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FAKULTÄT FÜR MATHEMATIK
Dekan Univ.-Prof. Dr. Radu Ioan Bot

Einladung zur öffentlichen Defensio

Fabian Kai Parzer

Thema der Dissertation

Low-Rank and Scale-Space Methods for Imaging with Uncertainty Quantification

Abstract:

Imaging inverse problems are ubiquitous in science and engineering. In many applications, the reconstructed image comes with significant uncertainties due to measurement or modelling error. Developing computational methods to characterize these uncertainties is a challenging task that has attracted considerable research interest, especially in the last decade.

In the first part of this presentation, we consider the computational solution of linear imaging inverse problems using stochastic low-rank approximations. We focus on ensemble Kalman inversion, a method based on ideas from stochastic filtering that recently attracted considerable research interest. By interpreting it as a stochastic low-rank approximation of Tikhonov regularization, we are able to derive error estimates and formulate an adaptive version for which we prove convergence rate results.

In the second part of this talk, we focus on a specific application of uncertainty quantification in imaging: the detection of significant structures. This investigation was motivated by an astronomical application – integrated-light stellar population recovery – where the aim is to detect blob-like structures in an image which has to be reconstructed from a noisy spectrum and hence comes with considerable uncertainties. Using ideas from scale-space theory, we then formulate an uncertainty-aware Laplacian-of-Gaussians method for the detection of significant blobs from the generated samples.

Finally, we consider the problem of uncertainty-aware blob detection in a more general setting and propose a significantly improved method for blob detection with uncertainties, based on insights from classic tube methods and total variation regularization. The method requires the numerical solution of a challenging non-smooth optimization problem, but has the advantage that it allows for a more informative representation of the uncertainty in position and scale.

Prüfungssenat
Univ.-Prof. Mag. Dr. Andreas Cap
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Zeit und Ort:

Thema: Defensio F. Parzer

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