

## Writing a master's thesis

### *Cannon*

This brief guide addresses the master's thesis. It may also be useful for the master's report with limitations agreed upon by the student's committee.

### The premise

A thesis represents both a *report* of a student's work and a *defense* of a student's premise. A student always begins with a premise, chosen with help from the committee. A premise is an objective or goal that when achieved, leads to something useful to the field. A premise is never just a project. Rather, it is always the goal or objective associated with a project.

For example, suppose a student will implement an idea for improving an image compression algorithm. The premise might be that this improved algorithm will lead to a more memory efficient implementation, or be faster than the original algorithm, or result in less image quality loss.

If your project is to build a tool, your premise might be that your tool will allow some activity to be accomplished easier, faster, or cheaper than other existing software.

### Thesis format

Traditionally, all scientific reporting is done basically in the same format. This applies not only to the thesis, but to journal articles, conference presentations and the like. Chapter divisions are up to the author, but each report should contain the following five parts:

1. **Introduction.** Clearly state your premise. Everything you subsequently write in the rest of the thesis relates to this premise. State the restrictions of your premise.

For example: "My premise is that image compression algorithm X can be modified to be more memory efficient in a C-language implementation for 8-bit natural images of 512x512."

2. **Literature Review.** In this section, the author reviews the current state of knowledge and progress associated with the premise. The purpose is to show that the author understands the problems associated with the premise and is aware of the work done by others. The literature review is *not* a tutorial to teach the reader about the field -- if the reader needs to be taught, they can read the references. Rather, the literature review addresses the following questions:
  - a. Why is the premise important?
  - b. What problems or difficulties need to be addressed?
  - c. What have other authors achieved relative to the premise?
  - d. What premise requirements have other authors not achieved?

Generally speaking, all references to the work of others should be introduced in the literature review. A reference can be repeated in later thesis sections, but the first reference should be made in the literature review.

A reference should first summarize what was accomplished and then *critique* the work. Be specific. For example: "Smith [4] demonstrated that algorithm X performed 20% (standard deviation 5%) faster than algorithm Y when applied to random data sets. However, all data sets tested were less than 1MB and thus relatively small. In addition, the work did not address the issue of memory usage".

3. **Methods.** In this section, the author should adequately describe the methods used to achieve the premise. This includes a full description of implementation details and might include flow charts, pseudo code, state diagrams, design documents, and implementation details. It generally does not include full listings -- these are usually relegated to an appendix.

In a sense, the methods section reads like a *diary*. It should contain sufficient detail to allow another researcher to duplicate the work and achieve the same results.

The methods section also describes the tests and experiments used to verify that the premise was accurately achieved. It is never sufficient to simply say that “software was tested”. Rather, the author should document specifically how testing was done and what results were recorded. If the premise involved showing improved speed, better efficiency, or more accuracy, this section should include the design of an experiment to show how the premise was tested. This design should state how statistics were applied and why the particular statistical tests were appropriate.

4. **Results.** The results section adequately describes the data collected during software and premise testing -- as described in the methods section. Typically, this section includes graphs and tables used to represent data. It should also include the results of all statistical tests.

Each graph or table should be adequately labeled and easily readable. Any data points that are unusual or *outliers* should be noted and explained. An explanation should include any differences in data collection or testing methods that might have caused the outlier.

Always provide the raw data to the reader. If it is too bulky to be presented in the results section, put it in an appendix. If it is too bulky for an appendix, reference where the original data can be found. The reader should always be able to apply your statistical tests to your raw data and verify your conclusions.

5. **Discussion.** In this section, the author should review the results of the previous section with respect to the premise. Explain what data support the premise. Explain and justify data that do not seem to support the premise. Defend why you think the premise was achieved. No one is interested in your opinions here – a defense refers only to data, logic, and reasoning.

Lastly, critique your own work: What would you have done differently? What areas of the premise were not fully achieved? What suggestions do you have to the next researcher that would like to extend your work?

## Common mistakes

Carefully review the following common mistakes – and avoid them. This will greatly facilitate your defense and the acceptance of your thesis by the committee.

- **Using plurals.** There is no “we” in a thesis – you are only reporting your work and your results. Use first-person “I”. If your project was part of a team effort, clearly delineate your contribution and your premise part of the project in the introduction. From that point on, it should be your thesis. If you wish to finish up by presenting how your work was combined into the total project, use the discussion section.
- **Mixing sections.** Some students mix up the material in the four thesis sections throughout the entire thesis. You may assign chapters as you wish, but there should be a clear boundary between these four sections. It is common for some to mix the methods and results section – avoid this. Do not combine the literature review with the methods section. Fundamentally, there should be no references to anyone else’s work in the methods section. One exception to

this might be reviewing or referring back to part of the literature review and *re-referencing* material that has already been reviewed. There should be a clear boundary between what others have done and what you have done.

- **Weak references.** Your references should come from peer-reviewed journals and conference proceedings. Avoid using unpublished information or material that is not peer-reviewed as key references. This includes web pages. On occasion, it may be useful to refer to such information, but it should only be ancillary background to your literature review. If it's not peer-reviewed, it's just an opinion.
- **Excessive background.** Avoid the tendency to provide tutorials or teaching explanations in your thesis. Some background information may be useful, but be judicious. Your thesis is not a textbook – it's a defense.
- **Not reporting data.** If the reader cannot verify your conclusions from your raw data – your conclusions are just opinions. The statement; “The software was tested and verified” is unacceptable if it is not accompanied with a complete description of the test and the measured results. The statement; “This tool provides an effective way to accomplish X” is unacceptable if it is not accompanied with data, reasoning, or logic defending your conclusion.