

# Using Thinking Machines to Alleviate our Dependency on Guild Navigators

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A thesis submitted in fulfilment  
of the requirements for the degree of  
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Victoria, Australia

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*Using Thinking Machines to Alleviate our Dependency on Guild Navigators*, © October 2018

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## ABSTRACT

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This page is mandatory. Put a summary of your thesis here. A good abstract should fit on a single page. Until up to approximately 1.5 pages nobody will probably complain. If you hit the two pages mark, you have done something wrong.

Ideally, this abstract and the one that you submitted along with your *notice of intention to submit (NOI)*<sup>1</sup> should be identical. However, slight variations are permissible.

---

<sup>1</sup> <https://www.latrobe.edu.au/researchers/grs/hdr/candidature/forms-and-resources>



## STATEMENT OF AUTHORSHIP

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This page is mandatory. The content and structure must comply with the regulations of your school or department. Rules and regulations may change during your candidature. Please consult the *guidelines for preparing a thesis*<sup>2</sup> to make sure you got things right. Talk with your supervisor or research coordinator if you intend to deviate from the standard.

I, Feyd-Rautha Harkonnen, born January 31, 1965 in Lankiveil, declare that this thesis titled *Using Thinking Machines to Alleviate our Dependency on Guild Navigators* and the work presented in it are my own. I confirm that this work was done mainly while in candidature for a research degree at La Trobe University.

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma. No other person's work has been used without due acknowledgment in the main text of the thesis. This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

Your Signature

figures/signature.png

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Feyd-Rautha Harkonnen

October 31, 2018

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<sup>2</sup> <https://www.latrobe.edu.au/researchers/grs/hdr/candidature/forms-and-resources>



## ACKNOWLEDGMENTS

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While not required, it is a good idea to write a couple of paragraphs to thank the people that helped you. Try to stay within the margins of this page. There is no need to write a novel. You can structure this any way you like. The text below should be considered as an example to give you an approximate idea what this section may look like. Please do not simply copy. Write your own acknowledgments! This can be very personal!

This work would not have been possible without all the help and support provided by others. During my time here in Australia and in particular at La Trobe University, I had the honor of meeting a lot of interesting people, many of whom became friends. To all of you, I hereby say: *Thank You for everything! This would not have been possible without you!* However, there are a couple of individuals who deserve special mention.

Firstly, I would like to thank my supervisor **Prof. Piter De Vries** for ... well, you should know why. You supervisors are definitely going to read this. What exceptional traits of them helped you to further your research or were there memorable moments during your candidature that you would like them to recall?

I also want to thank my co-supervisor **Dr Thufir Hawat** for ... well, you should know why. You supervisors are definitely going to read this. What exceptional traits of them helped you to further your research or were there memorable moments during your candidature that you would like them to recall?

Furthermore, I also want to thank all the members of the *La Trobe student society / club / research group* (whichever applies) for the many discussions and valuable inputs along the way. A special thanks goes to **Proofreader's name** for helping me improve my English grammar (if English is not your mother tongue you should get your thesis checked!); **Name of individual or organization that supported you** for ... (try to sum up in one sentence what they did to aid your research, personal development, etc.); and **Author who wrote letter of support no. 1**, **Author who wrote letter of support no. 2** and **Name of the research coordinator at the time** for their support of my scholarship application, without which my candidature would not have been possible.

I also want to thank my wife/husband/partner **Spouse's name**, who took care of our son/daughter/kids during the many days and nights that I spent at the university and made sure that I had a comfy home to go back to every day. And of course—last but not least—I want to thank my son/daughter/kids **Child Name 1**, **Child name 2** and **Child name 3** for ... well, you should know why!

Hence, generally speaking, I would start with a blanket statement in the first paragraph. This way, you have covered all entities that are not explicitly named thereafter. Then, you should address all people that provided academic support (supervisor, co-supervisor, the research group, individuals that helped you). Then, give credit to the people that believed in you and supported your candidature before you actually started your research. In par-

ticular, I would suggest mentioning the 2-3 people that provided letters of support and the responsible research coordinator. Finally, add one paragraph for individuals that provided significant support that is not directly associated with your research (e. g. your spouse/-sweetheart).

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In particular, some data, ideas, opinions and figures presented in this thesis have previously appeared or may appear shortly after the submission of this thesis as follows:

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- Feyd-Rautha Harkonnen, Glossu Rabban “**How to use Ixian Probes to Extract Memories from Tleilaxu Masters**” accepted for publication in *Technological and Scientific Journal of the Spacing Guild*, ISSN: 1234-5678, DOI: [99.8765/SPACE.2018.312134](https://doi.org/99.8765/SPACE.2018.312134)
- Feyd-Rautha Harkonnen, Shaddam Corrino, Piter De Vries “**A novel approach to use the Holtzmann Effect to break through shield walls**” published in *League Worlds Joint Engineering Society Journal*, ISSN: 9122-9122, DOI: [00.1234/LRAAD.2018.123344](https://doi.org/00.1234/LRAAD.2018.123344)
- Piter De Vries, Feyd-Rautha Harkonnen “**Why the Spice must flow?**” – Working draft currently under preparation for submission. This is not required, but it may be useful in case your thesis is accepted earlier than your paper.

Except where reference is made in the text of the thesis, this thesis contains no other material published elsewhere or extracted in whole or in part from a thesis accepted for the award of any other degree or diploma. No other person’s work has been used without due acknowledgment in the main text of the thesis. This thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

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<sup>3</sup> <https://www.latrobe.edu.au/researchers/grs/hdr/candidature/forms-and-resources>





## DEDICATION

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*to my ~~cruel~~ caring uncle Baron Vladimir Harkonnen*

You may dedicate your work to somebody. For instance, a person, group, organization or even a pet. You may write more than a line or put a graphic<sup>4</sup> here.

Dedicating to dissolved groups or deceased individuals is permissible. This section just has to make sense to you and the person or entity that you dedicate your work to.

However, others that read your thesis may see this. Keep in mind that your thesis will be archived and publicly visible. Avoid anything that could be considered as *problematic* or that could be *misunderstood* by a third party. The dedication above is definitely a bad example!

---

<sup>4</sup> Make sure you reference the source appropriately if you do so.



## ACRONYMS

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<b>CDMA</b>	Code Division Multiple Access
<b>GSM</b>	Global System For Mobile Communication
<b>TDMA</b>	Time Division Multiple Access



## INTRODUCTION

---

This is where the actual thesis begins. Explain the field of research and how your work fits in. Try to answer to the reader how your contributions provide new insights. However, keep this simple. Assume that the reader has only a very basic understanding of the field. Try to use lingo and terms that do not need to be explained. You may use forward references. But use them sparingly. You do not want the reader to frequently flip ahead 100 pages!

### 1.1 CONTRIBUTIONS

Our key contributions include:

1. List all important contributions that you intend to make.
2. Be brief!
3. The number of contributions does not have to match the number of contribution chapters.

### 1.2 THESIS OUTLINE

The remainder of this thesis is organized as follows. *Note: Depending on your research, you will have to change the structure of the thesis. For example, if you have many contribution chapters that are only loosely related, it might be useful to have a separate related works and/or experiments section per chapter.*

**Chapter 2** provides background information relevant to the field of research. Provide details regarding topics and concepts that you will refer to throughout the thesis and that cannot be assumed to be already known by typical readers. A background chapter is not mandatory, but chances are that you need one. See `text/ch2.tex` for details.

**Chapter 3** provides a detailed discussion of the major existing contributions to the field and how they relate to each other and our proposed algorithm ... *This must be adapted depending on your research. See `text/ch3.tex` for details.*

**Chapter 4** details the properties and development of ... Write at least 1-2 sentences more to give the reader an idea what your first major contribution chapter is about. See `text/ch4.tex` for details.

**Chapter 5** details the properties and development of the ... algorithm. Write at least 1-2 sentences more to give readers an idea what your second major contribution chapter is about. See `text/ch5.tex` for details.

Expand this list if you have further contribution chapters.

**Chapter 6** details testing of our proposed ... algorithm in an experimental setting. Write at least 1-2 sentences more to give an idea what the chapter is about. See `text/ch6.tex` for details.

**Chapter 7** concludes this thesis. First, we summarize our work. Then, we highlight interesting aspects that we did not fully cover and provide a thorough discussion of potential topics and areas, with respect to ..., that may be interesting for future research activities. A conclusion chapter is mandatory. Please do not copy. Rewrite this! See `text/ch7.tex` for details.

# 2

## LITERATURE REVIEW

---

!!!ACTION REQUIRED!!! From this point forward until the conclusion, everything becomes pretty individual. The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

The beginning of each section should start with a paragraph that tells the reader how the chapter is organized.

### 2.1 FIRST BACKGROUND TOPIC

Provide background information that will help potential readers to understand your research. It is up to you to decide the volume and content of this chapter.

At the time you start writing your thesis you have probably already published novel works and become an expert in your field of research. You may find it difficult to assume the perspective of a less experienced reader.

Your potential audience is predominately academic and works on tangentially related things. Thus, you may assume that a typical reader has successfully completed all compulsory undergraduate-degree subjects for a related degree. For example, if you do a PhD in computer science or a related discipline, you may assume that the reader knows what the difference between the declarative and imperative programming paradigm is, or what the difference between a linked-list and a tree is.

### 2.2 SECOND BACKGROUND TOPIC

Are there people in your department that teach an elective or graduate-level subject that relates to your field of research? If yes, check how they structure their lecture! Tap into the knowledge of the more experienced people around you. Discuss with your supervisors or research coordinator what background information they regard as relevant. Sometimes, they may have a very clear idea.

### 2.3 GRAMMAR CHECKING

While `overleaf` includes a spellcheck function, it doesn't include grammar checking. Installing a browser plugin such as [language tools](#) is the best way to overcome this.

## 2.4 ACRONYM EXAMPLE

In the early nineties, **GSM** was deployed in many European countries. **GSM** offered for the first time international roaming for mobile subscribers. The **GSM's** use of Time Division Multiple Access (**TDMA**) as its communication standard was debated at length. And every now and then there are big discussion whether Code Division Multiple Access (**CDMA**) should have been chosen over **TDMA**.

## 2.5 PYTHON PLOTTING EXAMPLES

The Jupyter notebook can be found in the folder 'Python plotting example' and contains code and advice for plotting publication quality figures for your thesis using python. View this notebook without installing python [here](#).

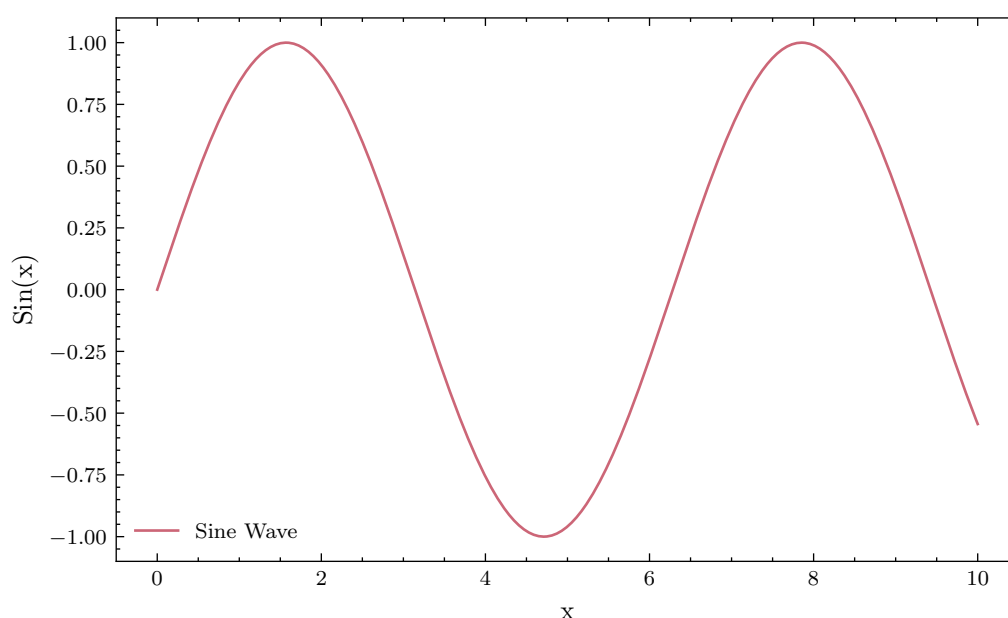
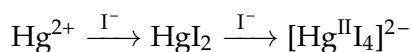
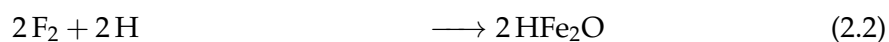
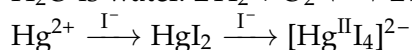


Figure 2.1: Python example plot 1, a simple sine plot.

## 2.6 CHEM EXAMPLE

H<sub>2</sub>O

H<sub>2</sub>O is water.  $2\text{H}_2 + \text{O}_2 \longleftrightarrow 2\text{H}_2\text{O}$





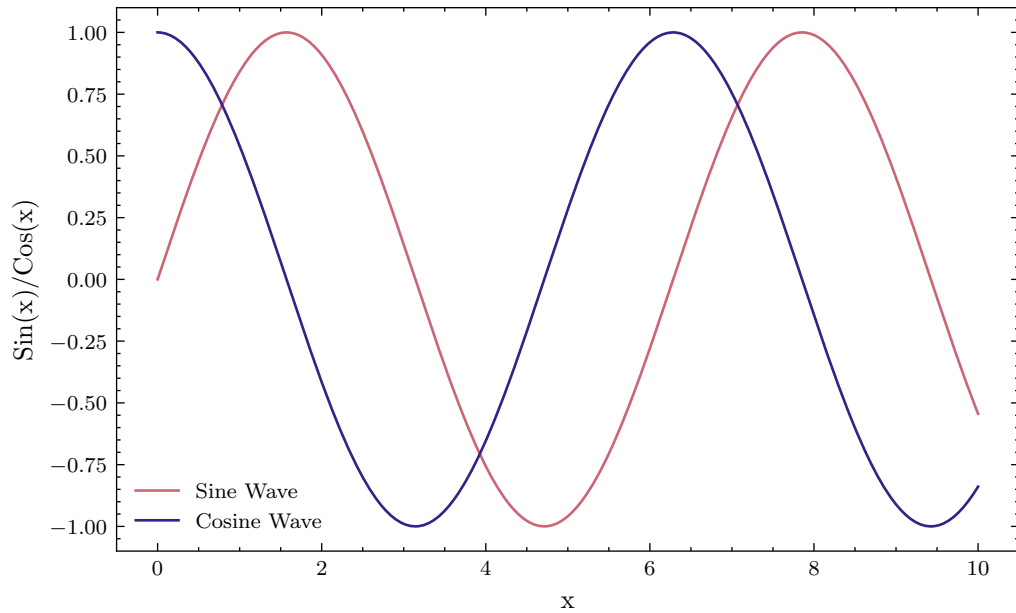


Figure 2.2: Python example plot 2, a sine and cosine plot.

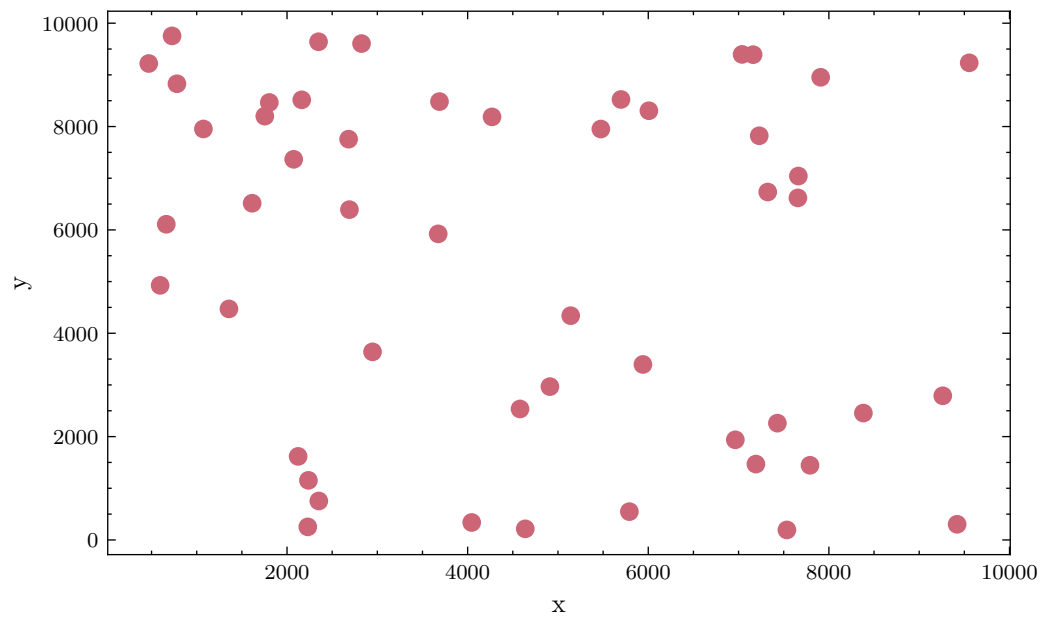


Figure 2.3: Python example plot 3, a scatter plot of random data.

## 2.7 MATH EXAMPLE

Math requires the use of a special environment, with between single  $\$$ 's for inline math like  $2^2 = 4$ , or between double  $\$\$$ 's for on it's own line like

$$2^3 = 8$$

Math mode is also required to use the `siunitx` package to produce standardised units like

$$1.23 \text{ \% mL}^{-1}$$

$$123 \text{ }^\circ \text{ pL}^{-1}$$

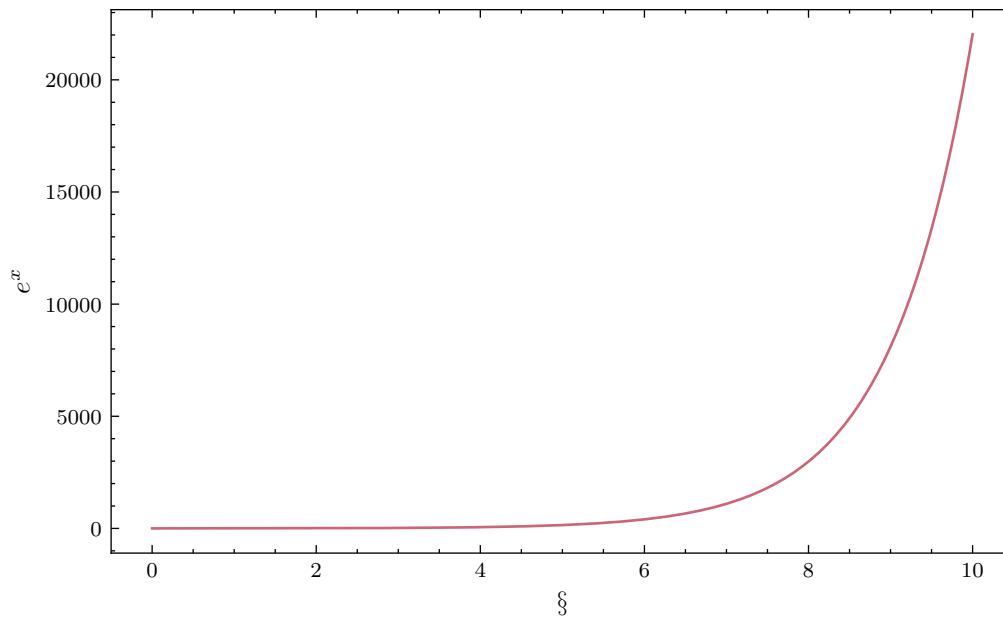


Figure 2.4: Python example plot 4, an exponential plot showing how tex can be used within python.

$$2^3 = 8$$

$$27 = 3^3 \tag{2.3}$$

$$= 9 \times 9 \tag{2.4}$$

## 2.8 SECTION EXAMPLE

### 2.8.1 Subsection Example

#### 2.8.1.1 Subsubsection Example

## 2.9 TABLES EXAMPLES

Unlike figures and the standard table environment, the longtable package will put tables wherever you put them, so you might have to play around with their location. Tables are without a doubt the most annoying aspect of  $\text{\LaTeX}$ . A helpful tool which can convert Excel tables to latex tables can be found [here](#).

2.9.1 *Portrait Table*

Table 2.1: Portrait Table example; long caption

<b>Sample</b>	<b>Number</b>	<b>Number</b>
Sample	1	2
Sample	1	2
Sample	1	2

2.9.2 *Landscape Table*

## 2.10 SUMMARY

The final section of each chapter should summarize the chapter. In comparison to the chapter, the summary should be short ( $\frac{1}{2}$  to 2 pages is normal).

Example beruwoeruioh [1] Herbert and Anderson 1999



## RELATED WORKS

---

!!!ACTION REQUIRED!!! The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

A major point in this chapter should be to demonstrate that you are aware of the research of others. Thereby, you should clearly identify how your approach deviates from theirs. There are many ways to write related works.

For example:

The idea to utilize the Holtzmann effect to fold space was conceived 1965 by Herbert [1]. In the following years, he incrementally refined the theory [4–6]. After his early death, Herbert and Anderson [7] continued the research and formalized the Holtzmann theorem, which made space travel significantly more safe (cf. [2, 3, 8–10]).

However, all these approaches to fold space are severely dependent on the resources of the Spacing Guild<sup>1</sup>. Unlike these methods, our approach does not require a registered Spacing Guild navigator to fold space. Instead, we rely on intelligent machines to ... (see [Chapter 4](#)). Thereby, we are able to solve the infinite recursion problem [3] numerically with sufficient precision (see [Chapter 5](#)).

### 3.1 SUMMARY

The final section of each major chapter should summarize the chapter. In comparison to the chapter, the summary should be short ( $\frac{1}{2}$  to 2 pages is normal).

---

<sup>1</sup> [https://en.wikipedia.org/wiki/Spacing\\_Guild](https://en.wikipedia.org/wiki/Spacing_Guild)



## MAJOR CONTRIBUTION 1

---

!!!ACTION REQUIRED!!! The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

The structure for these kinds of chapters is highly dependent on your research. See [Chapter 5](#) for a very generic layout.

However, in case you want to use equations you may do so as shown in [Eqn. 4.1](#) and [Eqn. 4.2](#).

$$\mu = \frac{1}{n} \sum_{i=1}^n x_i \quad (4.1)$$

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \mu)^2} \quad (4.2)$$

In case you think that figures are more appropriate, you may use them as demonstrated in [Fig. 4.1](#) and [Fig. 4.2](#). I personally prefer not to place figures explicitly. Instead, I just define `[t]` to align them at the top of the page and rely on  $\text{\LaTeX}$  to automatically figure out the page on which they should appear. In some cases this results in an extra page being injected. There is no upper page limit for a thesis. However, note that word count limits exist.

Figures, tables, pseudo-code algorithms and source code listings will automatically be indexed and listed at the beginning of the thesis.

### 4.1 SUMMARY

The final section of each major chapter should summarize the chapter. In comparison to the chapter, the summary should be short ( $\frac{1}{2}$  to 2 pages is normal).



Figure 4.1: The logo of La Trobe University.



Figure 4.2: La Trobe University's coat of arms.



# 5

## MAJOR CONTRIBUTION 2

---

!!!ACTION REQUIRED!!! The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

In § 5.1 we discuss how ... Explain how this chapter is structured. Make sure you cover all sections! We summarize our discussion in § 5.4.

### 5.1 MOTIVATION

Well... You have to start somewhere. Explain what you did and why. You may assume that the reader already knows the background, related works and major contribution 1.

### 5.2 MAJOR POINT 1

Develop your idea! For example, discuss the axioms that underpin the inner workings of your algorithm.

In case you want to use tables, use either `tabular` or `tabularx` (fixed width) in a table environment. Aside from the default column types, we have configured the fixed-width column-types L, C and R as demonstrated in [Table 5.1](#).

#### 5.2.1 *Minor idea 1*

Develop your idea! For example, explain how your algorithm actually works.

##### 5.2.1.1 *For structuring...*

Develop your idea!

##### 5.2.1.2 *For structuring...*

Develop your idea!

#### 5.2.2 *Minor idea 2*

Develop your idea! For example, explain how the theoretical limits of your approach.

Name	Units of Spice consumed	House Harkonnen	Comments
Feyd-Rautha	19	yes	Hey, that's me!
Paul	18	no	Heir to House Atreides
Valdimir	142	yes	My boss!
Piter	242	yes	Our Mentat
Shaddam IV.	156	no	Emperor of the known universe
Thufir	261	no	Mentat of the Atreides

Table 5.1: A very simple example table!

### 5.2.2.1 *For structuring...*

Develop your idea!

### 5.2.2.2 *For structuring...*

Develop your idea!

## 5.3 MAJOR POINT 2

Develop your idea! For example, discuss the difficulties when implementing the proposed algorithm in software.

### 5.3.1 *Minor idea 1*

Develop your idea! For example, properties of your implementation.

#### 5.3.1.1 *For structuring the section...*

Develop your idea!

#### 5.3.1.2 *For structuring the section...*

Develop your idea! If you think it helps, you can use algorithms as shown below in [Algorithm 5.1](#).

### 5.3.2 *Minor idea 2*

Develop your idea! For example, the particular properties of your implementation.

#### 5.3.2.1 *For structuring the section...*

Develop your idea!

---

**Algorithm 5.1** How Bogosort works.

---

**Require:** Unsorted dataset  $d$ , length of dataset  $n$ 

```
1: shuffle  $d$ 
2: for  $i = 2 \dots n$  do
3:   if  $d_{i-1} > d_i$  then
4:     goto 1
5:   end if
6: end for
```

---

Listing 1: Classic implementation of Bogosort.

```
def is_sorted(d):
    for i in range(len(d) - 1):
        if d[i] > d[i + 1]:
            return False
    return True

def bogosort(d):
    while not is_sorted(d):
        random.shuffle(d)
    return data
```

5.3.2.2 *For structuring the section...*

Develop your idea! If you think it may be useful, you may print excerpts from your implementation. For example, in [Listing 1](#), we implement Bogosort in a software program. However, do not go crazy with this. The reader might now know the programming language you use. If you can use pseudo-code (i.e. `\begin{algorithmic}... \end{algorithmic}`) instead, use it!

## 5.4 SUMMARY

Summarize contribution 2. Highlight what makes it relevant. Assuming that the reader knows the details of the contribution now, you should also try to clearly explain in what particular key properties this method deviates from existing research.



## EXPERIMENTS

---

!!!ACTION REQUIRED!!! The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

This is just an example. You may want to restructure this chapter, or even integrate it into your contribution chapter.

### 6.1 EXPERIMENT SETUP

Define the goal of the experiment. If you compare algorithms, define the metrics/techniques that you will use to compare them and why.

#### 6.1.1 *Environment and System Setup*

Detail the properties of the environmental conditions of your experiment. What hardware did you use? What compiler?

#### 6.1.2 *Implemented Algorithms*

Now you need to outline the scope of the experiment. For example, by listing the algorithms that you have implemented:

In this section, we list the algorithms that we have included in our experimental study.

**Naïve Space Folding** is the classic method that was originally proposed by Herbert [1] to utilize the Holtzmann effect to fold space.

**Post-Butlerian Algorithm:** This approach uses the extended fold space theory as described by Herbert and Anderson [2]. It relies on infinite recursion and can currently only be implemented by beings with a heightened perception through massive infusion of *Spice Melange*.

**Ixian Inverse:** This is our new approach to fold space using an intelligent apparatus that implements the complete algorithm discussed in § 5.3.2.

## 6.2 RESULTS

Use a somewhat expressive title for each experiment. This way you may easily reference them again in the summary.

### 6.2.1 *Short Distance Travel*

In this experiment we attempt to fold space from the planet Giedi Prime<sup>1</sup> to Arrakis<sup>2</sup>. [...]

### 6.2.2 *Long Distance Travel*

In this experiment we attempt to fold space from the planet Giedi Prime to the imperial capital on Salusa Secundus<sup>3</sup>. [...]

## 6.3 SUMMARY

Summarize the key findings of the experiments you conducted.

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1 [https://en.wikipedia.org/wiki/Giedi\\_Prime](https://en.wikipedia.org/wiki/Giedi_Prime)

2 <https://en.wikipedia.org/wiki/Arrakis>

3 [https://en.wikipedia.org/wiki/Salusa\\_Secundus](https://en.wikipedia.org/wiki/Salusa_Secundus)

## CONCLUSIONS

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!!!ACTION REQUIRED!!! The structure I defined is generic and will most likely have to be adapted. I suggest that you skim through the pages and then clear the files `text/ch2.tex` to `text/ch7.tex` before you start writing.

Optional: Talk about the general development of the respective field of research during your candidature. Talk about how this influenced your work.

### 7.1 MAJOR CONTRIBUTION 1

What are the major thoughts and findings discussed in this thesis with respect to [Chapter 4](#)? How does your research advance the current state-of-the-art? Make sure that you do NOT simply repeat the summary of that chapter.

### 7.2 MAJOR CONTRIBUTION 2

What are the major thoughts and findings discussed in this thesis with respect to [Chapter 5](#)? How does your research advance the current state-of-the-art? Make sure that you do NOT simply repeat the summary of that chapter.

### 7.3 OUTLOOK AND FUTURE WORK

Give an outlook regarding your expectations for the overall development of your chosen field of research. List topics that were not covered by your work. Identify and discuss potential avenues for follow-up research that you would consider worthwhile pursuing.





# A

## APPENDIX 1

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# B

## APPENDIX 2

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## COLOPHON

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- 1 <https://www.texstudio.org>
  - 2 <https://github.com/bashimao/ltu-thesis>
  - 3 <https://bitbucket.org/amiede/classicthesis>
  - 4 <https://tug.org/texlive>
  - 5 <https://linuxmint.com>
  - 6 <https://www.gnu.org/software/octave>
  - 7 <https://www.libreoffice.org>
  - 8 <https://www.gimp.org>
  - 9 <https://inkscape.org>
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