

Einladung zur öffentlichen Defensio

**Julius Konstantin Berner**Thema der Dissertation  
**Mathematical Analysis of Deep Learning with Applications to  
Kolmogorov Equations****Abstract:**

This thesis comprises a series of publications that contribute to the emerging field of mathematical analysis of deep learning. The term deep learning refers to machine learning methods that use gradient-based optimization techniques to fit the parameters of deep neural networks to given data. Over the past decade, such approaches have catalyzed unprecedented advances across a wide range of applications. While a comprehensive mathematical explanation for their success remains elusive, this work provides fundamental insights that improve the theoretical understanding of deep learning. To facilitate a rigorous analysis, we focus on learning problems with known regularity properties, as frequently encountered in the context of differential equations. Specifically, we analyze deep learning algorithms for the numerical solution of a class of partial differential equations, known as Kolmogorov equations, employing representations based on stochastic differential equations. It is demonstrated that empirical risk minimization over deep neural networks efficiently approximates the solutions of families of Kolmogorov equations, with both the size of the neural networks and the number of samples scaling only polynomially in the underlying dimension. Furthermore, we introduce variance-reduced loss functions and identify settings in which local minima of corresponding optimization problems are nearly optimal. On the other hand, we also address the shortcomings of deep learning and establish fundamental constraints on learning neural networks from samples. Extensive numerical experiments corroborate the potential of deep learning to overcome the curse of dimensionality while revealing its inherent limitations. This comprehensive investigation contributes toward principled and reliable applications of deep learning in the natural sciences.

**Prüfungssenat**

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**Zeit und Ort:**

Topic: Thesis defense J. Berner  
Time: Jun 19, 2023 14:00 Vienna

Join Zoom Meeting

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