

Programme

Oberwolfach Seminar:

Mathematics of Deep Learning

Dates:

14 Oct - 20 Oct 2018 (Code: 1842b)

Organizers:

Gitta Kutyniok, Berlin
Philipp Grohs, Wien

Motivation:

Despite the outstanding success of deep learning in real-world applications, most of the related research is empirically driven and a mathematical foundation is almost completely missing. At the same time, those methods have already shown their impressive potential in mathematical research areas such as imaging sciences, inverse problems, or numerical analysis of partial differential equations. Recently, theoretical research aiming to derive a fundamental understanding of different aspects of deep learning such as expressibility, generalization, identifiability, and learning as well as improving current methodologies has been intensified. Summarizing, deep learning is a rich research area, touching various areas of mathematics and posing an exciting challenge to mathematicians. This seminar is intended to provide an introduction to the current state-of-the-art in the mathematical analysis of deep learning algorithms.

Programme:

We intend to cover the following topics:

- **Expressibility:** In this part, we will study the expressibility of neural networks. In particular, we will investigate questions such as: "Which function classes can be efficiently approximated by neural networks?"
- **Learning:** This part is devoted to stochastic optimization methods for the solution of learning problems. Practical sessions, using Tensorflow, will be an integral part.
- **Generalization:** In this part we will discuss the question of how a given algorithm generalizes to new data.
- **Identifiability:** This part is concerned with the question of how a neural network reached a decision, i.e., which features in the original data are most relevant for a decision.
- **Applications:** In this part, we will study applications to inverse problems and solvers of partial differential equations, both from a theoretical and a practical view.

Goal:

The goal is to provide an introduction into this exciting research area. We will discuss current main theoretical results, and also include practical sessions. The seminar will also include problem sessions which are intended to initiate collaborations on particular projects, as well as preparing the participants to conduct their own research in this area.