# Nathanael Bosch

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nathanaelbosch

## Research Interests

**Probabilistic machine learning *for* and *with* dynamical systems:** probabilistic numerics, scientific machine learning, differential equations, state-space models, Gaussian processes.

## Education

2020 – today **Ph.D. Computer Science**, *University of Tübingen*.
Researching and developing probabilistic numerical solvers for differential equations.
Advisor: Philipp Hennig.

2018 – 2019 **M.Sc. Data Engineering and Analytics**, *TU Munich*, *1.3 (Distinction; GPA 3.7)*.
Master thesis: "Learning Gaussian Process Dynamics Models from Visual Observations for Control".

2016 – 2018 **M.Sc. Mathematics**, *TU Munich*, *1.2 (High Distinction; GPA 3.8)*.
Master thesis: "Evolutionary Games for Global Function Minimization".

2012 – 2016 **B.Sc. Mathematics**, *TU Munich*, *1.8 (GPA 3.2)*.
Bachelor thesis: "Different Noise Models in Variable Density Compressed Sensing".

2007 – 2012 **Abitur**, *Landesgymnasium für Hochbegabte*, Schwäbisch Gmünd, *1.4 (GPA 3.6)*.

## Publications

2023 **Nathanael Bosch**, Adrien Corenflos, Fatemeh Yaghoobi, Filip Tronarp, Philipp Hennig, and Simo Särkkä. *"Parallel-in-Time Probabilistic Numerical ODE Solvers"*. arXiv, 2023.

**Nathanael Bosch**, Philipp Hennig, and Filip Tronarp. *"Probabilistic Exponential Integrators"*. NeurIPS, 2023.

2022 **Nathanael Bosch**, Filip Tronarp, and Philipp Hennig. *"Pick-and-Mix Information Operators for Probabilistic ODE Solvers"*. AISTATS, 2022.

Nicholas Krämer*, **Nathanael Bosch***, Jonathan Schmidt*, and Philipp Hennig. *"Probabilistic ODE Solutions in Millions of Dimensions"*. ICML, 2022.

Filip Tronarp*, **Nathanael Bosch***, and Philipp Hennig. *"Fenrir: Physics-Enhanced Regression for Initial Value Problems"*. ICML, 2022.

2021 **Nathanael Bosch**, Philipp Hennig, and Filip Tronarp. *"Calibrated Adaptive Probabilistic ODE Solvers"*. AISTATS, 2021.

Jonathan Wenger, Nicholas Krämer, Marvin Pförtner, Jonathan Schmidt, **Nathanael Bosch**, Nina Effenberger, Johannes Zenn, Alexandra Gessner, Toni Karvonen, François-Xavier Briol, Maren Mahsereci, and Philipp Hennig. *"ProbNum: Probabilistic Numerics in Python"*. arXiv, 2021.

2020 **Nathanael Bosch***, Jan Achterhold*, Laura Leal-Taixé, and Jörg Stückler. *"Planning from Images with Deep Latent Gaussian Process Dynamics"*. L4DC, 2020.

## Teaching Experience

2022 – 2023 **Co-lecturer: "Numerics of Machine Learning"**, *University of Tübingen*.
Gave two full M.Sc.-level lectures, on "Ordinary Differential Equations" and "Probabilistic Numerical ODE Solvers", as part of a course taught by Philipp Hennig together with multiple other PhD students from the group.

2022 **Guest lecturer: "Probabilistic Numerics for Ordinary Differential Equations"**, *Uppsala University*.
Gave a single guest lecture as a part of a seminar on "A computational introduction to stochastic differential equations", organized and taught by Zheng Zhao.

2021 – 2022 **Teaching assistant: "Data Literacy"**, *University of Tübingen*.
Course taught by Philipp Hennig.

2021 **Seminar: "Machine learning for and with dynamical systems"**, *University of Tübingen*.
Jointly organized with Nicholas Krämer and Philipp Hennig.

2020 – 2021 **Teaching assistant: "Time Series"**, *University of Tübingen*.
Course taught by Filip Tronarp.

2017 **Teaching assistant: "Principles of Mathematics 2"**, *Technical University of Munich*.
Mathematics course, aimed at B.Sc. Engineering Science students.

2016 & 2017 **Course instructor**, *abiturma GbR*, Munich and Stuttgart.
Intensive five-day preparation course for the german Abitur in mathematics.

### Supervision

2021/2022 **Thomas Albrecht**, *Master's thesis*.
Bayesian physics-informed neural networks via Laplace approximations.

2021/2022 **Felix Böhm**, *Bachelor's thesis*.
"Inferring ODE parametric latent forces via Neural ODEs".

2021 **Dingling Yao**, *Master's thesis*.
"Uncertainty Propagation in Probabilistic Ordinary Differential Equation Solvers".

2021 **Joanna Sliwa**, *Essay rotation*.
"Physics Informed Neural Networks"; co-supervised with Nicholas Krämer.

## Work Experience

2019 **Student Assistant**, *Max Planck Institute for Intelligent Systems, Embodied Vision Group*, Tübingen, supervised by Jörg Stückler.
Master's thesis project on combining Gaussian process dynamics models with variational autoencoder-like deep neural networks for planning and control in image-based environments.

2016 **Data Science Intern**, *Horváth&Partners*, Munich.
- Basket analysis of a large quantity of retail sales data;
- Automatic keyword extraction from scientific papers and trend discovery;
- Visualization and presentation of the results in interactive apps using R-Shiny.

## Software

`ProbNumDiffEq.jl`, *maintainer*.
Probabilistic Numerical Differential Equation solvers via Bayesian filtering and smoothing in Julia; compatible with the popular DifferentialEquations.jl / SciML ecosystem.

`probnum`, *contributor*.
A library for probabilistic numerics in Python, which covers not only differential equations and Bayesian state estimation, but also linear solvers, numerical quadrature, and more.

## Technical skills

Working knowledge: Julia, Python, jax, NumPy/SciPy, git/GitHub, LaTeX, Unix, SLURM.
Basic knowledge: PyTorch, C/C++, R, SQL, MATLAB.

## Languages

German: Native speaker
English: Fluent
Russian: Basic communication skills
French: Near native
Spanish: Good working knowledge

## Scholarships

2013 – 2019 **German Academic Scholarship Foundation**.
2017 – 2018 **Siemens Mentoring Program**.