TECHNISCHE UNIVERSITÄT DRESDEN

ACADEMIC SKILLS IN COMPUTER SCIENCE

Lecture 6: Writing Research Reports

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Knowledge-Based Systems

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Review: Planning your research

Summary of previous hints:

- Be conscious about what your hypothesis actually is
- Avoid common pitfalls and weaknesses
- Refine your hypothesis by critical enquiry
- Plan your evaluation along with your hypothesis
- Be optimistic and sceptical

Moreover: use your strengths!

- Choose work that is easier for you than for others (your “unfair advantage”)
- Take advantage of your environment (supervisor/colleagues, resources, infrastructure)
- Seek role models; read good papers
- Dare to be original (don’t follow the hype, unless for motivating readers)

Goals for today

Learning goals of this lecture:

(1) Get an overview on how to structure your written report

(2) Learn about appropriate writing style and common issues in English writing

(3) Understand how to cite and quote correctly

Planning Your Report Structure

Structuring your work

The first step to writing a research report is planning its basic structure

General structure of research reports:

1. **Title, authors, affiliations**
2. **Abstract**
3. **Introduction**
4. The Research: details, methodology, results
5. **Conclusions**
6. **References**

$\rightsquigarrow$ we need to fill in “The Research”

Note: A chronological/causal description of how you arrived at your insights is not appropriate for a research report!

Structuring principles: (1) Research sequence

The simplest approach is to turn the research process into a report structure:

Sequence of research

- Problem definition (background, preliminaries)
- Proposed solution (conjecture, hypothesis, design)
- Evaluation (proof, experiment)

Parts can be split further depending on content, e.g.,

- Solution: (1) main algorithm, (2) implementation techniques
- Evaluation: (1) requirements analysis, (2) theoretical analysis, (3) empirical evaluation

$\rightsquigarrow$ good general-purpose structure for many papers and shorter theses

Structuring research reports: (2) Special case first

Complicated solutions are sometimes best represented by starting with a simpler case

Special case first

- Common background & definitions
- Simpler special case (definition, solution, evaluation)
- Fully general case (definition, solution, evaluation)

Especially theoretical evaluations benefit from this split:

1. analyse simpler case (introduce necessary methods)
2. analyse general case (use methods from simple case without explaining them again)

In contrast, empirical evaluations might better be placed after everything was explained.

$\rightsquigarrow$ useful scheme to focus on one idea at a time

Structuring research reports: (3) Example first

Another way of explaining a complex solution is to start with an example:

Guiding example

- Common background & definitions
- Worked example/important use case
- Complete solution (and evaluation)

$\rightsquigarrow$ example can clarify and motivate technical details to come

Structuring research reports: (4) Overview first

Systems with many components might be best described by giving an overview first:

Overview first

- Common background & definitions
- Overview of solution
- Individual components with separate evaluations
- Joint evaluation of complete system

$\rightsquigarrow$ appropriate for application-oriented research (and also for tool papers)

How to decide for a structure?

The structure depends on the report's context as much as on its contents

Questions to ask:

- Who is your target reader (reviewer, colleague, student, examiner)?
- What is his or her main goal (judging your work, getting new insights, learning new topics, grading your performance)?
- How much space do you have (thesis with many chapters vs. 6-page submission)?

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General guidelines:

- Give a guided tour of your research, as if to teach your former self
- Focus on result of greatest significance
- Separate own contributions from background on level of sections/chapters (do not let readers guess what is your contribution and what was known)

Structures can evolve – radical changes might be needed later on

Related work

It can be useful to have a dedicated related work section – where to put this?

Right after introduction (or as part of it)

- Pro: clarify scope of work early on
- Con: possibly superficial, since reader does not know details yet

Right before conclusions

- Pro: can discuss other works in more detail
- Con: rather late to clarify position relative to other works

$\rightsquigarrow$ possibly additionally outline positioning of the work (without details) in introduction

Dispersed across report

- Pro: discuss other works where most relevant during work
- Con: possibly disrupting overall structure; information distributed across report

$\rightsquigarrow$ mainly for related works that are specific to some detail, not to the whole work

The Appendix

Research reports can have one or more appendices

Appendices are for auxiliary material:

- Comprehensive details (e.g., a list of all database queries used in an evaluation)
- Tedious proofs for which only sketches were included in the main text
- Auxiliary tables or figures that are not essential for reading
- . . .

What to not use appendices for:

- Important assumptions or parts of the problem definition
- Essential claims or unexpected additional results
- Full source code listings (a link to an online repository or submission on a CD etc. is enough)
- Previously written sections that do not have any justification for being included in the report, but that the author wanted to keep somewhere for sentimental reasons

Managing the Write-Up

Getting started

Writing your report will take longer than you expect!

General guideline: Start as early as possible!

- Set up a directory for your research project when you start (to keep notes, papers etc. in one place)
- Start a written document there early on, even if it is just an empty page
- If possible, use the correct style/technical writing setup already for early drafts

$\rightsquigarrow$ remove excuses for not getting started immediately

What to start with

There are many things that you can write early:

- Planned section/chapter structure (as just discussed)
- Written notes on literature you read, and literature list (in correct format)
- Problem statement, requirement analysis
- Preliminary definitions/background chapters

  (but do not spend all your research time on developing background material you might not need in the end!)
- Proofs and definitions are developed on paper

  (theoretical research happens in writing; doing it at the screen is useful for getting feedback)

However, there are also parts that are better written later:

- abstract, introduction/motivation, conclusions (need the complete picture)
- empirical evaluation sections (evaluation results needed first)

Be prepared to change/remove anything you wrote later on.

Time planning

Make a sound time plan based on realistic assumptions!

Example: Assume you are writing a thesis:

- your thesis is planned to have five main chapters,
- your advisor needs two weeks average to provide detailed comments on a chapter,
- each chapter should be revised and re-checked once.

$\rightsquigarrow$ about five months total reviewing time needed before submission!

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Writing speed:

- Productive writers may produce as much as ten final pages per day
- Don't expect to create more than 3–4 pages of technical text per day on average
- Novice writers will usually produce much less

Getting stuck

It is common to get stuck in writing, i.e., finding it very hard or impossible to produce text

Some (more or less) common reasons:

1. Lacking content to write about
2. Fear (a.k.a. “perfectionism”)
3. Depression, burn-out, etc.
4. Laziness or lack of motivation

Possible challenge: Tell them apart (you’ll usually know – just don’t cheat yourself)

Getting stuck (1): Lacking content to write about

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Solution: maybe it's too early to write up (this part):

- plan your research,
- conduct more research,
- seek inputs from others
- dedicate reasonable amounts of time to non-working activities that inspire you (sports, conversations, mediation, walking, reading, . . .)

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Non-Solution: spending time optimising your writing of general parts that don't require further work

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- Combat fear/tension (meditate, walk, exercise, make tea/coffee, take some time off)
- Watch your sleep patterns (most people: 7h–9h; various health risks increase if permanently under 7h)

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Non-Solutions: Procrastination and/or increasing the pressure

- Drowning your thoughts: consuming online media, playing computer games, watching TV
- Occupying yourself with "useful" tasks: household chores, minor tasks related to your research (e.g., improving your experimentation code), other work
- Stressing yourself even more (rarely works)

Getting stuck (3): Depression, burn-out, etc.

Symptoms:

- lack of energy to do anything
- low self-esteem & confidence
- feeling hopeless and helpless, extremely sad, anxious or worried
- neglecting work, hobbies, friends, and family

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Symptoms:

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- low self-esteem & confidence
- feeling hopeless and helpless, extremely sad, anxious or worried
- neglecting work, hobbies, friends, and family

Solution:

- Seek help (from friends or from professionals)
- Free support: Psycho-social counceling for students (Studentenwerk Dresden, link)

Non-solution: doing nothing

Working with others

If you have co-authors, clarify what your collaboration model will be!

Common options:

- Rotating responsibility (authors take turns working on parts)
  $\rightsquigarrow$ best result
- Divide responsibility for parts (e.g., define who writes which sections)
  $\rightsquigarrow$ faster, but might lead to incoherence
- Asymmetric roles (e.g., not all collaborators write at all)
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Not acceptable:

- Gift authorships (some “co-authors” get included without having done any work)
  $\rightsquigarrow$ light reviewing does not justify authorship

How to Write

Goals of writing

Remember why you write:

- Inform readers (research guided tour for your former self)
- Paper: convince reviewers of the worthiness of your results
  $\rightsquigarrow$ relevance, significance, originality, correctness, readability
- Thesis: convince examiners of your competence
  $\rightsquigarrow$ expertise (in topic area), competent use of methods, professional skills

Keep this in mind while writing

Planning the narrative

A clear and logical structure is essential to research reports

- One topic per section (as per draft structure; distinguish new from known)

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  - maybe use the headlines as placeholders/todos in writing
  - use short paragraphs
- Follow a logical train of thought
- Avoid forward-references (don't rely on content not covered yet)

No surprises!

The logical structure must be made obvious to the reader

Main principle of scientific writing: Don't surprise your readers!

- research reports are not novels
- being clear about where to find what supports efficient reading

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Approaches:

- continuously explicate your presentation plan
- include "spoilers" and previews in introduction, and at the beginning of each section
- give an overview of the section/chapter structure at the end of the introduction
- connect paragraphs and sentences (use words like "but", "however", "nonetheless"; and "therefore", "hence", "in consequence" to indicate contrasting and following statements)
- Explain what you are up to (e.g., why a definition is given)

Citations

Main purposes of citing:

- Provide support for claims
- Position own work with respect to the state of the art
- Point to material for further reading

The choice of citations must be balanced:

- Don’t cite for common concepts (e.g., a pseudocode listing does not require citation of a textbook that explains pseudocode)
- Don’t cite to drop names or pad the literature list
- Self-citations are useful to show own prior expertise, but must not be excessive

How to cite

There are several common ways of referring to citations in text:

- Numerical keys: [42]
- Harvard style: (Knuth 1969) or (Papadimitriou et al. 2012)
- Alpha-numeric: [Knu69] or [RSA83]
- Footnote-style: [42]

The first two are most common in computer science (and usually created by typesetting software – see later in this course).

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Citation keys are treated as parenthetical remarks:

- Wrong: “The authors of [7] introduced Alternating Turing Machines.”
- Right: “Chandra and Stockmeyer introduced Alternating Turing Machines [7].”
- Wrong: “As shown by (Cook 1971), SAT is NP-complete.”
- Right: “As shown by Cook (1971), SAT is NP-complete.” (note the shorter key)
- Right: “SAT is NP-complete (Cook 1971).”

Reference lists

Each cited reference is shown in detail in the bibliography.

Essential information (for every references)

- Who? (all authors or editors; include everybody unless the list is extremely long)
- What? (title of the work; web page title for online resources)
- Where? (publication medium or other mode of publication)
- When? (year of publication, optionally also month; date of access for Web pages)

Further information can be useful

- DOI (Digital Object Identifier): unique reference of many publications
- URL: place where informal/obscure publications can be found
- Date of last modification for Web pages
- Publisher or publishing organisation

Guideline: Human readers must immediately understand what is cited and be able to find it; machines must match citations unambiguously to their databases

What can/should be cited?

What can be cited?

- Everything that can be reasonably referred to and accessed by (at least some) other readers
- Including web pages, theses, data sets (ideally with DOI), TV shows, public talks (ideally recorded at some URL), etc.
- With caution: unpublished manuscripts (clarify how this can be accessed; or use only to credit author without relying on its content)
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What should be cited?

- Trustworthy research of high quality (use same guidelines as for judging research, e.g., journal article > workshop paper)
- Original sources are better than later summaries (exception: textbooks are better than historic originals for background reading)
- Archival publications are better than web pages

Summary

There are several ways in structuring a report

Writing reports needs careful planning and an early start

Writing requires an underlying logical structure, which is made obvious to the reader

There are several styles of citation, but all references must mention certain key information

What's next?

- Writing style
- Persuasive writing
- Typesetting with LaTeX