CRUNCH Seminars at Brown, Division of Applied Mathematics

Friday - May 26, 2023

Fixing Physics-informed Neural Networks (PINNs)

Shams Basir, Bristol Myers Squibb

Physics-informed neural networks (PINNs) incorporate equations of known physics into the objective function as a regularization term, necessitating hyperparameter tuning to ensure convergence. Lack of a validation dataset or a priori knowledge of the solution can make PINNs impractical for solving partial differential equations (PDEs). Moreover, learning inverse PDE problems with noisy data can be difficult since it can lead to overfitting noise or underfitting high-fidelity data. To investigate these limitations, we propose to create paired or twin models comprising both a PINN and its data-driven neural network counterpart. This approach allows us to examine challenges associated with embedding physics into the objective function instead of labelled data. We also visualize and investigate the loss landscapes for further insight. We then introduce physics-equality constrained artificial neural networks (PECANNs), which leverage well-established optimization methods to address the challenges in solving forward and inverse partial differential equation (PDE) problems. Through the application of PECANNs, we demonstrate the efficacy and versatility of our approach by successfully solving various forward and inverse PDE problems.