

Aalto University
School of Science
Master's Programme in Computer, Communication and Information Sciences

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Software Processes for Dummies: Re-inventing the Wheel

Master's Thesis
Espoo, February 14, 2018

DRAFT! — February 7, 2020 — DRAFT!

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 Information Sciences

 ABSTRACT OF
 MASTER'S THESIS

Author:	Stella Student		
Title:	Software Processes for Dummies: Re-inventing the Wheel		
Date:	February 14, 2018	Pages:	28
Major:	Computer Science	Code:	SCI3042
Supervisors:	Professor Antti Yl _i ¹ / ₂ -J _i ¹ / ₂ ¹ / ₂ ski Professor Petra Perustietelij _i ¹ / ₂		
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<p>The abstract provides goal, motivation, background, and conclusions of the work. It has to fit to one page together with the bibliographical information.</p> <p>If the thesis is in English and the language of school education is Finnish or Swedish, the abstract is written in English and in Finnish or in Swedish. If the language of school education is other than Finnish or Swedish, the abstract is written in English only.</p> <p>The thesis example file (<code>thesis-example.tex</code>), all the chapter content files (<code>1introduction.tex</code> and so on), and the Aalto style file (<code>aalto-thesis.sty</code>) are commented with explanations on how the Aalto thesis works. The files also contain some examples on how to customize various details of the thesis layout, and of course the example text works as an example in itself. Please read the comments and the example text; that should get you well on your way!</p> <p>In the thesis template, you can find the text of the abstract in the abstract in the <code>thesis-example.tex</code> file, together with the bibliographical information of the abstract tables. !FIXME This is an example how to use fixme: add your abstract here. !FIXME! Fixme is a command that helps you identify parts of your thesis that still require some work. When compiled in the custom <code>mydraft</code> mode, text parts tagged with <code>fixme</code>s are shown in bold and with <code>fixme</code> tags around them. When compiled in normal mode, the <code>fixme</code>-tagged text is shown normally (without special formatting). The draft mode also causes the “Draft” text to appear on the front page, alongside with the document compilation date. The custom <code>mydraft</code> mode is selected by the <code>mydraft</code> option given for the package <code>aalto-thesis</code>, near the top of the <code>thesis-example.tex</code> file.</p> <p>The instructions on how to compile LaTeX *.tex files to *.pdf files like this are giving in the <code>thesis-example.tex</code> file as comments and also in this pdf in a Section 3.3.</p>			
Keywords:	ocean, sea, marine, ocean mammal, marine mammal, whales, cetaceans, dolphins		
Language:	English		

Aalto-yliopisto

Perustieteiden korkeakoulu

Tieto-, tietoliikenne- ja informaatiotekniikan maisteriohjelma

DIPLOMITYÖN

TIIVISTELMÄ

Tekijä:	Stella Student		
Työn nimi:	Ohjelmistoprosessit m ₂ nteille: Uusi organisaatio, uudet py ₂ r ₂ t		
Päiväys:	14. helmikuuta 2018	Sivumäärä:	28
Pääaine:	Tietotekniikka	Koodi:	SCI3042
Valvojat:	Professori Antti Yli ₂ -Ji ₂ i ₂ ski Professori Petra Perustieteilij ₂ i ₂		
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Asiasanat:	aineistot, aitta, akustiikka, Alankomaat, aluerakentaminen, aapinen, ankka, aasinsilta		
Kieli:	Englanti		

Aalto-universitetet

Högskolan för teknikvetenskaper

Magisterprogrammet i data-, kommunikations- och infor- SAMMANDRAG AV
mationsteknik DIPLOMARBETET

Utfört av:	Stella Student		
Arbetets namn:	Den stora stygga vargen: Lilla Vargens universum		
Datum:	Den 18 februari 2018	Sidantal:	28
Huvudämne:	Datateknik	Kod:	SCI3042
Övervakare:	Professor Antti Yli-Ji ₂ -Ji ₂ i ₂ ski Professor Petra Perustieteilij ₂ i ₂		
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Om ditt skolespr ₂ k i ₂ r svenska, m ₂ i ₂ ste din diplomarbetet ha en svensk-spr ₂ kig sammanfattning. Sammanfattningen m ₂ i ₂ ste passa p ₂ i ₂ en sida.			
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Språk:	Engelska		

Acknowledgements

I wish to thank all students who use L^AT_EX for formatting their theses, because theses formatted with L^AT_EX are just so nice.

Thank you, and keep up the good work!

Espoo, February 14, 2018

Stella Student

Abbreviations and Acronyms

2k/4k/8k mode	COFDM operation modes
3GPP	3rd Generation Partnership Project
ESP	Encapsulating Security Payload; An IPsec security protocol
FLUTE	The File Delivery over Unidirectional Transport protocol
e.g.	for example (do not list here this kind of common acronyms or abbreviations, but only those that are essential for understanding the content of your thesis.
note	Note also, that this list is not compulsory, and should be omitted if you have only few abbreviations

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Chapter 1

Introduction

Introduction tells the motivation, scope, goal and the outcome of the work. Anyone should be able to understand it. The preferred order of writing your master's thesis is about the same as the outline of the thesis: you first discover your problem and write about that, then you find out what methods you should use and write about that. Then you do your implementation, and document that, and so on. However, the abstract and introduction are often easiest to write last. This is because these really cover the entire thesis, and there is no way you could know what to put in your abstract before you have actually done your implementation and evaluation. This means that you have to rewrite them in the end of your work.

By the way, rarely anyone write the thesis from the beginning to the end just one time, but the writing is more like process, where every piece of text is written at least twice. Be also prepared to delete your own text. In the first phase, you can hide it into comments that are started with % but during the writing, the many comments should be visible for your helpers, the advisor(s) and supervisor.

Read the information from the university master's thesis pages [4] before starting the thesis. You should also go through the thesis grading instructions [3] together with your advisor and/or supervisor in the beginning of your work.

This is my master's thesis, and I am very proud of it. Of course, when I write my *real* master's thesis, I will not use the singular pronoun *I*, but rather try to avoid referring to myself and speak of the research *we* have conducted—I rarely work alone, after all. Yet, both *I* and *we* are correct, and it depends on the advisor and the supervisor (of course from you, too), which one they would prefer. Anyway, the tense should be active, and passive sentences should be avoided (especially, writing sentences where the subject is presented with by preposition), so often you cannot avoid choosing between

the pronouns. Life is strange, but there you have it.

The introduction in itself is rarely very long; two to five pages often suffice. It usually has two subsections with titles Problem statement and Structure of the Thesis, as follows next.

1.1 Problem statement

Undergraduate students studying technical subjects do not consider typography very interesting these days, and therefore the typographical quality of many theses is unacceptably low. We plan to rectify this situation somewhat by providing a decent-quality example thesis outline for students. We expect that the typographical quality of the master's theses will dramatically increase as the new thesis outline is taken into use.

1.2 Structure of the Thesis

You should use transition in your text, meaning that you should help the reader follow the thesis outline. Here, you tell what will be in each chapter of your thesis. Often the thesis does not have as many chapters as is in this template. For example, environment and implementation can be combined as well as chapters of evaluation and discussion. The rest of this thesis is organized as follows. Chapter 2 gives the background, etc.

Chapter 2

Background

The problem must have some background, otherwise it is not interesting. You can explain the background here. Probably you should change the title to something that describes more the content of this chapter. Background consists of information that help other masters of the same degree program to understand the rest of the thesis. Often the background has two parts: the first part tells the theoretical background and the second one describes the background tied to the implementation.

Transitions mentioned in Section 1.2 are used also in the chapters and sections. For example, next in this chapter we tell how to use English language, how to find and refer to sources, and enlight different ways to include graphics in the thesis.

2.1 Language and Structure

Moreover, the transitions are also used in the paragraph and the sentence level meaning that all the text is linked together. For example, the word “moreover” here is one way, but of course you should use variation in the text. Examples of transitional devices (words) and their use can be found from writing guides, e.g. from the Academic writing instructions of Aalto University Language Center ¹ of Purdue University or Strunk’s Elements of Style². Remember that footnotes are additional information, and they are seldom used. If you refer to a source, you do not use footnote. The right command for the references is *cite*, and we will discuss about that later in this Chapter.

¹<http://sana.aalto.fi/awe/> and especially for connecting words
<http://sana.aalto.fi/awe/cohesion/signposts/index.html/>

²<http://www.bartleby.com/141/>

Language Center of Aalto University offers many good courses for thesis writers. For example, LC-1320 Thesis Writing for Engineers (MSc) is planned to support writing the master's thesis and LC-1310 Academic Communication for MS Students covers both oral and written language.

The language used in the thesis should be technical (or scientific). For example, the abbreviations aren't used but all them are written open (i.e. "are not"). Since the content itself is often hard to understand (and explain), the sentences should not be very long, use complex language with several examples embedded in the same sentence, and, also, seldom used words and weird euphemism or paraphrases can make the sentence hard to follow and to read it with only one time, and making everything even harder to understand all this without any punctuation marks makes the instructor cry and finally after trying to correct the language, you will get boomerang, and everyone's time has just been wasted.

Please use proofreaders before sending even your unfinished version to the instructor and/or supervisor. You will get better comments when they do not need first proofread your text. Moreover, they can concentrate to the content better if the language and spelling mistakes are not distracting the reading. Several editors have their own proofreading tools, e.g. `ispell` in emacs. You can also use Microsoft Word to proofread your thesis: it can correct also some grammatical errors and not just misspelled words. You can translate your latex file to rtf with the `latex2rtf` command in the `kosh.aalto.fi` shell server. Then, the line breaks will not be problems for the proofreader of Word.

Note also that if you have a section or a subsection, you have to have at least two of them, or otherwise the section or subsection title is unnecessary. Same with the paragraphs: you should not have sections with only one paragraph, and single sentence paragraph. Furthermore, always write some text after the title before the next level title.

2.2 Finding and referring to sources

Never ever copy anything into your theses from somebody else's text (nor your own previously published text). Never. Not even for starting point to be rewritten later. The risk is that you forgot the copied text to your thesis and end up to be accused of plagiarism. Plagiarism is a serious crime in studies and science and can ruin your career even its beginning. To repeat: never cut and paste text into your thesis!

2.2.1 Finding sources

All work is based on someone else's work. You should find the relevant sources of your field and choose the best of them. Also, you should refer to the original source where a fact has been mentioned first time. Remember source evaluation (criticism) with all sources you find.

Good starting points for finding references in computer science are:

- Aalto library's Computer Science Guide: <http://libguides.aalto.fi/computer> (in English) and <http://libguides.aalto.fi/tietotekniikka> (in Finnish)
- Finna Portal (Aalto Library): <https://aalto.finna.fi/?lng=en-gb> (in English) and <https://aalto.finna.fi/> (in Finnish)
- ACM Digital library: <http://portal.acm.org/>
- IEEEExplore: <http://ieeexplore.ieee.org>
- ScienceDirect: <http://www.sciencedirect.com/>
- ...although Google Scholar (<http://scholar.google.com/>) will find links to most of the articles from the abovementioned sources, if you search from within the university network

Some of the publishers do not offer all the text of the articles freely, but the library has agreed on the rights to use the whole text. Thus, you should sometimes use computers in the domain of the university in order to get the full text. Sometimes the Finna Portal can also help getting the whole article instead of just the abstract. The library has also a self-study guide to information retrieval [2].

Instead of normal Google, use Google Scholar (<http://scholar.google.fi/>). It finds academic publications whereas normal Google find too much commercial advertisements or otherwise biased information. Wikipedia articles should be referred to in the master thesis only very, very seldomly. You can use Wikipedia for understanding some basics and finding more sources, but often you cannot be sure if the article is correct and unbiased.

One important part of the sources that you have found is the reference list. This way you can find the original sources that all the other research of the field refer. Often you can also find more information with the name of the researchers that are often referred in the articles.

2.2.2 Sources and reference list

The main point in referring to sources is to separate your own thinking and text from that of others. Facts of the research area can be given without

reference, but otherwise you should refer to sources. This means two things: marking the source in the text where it has been used, and listing the sources usually in the end of the thesis in a way that help the reader to find the original source. Aalto library has a comprehensive citation guide [1].

There are several bibliography styles, meaning how to form the bibliography in the end of the thesis and how to mark the references in the text. You should ask from your supervisor or instructors which style you should use. This thesis template uses the number style that is often used in software engineering. Here, the bibliography is in the alphabetical order, not in the order where the sources are referred, and the sources are marked with numbers in the text. In all styles, the key idea is to collect as much information of the sources as is possible in the bibliography, and then let the latex environment take care of organizing the necessary information to the reference list.

The other bibliographic styles are also used in the CS field. For example, usability uses the Harvard style where instead of numbers, the reference is marked into the text with author's name and publishing year. You can change the bibliography style in the thesis-example.tex file. You get the normal text reference, e.g. (Haapasalo, 2010), with latex command `citet` or the plain `cite`, and with command `citep`, you get the text reference "Haapasalo (2010)" that you can use as subject of a sentence. Next, we tell more about how to mark the references in the text.

2.2.3 Referring to sources

In addition to the list in the end of the thesis, you have to mark the source in the text where the source is used. There are three places for the reference: in a sentence before the period, in the end of a sentence after the period, or in the end of a paragraph. All of them have different meaning. The main point is that first you paraphrase the source using your own words and then mark the source. Next, we give short examples that are marked with *emphasised text*.

Haapasalo [8] researched database algorithms that allows use of previous versions of the content stored in the database. This kind of marking means that this paragraph (or until the next reference is given) is based on the source mentioned in the beginning. Giving the source you should use only the family name of the first author of the article, and not give any hints about what is the type of the article that is referred nor its title.

B+-trees offers one way to index data that is stored in to a database. Multiversion B+-trees (MVBT) offer also a way to restore the data from previous versions of the database. Concurrent MVBT allows many simultaneous updates to the database that is was not possible with MVBT. [8] When

the marking is after the period, the reference is retrospective: all the paragraph (or after previous reference marking) is based on the source given in its end. If the content is very broad, you can start with saying *According to Haapasalo*, then continue referring the source with several separate sentences, and in the end put the marking of your source *that shows that CMVBT are the best.* [8].

If your paragraph has several sources, the above mentioned styles are not proper. The reader of your thesis cannot know which of your sources give which of the statements. In this case, it is better to use more finegrained referring where the reference markings that are embedded in the sentences. For example, *the multiversion B+-tree (MVBT) index of Becker et al. [5] allows database users to query old versions of the database, but the index is not transactional. It's successor, the transactional MBVT (TMVBT), allows a single transaction running in its own thread or process to update the database concurrently with other transactions that only read the database [9]. Further development, titled the concurrent MBVT (CMVBT), allows several transactions to perform updates to the database at the same time [8].* Here, the references are marked before the period in the sentences where they are used. You should never but all these sources in the end of the paragraph. Referring several source at once should only used when you give a set of examples.

Finally, direct quotes are allowed. However, often you should avoid them since they do not usually fit in to your text very well. Using direct quotes has two tricks: quotation marks and the source. *“Even though deletions in a multiversion index must not physically delete the history of the data items, queries and range scans can become more efficient, if the leaf pages of the index structure are merged to retain optimality.”* [8] Quotes are hard to make neatly since you should use only as much as needed without changing the text. Moreover, you often do not really understand what the author has mentioned with his wordings if you cannot write the same with your own words. Remember also that never cut and paste anything without marking the quotation marks right away, and in general, never cut and paste anything at all!

Sometimes getting the original source can be almost impossible. In an extremely desperate situation, you can refer with structure *ms X [...] according to mr Y [...] defined that*, if you find a source that refers to the original source. Note also that the reference marking is never used as sentence element (example of how **not** to do it: *[8] describes an optimal algorithm for indexing multiversiond databases.*).

Chapter 3

Environment

A problem instance is rarely totally independent of its environment. Most often you need to describe the environment you work in, what limits there are and so on. This is a good place to do that. Sometimes the environment is described together with your own implementation, in the same chapter. Here, we first tell you about the LaTeX working environments and then we have an example from a thesis written some years ago.

3.1 LaTeX working environments

To create L^AT_EX documents you need two things: a L^AT_EX environment for compiling your documents and a text editor for writing them.

3.1.1 Environment

Fortunately L^AT_EX can nowadays be found for any (modern) computer environment, be it Linux, Windows, or Macintosh. For Linuxes (and other Unix clones) and Macs, I'd recommend *TeX Live* [11], which is the current default L^AT_EX distribution for many Linux flavors such as Fedora, Debian, Ubuntu, and Gentoo. TeX Live is the replacement for the older *teTeX*, which is no longer developed. For Macintosh, this environment is called *MacTeX*.

TeX Live works also for Windows machines (at least according to their web site); however, I have used *MiKTeX* [6] and can recommend it for Windows. MiKTeX has a nice package manager and automatically fetches missing packages for you. There are also web service environments, for example Sharelatex (<https://www.sharelatex.com/>) is available with low or no fee for students.

3.1.2 Editor

You can write \LaTeX documents with any text editor you like, but having syntax coloring options and such really helps a lot. My personal favourite for editing \LaTeX is the *TeXlipse* [10] plugin for the Eclipse IDE [12]. Eclipse is an open-source integrated development environment (IDE) initially created for writing Java code, but it currently has support for editing languages such as C, C++, JavaScript, XML, HTML, and many more. The TeXlipse plugin allows you to edit and compile \LaTeX documents directly in Eclipse, and compilation errors and warnings are shown in the Eclipse *Problems* dialog so that you can locate and fix the issues easily. The plugin also supports reference traversal so that you can locate the source line where a label or a citation is defined.

Eclipse is an entire development environment, so it may feel a bit heavy-weight for editing a document. If you are looking for a more light-weight option, check out TeXworks. TeXworks is a \LaTeX editor that is packaged with the newer MiKTeX distributions, and it can be acquired from <http://www.tug.org/texworks/>.

And if you are attached to your *emacs* or *vim* editor, you can of course edit your \LaTeX documents with them. Emacs at least has syntax coloring and you can compile your document with a key binding, so this may be a good option if you prefer working with the standard Linux text editors.

3.2 Graphics

When you use `pdflatex` to render your thesis, you can include PDF images directly, as shown by Figure 3.1 below. You can also include JPEG or PNG files, as shown by Figure 3.2.

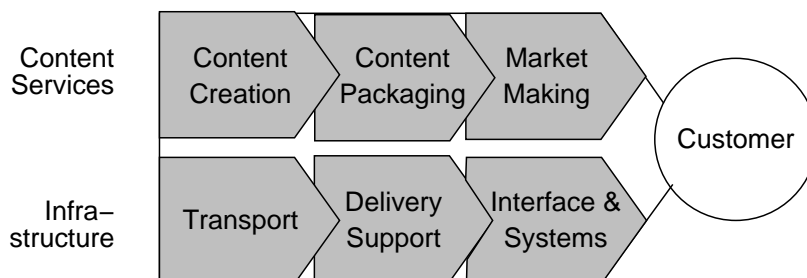


Figure 3.1: The INDICA two-layered value chain model.



Figure 3.2: Eeyore, or Ihaa, a very sad donkey.

You can create PDF files out of practically anything. In Windows, you can download PrimoPDF or CutePDF (or some such) and install a printing driver so that you can print directly to PDF files from any application. There are also tools that allow you to upload documents in common file formats and convert them to the PDF format. If you have PS or EPS files, you can use the tools `ps2pdf` or `epspdf` to convert your PS and EPS files to PDF.

Furthermore, most newer editor programs allow you to save directly to the PDF format. For vector editing, you could try Inkscape, which is a new open source WYSIWYG vector editor that allows you to save directly to PDF. For graphs, either export/print your graphs from OpenOffice Calc/Microsoft Excel to PDF format, and then add them; or use `gnuplot`, which can create PDF files directly (at least the new versions can). The terminal type is *pdf*, so the first line of your plot file should be something like `set term pdf`

To get the most professional-looking graphics, you can encode them using the TikZ package (TikZ is a frontend for the PGF graphics formatting system). You can create practically any kind of technical images with TikZ, but it has a rather steep learning curve. Locate the manual (`pgfmanual.pdf`) from your \LaTeX distribution and check it out. An example of TikZ-generated graphics is shown in Figure 3.3.

Another example of graphics created with TikZ is shown in Figure 3.4. These show how graphs can be drawn and labeled. You can consult the example images and the PGF manual for more examples of what kinds of figures you can draw with TikZ.

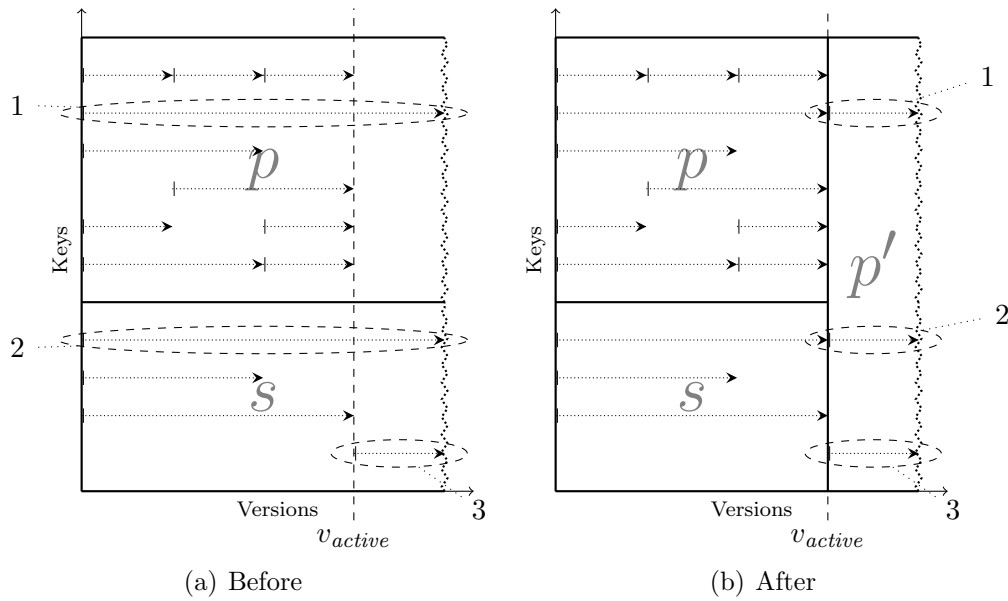


Figure 3.3: Example of a multiversion database page merge. This figure has been taken from the PhD thesis of Haapasalo [8].

3.3 Compilation

After you have written your text, you have to compile your *.tex files to get a pdf presentation. Use pdflatex to compile, because the input images are expected as PDF files. Your L^AT_EX environment can provide the compiling tool, too.

An example how to compile your thesis:

- pdflatex thesis-example.tex
- bibtex thesis-example
- pdflatex thesis-example.tex
- pdflatex thesis-example.tex

You need to run pdflatex multiple times, so that all the cross-references are fixed. Pdflatex will tell you, if you need to re-run it (a warning will be issued).

The compilation has been tested to work in `kosh.aalto.fi`, in an Ubuntu operating system with TeX Live, in an Arch Linux, in a Mac (OSX) with

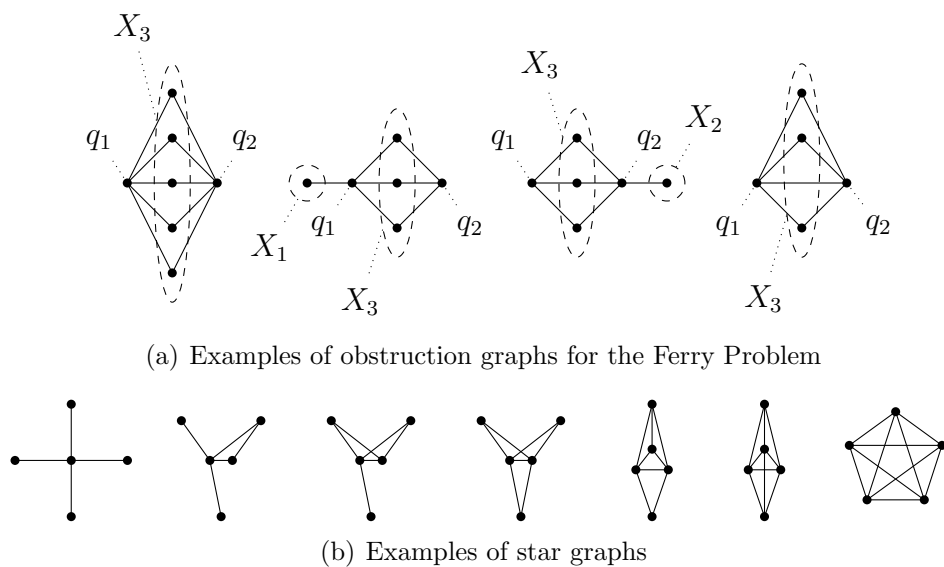


Figure 3.4: Examples of graphs draw with TikZ. These figures have been taken from a course report for the graph theory course [7].

MacTex and TeXShop, and also in an online LaTeX editor ShareLaTeX. If you have problems of missing .sty -files, when compiling, then the local LaTeX environment does not have all the required packages installed.

Chapter 4

Methods

You have now stated your problem, and you are ready to do something about it! *How* are you going to do that? What methods do you use? You also need to review existing literature to justify your choices, meaning that why you have chosen the method to be applied in your work.

If you have not yet done any (real) methodological courses, now is the time to do so or at least check through material of suitable methodological courses. Some methodological courses that concentrates especially to methods in different fields of computer science are presented in Table 4.1. Remember to explain the content of the tables (as with figures). In the table, the last column gives the research area where the methods are often used.

Here we used table to give an example of tables, and you can read more about tables from the latex source file `4methods.tex`. In the beginning of the thesis, the section Abbreviations and Acronyms is also a long table. The difference is that longtables can continue to next page.

Code	Name	Methods	Area
CS-E4900	User-Centered Methods for Product and Service Design	Interviews, observations, questionnaires, probes, etc	Usability
MS-E2108 Simulation (here is an example of multicolumn for tables)		Details of how to build simulations	Computer Science
ELEC-E7130	Internet Traffic Measurements and Analysis	How to measure and analyse network traffic	Communications

Table 4.1: Research methodology courses

Chapter 5

Implementation

You have now explained how you are going to tackle your problem. Go do that now! Come back when the problem is solved!

Now, how did you solve the problem? Explain how you implemented your solution, be it a software component, a custom-made FPGA, a fried jelly bean, or whatever. Describe the problems you encountered with your implementation work. Sometimes the content of the environment chapter is combined together with the implementation chapter.

Chapter 6

Evaluation

You have done your work, but that's¹ not enough.

You also need to evaluate how well your implementation works. The nature of the evaluation depends on your problem, your method, and your implementation that are all described in the thesis before this chapter. If you have created a program for exact-text matching, then you measure how long it takes for your implementation to search for different patterns, and compare it against the implementation that was used before. If you have designed a process for managing software projects, you perhaps interview people working with a waterfall-style management process, have them adapt your management process, and interview them again after they have worked with your process for some time. See what's changed.

The important thing is that you can evaluate your success somehow. Remember that you do not have to succeed in making something spectacular; a total implementation failure may still give grounds for a very good master's thesis—if you can analyze what went wrong and what should have been done.

¹By the way, do *not* use shorthands like this in your text! It is not professional! Always write out all the words: “that is”.

Chapter 7

Discussion

At this point, you will have some insightful thoughts on your implementation and you may have ideas on what could be done in the future. This chapter may be combined together with the evaluation chapter. All the new insights and findings are given here! This chapter is a good place to discuss your thesis as a whole and to show your professor that you have really understood some non-trivial aspects of the methods you used...

Chapter 8

Conclusions

Time to wrap it up! Write down the most important findings from your work. Like the introduction, this chapter is not very long. One to two (never over three) pages might be a good limit. Still, the chapter gives the background, goals, content, and the findings. However, all that should already be in the previous chapters. This is just a summary (as are the abstract and the introduction).

For making PDF/A version requested by the Aalto Library, open the end result pdf file in Acrobat and store it as PDF/A. Then verify the result (everything should be fine, at least as PDF/A-2b version works).

Congratulations, your thesis is ready and it looks beautiful!

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Appendix A

First appendix

This is the first appendix. You could put some test images or verbose data in an appendix, if there is too much data to fit in the actual text nicely.

For now, the Aalto logo variants are shown in Figure A.1.



(a) In English



(b) Suomeksi



(c) På svenska

Figure A.1: Aalto logo variants