Thesis Template Created with a Little Help from Artifical Intelligence

by Ian McLoughlin

PhD Thesis

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Atlantic Technological University

Contents

Abstract

Writing a compelling abstract for a Ph.D. thesis requires conciseness, clarity, and the ability to convey the significance of your research. Here are some tips to help you craft an effective abstract. (1) Clearly State the Problem: Begin by clearly stating the problem or question your research addresses. Be concise and specific about the problem you are investigating. (2) Highlight the Objective: Clearly state the main objective of your research. What are you contributing to the field of study? Make it evident how your work fits into the broader context. (3) Provide a Brief Overview of Methods: Mention the key methods used in your research. Briefly explain the tools or frameworks you used to address the problem. However, avoid going into excessive detail. (4) Present Key Results: Summarize the main findings and results of your research. Highlight any breakthroughs, novel insights, or contributions your work has made to the field. (5) Contextualize the Significance: Communicate the significance and relevance of your research. Explain how your findings contribute to and address gaps in the field. (6) Use Concise and Accessible Language: Write in a clear, concise, and accessible language. Avoid unnecessary jargon that may be unclear to readers outside your specific subfield of study. Remember that the abstract serves as a short summary of your entire Ph.D. thesis. It provides readers with a quick overview of your research. Striking the right balance between conciseness and informativeness is key. Put your best foot forward without overstating your findings.

About the Author

When writing about yourself, highlight your academic background, research interests, accomplishments, and any relevant experiences. Here are some tips to help you craft an effective blurb. (1) Start with a Strong Opening: Begin with a concise and engaging statement that captures the reader's attention. For example, you might start with a brief description of your academic journey or research focus. (2) Highlight Your Academic Background: Provide a brief overview of your academic qualifications, including your degree(s) and any relevant academic honors or awards you have received. (3) Emphasize Your Research Interests: Clearly articulate your research interests and the topics you are passionate about. Briefly mention any specific areas of mathematics or related fields that you have focused on in your thesis work. (4) Showcase Your Accomplishments: Highlight any significant achievements or contributions you have made in your field. This could include publications, conference presentations, research projects, or collaborations. (5) Include Relevant Experiences: Mention any relevant academic or professional experiences that have shaped your research interests and expertise. This could include internships, research assistantships, teaching positions, or involvement in academic societies.

Chapter 1

Introduction

In the introduction, you should describe what your thesis is about, how the thesis is organised, and what the reader can expect as they read down through it. The most important aspect of the introduction is to set the context for the rest of the thesis. You should sign-post for the reader the most important parts of your work and where they appear in the document. In LaTeX, you should refer to sections, tables, and figures using commands rather than specifying a page or saying "the table below". The `ref` command will keep track of changes to the layout to the document. So, for example, I can just refer to Section 2 rather than worrying where that might move to in future. Note to refer to an item in the bibliography, you use the `cite` command, which should generally be placed after a `tilde`(~) rather than a space [1].

1.1 Sections

The introduction chapter of a Ph.D. thesis serves as the gateway to your research and sets the stage for the reader to understand the context, significance, and objectives of your study. Here's a comprehensive guide on what to include in the introduction chapter:

Background and Context:

Provide an overview of the broader field of study and the specific research area your thesis addresses. Discuss the historical background, key concepts, theories, and previous research relevant to your topic. Research Problem and Motivation:

Clearly articulate the research problem or question your thesis aims to address. Explain why this problem is significant and worthy of investigation. Discuss any gaps or limitations in existing literature that your research seeks to fill. Objectives and Research Questions:

State the objectives of your research and the specific research questions you seek to answer. These objectives should be clear, specific, and aligned with the overall purpose of your study. Scope and Limitations:

Define the scope of your research by outlining what is included and excluded from your study. Discuss any limitations or constraints that may impact the interpretation or generalizability of your findings. Conceptual Framework or Theoretical Framework:

If applicable, introduce the conceptual framework or theoretical framework that underpins your research. Explain the theoretical perspectives, models, or frameworks you will use to guide your analysis and interpretation. Methodology:

Provide an overview of the research methodology and approach you have adopted. Discuss the research design, data collection methods, analytical techniques, and any other procedures used to conduct your study. Significance and Contributions:

Clearly articulate the significance of your research and the potential contributions it makes to the field. Explain how your study advances knowledge, addresses gaps in the literature, or has practical implications. Organizational Structure:

Outline the structure of your thesis by briefly describing the contents of each chapter. Provide a roadmap that helps the reader navigate through your thesis and understand the sequence of your argumentation. Literature Review:

While the main literature review may be presented in a separate chapter, briefly summarize the key literature that informs your research in the introduction. Highlight the most relevant theories, concepts, and empirical studies that provide context for your study. Engage the Reader:

Write in a clear, engaging, and concise manner to capture the reader's interest. Use compelling language and examples to draw the reader into the topic and motivate them to continue reading. Remember, the introduction chapter sets the tone for your entire thesis and should provide a comprehensive overview of your research topic, objectives, methodology, and significance. It should be well-structured, focused, and persuasive, laying the foundation for the reader to understand and appreciate the rest of your work.

Subsections

You might even use subsections if you really need to. There are also subsubsections in LaTeX, but be careful not to overdo it.

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Maxwell's Equations

Gauss's Law for Electricity

Gauss's Law for Electricity is one of the four fundamental equations in classical electromagnetism, formulated by Carl Friedrich Gauss. It describes the relationship between the electric flux through a closed surface and the electric charge enclosed within that surface. Mathematically, Gauss's Law for Electricity is expressed as:

$$\oint_S \mathbf{E} \cdot d\mathbf{A} = \frac{Q_{\text{enc}}}{\varepsilon_0}$$

Here's an explanation of the key components of Gauss's Law for Electricity:

- $\oint_S$ represents a closed surface integral over a closed surface S. This means that we are summing the electric field ($\mathbf{E}$) over all infinitesimal areas ($d\mathbf{A}$) of the closed surface S.
- $\mathbf{E}$ is the electric field vector at each point on the surface. It represents the force experienced by a unit positive charge placed at that point.
- $d\mathbf{A}$ is a vector representing an infinitesimal area element of the surface. It is oriented perpendicular to the surface at each point.
- Q_{enc} is the total electric charge enclosed within the closed surface S. This includes the sum of all positive and negative charges within the enclosed region.
- ε_0 is the permittivity of free space, a fundamental constant in electromagnetism. It represents the ability of a material to permit the formation of an electric field in response to an applied electric field.

In simpler terms, Gauss's Law for Electricity states that the total electric flux through a closed surface is proportional to the total electric charge enclosed within that surface, with the constant of proportionality being the permittivity of free space. In other words, it quantifies how much electric field passes through a closed surface due to the presence of electric charges inside that surface.

Gauss's Law for Magnetism

Gauss's Law for Magnetism states that the magnetic flux through any closed surface is always zero. Mathematically, it is expressed as:

$$\oint_S \mathbf{B} \cdot d\mathbf{A} = 0$$

Here's an explanation of the key components of Gauss's Law for Magnetism:

- $\oint_S$ represents a closed surface integral over a closed surface S. This means that we are summing the magnetic field ($\mathbf{B}$) over all infinitesimal areas ($d\mathbf{A}$) of the closed surface S.
- $\mathbf{B}$ is the magnetic field vector at each point on the surface. Unlike electric fields, magnetic fields do not have sources or sinks (monopoles), so the magnetic flux through any closed surface is always zero.

- $d\mathbf{A}$ is a vector representing an infinitesimal area element of the surface. It is oriented perpendicular to the surface at each point.

In summary, Gauss's Law for Magnetism implies that there are no magnetic monopoles (isolated north or south poles), and the magnetic flux through any closed surface is always zero, indicating that magnetic field lines neither start nor end but always form closed loops.

Faraday's Law of Induction

Faraday's Law of Induction describes how a changing magnetic field induces an electromotive force (EMF) and hence an electric current in a conducting loop. Mathematically, it is expressed as:

$$\oint_C \mathbf{E} \cdot d\boldsymbol{\ell} = -\frac{d\Phi_B}{dt}$$

Here's an explanation of the key components of Faraday's Law of Induction:

- $\oint_C$ represents a closed path integral around a closed loop C. This means that we are summing the electric field ($\mathbf{E}$) around the closed loop C.
- $\mathbf{E}$ is the induced electric field within the conducting loop. It is created by a changing magnetic flux through the loop according to Faraday's law.
- $d\boldsymbol{\ell}$ is a vector representing an infinitesimal displacement along the closed loop C.
- $d\Phi_B/dt$ represents the rate of change of magnetic flux (Φ_B) through the surface enclosed by the loop with respect to time. The negative sign indicates that the induced EMF and hence the induced electric field opposes the change in magnetic flux.

In summary, Faraday's Law of Induction states that a changing magnetic field induces an electric field and hence an electromotive force (EMF) in any closed conducting loop, producing an electric current in the loop. This phenomenon forms the basis of many practical devices, such as electric generators and transformers.

Ampere's Circuital Law (with Maxwell's addition)

Ampère's Circuital Law relates the magnetic field around a closed loop to the electric current passing through the loop. With Maxwell's addition, it accounts for the displacement current, which arises from changing electric fields. Mathematically, it is expressed as:

$$\oint_C \mathbf{B} \cdot d\boldsymbol{\ell} = \mu_0 \left(I_{\text{enc}} + \varepsilon_0 \frac{d\Phi_E}{dt} \right)$$

Here's an explanation of the key components of Ampère's Circuital Law (with Maxwell's addition):

- $\oint_C$ represents a closed path integral around a closed loop C. This means that we are summing the magnetic field ($\mathbf{B}$) around the closed loop C.
- $\mathbf{B}$ is the magnetic field vector at each point along the closed loop C.
- $d\boldsymbol{\ell}$ is a vector representing an infinitesimal displacement along the closed loop C.
- μ_0 is the permeability of free space, a fundamental constant in electromagnetism.
- I_{enc} is the total current passing through the loop C. This includes both conduction current and displacement current.
- ε_0 is the permittivity of free space, another fundamental constant in electromagnetism.
- $\frac{d\Phi_E}{dt}$ represents the rate of change of electric flux (Φ_E) through the surface enclosed by the loop with respect to time. This gives rise to the displacement current, which is included in Ampère's law with Maxwell's addition.

In summary, Ampère's Circuital Law with Maxwell's addition states that the magnetic field around a closed loop is proportional to the total current passing through the loop, including both conduction current and displacement current arising from changing electric fields. This law plays a crucial role in understanding the behavior of electromagnetic fields in various physical systems.

Chapter 2

Literature

One of the most important parts of a thesis is an overview of work done by others. This gives the reader confidence that you are speaking from a knowledgable position, that you have done your hoemwork on the subject. You should not just list out a bunch of papers you have found in journals. Rather, you need to find the most relevant papers, describe their main results and how they relate to your work, and also give a brief critique of the work if necessary.

2.1 Sources

Look at the beautiful mathematics in this equation:

$$e^{i\pi} + 1 = 0 \tag{2.1}$$

It belongs to Euler, and is often cited as an example of the beauty of mathematics.

The sources of information you use are important too. You'll need to use the academic literature, but you'll also likely need to use technical specifications and other non-academic sources of literature. They should all be referenced. See the `bibliography.bib` file for information about referencing.

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Chapter 3

Methodology

You are expected to be methodical in your work, so that it could and can be reproduced and replicated by others to verify your results. If you are clear in your methodology, you will have a better chance of someone building on your work [2]. That will lead to more people being interested in what you have done, and will give you a higher profile. Remember that undergraduate students will sometimes do projects based on academic research, so it's a good idea to be explicit enough that they can easily replicate your results.

It is important that you demonstrate that you were methodical from the start. While it is tempting to play around with various algorithms or techniques before you really sit down to work. If you take five minutes beforehand to think through what you are about to do and write it down, you will quickly build up a portfolio of writing and results that can go into your thesis. There is often very little pracitcal difference between being methodical and playing around – it's largely in your attitude while you are doing the work.

Note that LaTeXhas a lot of nice functionality for creating various types of plots and diagrams. Check out the nice graphs in Figure 3.1.

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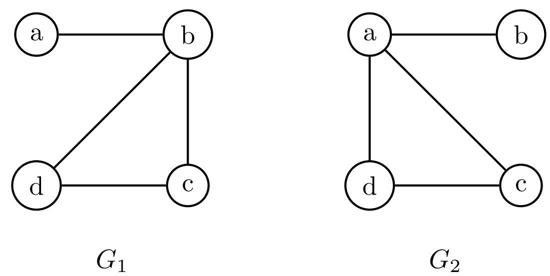

Figure 3.1: Nice pictures

Vector Spaces

A **vector space** V over a field $\mathbb{F}$ is a set equipped with two operations:

- Vector addition: $+ : V \times V \to V$, denoted as $(\mathbf{v}, \mathbf{w}) \mapsto \mathbf{v} + \mathbf{w}$.
- Scalar multiplication: $\cdot : \mathbb{F} \times V \to V$, denoted as $(\lambda, \mathbf{v}) \mapsto \lambda\mathbf{v}$.

These operations satisfy the following properties for all $\mathbf{u}, \mathbf{v}, \mathbf{w} \in V$ and $\lambda, \mu \in \mathbb{F}$:

1. **Addition is commutative**: $\mathbf{u} + \mathbf{v} = \mathbf{v} + \mathbf{u}$.
2. **Addition is associative**: $(\mathbf{u} + \mathbf{v}) + \mathbf{w} = \mathbf{u} + (\mathbf{v} + \mathbf{w})$.
3. **Additive identity**: There exists a vector $\mathbf{0} \in V$ such that $\mathbf{v} + \mathbf{0} = \mathbf{v}$ for all $\mathbf{v} \in V$.
4. **Additive inverse**: For every vector $\mathbf{v} \in V$, there exists a vector $-\mathbf{v} \in V$ such that $\mathbf{v} + (-\mathbf{v}) = \mathbf{0}$.
5. **Scalar multiplication is distributive over vector addition**: $\lambda(\mathbf{v} + \mathbf{w}) = \lambda\mathbf{v} + \lambda\mathbf{w}$.
6. **Scalar multiplication is distributive over scalar addition**: $(\lambda + \mu)\mathbf{v} = \lambda\mathbf{v} + \mu\mathbf{v}$.
7. **Scalar multiplication is associative**: $(\lambda\mu)\mathbf{v} = \lambda(\mu\mathbf{v})$.
8. **Scalar multiplication identity**: $1 \cdot \mathbf{v} = \mathbf{v}$, where 1 is the multiplicative identity in $\mathbb{F}$.

Chapter 4

Prototypes

You might consider including a section describing your algorithm and code. The minted package is great for displaying short sections of code, as in Listing 4.1.

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```python
# Ian McLoughlin, 2018-02-01
# Is it Tuesday?

import datetime

if datetime.datetime.today().weekday() == 1:
  print("Yay! It is Tuesday.")
else:
  print("Unfortunately it is not Tuesday.")
```

Listing 4.1: Is it Tuesday?

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Chapter 5

Something interesting

You will sometimes, over the course of your research, find something particularly interesting. If you think it is worthy of a published paper in its own right, you can add a chapter about it.

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Table 5.1 is a nice table.

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Column 1	Column 2
Hello	world!

Figure 5.1: A table.

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Chapter 6

Conclusion

The conclusion generally summaries the thesis and suggest further work you would like to complete based on the work in your thesis.

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