Prague University of Economics and Business
Faculty of Informatics and Statistics

Title of thesis

MASTER THESIS

Study program: Study programme title
Specialization: Specialization title if included in the study programme division

Author: Author's name and surname, including acquired degrees
Supervisor: full supervisor's name (incl. degrees)
Consultant: full consultant's name (incl. degrees)

Prague, month YYYY

Acknowledgements

Thanks.

Abstract

Abstract.

Keywords

keyword, important term, another topic, and another one

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List of abbreviations

BCC Blind Carbon Copy
CC Carbon Copy
CERT Computer Emergency Response Team
CSS Cascading Styleheets
DOI Digital Object Identifier
HTML Hypertext Markup Language
REST Representational State Transfer
SOAP Simple Object Access Protocol
URI Uniform Resource Identifier
URL Uniform Resource Locator
XML eXtended Markup Language

Note: Add a list of abbreviations if the number of abbreviations used in the thesis exceeds 20 and the abbreviations used are not common.

Recommendations for the preparation of thesis at FIS

This part of the template does not normally belong to the thesis. For the final text is needed:

- ***in file*** `thesis.tex` ***delete line*** `\include{recommendation}`
- ***and possibly also an unnecessary file*** `recommendation.tex`

The following thesis recommendations (hereinafter referred to as "recommendations") are intended to evaluate the defensibility of the thesis. They are intended for all types of theses in all Bachelor's and Master's degree programmes. They are not a substitute for thesis evaluations. If the committee considers the thesis undefensible, it should argue that an item in these recommendations has not been met.

Work done

- The student has carried out professional work in the field of his/her study programme (including interdisciplinary areas).
- The final thesis demonstrates the student's orientation in the chosen field and his/her ability to define and achieve the chosen goal in this field.
- The student has done professional work of a workload in the range of months.

Objectives and context

- The text of the thesis describes the background - the expert context on which the student is based - the situation in professional knowledge or the situation in a specific application case.
- The starting points contain only the findings that have an impact on the results of the thesis.
- The text of the thesis clearly describes the aim of the thesis; if the aim is to solve a problem, the problem is sufficiently defined.
- The reasonableness of the objectives in relation to the baseline is argued.
- The specificity of the main objective is argued in the text - it is not a generic problem, which has been solved in the same way many times.
- The formulation of the aim refers to a professional problem, not to the text of the thesis itself, to the reader or to the author. Thus, the objective is not formulated as "to write a text", "to communicate to the reader", "to describe the issue", "to explain", "to become familiar with the literature in the field", etc.
- The text of the thesis is professional, not popular science. It solves a professional (practical or theoretical) problem.

Methodology

- The text of the final thesis describes the process by which the student worked, separately

from the results.

- The procedure is described in steps, from which you can estimate their laboriousness.
- The procedure lists all the work the student has done. If there are steps in the procedure that the student has not done, they are clearly marked as such (and the reason is given).
- The procedure is described in such a way that if someone else followed it, they would get similar results as the student.
- The procedure is described in concrete terms, not just using generic names of thought processes such as analysis, deduction, synthesis, etc.
- If the procedure used follows established methods described in the literature, it is not necessary to explain their operation in detail. However, the student should justify his/her choice of methods used or describe the deviations of the actual procedure from the established methods.

Results

- The results demonstrate that the student has carried out expert work in the field of the study programme (including interdisciplinary areas).
- From the wording of the text of the final thesis it is clear what is the original result of the student, what is a fact taken from sources and what is speculation or discussion of results.
- The text describes and interprets the results according to the procedure.
- The text describes the partial results as outputs of the individual steps. Less important results are presented in the appendices, so that the text remains clear.
- It is documented that the individual steps (e.g. calculations, descriptive statistics, interview records, program code, researcher's diary, etc.) have been performed, e.g. by uploading attachments to InSIS.
- The text of the thesis describes the scientific results in a logical flow of argumentation.

Conclusions

- Conclusions assess the degree to which the objective has been met.
- The conclusions argue how the results have contributed to solving the problem.
- Conclusions describe the possible impact of the results on the context (situation in the professional environment or in a specific application case), e.g. possible further work.
- The conclusions mention possible limitations of the results obtained.

Originality

- All adopted, translated or paraphrased texts are properly marked and cited in accordance with citation standard APA 7 (we recommend using the Zotero citation tool).
- In the case of the use of automatic text generation tools, this is in accordance with the rules and methodological recommendations of the Prague University of Economics and Business.
- The text of the thesis cites and paraphrases only the sources that were used to solve the problem or define the context.
- The text of the thesis does not unnecessarily recapitulate obvious theoretical knowledge (e.g. from the basic courses of the study programme).

- In exceptional cases, if the student did not work completely alone, the collaborators (company, academic) and the student's contribution to their performance are indicated at each step of the procedure or in the form of a table in an appendix.

Form

- The text of the thesis is written as a coherent structured text, as paragraphs divided into chapters, in a structure suitable for the problem addressed.
- Pages, tables, figures, appendices (etc.) are numbered.
- Tables, figures, appendices, program code (etc.) that are not referenced from the body of the text do not appear in the thesis.
- The format of the thesis is in accordance with the recommendations available on the FIS intranet for students.
- The final thesis may take the form of a scientific article. In this case, it may be accompanied by an explanatory introduction (e.g. description of the journal, review process, co-authorship of the thesis supervisor, etc.).

Additional requirements for the thesis

- The diploma thesis significantly deepens the field of knowledge in the given topic.
- The thesis clearly specifies the author's own contribution, which is in line with the objectives of the thesis.
- It is necessary to validate the results of the thesis (e.g. comparison of the results obtained with the literature, mathematical proof, structured interviews with interest groups, exact testing/measurement of results, etc.).

Specifics of team theses

- The fact that the thesis will be carried out in a team must be stated in the Thesis Assignment stored in InSIS and therefore approved by the thesis supervisor and the guarantor of the study programme (specialisation).
- Each student in the team submits an individual thesis, which is individually assessed, individually defended and evaluated. Each student is responsible for the entire text of the thesis.
- Only a small part of the thesis may be shared in cases approved by the thesis advisor. More than 70
- The artifacts produced by the team should be published in Git or on the project wiki, for example, and referenced by the authors of the thesis.
- Each thesis completed by the team includes an appendix entitled Team Members' Contribution to the Result.

Introduction

In the introduction of the thesis, the author explains why she/he choose the chosen topic, thus the **motivation** of the whole thesis. The introduction must not miss the precisely formulated **main goal** of the thesis (or sub-goals), the **methodology** of the whole thesis (or research questions of hypotheses) should be outlined. It is also common practice to outline the **main results/outcomes** of the thesis.

The introduction is followed by individual **numbered chapters** divided into subchapters.

1. The use of Figures, Tables and Programmes

The use of tables and graphs/figures in technical text has some common rules and some specific ones. We do not present tables and graphs/figures directly in the text, but we place them either on separate pages or in a reserved place at the top or bottom of regular pages. LaTeX will take care of the placement of floating graphs and tables automatically.

Graphs/figures and tables are numbered and equipped with a legend. The legend should describe the content of the graph or table in such detail that the reader understands them without a thorough study of the text of the work.

There must be a numerical reference to the table and graph/figure in the text (a dynamic cross-reference mechanism, which is part of LaTeX, can be strongly recommended). At the appropriate place in the text, we then summarize the most important conclusions that can be drawn from a table or graph. The text should be legible and understandable even without looking at the tables and graphs, and the tables and graphs should be understandable even without reading the text in detail.

1.1 Figures

There are several general tips for figures and diagrams.

- A figure/diagram should be created in the same size as used in the thesis. Decreasing a large diagram leads to having unreadable labels. Increasing a small diagram leads to poor graphical quality.
- The diagram axis shall be properly labelled in the thesis language. Missing punctuation is tolerable. If a diagram deals with, e.g., weight and height, the labels shall say *Height [cm]* and *Weight [kg]*. If the graph includes the function *h(x)*, the axes get a label of x and *h(x)*. Each axis shall bear a clearly defined scale.
- If a two-dimensional diagram marks many points, the author should make sure that they do not get mixed. If the number of points is too high, the author should decrease the size of the symbols that refer to them or select a lower number of points to mark in the diagram. Diagrams with thousands of marked points cause problems mainly in electronic documents by increasing the file size.
- If the thesis is to be printed in black and white, the author should avoid using colours. Lines should be distinguished by line type (full, dotted, dashed...). Sections should be distinguished by distinct shades of grey or hatching. The sense of individual line types or hatched sections shall be explained either in the diagram textual legend or in a graphic legend integrated into the diagram.

- Avoid bitmap figures with a low resolution, especially JPEGs. Compression artifacts do not look good on paper.

Use the floating environment `figure` to insert images and in addition:

- for captions use the command `\caption` – is then also placed in the list of images,
- The command `\label` is used to identify the image (must always be after the command `\caption`) – refer to the image in the text with the command `\ref`.

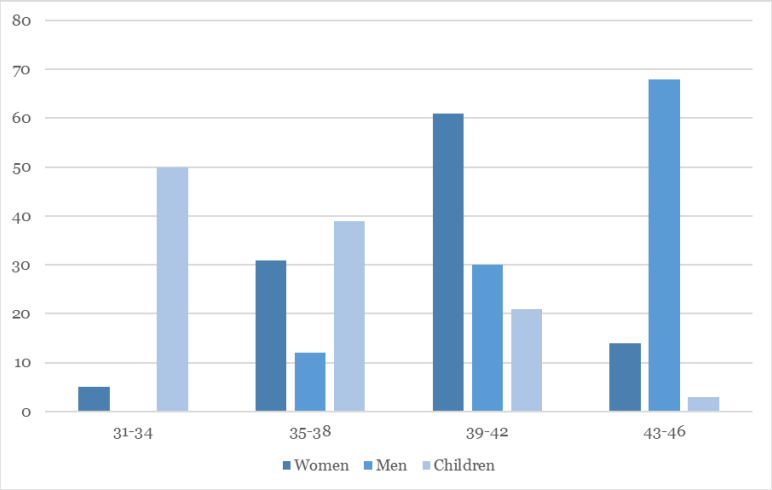

Figure 1.1: Frequency of shoe size in the population of men, women and children (CZSO data, Author's calculation)

1.2 Tables

Use the floating environment `table` to insert tables and in addition:

- for captions use the command `\caption` – is then also placed in the list of tables,
- is used to identify the table using the command `\label` (must always be after the command `\caption`) – then refer to the table in the text with the command `\ref`.

The following tips specifically apply to **tables**:

- Never copy tables from statistical software to a thesis. Typically, statistical software also includes more information in tables than necessary.
- Avoid vertical lines. Thicker horizontal lines separate the table from the surrounding text, including the legend, weaker horizontal lines separate the column headers from the table body, and the individual parts of the table from each other. In LaTeX, the `booktabs` package implements this form of tables. If we want to significantly separate some columns from others, we insert a larger space between them
- Keep the type, format and sense of the field content in a single column. It is not advised to enter, e.g., average and percent in the same column.

Table 1.1: Maximum plausible estimates of models 1 and 2 (CZSO data, own processing)

	1	**2**
Abs	−10.01***	42.01**
	(1.01)	(1.89)
Gender (Male)	9.89*	8.16
	(5.98)	(8.18)
Height (cm)	0.78***	(0.12)

Note:: (i) Standard errors obtained based on 500 non-parametric bootstrap iterations are given in parentheses. (ii) * p < 0.05, ** p < 0.01, *** p < 0.001.

- Avoid repeating the same field content too many times. E.g., if the column Variance shows the value of 0.5 in the first ten lines and 1.5 in the following ten lines, cancel the column. Find a different solution. E.g., one can divide the table to two. Alternatively, one can enter descriptive lines that inform of a variable value repeating in the following table section. E. g. „*Variance* = 0,5 “ and below „*Variance* = 1,5 “).
- All numbers shall have the same number of valid digits. Numbers in a table shall be aligned to the decimal point.
- A table sometimes requires the use of abbreviations that do not occur elsewhere. Such abbreviations may be explained in the legend or notes below the table. Notes below the table may also be used for an explanation of the sense of some columns or values.

1.3 Source codes

Algorithms, program listings and description of interaction with programs should be distinguished from the rest of the text. One possibility is to use LaTeX's `listings` package and its environment `lstlistings`.

In the file `makra.tex` the `code` environment is defined. Its use looks like this:

```
\begin{code}{programming-language}{description}{label-for-ref-ccmmand}
import numpy as np

def incmatrix(genl1,genl2):
...
\end{code}
```

List of supported programming languages: https://www.overleaf.com/learn/latex/Code_listing#Supported_languages.

For example, the 1.1 listing is inserted like this:

```
\begin{code}{Python}{Sample processing using Python}{python-processing}
...
\end{code}
```

Source code 1.1: Sample processing using Python

```
1  import numpy as np
2
3  def incmatrix(genl1,genl2):
4      m = len(genl1)
5      n = len(genl2)
6      M = None #to become the incidence matrix
7      VT = np.zeros((n*m,1), int)  #dummy variable
8
9      #compute the bitwise xor matrix
10     M1 = bitxormatrix(genl1)
11     M2 = np.triu(bitxormatrix(genl2),1)
12
13     for i in range(m-1):
14         for j in range(i+1, m):
15             [r,c] = np.where(M2 == M1[i,j])
16             for k in range(len(r)):
17                 VT[(i)*n + r[k]] = 1;
18                 VT[(i)*n + c[k]] = 1;
19                 VT[(j)*n + r[k]] = 1;
20                 VT[(j)*n + c[k]] = 1;
21
22                 if M is None:
23                     M = np.copy(VT)
24                 else:
25                     M = np.concatenate((M, VT), 1)
26
27                 VT = np.zeros((n*m,1), int)
28
29     return M
```

However, the `listings` package and its environment `lstlisting` offer an almost endless number of configuration parameters, e.g. for syntax highlighting of programming languages (several dozen), line numbering, etc. Examples:

- https://en.wikibooks.org/wiki/LaTeX/Source_Code_Listings
- https://www.overleaf.com/learn/latex/Code_listing#Using_listings_to_highlight_code

1.4 Typesetting of mathematics

We type the variables in italics (TEX does this in math mode itself, but don't forget that in the surrounding text and also turn on math mode). We place function names upright. For example: $\mathrm{var}(X) = \mathsf{E}\, X^2 - (\mathsf{E}\, X)^2$.

Fractions inside a paragraph (e. g. $\frac{5}{7}$ or $\frac{x+y}{2}$) they can be too cramped, so it's better to bet simple fractions with a slash: $5/7$, $(x+y)/2$.

The possibilities of LATEX for typesetting mathematics are rich, but they may not be sufficient in some specific situations. Therefore, American Mathematical Society (AMS) packages can be recommended for use. The `makra.tex` file loads the `amsmath`, `amsfonts` and `amsthm` packages by default. To penetrate their possibilities, the following will serve:

- Math Extension with AMSLATEX – http://ptgmedia.pearsoncmg.com/images/0321173856/samplechapter/kopkach15.pdf
- https://www.overleaf.com/learn/latex/Aligning_equations_with_amsmath
- Math Mode – http://tex.loria.fr/general/Voss-Mathmode.pdf
- More Math into LaTeX – http://tug.ctan.org/info/Math_into_LaTeX-4/Short_Course.pdf

Example of a numbered formula:

$$\mathbf{b} = (\mathbf{X}^{\mathsf{T}}\mathbf{X})^{-1}\mathbf{X}^{\mathsf{T}}\mathbf{y} \tag{1.1}$$

Example of unnumbered formulas with functions and indexes:

$$d_{ij} = \max_{k=1,2,\ldots,n}\{d_{ik} + d_{kj}\},$$
$$x_{1,2} = b \pm \sqrt{\ln y}.$$

An example of a formula as part of one paragraph is given on the example of supplier capacities in a mathematical model of a traffic problem, which we take into account using constraints:

$$\sum_{j=1}^{n} x_{ij} \leq a_i, \qquad i = 1,2,\ldots,m\ , \tag{1.2}$$

where expression a_i represents capacity of i-th supplier.

When deriving a formula by incremental modification, the individual steps are usually listed on separate lines (`align*` environment from the `amsmath` package):

$$\begin{aligned} f(x) &= (x+a)(x+b) = \\ &= x^2 + bx + ax + ab = \\ &= x^2 + (a+b)x + ab \end{aligned}$$

Example of column adjustment (`eqnarray*`):

$$\begin{aligned}
\sum_{i=1}^{n} x_{ij} &= 1, && j = 1,2,\ldots,n, \\
\sum_{j=1}^{n} x_{ij} &= 1, && i = 1,2,\ldots,n, \\
u_i + 1 - M(1 - x_{ij}) &\leq u_j, && i = 2,3,\ldots,n, \quad j = 1,2,\ldots,n, \\
u_i &\geq 0, && i = 1,2,\ldots,n, \\
x_{ij} &\in \{0,1\} && i = 1,2,\ldots,n, \quad j = 1,2,\ldots,n,
\end{aligned}$$

2. Bibliography management

The template assumes the use of This template assumes the use of a bibliographic database in BibTeX format for greater flexibility. The use of a bibliographic database is not a necessary condition, the standard environment `thebibliography` can also suffice. However, in such a case, it is necessary to make interventions in some files, as shown below.

2.1 Use of bibliographic database

1. **Package `biblatex`, APA-7**
   The template uses settings via the `biblatex` package to process the bibliographic database and also guarantees the use of the **APA-7** citation standard. All settings are listed in the file `biblatex-setup.tex`.
2. **Change the database name**
   The template assumes a database stored in the file `bibliography.bib`. If the database has a different name, then it is necessary to change the value of the command parameter `\bibliography` in the file `biblatex-setup.tex`.
3. **Change citation style**
   By default, in-text citations are given in a combination of last name and year (Harvard style). You can switch to references by number by changing the file `biblatex-setup.tex`, where the comment character in the lines is canceled:

   ```
   % ,citestyle=numeric-comp
   ...
   %\makeatletter
   %\RequireBibliographyStyle{numeric}
   %\makeatother
   ```

4. **Using the popular citation manager Zotero**:
   (a) more information – homepage, information from the VŠE Library
   (b) Installation – `https://www.zotero.org/download/`
   (c) Installing the browser connector – Firefox, Chrome, Edge, Safari
   (d) Better BibTeX for Zotero extension – `https://retorque.re/zotero-better-bibtex/`:
      i. Download the .xpi file
      ii. And then `Tools-Add-ons-Install Add-on From File`
   (e) Zotero workshop or Zotero&LaTeX step by step

2.2 Use of the environment `thebibliography`

1. In the file `makra.tex` at the beginning delete these lines:

```
%%% Nastavení pro použití samostatné bibliografické databáze.
%%% Settings for using a separate bibliographic database.
\input biblatex-setup
```

2. In the file `bibliography.tex` delete the line `\printbibliography` and remove the comment flag in the next section containing the environment `thebibliography`.
3. Individual items `bibitem` must be compiled according to the APA-7 standard. Instructional examples are available for example here: https://knihovna.vse.cz/citace/priklady/?norm=apa.

2.3 How cite in the text

`\parencite {Cermak2018}`	⟶	(Čermák & Smutný, 2018)
`\parencite {Hladik2018,Jasek2018}`	⟶	(Hladík & Černý, 2018; Jašek et al., 2018)
`\parencite [chap. 3]{Pecakova2018}`	⟶	(Pecáková, 2018, chap. 3)
`\parencite {Furtuna2023}`	⟶	(Furtună et al., 2023)

3. PDF/A format

Electronic form of final work must be submitted in PDF/A format level 1a or 2u. They are PDF profiles that determine which PDF properties are allowed to use to make the documents suitable for long-term archiving and further automatic processing. Next we will deal with level 2u, which we bet on LaTeX.

The most important requirements of PDF/A-2u include:

- All fonts must be built into the document. They are not allowed links to external fonts.
- Fonts must contain a ToUnicode table that defines the conversion from encoding characters used inside a Unicode font. This makes it possible from the document reliably extract text.
- The document must contain metadata in XMP format and, if colored, then also the formal specification of color space.

This template uses the `tt pdfx` package, which LaTeX can set up to meet the requirements of PDF/A. Metadata in XMP is generated automatically by information in the file `tt thesis.xmpdata` (you can refer to the generated file see in `tt pdfa.xmpi`).

The correctness of PDF/A can be checked using an online validator: https://www.pdf-online.com/osa/validate.aspx/.

If the file is not valid, common causes include less use common fonts (which are inserted only in bitmap format and/or without unicode tables) and embedding images in PDF, which are standard in themselves PDF/A do not meet.

This is likely to be the case for images created by many different programs. In this case, you can try to convert the image to PDF/A using GhostScript, for example, as follows:

```
gs -q -dNOPAUSE -dBATCH
   -sDEVICE=pdfwrite -dPDFSETTINGS=/prepress
   -sOutputFile=vystup.pdf vstup.pdf
```

Conclusion

In the conclusion, the author summarizes the individual conclusions, analyses and interpretations. It is useful if the author concludes by acknowledging the limits of his/her work and possibilities of continuing the topic.

List of references

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Appendices

A. Name of appendix

B. Name of another appendix