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Mechanical Engineering Seminar Series

Derivative-informed Neural Operators

Peng Chen

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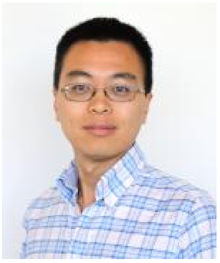

Room 1200 EECS

September 12, 2023

3:30 PM

ME Seminar Zoom link

Passcode 692510

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Abstract

In this talk I will present a novel machine learning framework for solving optimization problems governed by large-scale partial differential equations (PDEs) with high-dimensional random parameters. Such optimization problems can be found in Bayesian inverse problems for parameter estimation, optimal experimental design for data acquisition, and stochastic optimization for risk-averse optimal control and design. These problems are computationally prohibitive using classical methods, as the estimation of statistical measures may require many solutions of an expensive-to-solve PDE at every iteration of a sampling or optimization algorithm. To address this challenge, we will present a class of Derivative-Informed Neural Operators (DINO) with the combined merits of (1) being able to accurately approximate not only the mapping from the inputs of random parameters and optimization variables to the PDE state, but also its derivative with respect to the input variables, (2) using a reduced basis architecture that can be efficiently constructed and is scalable to high-dimensional problems, and (3) requiring only a limited number of training data to achieve high accuracy for both the PDE solution and the optimization solution. I will present some applications in material science, computational fluid dynamics, and structure mechanics.

Bio

Peng Chen is currently a tenure-track assistant professor in the School of Computational Science and Engineering at Georgia Tech. Previously, he was a Research Scientist at the Oden Institute for Computational Engineering and Sciences at University of Texas at Austin. Before joining UT Austin, he spent a year as a lecturer and postdoc at ETH Zurich, 2014-2015. He obtained his Ph.D. degree in Computational Mathematics from EPFL in 2014. His research is driven by challenge problems in scientific and engineering fields that involve data-driven modeling, learning, and optimization of complex systems under uncertainty, and focuses on scientific machine learning, uncertainty quantification, Bayesian inference, experimental design, and stochastic optimization.

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ME Seminar Series

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