CRUNCH Seminars at Brown, Division of Applied Mathematics

Friday - August 4, 2023

Corrector Operator to Enhance Accuracy and Reliability of Neural Operator Surrogates of Nonlinear Variational Boundary-Value Problems

Prashant K. Jha, The University of Texas at Austin

This talk focuses on developing methods for approximating the solution operators of parametric partial differential equations via neural operators. Neural operators have several limitations, including unpredictable accuracy, generating appropriate training data, cost-accuracy trade-offs, and nontrivial hyperparameter tuning, impacting their applications in downstream problems of inference, optimization, and control. This talk will introduce a framework for enhancing the accuracy and reliability of neural operators. A linear variational problem is identified to govern the corrections to the prediction furnished by neural operators. The corrector problem is essentially a Newton step. As a testbed, a nonlinear diffusion equation in two dimensions is considered. PCANet-type neural operators with a residual network and singular-value decomposition-based dimension reductions are employed in numerical tests. The accuracy of neural operators with varying input and output reduced dimensions and training data samples is examined. A problem involving topology optimization is also considered to test the efficacy of neural operators as surrogates of the forward model. Optimizers, when using neural operator surrogates, consistently make significant errors. However, the error is reduced significantly when the neural operator predictions are corrected using the proposed scheme. The talk is based on the work in arXiv:2306.12047 and will soon appear in CMAME.