COMPUTATIONAL RESEARCH IN BOSTON AND BEYOND SEMINAR

Friday, October 4, 2024

12:00 PM – 1:00 PM

https://mit.zoom.us/j/96155042770

Machine-Learning-Based Spectral Methods Toward Reduced-Order Modeling for Partial Differential Equations

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Abstract:

Many multiscale physical systems contain too many degrees of freedom to simulate accurately given limited computational resources. Reduced-order modeling techniques reduce the prohibitively large system to a computationally feasible size without sacrificing essential dynamical features. Model reduction which involves coarsening a representation using standard basis functions, e.g. Fourier functions, is well developed. The applicability and effectiveness of spectral methods depend crucially on the choice of basis functions used to expand the solution of a partial differential equation. Deep learning is a strong contender in providing efficient representations of complex functions [Meuris et al., Sci. Rep. 13, 1739, 2023]. Deep neural networks (DNNs) have shown potential in learning continuous operators or complex systems from streams of scattered data. The deep operator network (DeepONet) [Lu et al., Nat. Mach. Intell 3, 2021] consists of a DNN for encoding the discrete input function space (branch net) and another DNN for encoding the domain of the output functions (trunk net). Physics-informed DeepONets [Wang et al., Sci. Adv. 7, 40, 2021] leverage automatic differentiation to impose the underlying physical laws during model training. In this work, we employ physics-informed machine-learning extracted basis functions from DeepONets which are custom-made for the particular system, with the goal of reduced-order modeling with spectral methods for partial differential equations.

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