



THU
Technische
Hochschule Ulm
University of
Applied Sciences

Guidelines on the procedure for a

- Bachelor thesis
- Master thesis

in the Department of Computer Science

Version: July 25, 2019

(Technische Hochschule Ulm, otherwise identical to the version dated January 22, 2014)

English version. For information purposes only. Please note that only the German version of this document is legally valid. This document is a translation made in good faith to the translator's best knowledge.

Foreword

Step-by-step, these guidelines should help answer all the relevant and frequently asked questions which may arise while working on a Bachelor thesis or a Master thesis. Although the following consistently refers to Bachelor theses, these guidelines also apply analogously to Master theses.

On the one hand, this document explains established approaches and offers much advice which is certainly generally applicable. On the other hand, depending on the character of the thesis, deviations from these approaches are not just possible but are certainly also sensible in some cases. However, this document also touches upon binding framework conditions which are non-negotiable.

Feedback is always welcome: both with regard to topics which have not been covered and regarding information which has not been expressed with sufficient clarity. Good practices are established over time, saving future students a great deal of tedious research.

Version: July 25, 2019

(Technische Hochschule Ulm, otherwise identical to the version dated January 22, 2014)

1. General

At the beginning, a common question is: what actually goes into a Bachelor thesis? The examination regulations provide the answer.

The Bachelor thesis is an academic assessment. Its purpose is to demonstrate the ability to work on a problem from the degree subject independently, using scientific methods and within a specified period of time.

Three important criteria are stated here: *complying with deadlines, working independently and using scientific methods*. This document provides important information about these criteria.

How do I find a subject for my Bachelor thesis? There are numerous possibilities which are all of equal value:

1. On request, professors at the University of Applied Sciences offer subjects from their relevant field of research / project environment / area of interest. These topics can often also be found on the professors' personal homepages or on the Department website. Get in touch with the relevant professor.
2. You have an idea yourself and would like to work in a particular field? Then don't hesitate to get in touch with a professor active in that area and work out a specific topic together, based on your general idea.
3. You would like to do your thesis externally, and you have found an interesting invitation for application from a particular company? In this case, it is essential you comply with the following information.

You are not automatically entitled to do your Bachelor thesis *externally*. Naturally, in many cases external Bachelor theses offer an excellent chance to get to grips with the latest issues in a particular field of work and are therefore generally supported.

However, it is essential to consider a few important things when doing your Bachelor thesis externally:

- **Before committing to** an externally-supervised Bachelor thesis, you MUST consult a THU professor.
- Whether the topic and the general field are sufficient to meet the requirements of a Bachelor thesis will be decided on a case-by-case basis. In the right circumstances we will then take on the role of supervising reviewer.
- Just because a Bachelor thesis is written externally **does not** mean that it automatically fulfills the requirements for a Bachelor thesis. This therefore also means that not every Bachelor thesis advertised can be accepted as such automatically.

- Companies often require you to sign a non-disclosure agreement. Depending on how this is formulated, it may give rise to burdens of proof or liability claims, or hinder the proper procedure for the Bachelor thesis as an academic assessment.

Never sign a non-disclosure agreement without considering it carefully first!

Do not assume that your supervising professor will sign such an agreement!

The University of Applied Sciences has standard formulations which will protect your academic assessment from being obstructed, and which will protect everyone involved from inappropriate liability claims. Therefore, you must clarify the question of confidentiality with your supervising professors when you register your thesis!

The normal case is to have neither a non-disclosure agreement, nor a confidentiality agreement. So you should not by any means interpret the presence of the relevant categories on the registration form as an invitation for you to choose one at your own discretion. If an appropriate agreement is necessary, then no other agreements may be made apart from those formulated by Ulm University of Applied Sciences. Of course, no reviewer is obliged to sign even these agreements.

You can find the templates at

<http://www.hs-ulm.de/Studium/SatzungenundRichtlinien/>

2. Thesis topics

- Some theses are strongly application-related and others are highly theoretical. A Bachelor thesis in Computer Science must not necessarily include implementation work. Conceptual or theoretical theses can do without programming work entirely.
- Pure implementation and porting tasks are generally not suitable for a Bachelor thesis. This applies especially if a specified procedure is merely followed from start to finish according to instructions. Rather, in this kind of work, the motivation behind the design of the program structure needs to be explained according to Computer Science criteria, for example. Then an implementation is used to underpin and discuss whether the conceptual considerations prove to be workable.
- Porting work is suitable if, for example, a selection has been made from multiple options for a good reason, and this reasoning is explained and the viability of the selection is verified.
- The scope of the topic must be arranged so that it can be achieved within the workload prescribed by the examination regulations, and may also lead to outstanding results. It is better to reduce the scope of the contents and work through and evaluate this topic in a systematic and reasoned way, than not being able to complete any particular topic all the way through.
- The application for a topic should take up approx. one page of A4 and should at least touch on the following aspects:

- What is the starting situation and what is the problem?
- How is the problem relevant?
- What position do you want to be in after having completed the Bachelor thesis?
- (optional) Which approaches should be considered for solving the problem?
- (optional) Comparable approaches with sources

3. Formal framework conditions

The examination regulations are authoritative. The following guidelines explain the information provided there in more detail.

3.1 Bachelor thesis

- A Bachelor thesis may only be started when a maximum of 1 academic assessment from the previous semesters is still to be completed.
- The student workload is defined in section 22(5). You have **four months** to complete the thesis.
- Section 23(2) defines the terms for supervision and evaluation. This means that external examiners (reviewers) are not permitted, but external supervisors very much are. Section 23(4) provides more detailed information on evaluation.
- Part of the academic assessment is an oral presentation at THU, with a subsequent discussion. The assessment period is 20 minutes in total. With the agreement of the supervisor, the presentation can last between 10 to 15 minutes. The remaining time shall be used for discussion.

3.2 Master thesis

- Section 20(5) defines the completion period for your thesis. As 30 ECTS credits are given for the Master thesis in the Master's degree program *Information systems*, the completion period is **six months**.
- Section 21 gives more detailed information about evaluation and questions regarding supervision.
- Part of the academic assessment is an oral presentation at the THU, with a subsequent discussion. The assessment period is 45 minutes in total. With the agreement of the supervisor, the presentation can last between 25 to 35 minutes. The remaining time shall be used for discussion.

4. Formal registration

You will find a registration form at <http://www.hs-ulm.de/Studium/SatzungenundRichtlinien/>. You need to sort this out yourself and present it to your supervising professor for signing. The start and end date of the thesis (as per the examination regulations) and the preliminary topic are all required information.

It is not necessary to specify the second reviewer upon registration. However, it is essential to define who this is at latest before submitting your thesis – because their name needs to appear on the cover sheet. If you do not suggest a second reviewer yourself, your supervisor will choose and involve a second reviewer on your behalf.

It is still important that you yourself present a document of maximum one page of A4 which describes the intention for your Bachelor thesis. If the application does not already cover the following points, you should cover them in your own words, using a separate paragraph for each:

- What is the starting situation and what is the problem?
- How is the problem relevant?
- What do you predict the situation to be after completing your Bachelor thesis?
- Which approach do you intend to use to close the currently existing gaps?
- Are comparable solution approaches already available and where are they documented?

5. Procedure for supervision

The following explanations are formulated for an *external* thesis, but naturally also apply to an internal thesis. Typically there are ***three important events*** which, for external theses, need to be held on location wherever possible. In individual cases, you can discuss an alternative mode of consultation with your supervisor.

1. Meeting 1

Promptly – preferably before or right at the start of the Bachelor thesis – the supervising professor, the external company supervisor and the student have a meeting. They discuss the objectives of the Bachelor thesis together, define them in more detail and specify them in the form of keywords according to the categories *minimum requirement, should be achieved* and *achievement optional*. The student must organize and make the preparations for this meeting.

During this meeting, the supervising professor ensures that the topic offers the potential for a Bachelor thesis; that the necessary requirements for a Bachelor thesis can be covered; that, in principle, the work environment provides the conditions to enable successful project work etc.

If the external thesis is unsuitable, it goes without saying that the supervising professor reserves the right to reject it! Therefore you need to consult them in plenty of time!

2. Meeting 2 (generally four weeks later)

The supervising professor, the company supervisor and the student get together again and check whether what was initially defined still makes sense – or if insurmountable difficulties / problems have been encountered after starting work which will require an adjustment (correcting unrealistic assumptions, taking into account the student's wishes concerning areas to be studied in greater depth, etc.).

From this point on (also for the security of the student and the continuity of the work), there

should be no more big changes – especially not any change in the direction of the work etc. From now on, the central theme for the rest of the thesis is set in stone.

The supervising professor now takes on the responsibility that – with the agreements made – completion of the thesis is possible, the requirements for a Bachelor thesis have been covered, and that the topic provides potential for the thesis to be an excellent piece of work.

3. Final presentation

The final presentation goes through all the areas of focus, details, special features etc. one more time. The supervising professor generally uses this event to probe unclear points and details. In addition, at the end, the supervising professor meets the other supervisors on location to get an idea about the way the work was performed and the scope of the student's contribution.

Even for an external Bachelor thesis, it is *required* that you do your final presentation as an academic assessment at Ulm University of Applied Sciences. During your presentation at University of Applied Sciences, you are expected to assess what you have achieved as well as reflecting upon the procedure you used. You are expected to defend your thesis during the discussion.

It is up to you whether you do a presentation at the company. Doing a presentation at the company is a chance for you to raise your profile again in the company environment. Discuss this individually with both your company supervisor and your university supervisor. The presentation in the company and at THU can also be identical.

The program coordinators bundle the final presentation academic assessments for Bachelor theses (currently not yet for Master theses). The days planned for this event are announced in advance for the current semester. Your supervisor will inform you about this when you register your Bachelor thesis.

In general, of course, the following applies:

- The supervising professor is available anytime for all thesis-related questions and discussions – particularly with regard to timely information about the conventional structure for a scientific paper.
- **The essential role of the supervising professor is to ensure that, on the one hand, the student has time for the Bachelor thesis (and is not working towards company deadlines which are not related to the thesis) and, on the other hand, to ensure that the student remains on schedule and thus has the opportunity to produce a first-class thesis within the designated timeframe.**
- It is completely normal to ask for feedback or hints from the supervising professor during the course of the project. Generally, it also makes sense to discuss the structure of the Bachelor thesis document. This kind of feedback is part of the professor's supervision task and does not in itself mean that the prerequisite for independent working has not been met.

6. Structure of the written thesis

- You must start writing your thesis by the time the project is halfway through at the latest. For the Bachelor thesis especially, we recommend you start working on it straight away.
- To start with, put together a sensible structure which highlights the central theme of your work. In general when writing, we recommend you do not proceed rigidly from beginning to end, but start with an analysis of the task and a presentation of the current state-of-the-art. If it is appropriate to have a section in your thesis entitled *Fundamentals*, it is generally possible to write this very early on as well. It is generally the case that the sections *Introduction* and *Conclusion and future work* can only be written satisfactorily right at the end.
- When you start working on your thesis, we urgently recommend that you collect and comment upon all the references you use – in a simple text document, for example – so that the sources you used are to hand for quoting properly once you start writing your thesis.
- The correct citation format for scientific papers is of fundamental importance! Incorrect citations or not stating your sources is **not** a trivial matter. The declaration that the thesis is the result of your own work means it is extremely important!
- A Bachelor thesis is not a report of your experiences but a scientific paper. This means it is not appropriate to write in the first person etc. Furthermore, the length of the individual sections is not aligned with the time taken for the work covered, but only with the pursued objective. Typically, time-consuming preliminary work and extensive implementation work are only presented briefly, whereas the justification for favorite solutions and the differentiation from the current state-of-the-art take up much more space.
- Completely unnecessary descriptive or historical discourses in Bachelor theses (especially in the introduction) are unfortunately very common. If you are doing an external thesis, you only need to introduce the company as far as it is necessary for the reader to understand the thesis. Therefore, an introduction to the company or even a description of its history is generally superfluous. Historical treatises (for example, on the development of Java) should only be included if they are necessary for understanding your work, i.e. your approach.

In scientific work, a basic structure has become established which is outlined here only very roughly:

- Title page
You can find a sample suggestion on the Department of Computer Science website under *Final theses*. The title sheet **must** include
 - Ulm University of Applied Sciences logo
 - Title of the thesis
 - and the following information:

Bachelor thesis at Ulm
University of Applied
Sciences

Department of Computer
Science

Degree Program <X>

Presented by
<Your name>

<Month of submission>
<Year of submission>

1. Reviewer: <Name>
2. Reviewer: <Name>

The title sheet **may** include, for example, company logos or the name of your company supervisor.

- Declaration that the thesis is the result of your own work
 - In German for German texts:

Diese Abschlussarbeit wurde von mir selbständig verfasst. Es wurden nur die angegebenen Quellen und Hilfsmittel verwendet. Alle wörtlichen und sinngemäßen Zitate sind in dieser Arbeit als solche kenntlich gemacht.

Place, date and signature

- In English for English texts:

I hereby declare that this thesis is entirely the result of my own work except where otherwise indicated. I have only used the resources given in the list of references.

Place, date and signature

- Zusammenfassung / Abstract
- Danksagung / Acknowledgments
- Inhaltsverzeichnis / Table of Contents
- 1. Einleitung / Introduction
- 2. Stand der Technik / Related work
- 3. Methode / Method
- 4. Ergebnisse / Results
- 5. Zusammenfassung und Ausblick / Conclusion and future work
- Literaturverzeichnis / References

Sometimes the following version is more appropriate for the basic structure:

- Title sheet
- Declaration that the thesis is the result of your own work
- Summary
- Acknowledgments
- Table of contents
- 1. Introduction
- 2. Related work
- 3. Fundamentals
- 4. Methods
- 5. Results
- 6. Conclusion and future work
- References

You do not need to stick rigidly to the structure; just follow the general principle of it. However, the main headings generally remain. In particular, it may be sensible to choose your own, topic-related section headings. For example, the choice of your own, topic-related heading is nearly always appropriate for the *Methods* section. It is important to record the significance of the individual sections and their specific roles, and to reflect these aspects in your own structure.

A good thesis is characterized by the feature that, at all times, the reader knows exactly where which contributions come from, and where the distinction is made between facts, evaluations etc. The clearer the justifications for your approach, the clearer the interpretation of your results and the clearer the underpinning of your decisions, the better.

6.1 Acknowledgments

This section gives you the chance to state who worked with you on the project and to highlight the support you received.

6.2 Introduction

- Introduce the problem, explain the significance of the problem and the motivation for the thesis.
- Just by reading your *Introduction* and your section *Conclusion and future work*, a reader unfamiliar with the subject area should be able to understand which problem you are solving in which field, and within what scope you found a solution.

6.3 Related work

- This is where all the relevant terms and topics are introduced, which are used in particular in the *Methods* section, and therefore need to be understood by the reader.
- At the same time, existing approaches are named and discussed, and cited with appropriate references.
- Classification should always be made in terms of their significance for the objectives of your thesis.
- It is not a problem to make the following argument:
 - *Problem X is also examined in [...], but with the focus on..., which is not the main focus here.*
 - *The approach in X appears to be suitable, so it is worth examining algorithm Y in closer detail.*
 - *According to [...], the software package X represents a standard in the field of ..., so it should also be used for the work in this thesis.*

6.4 Methods

- This is where to describe everything that makes your thesis an independent piece of work.
- Essentially, this is where to describe *how your solution works*.
- Typically, the individual aspects are simply arranged one after the other in the document structure, with suitable subheadings.
- The chosen solution naturally also includes your line of argument about which other variants might have been an option, and the reasons why you decided upon this particular solution.

The following substructure is typical:

- 3.1 Analysis of the requirements
- 3.2 Potential approaches and problems
- 3.3 Selected approach and detailed solutions

When working with highly conceptual software components or implementation components, the following subheadings are generally added in addition:

- 3.4 Software design
- 3.5 Implementation

The *Implementation* section contains **no** listings, but examines the software environment and addresses all those points which are not self-explanatory for the route from the design to a specific software structure.

For a "software-heavy" Bachelor thesis, you'll know you're on the right level of abstraction if you can give your Bachelor thesis to someone and they are able to re-implement your work in a different programming language.

If this is possible, then you have covered all the relevant details on the level of the design and the structure, independently of a particular programming language.

Implementation details on the level of specific C/C++/Java constructs are generally only added (and then frequently only as an appendix), if these concern less relevant implementations of the interrelationships otherwise already presented. UML diagrams generally provide sufficient and adequate means of expression.

6.5 Results

- This section presents the procedure you used to prove that your solution from the *Method* section meets the requirements.
- Typically, you will need to describe why the selected test scenarios are at all suitable for a substantiated statement, which characteristics the test has, etc.
- In addition, for each test you must specify with which parameterization and in which environment etc. the test was carried out, and which results this gave (objective, factual).
- Subsequently, you need to evaluate the significance of these results (subjective, evaluation).

The following structure is common in many theses:

- 4.1 Test cases and their relationship to the problems described in Section 3
- 4.2 The individual test cases and their results
- 4.3 Evaluation of the results

Formulated slightly differently:

- 4.1 Validation of the overall concept
- 4.2 Description and motivation for the test cases
- 4.3 Overview and evaluation of the acquired results

It is often helpful to present the contents of this section in a table displaying the requirements/problems from section 3 and the tests/results from section 4. The table format makes it clear to see which parts were covered, tested, could not be tested, were as expected, deviated etc.

6.6 Conclusion and future work

- This is where the results from section 4 are revisited in a broader context and assessed in terms of the thesis objectives.
- Sometimes it makes sense to put a table together showing
 - which objectives were implemented completely,
 - which were implemented but not tested,
 - which were not implemented but were incorporated in the design,

- which should have been taken into account, but which you only became aware of with the benefit of hindsight etc.
- The outlook on future work permits statements to be made regarding ideas for further work or unanswered questions, although these ideas have in no way been expanded upon. Generally, upon completing a thesis, you end up with more new questions than you answered. Readers of this section will be able to immediately recognize whether you have thought the problem through well.

It is expected that you reflect upon your approach and the results you achieved retrospectively – i.e. to critically assess and categorize your work.

6.7 Listings in the Bachelor thesis

If extensive implementation work is part of your Bachelor thesis, then you must consider the following:

- You should only include listings in the appendix of your Bachelor thesis if the type of implementation was exceptional or if, for example, it is appropriate to provide more details about a design pattern by using a more extensive example, etc.
- Normally, the UML diagrams, the design patterns you used etc., will provide sufficient explanation, so that the code you actually wrote does not even need to appear in the appendix. Generally, it makes more sense to submit your Bachelor thesis along with a CD / DVD of all the necessary tools, source code and instructions etc.
- You can include brief, explanatory fragments of code in the *Implementation* section, although typically not more than around 10 lines are necessary in each case.

7 Evaluation

For the evaluation, the following criteria are considered as a whole. Each thesis is assessed individually, taking into account its character (e.g. application-oriented, theory-related).

An evaluation of *fail* in one of the following four categories can result in failure of the academic assessment!

Example:

However good your problem-solving is, it cannot result in a successfully completed Bachelor thesis if your written presentation is unusable and does not meet the requirements.

- Work
 - Understanding, overview taking into account the level of difficulty
 - Depth and breadth of the subject coverage

Very good weighting	Good weighting	Suboptimal	One-sided	Incorrect weighting
---------------------	----------------	------------	-----------	---------------------

- Scope and content

Very extensive	extensive	average	Little substance	Very little substance
----------------	-----------	---------	------------------	-----------------------

- Evaluation / revision / incorporation of the literature

Comprehensive	Essentials	Acceptable despite lack of completeness	Unacceptable
---------------	------------	---	--------------

- Personal engagement, creativity, ideas, initiative, stamina, hard work
- Independent working, practical scientific personal input

- Result
 - Achievement of objectives taking into account the requirements

More than expected	Complete	With gaps in secondary objectives	Main objectives with some gaps	No main objective achieved completely
--------------------	----------	-----------------------------------	--------------------------------	---------------------------------------

Achievement of objectives rated as *complete* (or *more than was to be expected*) generally results in an evaluation of *very good* in the category *Achievement of objectives*. An evaluation of *good* in the category *Achievement of objectives* covers the range *complete, with gaps in secondary objectives* and *main objectives with some gaps*. An evaluation of *satisfactory* in this category is typically characterized by *main objectives with some gaps*. If the evaluation is *no main objective achieved completely*, the grade in this category will be between *pass* and *fail*. This range of classification is due to the fact that the requirements must always be taken into consideration when evaluating the achievement of objectives.

- Execution of the work, functional capability, scientific investigation
- New content (scientific innovation, creativity, new aspects)

A very large quantity of new content	A large quantity of new content	Little new content	No new content
Creativity, new aspects	Independent assignment of methods to solve the problem	Obvious approach / solution, proper diligent work	Derivative work and obvious solution

Example 1:

The redesign of a database schema also includes new content if, for example, it improves the extensibility.

Example 2:

A software package which was previously not available with this range of functions also has new content.

- Written work
 - Clarity of structure, completeness, precision of presentation
As long as necessary but as short as possible!
 - Evaluation of the results

Precise with limits clearly stated	Normal, with some open points	Imprecise with open points	Unusable
------------------------------------	-------------------------------	----------------------------	----------

An important part of your thesis is the presentation of your results and arranging them in order. If you present, categorize and evaluate your results *precisely with the limits clearly stated*, this will give you an evaluation of *very good* in this category. An evaluation of *good* is appropriate if your presentation is *normal, with some open points*. Typically, an evaluation of *imprecise presentation with open points* will result in a grade of *satisfactory* or *pass*. An evaluation of *unusable presentation of the results* will result in this category being graded with a *fail*.

- External appearance, style, expression, lack of errors, spelling, citation format

Manuals or similar are not scientific papers and therefore will not serve as the written presentation for a Bachelor thesis.

- Oral presentation
 - Quality of the presentation of the results, presentation, behavior during discussion

The evaluation categories are as follows:

- **Very good: 1.0 and 1.3**

An evaluation of "very good" requires that the work, the results, the written documentation and the presentation all fulfill this standard. A very good thesis has solved and presented the given problem independently, according to the standards for a piece of scientific work. In particular, this quality is demonstrated by the confident selection, categorization, demarcation and justification of the approach chosen for solving the problem. It can be seen that the candidate has not only mastered the methods taught on the course, but is reliably able to evaluate and assess them in terms of their use in solving a particular problem. The candidate is able to take a step back from their work and reflect upon it.

A grade of *excellent* (1.0) can be awarded for theses which demonstrate creative application of the methods taught on the degree program. In addition to the characteristics stated above, the work contains an approach, a perspective or idea which – although it is built on the level of knowledge acquired from the degree program – unmistakably demonstrates a creative component which makes the candidate stand out.

- **Good: 1.7 and 2.0 and 2.3**

A grade of "good" requires all the main objectives to have been achieved and presented in line with the standards for a scientific paper. Theses which are essentially a solid piece of work but which demonstrate little creativity and in no way go beyond the obvious approaches belong in this category. A thesis which demonstrates deficits in one of the aspects listed above is also evaluated in this category. Examples would be outstanding implementation with insufficient justification for the approach, pure hard work with proper technical execution in line with an obvious or specified solution approach, or a thesis which demonstrates deficits in the secondary objectives (for example, incomplete argumentation).

- **Satisfactory: 2.7 and 3.0 and 3.3**

An evaluation of "satisfactory" is given when there are significant gaps in the main objectives. Here it is common that, while working on the thesis, the candidate repeatedly had to be given detailed instructions, and the approach or path to the solution had to be repeatedly specified for them.

- **Pass: 3.7 and 4.0**

An evaluation of "pass" is given when there are multiple gaps in the main objectives. However, the quality of the thesis at least fulfills the basic requirements for a Bachelor thesis.

An essential requirement is that the presentation of a written thesis is structured in line with the standards for a scientific paper and in the style of a scientific paper.

- **Fail: 4.7 and 5.0**

A solution which doesn't work may also be very good if you can give a well-reasoned presentation of which initial misjudgment was ultimately the cause of failure, and can identify and verify this in a focused way. If you had known about this before, you would have certainly selected a different approach. It is also legitimate to leave the beaten track on purpose – as long as you present your progress and results in line with scientific standards. However, this must not be confused with constant resistance to taking advice which, in certain circumstances, will clearly result in the failure of the approaches assessed.

The formulation of the grade for evaluating the Bachelor thesis is defined in section 23(4) (section 21(4) for the Master thesis). However, only one point after the decimal is permitted in the result (without rounding, i.e. cut off).

Therefore, it is possible that the final grade for the Bachelor thesis evaluation may deviate from the grade levels 1.0, 1.3, 1.7, 2.0 etc.