

Sparse Bayesian learning for inverse problems: Models, inference, and open problems

Speaker. Jan Glaubitz (Assistant Professor, Mathematics, Linköping University)

Short bio. Jan is an Assistant Professor in Computational Mathematics at Linköping University and the PI of a VR Starting Grant. Prior to joining Linköping University in 2024, he earned his PhD from TU Braunschweig (Germany) in 2020 and held postdoctoral positions at Dartmouth College and MIT.

Abstract. How can we reconstruct high-quality images from measurement data? How can we uncover biochemical reactions from experiments? How can we quantify uncertainty in the predictions of mathematical models, such as neural networks?

These questions arise across a wide range of applications—from medical imaging, remote sensing, and data assimilation to computational chemistry, biology, and neuroscience. Despite their differences, these problems share a common mathematical structure: they can all be formulated as **inverse problems**—in which unknown quantities must be inferred from indirect and noisy observations.

In this talk, I will adopt a **Bayesian** perspective to inverse problems—modeling unknown quantities probabilistically—enabling uncertainty quantification in reconstructions and downstream predictions. This, in turn, supports more trustworthy scientific inference and informed decision-making. Specifically, I will focus on **hierarchical sparsity-promoting priors** and discuss recent advances in their **computationally efficient inference**. To this end, I will draw on techniques from numerical analysis, optimization, and measure-transport theory. Topics will include block-coordinate descent methods for maximum a posteriori (MAP) estimation and accelerated sampling using prior-normalizing transport maps. Finally, I will discuss some open problems and their connection to stochastic differential equations.

Parts of this talk are based on joint work with Youssef Marzouk (MIT), Anne Gelb (Dartmouth College), Jonathan Lindbloom (Dartmouth College), and Mirjeta Pasha (Virginia Tech).

Keywords. Bayesian inverse problems, sparse Bayesian learning, uncertainty quantification, MAP estimation, sampling, transport maps