MASARYK UNIVERSITY
FACULTY OF INFORMATICS



# The Proof of $P = NP$

BACHELOR'S THESIS

**Jane Doe**

Brno, Fall 1999

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## FACULTY OF INFORMATICS



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*Replace this page with a copy of the official signed thesis assignment and the copy of the Statement of an Author.*

# Declaration

Hereby I declare that this paper is my original authorial work, which I have worked out on my own. All sources, references, and literature used or excerpted during elaboration of this work are properly cited and listed in complete reference to the due source.

Jane Doe

**Advisor:** John Smith

# Acknowledgement

This is the acknowledgement for my thesis, which can span multiple paragraphs.

# Abstract

This is the abstract of my thesis, which can span multiple paragraphs.

# Keywords

keyword1, keyword2, …

# Contents

# List of Tables

# List of Figures

# 1 Introduction

Theses are rumoured to be the capstones of education, so I decided to write one of my own. If all goes well, I will soon have a diploma under my belt. Wish me luck!

Říká se, že závěrečné práce jsou vyvrcholením studia a tak jsem se rozhodl jednu také napsat. Pokud vše půjde podle plánu, odnesu si na konci semestru diplom. Držte mi palce!

Hovorí sa, že záverečné práce sú vyvrcholením štúdia a tak som sa rozhodol jednu tiež napísať. Ak všetko pôjde podľa plánu, odnesiem si na konci semestra diplom. Držte mi palce!

Man munkelt, dass die Dissertation die Krönung der Ausbildung ist. Deshalb habe ich mich beschlossen meine eigene zu schreiben. Wenn alles gut geht, bekomme ich bald ein Diplom. Wünsch mir Glück!

Говорят, что тезис – это кульминация обучения. Поэтому я и решил написать собственный тезис. Если всё сработает по плану, я скоро получу диплом. Желайте мне удачи!

# 2 These are

## 2.1 the available

### 2.1.1 sectioning

commands.

**Paragraphs and**

    **subparagraphs are available as well.** Inside the text, you can also use unnumbered lists,

- such as

- this one

  - and they can be nested as well.
  - » You can even turn the bullets into something fancier,
  - § if you so desire.

Numbered lists are

1. very

   (a) similar

and so are description lists:

**Description list** A list of terms with a description of each term

The spacing of these lists is geared towards paragraphs of text. For lists of words and phrases, the paralist package offers commands
- that
  - are
    - ∗ better
      - · suited
1. to
   (a) this
      i. kind of

A. content.

The amsthm package provides the commands necessary for the typesetting of mathematical definitions, theorems, lemmas and proofs.

**Theorem 2.1.1.** *This is a theorem that offers a profound insight into the mathematical sectioning commands.*

**Theorem 2.1.2** (Another theorem)**.** *This is another theorem. Unlike the first one, this theorem has been endowed with a name.*

**Lemma 2.1.3.** *Let us suppose that $x^2 + y^2 = z^2$. Then*

$$\left\langle u \,\middle|\, \sum_{i=1}^{n} F(e_i, v)e_i \right\rangle = F\left( \sum_{i=1}^{n} \langle e_i | u \rangle e_i, v \right). \tag{2.1}$$

*Proof.* $\nabla^2 f(x, y) = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}.$ □

**Corrolary 2.1.4.** *This is a corrolary.*

*Remark.* This is a remark.

# 3 Floats and references

The logo of the Masaryk University is shown in Figure 3.1 and Figure 3.2 at pages 5 and 6. The weather forecast is shown in Table 3.1 at page 6. The following chapter is Chapter 4 and starts at page 7. Items 3, 3b, and 3(c)iv are starred in the following list:

1. some text
2. some other text
3. ★
    (a) some text
    (b) ★
    (c) some other text
        i. some text
        ii. some other text
        iii. yet another piece of text
        iv. ★
    (d) yet another piece of text
4. yet another piece of text

If your reference points to a place that has not yet been typeset, the `\ref` command will expand to **??** during the first run of `pdflatex fi-pdflatex.tex` and a second run is going to be needed for the references to resolve. With online services – such as Overleaf – this is performed automatically.

Figure 3.1: The logo of the Masaryk University at 40 mm

Figure 3.2: The logo of the Masaryk University at $\frac{2}{3}$ and $\frac{1}{3}$ of text width

| Day | Min Temp | Max Temp | Summary |
|-----|----------|----------|---------|
| Monday | 13°C | 21°C | A clear day with low wind and no adverse current advisories. |
| Tuesday | 11°C | 17°C | A trough of low pressure will come from the northwest. |
| Wednesday | 10°C | 21°C | Rain will spread to all parts during the morning. |

Table 3.1: A weather forecast

# 4 Mathematical equations

TEX comes pre-packed with the ability to typeset inline equations, such as $e^{ix} = \cos x + i \sin x$, and display equations, such as

$$\mathbf{A}^{-1} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{\det(\mathbf{A})} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}.$$

LATEX defines the automatically numbered `equation` environment:

$$\gamma Px = PAx = PAP^{-1}Px. \tag{4.1}$$

The package amsmath provides several additional environments that can be used to typeset complex equations:

1. An equation can be spread over multiple lines using the `multline` environment:

$$a + b + c + d + e + f + b + c + d + e + f + b + c + d + e + f$$
$$+ f + g + h + i + j + k + l + m + n + o + p + q \tag{4.2}$$

2. Several aligned equations can be typeset using the `align` environment:

$$a + b = c + d \tag{4.3}$$
$$u = v + w + x \tag{4.4}$$
$$i + j + k + l = m \tag{4.5}$$

3. The `alignat` environment is similar to `align`, but it doesn't insert horizontal spaces between the individual columns:

$$a + b + c + d \quad = 0 \tag{4.6}$$
$$e + f + g = 5 \tag{4.7}$$

4. Much like chapter, sections, tables, figures, or list items, equations – such as (4.8) and (My equation) – can also be labeled and referenced:

$$b_{11}x_1 + b_{12}x_2 + b_{13}x_3 \qquad = y_1, \tag{4.8}$$
$$b_{21}x_1 + b_{22}x_2 \qquad + b_{24}x_4 = y_2. \tag{My equation}$$

5. The `gather` environment makes it possible to typeset several equations without any alignment:

$$\psi = \psi\psi, \tag{4.9}$$
$$\eta = \eta\eta\eta\eta\eta, \tag{4.10}$$
$$\theta = \theta. \tag{4.11}$$

6. Several cases can be typeset using the `cases` environment:

$$|y| = \begin{cases} y & \text{if } z \geq 0, \\ -y & \text{otherwise.} \end{cases} \tag{4.12}$$

For the complete list of environments and commands, consult the amsmath package manual[1].

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1. See `http://mirrors.ctan.org/macros/latex/required/amslatex/math/amsldoc.pdf`. The `\url` command is provided by the package url.

# 5  We have several FONTS *at* **disposal**

The serified roman font is used for the main body of the text. *Italics are typically used to denote emphasis or quotations.* The `teletype font is typically used for source code listings`. The **bold**, SMALL-CAPS and sans-serif variants of the base roman font can be used to denote specific types of information.

We can also change the font size, although it is usually not necessary.

A wide variety of mathematical fonts is also available, such as:

$$ABC, \mathcal{ABC}, \mathbf{ABC}, ABC, \mathit{ABC}, ABC$$

By loading the amsfonts packages, several additional fonts will become available:

$$\mathfrak{ABC}, \mathbb{ABC}$$

Many other mathematical fonts are available[1].

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1.  See `http://tex.stackexchange.com/a/58124/70941`.

# 6 Inserting the bibliography

After loading the `biblatex` package and linking a bibliography database file to the document using the `\addbibresource` command, you can start citing the entries. This is just dummy text [1] lightly sprinkled with citations [2, p. 123]. Several sources can be cited at once [3–5]. "Fundamental Algorithms" was written by Knuth in 1973. We can also produce Knuth [1] or (Knuth [1], 1973). The full bibliographic citation is: *Donald E. Knuth. "Fundamental Algorithms". In: Second. Vol. 1. The Art of Computer Programming. This is a full INBOOK entry. Reading, Massachusetts: Addison-Wesley, Oct. 1973. Chap. 1.2, pp. 10–119.* We can easily insert a bibliographic citation into the footnote[1].

The `\nocite` command will not generate any output, but it will insert its argument into the bibliography. The `\nocite{*}` command will insert all the records in the bibliography database file into the bibliography. Try uncommenting the command and watch the bibliography section come apart at the seams.

When typesetting the document for the first time, citing a `work` will expand to [**work**] and the `\printbibliography` command will produce no output. It is now necessary to generate the bibliography by running `biber fi-pdflatex.bcf` from the command line and then by typesetting the document again twice. During the first run, the bibliography section and the citations will be typeset, and in the second run, the bibliography section will appear in the table of contents.

The `biber` command needs to be executed from within the directory, where the LaTeX source file is located. In Windows, the command line can be opened in a directory by holding down the Shift key and by clicking the right mouse button while hovering the cursor over a directory. Select the Open Command Window Here option in the context menu that opens shortly afterwards.

With online services – such as Overleaf – all commands are executed automatically.

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1. Donald E. Knuth. "Fundamental Algorithms". In: Second. Vol. 1. The Art of Computer Programming. This is a full INBOOK entry. Reading, Massachusetts: Addison-Wesley, Oct. 1973. Chap. 1.2, pp. 10–119.

# Bibliography

[1]  Donald E. Knuth. "Fundamental Algorithms". In: Second. Vol. 1.
     The Art of Computer Programming. This is a full INBOOK entry.
     Reading, Massachusetts: Addison-Wesley, Oct. 1973. Chap. 1.2,
     pp. 10–119.

[2]  Daniel D. Lincoll. "Semigroups of Recurrences". In: *High Speed
     Computer and Algorithm Organization*. Ed. by David J. Lipcoll, D. H.
     Lawrie, and A. H. Sameh. Third. Fast Computers 23. This is a full
     INCOLLECTION entry. New York: Academic Press, Sept. 1977.
     Chap. 3, pp. 179–183.

[3]  David J. Lipcoll, D. H. Lawrie, and A. H. Sameh, eds. *High Speed
     Computer and Algorithm Organization*. Third. Fast Computers 23.
     This is a cross-referenced BOOK (collection) entry. New York:
     Academic Press, Sept. 1977.

[4]  *The Definitive Computer Manual*.

[5]  Larry Manmaker. *The Definitive Computer Manual*. Silver. This is
     a full MANUAL entry. Chips-R-Us. Silicon Valley, Apr. 1986.

[6]  Jill C. Knvth. *The Programming of Computer Art*. Vernier Art Center.
     This is a full BOOKLET entry. Stanford, California, Feb. 1988.

# 7 Inserting the index

After using the \makeindex macro and loading the makeidx package that provides additional indexing commands, index entries can be created by issuing the \index command. It is possible to create ranged index entries, which will encompass a span of text. To insert complex typographic material – such as $\alpha$ or TEX – into the index, you need to specify a text string, which will determine how the entry will be sorted. It is also possible to create hierarchal entries.

After typesetting the document, it is necessary to generate the index by running

    texindy -I latex -C utf8 -L ⟨*locale*⟩ fi-pdflatex.idx

from the command line, where ⟨*locale*⟩ corresponds to the main locale of your thesis – such as english, and then typesetting the document again.

The texindy command needs to be executed from within the directory, where the LaTeX source file is located. In Windows, the command line can be opened in a directory by holding down the Shift key and by clicking the right mouse button while hovering the cursor over a directory. Select the Open Command Window Here option in the context menu that opens shortly afterwards.

With online services – such as Overleaf – the commands are executed automatically, although the locale may be erroneously detected, or the makeindex tool (which is only able to sort entries that contain digits and letters of the English alphabet) may be used instead of texindy. In either case, the index will be ill-sorted.

# Index

# A An appendix

Here you can insert the appendices of your thesis.