Proposal for Minisymposium on Machine Learning (Subject 1700)

Machine Learning for Physical Systems

Organizers: George Em Karniadakis (Brown) and Nikolaus Adams (TUM)

Machine learning is beginning to change computational science and engineering in many different and fundamental ways. Traditional computational methods that have been around for decades may not be able to directly deal with noisy and dynamic big or small data, and it is worth exploring novel combinations of traditional and emerging machine learning techniques to reach beyond the current state of the art. Deep neural networks (DNNs), in particular, is an enabling technology for data-driven modeling as well as physics-informed modeling or a combination of the two. Inverse problems for parameter estimation or even discovery of new functional relationships can be effectively tackled using DNNs. A potentially breakthrough property of DNNs is that they represent nonlinear approximations, which are independent on the dimensionality.

However, the urgent and unmet need to formally analyze, design, develop and deploy machine learning methods and develop algorithms that can scale in statistical and computational complexity to the size of modern data sets must be addressed. Many central problems, of both mathematical and physical nature, remain open and there is no clear guidance on when it is more appropriate to use machine learning tools compared to classical numerical tools in engineering applications. Similarly, optimization of neural networks is becoming an art developed mostly in the context of the non-scientific world for classification but not for regression, which is more relevant for computational science and engineering. To make significant and fast progress, it requires a holistic approach involving both new foundational theory and algorithms, and diverse applications. The primary goal of this minisymposium is to discuss recent results and techniques at the interface between traditional methods and emerging data-driven techniques to enable innovation in scientific computing in computational science and engineering.

Possible List of speakers

Remi Abgrall, U Zurich
Andrea Beck, University of Stuttgart
Steve Brunson, University of Washington
Jan Hesthaven, EPFL
Dongbin Xiu, Ohio State
Nicholas Zabaras, Warwick
Phaedon-Stelios Koutsourelakis, TU Munich
Paris Perdikaris, U Penn