THE UNIVERSITY OF CHICAGO | THE COMMITTEE ON COMPUTATIONAL AND APPLIED MATHEMATICS

COLLOQUIUM

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Neural Galerkin Schemes for Evolution Equations

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Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

ABSTRACT

While machine learning methods have been shown to provide accurate predictions when trained on sufficient data, many of the most interesting phenomena in science and engineering applications happen in regimes where there is no data available a priori and where it is even unclear how to collect informative data at all. In this work, we propose Neural Galerkin schemes that integrate data acquisition into the process of solving partial differential equations with deep learning so that new data samples are collected in a self-informed manner that is guided by the dynamics of the solution itself. The proposed Neural Galerkin schemes build on Dirac-Frenkel variational methods to learn nonlinear parameters by time-integrating systems of differential equations given by the physics of the problem, which allows the intertwining of learning parameters with data collection. Numerical experiments demonstrate that the adaptive data collection of Neural Galerkin schemes is key to providing accurate approximations of solutions in high dimensions, especially if features of the solutions are local such as in interacting particle systems described by kinetic equations and when advecting coherent structures and waves in high dimensions.

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