CRUNCH Seminars at Brown, Division of Applied Mathematics

Friday - December 17, 2021

Confluence of Numerical Modeling Methods and Artificial Intelligence in Physics-based Simulations

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The rise of the fourth paradigm of science, which is data-driven discovery, has been lately enabled by our ability to collect, generate, and analyze "big data" on HPC. State-of-the-art deep learning (DL) techniques require enormous datasets for successful training. Physics-based finite element analysis (FEA) and computational fluid dynamics (CFD) simulations using high-throughput and parallel capabilities of high-performance computing (HPC) are used to generate a large amount of training data for DL on thousands of simulated modeling scenarios. Once our innovative DL models are properly trained on high-end GPUs, they can instantly make inferences on any low-end computing system (such as a laptop) of various forms of accurate modeling predictions when a novel input is presented. In our 40 min talk, we'll provide an overview of our data-driven surrogate or physics-informed deep learning models successfully applied to accelerate modeling and design in topological optimization, highly nonlinear material responses, turbulence, advanced manufacturing, uncertainty quantification, and similarly numerically intensive workflows.