

# Uni Scientific Writing Notes

Notes for the Anleitung zum wissenschaftlichen Arbeiten (scientific writing) course at HdM Stuttgart

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2021-11-19

# Introduction

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## Contributing

These study materials are heavily based on professor Charzinski's "Anleitung zum wissenschaftlichen Arbeiten" lecture at HdM Stuttgart.

**Found an error or have a suggestion?** Please open an issue on GitHub ([github.com/pojntfx/uni-sciwriting-notes](https://github.com/pojntfx/uni-sciwriting-notes)):



Figure 1: QR code to source repository



Figure 2: AGPL-3.0 license badge

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## Organization

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- Primarily based on the inverted classroom principle
- Sent files should not contain metadata on person-specific info (make pseudonymous)
- Paper must be sent in by 2022-01-09
- Notes must be sent in by 2022-02-27
- Paper may be in German or English

## Overview

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1. What is the scientific method?
2. Formulating scientific questions
3. Designing experiments
4. Analyzing experiments
5. Planing scientific papers
6. Researching topics and staying up-to-date
  - 6.1 Finding papers → Sci-Hub
  - 6.2 Analyzing papers
  - 6.3 Referencing papers
7. Writing a scientific paper
8. LaTeX



## What is the Scientific Method?

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- Structure should not follow the timeline research, but the semantic structure of the discovery
- No rhetorical questions
- No judgmental formulations
- Sentences should be able to stand on their own; reference people and things by their name, not implicit references
- Do not use the present tense when referring to past events, even if it is popular in journalism
- Do not use metaphors which are highly imprecise, even if they are common among technical people
- “I” should not be used in texts
- Summaries should be about the effect of the research on the subject, not the author’s view on the subject
- The “motivation” at the start of the paper should not be the personal factors, but prior pointers

## Typical Criteria

- Complexity of the theme
- Amount of personal research
- Quality of the content
- Depth of research
- Selection of sources
- Implementation of prior knowledge
- Structure of the paper
- Visual style (used fonts, formatting etc.)
- Quote style (standardized quotes)

## Formulating Scientific Questions

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- Argumentation
- Logical conclusions
- Proofs (i.e. mathematical proofs)
- Experiments and their design, execution and analysis
- New analysis is always based on existing knowledge
- There are different levels of formalism: Argumentation, validation, predicate-based proofs
- Referencing ideas can be done in an “informal” way (whitepapers etc.), but they must not be the base of any claims!

# The Purpose of Writing

- Communication is the primary purpose of scientific writing
- But scientific writing is also a means of analysis
  - Formulating thesis helps to grasp the connections between arguments
  - Clear formulation makes it much harder to avoid critical questions
  - Gaps in analysis and open questions become obvious and lead to new research opportunities
  - Writing leads to a deeper internal understanding
- Even if scientific writing is limited to Uni, research methods are always required

# The Scientific Thought Model

1. Outlook
2. Own research
  - 2.1 Discussion
  - 2.2 Proofs, research, experiments, studies
  - 2.3 Hypothesis, underlying idea
3. Summary of the current state of research/technology (“related work”)
4. Sources (own and external)

- New ideas should be able to be based on existing works
- Peer reviews try to check the quality of scientific works and ensures that existing work can serve as a solid base
- Own share of own work must be made obvious



# Scientific Questions

- Formulation a concrete question is required in order to reduce the scope of topics
- The question doesn't have to be clear in the beginning of the writing process, but must be at the end
- The focus is always on the question, not the means: "Does the raft algorithm work reliably?" for example would not include/require an implementation of the raft algorithm, so always make the implementation a requirement of the question!
- The scientific question is not the title of the paper
- Just like the goals of the research need to be clearly defined, the "non-goals" need to be too!

# Experiments

- Gathering of data
- Hypothesis
  - Creating the hypothesis
  - Designing the experiment
  - Executing the experiment
  - Testing the hypothesis with the result
  - Further, refined hypothesis ideas
- The hypothesis is often “my idea/solution/architecture works”
  - Experiments support the hypothesis
  - Paper then describes the current technological state, experiments and results
- All dependencies and state required to reproduce the experiment must be notes

# Methods of Experiments

## 1. Design

- 1.1 Matches the scientific question
- 1.2 Creativity is required
- 1.3 Viability in time, budget and with available technology

## 2. Planning

- 2.1 Prevention of side effects
- 2.2 No convenience samples
- 2.3 No unethical experiments

## 3. Execution

- 3.1 With proper process
- 3.2 Proper documentation, including all unexpected incidents

## 4. Analysis

- 4.1 Objective analysis
- 4.2 No suppression of “unwanted” results

## 5. Interpretation

- 5.1 Objective interpretation
- 5.2 Usage of statistics: Is the result even statistically relevant?

- Verification using proofs
- Validation based on empirical data
- Multiple supporting hypothesis can build a theory

- Experiments should produce a result
- Testing in a specific set of parameters
  - Searching for optimal parameter combinations
  - Checking for valid sets
- Sensitivity analysis
  - Checking the hypothesis with parameters
  - Checking if parameters influence results
- Hypothesis tests: Statistically testing the results of experiments

- Be neutral
- Always ask question about results, even if they are positive
- Search for additional sources
- Comment on unknown factors, don't hide them - they are means of finding the next topic to research on!

- Don't remove or ignore them
- Test if they are relevant: Do more research - are they statistically relevant?
- If they are not relevant: Classify and document

# Comparisons

- The new is not automatically better
  - Comparison with a baseline reference is required
  - Detailed description of the reference system used is required
- Define the used dimensions for the comparison
  - Differences often occur in different dimensions
  - Elaborate why dimensions are being used
- Fair basis: i.e. not using an under powered server
- Also point out that the tool might perform worse under different dimensions (i.e. memory constrained systems)
- Comparison by
  - Comparison the reference solution and the new solution
  - Comparison of the new solution with existing literature



## Planning Scientific Papers

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- Might be required
- Significant research requires planning
  - Assessment of feasibility
  - Usage of time slots
  - Focus on the most important goals or topics
- Short description of the planned research
  - Which problem is the basis of the planned research?
  - Prior, existing research and open questions
  - The main scientific question: Which question is the research going to answer?
  - Goal of the research
  - What theories is the research based on
  - Methods
  - Materials
  - Structure
  - How much time are the individual slots expected to take

- Based on argumentation or path of discovery
- Balanced
- Not too much hierarchy
- Minimum length of the chapters and sections
- Total average ~50-60 pages
- Per chapter ~3-10 pages
- Typical:
  - Abstract (no section number, in both English and German)
  - Introduction (including overview)
  - Related work
  - Main investigation (multiple sections)
  - Results
  - Summary and conclusions
  - References

# Basic Procedure

- Clarification
  - Which questions should be answered?
  - What are the non-goals?
- Creating the project plan
- Getting up to date from a technical perspective
  - Which state is the research based on?
  - Search and analyzing papers
- Own works
  - Sometimes simply structuring the comparison
  - Normally: Experiments!
    - Definition
    - Execution
    - Analysis
- Selecting tools (BibTeX, LaTeX)
- Sketching
  - Creating a structure (i.e. mind maps)
  - Taking note of keywords and images

- Every project needs planning
- Sketched planning needs to happen early in the project
  - Literature studies are often underestimated
  - Own works
  - Writing (min. four weeks before time is over!)
- More fine-tuned research with more knowledge
- Current state of research must be checked during own research
- Immediate active countermeasures are required
  - Plan must be changed
  - Assess severity of changes

## Planning the Main Section

- Structure is central
- Amount of pages per section is required
- Contents per section must be planned: Keywords, sources, images
- Writing takes time; start writing meta before actually starting to write

## Planning the Paper for this Module

- Formulating the scientific question
- Creating a structure
- Searching and analyzing literature
- Refining the structure (two layers) including page numbers
- Selecting graphics (with sources)
- Writing
- Checking
- Submitting the paper

## Researching Topics and Staying Up-to-Date

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- Web
- Wiki
- Google
- Libraries: Books and articles
- Journals and conferences: Finding journals, special issues, searching for articles
- Use catalogs

1. Starting with research
  - 1.1 Internet (Wikipedia, Library Genesis, Sci-Hub, Scholar, CiteSeerX, arXiv, ResearchGate)
  - 1.2 Libraries
  - 1.3 Journals
2. Skimming the first articles
3. Doing more research on interesting literature
  - 3.1 Finding the primary source
  - 3.2 Finding papers which have been cited often
4. Finding related authors and researching their latest papers

# Skimming Papers

- Don't start by reading the paper from start to finish
- What did the authors do?
  - New understanding of existing systems
  - New solutions for the issue
  - Explanation of a new research question (with or without a solution)
  - Reviewing existing solutions or ideas
- What is the result of the paper?
- Don't check only the abstract - skim for keywords too!
- Analyze included graphics
- Checking the title
- Checking figure descriptions
- Don't check all math unless necessary (which it mostly isn't)

- Maintaining a critical view: Many papers over-promise and under-deliver
- Still: Skim the paper first
- Extracting main expressions
- Only read subjects in detail which are interesting for the research topic

- Be aware of deceptive terminology
- Don't use "common sense"
- Note implicit and explicit assumptions, approximations: Are they warranted?

# Documenting the Reading Process

- Excerpts
  - In sections or with paraphrasing
  - What is the topic? What is being published on it?
- Creating a summary
- Paraphrasing
- Adding comments
- Visualizations: Mind maps, concepts maps or logical formulas

- **Scientific Standards:** Scientific questions, methods, literature and other sources
- **Ideology:** Author's bias and own ideology
- **Context:** In reality, norms-values-means
- **Argumentation:** Facts, experiences, norms-values-means, authority

- As it is known, ... → I think, ...
- It is obvious ... → I think, ...
- Maybe one could argue, that → I'm not sure what to think
- There is consensus → Some people think
- For obvious reasons → I have no proof
- There is no doubt → I am sure
- It is likely → I have no proof and don't have the time to check
- It is not necessary to take a closer look → I do not want to take a closer look

TODO: Add section on referencing other works



## Citation

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- Contains all read works
  - Used sources
  - Current state of research
  - Support for argumentations
  - Base for comparisons
- In .bib file
- Can be used for multiple papers

- What
  - Bibliographic references
  - Own annotations
    - Excerpts
    - Comments
    - Keywords
    - Opinions
  - Relation to other references
- How
  - Findable
  - Extensible
  - Linkable (in both directions)
  - Useful in bibliography
- Where: List or database

- Before reading: Taking note of bibliographic data
- While reading: Excerpts, annotation and links between references
- While writing
  - Citing directly (including page number)
  - Automatic creation of references allows automatic import into word processing

## Purpose of Citations

- Showing which ideas came from whom and which publication
- Often a requirement due to copyright restrictions (attribution)
- Shows that relevant literature was consulted
- Creates a chain of trust based on trusted sources
- Can allow checking the novelty of a work (what is new, what is referenced?)

## Evaluation of Source Quality

- Sources must be verifiable and trusted, so peer-reviewed publications are the best basis
- Wikipedia is a good entry point due to high quality and depth, but citing original sources is often the better choice
- Blogs and popular science publications are useful for citing opinions and events, but should not be used to give an overview of the current state of technology
- Whitepapers should only be used for research specific to the publisher's technology

- **Primary source:** The first publication of an idea by its inventor
- **Secondary source:** Recitation or analysis of an idea
- Reading primary sources allows checking if secondary sources have maybe misrepresented studies or used out-of-context quotes

- In non-English publications, using both sources in the native language and English is acceptable
- In English publications, non-English publications should only be cited if no other sources could be found



# Quotes

- Short quotes must always be marked using ”
- Longer quotes should be in an own paragraph and have a different style
- Require exact source, including page number
- Have to be 1:1 representation
  - Including punctuation and writing style
  - Mark exclusions and own additions with []
- Should be from primary source
- Quotes are not typically used in informatics papers, except for loosening up the structure or to introduce chapters; in social sciences, they are used more frequently, as they can be a subject to analysis (i.e. in literature analysis)

- Reference should link to an information source
- Using a reference means that the statement of the work inherit the quality properties of the reference, as it is based on it
- Source reference must contain the relevant data to uniquely identify a source
- Different styles are available
  - Chicago style (EU method)
  - Harvard style
  - Legal style (footnotes)

- Contains properties for each source
  - Name of authors
  - Title of publication
  - Name, volume, year, edition and page number
  - Publisher, location, date of publication
- BibTeX can generate literature lists for most styles

# Writing a Scientific Paper

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- **Formally:** A general diligence guideline is mandatory in scientific writing
- **Practically:** Spelling, syntax and layout issues
  - Readers get more critical and find more errors
  - Worse marks

- Survey papers: Overview of a subject
- Scientific protocol: Documentation and interpretation of a experiments
- Research paper
- Thesis (BSc, MSc, PhD)
- Certificate

# Types of Documents

- Protocol
- Whitepaper
- Specification
- Offers
- Presentation
- Advertisement
- Functional descriptions
- Manuals
- Press releases
- Patents
- News articles
- Blogposts

- German
  - Easier as a native speaker
  - Many proofreaders
- English
  - Important for all relevant documents
  - More readers



- Writing is an exercise
- Structure is a hard requirement
- No suspense
- Use simple and clear styles
- Rather try to impress with content than with complex sentences
- Clearness is important, because it is required in the job, makes reading and writing easier and is polite to the reader
- Use foreign words with care
- Keep the audience in mind

## How to Deal with Writer's Block?

- Deadlocks?
- Just start writing *anything*
- Work on structure instead
- Creating a mind map
- Don't trash drafts, refactor them instead

- Scientific question  $\neq$  title (title should not be a question)
- Don't be too general or too precise
- Must contain the main theme

- Short summary of the subject's field and the solution
- Must include the result (should *not* build suspense)
- Should not contain short abbreviations, references, formulas and sentences like "In this paper ..."
- ~250 words
- Should be in English and German
- Current and future relevance of the subject
- Contexts in which the subject has been analyzed

- Last section of the introduction (first section)
- Shows the relations and dependencies between the sections
- Should not just reiterate the table of contents

## Writing the “Related Work” Section

- Overview of prior and similar work
- Creates the base/foundation of knowledge
- Who researched what?
- Where has the result been published?
- Which problems have not been solved in prior work?
- In which context does the work stand to related work?
- Should exist before starting to write!

- What has been researched?
- What could be improved?
- Short summary of the results
- Meaning of the results
- Which problems could not be solved?
- Judgement of the implementation
- Learned experiences
- New contexts to other research topics

## Writing the Acknowledgements Section

- Not a formal requirement, but a social requirement
- Especially relevant if access to internal info or external units has been provided
- Can be used for other sources or ideas that can't be formally sourced



- Third person
- Simple past
- Never reference self or other groups/people
- Short sentences and words
- Don't repeat formulations but do repeat words instead of using synonyms (server, node, VPS etc. - choose one!)
- Use SI units
- Use significant figures
- Use consistent list style, examples, unit structure (Mbit/s instead Mbps, Mbit/sec etc.)
- The first sentence of each paragraph should be the paragraph's introduction
- Define acronyms
- Simple and reserved
- Should leave no space for interpretation

- Always numerated
- Must have an alt text
- Referenced in text by figure number
- Text must *never* flow to the left or right of the figure
- Source can be in alt text (i.e. “(...) using data from [3]”)

- Diagrams (ER, UML etc.)
- Code or pseudocode
- Sequential numbering of tables and figures
- Tables must have their titles on their top
- Figures must have their titles below
- Use consistent font sizes for descriptions

- Spelling
- Style/Syntax
- It's a project description, not a scientific paper
- Separating defects
- Broken references
- Missing alt texts
- Text in description of graphics too small
- Inconsistent terminology

- Spelling (i.e. L<sup>A</sup>T<sub>E</sub>X for LaTeX)
- Check if all diagrams and graphics
- Check for broken References
- Empty pages
- Do all graphics work in black/white?
- Have all acronyms been introduced before they have been used?
- Always re-check everything after fixing