Winter School of SIAM/GAMM Student Chapter Berlin



21 - 22 February 2024, Institute of Mathematics, Humboldt-Universität zu Berlin

Inverse and Optimal Control Problems

The SIAM/GAMM student chapter Berlin proudly presents its first Winter School on Inverse and Optimal Control Problems, which will take place on **21 and 22 February 2024 in Adlershof at the Institute of Mathematics, Mathematical Optimization Group.**

The aim of this event is to give SIAM/GAMM student members (PhD, Master students) an introduction to inverse problems and optimal control problems and, building on this, an insight into current research areas, trends and research activities in these fields. Therefore, this winter school bridges the gap between the basics and the current state of research of the respective topic, see abstracts below.

The winter school will be held in person and **registration is free but mandatory** and can be done by sending an informal E-mail to siam-gamm-student-chapter@hu-berlin.de. Coffee breaks and snacks will be provided by the organizers. We hope to have sparked your interest, if not the abstracts below will surely change your mind :)

On behalf of the SIAM/GAMM Student Chapter, Raphael Kuess (Secretary)

Quasi-Monte Carlo methods for PDE uncertainty quantification

Speaker: Vesa Kaarnioja (Freie Universität Berlin)

High-dimensional numerical integration plays a central role in the contemporary study of uncertainty quantification. The analysis of how uncertainties associated with material parameters or the measurement configuration propagate within mathematical models leads to challenging high-dimensional integration problems. Meanwhile, Bayesian inference can be used to express the solution to inverse problems in terms of a high-dimensional posterior distribution. Evaluating the mean or uncertainty of the posterior distribution involves the computation of high-dimensional integrals.

Modern quasi-Monte Carlo (QMC) methods are based on tailoring specially designed cubature rules for highdimensional integration problems. By leveraging the smoothness and anisotropy of an integrand, it is possible to achieve faster-than-Monte Carlo convergence rates. QMC methods have become a popular tool for solving partial differential equations (PDEs) involving random coefficients, a central topic within the field of uncertainty quantification.

This course provides a brief introduction to forward and inverse uncertainty quantification for elliptic PDE problems using QMC methods.

Geometry-exploiting algorithms for nonsmooth optimization and variational regularization

Speaker: Daniel Walter (Humboldt-Universität zu Berlin)

The incorporation of convex but nonsmooth regularization functionals into infinite dimensional minimization problems has become a cornerstone of modern approaches to optimal control, variational regularization in inverse problems as well as machine learning.

This is attributed to the observation that the correct choice of the minimization space as well the regularization functional promotes desired structural features in the obtained reconstructions. We point out, e.g., the staircasing effect in image denoising problems or super-resolution effects obtained by Radon-norm regularization. However, these desirable effects come at the cost of new difficulties, both, in the theoretical aspects of the arising minimization problems as well as their practical realization.

In this short course, we review a recently popularized approach to alleviating these problems by studying the geometry of the generalized unit ball associated to the regularization functional. A focus is put on two particular topics: A proof of a convex representer theorem for solutions of minimization problem with nonsmooth regularization as well as the derivation of a fully corrective generalized conditional gradient method.

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Program

	Wednesday 21.02.2024	Thursday 22.02.2024
09:10-09:30	Coffee/Opening	Coffee
09:30-10:50	V. Kaarnioja	D. Walter
10:50-11:10	Coffee Break	Coffee Break
11:10-12:30	V. Kaarnioja	D. Walter
12:30-13:30	Lunch Break	Lunch Break
13:30-14:50	D. Walter	V. Kaarnioja
14:50- 15:10	Coffee Break	Coffee Break
15:10-16:30	D. Walter	V. Kaarnioja

All lectures and coffee breaks will take place at **seminar room 1.114** at Rudower Chaussee 25, 12489 Berlin (HU Berlin Campus Adlershof).