How to Write a Paper
The Harsh Truth

"When you understand that nobody wants to read your shit, your mind becomes powerfully concentrated. You begin to understand that writing/reading is, above all, a transaction. The reader donates his time and attention, which are supremely valuable commodities. In return, you the writer must give him something worthy of his gift to you."

Steven Pressfield
Why do We Read Papers?

Reading papers is a critical skill:

• Understand latest developments before they are covered by other media like books
• Learn how to write and communicate ideas
• Learn to read critically:
  - Ask the right questions, challenge assumptions
• Synthesize new ideas:
  - inspiration comes more often than not when reading the work of others
What to Extract From a Paper?

- **Research question**: Central message
- **Impact**: Motivation, relevance, and impact
- **Contributions**: What is new compared to previous work? How applicable is approach in general?
- **New info for yourself**: What can you learn from this paper? (e.g., good summary of related work)
- **Conclusions**: Takeaways: Can we build upon this work? If so, how? Ideas for future work?
How to Read

You should read a paper in three passes:

1. Get general idea (5-10 minutes)
   - Read abstract, introduction, headings and subheadings, and conclusion
   - You should know what the paper is about now

2. Understand Content (>= 1 hour)
   - Read full paper, ignore details (e.g. proofs)
   - Find key points, take notes
   - Understand figures
   - Mark references for further reading
   - You should understand the key points now

3. Understand in depth (>= 4 hours)
   - Fully understand everything, pay attention to all details
   - Check related work
   - Imagine your own implementation of the solution
   - Question everything
   - Generate new ideas for your own work
How to Read for a Review in This Course

1. Get general idea (5-10 minutes)
   - Read abstract, introduction, headings and subheadings, and conclusion
   - You should know the main goal of the paper now

2. Understand Content (≥ 30 min)
   - Read full report
   - Find key points, take notes
   - Understand figures
   - You should understand the key points now

3. Review Report (≥ 20 min)
   - Check each of the required points in the text
   - Take notes
   - You should have all information for your review now
What You Might Write

- **Thesis**: Bachelor, Seminar, Master, PhD
- **Research**: Research paper, project proposal
- **Industry**: Documentation, design document, white paper, website
Writing is Thinking

- Writing forces you to make thoughts concrete
- Writing organizes thoughts
- Clear writing is explaining
- Helps you to understand
- Along the process you will have new ideas
- Will even improve your code
- Writing is hard
Good Writing is Important

• More and more papers are written and published
• Attention is scarce
• Effects of bad writing:
  • Reader slows down, re-reads
  • Reader does not understand
  • Reader gets angry
  • Reader stops reading
• Badly written papers get rejected or ignored (or graded poorly)
• Even if the idea is good, no one will care
Write Your Paper in Drafts

• You should spend most of your time revising
• The first draft should be done very quickly
  • Avoid writers block
  • The first draft is just for you
• Iterate drafts often
  • Requires extreme concentration
  • Maybe do it every morning for an hour
  • Kill your darlings: Rewrite often
Revising is Difficult

- When reading, it is hard to view your own text form the perspective of a reader
- You can try the following:
  - **Dead Trees**: Print your paper and read at another physical location than you write
  - **Random**: Don’t read from start. Jump to random sections and start revising
  - **Read Aloud**: Helps catching issues you are otherwise blind to
For the paper structure, please refer to the organization slides
Title

- The title of a paper is the first impression people have
- Should be catchy, intriguing, and meaningful
- Will be used to talk about paper
  - "Did you read the Polaris paper?" - Good name
  - "There was that serverless architecture paper!" - Content is clear
- Naming things is very important: (components, algorithms, methods, products, ...)
  - Makes it easier to talk about things
  - Makes it easier to think about things
  - Makes it easier to remember things
- The title should give the reader an idea what your paper is about
Abstract

• Readers will only read title and (maybe) abstract to decide whether to read your paper
• Abstract should summarize the whole paper
  • What is it about
  • Motivation
  • Core ideas, methods, and solutions
  • Impact, conclusions, and findings
• Should be as short and expressive as possible
Goal Oriented Writing

- Your text has to **provide value** to the reader. Why bother writing it otherwise?
- You cannot express everything you have to say in one text.
- **Define one clear goal** that your text has to achieve (e.g., answer a research question).
- **Kill your darlings**: Remove text that does not help to achieve the goal. See Chekhov’s Gun: (If the gun is there it will be important).
- **Know your audience**: The text should be optimized for the reader.
Structure Top Down

- It’s natural to start writing small pieces of text
  - You need to figure out how to combine them
  - Makes it hard to get a good overall structure

- Plan your paper top down
  - Start with a very rough outline
  - Iteratively specify section contents with increasing detail
  - Works for whole paper as well as individual sections
Write Sections with the Onion Principle

- Sometimes you need to explain several independent things to lead to the next point
- Use the onion principle:
  - Start with the main point / complete overview but do not go into detail
  - Add several layers: Each layer may go down further into detail
- This holds for sections as well as the whole paper:
  - Title
  - Abstract
  - Introduction
  - Main part (may contain several layers)
Structure Paragraphs

- The first sentence in a paragraph should introduce its topic
- The rest should discuss it
- Make clear what the point of the paragraph is:
  - After the introduction
  - At the end of the paragraph
Avoid the Wall of Text

• Reader looses attention when reading (or even seeing) long text
• Use subsections
• Use small titles
• Use short paragraphs
• Use bullet points
Examples are Crucial

- Help reader to check whether they understood something
- Should be minimal but interesting
- May be used in whole paper, also as motivation
The Baseline Idea

• When writing about an approach it may be useful to compare against a well-known baseline
• Problems of baseline lead to solution
• This might help with the whole story of a paper
Repeat Important Points

• Readers may read superficially or only parts of the text
• Important points should be clear to them too
• Repeat them in: (abstract), introduction, main part, conclusion
What Makes Text Good?

• Good Writing is clear, easy-to-understand writing
• Minimize the effort and time the reader has to spend to read
• Maximize the value the reader has to gain
Why is Good Writing so Difficult?

- Text is linear - Humans think associatively
- Curse of knowledge:
  - Once you understand something, it is hard to identify with someone who doesn’t
Example: Clear Sentences

Our lack of knowledge about local conditions precluded determination of committee action effectiveness in fund allocation to those areas in greatest need of assistance.
Example: Clear Sentences

- Our lack of knowledge about local conditions precluded determination of committee action effectiveness in fund allocation to those areas in greatest need of assistance. ✗

- Because we knew nothing about local conditions, we could not determine how effectively the committee had allocated funds to areas that most needed assistance. ✔
Example: Clear Sentences

- Our lack of knowledge about local conditions precluded determination of committee action effectiveness in fund allocation to those areas in greatest need of assistance. ✗
- Because we knew nothing about local conditions, we could not determine how effectively the committee had allocated funds to areas that most needed assistance. ✓
- Why is the second version easier to understand?
Example: Clear Sentences

- Our lack of knowledge about local conditions precluded determination of committee action effectiveness in fund allocation to those areas in greatest need of assistance. ❌
- Because we knew nothing about local conditions, we could not determine how effectively the committee had allocated funds to areas that most needed assistance. ✔
- Why is the second version easier to understand?
- Unclear who does what!
Clear Sentences Like Stories

- People think in stories
- **Who does what?**
  - Clear actors (subjects)
  - Clear actions (verbs)
Actors - Subjects

- Actors should be clear: "Knuth developed TeX" ✔
- Things or representations can be actors:
  - "The compiler tells you..." ✔
  - "The community observes..." ✔
- Avoid hidden actors:
  - "In your paper there is an explanation for ..." ✗
Actors - Subjects

• Actors should be clear: "Knuth developed TeX" ✓

• Things or representations can be actors:
  • "The compiler tells you..." ✓
  • "The community observes..." ✓

• Avoid hidden actors:
  • "In your paper there is an explanation for ..." ✗
  • "You explain ... in your paper." ✓
Verbs and Adjectives

• Avoid nouns that are hidden verbs:
  • "We made an analysis of the behavior of ..." ✗
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- Avoid nouns that are hidden verbs:
  - "We made an analysis of the behavior of ..." ✗
  - "We analyzed the behavior of ..." ✔

- Avoid nouns that are hidden adjectives:
  - "The implementation of this data structure poses difficulties" ✗
Verbs and Adjectives

• Avoid nouns that are hidden verbs:
  • "We made an analysis of the behavior of ..." ❌
  • "We analyzed the behavior of ..." ✔

• Avoid nouns that are hidden adjectives:
  • "The implementation of this data structure poses difficulties" ❌
  • "The implementation of this data structure is difficult" ✔
Not All Nouns are Bad

Use nouns to:

• Refer to the previous sentence:
  • "These arguments are convincing" ✓

• Create an object instead of a complicated construct:
  • "I do not understand either his meaning or her intention" ✓
  • "I do not understand either what he means or what she intends" ✗

• Identify the correct actor (subject):
  • "The fact that I set the correct flags was crucial" ✗
  • "My correct choice of flags was crucial" ✓

• Name repeated concepts (create new actors):
  • "Anyblob is a download manager" ✓
More Useful Methods

- Be careful with passive voice
- Write specific and concrete
- Fewer prepositions
- Shorter sentences
- Logical order
- Clear logical relationships
Connected Information Flow

• Sentences often start with a transition or evaluation:
  • Hence, but, fortunately, importantly
• The beginning of a sentence should contain known easy to recognize things
• The end of a sentence should contain newest and significant information
• You automatically stress the end of a sentence
Balance Clarity and Flow

- Sometimes clarity and flow are in conflict
  1. "A black hole is created by the collapse of a dead star into a point perhaps no larger than a marble."
  2. "The collapse of a dead star into a point perhaps no larger than a marble creates a black hole."
Balance Clarity and Flow

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• (2) is more clear

• "Some astonishing questions about the nature of the universe have been raised by scientists exploring the nature of black holes in space. (1) or (2) So much matter compressed into so little volume changes the fabric of space around it in profoundly puzzling ways.”
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• "Some astonishing questions about the nature of the universe have been raised by scientists exploring the nature of black holes in space. (1) or (2) So much matter compressed into so little volume changes the fabric of space around it in profoundly puzzling ways."

• (1) connects better to the previous sentence: "black hole"

• (1) connects better to the next sentence: "... no larger than a marble." "So much matter compressed"
Be Concise

• Use as few words as possible to express what you mean
  • "In my personal opinion, we must listen to and think over in a punctilious manner each and every suggestion that is offered to us." ✗
  • "We must consider each suggestion carefully." ✔

• Another example:
  • "Imagine a picture of someone engaged in the activity of trying to learn the rules for playing the game of chess." ✗
  • "Imagine someone trying to learn the rules of chess." ✔
Avoid Wordy Phrases

• Avoid wordy phrases:

<table>
<thead>
<tr>
<th>X</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>the reason for, due to the fact that, this is</td>
<td>because, since, why</td>
</tr>
<tr>
<td>despite the fact that, regardless of the fact that</td>
<td>although, even though</td>
</tr>
<tr>
<td>in the event that</td>
<td>if</td>
</tr>
<tr>
<td>on the occasion of</td>
<td>when</td>
</tr>
<tr>
<td>it is crucial that</td>
<td>must, should</td>
</tr>
<tr>
<td>is able to</td>
<td>can</td>
</tr>
<tr>
<td>it is possible that</td>
<td>may, might, can, could</td>
</tr>
<tr>
<td>prior to</td>
<td>before</td>
</tr>
<tr>
<td>does not have</td>
<td>lacks</td>
</tr>
</tbody>
</table>
Figures Matter

• Figures are an integral part of communication
• Many people only look at figures and captions
• Papers are recognized by graphs: Add a first page figure
• Figures are equally important as text
• Text should discuss the takeaways of a figure
Figures Should be Stand-Alone

- It should be possible to understand a figure without the text
- Use captions to explain figures
- Captions may be several lines long
- Use text within figures to explain
- Nonetheless, text should refer to all figures!

Figure 1: Sub-operators ① build more complex data operations ② or dataflows ③, where each sub-operator can be implemented on multiple hardware platforms ④.

Stand-alone figure ✅
Figures Should be Simple

- Make figures as simple as possible
- Better use two figures than one complex figure

Figure 1: Fixed-design systems capture only a small fraction of the possible storage-engine design space on the cloud.

Complex figure ✗
Rely on Color?

- Good coloring can make a graph more understandable
- Should be accessible to colorblind and people with black and white printers
  - Important to many, ignored by many
- Our advice:
  - Use color to make figures as expressive as possible
  - Use shades (\(\leq 4\)), shapes, or text to present the same information without color
  - Ignore this rule if it is impossible

Figure 10: Runtime decomposition of linear regression.

Colored figure that works on black and white.
Revise Figures

- Just as for text, you should spend most of your time revising a figure
- Start with *killer plots* to explore data
- Drill down to the plots that are really useful
- Graphs are comparisons: Make sure it compares what you want to show

![Killer plot that should be used for exploring data](image)

Figure 6: Compile-time and throughput of different query-compilation strategies in Umbra running the TPC-H benchmark.
### Graphs and Tables

- Usually, graphs are better than tables
- Tables allow to perform lots of comparisons
  - You can provide a lot of detail in tables
- Use visual hints in tables:
  - Bold for **best**
  - Color for **good**/**neutral**/**bad**

**Table with visual hints ✓**

<table>
<thead>
<tr>
<th>Method</th>
<th>avg IoU</th>
<th>Chair</th>
<th>Floor</th>
<th>Other Furniture</th>
<th>Picture</th>
<th>Sofa</th>
<th>Table</th>
<th>Wall</th>
<th>...</th>
</tr>
</thead>
<tbody>
<tr>
<td>PointNet++</td>
<td>0.339</td>
<td>0.360</td>
<td>0.677</td>
<td>0.183</td>
<td>0.117</td>
<td>0.346</td>
<td>0.232</td>
<td>0.523</td>
<td>...</td>
</tr>
<tr>
<td>PointNet++ (^1)</td>
<td>0.481</td>
<td>0.686</td>
<td>0.931</td>
<td>0.299</td>
<td>0.102</td>
<td>0.580</td>
<td>0.470</td>
<td>0.711</td>
<td>...</td>
</tr>
<tr>
<td>Additional Features (ours)</td>
<td>0.557</td>
<td>0.744</td>
<td>0.946</td>
<td>0.376</td>
<td>0.205</td>
<td>0.643</td>
<td>0.497</td>
<td>0.756</td>
<td>...</td>
</tr>
</tbody>
</table>
Pseudocode

- Pseudocode can be very helpful
- Describes algorithms very accurately
  - Be precise on details, there is no room for interpretation
- Is difficult to understand
  - Reduce cognitive load as much as possible
  - De-clutter syntax (Python-like syntax can be good)
  - Use syntax highlighting
  - Name variables well
  - Name algorithms / functions / methods
  - Add descriptive captions
  - Specify input and output

Algorithm 4: Refining binary join trees

```
input : An optimized operator tree T
output : A semantically equivalent operator tree T' which may employ multi-way joins

1 function refineSubtree(T)
2    if T ≠ T_l △ T_r then
3        return T;
4    T'_l ← refineSubtree(T_l);
5    T'_r ← refineSubtree(T_r);
6    // Detect growing joins and multi-way join inputs
7    if |T| > max(|T'_l|, |T'_r|) ∨ T'_l ≠ T_l ∨ T'_r ≠ T_r then
8        return collapseMultiwayJoin(T'_l △ T'_r);
9    return T'_l △ T'_r;
```
Large Language Models (LLMs)

- LLMs can write text
- For now (2024) they lack understanding of new things
- They are useful for (re-)formulating your own text
- They are not useful for structuring and reasoning
- You can ask them for 10 variants of a sentence for inspiration
- If you don't want to give some company all your data, you can also self-host small models
  I like ollama with lama3-8b
- If we notice that your paper includes any text you did not understand or find long sections that just paraphrase sources you will not pass this course
LaTeX

- LaTeX composes visually nice results (visual appeal is important)
- Often, you have to use templates anyway
- Write one sentence per line
  - Check length of sentences
  - Easier reasoning about sentences (each sentence should have a purpose)
  - Works well with version control
Git

- **Always use git** even if you are working alone
- Helps with collaboration
- Synchronizes across devices
- Shows diffs
- Makes it harder to lose data
- Commit often, push often
- Check in all stuff necessary for building (text and figures) but not outputs
Building

- We provide you a template with a makefile
- Error messages are terrible, compile often
- Overleaf can be good, but we recommend building locally
- Typst can be nice, but there is no suitable template
  - If you can create a template that is visually indistinguishable from our LaTeX template you may use it
  - We are extremely pedantic here
  - All Typst versions we received for application were not sufficient
LaTeX is a Time Sink

- Prototyping of any construct that is not text (tables, diagrams) should be done outside of LaTeX.
- Sketching on real paper is generally the fastest.
- `\usepackage{booktabs}` works well for tables.
Citing with BibTeX is easy
• Get correct .bib files from dblp.org
  • Be sure that you cite the correct version of the paper
  • Arxiv is one of the worst sources, try to find a source from a journal or conference
  • Especially on google scholar you will often find bad BibTeX files
• Add new bib entries as soon as you \cite them (or earlier)

--- sample.bib ---

@Article{Abril07,
    author = "Patricia S. Abril and...",
    title = "The patent holder's...",
    journal = "Communications of the ACM",
    volume = "50",
    number = "1",
    month = jan,
    year = "2007",
    pages = "36--44",
    doi = "10.1145/1188913.1188915",
    url = "http://doi.acm.org/..."
}

--- main.tex ---
\section{Citations}
Some examples of references.
A paginated journal article~\cite{Abril07}, ...
Final Touches

• New terms should be written once in *italics* and then explained
• Make sure each figure is referenced in text
• Position figures when you are finished with the rest
• Optimize line breaks
• Check references
• Spell check
• Try grammarly (don’t blindly follow everything)
Further References

- Larry McEnerney, *The Craft of Writing Effectively* [link]
- Lorenz Froihofer, *Tips for scientific writing (for Germans)* [link]
- Lorenz Froihofer, *How to write a computer science paper* [link]
Summary

- Good writing is hard but important
- Each sentence needs to contribute to your goal
- Revise more than you write
- Write clear and concise
- A perfect text is one where you cannot omit anything