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Scientific Writing

Scientific Writing and Structure Your Work

Table of contents

Basic Common Structure for CS

	English title(s)	German title(s)	Core goal
1.	Introduction	Einleitung	einleiten
2.	Foundation / Basics	Grundlagen	einführen
3./4.	Related Work	Literatur	einordnen
4./3.	Analysis	Analyse	analysieren
5.	Approach / Methodology	Methodik	planen
6.	Case Study / Evaluation	Evaluation / Fallstudie	dokumentieren
7.	Results	Ergebnisse	präsentieren
8.	Discussion, Limitations	Diskussion	diskutieren
9.	Summary, Outlook	Fazit / Ausblick	zusammenfassen

Note: We rarely have an "Implementation"

A typical document from...

Software Engineering

1. Introduction
2. Foundations
3. Related Work
4. Approach
5. Case Study
6. Summary and Outlook

Theoretical CS

1. Introduction
2. Basics
3. Analysis
4. Proof
5. Conclusion

High-Performance-Computing

1. Introduction
2. Background and Related Work
3. Methodology
4. Evaluation
5. Results
6. Discussion
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Core difference: **Case Study** (with humans), **Proof**, **Metrics** evaluation

Finding the right structure for your thesis

- Not every work needs every chapter
- You often do not know in advance
- A good strategy:
  1. Add all possible chapters
  2. Add goals to chapter beginning (bulletpoints are ok): "What to say here"
  3. Start writing
  4. Remove / Merge chapters as makes sense
- Ask your supervisors!

Prioritize

- Not every part of a thesis is equally important
- For papers a rule of thumb is[1]:
  1. Polish page 1 for acceptance
  2. Use the remaining pages to avoid rejection
- While this is not true for theses, the core idea is important
- First impressions count for a lot
- Some parts of your thesis might not be read!
- $\Rightarrow$ Focus on the introduction

[1] https://maxwellforbes.com/posts/how-to-get-a-paper-accepted/

Abstract

- Research goal, often also motivation
- Brief description of approach
- Core outcomes: results and/or conclusions
- Example:
  - When building new data centers power usage needs to be accounted for.
  - To determine power usage, we developed a predictive model based on...
  - We trained this model on ... and evaluted it's accuracy against ...
  - We show that our model is easy to implement and X% accurate but ...

Introduction

- Introducing the topic
- Motivation (relevant + important, **not** personal) / Problem Statement
- Research goals, research questions (if applicable)
- Structure of your thesis
- *Example*:
  - Open Source Software (OSS) is often seen as less user-friendly than proprietary software.
  - We want to improve user acceptance of OSS.
  - For this we need to know: Why is OSS seen as less user-friendly?
  - To answer this question, we designed and conducted a case study ...
  - The thesis is structured as follows. In ...

Introduction Extended

It is possible, but not always advisable, to extend the introduction:

- Related work
  - If some related work is at the core of your thesis (extending/applying)
  - Just for context
- Other approaches / Overview
- A guiding example
  - To explain / demonstrate some method
  - To provide motivation or goals
- Pre-empting important outcomes
  - Generally avoid.
  - E.g. when unexpected findings shape your general approach
  - If you do this, make it very clear!

Foundations / Basics

- Basic knowledge needed to understand your thesis
- Can be text book knowledge, avoid broadly accepted common knowledge
- Define terminology

Related Work

- Present other research that either aims at similar goals or uses similar methods
- Compare/Contrast with your work, put your work into a greater context
- *Different approaches for this chapter*:
  - Integrative i.e. summarize multiple works within one section e.g. chronologically
  - Separately i.e. multiple sections for comparing e.g. against different approaches
  - Comparatively i.e. provide multiple summarizations, then compare them all

Analysis

- Identify requirements
- Disect and analyze problems, gain knowledge
- *Note: There might not be a clear difference to Approach; sometimes people already propose solutions in Analysis*

Approach / Methodology

- How you aim to answer your research question(s)
- Avoid implementation details, avoid source code; this is planning, not results!

Case Study

- Report on your case study (when, where, how, notable events)
- *Use past tense here, as you are reporting past events*
- *In many case studies, this chapter also includes Results*

Results, Discussion

- Results
  - Presents only observations, not inferences or opinions
  - *Results is often Results+Discussion (but separated!)*
- Discussion
  - Interpretation of the raw results
  - Answering research questions
  - Limitations (also sometimes separately)

Conclusion, Outlook

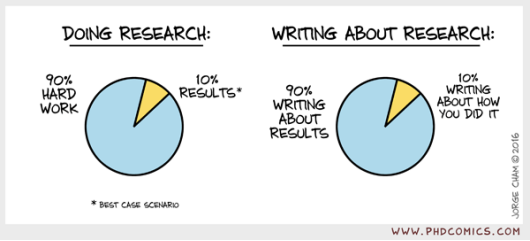
- What did you do in your thesis?
- Summarize major outcomes
- (Sometimes) Mention limitations
- What are (possible) next steps?

Typical Mistakes

- Unclear introduction
  - The introduction is like a blueprint for the entire work
  - Provide valid goal: Improve, Find out, Prove
- Unimportant foundations
  - Only present what's useful, important & relevant
- No or too much related work
  - Ideally 1-3 important AND relevant publications

Typical Mistakes

- Source Code from a software implementation
  - Describe concepts, not implementations
  - Examples, procedures can be ok
  - *Note: Opinions differ a lot here, from "should" to "must never"*
- No separation between approach and case study / results
- No separation between results and discussion
- Wrong / Overreaching conclusions



Scientific "We"

- Writing as "we":
  - "We asked participants to estimate the size of the object."
  - "We" is the default in papers, even for single authors. Good default for theses.
  - Easy to understand, takes responsibility but not too much focus on the individual.
- Use active (in english):
  - Avoid: "Participants we asked to estimate the size of the object."
  - Passive is harder to understand and creates distance.
- Tenses:
  - Present for everything, except for...
  - Past for what happened in studies ($> 90\%$ in Results / Case Study)

Simple Language

- Use short sentences.
- Each sentence makes its own statement.
- Avoid fancy adjectives/adverbs and filler words.
- Use meaningful connectors like "Therefore", "However", "Furthermore", "Because of", "Although", "Consequently", "Firstly", "Finally"

Clean Writing

- Repetition is acceptable.
- Do not use forward references.
  - *Exceptions: abstract, introduction, (chapter overview)*
  - If you cannot do without, you probably need to improve your structure.
- Avoid paragraphs with only one sentence.
- Use headings for structure, not paragraphs.
- Don’t repeat yourself (first: explain, afterwards: only reference)
- Be consistent!

Adjectives

- "This result is obviously wrong."
  - Avoid judgmental adjectives like "obvious", "apparent", ...

Figures

- Reference and briefly describe them in the section.
- Captions can guide focus
  - Ok: "Total precipitation per month in 1995 and, for comparison, 1994."
  - Better: "Total precipitation in 1995 peaked in august and was consistently higher than in 1994."

Images, Tables and Code

- Use `figure`, `table`, `listing` environments
- Set a `label` and use `ref` or `Cref` to reference in text
  - Always use this for discussing them
- Use high-resolution images
- Ensure tables are readable
  - Use alternating row colors, highlighting
- Use code highlighting
  - Only show relevant code snippets, not entire files

Citations

- Be consistent
- See upcoming lecture on citations
- Default style (IEEE)
  - "Doe et al. show that the sky is blue [4]."
  - "The sky is typically considered to be blue[4,10-14]."

Footnotes

- Generally: avoid.
- Ok: Referencing information that is not cited.
- Not good: Commenting your thesis.

Acknowledgements

- Should be its own chapter in the beginning of your work
- Should be used to make contributions transparent.
  - Important: Selbstständigkeitserklärung
- Don’t put acknowledgements into text:
  - Avoid: "The university provided us with high-speed cameras."
  - Better: "We used high-speed cameras to ..."

Making AI usage transparent

- The university requires making AI usage transparent.
- Can be described in the thesis.
- Better: Fill the new question template from the university.
- *Be complete but not too detailed.* $<$ 2 *pages*

Task: Using GPTZero.me

1. The task involves submitting the prepared narrative text to GPTZero.me.
2. The aim is to evaluate its originality and detect possible AI-generated content.
3. To ensure academic integrity and verify that the narrative reflects authentic human writing.
4. Addresses the growing concern over AI-assisted writing in scholarly and creative work.

Scientists are Professional Writers

- Inform & Communicate
  - Most scientific communication is written
  - Great writing makes your work more visible
- Writing is Thinking
  - Formalize ideas
  - Identify gaps & errors
  - *Get ideas out of your head*
- Recommendation: Write a lot
  - Personal note-taking
  - Focus on content, not form
  - Practice free writing

Tips for Bottom-up Writers

- Reuse pre-written texts for your drafts
- Create a mind-map to sort your ideas
- Prepare a rough structure to guide your writing

Tips for Top-down Writers

- Start writing even without perfect structure
- Just write without fixing to get to the first draft
- Practice free writing to overcome writer’s block

Free Writing

Individual Task 5 Min

- Open any writing app or text editor.
- Choose a topic (e.g., seminar ideas, your day, or something on your mind).
- Write continuously for 5 minutes without stopping.
- Do **not** edit, fix typos, or rewrite while writing.
- You will **not** be asked to share your text.

Tip: Free writing helps overcome the blank page and get ideas flowing.

Exercise: Clarity and Precision

Individual Task 10 Min

Identify and improve unclear sentences.

1. The experiment was kind of successful in most cases.
2. Many different aspects were analyzed in various ways.
3. It is obvious that the results are good.
4. The data was handled somehow by the algorithm.

Hint: Replace vague words (*kind of, various, obvious, somehow*) with precise and measurable expressions.

Exercise: Active vs. Passive Voice

Pair Task 10 Min

Rewrite the sentences using active voice.

1. The model was trained by the team for several days.
2. A solution was implemented by the researchers.
3. The data was collected by multiple institutions.
4. Errors were detected by the program.

Hint: Start sentences with the acting subject to make them more direct.

Exercise: Objectivity and Tone

Group Task 10 Min

Detect and rewrite unscientific or biased language.

1. Our algorithm is the best and solves all problems.
2. Surprisingly, the results were totally amazing!
3. This method is much cooler than the previous one.
4. The user obviously made a stupid mistake.

Hint: Keep tone neutral and factual. Avoid emotional or subjective expressions.