Low-rank tensor decompositions in scientific machine learning
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In scientific machine learning, cutting-edge learning techniques such as deep learning, i.e., the training of deep neural networks (DNN), are applied to solve complex problems in science and engineering.

In this context, a fundamental task is to use DNN-based methodologies to solve complex (high-dimensional) partial differential equations (PDEs). While machine learning has had enormous success in recent years, in the context of scientific machine learning, it lacks three central properties: accuracy, reliability, and interpretability.

It is believed that the aforementioned issues can be overcome by combining DNN-based methods with established methods from numerical analysis. Especially in very high dimensional problems, low-rank tensor decompositions have established themselves as an extremely successful tool with deep theoretical understanding. Notable examples of their applications are matrix-product states in the simulation of quantum systems and tensor train decomposition in computational mathematics.

The combination of these methods with DNN based approaches offers the possibility of establishing a solid theoretical framework to analyze DNNs.

The goal of the project is to develop stable and accurate numerical schemes for the numerical solution of PDE problems based on DNNs and low-rank tensor decompositions. This includes the construction and analysis of appropriate architectures, the conceptualization and analysis of high-performance solvers, and the derivation of theoretical robustness and convergence guarantees.

We are looking for a highly motivated student who is willing to work at the forefront of applied mathematics and integrate into a vast international network of experts in the field. The candidates should have a solid theoretical background in numerical mathematics, functional analysis, and computational science, programming skills and an aptitude for the implementation and experimental exploration of numerical algorithms. Experience in the development of scientific software is desirable. Proficiency in English (written and spoken) is required.