Abstract

Oberwolfach Workshop:

Deep Learning for PDE-based Inverse Problems

Dates:

27 Oct - 1 Nov 2024 (Code: 2444)

Organizers:

Simon Arridge, London
Peter Maass, Bremen
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This workshop aims at bringing together researchers from three different research areas (inverse problems, partial differential equations (PDE), mathematical foundations of deep learning) with the aim of developing a solid mathematical theory for deep learning concepts for PDE-based inverse problems. Such problems typically require to solve operator equations posed by the parameter-to-state map of the underlying PDE. Even if the PDE itself is linear, the related parameter identification problems and parameter-to-state operators are non-linear. More importantly, the inversion process is unstable or ill-posed and needs specific measures for regularization.

Numerical schemes for such parameter identification problems require very efficient solvers for the underlying system of PDEs. Classical numerical schemes such as finite elements are well established and efficient - but not to the extend needed for large scale parametric studies of complex PDEs. This naturally leads to data driven concepts based on neural networks. However, the instability of inverse problems posed by parameter-to-state maps is mirrored by the failure of directly applying the otherwise well studied deep learning concepts for PDE forward solvers. Such problems require additional regularization strategies and can only be solved in a combination of model driven expert knowledge of the underlying PDE in combination with specific network architectures. Creating an analytic theory for novel deep learning concepts, which utilize the existing and rich analytic theory for partial differential equations in combination with the proven approximation properties of neural networks, is the main challenge of the field for the coming years.

We hope attack the mentioned challenges from different angels during the workshop and to create lively discussion amongst the participants. We believe, that your recent research on this topic will be a most valuable contribution.

Looking forward to seeing you in Oberwolfach.