Preface

Recent innovations in machine learning, particularly in deep learning, have led to remarkable successes across various domains, including computer vision, speech recognition, and automated game playing, to name a few. These advances are increasingly influencing scientific computing, driven by developments in neural network approximation theory and the creation of efficient optimization tools for training tasks. However, significant challenges remain in computational science and engineering, such as achieving the high accuracy required for certain applications and ensuring that neural network models faithfully preserve underlying physical principles. This special issue seeks to present high-quality contributions that advance the mathematical foundations of machine learning and explore its applications in scientific computing.

In particular, the issue highlights recent advancements in deep learning-based solvers for (partial) differential equations, such as least-squares neural networks and deep neural networks inspired by Legendre-Galerkin approximation. It also features approaches for parametric systems, including deep surrogate models for learning Green's functions and convolutional neural network-based techniques for learning solution manifolds. Additionally, the issue covers the use of neural networks for detecting and characterizing singularities in functions and tuning parameters in conventional numerical methods. Furthermore, recent efforts to enhance the expressive power of deep neural networks and address optimization challenges in training are also showcased.

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