitted.
- Limited time.
  - Conference papers have a definite submission deadline.
  - Unless you start early, it will be difficult to write properly.
- Limited reviewer time.
  - A reviewer has a deadline within which to give decisions on several papers.
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