Department of Physics

UNIVERSITY OF OXFORD

Machine Learning and Physics Seminar Series

Thursday, 5 November 2020 at 3.00pm
To receive the Zoom room link, send an empty email to
request.zoom.ox.ml.and.physics [AT] gmail [DOT] com

Can Deep Learning Discover the Functional Form of PDEs from Data?

Prof Justin Sirignano
Oxford

Although the exact physics equations for an application may be available, numerically solving these equations can be computationally intractable. The exact physics typically involve complex phenomena at small scales, which can require an infeasibly large computational grid to accurately resolve. An example is turbulence, which is relevant to modeling airplanes, ground vehicles, biomedical technology, and power generation. In this presentation, we will investigate if deep learning can be used to identify reduced-order PDE models from data. We use deep learning to develop a PDE model for the low frequencies of the Navier-Stokes equations for turbulent flows. By modeling only the low frequencies, the PDE model can be solved at a low computational cost on a coarse grid. The "deep learning PDE model" is calibrated to high-fidelity data. Training uses adjoint PDEs to optimize over the full nonlinearity of the PDE model. The approach is implemented for isotropic turbulence and turbulent jet flows, where it outperforms standard models such as Dynamic Smagorinsky in out-of-sample tests.

Justin is an Associate Professor of Mathematics at the University of Oxford. Justin's research focuses on the theory and applications of machine learning in financial mathematics and computational sciences. He has also worked on the asymptotic analysis of deep learning models. Justin was a Chapman Fellow at the Department of Mathematics at Imperial College, received his PhD from Stanford University, and has a Bachelors degree from Princeton University.