DEGREE PROJECT IN TECHNOLOGY,
SECOND CYCLE, 30 CREDITS
STOCKHOLM, SWEDEN 2022

Template

KTH Thesis Report

Max Schaufelberger

KTH ROYAL INSTITUTE OF TECHNOLOGY
SCHOOL OF ENGINEERING SCIENCES

Author

Max Schaufelberger <maxscha@kth.se>
School of Engineering Sciences
KTH Royal Institute of Technology

Place for Project

Stockholm, Sweden
Ottignies-Louvain-la-Neuve, Belgium

Examiner

Prof. Olof Runborg
Department of Numerical Analysis
KTH Royal Institute of Technology
Stockholm, Sweden

Supervisor

Prof. Elias Jarlebring
Department of Numerical Analysis
KTH Royal Institute of Technology
Stockholm, Sweden

Supervisor

Arvind Kumar
Division of Computational Science and Technology
KTH Royal Institute of Technology
Stockholm, Sweden

Supervisor

Frédéric Crevecoeur
Institute of Information and Communication Technologies, Electronics and Applied Mathematics
UCLouvain Catholic University of Louvain
Louvain-la-Neuve, Belgium

Abstract

This is a template for writing thesis reports for the ICT school at KTH. I do not own any of the images provided in the template and this can only be used to submit thesis work for KTH.

The report needs to be compiled using XeLaTeX as different fonts are needed for the project to look like the original report. You might have to change this manually in overleaf.

This template was created by Hannes Rabo <hannes.rabo@gmail.com or hrabo@kth.se> from the template provided by KTH. You can send me an email if you need help in making it work for you.

Write an abstract. Introduce the subject area for the project and describe the problems that are solved and described in the thesis. Present how the problems have been solved, methods used and present results for the project. Use probably one sentence for each chapter in the final report.

The presentation of the results should be the main part of the abstract. Use about ½ A4-page. English abstract

Keywords

Template, Thesis, Keywords ...

Abstract

Svenskt abstract Svensk version av abstract – samma titel på svenska som på engelska.

Skriv samma abstract på svenska. Introducera ämnet för projektet och beskriv problemen som löses i materialet. Presentera

Nyckelord

Kandidat examensarbete, ...

Acknowledgements

Write a short acknowledgements. Don't forget to give some credit to the examiner and supervisor.

Acronyms

NN Neural Network

Contents

Chapter 1

Introduction

Provide a general introduction to the area for the degree project. Use references!

Link things together with references. This is a reference to a section: 1.1.

1.1 Background

Present the background for the area. Give the context by explaining the parts that are needed to understand the degree project and thesis. (Still, keep in mind that this is an introductory part, which does not require too detailed description).

Use references[1]

Detailed description of the area should be moved to Chapter 2, where detailed information about background is given together with related work.

This background presents background to writing a report in latex.

Example citation [**Jones2017**] or for two authors: [**Jones2017**, **Liu2017**]

Look at sample table 1.1.1 for a table sample.

Boxes can be used to organize content

[1]You can also add footnotes if you want to clarify the content on the same page.

Table 1.1.1: Sample table. Make sure the column with adds up to 0.94 for a nice look.

SAMPLE	TABLE
One	Stuff 1
Two	Stuff 2
Three	Stuff 3

Development environment for prototype

```
Operating systems
computer: Linux - kernel 4.18.5-arch1-1-ARCH
android phone: 8.1.0

Build tools
exp (build tool): version 55.0.4


...
```

1.2 Problem

NN have excelled at many fields
Fields where they are not fit
aka temporal data
They have ways to compromise on that
-> reference
Spiking nn inherently temporal
more natural choice
However they also have problems
like the following:::: reference!!

1.3 Purpose

The purpose of the degree project/thesis is the purpose of the written material, i.e., the thesis. The thesis presents the work / discusses / illustrates and so on.

It is not “The project is about” even though this can be included in the purpose. If so, state the purpose of the project after purpose of the thesis).

Probably delete as a own paragraph but mention smth like that.

1.4 Goal

The goal means the goal of the degree project. Present following: the goal(s), deliverables and results of the project.
Goal is to write a SNN that can deliver good performance in solving a task that sucks with a conventional NN. The performance of of the SNN should be close to equal to conventional control schemes and better than conventional NNs.
Ideally the SNN has desired features like small number of spikes, precision, learning, poisson distribution etc. more find references.
Ideally we stress the network by removing many neurons and see the performance. maybe to recreate the performance of the one paper..
Potentially find the optimal minimal network in the network. The paper dass der Typ aus louvain vorgestellt hat.

1.5 Benefits, Ethics and Sustainability

Describe who will benefit from the degree project, the ethical issues (what ethical problems can arise) and the sustainability aspects of the project.

Use references!

1.6 Methodology

Introduce, theoretically, the methodologies and methods that can be used in a project and, then, select and introduce the methodologies and methods that are used in the degree project. Must be described on the level that is enough to understand the contents of the thesis.

Use references!

Preferably, the philosophical assumptions, research methods, and research approaches are presented here. Write quantitative / qualitative, deductive

/ inductive / abductive. Start with theory about methods, choose the methods that are used in the thesis and apply.

Detailed description of these methodologies and methods should be presented in Chapter 3. In chapter 3, the focus could be research strategies, data collection, data analysis, and quality assurance.

We build a SNN for a control problem and check it for performance as mentioned above. In addition we design a conventional controller and compare the result. IF we have the time for it we put a conventional NN to it too. We see the performance compared to the others and look at the specs we mentioned above. The SNN is trained by learning using STDP rule. We can compare the learned weights with the optimal weights when we have our own optimal controller/ we simulate our trajectory. For our approach we use a balanced spiking network.

1.7 Stakeholders

Present the stakeholders for the degree project.

1.8 Delimitations

Explain the delimitations. These are all the things that could affect the study if they were examined and included in the degree project. Use references!

1.9 Outline

In text, describe what is presented in Chapters 2 and forward. Exclude the first chapter and references as well as appendix.

Chapter 2

<Theoretical Background>

In this chapter, a detailed description about background of the degree project is presented together with related work. Discuss what is found useful and what is less useful. Use valid arguments.

Explain what and how prior work / prior research will be applied on or used in the degree project /work (described in this thesis). Explain why and what is not used in the degree project and give valid reasons for rejecting the work/research.

Use references!

2.1 Use headings to break the text

Do not use subtitles after each other without text in between the sections.

2.2 Related Work

You should probably keep a heading about the related work here even though the entire chapter basically only contains related work.

Here just what has been done for each of the headlines

Neural networks in general spiking neural networks and their differences and what they are better for. neuron models, iwazishi neuron and maybe one more mein neuron model und warum ich es ausgewaelt habe: einfach zu implementieren. Bereits fuer

dynamische systeme verwendet, Nachteile dieses modells. Vlt vergleich mit einem anderen modell. Ganz kurzer ausflug in die regelung von dynamischen systemen.

What is a neural network? -> not here ref a paper. kurze erkl'rung in der einfuerung in der einfuhurng vlt auch hodgekin huxley erwaehen :)

2.2.1 Dynamic systems

2.2.2 Neural Networks

2.2.3 Spiking Neural Networks

A spiking Neural network is one step closer to a biologic representation of a brain. Instead of conveying information using a gradient in conventional Neural Network (NN)s, information is propagated using discrete spikes of excitation, similar to biological neurons. Hereby one can distinguish between several ideas of implementation.

Neuron types

Classic
Izhekevich neuron

Poisson-Networks

Test

Liquid state machines

GLM

Balanced Networks

Learning: SGD and STDP

Here explain the conpects for each of the NNs
Give references for the STDP variances
test

Chapter 3

<Engineering-related content, Methodologies and Methods>

Describe the engineering-related contents (preferably with models) and the research methodology and methods that are used in the degree project.

Most likely it generally describes the method used in each step to make sure that you can answer the research question.

3.1 Engineering-related and scientific content:

Applying engineering related and scientific skills; modelling, analysing, developing, and evaluating engineering-related and scientific content; correct choice of methods based on problem formulation; consciousness of aspects relating to society and ethics (if applicable).

As mentioned earlier, give a theoretical description of methodologies and methods and how these are applied in the degree project.

was ist meine research question?

zusammensetzung von den beiden systeme: dynamisches system und neuronales netz. mehr oder weniger die herleitung kopieren aus dem paper. Dann mit learning von den gewichten.

Here I describe what how it needs to be done. So this is the place for the derivation The concept and the process whatever that means Later there comes the how I implemented

it. Here is what we needs to be implemented.

Here very detailed explanation of the Balanced network for this problem
Very detailed way for the regular NN for this problem Basics of the controller design used in this comparison aka LQG controller
Method of learning the weights for the SNN Method of comparison

Chapter 4

<The work>

Describe the degree project. What did you actually do? This is the practical description of how the method was applied.

4.1 Creating the SNN

How do we make the SNN MAtlab Balanced spiking network (say why to use that) maybe pseudo code Ideally some theorem (convergence???) Simulation? nein kommt in den naechsten part

4.2 Creating the NN

4.3 Creating the regular Controller

Chapter 5

<Result>

Describe the results of the degree project.

Chapter 6

<Conclusions>

Describe the conclusions (reflect on the whole introduction given in Chapter 1).

Discuss the positive effects and the drawbacks.

Describe the evaluation of the results of the degree project.

Describe valid future work.

The sections below are optional but could be added here.

6.1 Discussion

6.1.1 Future Work

6.1.2 Final Words

If you are using mendeley to manage references, you might have to export them manually in the end as the automatic ways removes the ”date accessed” field

Appendix - Contents

Appendix A

First Appendix

This is only slightly related to the rest of the report

Appendix B

Second Appendix

this is the information