CRUNCH Seminars at Brown, Division of Applied Mathematics

Friday – May 3, 2019

Paper Review: Data driven nonlinear dynamical systems identification using multi-step CLDNN

Zhiping Mao

In many cases, the equations that dynamical systems are based on are unknown and hard to model and predict. On the other hand, machine learning algorithms are based on the data of a solution as it evolves and do not need equations. In the era of abundant data, using machine learning technology to discover accurate mathematical models of dynamical systems directly from time series data becomes increasingly important. Recently, a multi-step deep neural networks (multi-step DNN) model without need of direct access to temporal gradients is proposed, which can accurately learn the evolution from a given set of observed data, identify nonlinear dynamical systems, and forecast future states. However, the architecture lacks the capability to capture long term temporal dependencies from dynamical time-series data. In the paper, based on the multi-step time-stepping schemes, we proposed a new CLDNN model which combine convolutional layer, long short-term memory layer and fully connected layer, to address the aforementioned weakness. The effectiveness of our model is tested for several benchmark problems involving the identification and prediction of complex, nonlinear and chaotic dynamics. The experiment results show that the multi-step CLDNN has better identification and prediction performance than the multi-step DNN. The research provides possible corroboration for developing new deep learning based algorithms for nonlinear system identification.