

Degree Project



Title

Subtitle (optional)

Project in Data Science

Spring term Year

Student: First name Family name

Supervisor: First name Family name

Examiner: First name Family name

Abstract

An abstract is a summary that provides a brief account of the main content of an academic paper. The purpose of the abstract is partly to generate interest, and partly to present the main issue and key results. Most importantly, the abstract should capture what the report is about. The abstract is best written when you have almost completed your project. Only then will you know what you have actually written. A good idea is to work on a draft summary alongside your paper, and revise it as you go along. The summary is a difficult text to write, as it is to cover a lot of content in a small space. But, that is also why it is a useful text to work on – it forces you to formulate what your project is about. The abstract should not be long, only around 250 words

Keywords: Keyword 1, keyword 2, ..., keyword 3...Keyword 4, keyword 5, ..., keyword 6

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1. Introduction

The introduction often contains:

- background to the topic
- aims and objectives
- a description of the outline of the text

An introduction is necessary in order to engage the reader and acquaint them with the subject as a soft-start and orientation. The aim of the academic paper is usually included in the introduction, but sometimes, especially in more lengthy texts, the aim has its own subheading. In the introduction, you can also provide a background to the topic and an overview of relevant published research in order to place the topic in a wider context. The introduction is intended to lead to the research issue of the paper. The introduction is not something you simply write at the beginning of your project and then lay aside. We recommend that you return to the introduction throughout the writing process to see if something needs to be added, removed or rephrased, as this chapter reflects the entire paper, including your discussion and conclusions. It should be possible to link any drawn conclusions to what you wrote in your introduction.

Students often struggle with tenses. As a piece of general advice, write your text in the past tense as, in the end, you will write a report on the work conducted throughout the full course.

1.1. Subsection

The best way to learn how to write a certain type of text is to read others' texts of the same type. Ask your supervisor or course coordinator for examples of texts, or search for them yourself in DiVA, where you can find student papers and research publications produced at a large number of Swedish higher education institutions.

1.2. Another subsection

Often you will need to make use of sub-sections in order to structure your text in a good way. If your work is multidisciplinary, for example, you will need to introduce the reader to each theme separately and, thereafter, present the gains of joining the themes for the purpose of the project's aim.

1.2.1 Don't go further down than this

Please do not use more than three levels when structuring your text. It usually only gets messy...

1.2.2 Problem definition

At the end of the introduction, it is often common to formulate your research problem, with associated aims, objectives and research questions for solving the problem. The aim is the very essence of the introduction. Everything you write in the introduction, and by extension in your paper, must therefore be related to the aim. You may need to break down the aim into one or several research questions. Discuss this with your supervisor.

End the introduction with an overview of the text to come, i.e. in Chapter 2, the reader will find X and in Chapter 3, theme Y will be introduced (i.e. here you use the future tense).

2. Background

This chapter gives the reader the necessary background information to understand the context in which your study was conducted. Depending on the scope of the text, the background is sometimes part of the introduction and sometimes included as a separate chapter. If you are unsure of what applies in your case – talk to your teacher or supervisor.

In the background chapter, you can, for example, provide a historical overview and explain important concepts. For instance, if your thesis is about privacy regulations, perhaps you will want to account for relevant policy documents (the GDPR, HIPPA, etc.), and if your thesis concerns a comparison of different machine learning techniques for solving problem X, you will want to provide information about these techniques.

In many reports, it pays off to divide the background chapter into two parts: preliminaries and research background. The first part, preliminaries should present everything that the reader needs to understand to grasp the rest of your work, for example ANNs, random forests and the like. The second part, research background, should present what other researchers have done within the field you have selected for your thesis. Here you are to present similar studies or research findings which can be related to your work. You must justify why the selected research is relevant to your own study and how your work will contribute to the research out there (i.e. how does it differ from previous research). The above shows that the background should be quite extensive, i.e. just a couple of pages won't suffice.

2.1. Preliminaries

2.1.1 Model 1

Describe your model here...

2.1.2 Model 2

Describe your model here...

2.1.3 Aspect 3

Describe your model here...

2.2. Research background

3. Theoretical framework (optional)

In an academic paper, it is important to present the theoretical framework and central concepts in the subject area you have chosen for your paper. Sometimes this is done in a separate chapter; other times, it is included in the introduction or in the method chapter. If you are unsure – ask your supervisor what applies to your particular subject. When presenting the theoretical framework you have applied, it is important that you, with reference to your aim, justify why the particular theories you selected are relevant. Do not mistake the theory chapter with the part of the background that concerns previous research – the theoretical framework is more general and provides a particular perspective or lens through which you have examined a topic. It is important that you reflect on your theoretical framework chosen as it will have implications for which method(s) you choose and how you design your study.

4. Method

Describing your method is an important part of your paper, as this is where research credibility is established. In the method chapter, you are to account for what you have done, and explain why. You are also to describe how you collected your material and how you will analyse it, as well as any delimitations you have made. You will also need to provide a methodological discussion - why have you selected these methods and not others, what are the pros and cons? For example, why did you choose to do an interview, and not a survey? The first thing to consider when writing the method chapter is whether the method you have chosen reflects the aim of your text. Consequently, you must explain your choice of research method and how you will apply it to address and answer your research issue or research question. You are also to describe how the choices you made have affected the validity and reliability of the study. In simple terms, validity and reliability describe how well you have succeeded in measuring what you intended to measure in a quantitative study. For qualitative research, validity refers to the integrity and application of the methods undertaken and the precision in which the findings accurately reflect the data, while reliability describes consistency within the employed analytical procedures (find more information here). To produce credible results, you must strive for high validity and reliability. An introduction to these terms is given here.

5. Implementation

Some students describe the implementation of the methods already in the “methods” chapter, which is also fine, however it sometimes gets a bit massive and oftentimes the students then forget to motivate their selection of method(s). Then, it might be a good idea to explain, in detail, how you have actually applied the selected methods in a separate chapter. Data Science students oftentimes have an “implementation” chapter, describing everything from dataset collection, preparation, analysis, ML model setup and implementation, interview setup and execution etc. For PICS students, this chapter is relevant if you have chosen design-oriented research (e.g., DSR, or ADR). Please discuss how to structure the text together with your supervisor.

5.1. Dataset

Describe your implementation here...

5.2. Implementation of technique 1

Describe your implementation here...

5.3. Implementation of technique 2

Describe your implementation here...

6. Results

In this chapter, the results from the implementation of the methods are to be described and analysed. It is perfectly fine to instead have an “Implementation and Results” chapter, if that makes the writing easier.

What is the difference between results, analysis and discussion? One way to describe it is by comparing the academic paper to a puzzle. You start with the empirical material (the pieces of the puzzle); then, in the analysis, you examine every detail of this material to explain what the pieces mean and their function (connecting the pieces). Finally, the discussion is about interpreting and understanding the whole (the completed puzzle).

Things to consider when writing your results, analysis and discussion:

- In the results section, you are to present, communicate, account for, organise and categorise.
- In the analysis section, you are to interpret, compare, explain and contrast, on the basis of the theories you have chosen. This part might not be applicable for all students, therefore, consult with your supervisor if you need to include it.
- In the discussion section, you are to summarise, generalise, justify, question, take a position and look to the future.

The results, or empirical data, are to be presented in a factual and objective manner. For example, if you have conducted an interview study, the results section describes what was found in the interviews without interpreting or evaluating the interviewees’ responses. The empirical data must be presented in an accessible and transparent way. You are not to report what each interviewee said verbatim

6.1. Results when having applied method 1

Describe your result here...

6.2. Results when having applied method 2

Describe your result here...

6.3. Analysis of the joint results

Describe your result here...

7. Discussion

One of the most important parts of your report is the discussion of your results. This should involve an analysis of your results in relation to your selected theoretical framework, previous research, your implementation approach, and ethical and societal concerns. Discussion points can be: did your implementation and selection of methods have an impact on your results that you need to explain in more detail? Can your results be interpreted in a different way? Can the results be applied in general? How do the results hold up in relation to comparable studies? What do the results mean for the practical activities reviewed in your study (if applicable)? What are the possible ethical and societal impacts of your work?

As such, it is oftentimes useful to divide the discussion chapter into the following:

7.1. Theoretical framework (or Previous Research)

You should discuss how the results relate to your theoretical framework or previous research. How well do your results hold up compared to previous studies? Are there similarities? Are there differences? How can your results be explained by theory? Based on the theoretical perspective, in the discussion section, you explain how your results are linked. You must avoid personal opinions or introduce new theories. Everything you write must be connected to your aim and the theories and methods you described earlier. Also, be sure to support everything you write with explicit references.

7.2. Methods, implementation and results

How did your implementation and selected methods impact your results? Can your results be interpreted in a different way? Can the results be applied in general? What do the results mean for the practical activities reviewed in your study (if applicable)? What opportunities do your results give to other researchers?

7.3. Ethical and societal aspects

You also need to discuss your work in terms of ethical and societal issues. For example, how have you addressed GDPR when conducting your interviews? Or are there ethical/privacy concerns regarding the data used? What if your results were to be implemented in a real product used by others? What would possible societal impacts be? Can your work be linked to the UN's Sustainable development goals? If you are uncertain what to discuss here, please contact your supervisor for advice – this is a central discussion point in your report and cannot be omitted! See the course objectives for more information.

8. Conclusion

In this chapter, you summarize and conclude your work – link back to your aims and objectives. Also, remember that a research question that does not receive an unequivocal answer is also a valid result. Repeat the most important parts of the study, but preferably in a new way, for example, by placing them in a broader context.:

8.1. Future work

You should acknowledge the study's limitations, which allow you to place your thesis in a broader perspective and point to a possible continuation. During the project, new research issues may have emerged, complimentary data collected, data analysed differently, research setting changed, or interesting literature that could be followed up, but this has fallen outside the scope of your project. If this is the case, you should write something about it.

9. References

- [1] T. Berners-Lee, R. Cailliau, A. Luotonen, H. F. Nielsen, and A. Secret. The world-wide web. *Communications of the ACM*, 37(8):76–82, 1994.
- [2] U. of Skövde. Regulations, forms and templates, 2022.
- [3] J. M. Swales and C. B. Feak. *Academic writing for graduate students*. University of Michigan Press Ann Arbor, MI, 1994.

A. Appendices

If your paper includes appendices, they are to be placed at the very end of your paper. If you have conducted a survey or interviews, the questionnaire and interview guide are to be included as appendices. If you have made some ML implementation, attach the code. If you are unsure about what to include as an appendix, consult with your lecturer or supervisor. Make sure to name the appendices correctly, like A, B and C.

A.1. LaTeX usage examples

This chapter is included solely as a help and reference for using \LaTeX . It should not appear in the final document.

A.2. Introduction

This chapter shows examples of using \LaTeX for common operations.

A.3. Styles

Styles such as **bold**, *italic*, and underline can be applied to text. You can also use **apply colors**, and combine styles. It is recommended to use only bold to emphasize, and not abuse this resource.

A.4. Listings

With `itemize` you can create unnumbered lists:

- strawberries
- Peaches
- Pineapples
- Nectarines

Similarly, `enumerate` allows you to create numbered lists:

1. Prepare the memory of the TFG
2. Prepare the presentation
3. Present the TFG
4. Apply for the Bachelor's degree

A.5. Subsections

Subsections can be defined with the subsection command:

A.5.1 First subsection

This is a subsection

A.5.2 Second subsection

This is another subsection.

A.6. Images and figures

All images and figures in the document will be placed in the “fig” folder. They can be included as follows:



Figure A.1: An example of image

Note that the figures are automatically numbered according to the chapter and the number of figures that have previously appeared in that chapter. There are many ways to define the size of a figure, but it is advisable to use the one shown in this example: the width of the figure is defined as a percentage of the total width of the page, and the height is automatically scaled. In this way, the maximum width of a figure would be $1.0 * \text{textwidth}$, which would ensure that it is displayed at the maximum possible size without exceeding the margins of the document.

Note that LaTeX tries to include figures in the same place where they are declared, but sometimes this is not possible due to space constraints. In those cases, LaTeX will place the figure as close to its declaration as possible, perhaps on a different page. This is normal behavior and should not be avoided.

A.7. References

Notice how the “label” command has been used several times in the source code for this section. This command allows you to mark an element, be it a chapter, section, figure, etc. to make a numeric reference to it. To reference a “label”, use the “ref” command including the name of the reference:

This is the chapter [2](#).

Examples of styles are shown in the [A.3](#) section.

The subsection [A.5.1](#) explains...

In Figure [A.1](#) we see that...

This saves us from having to directly write the indexes of the sections and figures we want to mention, since LaTeX does it for us and also takes care of keeping them updated in case they change (try moving this chapter to the end of the document and see how all referenced indices are updated automatically). Also, “ref” references act as hyperlinks within the document that take you to the referenced element when you click on them.

It is usual to name “label” with a prefix indicating the type of element to find it later more easily, but it is not mandatory.

A.8. Code snippets

Code snippets can be included via listing:

```
num = float(input("Enter a number: "))
if num > 0:
    print("Positive number")
elif num == 0:
    print("Zero")
else:
    print("Negative number")
```

Code extraction A.1: Python code

A wide variety of languages are supported:

```
public class Test {
    public static void main(String[] args) {
        System.out.println("Hello, world!");
    }
}
```

Code extraction A.2: Java code

Code snippets can also be referenced via label/ref: Code snippets [A.1](#) and [A.2](#).

A.9. Links

You can link to an external website using the url command: <https://www.example.com>. A link can also be linked to text using the href command: [example domain](#).

A.10. Citations and bibliography

In LaTeX, bibliography items are stored in a bibliographic file in a format called BibTeX, in the case of this project they are in “bibliography.bib”. To cite an element, use the “cite” command. You can cite both scientific papers [1] or books [3] as well as web links [2]. Citations are automatically numbered and included in the bibliography section of the document.

Note how bibliographic items stored in “bibliography.bib” have an associated tag, which is the one included when citing them using cite. Adding a reference to the bibliographic file does not make it automatically appear in the bibliography section of the work, it is necessary to cite it somewhere in it.

A.11. Equations

LaTeX has a powerful engine for displaying mathematical equations and an extensive catalog of mathematical symbols. The math environment can be activated in many ways. To include simple equations in a text, they can be surrounded by dollar signs: $1 + 2 = 3$, $\sqrt{81} = 3^2 = 9$, $\forall x \in y \exists z : S_z < 4$.

More complex equations can be expressed separately and are numbered: equation A.1.

$$\lim_{x \rightarrow 0} \frac{e^x - 1}{2x} \stackrel{\left[\frac{0}{0} \right]}{\text{H}} \lim_{x \rightarrow 0} \frac{e^x}{2} = \frac{1}{2} + 7 \int_0^2 \left(-\frac{1}{4} \left(e^{-4t_1} + e^{4t_1-8} \right) \right) dt_1 \quad (\text{A.1})$$

There is [here](#) an extensive list of symbols that can be used in math mode.

A.12. Special characters and symbols

Some characters and symbols must be escaped in order to be rendered in the document, as they have a special meaning in LaTeX. Some of them are:

- The dollar sign \$ is used for equations.
- The percentage % is used for comments in the source code.
- The euro symbol € often causes problems if typed directly.
- The underscore _ is used for subscripts in math mode.
- Quotes must be expressed ‘like this’ for single quotes and “like this” for double quotes. Spanish quotation marks can be expressed “like this”.

- The backslash `\` is used for LaTeX commands.
- Other symbols that must be escaped include the braces `{ }`, the ampersand `&`, the hash `#`, and the greater-than `>` and less-than `<` symbols.