Scientific Writing – I

Debnath Bhattacharyya, PhD

“The best books... are those that tell you what you know already.”

“But if thought corrupts language, language can also corrupt thought.”

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.

Language -----> Flow of writing ------> Grammar

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.

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.

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.

We will not be discussing these.

Structure: Order of Presentation

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

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.

Check the title of the paper::

Handwritten signature recognition using departure of images from independence

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.

https://scientific-publishing.webshop.elsevier.com/publication-recognition/what-corresponding-author/

https://www.sciencemag.org/careers/2010/04/conventions-scientific-authorship

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3010799/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6774542/

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.

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.

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.

Maintain consistency of notation across all sections of the paper.

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.

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.

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.
- If non-trivial, then these should be stated as theorems.

Algorithms (contd.)

Complexity:

- Depending on your algorithm, these may need rigorous proofs.
- Use of asymptotic 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.

Comparison to Previous Work

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

1. An improved algorithm:

- Faster/smaller memory/smaller code size/lesser randomness.
- Comparison may be theoretical and/or experimental.

2. An improved theorem:

- Previous results follow as special cases.
- Previous results require more conditions and so apply to more restricted situations.

3. An improved proof:

- A new technique is used.
- The technique applies to other situations.
- The proof is simpler.
- The proof is more “elegant”.

4. Increased practicability:

- Provide a real-life scenario which your work covers but is not
- covered by previous work.

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.

  Do not try to please a possible reviewer by unnecessary references.

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.

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.

Abstract

- 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.
- It is a place to state your contributions and explain why they are important.
- 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.

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.

  Some people think that without a conclusion the ending of the paper is abrupt.

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:

  1. 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.

  2. A generalisation, even if non-trivial, may not be of interest to a conference.
- A topic/result that will appeal to a larger group will be preferred compared to a topic/result that will appeal to a smaller group.

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.
- A reviewer has to quickly decide whether the paper is interesting enough for a more detailed reading.

Q & A

You can also send your questions to **debnathb@gmail.com**