Basics on scientific working

Scientific working:

Scientific working means to start from a question and then analyze and work with this question. The aim is to get new findings and to document the process and the finding clearly.

- With a scientific work the student shows his competences in systematically and analytical scientific working
- A distinction is drawn between a scientific thesis as a result and scientific working as a process

Following criteria are important for a scientific work:

- The research deals with a visible topic, including a detailed description, so that others can identify the topic.
- Your research has to tell new foundations about the topic, no one has talked about before, or your research has to describe a new point of view.
- The research has to be of avail for others
- Your research has to include details that allow others to verify your hypotheses. So it has to include information that allow a discussion within the scientific community

Procedure model for scientific working

- To hypothesize, describe a problem
- Describe the current state of research about your topic, which is relevant for your hypothesis or problem
- Describe your approach for a new solution of your problem/ of the proof or the falsification of your hypothesis
- Constitute/ show / proof, that your approach (a) solves a problem and (b) is novel.
- Sum up your results and discuss possibilities for further research (open problems, new questions) which results from your work.

Steps of scientific working:

- Problem
- Current state of research
    - Search material
    - Literature review

- Approach
    - Create a structure/outline
    - Own work (architectures, models, hypothesize, algorithm, …)
    - validation, implementation , proof, experiment
- …
- Write your thesis

Find a Topic:

To find a topic it's often helpful to have a look at the different research groups of your university or at different companies where you want to write your thesis or have a look on your own ideas.

- Often research groups have announcements
    - Topics are often defined clearly, but there is also place for own ideas
    - Advisors have often a big interest on the results
- Talk with possible advisors
    - Create a topic within talks
    - More place for your own interests
    - In addition often an orientation to the interests of your advisor
- Own topic
    - Rather an exception, but possible
    - Results are oft not so important for the advisor
    - Students often want to much
- Topic in a company
    - Often you are the butler of two sides
    - In the best case your advisor at university is part of the industry project
- You have to attend the following points:
- Which coverage and which depth should the work have?
- Has the topic enough potential for a scientific work?
- Can you contain and specify the topic?
- Which hypotheses and questions can derive from the topic?
- Which material can you use for this topic?

Important:

- To describe the implementation of a system is no scientific work!
    - In the best case it's part of the use of a software engineering process
- Why?
    - Does not express a problem which has to solve
    - Does not show the state of the art of the research!
    - No evaluation of the results

    - Does not show open questions and future research

Contain your topic to a question to attend in your thesis/ create a Proposal

- Familiarizing yourself with the topic/ plan your work
    - Bachelor thesis: 4 weeks → 90 hours
- Written fixing of your topic, assignments, time schedule
    - What should be the achievement of your work?
    - Target agreement
        - Draft by student
        - Creation in agreement with advisor
    - Detailed time schedule
        - Name work packages
        - Plan the order and time for the different packages
- Registration
- Development
    - Bachelor thesis: 5 month → 360 hours

Project plan:

- Time scheduling
    - Take your deadlines seriously
    - During thesis with implementation, define the time for it
        - In agreement with your advisor
        - Normally max. 50% of your time
    - You need more time for writing than you think!
    - Plan 14 days for correction at the end of your thesis
- Time management
    - Time schedule is not equal to execution
    - But have a look on your time schedule and adapt it permanently
        - Adapt consequences of delays
    - If you have big problems, talk with your advisor early!
    - Always have a look at: study, exams, job, semester times

Search for material: Sources

- Sources must have a relevance to guarantee the quality of scientific work
- Need to use the whole spectrum of sources. Restriction on appropriate sources is not legal.
- Don't use trivial literature and unsecured internet resources as well as resources without reference
- Books: always use the newest edition
- Journals and Paper: good for actual topics
    - Citeseer, http://citeseer.ist.psu.edu/
    - ACM Digital Library, http://portal.acm.org/
    - IEEE Digital Library, http://ieeexplore.ieee.org
    - Springer: http://www.springerlink.com/
    - University library: ub.upb.de
    - ➔ Access to the portals from the network of the university!

Resource search on the web:

- Resources on the web are often more actual
- It's difficult to retrace the quality of the resources
- Therefore prefer scientific articles or technical reports (for example of a research group) Also you can use specifications and manuals.
- Internet references: URL+Description+day of download
- http://scholar.google.com – scientific search engine (shows also what resources are accessible from university network)
- Wikipedia:
    - Not good for primary reference
    - Good for orientation and finding of good literature
    - Good for some really actual topics

Collect literature /bibliography

- Founded literature hat to note with complete references, so a later locating is easier.
- In best case write a short summary after reading an article:
    - What is the input?
    - Why is it relevant for my thesis?
- To collect and administrate your literature and the reference, there exists many tools
    - Citavi
    - Zotero
    - Etc.
- If you write your thesis with LaTeX it's good to use BibTeX and Tools like jabref.

Formalism

- *Language*: German or English
- *Orthography, grammar*: error free
- *Typological presentation*
  - Accentuation with italic or bold
  - no CAPITALIZATION, underline
- *Footnote*
  - Use advised
- *Foreign words and terms*
  - Explain unknown foreign words (glossary)
- *Abbreviation*
  - Explain abbreviations which are not used in dictionaries

Content

- Phrasing
  - Scientific, precise style
  - Clipped and precise explanations
  - No personal terminology ("I think…")
- Line of argument
  - Reproducible and clear argumentation
  - Show known facts with resources
  - Connections between the different chapters of your thesis
- Graphics
  - Connection between graphics and text is very important
  - Only readable graphics
- Citation
  - Needed for the corroboration of your own argumentation line
  - **You have to mark foreign ideas!**
  - Show your own ideas as your own and ideas and results of others as foreign ideas and results!
  - Direct vs. Indirect citation
    - Direct:
      - *„A formula F is a tautology iff ¬F is unsatisfiable." (Schöning 2000, S. 19)*
    - Indirect:
      - *We have shown that ¬F is unsatisfiable, so F is a tautology (Schöning 2000, S. 19)*
    - Indirect:
      - *Because of the unsatisfiably of ¬F, F is like written in Schöning (2000, S. 19) a tautology.*

The structure of a scientific work

- Title page
  - Title, with subtitle if applicable
  - Type of thesis (bachelor, master etc.)
  - Author, location, date
  - Have a look at special regulations (examination office)
- Affirmation
- Abstract
- Outline/Table of contents
  - Title until sub subtitle or subsubsubtile
  - With page number
- List of figures, or at the end
- List of figures, or at the end
- List of abbreviations (optional) , or at the end
- Introduction
- Main section
- Related work
- Conclusion/Outlook
- Appendix (optional)
- Bibliography
  - Alphabetical order of author
- Glossary (optional)
- Index (optional)
- enclosure (optional)

Explanatory notes:

- Title
  - Clear declaration of the title
  - To attract interesting readers
- Abstract
  - Defines the topic of the thesis
  - Shows the important theses
  - Short conclusion of the work
  - No background material!
    After reading the abstract, the reader decides to read the work or not
  - The structure must show the central theme
- Introduction:
  - Motivation, problem description and aim of your work
  - Research areas, which are important for your work and there meaning
  - goal
  - approach

    - structure of your work
- main part
    - important fundamentals for your work
    - “state of the art“ / “state-of-practice“
    - Own approach
    - Practical example/Implementation etc.
    - Evaluation of the results
    - structure:
        - content discussed with advisor
        - connection for each section
            - Introduction, Content , Conclusion
        - Section in each chapter to show connections
            - subheading
            - Three or max. 4 levels of subsection
        - Formalism:
            - Decimal number
            - chapters (and only those) always start on a new page
                - double page → new chapter on the right side
- related work
    - Fundamentals: Gives an overview of other related works, which are important for an exact dealing with your topic
        - Only in short way
    - Discuss the related work in a critical way in contrast to your own work
        - Describe advantages and disadvantages of the work, different assumptions, similarities etc.
    - Oft last part, before the conclusion, but can also find before the basic foundations
        - Advantage: You can discuss the other work on a better knowledge of the reader
        - Disadvantage: Classification of the topic sometimes more difficult
- Conclusion
    - Conclusion of all results
        - Only results!
    - Discusses the results from a bigger point of you, shows bigger connections
    - Can make recommendations if applicable
    - Shows the amount of your work
    - Discusses limitations of your work
    - Important chapter after the abstract!

How to write a good scientific work?

- There exists no patent remedy- but a good article of Prof. Hal Varian (from Berkeley) related to this topics
- Varian has five tips (for beginners and advanced learners)
    - 1. Look for ideas in the world, not in the journals!
        - You don't find ideas in an article or book
        - Your live shows you the ideas, talking with others, reading the newspaper
        - Go through your live with open eyes!
    - 2. First make your model as simple as possible, and then generalize it!
        - Try to describe your idea in your own words, so that another person, "not related to your subject" understand it.
        - Reduce to the essential parts, what you need to explain it.
        - May be you can generalize it.
    - 3. Look at the literature later, not sooner!
        - Only than when you form your own idea
        - Take time to formulate your own point of view
    - 4. Model your paper after your seminar!
        - Take every chance to present your ideas to other people
        - They force you to come to the point
        - The audience penalize redundancy, unclarity etc.
        - Take the chance to use feedback for your written work. What was difficult to understand? Are there addtional ideas? Literature?
    - 5. Stop, when you've made the point!
        - When there exists no more questions (during your presentation) stop to think about
        - You are finished with your work
        - (Or: Your topic was not good ;))

More tips:

- Helpful techniques for structuring are mind mapping and clustering
- Talk with your advisor regularly
- If you have questions, ask your advisor or come to the learning center!

Resources (in German):

http://plm.in.tu-clausthal.de/PCP/documents/wernigerode/mueller_einfuehrung_wiss_arbeiten.pdf

http://groups.uni-paderborn.de/matiker/index.php?action=download_resource&id=45&module=resources module&src=%40random46cda89ab5569

http://www.cs.uni-paderborn.de/fileadmin/Informatik/AG-Karl/Lehre/Sonstige_Lehre/Seminare/ausarbeitung.pdf