Professional Communication in Computer Science

Writing a scientific paper

$$\begin{aligned}
\frac{-\hbar^2}{2m}\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)\psi(\mathbf{r})-\frac{\alpha}{r}\psi(\mathbf{r}) &= E\psi(\mathbf{r})\\
\frac{-\hbar^2}{2m}\frac{1}{l^2}\left(\frac{\partial^2}{\partial x'^2}+\frac{\partial^2}{\partial y'^2}+\frac{\partial^2}{\partial z'^2}\right)\psi(\mathbf{r}')-\frac{\alpha}{lr'}\psi(\mathbf{r}') &= E'\epsilon\psi(\mathbf{r}')\\
-A\frac{1}{(2A/B)^2}\left(\nabla'^2\psi(\mathbf{r}')\right)-\frac{B}{(2A/B)r'}\psi(\mathbf{r}') &= E'\left(\frac{B^2}{2A}\right)\psi(\mathbf{r}')\\
-\frac{1}{2}\left(\nabla'^2\psi(\mathbf{r}')\right)-\frac{1}{r'}\psi(\mathbf{r}') &= E'\psi(\mathbf{r}')
\end{aligned}$$

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Today's Plan

- Introduction
- Organization of a typical paper
- Notes on technical writing
- How to write mathematics
- Group work
- Summary and discussion

Credits and Many Thanks To

Luca Aceto, Olivier Danvy, Emmanuel Fleury and Albrecht Schmidt

Introduction

"The preparation of a scientific paper has almost nothing to do with literary skills. It is a question of *organization*."

– Robert A. Day, *How to Write and Publish a Scientific Paper*

" I feel disloyal, but doubtlessly truthful in saying that most scientists do not know how to write ...

The only way to learn how to write is above all to read, to study good models, and to practice."

– P. B. Medawar

IMRAD Approach

- Introduction
- Methods
- Results And
- Discussion

This approach can/should be used for most forms of expository writing.

Writing a Paper

A scientific paper is written to be read by:

- other researchers,
- reviewers, and
- yourself in the future.

The main demands on the paper:

- logic,
- clarity,
- precision.

The key word to scientific writing is clarity.

Organization of a Typical Paper in Computer Science

- Title, authors, abstract.
- Introduction, compelling example, related work, overview.
- Development.
- Conclusion.
- Acknowledgments.
- References.

Title

- It should be informative.
- It should be concise.
- It should be catchy and memorable.
- It should be original.
- It does not have to be funny.

Hints:

- Title is a label, not a sentence.
- Avoid abbreviations, jargon, maths formulas and symbols.

Title: Examples

Standard titles (majority of all titles):

- Labelling Schemes for Dynamic Tree Networks
- Recognizable Sets of Message Sequence Charts
- On Dualization in Products of Forests

What do you think about these titles?

- Why Is Simulation Harder Than Bisimulation?
- To Store or Not to Store
- Silence Is Golden: Branching Bisimilarity Is Decidable for Context-Free Processes
- L(A) = L(B)?
- Types, or: Where's the Difference Between CCS and π?

On the Temptation of Making a Funny Title

Be aware of potential risks:

- The messenger can hide the message.
- Most funny titles do not convey concrete message; they tend to be insiders' jokes.
- Do you want to be remembered as the funny one, or for the content of your work?

Common Practice in Capitalization of Titles

Capitalize

- First and last word,
- nouns, pronouns, verbs, adverbs, adjectives,
- subordinating conjunctions (Before, After, When, If, Than, While, As...),
- hyphenated compound words (Depth-First Search),
- first word following a colon (Vegas: The City of Gamble) .

Common Practice in Capitalization of Titles

Do Not Capitalize

- Articles (a, an, the),
- coordinating conjunctions (for, and, nor, but, or, yet, so — FANBOYS)
- the word 'to' when it precedes a verb (infinitive)
- prepositions (sometimes only with fewer than five letters).

Capitalization of Titles: Examples

- Petri Nets and Their Properties ('their' is adjective)
- Do It Right ('it' is a pronoun)
- When Is a Continuous Function Continuous? ('is' is a verb)
- Analyzing Protocols in Hierarchical Networks ('in' is a preposition)
- Bringing In Parallel Schemes ('in' is functioning as adverb)

See also: www.writersblock.ca/tips/monthtip/tipmar98.htm

List of Authors

- Alphabetically ordered, or
- ordered by degrees of contribution, or
- student first, advisor second, or
- any other scheme.

I almost always use an alphabetical order.

The list should also include:

- Authors' institutions with mail addresses.
- Email addresses.
- Contact/corresponding author (sometimes).

Abstract

Abstract is a "mini-version" of the paper, a summary. It

- identifies the area and main contribution, and
- helps the reader to decide whether to read the paper or not.

Abstract should

- be brief (5-20 lines, or max 250 words),
- be as informative as possible,
- state the main objectives and the scope of the work,
- summarize the main results, and
- possibly state a principal conclusion.

Abstract should be written (updated) last, to account to the actual content of the paper!

Abstract: Example

" We describe a probabilistic polynomial-time process calculus for analyzing cryptographic protocols and use it to derive compositionally properties of protocols in the presence of computationally bounded adversaries. We illustrate these concepts on oblivious transfer, an example from cryptography. We also compare our approach with a framework based on interactive Turing machines. "

More on Abstracts

- Abstracts are the key to locate papers on the web.
- Avoid references, tables, maths-formulas and special symbols because abstracts are stored as plain-text.
- Many more people will read your abstract than your paper!

Even More on Abstracts

Pitfalls

- Exaggerating:
  "We solve a problem X by using highly sophisticated technique which is without any doubt superior to all other known approaches."
- Seeking effect for seeking effect:
  "This paper bridges a much needed gap in the literature."
- Unnecessary words/phrases:
  In this paper, we are going to study the problem of whether we can ...
- Misspelling. (Always use a spell checker!)

Introduction

"A bad beginning makes a bad ending."

– Euripides

- The introduction often decides the destiny of a paper.
- The introduction is often the only part of your paper to be read.

Remember

The first paragraph should be your best paragraph, the first sentence should be your best sentence.

Introduction to Introduction

Purpose of Introduction

- It should present first, and in all possible clarity, the nature and scope of the problem you study.
- It should review and comment on the related work.
- It should clearly say what are the achievements of the paper.

Hints:

- Avoid the same pitfalls as in abstract.
- A compelling example is always good.
- It should not be too technical.
- Avoid too long sentences.
- Start with a bang!

Introduction: Examples

What do you think about these first sentences?

"In this paper, we apply to the framework of Pure Type Systems the insights into the relationship between sequent calculus and natural deduction as developed in previous papers by Herbelin [Her94, Her95], the second author and others [DP99b, PD00, DU03]."

"Termination of computer programs has received continuous interest in the history of computer science, and classical applications are total correctness and termination of partial evaluation.

Introduction: More Examples

"In [4] Cartwright, Curien and Felleisen have shown that for SPCF, an extension of PCF with error elements and a catch construct, one can construct extensional fully abstract models whose induced theory in the finitary case (i.e. over base type boolean) is still decidable and thus much simpler than the fully abstract models for PCF (see [1,7,15]) as demonstrated by Loader's result [11]."

"Model checking is one of the popular methods used in automated verification of concurrent systems like hardware circuits, communication protocols and distributed programs."

"Let us consider an $m \times n$ binary matrix $A : \mathcal{R} \times \mathcal{C} \to \{0, 1\}$, and an integral threshold value $t \in \{1, \ldots, m\}$. "

A Possible Structure of Introduction

1. Argue briefly for the relevance of the studied area/problem — start from general and end with your concrete problem.
2. Explain the problem that you study — be clear, do not dive into unnecessary details.
3. Describe your achievements — you can for example list them.
4. Comment on related work — compare your approach with others; mention both the strengths and weaknesses.
5. Give an overview of the sections to follow.

A Good Tip

1. Write headings of the things you want to mention in introduction on pieces of paper.
2. Order the headings so that they have a natural flow (one motivates the other to follow). Is the progression logical?
3. Connect the headings into a smooth text.

Different areas of science have different standards. Learn by reading good introductions and mimic their organization and style. Rest on the shoulders of giants.

Development — Presenting Your Results

- Start with technical preliminaries/background (setting up the scene).
- Progressive development of the material (organized in sections).
- Do not be afraid to state where you think that your contribution lies.
- Be as complete as possible.
- Be as concise as possible, but always precise.
- Anticipate, and answer, possible questions that a reader might have.

Anticipating Questions

Lemma. Let P and Q be CCS processes and let a, b, c be actions. Then $a.(b.P + c.Q)$ is trace equivalent to $a.b.P + a.c.Q$.

Good practice

Follow claims, essential definitions and examples with a remark answering possible reader's questions.

Remark. In fact, the reader can easily verify that the previous lemma does not hold for bisimulation equivalence, because ...

Obvious Things That Are Often Forgotten

- Present your results in a logical way. If the reader needs A to understand B, then present first A, then B!
- Always introduce technical terms, symbols, abbreviations and definitions before using them.

Related Work

- Mandatory!
- Situates the novelty and significance of your work. Should answer the questions:
  - Where do the ideas come from?
  - Have similar ideas been published/proposed earlier?
  - What is really new in the paper?

Either a part of introduction, conclusion or a stand-alone section.

Pitfalls:

- Forgetting or misinterpreting somebody else's work.
- Overestimating one's own contribution.

"Present to inform, not to impress; if you inform, you will impress."

– Fred Brooks

Conclusion

- Recapitulates the problem and the contribution.
- Assesses the significance of the contribution.
- Suggests and outlines future work, open problems, etc.

There is often no conclusion in the mathematical tradition.

In computer science I would strongly recommend to write a conclusion.

References

- Must be accurate (correct year, series, etc.).
- Must be complete (authors, full title, forum or journal, series/issue/number, publisher, year).
- Tip: Use BibTEX! Set up your own collection of bibitems as you start reading papers, you can store there also your own annotations. Bibitems can be often downloaded from the internet!

Always cite the best primary publication for some work. (For example journal versions have priority to conference versions.)

Acknowledgments

- Give credit where it is due. It does not cost anything and creates friends. Science is more of a social activity than you might think.
- Acknowledge the input from the anonymous referees (or from your supervisor).

General Tips

- Passive vs. active voice.
- Bibliographical references.
- Remarks on writing style.
- Writing maths.

Passive Voice Versus Active Voice

Passive Voice

Use it for work done by others:

- "It is known that ..."
- "It has been proved that ..."

Passive voice can be replaced by writing for example:

- "Wiles proved Fermat's Last Theorem [4]."

Active Voice

Use it to report on the achievements you have done in the paper:

- "In Section 5 we prove that ..."
- "We shall investigate the problem of ..."

Note: If you are a solo author, we means "the reader and I".

Bibliographical References

- Should be provided in parenthesis so that they do not disturb one's reading.
- Style depends on the conference/journal. For example: [4], [KM'98], (Kucera and Mayr, 1998), (Kucera et al., 2004)
- "[2] shows that ..."
  is ugly,
- "... as seen in [2]."
  is little bit better, and
- "... as introduced by Church in his monograph on the λ-calculus [2]."
  is best.

Remarks on Writing Style

- Refer to lemmas, propositions, theorems, examples, tables, figures, sections:
  - without articles,
  - with first capital letter.

  Examples: "In Theorem 6 we show ..." or "... as argued in Section 3."
- Replace let's, won't, can't, ... with let us, will not, cannot, ...
- Use neutral language. Avoid emotional adjectives and superlatives, in particular when describing your own results.
- If possible, avoid "could", "would" and "might", use rather "can", "will", "shall", "may".
- Do not use more words where fewer will do.

Two More Remarks on Writing Style

When introducing/recalling an entity X do not say

- "A bla, bla, bla is X." but rather
- "X is a bla, bla, bla."

Sentences should be readable from left to right without ambiguity.

- "A framework where infinite-state systems are verified by the use of automata theory is called Regular Model Checking."
- "Regular Model Checking is a framework for verification of infinite-state systems based on automata theory."
- "Regular Model Checking is an automata based framework for verification of infinite-state systems."

Writing Maths

LaTeX is nowadays a standard in computer science (in particular if some maths is involved). Learn it, it is very useful!!!

- Symbols in different formulas should be separated by words.
  Bad: Consider S_q, $q < p$.
  Good: Consider S_q, where $q < p$.
- Do not start a sentence with a symbol.
  Bad: $2x = 3$ has no integer solution.
  Good: The equation $2x = 3$ has no integer solution.
- Do not omit "that" when it helps to parse the sentence.
  Bad: Assume A is a group.
  Good: Assume that A is a group.
  However: "We have that $x = y$." $\rightarrow$ "We have $x = y$."
- Do not say "which" when "that" sounds better.

More on Writing Maths

- Don't use the same notation for two different things.

  Bad: Let A be an $n \times m$ matrix. For every $n \in \{1, \ldots, m\}$ let $A[n]$ be the ..

  Good: Let A be an $n \times m$ matrix. For every $i \in \{1, \ldots, m\}$ let $A[i]$ be the ...

- Use consistent notation for the same thing when it appears in several places.

  Example: Do not say "A_j, for $1 \leq j \leq n$" in one place and "A_k, for $1 \leq k \leq n$" in another.

More hints in: *Mathematical Writing* by D.E. Knuth, T. Larrabee and P.M. Roberts.

The Paper is Written, Is the Process Over?

NO WAY! Part of the hard work is still ahead of you.

- Proof-read the paper as carefully as you can. Do not be lazy to make changes!
- Let the paper rest of a couple of days and then proof-read it again.
- Ask other people to read the paper and listen to their comments.

Final Word

"What is written without effort is, in general, read without pleasure."

– Samuel Johnson

Deliverable 2 (group discussion, individual writing)

- Rewrite the title and abstract of your last year project. You should try to apply the rules/suggestions mentioned during the lecture and your target audience are computer science students that just finished their second year at the university.
- In the report write the names of all students participating at the preparation of the title/abstract.