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 often not so important for the advisor
  - Students often want too 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/
  - 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 unsatisfiability 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 subsubsubtitle
  - 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
    o Important fundamentals for your work
    o "State of the art" / "State-of-practice"
    o Own approach
    o Practical example/Implementation etc.
    o Evaluation of the results
  - Structure:
    o Content discussed with advisor
    o Connection for each section
      - Introduction, Content, Conclusion
    o Section in each chapter to show connections
      - Subheading
      - Three or max. 4 levels of subsection
    o Formalism:
      - Decimal number
      - Chapters (and only those) always start on a new page
        o Double page → New chapter on the right side

- Related work
  o Fundamentals: Gives an overview of other related works, which are important for an exact dealing with your topic
    - Only in short way
  o 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.
  o Often 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
  o Conclusion of all results
    - Only results!
  o Discusses the results from a bigger point of you, shows bigger connections
  o Can make recommendations if applicable
  o Shows the amount of your work
  o Discusses limitations of your work
  o 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)
  o 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!
  o 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.
  o 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
  o 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?
  o 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