Tue J. **Boesen**

Machine learning Specialist

Aarhus, Denmark

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Summary

I am a machine learning scientist and have previously worked as: software developer, researcher, project lead, and technical advisor/consultant on various projects. I have a solid foundation in: physics, mathematics, data science, and high-performance-computing. I am familiar with programming best practices and generating production code. Within machine learning, I have specialised in physics-informed and graph neural networks, but I have experience with most areas of deep learning, and I have applied machine learning in many different fields.

Selected experiences

Machine learning highlights

- Developed novel **physics-informed graph neural networks** that allows the consideration of constraints and symmetries, and used them on mechanical and molecular systems to lower constraint violations by several orders of magnitudes, while increasing prediction accuracy.
- Developed novel **active learning** techniques for image classification and used them to significantly lower the amount of training images required for high accuracy.
- Developed novel **clustering** techniques to more accurately predict oil and mineral concentrations in the ground.
- Built **NLP** models and used self-training to teach them how amino acid bind together and how proteins fold.
- Used **image-transfer-learning** and reversible networks to created geological maps from satellite data.
- Used **reinforcement learning** and monte carlo graph search techniques to create AI's that can play boardgames.

Owner - Consultant

Denmark

Neural Solutions — *Dec 2021 - Nov 2022*

- Scoping of business problems solvable by machine learning.
- Designed tailored neural network architectures.

Lead Machine Learning Specialist

Vancouver, Canada

Proteic Bioscience Inc. — *Jan 2022 - June 2022*

- Lead developer of equivariant twice-differentiable neural networks for biomolecules.
- Developed MLOps framework with MLflow and Optuna for automatic data ingestion, processing, and feature transforms, hyperparameter tuning and model tracking.

Postdoctoral Research Fellow in Machine Learning

Vancouver, Canada

University of Bristish Columbia (UBC) — *May 2019 - Aug 2021*

- Developed novel physics-informed neural networks inspired by differential algebraic systems of equations capable of honoring constraints and symmetries.
- Published reversible mimetic graph neural networks.
- Developed self-supervised conditional probability neural networks inspired by NLP models.
- Published a semi-supervised active learning algorithm utilizing pseudo-labelling which offers theoretical guarantees to be optimal.
- Deployed large scale training on Amazon Web Services.

AI Research Scientist

Vancouver, Canada

Computational Geoscience Inc. — *May 2019 - Aug 2020*

- Developed clustering techniques for oil exploration.
- Published novel graph-based semi-supervised learning methods applied to seismic data.

Research Assistant

Aarhus, Denmark

HydroGeophysics Group at Aarhus University — *Aug 2017 - Nov 2017*

- Open-sourced a sparse iterative parallel linear solver based on my research during my Ph.D.
- Open-sourced an OpenMP parallelization framework developed during my Ph.D.

Analyst, Graduate position

Copenhagen, Denmark

Danske Bank — *Sep 2013 - Apr 2014*

- Worked in customer insight creating forecast models.

Software Developer

Aarhus, Denmark

HydroGeophysics Group at Aarhus University — *Mar 2013 - Sep 2013*

- Created SPIA in Pascal, an application for ground-based electromagnetic measurements.

Education

Ph.D. in Geophysics *Denmark*

Aarhus University *2015 - 2018*

- Thesis: Numerical methods for electromagnetic geophysics beyond 1D

M.S. in Theoretical Physics *Denmark*

Aarhus University *2010 - 2011*

- Thesis: Foundation for a parallel time-dependent density functional theory simulator in a spherical harmonic basis using the exact exchange energy functional

B.S. in Physics *Denmark*

Aarhus University *2006 - 2010*

- Thesis: Feynmans Pathintegral i 1 dimension med fokus på sinusbaner (Feynman's path integral in 1 dimension with focus on sinusoidal trajectories)

Skills

Platforms	Windows, Linux Ubuntu, AWS
Programming	Python, Pytorch, LaTeX, Git, Matlab, Fortran, Julia, Delphi/Pascal, OpenMp, MPI
Languages	Danish, English

Teaching and supervision

Teaching *Aarhus University, Denmark*

Instructor *2009-2017*

- Calculus.
- Electric and Electromagnetic methods.
- Data processing and interpretation for groundwater mapping.
- Geophysical methods.
- Hydrogeophysical field course (twice).

Supervision *UBC, Canada*

Co-Supervisor *2020*

- Jingrong Lin – Ph.D. student in geophysics and machine learning.

About me

My main hobbies outside work are boardgames, rock climbing and beach volley. Apart from those I like to tinker with various projects, my current project is to develop a framework that can play various boardgames, while previous ones include: building a quadcopter, and designing and building a hangboard with a CNC machine and laser cutter.

Publications

Submitted

Neural DAEs: Constrained neural networks
Tue Boesen, Eldad Haber, Uri M Ascher
arXiv preprint arXiv:2211.14302 (2022). 2022

Journal Articles

A-optimal active learning
Tue Boesen, Eldad Haber
Physica Scripta 98.4 (Mar. 2023) p. 045014. IOP Publishing, 2023

Mimetic neural networks: a unified framework for protein design and folding
Moshe Eliasof, Tue Boesen, Eldad Haber, Chen Keasar, Eran Treister
Frontiers in Bioinformatics 2 (2022). 2022

Data-driven semi-supervised clustering for oil prediction
Tue Boesen, Eldad Haber, G Michael Hoversten
Computers & Geosciences 148 (2021) p. 104684. Pergamon, 2021

An efficient 2D inversion scheme for airborne frequency-domain data
Tue Boesen, Esben Auken, Anders Vest Christiansen, Gianluca Fiandaca, Casper Kirkegaard, Andreas Aspmo Pfaffhuber, Malte Vöge
Geophysics 83.4 (2018) E189–E201. Society of Exploration Geophysicists and American Association of Petroleum …, 2018

A parallel computing thin-sheet inversion algorithm for airborne time-domain data utilising a variable overburden
Tue Boesen, Esben Auken, Anders Vest Christiansen, Gianluca Fiandaca, Cyril Schamper
Geophysical Prospecting 66.7 (2018) pp. 1402–1414. European Association of Geoscientists & Engineers, 2018

A review of airborne electromagnetic methods with focus on geotechnical and hydrological applications from 2007 to 2017
Esben Auken, Tue Boesen, Anders V Christiansen
Advances in geophysics 58 (2017) pp. 47–93. Elsevier, 2017

Conference Proceedings

Semi-supervised clustering for oil prospectivity
Tue Boesen, Eldad Haber, G Michael Hoversten
ICLR AI for Earth Sciences workshop, 2020

Efficient 2D hybrid inversion of airborne frequency domain data
E Auken, T Boesen, AVC Christiansen, GF Fiandaca, AA Pfaffhuber, MV Vöge
Second European Airborne Electromagnetics Conference, 2017

2D FEM inversion with a moving footprint and a hybrid 1D and 2D forward and derivative implementation
Tue Boesen, Esben Auken, Malte Vöge, Casper Kirkegaard, Kristoffer Rønne Andersen, Andreas Aspmo Pfaffhuber, Anders Vest Christiansen
AGU Fall Meeting Abstracts, 2016

Rapid inversion of large airborne AEM data datasets utilizing massively parallel co-processors
C Kirkegaard, K Andersen, AV Christiansen, E Auken, T Boesen
First European Airborne Electromagnetics Conference, 2015

Utilizing massively parallel co-processors in the AarhusInv 1D forward and inverse AEM modelling code
Casper Kirkegaard, Kristoffer Andersen, Tue Boesen, Anders V Christiansen, Esben Auken, Gianluca Fiandaca
ASEG Extended Abstracts, 2015

2.5D inversion of sea ice thickness from helicopter EM data
M Vöge, A Pfaffhuber, E Auken, C Kirkegaard, T Boesen, S Hendricks, P Hunkeler
First European Airborne Electromagnetics Conference, 2015