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Bachelor's thesis / Master's thesis

Title of the thesis

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Page count: 7 pp.

Abstract:

The abstract should be about one page long. It also doubles as the maturity test. Do not use mathematical notation in the abstract, since it will also be displayed on the electronic thesis repository.

For the publication date, put in the month and year of submission of the finished thesis. Also include 3 to 5 keywords that support searching for your thesis. They are also shown on the repository page.

You can include the abstract in more than one language by copying and modifying this code between comment blocks. To get correct hyphenation for the language (and not with the rules of the main language), put the text in a `foreignlanguage` block as shown in the code (just modify the language parameter to match the abstract).

Keywords: Fill in some keywords, Separated by commas

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Chapter 1

Introduction

1.1 Compiling the document

Depending on the language of your thesis, pass the correct option to the `\usepackage{babel}` command in the preamble. This package changes all the built-in words (like *Bibliography*) to the specified language.

If possible, you should use either the LuaLaTeX or XeLaTeX compiler to produce the PDF file. You can change the compiler in the settings of your L^AT_EX editor. (In Overleaf, this setting is in the menu at the upper-left corner of screen.)

These compilers have better Unicode support than the old pdfLaTeX compiler, and any future accessibility improvements will depend on these compilers. If you use them, comment out the `\usepackage{fontenc}` line from the beginning of the document.

The bibliography is produced by a program called Biber. Overleaf handles this automatically. You can edit the `.bib` source file for bibliography entries either manually¹ or export the file from a reference management program like Zotero.

1.2 Figures and tables

L^AT_EX automatically “floats” figures and tables into a suitable position, usually at the top of current or next page. It is usually best to let the algorithm do its thing; any manual tweaks are likely to break if the layout changes even by a tiny bit.

To create a figure, you can use the `figure` environment. You can create a cross-reference point (like Figure 1.1) by adding a label after the caption.

¹See Section 2 of the biblatex documentation at <https://ctan.org/pkg/biblatex> for more information on the syntax. The documentation also explains customization of the bibliography and citation styles.



Figure 1.1: The emblem of University of Helsinki. As it is a trademark of the university, its use is governed by some restrictions.

Dissertation	Shorthand	Typical length	Credits
Bachelor's	BSc	10–20 pages	6 cr
Master's	MSc	30–50 pages	30 cr
Doctoral	PhD	3 articles + intro	N/A

Table 1.1: Various academic dissertations in mathematics.

Note that the cross-reference above is clickable – this feature is provided by the ‘hyperref’ package.

To create subfigures as in Figure 1.2, you can use the ‘subcaption’ package. It is possible to create subfigure references like Figure 1.2a by placing the label inside the subcaption definition. (You can also create automatic, clickable references to the subfigure letter, like (a)).

If you need to place a picture inline with text, you can also do so, but then the picture is not numbered (and it might cause ugly page breaking). Here the feature is illustrated with a simple diagram using the ‘tikz’ package. TikZ is an extremely powerful package for making diagrams. You can find a lot of examples online.



Like figures, there are also floating environments for tables. Tables are numbered in their own sequence (like Table 1.1) by default. Table contents are set with a `tabular` environment.

For better automatic handling of cross-references (although only in English-language text), you can look at the ‘cleveref’ package².

²<https://ctan.org/pkg/cleveref>

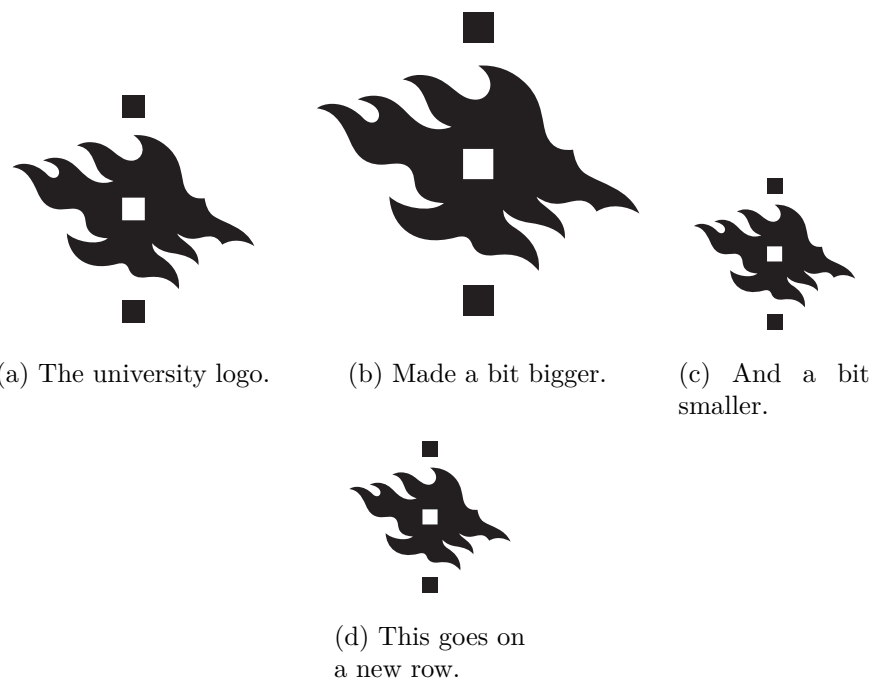


Figure 1.2: The subfigures are automatically placed in a grid. Manual break points can be created with empty lines.

1.3 Mathematics

This example equation illustrates some custom commands defined in the document preamble:

$$\int_0^{2\pi} \sin(x + k\pi) \, dx = - \int_0^{2\pi} \cos(x) \, dx = 0, \quad k \in \mathbb{Z}. \quad (1.1)$$

In particular, the `\dx` command ensures good spacing (and upright ‘d’) of dx within the integral. (The middle notation is only used in Finland.)

To create an unnumbered display equation like

$$a^2 + b^2 = c^2,$$

use the `\[\]` syntax or `equation*` environment. The old \TeX syntax `$$ $$` is not fully compatible with modern \LaTeX enhancements.

Remember that equations are part of text, so you should put punctuation (like `.` and `,`) inside equation environments if necessary. For inline mathematics like $a^2 + b^2$, keep the punctuation outside the dollar signs. Do not put empty lines around equation environments unless there is supposed to be a paragraph break.

To find a particular mathematical symbol, the Detexify tool³ is super useful. It lets you draw a symbol, and suggests similar symbols from base \LaTeX and common packages. Common symbols are also listed in the mathematics section of \LaTeX Wikibook⁴.

Equations are numbered within chapter by default. They too can be cross-referenced, like (1.1). There are several other equation environments, like the one that aligns lines (each line is numbered except for one, and one of them has a special name):

$$\left(\sum_{k=0}^2 a^{2-k} b^k \right) (a - b) = (a^2 + ab + b^2)(a - b) \quad (1.2)$$

$$= a^3 - a^2b + a^2b - ab^2 + b^2a - b^3 \quad (1.3)$$

$$= a^3 - (a^2b - a^2b) - (ab^2 - ab^2) - b^3$$

$$= a^3 - b^3. \quad (\text{AB})$$

The lines can be referred to as (1.2), (1.3), and (AB).

1.4 Theorems, definitions, and proofs

The preamble defines some theorem-like environments with different styles. You can create more such environments and change their names by modifying the code there.

³<https://detexify.kirelabs.org/>

⁴<https://en.wikibooks.org/wiki/LaTeX/Mathematics>

These environments are numbered within chapter and section. If you'd prefer to not reset the numbering in each section (that is, Definition 1.1 instead of Definition 1.4.1), you can change the indicated line in the preamble.

Definition 1.4.1. A triple (a, b, c) of positive integers is called *Pythagorean* if $a^2 + b^2 = c^2$.

It is possible to give a name to such a block.

Lemma 1.4.2 (A very silly lemma). *There exists at least one Pythagorean triple.*

Proof. Pick $(a, b, c) = (3, 4, 5)$. □

If you want the block name to refer to a result in a published work, you need to wrap the citation command in `{\}`. This is due to some unfortunate T_EXnical details.

Theorem 1.4.3 ([5, Theorem 0.5]). *There does not exist a triple (a, b, c) of positive integers such that $a^3 + b^3 = c^3$.*

Proof. Left as an exercise to the reader. □

Remark 1.4.4. The last proof was a joke.

1.5 Citing literature

Use the `\cite` command to cite entries from the `.bib` file, like [2]. You can also use an optional argument to cite a specific part, like [2, p. 20].

Only cited entries are included in the final bibliography. To force the inclusion of all entries (for testing purposes!), you can add `\nocite{*}` somewhere in the code.

Refer to the biblatex documentation [3] for changing the appearance of citations and the bibliography. The `.bib` file attached to this template shows the basic elements of various entry types.

Reference management programs like Zotero support exporting `.bib` files. You can also download citations from zbMATH, Google Scholar, and most journals directly in `.bib` format.

One more note: Some bibliography styles may change the capitalization of words. Use `{}` to protect specific words from this behaviour, like `{Fermat's}` in the entry for [5].

Bibliography

- [1] Michael Aizenman and Hugo Duminil-Copin. “Marginal triviality of the scaling limits of critical 4D Ising and ϕ_4^4 models”. arXiv preprint 1912.07973. 2019.
- [2] Petteri Harjulehto, Riku Klèn, and Mika Koskenoja. *Analyysiä reaali-luvulla*. Sixth, revised edition. Previously published by Unigrafia. Gaudeamus, 2023.
- [3] Philip Kime, Moritz Wemheuer, and Philipp Lehman. *The bibl_{at}ex package*. Version 3.20. 2024. URL: <https://ctan.org/pkg/biblatex> (visited on 08/22/2024).
- [4] Nana Nonexistent. “A 3-page solution to the Riemann hypothesis”. In: Firstname von Lastname. *A compendium of invalid proofs*. Puuhamaa University Press, 2024, pp. 14–16.
- [5] Andrew Wiles. “Modular Elliptic Curves and Fermat’s Last Theorem”. In: *Annals of Mathematics* 141 (3 1995), pp. 443–551. DOI: 10.2307/2118559.

Appendix A

Some more information

If you need to have appendices in your thesis, you can write them as usual chapters after the `\appendix` command. Appendices are numbered alphabetically.