HCM HAUSDORFF CENTER FOR MATHEMATICS

UNIVERSITÄT BONN

Hausdorff Workshop

"HCM Workshop: Synergies between Data Sciences and PDE Analysis"

June 13 - 17, 2022

organized by

Franca Hoffmann, Leon Bungert

Abstracts for Keynote Talks

Gitta Kutyniok (LMU Munich)

The Impact of Artificial Intelligence on Parametric Partial Differential Equations: From Successes to Limitations

Abstract: High-dimensional parametric partial differential equations (PDEs) appear in various contexts including control and optimization problems, inverse problems, risk assessment, and uncertainty quantification. Recently, numerical experiments demonstrated the remarkable efficiency of using deep neural networks to solve parametric problems. In this talk, after an introduction into deep learning, we will provide a theoretical justification for this class of approaches in term of approximation-theoretical results. Moreover, we will present a comprehensive numerical study of the effect of such results for neural networks on practical learning problems. We will finish with a word of caution when training neural networks for solving PDEs on classical digital hardware, and present fundamental limitations.

Michael Unser (EPFL)

Neural networks and minimum-norm ridge splines

Abstract: A powerful framework for supervised learning is the minimization of a cost that consists of a data fidelity term plus a regularization functional. In this talk, I investigate a Radon-domain regularization functional that depends on a generic operator L. The proposed formulation yields a solution that takes the form of a two layer neural network with an activation function that is determined by the regularization operator. In particular, one retrieves the popular ReLU networks by taking L to be the Laplacian. The proposed setting offers guarantees of universal approximation for a broad family of regularization operators or, equivalently, for a wide variety of shallow neural networks including cases (such as ReLU) where the activation function is increasing polynomially. It also explains the favorable role of bias and skip connections in neural architectures.