Uni Scientific Writing Notes

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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):



Figure 1: QR code to source repository

If you like the study materials, a GitHub star is always appreciated



License



Figure 2: AGPL-3.0 license badge

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Organization

- 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

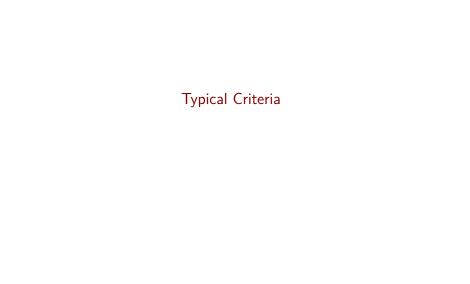
- 1. What is the scientific method?
- 2. Formulating scientific questions
- 3. Designing experiments
- 4. Analyzing experiments
- 5. Planing scientific papers
- 6. Researching topics and staying up-to-date
 - $\textbf{6.1} \ \, \mathsf{Finding} \,\, \mathsf{papers} \to \mathsf{Sci}\text{-}\mathsf{Hub}$
 - 6.2 Analyzing papers
 - 6.3 Referencing papers
- 7. Writing a scientific paper

What is the Scientific Method?



Writing Style

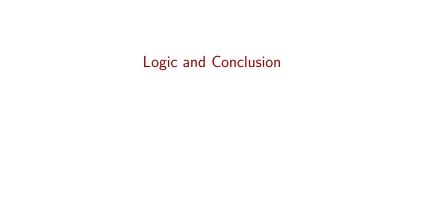
- Structure should not follow the timeline research, but the semantic structure of the discovery
- No rhetorical questions
- No judgmental formulations
- Sentences should be able to stand on their own; reference people and things by their name, not implicit references
- Do not use the present tense when 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



Logic and Conclusion

- 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

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
- Summary of the current state of research/technology ("related work")
- 4. Sources (own and external)



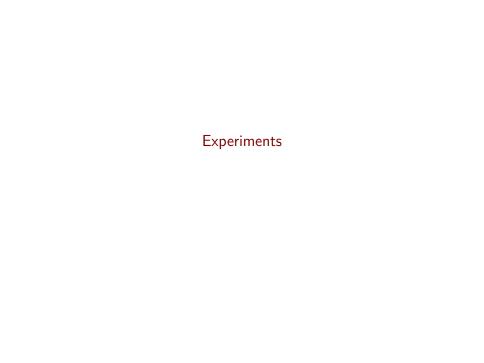
Quality Assurance

- 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

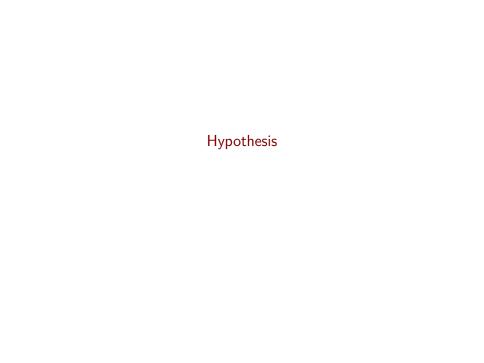
- 1. Design
 - 1.1 Matches the scientific question
 - 1.2 Creativity is required
- 2. Planning
 - 2.1 Prevention of side effects
 - 2.2 No convenience samples 2.3 No unethical experiments
- 3 Execution
 - 3.1 With proper process
 - 4. Analysis
 - 4.1 Objective analysis

1.3 Viability in time, budget and with available technology

- 4.2 No suppression of "unwanted" results
- Interpretation 5.1 Objective interpretation
- 5.2 Usage of statistics: Is the result even statistically relevant? 5.3 Testing the feedback loop: Has the research question actually been answered?

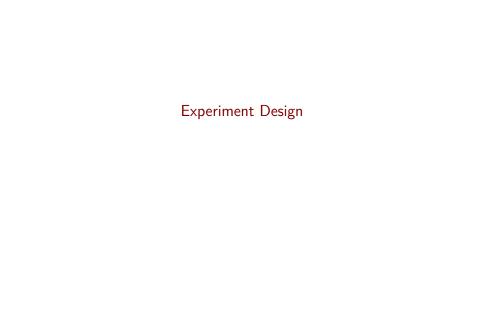
3.2 Proper documentation, including all unexpected incidents

6. Description: Include all information required to reproduce the



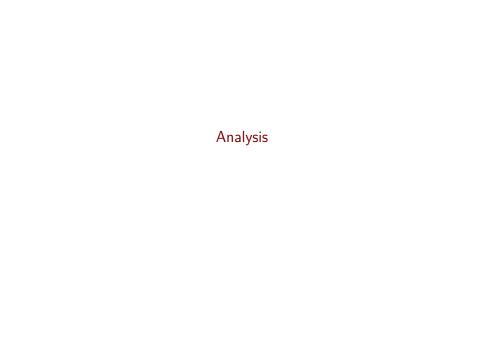
Hypothesis

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



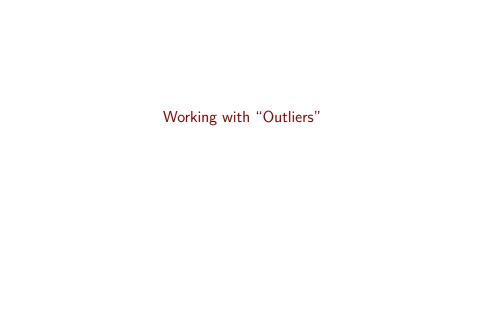
Experiment Design

- 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



Analysis

- ▶ 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!



Working with "Outliers"

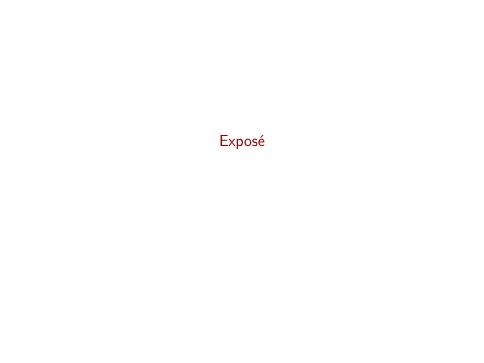
- Don't remove or ignore them
- ▶ Test if they are relevant: Do more research are they statistically relevant?
- ▶ If they are not relevant: Classify and document



Comparisons

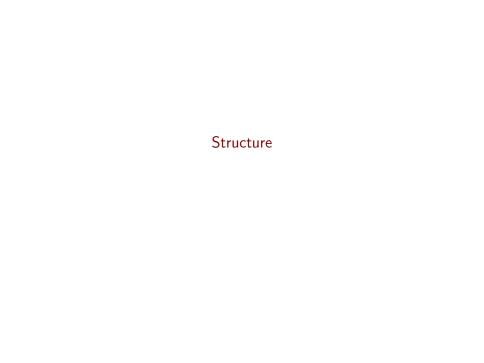
- The new is not automatically better
 - Comparison with a baseline reference is required
 - Detailed description of the reference system used is required
- ▶ Define the used dimensions for the comparison
 - Differences often occur in different dimensions
 - ▶ Elaborate why dimensions are being used
- 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



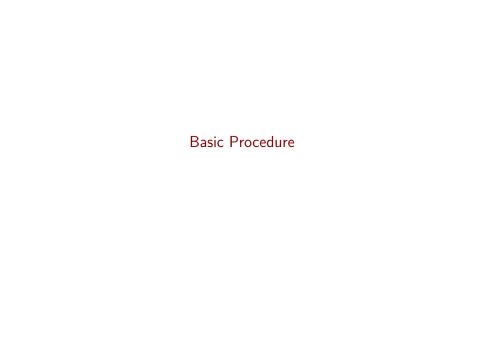
Exposé

- 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



Structure

- 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



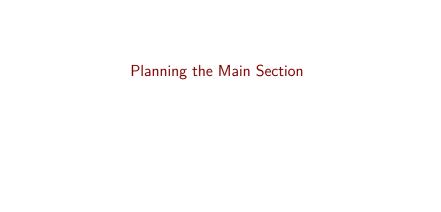
Basic Procedure

- 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
 - Deminition .
 - ExecutionAnalysis
- Selecting tools (BibTeX, LaTeX)
- Sketching
 - Creating a structure (i.e. mind maps)
 - Taking note of keywords and images
- Writing
 - Main section
 - Introduction



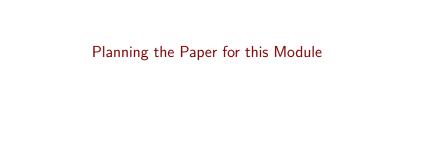
Planning

- 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
 - Asses severity of changes



Planning the Main Section

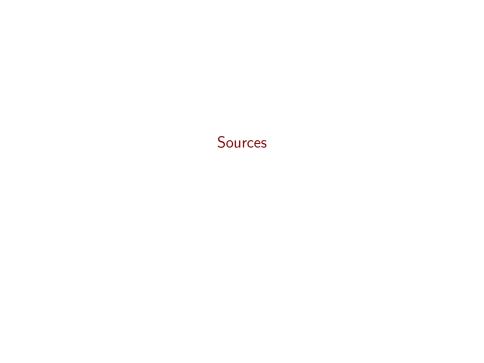
- Structure is central
- ▶ Amount of pages per section is required
- Contents per section must be planned: Keywords, sources, images
- Writing takes time; start writing meta before actually starting to write



Planning the Paper for this Module

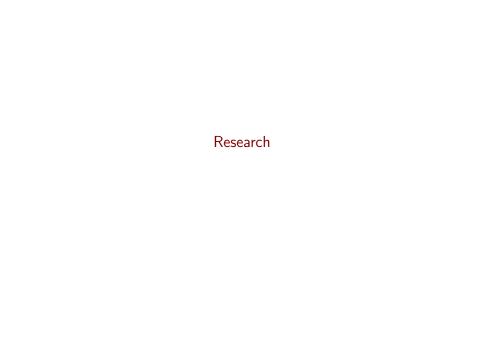
- Formulating the scientific question
- Creating a structure
- ► Searching and analyzing literature
- ▶ Refining the structure (two layers) including page numbers
- Selecting graphics (with sources)
- Writing
- Checking
- Submitting the paper

Researching Topics and Staying Up-to-Date



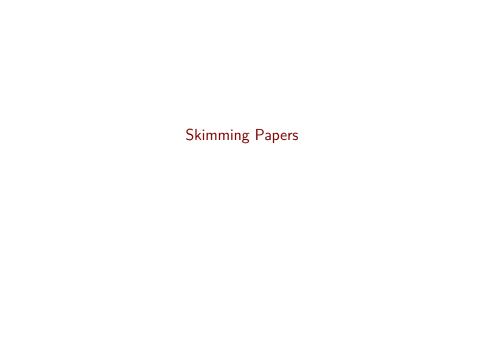
Sources

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



Research

- 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



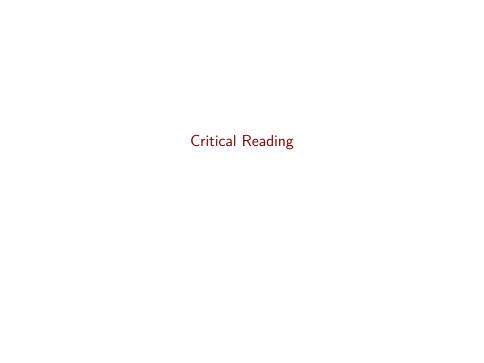
Skimming Papers

- 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)



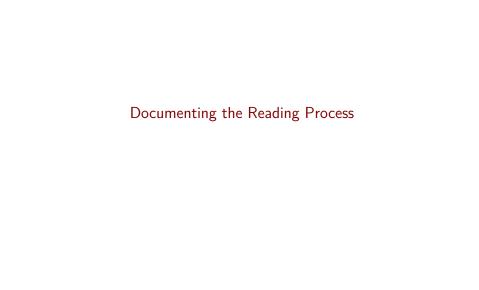
Reading Papers

- 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



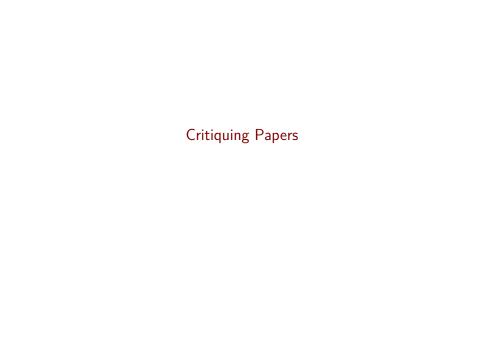
Critical Reading

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



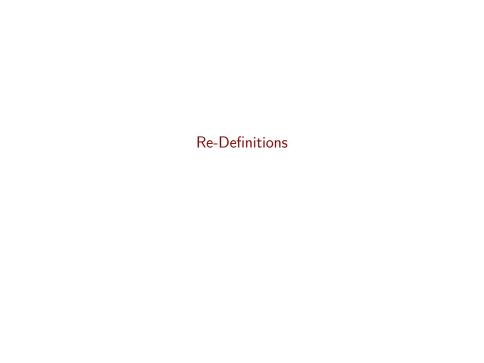
Documenting the Reading Process

- 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



Critiquing Papers

- ➤ Scientifc Standards: Scientifc 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



Re-Definitions

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