IMPERIAL

Imperial College London

Department of Mathematics

MSci Research Project

Title

Author:
Your name

Supervisor(s):
Name of supervisor(s)

Submitted in partial fulfillment of the requirements for the Type of Degree at Imperial College London

October 2, 2024

Abstract

Type your abstract here. The abstract is a summary of the contents of the project. It should be brief but informative, and should avoid technicalities as far as possible.

Acknowledgments

Comment this out if not needed.

Plagiarism statement

The work contained in this thesis is my own work unless otherwise stated.

Signature: Your name
Date: October 2, 2024

Contents

Chapter 1

Introduction

The introduction should attempt to set your work in the context of other work done in the field. It should demonstrate that you are aware of what you are doing, and how it relates to other work (with references). It should also provide an overview of the contents of the project. You should highlight your individual contributions and any novel result: which of the calculations, theorems, examples, proofs, conjectures, codes etc. are your own?

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Figure 1.1 This is an example of how you include a figure with a descriptive caption. This is an image of the South Kensington campus of Imperial College London on which we can recognize Queen's tower.

Module		
Module code	Module name	Number of students
	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Table 1.1 Example booktabs table. Booktabs tables are nicer than regular ones. This site has a nice GUI for making LaTeX tables, and has a Booktabs option: https://www.tablesgenerator.com/

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1.1 Section Example

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1.1.1 Subsection Example

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Subsubsection Example

Note that you can reference chapters, sections, subsections and subsubsections. For example: Subsection 1.1.1!

1.2 Math Example

While math can be written inline like so $f(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!}$, we often need to write stand-alone equations like so

$$\mathrm{score}(x) = \left(\lambda_m \sum_{i=0}^{|\mathbf{m}|} \log \hat{p}_m(d(x, \mathbf{m}_i) \mid l_i) \right) + \left(\lambda_l \sum_{i=0}^{|\mathbf{l}|} \log \hat{p}_l(d(x, \mathbf{l}_i) \mid \mathbf{v}_i) \right) + \lambda_p \hat{p}_p(x) \qquad (1.1)$$

To write equations over multiple lines (like systems of equation or equations too long to fit the page), one can use the *align* environment coupled to the *subequations* environment like so

$$\mathbb{P}(0 \rightsquigarrow -a) = D \int_0^\infty dt\, k_r e^{-k_r t} \int_0^t d\tau\, \partial_x u\big|_{x=-a}, \tag{1.2a}$$

$$\mathbb{P}(0 \rightsquigarrow b) = -D \int_0^\infty dt\, k_r e^{-k_r t} \int_0^t d\tau\, \partial_x u\big|_{x=b}. \tag{1.2b}$$

1.3 Algorithm Example

See Algorithm 1

Algorithm 1: Algorithm example

Input: $\mathbf{m}$, such that $\mathbf{m}_i$ is the position of the i'th monitor
$\mathbf{l}$, such that $\mathbf{l}_i$ is the position of the i'th landmark
$\mathbf{p}^m$, such that $\mathbf{p}_i^m$ is the ping latency from monitor i to the target
$\mathbf{p}^l$, such that $\mathbf{p}_i^l$ is the set of ping latencies to landmark i

Pre: Compute $\hat{p}_m(d \mid l)$, an estimator giving the likelihood of the target being distance d away from the monitor, given that the monitor records a latency of l to that target. Implemented by training a KDE using $\mathbf{p}^l$.
Compute $\hat{p}_l(d \mid v)$, an estimator giving the likelihood of the target being distance d away from the landmark, given a Canberra distance of v between the target and the landmark, using training targets.

Output: Most likely location of the target

Function *Likelihood(x, $\mathbf{v}$)*
    MonitorScore $\leftarrow \sum_{i=0}^{|\mathbf{m}|} \log \hat{p}_m(d(x, \mathbf{m}_i) \mid l_i)$;
    LandmarkScore $\leftarrow \sum_{i=0}^{|\mathbf{l}|} \log \hat{p}_l(d(x, \mathbf{l}_i) \mid \mathbf{v}_i)$;
    return MonitorScore + LandmarkScore
end

$\mathbf{v} \leftarrow$ {canberra_distance($\mathbf{l}_i, \mathbf{p}^m$) | $\mathbf{l}_i \in \mathbf{l}$}
$\mathbf{C} \leftarrow$ Constraint-Based-Geolocation($\mathbf{m}$, $\mathbf{p}^m$);
$\mathbf{C}_\mathbf{l} \leftarrow \{m \in \mathbf{m} \mid \mathbf{C} \text{ contains } m\} \cup \{l \in \mathbf{l} \mid \mathbf{C} \text{ contains } l\}$;

return $\operatorname{argmax}_{x \in \mathbf{C}_\mathbf{l}}$ Likelihood(x)

1.4 Reference Example

Here is how you can cite papers which you have added in the `/bibs/bibliography.bib` file. You can cite single references as such [1] or multiple references like so [1, 2]. Here is a reference to a website [3].

Chapter 2

Background

Chapter 3

Methods

Chapter 4

Results

Chapter 5

Discussion

Chapter 6

Conclusion

Appendix A

First Appendix

Appendix B

Second Appendix

Bibliography

[1] A. Einstein. Zur Elektrodynamik bewegter Körper. *Annalen der Physik*, 322(10):891–921, 1905.

[2] P. A. M. Dirac. *The Principles of Quantum Mechanics*. International series of monographs on physics. Clarendon Press, 1981.

[3] Wikipedia Contributors. Riemann hypothesis — Wikipedia, the free encyclopedia. https://en.wikipedia.org/wiki/Riemann_hypothesis, 2024. [Online; accessed 01-February-2024].