

# MASTER THESIS HINTS AND TIPS

In this document, we give a few hints on how a master thesis report usually is structured and a couple of things that are important during the process of doing the research and writing the report.

NOTE: In the end, it is YOUR thesis! We just give some advice based on our own previous experiences. Neither are we always right. There might be reasons to do something in a different manner than what has been done earlier (then, discuss with us).

NOTE: A lot of examples of theses are found here: <http://home.simula.no/~paalh/students/>

**ESSAY (@UiO):** We usually let the students write **Chapter 2 - Background** as the essay, ending with some motivation that leads to a temporary **Problem Statement (section 1.2 in the final thesis)**.

## Thesis structure

First thing that meets the reader is the abstract - it should be good!:

- **Abstract**

The abstract is often the first text the reader looks at. Thus, it should be very well written, concise and to-the-point - with the focus of SELLING your work. It is therefore often written at the very end, when you have all details of your work. Usually, we recommend something like this: i) A sentence or three about the background of the challenge you are addressing, which then leads to your "problem statement" (written as just a sentence); ii) Some text describing what you have done in your research, what have you developed, etc.; iii) A small overview of your main results and conclusions - what are the main take-aways from your thesis.

Note also that the abstract is a teaser, and it should therefore not be too long: Fast to read, fast to get to the point. We often recommend keeping it on one page.

Then, usually, our previous students have used as a structure with chapters and sections similar to this:

### 1. **Chapter 1 - Introduction**

#### 1.1. *Background and motivation -*

In about a page, summarize the most important background information. The text usually leads to YOUR PROBLEM STATEMENT (in the next section) and gives arguments about why this is a challenge today.

#### 1.2. *Problem statement -*

In a short and precise way, state what your research is about in this thesis. It can be in the form of a (set of) *research questions*, *goals/aims*, or *objectives* (or a mix) - but it should clearly state what the problems or challenges you are addressing.

Alternatively, one can state a *research hypothesis*, but if so, it should follow the rules of what a hypothesis is. A hypothesis is a statement that introduces a research question and proposes an expected result. It is an integral part of the scientific method that forms the basis of scientific experiments. Therefore, you need to be careful and thorough when building your hypothesis, following the “rules”.

Avoid having too many hypotheses/questions/... as it may make it harder to grasp the core of your work. This also makes it harder to “prove” that you solve the research task(s) as you should discuss how you solve each of them at the end.

1.3. *Scope and limitations -*

Here you can tell the reader about the scope of your thesis, kind of meaning describing what you have done in slighter more detail. The question in section 1.2 might be of the general type, but are you using any specific case studies/application scenarios? Are you limited to a specific type of platform? Have you performed experiments in special environments only, etc.? Describe such information here so that the reader does not expect something going beyond this.

1.4. *Research methods -*

You are doing a research education, so it might be nice to show that you are aware of different ways of doing research. Here, you should describe your research methods showing the reader that you are conscious of your method. There exist several methodologies, and finding a reference somewhere would probably be good. Many use the paradigms (theory, abstraction and design) described here: Peter J. Denning, Douglas E Comer, David Gries, Michael C. Mulder, Allen Tucker, A. Joe Turner and Paul R Young. ‘Computing as adiscipline’. In: Computer 22.2 (1989), pp. 63–70. However, whilst still relevant, this one is getting old so it might be nice to also use words like **qualitative/quantitative research** and/or **experimental/iterative prototyping**.

1.5. *Ethical considerations -*

Ethical considerations in research are a set of principles that guide your research designs and practices. Scientists and researchers must always adhere to a certain code of conduct when collecting data from people. For example, the goals of human research often include understanding real-life phenomena, studying effective treatments, investigating behaviors, and improving lives in other ways. What you decide to research and how you conduct that research involve key ethical considerations such as i) protect the rights of research participants (privacy); ii) enhance research validity, iii) maintain scientific integrity; etc. Thus include here a short description of an assessment of any relevant potential ethical considerations. Discuss this and put it in context of YOUR own work.

1.6. *Main contributions -*

It is important to briefly “sell” your work to the reader, making him interested and impressed with your accomplishments. Thus, you should **briefly** summarize what you have done, list your main results, drawn conclusions and knowledge gained - and put it back in the context of your problem statement. Show how you solved the

initial problem or answered the research questions! The level of detail here is often much less than the similar section(s) in the conclusion, but nice to give the reader a teaser!

1.7. *Thesis outline* -

Describe how you have divided your thesis into chapters, and briefly list what the reader will find in each chapter.

2. **Chapter 2 - Background**

In this chapter, you usually include all information needed as prior knowledge, brief introduction to existing technologies that are relevant (e.g., streaming technologies, AI/machine learning approaches, etc), what others have done, etc. All that builds a foundation for your own work. Whatever is important to know before starting to read about your ideas, your solutions, etc.

INTRO: Often, one starts the chapter with a sentence or two explaining why you have this chapter. In this case, you point at your topic and say that this chapter contains needed background knowledge and related work.

MIDDLE SECTIONS: This typically includes sections describing i) the problem area in more detail highlighting the challenges; ii) some basic needed knowledge about technology; iii) some related work, what have others done in context of your problem statement (not necessarily limited to only your case study). These sections should be discussed in the context of your thesis, your problem statement.

SUMMARY: Often, we recommend ending this chapter (and all chapters after except the conclusion) with a *summary*-section. The aim is to give an overview of, and tea-spoon-feeding the reader with, what he/she should have learned reading this chapter. What can be concluded from this chapter? What is missing in the existing work (motivating your work)? How does the information given here give arguments for your problem statement? Finally, lead to the next chapter (“... and we will therefore in the next chapter address these challenges, and describe our ideas/implementation/...”)

3. **Chapter 3 - Methodology**

This chapter may have many names. Lately, many have named it “*Methodology*”, but names like “*Design and Implementation*” are also often used. Feel free to find a more descriptive title, like a “*name*” of a developed system or the function/service your development provides. Just find a name that matches your research. Regardless, the important thing here is to describe YOUR research.

INTRO: Again, start the chapter with a sentence or two explaining why you have this chapter (repeating the last sentences from the proposed summary in the previous chapter) - assuming that some readers have not read the previous chapter.

MIDDLE SECTIONS: What are your ideas? Your solutions. How have you done “things”? Implementation details. Frameworks used. Etc. Also, discuss alternative ways of doing things and explain why you have chosen to do things as you have. **WHAT! HOW! WHY!**

SUMMARY: End this chapter with a *summary* section. Summarize what you have done and why! Main knowledge gained. What have we learned? Lead to the next chapter, stating that you will test your prototype.

#### 4. **Chapter 4 - Experiments and results**

It is important to “verify” your solutions and ideas with an evaluation. This should be described in this chapter.

INTRO: What will you look at in this chapter and why? Again, point back to the summary in the last chapter, and say that here you want to experiment with and evaluate the proposed “solution”.

MIDDLE SECTIONS: Explain your experiments and evaluations. Include a detailed description of the data you have used, which metrics you include, your test setup, etc. It is nice to discuss what the results also mean (in general and in the context of your problem statement), not only what you can observe. Also, try to explain WHY the results turn out as they do. **You are a researcher and should try to understand why things happen, not only observe what happens.**

DISCUSSION:

*(some put this as a separate chapter before the conclusion depending on the length of it)*

- It is often also nice to discuss the results in a broader setting, trying to generalize the results beyond the specific case study and selected data. Here, one can also typically include a discussion of challenges and pitfalls experienced, etc. Give a critical assessment of both the results and your approach / way of working. Could you have done anything differently?
- Additionally, topics may be very application specific, and it is easy to just discuss results in the context of the application (like medicine, sport, etc) - however, can you trust the data you have used? Do we have the specific skills to conclude in the application area? *It is therefore also important to discuss what your thesis can conclude in the context of Informatics / Computer Science, and for the application specific discussion, be a bit more carefull (would be perfect to get domain-specific experts involved like a user-study, or expert interviews).*

SUMMARY: As above, the *summary* section should summarize your achievements, results, etc. Briefly conclude what they mean, and what you have learned. NO need to lead to the next chapter - conclusion.

#### 5. **Chapter 5 - Conclusions**

Here you summarize and conclude the thesis, and it contains a lot of repetitions from previous chapters. Often, it has been structured in the following three sections, but sometimes they are also merged (especially the first two).

##### 5.1. *Thesis Summary*

Briefly summarize what you have done. More or less in a step-by-step manner.

## 5.2. *Main Contributions*

Again, you “sell” your work - a bit more detailed. Convince that you have performed a great piece of research (meaning, stay honest and to the facts, but make sure that all your achievements are listed). What are your main contributions? What have you and the readers learned, both in terms of the specific application domain and in the context of informatics/computer science? What is the main knowledge gained? (often merged with Summary)

## 5.3. *Revisiting the problem statement*

Put your gained knowledge and conclusions in the context of *section 1.2 - problem statement*. Detail out how your research/work answers the initially stated challenges and what the “answers” are. Usually, the main goal/question/objective(s) is (are) repeated and then answered. If you have also defined “under”-objectives/tasks, you often show how these have been addressed first and then you pull the strings together and show that you have answered the main research questions / problems. (often merged with Main Contributions)

## 5.4. *Future Work*

Your thesis will NOT answer everything. Still, it is important that you here show that you are aware of that and list various things that could be done to follow up on your work. What would be the next steps? Next experiments? Maybe link this up against *section 1.3 - scope and limitations*.

(Some like to include a discussion about future work in a discussion chapter)

NOTE: There are of course situations where this structure is not optimal. For example, if you are using some kind of iterative prototyping in a type of design-implement-test-evaluate-spiral, it might be feasible to merge chapters 3 and 4. Still, what is needed regarding the content in your thesis should at least match the above-listed items.

NOTE 2: We often have **interdisciplinary topics** using datasets from a real setting, often in sports or medicine. In this respect, **be careful to strongly conclude insights into these areas**, we are not medical doctors or sport scientists - here we “assume” more than we “know”. In this respect, we should try to get in touch with people from these areas to discuss the interdisciplinary insights, conclusions and contributions. We should also be careful about the dataset and its validity. Remember to discuss these issues.

# General Hint and Tips

Your ideas and what you have done should be easy to grasp and understand based on your thesis. And, in the end, it is the written report the censors/evaluators read. Thus the presentation should be perfect:

- **Start writing early!! Start writing early!! Start writing early!!** Writing the report takes MUCH longer than you expect. We also want a couple of iterations of the text to squeeze it into a master thesis format, and to make sure that it contains what it should. Also, details are often forgotten adding to the time needed if you need to go back and search for the information. Therefore, make a thesis document from day ONE, maybe setting up the

structure above (or similar), that both serves as a TODO, place for raw details and finished text - all at the same place.

- **Figures** - figures are important. You have probably heard “*a picture is worth a thousand words*”. If you make a diagram of what you want to explain, it is much easier to explain. Then, use the figure actively in the text, aiding your description given in the text. Figures also in general help readability. It eases the eyes. Page up and page down with text only is “boring” to look at, and you do not want to bore your evaluators.
- **Plots and tables** are kinds of figures too, but make sure that they are understandable. Axis should be explained and the trends/numbers should be explained and discussed. Font sizes should be large enough to easily read.
- **Reference all included figures, tables, etc.** in the text. You cannot just insert, for example, a figure without referring to the figure in the text. Do not expect the reader to understand what the figure shows. Feed him/her with a teaspoon. Point out the important take-aways in the figure also in the text.
- **The formatting** of the report is important. It should be visually good to look at. Do not use the smallest font and include too much information in a small space, and neither the opposite. Find a good tradeoff where it looks good, place figures close to where it is referred to in the text. Maybe find and use the template given by the University!??

We already have Overleaf **LaTeX**-templates for both OsloMet, UiT and UiO. As you can understand, we strongly recommend LaTeX for larger works like a thesis!

- **Language and language correctness.** You are free to write in English or Norwegian. Your thesis is NOT about language or correctness, but this definitely affects the readability of your report - thus also the quality. A “bad” language makes it difficult to understand, and your points may not be understood as you intend. Therefore, always do a round of error checking before handing in something for review, and especially before the final submission. The language and the presentation, in general, should be carefully optimized and fixed to the best possible. This also means the correct use of punctuation marks, like commas!

*Carefully use spelling and grammar checkers like Grammarly or similar for every delivery!!*

- **Be consistent!** Use the *same style everywhere*, be it font size/type, text terms, level of detail, colours, formatting, etc. For example, do not use “Fig. 1” in one place and “figure 2” somewhere else - choose one style and stick to it.
- **Citations / References** must be correct and accurate. Often these can be downloaded or exported from for example Google Scholar, ACM, or IEEE. Note, however, that often these are incomplete and use different types of formatting. Thus, you must go over the list and find the missing information and make sure that the *same type of references is formatted/written in the same way*. Otherwise, it is a sign of sloppiness, and *you do not want to appear sloppy to the evaluator*.  
As a minimum, you must include **authors (all), title, where it is published, publisher, data/year**.

If you use **LaTeX**, you will probably use **BibTeX** to manage your references, and then you will have different entries depending on what type of reference it is (there are many fields that can be included, but at least consider these):

For **all types**:

```
authors = {Firstname1 LastName1 and Firstname2 LastName2 and ...},  
(often when downloading the BibTeX, long author lists are cut, and they end with  
and others. Avoid this, and let the reference style decide whether the list should  
be cut or not - adding "et al." - THUS, include all authors here) (mandatory)  
doi = {doi number} (very nice to have)  
year = {year of publication} (mandatory)  
month = {month of publication} (nice to have)
```

**Conference-papers (@inproceedings)**, include at least using the following format:

```
booktitle = {Proceedings of the <International Conference of Something  
(conference_abbreviation)>}, (mandatory)  
location = where the conference was held (nice to have)  
pages = page numbers in the book (nice to have)
```

**Journal-papers (@articles)**, include at least using the following format:

```
journal = full journal name (mandatory)  
volume = volume number (mandatory)  
number = issue/number (nice to have)  
pages = pages in the journal (nice to have)
```

- **Allow some time for feedback! And several iterations!** It is not just your writing that takes a lot of time. Reading your thesis also takes time, and the more of the points above that are *not* followed, the longer it takes. Thus, follow these. Still, even though you have written a very nice report, it takes time. Therefore, set aside a long time before the submission deadline so that your supervisors can give proper feedback. Also, send smaller pieces of the report as soon as it is ready. Moreover, also note that the presentation of your work in the thesis often requires several iterations to be good. Thus, even more time is needed. Thus, do not come the last week before the submission deadline and ask for feedback on your 100 page report for the first time.