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Department Life Sciences and Facility Management

Institute of Computational Life Sciences

THESIS

Flood Modeling with Deep Learning

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Declaration of Authorship

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Abstract

The abstract is like a miniature version of the entire manuscript. Structure it similarly: Begin with the context and motivation for the project, a brief description of the method and available data, your findings, and conclusions. Limit yourself to one page! [1]

Acknowledgements

The acknowledgements belong here. Do not forget to mention your project supervisors, without flattering them too much.

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List of Abbreviations

LAH List Abbreviations Here
WSF What (it) Stands For

For/Dedicated to/To my...

Chapter 1

Introduction

1.0.1 Background

This is where the background will go. and example citation: [1] [2], [3, I have no idea what post note is but lets try]

1.0.2 Related Work

1.0.3 Objective

Chapter 2

Theoretical Background

2.1 Cellular Automata

2.1.1 What is a cellular automata

Game of Life

Elementary cellular automata

2.1.2 CA for flood modeling

2.2 Deep Learning Models used in this work

2.2.1 Convolutional Neural Network

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CNN as CA

Growing Neural cellular automata paper

2.3 Optimizers for backpropagation

2.4 Common loss functions for regression tasks

Chapter 3

Methodology

3.1 Data

3.1.1 data acquisition

3.1.2 data preprocessing

3.1.3 dataset creation

features

validation and test set

3.2 Model creation

3.2.1 classical CNN

3.2.2 depthwise layer

3.2.3 gradient filters

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3.3 custom loss functions

3.3.1 custom mse and mae

3.4 Proposed evaluation

3.5 pipeline creation

Chapter 4

Results

4.1 NCA

4.2 simple CNN

4.3 depthwise layer

4.4 performance of models on the different datasets

Chapter 5

Discussion

5.1 Interpretation of Results

Chapter 6

Conclusion

6.1 Conclusion

6.2 Outlook and future work

Appendix A

Frequently Asked Questions

A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

```
\hypersetup{urlcolor=red}, or
```

```
\hypersetup{citecolor=green}, or
```

```
\hypersetup{allcolor=blue}.
```

If you want to completely hide the links, you can use:

```
\hypersetup{allcolors=.}, or even better:
```

```
\hypersetup{hidelinks}.
```

If you want to have obvious links in the PDF but not the printed text, use:

```
\hypersetup{colorlinks=false}
```

A.2 How can I add a Figure in the Appendix?

You can refer to a figure in the Appendix (like [A.1](#)) and it will show up as expected.



FIGURE A.1: Bart Simpson. (2023, May 17). In Wikipedia. https://en.wikipedia.org/wiki/Bart_Simpson

DECLARATION OF ORIGINALITY

Master's Thesis for the School of Life Sciences and Facility Management

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Bibliography

- [1] C. J. Hawthorn, K. P. Weber, and R. E. Scholten. “Littrow Configuration Tunable External Cavity Diode Laser with Fixed Direction Output Beam”. In: *Review of Scientific Instruments* 72.12 (Dec. 2001), pp. 4477–4479. URL: <http://link.aip.org/link/?RSI/72/4477/1>.
- [2] A. S. Arnold et al. “A Simple Extended-Cavity Diode Laser”. In: *Review of Scientific Instruments* 69.3 (Mar. 1998), pp. 1236–1239. URL: <http://link.aip.org/link/?RSI/69/1236/1>.
- [3] Carl E. Wieman and Leo Hollberg. “Using Diode Lasers for Atomic Physics”. In: *Review of Scientific Instruments* 62.1 (Jan. 1991), pp. 1–20. URL: <http://link.aip.org/link/?RSI/62/1/1>.