

# Tue J. Boesen

MACHINE LEARNING SPECIALIST

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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-ready code. Within machine learning, I have specialized 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 allow 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 **natural language processing** and **convolutional** models and used self-training to teach them how amino acids bind together and how proteins fold.
- Used **transfer learning** and reversible networks to create geological maps from satellite data.
- Used **reinforcement learning** and Monte Carlo graph search techniques to create AIs that can play boardgames.

### Owner – Consultant

*Aarhus, 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 BRITISH 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 natural language processing models.
- Published a semi-supervised active learning algorithm utilizing pseudo-labeling 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, an application for ground-based electromagnetic measurements.

# Education

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## Ph.D. in Geophysics

AARHUS UNIVERSITY

- Thesis: Numerical methods for electromagnetic geophysics beyond 1D

[Denmark](#)

2015 - 2018

## M.S. in Theoretical Physics

AARHUS UNIVERSITY

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

[Denmark](#)

2010 - 2011

## B.S. in Physics

AARHUS UNIVERSITY

- Thesis: Feynman's path integral in one dimension with focus on sinusoidal trajectories

[Denmark](#)

2006 - 2010

# Skills

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**Platforms** Windows, Linux Ubuntu, AWS

**Programming** Python, Pytorch, Matlab, Fortran, Julia, Delphi/Pascal, OpenMP, MPI, LaTeX, Git

**Languages** Danish, English

# Teaching and supervision

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## Teaching

INSTRUCTOR

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

[Aarhus University, Denmark](#)

2009-2017

## Supervision

CO-SUPERVISOR

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

[UBC, Canada](#)

2020

# Publications

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## Submitted

Neural DAEs: Constrained neural networks

Tue Boesen, Eldad Haber, Uri M Ascher

*arXiv preprint arXiv:2211.14302*. 2022

## Journal Articles

A-optimal active learning

Tue Boesen, Eldad Haber

*Physica Scripta* 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*. 2022

Data-driven semi-supervised clustering for oil prediction

Tue Boesen, Eldad Haber, Michael G Hoversten

*Computers & Geosciences* p. 104684. Pergamon, 2021

An efficient 2D inversion scheme for airborne frequency-domain data

Tue Boesen, Esben Auken, Anders V Christiansen, Gianluca Fiandaca, Casper Kirkegaard, Andreas A Pfaffhuber, Malte Vöge

*Geophysics* 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 V Christiansen, Gianluca Fiandaca, Cyril Schamper

*Geophysical Prospecting* 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* pp. 47–93. Elsevier, 2017

## Conference Proceedings

Semi-supervised clustering for oil prospectivity

Tue Boesen, Eldad Haber, Michael G Hoversten

*ICLR AI for Earth Sciences workshop, 2020*

Efficient 2D hybrid inversion of airborne frequency domain data

Esben Auken, Tue Boesen, Anders V Christiansen, Gianluca Fiandaca, Andreas A Pfaffhuber, Malte 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 Andersen, Andreas A Pfaffhuber, Anders V Christiansen

*AGU Fall Meeting Abstracts, 2016*

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*

Rapid inversion of large airborne AEM data datasets utilizing massively parallel co-processors

Casper Kirkegaard, Kristoffer Andersen, Anders V Christiansen, Esben Auken, Tue Boesen

*First European Airborne Electromagnetics Conference, 2015*

2.5D inversion of sea ice thickness from helicopter EM data

Malte Vöge, Andreas A Pfaffhuber, E Auken, Casper Kirkegaard, Tue Boesen, Stefan Hendricks, Priska Hunkeler

*First European Airborne Electromagnetics Conference, 2015*

## About me

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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.