

Master Thesis

Title of Your Master Thesis

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July 1, 2024

Submitted to
Data and Web Science Group
Prof. Dr. Right-Name-Here
University of Mannheim

Abstract

Your thesis must contain an abstract. A good reference for thesis writing is ?; we highly recommend that you study this or a similar book during your studies. He writes the following about the abstract:

An abstract is typically a single paragraph of about 50 to 200 words. The function of an abstract is to allow readers to judge whether or not the paper is of relevance to them. It should therefore be a concise summary of the paper's aims, scope, and conclusions. There is no space for unnecessary text; an abstract should be kept to as few words as possible while remaining clear and informative. Irrelevancies, such as minor details or a description of the structure of the paper, are inappropriate, as are acronyms, abbreviations, and mathematics. Sentences such as "We review relevant literature" should be omitted.

The more specific an abstract is, the more interesting it is likely to be. Instead of writing "space requirements can be significantly reduced", write "space requirements can be reduced by 60%". Instead of writing "we have a new inversion algorithm", write "we have a new inversion algorithm, based on moveto-front lists".

Many scientists browse research papers outside their area of expertise. You should not assume that all likely readers will be specialists in the topic of their paper-abstracts should be self-contained and written for as broad a readership as possible. Only in rare circumstances should an abstract cite another paper (for example, when one paper consists entirely of analysis of results in another), in which case the reference should be given in full, not as a citation to the bibliography. (?)

Contents

1 Introduction

Railway systems play a crucial role in public transportation, and maintaining on-time train schedules is essential for operational efficiency and passenger satisfaction. In recent years, delays have become a growing concern for Deutsche Bahn, leading to disruptions that affect commuters and long-distance travelers alike. Understanding the underlying factors contributing to delays could provide valuable insights for improving service reliability and decision-making.

Our project aims to address this issue by developing a predictive model that forecasts whether future trains will arrive on time or be delayed. Using historical data from Deutsche Bahn, we will analyze variables such as location, train type (e.g., regional trains, S-Bahn), and additional factors like weather or time of day. From an academic perspective, this project will contribute to the field of predictive analytics, particularly in transportation systems. The findings will not only advance data mining techniques but also offer a practical application of machine learning models to real-world problems.

From a business perspective, the ability to predict delays could enable Deutsche Bahn to implement proactive measures to minimize disruptions. By understanding patterns in delays, Deutsche Bahn can allocate resources more effectively, optimize scheduling, and ultimately improve customer satisfaction. Furthermore, passengers may benefit from more accurate information about expected delays, helping them plan their journeys better. In this sense, our project offers both an academic challenge and the potential for a meaningful business impact.

2 Literature Review

? writes:

Few results or experiments are entirely new. Most often they are extensions of or corrections to previous research—that is, most results are an incremental addition to existing knowledge. A literature review, or survey, is used to compare the new results to similar previously published results, to describe existing knowledge, and to explain how it is extended by the new results. A survey can also help a reader who is not expert in the field to understand the paper and may point to standard references such as texts or survey articles.

In an ideal paper, the literature review is as interesting and thorough as the description of the paper's contribution. There is great value for the reader in a precise analysis of previous work that explains, for example, how existing methods differ from one another and what their respective strengths and weaknesses are. Such a review also creates a specific expectation of what the contribution of the paper should be—it shapes what the readers expect of your work, and thus shapes how they will respond to your ideas.

The literature review can be early in a paper, to describe the context of the work, and might in that case be part of the introduction; or the literature review can follow or be part of the main body, at which point a detailed comparison between the old and the new can be made. If the literature review is late in a paper, it is easier to present the surveyed results in a consistent terminology, even when the cited papers have differing nomenclature and notation. In many papers the literature review material is not gathered into a single section, but is discussed where it is used—background material in the introduction, analysis of other researchers' work as new results are introduced, and so on. This approach can help you to write the paper as a flowing narrative.

An issue that is difficult in some research is the relationship between new scientific results and proprietary commercial technology. It often is the case that scientists investigate problems that appear to be solved or addressed in commercial products. For example, there is ongoing academic research into methods for information retrieval despite the success of the search engines deployed on the web. From the perspective of high research principle, the existence of a commercial product is irrelevant: the ideas are not in the public domain, it is not known how the problems were solved in the product, and the researcher's contribution is valid. However, it may well be reckless

2 Literature Review

to ignore the product; it should be cited and discussed, while noting, for example, that the methods and effectiveness of the commercial solution are unknown. (?)

An example structure for the literature review is given below; as before, this structure is non-binding and should be changed as appropriate.

2.1 Preliminaries

2.2 Related Work on A

2.3 Related Work on B

2.4 Related Work on C

2.5 Summary

3 Body Chapter 1

? writes:

The body of a paper should present the results. The presentation should provide necessary background and terminology, explain the chain of reasoning that leads to the conclusions, provide the details of central proofs, summarize any experimental outcomes, and state in detail the conclusions outlined in the introduction. Descriptions of experiments should permit reproduction and verification, as discussed in Chapter 11. There should also be careful definitions of the hypothesis and major concepts, even those described informally in the introduction. The structure should be evident in the section headings. Since the body can be long, narrative flow and a clear logical structure are essential.

The body should be reasonably independent of other papers. If, to understand your paper, the reader must find specialized literature such as your earlier papers or an obscure paper by your advisor, then its audience will be limited.

In some disciplines, research papers have highly standardized structures. Editors may require, for example, that you use only the four headings Introduction-Methods-Results-Discussion. This convention has not taken hold in computer science, and in some cases such a structure impedes a clear explanation of the work. For example, use of fixed headings may prohibit development of a complex explanation in stages. In work combining two query resolution techniques, we had to determine how they would interact, based on a fresh evaluation of how they behaved independently. The final structure was, in effect, Introduction-Background-Methods-Results-Discussion-Methods-ResultsDiscussion.

Even if the standardized section names are not used, the body needs these elements, if not necessarily under their standard headings. Components of the body might include, among other things, background, previous work, proposals, experimental design, analysis, results, and discussion. Specific research projects suggest specific headings. For the "compression for fast external sorting" project sketched earlier, the complete set of section headings might be:

1. Introduction
2. External sorting

3 *Body Chapter 1*

3. Compression techniques for database systems
4. Sorting with compression
5. Experimental setup
6. Results and discussion
7. Conclusions

The wording of these headings does not follow the standard form, but the intent of the wording is the same. Sections 2 and 3 are the background; Section 4 contains novel algorithms, and Sections 4 and 5 together are the methods.

The background material can be entirely separate from the discussion of previous work on the same problem. The former is the knowledge the reader needs to understand your contribution. The latter is, often, alternative solutions that are superseded by your work. Together, the discussion of background and previous work also introduce the state of the art and its failings, the importance and circumstances of the research question, and benchmarks or baselines that the new work should be compared to.

A body that consists of descriptions of algorithms followed by a dump of experimental results is not sound science. In such a paper, the context of prior work is not explained, as readers are left to draw their own inferences about what the results mean.

In a thesis, each chapter has structure, including an introduction and a summary or conclusions. This structure varies with the chapter's purpose. A background chapter may gather a variety of topics necessary to understanding of the contribution of the thesis, for example, whereas a chapter on a new algorithm may have a simple linear organization in which the parts of the algorithm are presented in turn. However, the introduction and summary should help to link the thesis together-how the chapter builds on previous chapters and how subsequent chapters make use of it. (?)

4 Body Chapter 2

Our key result is given as Algorithm ?? . It's complete non-sense, of course! Note that algorithms, figures, and tables should generally be placed at the top of the page or on an individual page, but not within the main text.

The following highly informative text is here so that the correct placement of Algorithm ?? is visible. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

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Algorithm 4.1 Proof that X Holds

Require: A hypothesis H that X holds**Ensure:** A proof that X holds

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1:  $P \leftarrow \emptyset$  // Initialize proof as an empty set of statements
2:  $A \leftarrow$  Assumptions from hypothesis  $H$  // Extract assumptions from  $H$ 
3: for all  $a \in A$  do
4:   if  $a$  is a known axiom then
5:     Add  $a$  to  $P$ 
6:   else if  $a$  can be derived from known axioms then
7:     Derive  $a$  from axioms and add to  $P$ 
8:   else
9:     fail // If any assumption cannot be derived, proof fails
10:  end if
11: end for
12: Use logical deductions on  $P$  to prove intermediate results
13: Combine intermediate results to prove  $X$ 
14: return  $P$  // Return the completed proof

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5 Experimental Evaluation

5.1 Experimental Setup

5.2 Results 1

5.3 Results 2

5.4 Results 3

5.5 Discussion

Item	Quantity	Price
Apples	10	\$2.00
Oranges	5	\$3.00
Bananas	7	\$1.50

Table 5.1: Sample table using booktabs

6 Conclusions

? writes:

The closing section, or summary, is used to draw together the topics discussed in the paper. It should include a concise statement of the paper's important results and an explanation of their significance. This is an appropriate place to state (or restate) any limitations of the work: shortcomings in the experiments, problems that the theory does not address, and so on.

The conclusions are an appropriate place for a scientist to look beyond the current context to other problems that were not addressed, to questions that were not answered, to variations that could be explored. They may include speculation, such as discussion of possible consequences of the results.

A *conclusion* is that which concludes, or the end. *Conclusions* are the inferences drawn from a collection of information. Write "Conclusions", not "Conclusion". If you have no conclusions to draw, write "Summary". (?)

A Additional Experimental Results

? writes:

Some papers have appendices giving detail of proofs or experimental results, and, where appropriate, material such as listings of computer programs. The purpose of an appendix is to hold bulky material that would otherwise interfere with the narrative flow of the paper, or material that even interested readers do not need to refer to. Appendices are rarely necessary. (?)

In the context of a BSc or MSc thesis, the last sentence often does not hold.

B Proof Details

Ehrenwörtliche Erklärung

Ich versichere, dass ich die beiliegende Bachelor-, Master-, Seminar-, oder Projektarbeit ohne Hilfe Dritter und ohne Benutzung anderer als der angegebenen Quellen und in der untenstehenden Tabelle angegebenen Hilfsmittel angefertigt und die den benutzten Quellen wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner Prüfungsbehörde vorgelegen. Ich bin mir bewusst, dass eine falsche Erklärung rechtliche Folgen haben wird.

Declaration of Used AI Tools

Tool	Purpose	Where?	Useful?
ChatGPT	Rephrasing	Throughout	+
DeepL	Translation	Throughout	+
ResearchGPT	Summarization of related work	Sec. ??	-
Dall-E	Image generation	Figs. 2, 3	++
GPT-4	Code generation	functions.py	+
ChatGPT	Related work hallucination	Most of bibliography	++

Unterschrift

Mannheim, den XX. XXXX 2024