Some Guidelines to Writing Your Master Thesis

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1 Introduction

Over the years I have noticed that my thesis students have the same type of questions about starting and organizing their reports. This document contains an overview of the answers I have been giving time and again. So, what should you do with this document?

1. Read it.
2. Check your writing against the questions and checklists below.
3. If your report does not answer one of these questions or fails to meet a point on the checklist, then do it.
4. If you do more than what is here, it is probably superfluous, so scrap it.

2 The Most Important Rule

Think about how you read an article in the papers. If you are honest, you'll admit that as soon as you get bored, you shove it aside and you start reading/doing something else. Be very aware that your reader will do the same with your work if it gets boring/unclear/unmotivated/too abstract.

Thus, in general a reader has a number questions when s/he reads your work:

1. Why should I be interested in your work? (Typically, I am not, and I feel like I am wasting my time.)
2. Why should I believe you or any of claims you make? (Typically, I don't.)
3. Why should I (try to) understand what you write? (Typically, I have no clue what you are trying to achieve.)

Perhaps a few comments are in order here.

1. Realize that a reader is not principally interested in what you write. A reader (i.e., you as a reader, not as a writer) hates to read irrelevant, unrelated stuff. By all means, remove superfluous material in your thesis, it doesn't add anything, on the contrary, it confuses and *bores* the reader. About anything you write, think about if you need it; in case of the slightest doubt, scrap it.
2. Realize that you can write down any claim you like, e.g., 'There are dogs that fly backwards and read the papers at the same time.' Of course, I don't believe this claim, but you can write it down nonetheless. Similarly, with respect to making research claims, you can write anything you like, but the fact that you can do this does not make it true. Thus, to make people believe your claims, you should explain *explicitly* why (and how and the extent to which) your methods provide any credibility to any claim you make.

3. Finally, to me as a reader your topic is new. I don't have all the relations at the back of my mind to understand your reasonings. Hence, make relations between different topics explicit. Explain what you do/write about, and why you do/write about this. Otherwise I am left clueless about your intentions/goals.

So, for each section/paragrapy check that you did not sin against RULE ONE.

3 General Guidelines

- The thesis should be a piece of work in which each of the taken steps are defined and motivated. Since, typically, the problem under investigation is too hard to solve directly, the only way to obtain confidence in the final answer is to show that you asked a sensible question and you followed a sensible method to obtain the answer.
- By the above, write 'question driven'.
    1. Start with making a list of relevant questions. These questions should be 'natural', that is, they should make sense for a reader without detailed background.
    2. Write the questions down!
    3. Order these questions in a logical way, such that once the questions are answered, your work is complete.
    4. Answer the questions.
    5. Once you think you are ready:
        - Have you covered all questions? If not, repair.
        - Have you covered more than these questions? Why? If you cannot motivate these extra points/topics, remove them.
        - Check that you do not mix answers to different questions.
    6. Check your adherence to most important rules above.
    7. Once you completed the steps above, stop.
    8. At each step: use your common sense to determine what to do.
    9. Start with simple statements/models, and expand, rather than start with something complicated/general and end up with nothing.

4 Report

Here is the scheme I expect. If you do not follow this, I will stop reading, and send it back to you.

4.1 Abstract

Include a structured abstract with the following sub-headings:

- Purpose (mandatory)
- Design/methodology/approach (mandatory)
- Findings (mandatory)
- Research limitations/implications (if applicable)
- Practical implications (if applicable)
- Social implications (if applicable)
- Originality/value (mandatory)

Maximum is 250 words in total. Avoid the use of personal pronouns within the structured abstract and body of the paper (e.g. "this paper investigates..." is correct, "I investigate..." is incorrect).

4.2 Introduction

Per paragraph 5-8 sentences, and 1.5 page in total, at most. If longer, I will not read it.

1. Provide (business) context.
2. What is the problem/dilemma that derives from this context?
   (a) Where does the problem come from? (Concrete example, practical context, initial motive.)
   (b) What is the problem couched in more general terms?
   (c) Why is this problem relevant?
3. Discuss most relevant literature. 2-3 most related other work.
   (a) What did others do? (Provide theoretical context, investigate, for the problem you'll address. This is about getting the right problem.)
   (b) To what similar problems does the general problem relate, what are overlaps and differences? (Here you just mention this point briefly, just one or two most relevant references. In the literature section you should address this question thoroughly.)
   (c) What methods have been developed by others for these problems? To what extent can you use these methods, to what extent not? (Again, brief discussion, main methods. In the literature section, expand on this point.)
4. What is the specific gap you address? (Research problem, design method.)
   (a) What problem (research question) do you precisely address in the paper? (If you have more than one main topic, typically remove all topics, until just one remains.) Think about the type of answer you can give to your research question. For example, if the question is this: 'How to minimize the cost of inventory?', the obvious answer is not to have inventory at all. Most surely, this answer is not what you have in mind. The point is that the initial quesion was silly to begin with. A better question is: 'How increase the revenues with my inventory system by 5%?'
   (b) The research question should include a statement of the performance indicators you want to address.
   (c) What makes your (general) problem unique? Why should the reader care to know it? Why is your work necessary?
   (d) If you present a new method, why is this new method necessary, or why are the existing/known/published methods not sufficient?
   (e) Methods & indication of main results.
   (f) What method(s) are you going to use to get the answer? (Motivate methodology.)
   (g) What main result/insight do you achieve? (Provide a hint what the reader can expect. The main results will of course be discussed in the conclusion section.) Why is your work useful?
5. Structure/overview of the paper.

4.3 Literature

Basically, I want to see here that you did your homework.

- What are the overlaps and differences between the problems in the literature and your problem? Discuss the details, show that you understand what you are talking about.

- What methods have others (papers) used to tackle these similar problems?
- To what extent are these known methods useful, can be applied to your problem? If so, how, if not why not? Here again, show that you know what you are talking about. (Do not discuss methods you will not use. Recall RULE ONE: The reader is not interested.)
- How can you characterize your problem and characterize the methods so that you can make a match between method and problem?
- How do all the discussed concepts relate to each other and to your problem in particular?

Besides providing context, literature can be used to

- find (inspiration for) the design
- find other models/designs. (Compare these other models/designs with the chosen design.)
- find performance measures to assess the new design
- find methods to validate the design

If you discuss papers without right away showing how to relate it to your main problem, I'll stop reading at that point, and sent the paper back.

4.4 Methodology Section

Basically, here you have to convince readers that the methods you are going use lead to correct/plausible answers. Recall Question 2 of Rule one.

- How are you going to approach your problem?
- Do you have sub-questions? They help to decompose the main problem, hence organize your work. When these sub-questions are answered, there should be a direct way to answer the your research question.
- What would be suitable methods to solve your problem? why? Use your common sense to determine suitable methods.
- What are the (dis)advantages of these methods, in the light of your problem?
- How are you going to decide which method(s) is the most useful for your problem? Why?
- Finally, which method are you going to use (e.g., simulation)? Why?

If possible, try to relate all the above to a conceptual model. Recall Question 3 of Rule one. The reader has no mental framework of how you are approaching the problem. A figure can help to organize your reasoning and help with Question 3 of Rule one.

- What is the 'thing' you want to control, i.e., what is the unit of analysis?
- What are the 'things' you can control?
- Which KPIs do you use to evaluate the effect/success of these controls?
- Is the list of KPI's complete, consistent? (Are they defined properly?)
- How does the conceptual model relate to your problem?
- How do the sub-questions fit into the conceptual model?
- How does your conceptual model differ/overlap with with existing models?

- If possible, use your model to formulate a hypothesis, e.g., 'I suspect that by controlling such and so, the effect will be like this?'
- If possible, quantify the hypothesis/relation, e.g., by doubling the ..., the profit increases by....
- Define a base case (or base policy) against which you can compare your own work, e.g., if you analyze inventory systems, the base case can be the EOQ formula.

This is perhaps also the best place to discuss company details as a case study that you use to evaluate the value of your work in a practical setting.

One way to approach your problem is as follows. Suppose you like to improve the throughput of a production station. Then the station is the unit of analysis.

1. Describe/plot the demand for the station as a function of time.
2. Describe actual production plans/schedules of the station
3. Make a model of the station so that you can replicate, to some extent, the actual behavior of the station, and you can compute the KPIs.
4. Test this model with simple demand patters (e.g., constant demand)
5. Feed real data into the model, and check with management whether the behavior (expressed in terms of graphs or KPIs) is according to expectation.
6. Find rules, for instance to form production schedules, that affect the throughput.
7. Evaluate these rules bases on the KPIs.
8. Try to improve these rules, evaluate, and so on.

4.5 Experiments

- Describe a production process in the sequence in which the products are produced. Include only the relevant parts, parts that relate to the research question.
- What scenarios are you going to use? Why these? How do you collect the data? Why is the data ok?
- How will you test/ensure the correctness of your work, i.e., validation.? How to gauge the results/claims? How to check the reliability of the obtained data/insights?
- Include only figures and tables that can be related to the research question.
- Try to make the figures and tables self-explanatory. Describe in the captions what the table/figure is about, and what can be observed. For figures, state what is on the x and y axis, e.g., 'the profit as a function of time'.
- Check that figures are coherent, include the same type of data.
- Make observations explicit. Move conclusions to the conclusion section
- If you qualify results as 'good' or 'bad', provide benchmarks to show why the result is 'bad' or 'good'.
- How does all this work relate to the main question? Why and how does the chosen method and data will lead to an answer of the research question?
- Does your report contain sufficient detail and organization that somebody else can repeat your work? If not, repair this.

4.6 Results

- What general insights have you obtained?
- What are the limitations?
- To what extent do they apply to your initial/practical problem?
- How robust are your results? You might carry out sensitivity analysis as convincing evidence that your results make sense in practical settings. Sensitivity analysis adds a lot to the credibility of your work.

4.7 Pruning

One of the last steps of writing your thesis is to prune it. Use the checklist below to see whether you did this.

- Write down, in about five bullets, the main structure of your thesis. Do not exceed 100 words. Check your table of contents agains these five bullets.
- For each paragraph, think about the goal of this piece of writing. What do you want to achieve here? In view of your main problem, can it be left out? In case of the slightest doubt, remove it.
- Check the tense of the verbs. Wherever possible, use present tense. Avoid passive voice if possible (passive voice becomes boring and long-winded pretty soon.)
- For each sentence you write, think about whether it is strictly necessary to include. Does it help/support your main topic/message? If not, remove
- For all remaining sentences, think about its proper place.
- Your thesis should be self-contained.
- The writing should be coherent and logical.
- At each chapter/section, announce briefly your intent. Check that you do not embark on difficult explanations before giving an hint about what you intend to achieve.
- Finally, for all sentence in the report, think about whether it is necesarry to include(contributes to the total work). It you doubt, remove it. You might work in another way. Per sentence, ask what happens if you take it away. If the consequences are small, remove it.

5 Reading Sessions with Others

If you read a report of somebody else, answer the questions below, that is, write down your answers to all these questions!

- Before you start reading, formulate explicitly your initial opinion about the report.
  - What do you think about the size? Too thick most probably.
  - What do you think about the title?
  - Would you actually read this document from cover to cover? If so, why? If not, why not?
- Read the table of contents.
  - What do you think about it?

  - Is it clear/unclear? Why?
  - Do you get an impression about the contents of the report?
  - Do you understand the organization?

- Start at the first sentence of the introduction
  - Stop reading as soon as you feel you like to stop reading. Try to understand why you want to stop. Write your answer down!
  - What do you expect to see in an introduction? Are your expectations met? If this is not the case, what is missing?
  - Move to some arbitrary position in the introduction, start reading, and stop immediately at the slightest feeling that you dislike to continue. Why do you stop? What expectations of you, as a reader, are not met?
- Communicate your dissatisfaction to the author.
- The author has to repair your problem *on paper, not verbally.*
- And so on, i.e., Apply the above reading style to Chapter 2. Stop as soon as you dislike to continue, and figure out what makes you want to stop reading. What is missing, what is wrong with the text, why?

Apply all assembled criticism to your own thesis, and improve your work accordingly. This will be very rewarding:

- It will improve your writing skills
- It will save a *lot* of time, as you need to write less to get the main message across.
- It will increase the quality of the feedback of your supervisors, as they better understand your work.

6 Presentation

I noticed that presentations are often not as clear and explicit on certain points as they should have been. Not being explicit about the aims is a problem as it obscures the results and confuses, hence bores, the audience.

Please check that you *explicitly* deal with *each* of the points below in your presentation. You can either mention these points verbally during the presentation, or include it in one or two lines of the slides, or otherwise, but make sure that the answers to these points come across.

- What is your target/intended audience (e.g., researchers, managers, students, ...). Who needs this work? Why?
- What is the problem, its context, scope, and relevance? Provide motivation. Why is it a problem? Who said so? How do you know? Mind, if the audience does not understand your problem, does not care about your problem, you can just as well skip the rest. Hence, this step is essential, the most important part of the talk.
- What is the main question? What are the sub-questions?
- What is the product you deliver? Why do you carry out this research? What is the aim? Why do you want to know this? What is the benefit/off-spin?
- What do you want to with your insights, results, product? Or otherwise, what should your audience do with it?

- What results do you expect to obtain? Is there a hypothesis you can formulate, try to refute or accept?
- Explain the conceptual model. What relation do you want to show?
- What data do you need to support your hypotheses or to show the relations/correlations in the conceptual model?
- What methods, e.g., survey, questionnaire, do you use to obtain the insights/results? Why that method?
- What is the relation between the method and the main question(s) you asked? Show how the (expected) results answer your question, that is, make the relation explicit.