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Guidelines Master's Thesis Computer science

Science Faculty University of Antwerp

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Guidelines Master's Thesis

Master of Computer Science Programme – Faculty of Science - Universiteit Antwerpen

Introduction and Terminology

1. In conducting a Master's Thesis a student is to demonstrate the ability to independently (under the supervision of a promotor) study a complex subject matter in depth in a scientific manner and the ability to produce a coherent text that describes his/her findings.
2. The *thesis document* is an original written text that is to demonstrate the student's theoretical insight in and practical experience with the methods, techniques and tools that are applied in scientific research within a particular subdomain of Computer Science. The delivery of an original contribution to said scientific domain is not a prerequisite for a successful thesis. Such a contribution is required for a *doctoral dissertation* (PhD).
3. The *promotor*, a member of the University's faculty (Zelfstandig Academisch Personeel (ZAP)), takes responsibility for the proper supervision of the process that leads to the submission and defense of a student's thesis. The promotor selects reviewers, organizes the thesis defense and takes responsibility for a fair assessment of the thesis.
4. An optional *co-promotor* is an expert in the thesis's domain who can take shared responsibility for the quality of the thesis's content.
5. An *assistant* is a member of the Teaching Assistants (Assisterend Academisch Personeel (AAP)) or Research Assistants (Bijzonder Academisch Personeel (BAP)) of the University who can be the student's first point of contact for support.
6. An *internship supervisor* is a member of an organization outside of the University that has commissioned an internship within the context of which a Master's Thesis can be completed.
7. A *reviewer* is a person that takes shared responsibility for assessing the thesis. A reviewer needs to have obtained at least a Master's degree.
8. The *research group* is the group of researchers (PhD students, postdocs) for which the promotor is (partially) responsible. At least one of the thesis reviewers must be part of a research group different from the promotor's group.
9. The student submits a thesis before a predetermined date (cfr. Article 33). Submission implies the student's request to defend his/her thesis.
10. The thesis *defense* is an oral presentation of the work described in the thesis that is followed by a round of questions from the reviewers and, potentially, other members of the audience.

University of Antwerp

Content and form of the Master's Thesis

Learning outcomes

11. The Master's Thesis serves as an aptitude test for the Master in Computer Science. It thereby aims to realize the following learning outcomes within the program:

- You are able to clearly formulate a research question, motivate its relevance, and describe its context *[Fundamental Research]*.
- You are capable of correctly relating your work to existing scientific literature *[Fundamental Research].*
- You are able to describe your own work in a correct, verifiable, and well-founded manner *[Reporting / Fundamental Research].*
- You have gained theoretical insight and practical experience with the methods, techniques and tools that are used within a given subdomain of Computer Science *[Research and Development].*
- You are able to apply published research results or techniques to a new context independently [*Fundamental Research*].
- You are competent to make well-founded choices with regards to alternatives in aforementioned methods, techniques and tools that present themselves while conducting research *[Selection of techniques, methods, languages, architectures, … / Research and Development]*.
- You can draw correct conclusions with respect to the implications of your own work and the research question *[Fundamental Research].*
- You are capable of reporting both orally and in written form on the research conducted at an academic level *[Reporting].*
- You are competent to organize and plan research activities independently under the guidance of a promotor *[Leading a group of computer scientists**].***

Content

12. The content and associated structure of the thesis depends on the type of research question addressed (cfr. appendix A). As a rule, the following aspects should be reflected in the thesis's content:
    a) Formulation of the problem statement and context.
    b) Formulation of the research question.
    c) Description and motivation of the research method.
    d) Description and discussion of the research results.
    e) Formulation of a conclusion.

Structure

13. With respect to the thesis's text, its structure naturally reflects the content. Other artifacts that are produced during the course of the Master's Thesis, such as source code, documentation of developed software, design documentation, etc. are to be delivered to the promotor as electronic supplements to the text, and are therefore not an integral part of it.

University of Antwerp

Form

14. As a rule, the thesis is 60 to 100 pages long. In addition, the student is obliged to attach a short summary (1 page maximum) to the thesis. The summary sets out the essential elements with respect to content, method, results and points of reference of the research.
15. The thesis is to be written in English.

Procedure

Choice of subject and promotor

16. A list with possible subjects available to the student is permanently made available through the ESP system. The ESP-system is accessible through Blackboard. In addition, an informative session is organized in the beginning of May of the first Master's year during which an overview of the different subjects and the procedure is given. It is possible for students to propose their own subject, given that a promotor is found who agrees to take responsibility for it.
17. The student acts upon his/her own initiative to contact and negotiate with the different promotors of the subjects of interest. During this negotiation process, a promotor can refuse to provide guidance to a student and a student can decide to choose a different subject/promotor.
18. The choice of the thesis subject and promotor is made through the Blackboard platform (cfr. the "Time Schedule" section for important deadlines in this regard).

Supervision

19. The following are eligible to take on the role of promotor: all faculty members associated with the student's field of study. The list of faculty members associated with a given field of study can be found in the curriculum description.
20. All individuals that have obtained a PhD can act as a co-promotor. As a rule, a co-promotor is an expert in the subject matter of the thesis.
21. The following can act as an internship supervisor: all individuals who are not a member of the Computer Science Education Committee at the University of Antwerp. An internship advisor is associated with a company or organization in which a part of the Master's Thesis is conducted. In general this relates to practical or experimental activities that are conducted in the context of a specific assignment that aligns with the subject of the Master's Thesis.
22. The following can act as a teaching assistant: all members of the Teaching Assistant staff (Assisterend Academisch Personeel (AAP)) or Research Assistant staff (Bijzonder Academisch Personeel (BAP)) of the University of Antwerp.
23. The student and promotor define a work plan, possibly in consultation with a co-promotor, internship supervisor or teaching assistant, for completion of the Master's Thesis. The plan also defines how the supervision of the work will be arranged. (When will the parties concerned meet (bi-weekly / monthly / ...) ? How will they contact each other (telephone / e-mail / after class / Skype) ? Who takes the initiative (student / teaching assistant / ...?)
24. The student carries the final responsibility for the execution of the planning, for promptly pointing out potential problems, and for the submission of the thesis.
25. The promotor presents the student with the necessary feedback regarding to intermediate results, corrective supervision of the work, and suggests solutions for problems raised. This is done in possible cooperation with the co-promotor, internship supervisor and teaching assistant.

University of Antwerp

Defense

26. The promotor chairs the thesis defense and sees to its proper course.
27. The defense is public, open for all to attend.
28. All reviewers and (if applicable) the teaching assistant must attend the defense. In exceptional circumstances (e.g. a foreign co-promotor), a reviewer or teaching assistant can be excused from the defense. In that case a review is to be sent to the promotor prior to the defense.
29. The defense consists of an oral presentation during which the student concisely summarizes his work, followed by a question and answer session. Every attendee is entitled to ask questions to which the student is to respond to the best of his/her abilities.

Time Schedule

30. **Although the Master's Thesis is formally registered in the curriculum as a 2nd semester course, students are obliged to work on their thesis during the entire academic year, given the magnitude of the work.** Therefore, the subject and promotor choice can already be prepared in the year that precedes the Master's Thesis. In any case the choice has to be made in the first weeks of the year in which you enroll for the Master's Thesis.
31. **The registration of the subject and promotor choice through Blackboard is to be completed before the end of the 4th week (of the first semester) of the academic year in which you enroll for the Master's Thesis at the latest, and at the start of that academic year at the earliest. The instructions for making this choice are made available through Blackboard.** The promotor is to approve the choice before the end of the 5th week of said semester through Blackboard.
32. **If these deadlines are not respected, the Faculty Student Administration will cancel the enrollment for the Master's Thesis.** A notification is sent through e-mail of this fact.
33. **The thesis is to be submitted 14 days before the end of the exam period.** The thesis must be submitted in digital form (PDF) through the Blackboard electronic learning platform. In addition, the student must take responsibility for sending an email with this PDF attached to all reviewers at the time of submission. The respective email addresses are provided to the student by the promotor.
34. **The thesis defense is scheduled in the last week of the exam period.** The promotor fixes a date, time and location in consultation with the student and reviewers.

Assessment

Who?

35. The promotor will select two reviewers for each thesis. That number can be extended if called for.
36. The departmental administration will ask all promotors for the names of the selected reviewers before the submission deadline (cfr. Article 33).
37. At least one reviewer must be associated with a research group different from the promotor's.
38. A co-promotor (if present) always fulfills a reviewer role.
39. An internship supervisor (if present) always fulfills a reviewer role.
40. A teaching assistant (if present) *never* fulfills a reviewer role, but takes on an advisory role.
41. The promotor is to contact the reviewers, ask for their willingness to participate in the thesis' assessment and contact alternative reviewers if this is not the case.

University of Antwerp

Assessment criteria

42. The assessment can take into account the *process* (permanent evaluation), the *final product* (single evaluation) or both.
43. Regardless of the assessment methodology, each Master's Thesis must at a bare minimum demonstrate that the student :
    (a) has independently gained insight in the subject matter;
    (b) is able to present a complex subject matter at a level understandable by his fellow students.
44. The detailed assessment criteria and their impact on the final grade can be found in the assessment forms included in Appendix A.
45. If the thesis jury deems the aforementioned assessment methodology unfit for the thesis in question, the jury can, ad hoc and in consensus, propose their own motivation for the assessment made.
46. The assessment forms or motivation records must make note of the promotor, co-promotor and other reviewers.

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Appendix: Assessment forms

Assessment criteria Master's thesis

1. User guide

A thesis is evaluated by a three-person jury, which includes the promotor. This jury decides by conensus, although in practice, the promotor steers the decision. The assessment results in a grade out of 20 (integer numbers only), differentiating between [0 ... 9[which is a failing grade, and the following degree honours :

- [10 ... 13[or pass,
- [13 ... 15[or distinction,
- [15 ... 17[or great distinction
- [17 ... 20] or greatest distinction

Two possible evaluation methods for theses exist: evaluating either the *process* (permanent evaluation) or the *product* (one-time evaluation). In both cases, a text will have to include a truthful description of either the product or the process. Moreover, this text will have to be defended. In many cases, the promotor will clarify to the jury, the process (independent efforts, efficient working methods, etc.) and/or the developed product (quality, originality, etc.).

2. Rough criteria

In order to maintain the advantage of diversity, theses are divided according to the research methods that have been employed. The methods have been selected on the basis of popular research methods in the field of Computer Science (more precisely Software engineering[1]). They were adjusted to take into account the limited scope of a Master's thesis.

The commonly accepted research methods for a thesis are:

Feasibility Study

A feasibility study is a scientific method to determine whether a (combination of) technique(s) is *usable* for solving a specific type of problem. An essential factor in a feasibility study is the novelty of the technique. Therefore, a typical experiment will consist of building a prototype, and subsequently applying the technique to one problem example. The conclusions are primarily of qualitative nature in the form of "lessons learned".

A feasibility study has the following characteristics:

(a) The problem is *relevant*: The solution is not trivial and useful to at least some people.

(b) The technique is *innovative*: It is not yet known whether it will lead to a solution.

(c) The application of the technique seems *reasonable*: There are reasons to believe that the technique can lead to a solution.

University of Antwerp

Case Study

A case study is a scientific method that aims to determine to what degree a (combination of) scientific technique(s) is *appropriate* for solving a certain kind of problem. Unlike a feasibility study, the technique is not very new (it has already led to solutions in the past), but it is unclear to what degree the solutions are always equally good. For this reason, a typical experiment will build a tool, experimenting with the technique on different problem instances. Subsequently, the technique's effect is quantified in order to make comparison possible.

A case study has the following characteristics:

(a) The problem is *relevant*: The solution is not trivial and useful to at least some people.

(b) The technique is *useful*: There are known cases in which the technique has led to a solution.

(c) The technique's results are *uncertain*: There is reason to believe that the technique does not always lead to good solutions.

Comparative Study

A comparative study is a scientific method to *compare* different techniques (tools, methods) in order to solve a certain kind of problem. Similar to a case study, the technique is not very new (it has already led to solutions in the past), but it is unclear to what degree the solutions are always equally good. For this reason, a typical experiment will make up a list of criteria (that don't favour any particular technique over the other(s)). Subsequently, the techniques are compared based on these criteria.

A comparative study is characterized by the following:

(a) The problem is *relevant*: The solution is not trivial and useful to at least some people.

(b) At least *two* techniques to solve the problem exist.

(c) The techniques' usefulness is *uncertain*: There is reason to believe that one technique is better than another.

Literature Study

A literature study is a scientific method to find out which techniques are *applicable* to solving a certain kind of problem. For a literature study, it is essential that the problem is well documented and that several solution techniques have already been described. But the solutions' diversity range is so large that there is no clear overview of which techniques result in the best results and in which cases they do so. For this reason, a typical literature study analyses the different solutions according to a well-determined list of criteria, in order to compare the advantages and disadvantages of each technique. The conclusions are both qualitative and quantitative in nature.

A literature study can be recognized by the following characteristics:

(a) The problem is *relevant*: The solution is not trivial and useful to at least some people.

(b) There are several *applicable* techniques: Several sources describe solutions to the problem.

(c) The techniques are *well specified*: The advantages and disadvantages for each technique are known.

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Formal model

A formal model is a scientific method to determine to what degree it is possible to make a mathematical abstraction of a certain problem, and to prove a number of important properties based on that abstraction. The method emphasizes a good comprehension of the problem, in order to determine which factors should be included in the formal model. Therefore, a typical experiment will build a model of the problem domain, using a mathematical technique (analytical model, stochastic model, logical model, rewriting system, ...), defend the choice of factors included in the model and draw conclusions w.r.t. the degree to which the problem can be solved.

A formal model has the following characteristics:

a) The problem is *relevant*: The solution is not trivial and useful to at least some people.

b) The problem can be *abstracted*: Many factors exert an influence, but are not equally relevant.

c) There are a number of important properties that, once proved, facilitate the construction of solutions to the problem (e.g., synthesize a correct software solution).

Simulation

A simulation is a scientific method to study phenomena in the real world in detail and to make predictions about what can happen under certain situations (e.g., how a system reacts to external stimuli). Simulations are used when circumstances do not allow real observations (e.g., too expensive, physically impossible). Similar to a formal model, a good understanding of the problem is necessary to determine what will be included in the simulation model and what will be excluded. A typical experiment will build a model of the problem domain, using a series of events and their relationships to test the model using real observations and draw conclusions about hypothetical situations.

A simulation has the following characteristics:

a) The solution is *relevant*: Non-trivial and useful to at least some people.

b) The problem can be *abstracted*: Many factors exert influence, but they are not all equally relevant.

c) The problem requires *prediction*: Real observations (on a large scale) are practically impossible, but simulations can provide answers to “what-if” questions.

Process

Finally, there is also a separate category for assessing the process, using permanent evaluation. A process evaluation does not emphasize a student's ability to apply a certain scientific method, but rather a student's discipline and maturity to solve a complex problem within a limited period of time.

For each of the categories, the assessment form lists the prerequisites that have to be attained in order to reach a certain degree (pass, distinction, great distinction, greatest distinction). Note that the nature of the research method plays an important role for a pass or distinction degree, but becomes irrelevant for great and greatest distinctions.

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3. Fine-grained criteria

Once the degree has been decided on, the fine-grained criteria can refine the final grade. Extraordinary scores, both positive and negative, can lead to an increase or decrease of the degree.

- *Clarity*: The degree to which the text is written clearly and comprehensively.
- *Presentation*: The way the thesis was publicly defended.
- *Independence*: The degree to which the student has taken the initiative to solve any unanticipated problems.
- *Workload*: The degree to which the student has had a "normal" load during the final Masters year. A normal load corresponds to that of a student who graduates in the one-but-last year during the first exam period, begins to work on the thesis around September, is enrolled in the regular study program during both semesters of the final year and submits the thesis at the end of May. An above-normal load would be, for example, an Erasmus/Socrates/...-student (those who reside abroad for at least one semester), and, to a lesser degree, late starters (those who participated in the second exam period in their one-but-last year and start work on their thesis sometime in October). A below-normal load is a student who is enrolled in a thesis year (has already passed all other subjects and is taking an extra year to work exclusively on the thesis) and, to a lesser degree, those who hand in their work late (students who hand in their thesis during the second exam period of the final year).

4. Out of scope criteria

The following elements will explicitly NOT be used as criteria

- *Difficulty*: A subject's difficulty will not be seen as a criterion, as it is too relative a term, for both the promotor and for the student.
- *Amount of work:* The final grade for a thesis judges the end result. The amount of work needed to achieve this result is irrelevant. This, too, is too dependent on both promotor and student.
- *Source code and documentation:* If an experiment requires the development of software, the quality of the code and documentation (readability, maintainability, ...) is largely irrelevant, unless it is an essential element of the experiment. The motivation is that students writing a thesis are implicitly expected to hand in high-quality work.