



# **Reykjavík University Project Report, Thesis, and Dissertation Template**

by

Sigurður Helgason

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Examining Committee:

Yngvi Björnsson, Supervisor  
Professor, Reykjavík University, Iceland

Tough E. Questions, Examiner  
Associate Professor, Massachusetts Institute of Technology, USA

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December 2019

# Reykjavík University Project Report, Thesis, and Dissertation Template

Sigurður Helgason

December 2019

## Abstract

this is my abstract written in the language of English I am testing thought

alas I knew

ok so now I'm trying something new

asdf

test

# Herkænsku mat á djúptauganetum

Sigurður Helgason

desember 2019

## Útdráttur

this is my abstract written in the language of íslensku þæööasdf

# Important!!! Read the Instructions!!!

If you have not already done so,  $\LaTeX$  the `instructions.tex` to learn how to setup your document and use some of the features. You can see a (somewhat recent) rendered PDF of the instructions included in this folder at `instructions-publish.pdf`. There is also more information on working with  $\LaTeX$  at <http://samvinna.ru.is/project/htgaru/how-to-get-around-projects-publish.pdf>. This includes common problems and fixes.

This page will disappear in anything other than draft mode.

*I dedicate this thesis to my family who while not understanding most of what I do always support me. The friends that still want to talk to me even though my schedule has rendered me unmeetupwithable. Lastly but certainly not least, Hulda Lilja who always easead my mind during my spurts of imposter syndrome, and fear of failure. Don't Panic.*

# Acknowledgements

So long, and thanks for all the fish.

Acknowledgements are optional; comment this chapter out if they are absent Note that it is important to acknowledge any funding that helped in the work This work was funded by 2020 RANNIS grant “Survey of man-eating Minke whales” 1415550. Additional equipment was generously donated by the Icelandic Tourism Board.

# Preface

This dissertation is original work by the author, Sigurður Helgason.

The preface is an optional element explaining a little who performed what work. See [https://www.grad.ubc.ca/sites/default/files/materials/thesis\\_sample\\_prefaces.pdf](https://www.grad.ubc.ca/sites/default/files/materials/thesis_sample_prefaces.pdf) for suggestions.

List of publications as part of the preface is optional unless elements of the work have already been published. It should be a comprehensive list of all publications in which material in the thesis has appeared, preferably with references to sections as appropriate. This is also a good place to state contribution of student and contribution of others to the work represented in the thesis.



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# List of Abbreviations

MSc	Masters of Science
ML	Machine Learning
AI	Artificial Intelligence

This part of the dissertation introduces the concepts and the field.

# Chapter 1

## Introduction

State the objectives of the exercise. Ask yourself: Why did I design/create the item? What did I aim to achieve? What is the problem I am trying to solve? How is my solution interesting or novel?

In the world of deep learning is exciting, we have models that are able to examine images and very reliably be able to identify it's content. Deep learning models have beaten Ophthalmologists in identifying diabetic retinopathy, they've identified cancer cells where others have not. Deep learning models have even predicted the likelihood a person will die in the following year. These models have done these things extremely accurately, cheap, and fast. These successes allow us to dream of a future where all things are eventually possible with the help of technology.

The field of examining deep learning models to gain a richer understanding in how they work, and what makes them so much better than humans at various tasks is still new. This is the field of Explainable Artificial Intelligence (XAI). If we wish to continue using artificial intelligence (AI) and machine learning (ML), to improve our lives we must examine how they work, this is not only to improve ourselves but these explanations are a legal requirement now in many areas, namely, legal, and medical.

This thesis takes a look at how we can examine an artificial neural network (ANN) to understand which higher level concepts (HLC) it deems important for a given state within games. These games can be simple like Tic-Tac-Toe or Breakthrough and extremely complicated like Chess or Go. If an ANN values a HLC greatly which we

as humans don't find very important, and yet the ANN is able to defeat us there is reason to think that HLC should be of more importance to us.

The chess engine DeepBlue was the first chess engine to win a chess match against a chess grand master. Its power in the world of chess was a marvel. DeepBlue used tree-search to evaluate its position and possible moves, doing an immense amount of calculations in order to arrive at the best move it could given the time constraints. The tree search approach is dependent on knowing which board state is good and what board state is bad. This can be easy when the boardstate is such that you're guaranteed to have been checkmated in one move, and it's incredibly hard when your boardstate is such that both you and your opponent have 16 pieces and are only a handful of moves in. Generally the boardstate is a function of the pieces you have, how safe they are, and how opportunistic you are to capture your opponent's pieces. These values are not obvious and require a domain expert to describe the situations and give the values for these cases.

The process of evaluating chess positions did not change for many years. With the revival of deep neural networks this changed. A neural network is a network of connected nodes (neurons) that each have a specific weight. These networks are fed input which is passed through the network and it is updated by the weights of the neurons, the input is morphed into a more comprehensible value and these values are then used to generate some output. The output can be a binary classification for instance input=Image output={cat, dog}. Processing the pixels and altering them to numerical values to find the output cat or dog is not intuitive and understanding of the values of the neurons in the network is not considered fruitful.

This approach of chess engines is still popular today but not the reigning champion anymore. In today's best chess engines deep neural networks are used to

Deep neural network machine learning models have an amazing impact on modern society today, we use them to know which items to purchase, to know which people we should love, and we use them to drive us to work. These tasks given to deep learning models are all niceties for us to enjoy. However, as our dependence on them increases and their astounding success in any and all tasks continues, we will want to utilize

them for all things. This leads to a utopia where decision making is removed from the hands of humans. The question we must ask ourselves is when do we want to know why a decision was taken, is it only when the decision taken is not preferable to us. For instance, if a deep neural network model used by your lending authority decides you are not worthy of a loan. These questions should have answers but as it stands today no such answer is possible.

We can use methods like saliency maps to map a deep learning model emphasis on pixels to hopefully understand what portions the model is focusing on. This method however, tells us nothing about what

results that are nothing but amazing.



## 1.1 Background

### 1.1.1 Reinforcement Learning

In 2017 a Google based artificial intelligence research company published a paper called ‘Mastering Chess and Shogi by Self-Play with a General Reinforcement Learning Algorithm’. The paper described a Model based Reinforcement learning agent and an accompanying Residual Deep Neural Network architecture that was able to master the game of chess without being given any idea of how to play the game of chess, and others. The architecture used in this paper is heavily inspired by that architecture.

### 1.1.2 Model Interpretability

In 2018 the paper ‘Interpretability Beyond Feature Attribution: Quantitative Testing with Concept Activation Vectors (TCAV)’ was published where an approach to model interpretability was introduced which is able to distinguish

The deep neural network architecture that is used in this paper is based on the AlphaZero paper published by DeepMind,

This part of the dissertation describes the work done.

# Chapter 2

## Methods

### 2.1 Monte Carlo Tree Search

To train the models

This section discusses the various machine learning methods utilized throughout this project and discusses their applicability.

I'm a little teapot

I'm a smaller teapot

# Chapter 3

## Results

In this section you discuss any issues that came up while developing the system. If you found something particularly interesting, difficult, or an important learning experience, put it here. This is also a good place to put additional figures and data.ello world

This part of the dissertation talks about future work discussion concludes the work and

# Chapter 4

## Discussion

Here I will discuss the myriad of fields research like this can help for instance for health organizations, patients, taxpayers, and pharmaey

### 4.1 Summary

summarize the workey

### 4.2 Conclusion

conclude the work, discuss the significance of the workey