# Prakhar **Verma**

Doctoral Candidate · Machine Learning Researcher · Aalto University

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## Education

### Aalto University — *Finland*

Doctor of Philosophy (Ph.D.) — *2022 - Present*

- Exploring statistical machine learning with Prof. Arno Solin.
- Broadly researching Generative AI, Large Language Model (LLM) and Retrieval-Augmented Generation (RAG), Probabilistic Modeling, and Efficient Inference Techniques.

### Aalto University — *Finland*

Master of Science (M.Sc.) - 4.7/5 (Pass with Honors) — *2019 - 2021*

- Major in Machine Learning, Data Science, and Artificial Intelligence and Minor in Mathematics
- Thesis: *Sparse Gaussian processes for stochastic differential equations* with AaltoML. (PDF)

### Uttarakhand Technical University — *India*

Bachelor of Technology (B.Tech.) - 79.03% (First Division with Honors) — *2012 - 2016*

- Specialization in Information Technology
- Thesis: *Development of automated GIS Tools on various platforms* with TomTom India. (PDF)

## Professional Experience

### Adobe Research — *Bangalore, India*

Research Intern — *June 2024 - August 2024*

- Researched and developed an LLM-guided causal discovery framework to evaluate the effectiveness of LLMs as proxy experts in causal discovery, focusing on user behavior data. The project, conducted with Atanu R Sinha, resulted in a patent-pending methodology.

### Microsoft Research — *Bangalore, India*

Research Intern — *March 2024 - May 2024*

- Researched and developed a novel reasoning and planning framework for Retrieval-Augmented Generation (RAG) with Amit Sharma, focusing on improving multi-hop query performance, latency, and computational cost.
- Work under review; preprint available at link.

### University of Oxford — *Oxford, United Kingdom*

Visiting Researcher — *July 2023 - September 2023*

- Collaborated with Prof. Seth Flaxman and Elizaveta Semenova, focusing on encoding prior information and developing efficient inference techniques for life sciences and medical applications.

### Aalto University — *Espoo, Finland*

Research Assistant — *April 2020 - August 2022*

- Member of the AaltoML group; focused on probabilistic machine learning to develop learning and efficient approximate inference methods for dynamical systems and stochastic differential equation (SDE) models.

### SpectacularAI — *Espoo, Finland*

Research Engineer (Part-time) — *September 2021 - September 2022*

- Consulted for an electronics firm, researching methods to incorporate uncertainty estimation in deep learning models to improve robustness.

### TomTom — *Pune, India*

Software Engineer (R&D) — *July 2016 - August 2019*

- Researched and developed a semantic segmentation solution for extracting map features from satellite imagery and automatically ingesting them into the database, removing human-in-the-loop.
- Developed a proof-of-concept (PoC) for a real-time map vector tile server, which was later converted into an open platform product.
- Developed an ArcGIS plugin used daily by surveyors across the globe for field surveying and reporting.

## Publications

- **Prakhar Verma**, Sukruta Prakash Midigeshi, Gaurav Sinha, Arno Solin, Nagarajan Natarajan, Amit Sharma. Plan*RAG: Efficient Test-Time Planning for Retrieval Augmented Generation. (Under review)
- **Prakhar Verma**, Harshita Chopra, Arno Solin, Sunav Choudhary, David Arbour, and Atanu R. Sinha. LLM-guided Bayesian Causal Discovery and Parameter Estimation. (Under review)
- **Prakhar Verma**, Vincent Adam, Arno Solin. Variational Gaussian Process Diffusion Processes. *International Conference on Artificial Intelligence and Statistics (AISTATS), 2024.*
- Paul Edmund Chang[*], **Prakhar Verma**[*], S.T. John, Arno Solin, and Mohammad Emtiyaz Khan. Memory-based dual Gaussian processes for sequential learning. *International Conference on Machine Learning (ICML), 2023. (Oral Presentation)*
- Arno Solin, Ella Tamir, **Prakhar Verma**. Scalable Inference in SDEs by Direct Matching of the Fokker–Planck–Kolmogorov Equation. *Advances in Neural Information Processing Systems 35* (NeurIPS), 2021.
- **Prakhar Verma**, Paul Chang, Arno Solin, Mohammad Emtiyaz Khan. Sequential Learning in GPs with Memory and Bayesian Leverage Score. *Asian Conference in Machine Learning (ACML) workshop "Continual Lifelong Learning" 2022 (Contributed talk)*.
- Paul Chang, **Prakhar Verma**, ST John, Victor Picheny, Henry Moss, Arno Solin. Fantasizing with Dual GPs in Bayesian Optimization and Active Learning. *Gaussian Processes, Spatiotemporal Modeling, and Decision-making Systems, NeurIPS Workshop, 2022.*
- Elizaveta Semenova, **Prakhar Verma**, Max Cairney-Leeming, Arno Solin, Samir Bhatt, Seth Flaxman. PriorCVAE: Scalable MCMC parameter inference with Bayesian deep generative modelling. (Under review)
- **Prakhar Verma**, Vincent Adam, Arno Solin. Sparse Gaussian Processes for Stochastic Differential Equations. *The Symbiosis of Deep Learning and Differential Equations (DLDE), NeurIPS Workshop, 2021.*
- Fuzail Palnak[*], Kshitij Nikhal[*], **Prakhar Verma**[*], Ravi Panchani[*], and Sagar Rohankar[*]. M.A.G.E.C: machine assisted geometry extraction and creation. *Twelfth International Conference on Machine Vision* (ICMV 2019).

## Skills & Interests

- Probabilistic Machine Learning, Generative Machine Learning, Retrieval-Augmented Generation, Large Language Models (LLMs), Gaussian Processes, Bayesian Learning, Uncertainty Quantification, Deep Learning.
- Python, PyTorch, Transformers, GPFlow, numPy, scikit-learn, JAX, AWS

## Presentations

- Tensorflow case study on how convolution neural networks can be used to extract road networks and airports from satellite imagery and how TFServing can host the models at Google Developers Group 2018.
- An end-to-end machine learning framework to detect and extract essential map features from satellite imagery and ingest them into the database removing human-in-the-loop at GeoSpatial World Forum 2018.

## Accomplishments

- Awarded *"Nokia Scholarship"* in *2024* for exceptional progress and research excellence during doctoral studies.
- Awarded *"Dean Scholarship"* in *2020* and *2021* at Aalto University for commendable academic progress during MSc studies.
- Awarded *"Face of TomTom 2018"* for actively representing TomTom in conferences and promoting the brand.
- Winner of TomTom *"Innovation Day 2018"*, presented an AI plugin which bridges the gap between machines and cartographers.
- Mentor at "TomTom External Hackathon 2018".
- *"Electronic Health Record"* idea was selected in Top 10 at a national event, "India Ideathon 2015".
- Oracle Certified Associate Java SE 7 programmer.