CRUNCH Seminars at Brown, Division of Applied Mathematics

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Integrating Machine Learning & Multiscale Modeling in Biomedicine

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Machine learning and multiscale modeling complement each other in a unique way, enabling us to seamlessly integrate big data and biophysical pathways and interpret the results while formulating truly predictive and generalizable models based on both data and physics. In multiscale modeling, I have developed adaptive methods and kinetic models to simulate intracellular polymerization of sickle hemoglobin (HbS) and subsequent interaction with the membrane of a red blood cell (RBC) in sickle cell anemia, which occurs at multispatial scales, ranging from nanometers to micrometers. Machine learning, especially deep learning, usually requires a large amount of data of high accuracy, which is often difficult to obtain in biological and biomedical sciences. I have developed multi-fidelity neural networks, physics-informed neural networks (PINNs), and deep operator network (DeepONets), so that we can learn deep learning models accurately and robustly from even "small" datasets. I will present several examples and discuss further the interaction of both that will lead to a paradigm shift in modeling biomedical systems in the future.