CRUNCH Seminars at Brown, Division of Applied Mathematics

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Analysis and Application of PINNs for Two-Phase Interface Problems

Xiaozhe Hu, Tufts University

In this talk, we will present our recent numerical studies on two-phase interface problems using a meshfree method through the deep neural network (DNN) approach, which are essentially relevant with applications of PINNs to time-dependent two-phase flow problems and fluid-structure interaction problems with interface separations and high-contrast coefficients. In the development of our proposed DNN/mesh free method, we represent solutions of distinct evolving PDEs on either side of the interface using different DNN structures, reformulate the studied interface problem as a least-squares problem based upon a space-time sampling point (training) set, and then solve the induced minimization problem for a desired optimizer. In addition, we analyze approximation errors of the developed DNN/meshfree method for each studied interface problem, which reveals an intrinsic strategy about how to efficiently build a sampling-point training set in order to obtain a more accurate DNN approximation. The developed DNN/meshfree method can be easily extended to many kinds of interface problems comparing with traditional discretization approaches (e.g., finite element/volume/ difference methods). Numerical experiments will be illustrated as well in the talk to show accuracies of the proposed DNN/meshfree method for the presented three kinds of interface problems, and theoretical results are validated as well to some extents.