CRUNCH Seminars at Brown, Division of Applied Mathematics

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Combining Differentiable PDE Solvers and Graph Neural Networks for Fluid Flow Prediction (Paper Review)

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Solving large complex partial differential equations (PDEs) is a computationally expensive process. This has motivated the use of deep learning approaches to approximate the PDE solutions. However, the simulation results predicted from these approaches typically do not generalize well to truly novel scenarios. In this work, the authors have developed a hybrid (graph) neural network, that combines a traditional graph convolutional network with an embedded differentiable fluid dynamics simulator inside the network itself. By combining an actual CFD simulator (which is run on a much coarser resolution representation of the problem) with the graph network, the authors have shown that their method can generalize well to new situations. It also leads to the substantial speedup of the neural network CFD predictions, while substantially outperforming the coarse CFD simulation alone.