Aalto University School of Science Master's Programme in Life Science Technologies

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Probabilistic Precipitation Nowcasting using Bayesian Convolutional Neural Networks

Master's Thesis Espoo, July 20th, 2022

DRAFT! — May 12, 2022 — DRAFT!

Supervisor: Professor Arno Solin Advisor: Terhi Mäkinen D.Sc.

Seppo Pulkkinen D.Sc.



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ABSTRACT OF MASTER'S THESIS

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Abbreviations and Acronyms

DL

Deep learning

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Introduction

- 1.1 Problem statement
- 1.2 Structure of the Thesis

Background

2.1	Precipitation	Nowcasting

- 2.1.1 Weather radars and radar products
- 2.1.2 Overview of weather forecast methods
- 2.1.3 Precipitation nowcasting: classical methods
- 2.1.4 Machine learning approaches to precipitation nowcasting

2.2 Bayesian deep learning

- 2.2.1 Learning probability distributions
- 2.2.2 Intractable integrals and ways to deal with them
- 2.2.2.1 MCMC based methods
- 2.2.2.2 Variational inference
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- 2.2.4 Predictive uncertainty estimation
- 2.2.4.1 Epistemic and aleatoric uncertainty

2.3 Probabilistic machine learning in atmospheric sciences

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- 3.2 Model
- 3.2.1 The baseline: RainNet
- 3.2.2 Our model: a bayesian extension to RainNet
- 3.3 verification methods
- 3.3.1 Baseline models for verification
- 3.3.1.1 Deterministic predictions
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- 4.1 Case studies for nowcasts
- 4.1.1 Case study 1 : Large-scale Stratiform rain event
- 4.1.2 Case study 2 : Rapidly evolving convective rain event
- 4.2 Deterministic prediction skill (Metrics)
- 4.3 Probabilistic prediction skill (Metrics)
- 4.4 Uncertainty estimation
- 4.4.1 Uncertainties against leadtime
- 4.4.2 Uncertainties against rainfall intensity
- 4.4.3 Epistemic uncertainty against training parameters

Discussion

- 5.1 Goodness of results
- 5.2 Validity of results
- 5.3 What could we learn from uncertainty
- 5.4 What would have to be improved, potential problems in the study?
- 5.5 Directions for further work

Conclusions

Bibliography

Appendix A

First appendix

This is the first appendix. You could put some test images or verbose data in an appendix, if there is too much data to fit in the actual text nicely. For now, the Aalto logo variants are shown in Figure A.1.



(a) In English



(b) Suomeksi



(c) På svenska

Figure A.1: Aalto logo variants