Joel Oskarsson

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Research Interests

In my research I work with probabilistic machine learning methods for modeling data with spatial and temporal dependencies. I am motivated by applications of machine learning to earth system modeling, such as weather forecasting and climate modeling. Part of my research is in core machine learning method development, where unique challenges from earth science act as an underlying motivation. These challenges include: irregular observations, high-dimensional data, complex temporal dynamics and the need for accurate uncertainty estimates. I also enjoy developing methods specifically for earth science applications, tailoring the machine learning methods using domain knowledge to solve relevant problems in new ways.

Education

2020–2025 **Doctoral Studies in Computer Science (in progress)**
Linköping University, 240 ECTS
Linköping, Sweden

- At the Division of Statistics and Machine Learning (STIMA), Department of Computer and Information Science. Supervised by Fredrik Lindsten (main supervisor), Per Sidén and Tomas Landelius.
- Title of PhD thesis: *Graph-based Machine Learning for Spatio-Temporal Data* (preliminary). Planned defense May 2025.
- Affiliated PhD Student in the Wallenberg AI, Autonomous Systems and Software Program (WASP).

2015–2020 **Master's program in Computer Science and Engineering**
Linköping University, 300 ECTS
Linköping, Sweden

- Master's thesis: *Probabilistic Regression using Conditional Generative Adversarial Networks*.

2018–2019 **Exchange Studies**
ETH Zürich
Zürich, Switzerland
First year of my master's as an exchange student at ETH.

Employment

2020 – **PhD Student, Linköping University**
Linköping, Sweden
Research + 20% of employment teaching.

2016–2019 **Teaching Assistant, Linköping University**
Linköping, Sweden
Multiple periods.

2018, Summer **Summer Intern, Ericsson**
Linköping, Sweden
Internship at Ericsson Research, working with GNSS positioning.

Research Visits

2024 (1 week) European Centre for Medium-Range Weather Forecasts (ECMWF)
Bonn, Germany
Hosted by Mariana Clare

2024 (1 week) ETH Zürich + MeteoSwiss
Zürich, Switzerland
Hosted by Simon Adamov

2023 (5 weeks) University College London (UCL)
London, U.K.
Hosted by Marc Deisenroth

2022 (1 week) Finnish Center for AI + Aalto University
Helsinki, Finland
WASP International Study Visit

Publications

Journal papers

[1] Theodor Westny, **Joel Oskarsson**, Björn Olofsson, and Erik Frisk. "MTP-GO: Graph-Based Probabilistic Multi-Agent Trajectory Prediction with Neural ODEs". In: *IEEE Transactions on Intelligent Vehicles* (2023).

Peer-reviewed conference papers

[2] **Joel Oskarsson**, Tomas Landelius, Marc Peter Deisenroth, and Fredrik Lindsten. "Probabilistic Weather Forecasting with Hierarchical Graph Neural Networks". In: *Advances in Neural Information Processing Systems*. Vol. 37. [**Spotlight**]. Forthcoming. 2024.

[3] **Joel Oskarsson**, Per Sidén, and Fredrik Lindsten. "Temporal Graph Neural Networks for Irregular Data". In: *Proceedings of The 26th International Conference on Artificial Intelligence and Statistics*. 2023.

[4] Theodor Westny, **Joel Oskarsson**, Björn Olofsson, and Erik Frisk. "Evaluation of Differentially Constrained Motion Models for Graph-Based Trajectory Prediction". In: *2023 IEEE Intelligent Vehicles Symposium (IV)*. 2023.

[5] **Joel Oskarsson**, Per Sidén, and Fredrik Lindsten. "Scalable Deep Gaussian Markov Random Fields for General Graphs". In: *Proceedings of the 39th International Conference on Machine Learning*. PMLR, 2022.

Peer-reviewed workshop papers

[6] Vignesh Gopakumar, **Joel Oskarsson**, Ander Gray, Lorenzo Zanisi, Stanislas Pamela, Daniel Giles, Matt Kusner, and Marc Deisenroth. "Valid Error Bars for Neural Weather Models using Conformal Prediction". In: *ICML Workshop on Machine Learning for Earth System Modeling*. 2024.

[7] **Joel Oskarsson**, Tomas Landelius, and Fredrik Lindsten. "Graph-based Neural Weather Prediction for Limited Area Modeling". In: *NeurIPS 2023 Workshop on Tackling Climate Change with Machine Learning*. 2023.

[8] **Joel Oskarsson**, Per Sidén, and Fredrik Lindsten. "Temporal Graph Neural Networks with Time-Continuous Latent States". In: *ICML Workshop on Continuous Time Methods for Machine Learning*. 2022.

Under review

[9] Martin Andrae, Tomas Landelius, **Joel Oskarsson**, and Fredrik Lindsten. "Continuous Ensemble Weather Forecasting with Diffusion models". In: *preprint* (2024).

[10] Vignesh Gopakumar, Ander Gray, **Joel Oskarsson**, Lorenzo Zanisi, Stanislas Pamela, Daniel Giles, Matt Kusner, and Marc Peter Deisenroth. "Uncertainty Quantification of Pre-Trained and Fine-Tuned Surrogate Models using Conformal Prediction". In: *preprint* (2024).

Invited talks

2024-11-07 *Frontiers in Machine Learning for Weather Forecasting*, RISE Research Institutes of Sweden, Learning Machines Seminars
Online

2024-08-22 *Graph-based Machine Learning for Weather*, European Centre for Medium-Range Weather Forecasts (ECMWF)
Bonn, Germany

2024-05-02 *Graph-based Neural Weather Prediction for Limited Area Modeling*, MeteoSwiss
Zürich, Switzerland

2024-04-30 *Graph-based Neural Weather Prediction for Limited Area Modeling*, ETH Zürich
Zürich, Switzerland

2024-04-17 *Graph-based Machine Learning for Spatio-Temporal Data, with Application to Traffic and Weather Forecasting*, University of New South Wales (UNSW)
Sydney, Australia (Online)

2024-03-05 *Graph-based Neural Weather Prediction for Limited Area Modeling*, Uppsala University
Uppsala, Sweden

2024-01-11 *Neural Weather Prediction for Limited Area Modeling*, IEA Wind Task 51 Webinar: Forecasting for the Weather Driven Energy System
Online

2023-10-10 *Graph-based Neural Weather Prediction for Limited Area Modeling*, Danish Meteorological Institute
Copenhagen, Denmark

Participation in Scientific Events

2024 *ELLIIT Focus Period Symposium: Machine Learning for Climate Science*
Linköping, Sweden
Poster presentation

2024 *Large-Scale Deep Learning for the Earth System Workshop*
Bonn, Germany
Oral presentation

2024 *International Conference on Machine Learning (ICML)*
Machine Learning for Earth System Modeling Workshop at ICML 2024
Vienna, Austria
Workshop poster presentation

2024 *ESA-ECMWF workshop on Machine Learning for Earth System Observation and Prediction*
Frascati, Italy
Oral presentation + poster presentation

2024 *ELLIIT Annual Workshop*
Lund, Sweden
Poster presentation

2024 *WASP Winter Conference*
Norrköping, Sweden
Poster presentation

2023 *Conference on Neural Information Processing Systems (NeurIPS)*
Tackling Climate Change with Machine Learning Workshop at NeurIPS 2023
Online attendance
Workshop poster presentation

2023 *Large-Scale Deep Learning for the Earth System Workshop*
Bonn, Germany
Oral presentation

2023 *Nordic Conference in Mathematical Statistics (NORDSTAT)*
Gothenburg, Sweden
Oral presentation

2023 *International Conference on Artificial Intelligence and Statistics (AISTATS)*
Valencia, Spain
Poster presentation

2023 *Swedish Symposium on Image Analysis and Deep Learning*
Norrköping, Sweden
Poster presentation

2023 *WASP Winter Conference*
Norrköping, Sweden
Poster presentation

2022 *AI Day Finland*
Helsinki, Finland

2022 *Learning on Graphs Conference (LoG)*
Online attendance

2022 *International Conference on Machine Learning (ICML)*
Continuous Time Methods for Machine Learning Workshop at ICML 2022
Baltimore, U.S.
Poster presentation + Workshop poster presentation (*Cancelled due to illness*)

2022 *Nordic Probabilistic AI Summer School*
Helsinki, Finland
Poster presentation

Career Development Grants

2023 Research Visit Scholarship ($\approx 60\,000$ SEK)
Wallenberg AI, Autonomous Systems and Software Program (WASP)

Other Academic Activities

2023– Co-organizer of monthly online meetups for researchers working on machine learning limited area weather forecasting models.

2023– Creator and maintainer of the *Neural-LAM* open source python library for machine learning weather forecasting models.

2022– Organizer of the *STIMA Machine Learning Reading Group* at Linköping University.

Reviewing

2025 International Conference on Learning Representations (ICLR)

2024 Conference on Neural Information Processing Systems (NeurIPS)

2023–2024 International Conference on Artificial Intelligence and Statistics (AISTATS)

2024 Tackling Climate Change with Machine Learning Workshop (Climate Change AI), *(Multiple occasions).*

Media Coverage of Research

2024 *De vill göra väderprognoser mer pålitliga – med hjälp av AI*
News coverage, SVT (Swedish Public Service Television)

2023 *Förbättrade väderprognoser med AI*
News posting, Linköping University

Specific Skills and Knowledge

- Extensive knowledge of modern **machine learning** methods. Specific expertise in:
  - Probabilistic deep learning
  - Spatio-temporal models of physical systems
  - Bayesian models and inference methods
  - Graph neural networks
- Sound knowledge of good **software engineering** practices, acquired from my undergraduate studies and research experience.

- Programming languages and frameworks:
  Python, PyTorch, SciPy, NumPy, PyTorch Lightning, Xarray, PyTorch Geometric, scikit-learn, Bash, R, C++, JavaScript
- Highly accustomed to **Linux** environments.
- Used to working with **high-performance computing** systems.
- Languages:
  - Swedish: Native
  - English: Fluent
  - German: Basic skills

References

- *Prof. Fredrik Lindsten*

  Position: Senior Associate Professor at Linköping University, Sweden

  Relation: Main supervisor of my PhD

  Webpage: `https://lindsten.netlify.app/`

  E-mail: `fredrik.lindsten@liu.se`

- *Prof. Marc Deisenroth*

  Position: Google DeepMind Chair of Machine Learning and Artificial Intelligence at University College London, U.K.

  Relation: Collaborator

  Webpage: `https://www.deisenroth.cc/`

  E-mail: `m.deisenroth@ucl.ac.uk`

- *Dr. Tomas Landelius*

  Position: Researcher at the Swedish Meteorological and Hydrological Institute

  Relation: Co-supervisor of my PhD

  Webpage: `https://www.smhi.se/en/research/research-departments/meteorology/tomas-landelius-1.4817`

  E-mail: `tomas.landelius@smhi.se`