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LLMS - The Death of GIS Analysis?

An Investigation into using Large Language Models to Simplify GIS Analysis

Master's Thesis in Computer Science and Geomatics, June 2024
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Abstract

This paper provides a template for writing a Master's Thesis (parts of it can also be used when writing a Specialisation Project Report). The template does not form a compulsory style that you are obliged to use, but rather provides a common starting point for all students. For a given thesis, tuning of the template may still be required, depending on the nature of the thesis and the author's writing style. Such tuning might involve moving a chapter to a section or vice versa, or removing or adding sections and chapters.

[If you write a Specialisation Project Report, it should normally focus on the background, related work (i.e., your literature study), and future work sections — with the "future work" section containing the plan for the Master's Thesis work to be carried out in the second semester. Architectural and experimental sections can also be included, but in preliminary versions. All those sections should of course be updated in the Master's Thesis and adapted to the actual work carried out.]

Note that the template contains a lot of examples of how to write different parts of the thesis as well as how to cite authors and how to use LaTeX and BibTeX. Some of those examples might only be clear if you actually look at the LaTeX source itself.

The abstract is your sales pitch which encourages people to read your work, but unlike sales it should be realistic with respect to the contributions of the work. It should include:

- the field of research,
- a brief motivation for the work,
- what the research topic is,
- the research approach(es) applied, and
- contributions.

The abstract length should be roughly half a page of text (and not more than one page). It will normally be longer than the abstracts you see in research papers, since some more background / motivation is included. Do not include lists, tables or figures. Avoid abbreviations and references.

When writing the abstract, keep in mind that most people might only read this text (and many only the title), so be sure to make it sound good. What you really want to accomplish is that people who read the abstract will get drawn into your project and read the rest of the text too. However, the old saying most definitely applies here: You never get a second chance to make a first impression.

Sammendrag

Husk at hvis du er en norsk student og skriver masteren din på engelsk, så *må* du lage et sammendrag på norsk. Bruk ikke Google Translate eller lignende, uten skriv teksten direkte på norsk. Sammendraget trenger absolutt ikke å være identisk ord-for-ord med abstract, men skal selvsagt ha i prinsipp samme innehold, på semantisk nivå.

(If you are a non-Norwegian student, it is not obligatory to include an abstract in Norwegian.)

For those who write a Norwegian summary, whatever you do, do *not* just directly translate the English abstract. It might be tempting to think that the Norwegian summary is something you can do on the fly — maybe assuming that nobody will read it. However, in fact the opposite might be true: it is very likely that it will be read by the people you most want to make a good impression on, such as your friends, family, and future employers.

Preface

The Preface includes the facts: what type of project, where it is conducted, who supervised, and any acknowledgements you wish to give.

This Master's Thesis template was created by Björn Gambäck and is based on a template that he created for the 2016 "Experts in Team" course on Computational Creativity (TDT4853) at the Norwegian University of Science and Technology (NTNU), which in turn was heavily based on the 2014 AI Master's Thesis template created by Anders Kofod-Petersen — with some of the explaining text stemming from Anders' original template.

You may basically thank anybody you like (and avoid thanking anybody you do not like) and in any form you like. However, it is a good idea to always thank people who made direct contributions, e.g., those whose data you have been given access to or those whose images you have been given permission to reproduce.

Some students choose to include the text of the original project description in the Preface. This is possible but not necessary, in particular not if you have changed the theme somewhat over time. The Preface of the Master's Thesis might also be a good place to introduce your Specialisation Project, in case you plan on reusing some texts from it (since the Specialisation Project is not a published and easily accessible work, and might not be known to your audience, neither your text in itself nor even the general concept as such).

Karl Oskar Magnus Holm
Trondheim, 3rd October 2023

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1. Introduction

All chapters should begin with an introduction before any sections, giving an overview of the chapter content. Each section should in addition start with an introduction before its subsections begin. Chapters with just one section — or sections with just one sub-section — should be avoided. Think carefully about chapter and section titles as each title stands alone in the table of contents (without associated text) and should convey the meaning of the contents of the chapter or section.

In all chapters and sections it is important to write clearly and concisely. Avoid repetitions and if needed refer back to the original discussion or presentation. Each new section, subsection or paragraph should provide the reader with new information and be written in your own words. Avoid direct quotes. If you use direct quotes, unless the quote itself is very significant, you are conveying to the reader that you are unable to express this discussion or fact yourself. Such direct quotes also break the flow of the language (yours to someone else's).

1.1. Background and Motivation

Having a template to work from provides a starting point. However, for a given project, a slight variation in the template may be required due to the nature of the given project. Furthermore, the order in which the various chapters and sections will be written will also vary from project to project, but the writing will seldom start at the abstract and sequentially follow the chapters of the report. One critical reason for this is that you need to start writing as early as possible and that you will begin to write up where you are currently focusing. However, do not leave working on the abstract until the very last days. The abstract is the first thing anyone reads of an article or thesis — after the title; and thus it is important that it is very well written. Abstracts are hard to write, so create revisions throughout the course of your project.

The background and motivation here should state where your project is situated in the field and what the key driving forces motivating this research are. However, keep this section brief, as it is still part of the introduction. The motivation will be further elaborated on in Chapter 3, presenting your complete state-of-the-art.

Note that this template uses italics to highlight where Latin wording is inserted to represent text and the text of the template that we wish to draw your attention to. The italics themselves are not an indication that such sections should use italics.

At vero eos et accusamus et iusto odio dignissimos ducimus qui blanditiis praesentium voluptatum deleniti atque corrupti quos dolores et quas molestias excepturi sint occaecati

cupiditate non provident, similique sunt in culpa qui officia deserunt mollitia animi, id est laborum et dolorum fuga. Et harum quidem rerum facilis est et expedita distinctio.

1.2. Goals and Research Questions

A research project needs to have one or several question(s) that should be answered. It is desirable to formulate such questions as early as possible as they provide both an important driving force for the project and clarity as to the goals sought. However, expect to refine the questions and thus the final path of the project as work progresses. Any refinements should be conducted with care, so as to avoid that the original aims and previous work are lost. It is always good to have one (or max two) research goals and perhaps some subgoals, together with 2–3 explicit research questions (or max four).

Goal *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Your goal/objective should be described in a single sentence. In the text underneath it you can expand on this sentence to clarify what is meant by the short goal description. The goal of your work is what you are trying to achieve. This can either be the goal of your actual project or can be a broader goal that you have taken steps towards achieving. Such steps should be expressed in the research questions. Note that the goal is seldom to build a system. A system is built to enable experiments to be conducted. The research goal stages the needs that the system is implemented to meet.

Research question 1 *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Each research question provides a sub-goal and these should be precise and clearly stated enabling the reader to match your results to the original goals. They will also form the driving force for the experimental plan.

Research question 2 *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

Potentially, how well the goals have been met (and how well the research questions have been answered) is a theme that you should return to towards the end of the thesis (so in Chapter 8 and/or Chapter 7).

For a Specialisation Project, the goal would primarily be to get up to speed with the research field, so the research questions will rather be limited to exploring what the state-of-the-art is, what methods and data have been used, etc. A secondary goal of the specialisation is to frame the research questions and goals of the Master's Thesis. Note that a major difference between the Specialisation Project and the Master's Thesis is that the Master's Thesis work *has* to introduce new research. Of course the Specialisation Project can also introduce novel work, but there is no such requirement — and most commonly it does not, since the core of the project really is to figure out what is "old" before you can introduce something which is new.

1.3. Research Method

What methodology will you apply to address the goals: theoretic/analytic, model/abstraction or design/experiment? This section will describe the research methodology applied and the reason for this choice of research methodology. You should return to the actual choices made in the work and the alternatives in the Discussion chapter.

1.4. Contributions

This section just provides a brief summary of the main contributions of the work. The main description of the contributions will come in Section 8.1, after the results are presented. (Hence Section 1.4 can also be left out, leaving the discussion completely to Section 8.1.)

The format of this section will generally be as follows:

1. *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*
2. *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*
3. *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*

where the items on the list briefly describe the key contributions.

The order of the contributions here is important. List your main contribution first! Creating this list will help you not only with writing the Conclusion (where all items listed here definitely should be included, and in more detail), but also with items that need to be mentioned in the Abstract, as well as with points that you will want to bring to attention in the Discussion. Hence most of the content on this list will be addressed 4–5 times in your text: here, in the Abstract, Discussion, Conclusion, and (most likely) in the Results chapter.

1.5. Thesis Structure

This section provides the reader with an overview of what is coming in the next chapters. You want to say more than what is explicit in the chapter name, if possible, but still keep the description short and to the point. So something along the lines of:

- Chapter 2 introduces the theory, tools and methods necessary to understand the work.
- *Lorem ipsum dolor sit amet, consectetur adipiscing elit.*
- Chapter 8 sums up the work and points to ways it can be improved or extended in the future.

2. Background Theory

The background theory depth and breadth depend on the depth needed to understand your project in the different disciplines that your project crosses. It is not a place to just write about everything you know that is vaguely connected to your project. The theory is here to help the readers that do not know the theoretical basis of your work so that they can gain sufficient understanding to understand your contributions — and also for yourself to show that you have understood the underlying theory and are aware of the methods used in the field. In particular, the theory section provides an opportunity to introduce terminology that can later be used without disturbing the text with a definition. In some cases it will be more appropriate to have a separate section for different theories (or even separate chapters). However, be careful so that you do not end up with too short sections. Subsections may also be used to separate different background theories.

Be aware that "background" is a general term that refers to everything done by somebody else, in contrast to the "foreground", which is your own work. Hence there can (and will) be several background chapters, with the background theory being one of them — or several of them, since it thus is quite possible to split the background theory over more than one chapter, e.g., by having a chapter introducing the theory directly needed for the research field in question and another chapter discussing the machine learning theory, algorithms, tools, and evaluation methods commonly used in the field. The related work chapter is thus also part of the background, while a chapter about data might be background (if you only use somebody else datasets), but can also be part of the foreground (if you collect and/or annotate data yourself, or if you process or clean the data in ways that can make it part of your own contribution).

It is ok to reuse material from other texts that you have written (e.g., the specialisation project), but if you do so, that must be clearly stated in the text, together with a description of how much of the text is new, old or rewritten/edited. Such a statement about recycling of material in the Background Theory chapter can thus come here in the chapter introduction.

2.1. Writing References in the Text

When introducing techniques or results, always reference the source. Be careful to reference the original contributor of a technique and not just someone who happens to use the technique.[1] For results relevant to your work, you would want to look particularly at newer results so that you have referenced the most up-to-date work in your area.

[1] But always make sure that you have read the work you are citing — if not, cite someone who has!

A common rule of thumb is to at least reference the first paper introducing the issue and the paper containing the latest / state-of-the-art results. Additional papers making substantial contributions should also be referenced, as well as of course the ones you find most interesting. Remember to use the right verb form depending on the number of authors.

add reference

If you do not have the source handy when writing, mark in the text that a reference is needed and add it later. Web pages are not reliable sources — they might be there one day and removed the next; and thus should be avoided, if possible. A verbal discussion is not a source and should normally not be referenced (though you can reference "personal communication", if there are no other options). The bulk of citations in the report will appear in Chapter 3. However, you will often need to introduce some terminology and key citations already in this chapter.

You can cite a paper in the following manner (and several other versions, see the `natbib` package documentation):

(i) When referring to authors, using their names in the text:
Authorson;Bobsen:10 stated something rather nice. (using `\citet`)

(ii) To cite indirectly:
Papers should be written nicely (**Authorson;Bobsen:10**) (using `\citep`) *or*
In **Authorson;Bobsen:10**, a less detailed template was presented.

(iii) To just cite the authors:
Authorson;Bobsen:10 wrote a nice paper (using `\citeauthor`).

(iv) Or just the year:
Authorson;Bobsen:10 (using `\citeyear`).

(v) You can even cite specific pages or chapters: **Authorson;Bobsen:10** (using `\citet[...]{...}`).

You should obviously always cite your supervisor's work (Li and Ning, 2023), even if it is completely irrelevant (**Das;Gamback:13a**) or very old (**AlshawiEA:91b**). Digging up an even older book can also appear impressive (**Diderichsen:57**). (Or? ;-)

2.2. The Reference List

In general, make sure that the references that appear in your reference list can be easily located and identified by the reader. So include not only authors and title, but year and place of publication, the full names of conferences and workshops, page numbers in proceedings and collections, etc. Hyperlinks or Digital Object Identifier (DOI) numbers are also nice to include. Just as in the text itself, it is important to be consistent in the reference list, so include the same type of information for all references and write it in the same way.

Some other good sites to find state-of-the-art work:

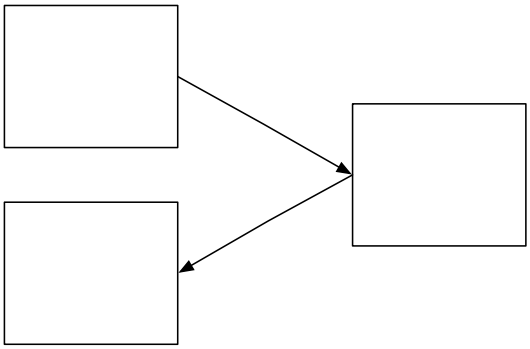

Figure 2.1.: Boxes and arrows are nice (adapted from **Authorson;Bobsen:10**, reprinted with permission)

- paperswithcode.com
- nlpprogress.com

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2.3. Introducing Figures

LaTeXis a bit tricky when it comes to the placement of "flooting bodies" such as figures and tables. It is often a good idea to let their code appear right before the header of the (sub)section in which they appear. Note that you should anyhow always use an option for the placement (e.g., `[t!]` to place it at the top of a page).

Remember that if you reproduce someone else's figures you must credit the original author — such as Figure 2.1 (adapted from **Authorson;Bobsen:10**), as well as state that you have permission to reprint it (e.g., if it is published under a Creative Commons License, or if you have gained explicit permission from the author).

Do not just put the figure in and leave it to the reader to try to understand what the figure is. The figure should be included to convey a message and you need to help the reader to understand the message intended by explaining the figure in the text. Hence **all** figures and tables should always be referenced in the text, using the `\ref` command. It is good practice to always combine it with a non-breakable space (`~`) so that there will be no newline between the term referring to it and the reference, that is, using `Figure~\ref{fig:BoxesAndArrowsAreNice}`.

If a figure appears far from the text explaining it, it is a good idea to add its page number (using the `\pageref` command), so that you can refer to Figure 2.1 (on Page 7).

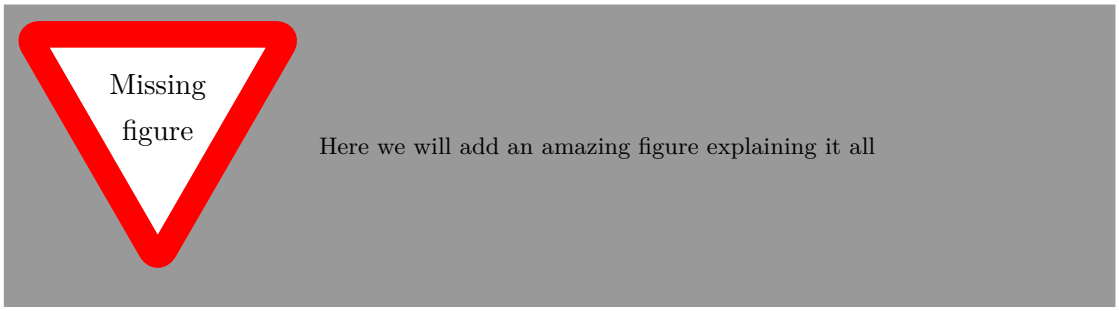

Figure 2.2.: A missing figure

Also, note that you can have a longer version of the figure (and table) caption attached to the actual figure, while using the optional first argument to `\caption` to include a shorter version in the list of figures (lof) or list of tables:

```
\caption[Shorter lof text]{Longer text appearing under the figure}
```

It is good practice to add a note about a missing figure in the text, such as the completely amazing stuff that will appear in Figure 2.2.

In general it is good to add notes about things that you plan on writing later. The `todonotes` package is great for that kind of book-keeping, letting you write both shorter comments in the margin and longer comments inside the text, using the option `[inline]`.

l8r dude

There are always some more stuff that you will need to add at some later point. Be sure to at least make a note about it somewhere.

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2.4. Introducing Tables in the Report

As you can see from Table 2.1, tables are nice. However, again, you need to discuss the contents of the table in the text. You do not need to describe every entry, but draw the reader's attention to what is important in the table, e.g., that 94.99 is an amazing F_1-score (and that probably something fishy happened there). Use boldface, boxes, colours, arrows, etc. to mark the important parts of the table.

As can be seen in the example, elements in a table can sometimes benefit from being rotated (such as EMNLP in the 'Source' column) or cover more than one row (EMNLP, as well as EN-HI and EN-BN in the 'Langs' column) — or more than one column, for that matter.

Table 2.1.: Example table (F_1-scores); this table uses the optional shorter caption that will appear in the list of tables, so this long explanatory text will not appear in the list of tables and is only here in order to explain that to the reader.

Langs	Source	Lang1	Lang2	Univ	NE	Mixed	Undef
EN-HI	FB+TW	54.22	22.00	19.70	4.00	0.05	0.03
	FB	75.61	4.17	18.00	2.19	0.02	0.01
	TW	22.24	48.48	22.42	6.71	0.08	0.07
	Vyas	54.67	45.27	0.06	-	-	-
	FIRE	45.57	39.87	14.52	-	0.04	-
EN-BN	TW	55.00	23.60	19.04	2.36	-	-
	FIRE	32.47	67.53	-	-	-	-
EN-GU	FIRE	5.01	**94.99**	-	-	-	-
DU-TR	Nguyen	41.50	36.98	21.52	-	-	-
EN-ES	EMNLP	54.79	23.50	19.35	2.08	0.04	0.24
EN-ZH		69.50	13.95	5.88	10.60	0.07	-
EN-NE		31.14	41.56	24.41	2.73	0.08	0.08
AR-AR		66.32	13.65	7.29	11.83	0.01	0.90

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3. Related Work

What other research has been conducted in this area and how is it related to your work? This section is thus where your literature review will be presented. It is important when presenting the review that you give an overview of the motivating elements of the work going on in your field and how these relate to your work, rather than a list of contributors and what they have done. This means that you need to extract the key important factors for your work and discuss how others have addressed each of these factors and what the advantages/disadvantages are with such approaches. As you mention other authors, you should reference their work. Note that the reference list reflects the literature you have read *and* have cited. This will only be a subset of the literature that you have read.

A good way to find relevant work is by checking what others are referencing, e.g., in papers you have already found or in previous studies carried out at NTNU, such as **Berg;Gopinathan:17**. However, when doing that, do not fall into one of the common traps, such as re-iterating someone's false quote or faulty analysis of a previous paper (check the original source!), or getting stuck inside a local research cluster (a group of researchers that mainly refer to the ones using the same type of approaches or similar ideas).

Make sure that it is clear how and why you decided to include some references (and discard others). As in all parts of research, it should ideally be possible for someone else to reproduce your work, also when it comes to finding the relevant references. There are (at least) three basic methods for finding references:

1. Trust the authorities (e.g., your supervisor) to dig out good texts for you. Those can often be used as a seed set for:

2. Snowballing, where you have some good articles and check the references in them for other good ones. Note that this can be done both backwards and forwards on the timeline; that is, using tools like Google Scholar, you can also check who refers *to* the good articles you have already found.

3. Carry out a Systematic Literature Review (or Structured Literature Review, SLR), a method introduced more formally into Software Engineering by **Kitchenham;Charters:07**, but based on several similar methods for other disciplines. At the core of the method is an SQL-related search over a reference database (such as Google Scholar). A good introduction to SLR is given by **Kofod-Petersen:14**.

Note that a reference needs to be complete: you should always give the full name of a conference or journal, always include page numbers, always say where a book or thesis was published, and where a conference took place, as further described in Section 2.2.

Just as described in the Background chapter (Chapter 2), it is possible (and even likely) that you will want to reuse some of the text that you have written for your specialisation project in your Master's Thesis. This is allowed, as long as it is clearly stated what you have reused and in what form (e.g., if a section is a straight-forward copy, if it has undergone only editorial changes, if it contains some old material but also some new, etc.).

4. Datasets

You will (probably) need to describe and discuss the dataset(s) that you use in your work. Depending on how much detail is needed and whether you have done any work on the data yourself (including analysing it, collecting or annotating some of it, or cleaning/preprocessing it), the data description can possibly be part of the Background chapter, the Related Work chapter, the Architecture chapter or the Experimental Setup. The dataset(s) can also be described in a separate chapter, either before or after the chapter on related work. Note that if you have put some effort of your own into the data, you will need to make sure that the text about it is part of the "foreground" (your own work) rather than the "background" (everything done by somebody else), which includes the theoretical background chapter(s) and the related work.

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Dataset	Normal	Offensive	Hateful	Spam	Total
Original	53,790	27,037	4,948	14,024	**99,799**
Available	41,784	14,202	2,941	9,372	**68,299**

Table 4.1.: The original **FountaEA:18** dataset vs its availability in 2020, given by **Isaksen;Gamback:20**

You probably want a table giving some statistics regarding the data. As an example, Table 4.1 shows a common problem when working with Twitter (X) data: the authors of a dataset may only provide tweet IDs that other researches can use to retrieve tweets through the Twitter Application Programming Interface (API); however, some tweets may for several reasons not be retrievable later on, e.g., since a tweet or the user account behind a tweet may have been deleted. Here, of 99,799 tweet IDs provided by **FountaEA:18**, only 68,299 tweets could actually be retrieved two years later, as described by **Isaksen;Gamback:20**.

Morbi viverra ante et tortor faucibus finibus nec sit amet sem. In ultrices, augue sed vestibulum congue, tortor turpis sodales odio, at interdum leo justo non massa. Nunc aliquet, nisl non vestibulum rhoncus, libero tortor laoreet nibh, vel ultricies nunc erat nec nisl. Praesent sed lorem arcu. Sed ultricies, tellus at euismod posuere, felis nibh cursus justo, vitae placerat nisl lorem ut est. Suspendisse sollicitudin sagittis nibh, ac interdum erat hendrerit id. Fusce est mi, semper eget mauris sed, posuere ultrices orci. Aenean nec est eu augue blandit maximus. Morbi ut nisl at metus condimentum tincidunt nec consectetur nibh. Phasellus eleifend dapibus elit ut cursus. Donec lacinia turpis a justo dignissim, sit amet venenatis libero pellentesque. Orci varius natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.

5. Architecture

Here you will present the architecture or model that you have chosen and which is (or will be) implemented in your work. Note that putting algorithms in your report is not always desirable, so in certain cases those might be placed in the appendix. Code is normally to be avoided in the report itself, but may be included in an appendix or submitted as additional documents. (The actual code must also be submitted together with the final Master's thesis, but as a zip-file.)

Any off-the-shelf tools and methods that you use in your architecture should have been introduced earlier, tentatively in the Background chapter (or in the Related Work chapter), so that they can be referenced here by giving backward pointers to the previous text.

Here, or in a separate chapter (or possibly in the Background chapter or in the Experimental Setup), you should also discuss the data that you use in your experiments (see Chapter 4).

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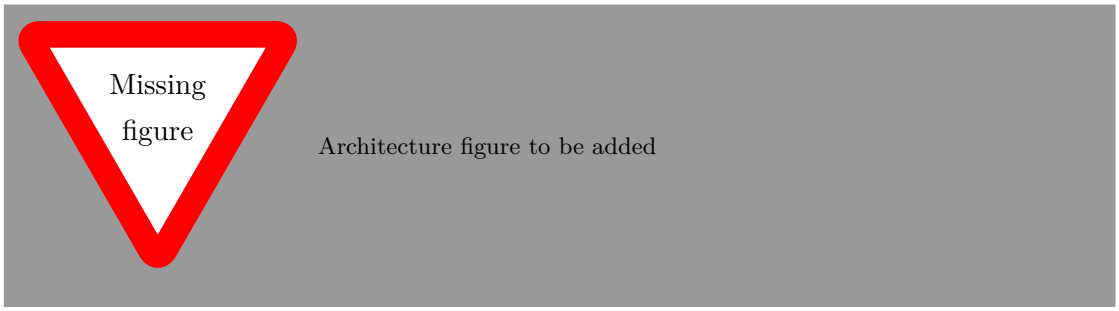

Figure 5.1.: The missing architecture

Clearly, a figure showing the architecture is a must, such as Figure 5.1. Describe all parts of such a figure in reasonable detail in the text, possibly with forward pointers to sections where they will be elaborated on (or backward pointers to sections where tools and methods already have been introduced). Mention work that motivated your architectural choices, parameter settings, etc. Those choices should then also be discussed and elaborated on in the Discussion chapter.

6. Experiments and Results

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6.1. Experimental Plan

Trying and failing is a major part of research. However, to have a chance of success you need a plan driving the experimental research, just as you need a plan for your literature search. Further, plans are made to be revised and this revision ensures that any further decisions made are in line with the work already completed.

The plan should include what experiments or series of experiments are planned and what questions the individual or set of experiments aim to answer. Such questions should be connected to your research questions, so that in the evaluation of your results you can discuss the results wrt to the research questions.

6.2. Experimental Setup

The experimental setup should include all data — parameters, etc. — that would allow a person to repeat your experiments. This will thus be the actual instantiation for each experiment of the general architecture described in Chapter 5.

6.3. Experimental Results

Results should be clearly displayed and should provide a suitable representation of your results for the points you wish to make. Graphs should be labelled in a legible font. If more than one result is displayed in the same graph, then these should be clearly marked. Please choose carefully rather than presenting every result. Too much information is hard to read and often hides the key information you wish to present. Make use of statistical methods when presenting results, where possible to strengthen the results. Further, the format of the presentation of results should be chosen based on what issues in the results you wish to highlight. You may wish to present a subset in the experimental section and provide additional results in an appendix. Point out specifics here but save the overall/general discussion to the Discussion chapter.

7. Evaluation and Discussion

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7.1. Evaluation

When evaluating your results, avoid drawing grand conclusions, beyond those that your results can in fact support. Further, although you may have designed your experiments to answer certain questions, the results may raise other questions in the eyes of the reader. It is important that you study the graphs/tables to look for unusual features/entries, and discuss these as well as the main findings. In particular, carry out an error analysis: What went wrong and why?

A confusion matrix can, for example, be a good way to display misclassifications. Figure 7.1 (on Page 20) shows two confusion matrices. If there were perfect correlation between true and predicted labels, the long diagonals (from the upper left to the lower right corner) would be completely red. However, the confusion matrices indicate that this classifier was quite biased towards the neutral label (illustrated with 😐), as can be seen from the warm colours in the positive (☺) and negative (☹) true label cells of the 😐 predicted label column.

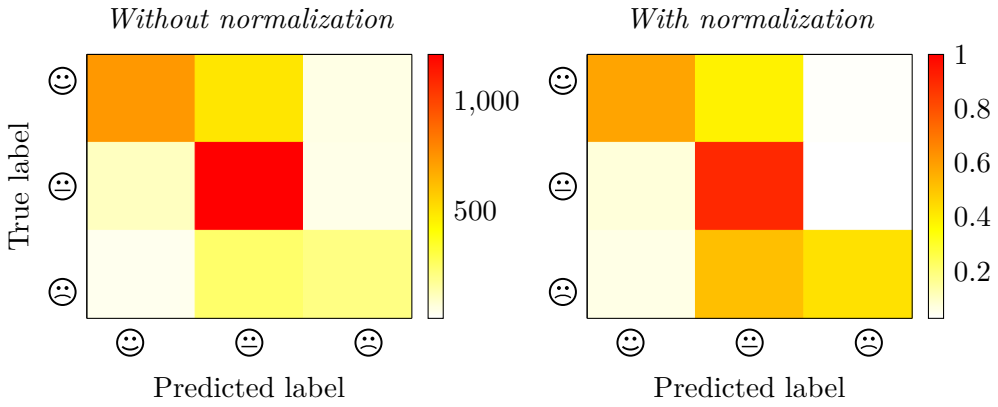

Figure 7.1.: Sentiment classifier confusion matrices

7.2. Discussion

In this section it is important to include a discussion of not just the merits of the work conducted, but also the limitations. Which choices did you make? Why? What alternatives were there? **Note that a key part of the Master's Thesis grading is based on the student's ability to discuss the results in light of the work by others as well as the restrictions and potential of the work itself.** While the Results section will report the outcome of each specific experiments, the Discussion should put those results into perspective and look at overall lessons that can be learned from the entire series of experiments.

You should be able to discuss your work in relation to its overall goal and your research questions (i.e., those introduced in Chapter 1), but also address issues such as any ethical considerations that the work may entail, as well as its technical challenges and limitations.

Discussion and evaluation can either be two different chapters, a joint chapter (as here), or part of the concluding chapter — or the discussion can be part of that chapter while the evaluation is part of the experimental chapter.

As for most parts of the thesis, it is possible to select various outlines and setups for the discussion; the important thing is that all the relevant parts appear *somewhere* in the text.

8. Conclusion and Future Work

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8.1. Contributions

What are the main contributions made to the field? How significant are these contributions? Also discuss the contributions in terms of the goals and research questions formulated in the Introduction.

The contributions section will normally contain everything that you address in the abstract, but in an extended form and quite possibly additional issues that cannot be included in the abstract. An obvious difference is that when the reader has come this far in the text, she/he should be quite familiar with the work, but while reading the abstract they will have little to no knowledge of the work.

The section "Contributions" in Chapter 1 differs from this one in that the former is just a list of the main bits, while this section should explain them in more detail. However, basically the same items should appear in both sections.

8.2. Future Work

Consider where you would like to extend or improve this work, or how somebody else could continue it. These extensions might either be continuing the ongoing direction or taking a side direction that became obvious during the work. Further, possible solutions to limitations in the work conducted, highlighted in Section 7.2 may be presented.

Note that in the Specialisation Project Report, the Future Work section will be a key part of your plan for the novel work to be carried out in the next semester, while in the Master's Thesis, the Future Work section rather will point to issues that others might be interested in addressing. This can include options and alternatives that you did not try out yourself, or potential improvements and extensions to your experiments or system.

Bibliography

Li, Z., & Ning, H. (2023). Autonomous GIS: The next-generation AI-powered GIS.

Appendices

A. Proof of the First Zonklar Equation

Appendix one text goes here.

B. Structured Literature Review (SLR) Protocol

Appendix two text goes here.