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SenSIP Seminar Series

Next-Generation Reservoir Computing, and On Explaining the Surprising Success of a Random Neural Network for Forecasting Chaos

Presenter: Professor Erik Bollt, Clarkson University

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Abstract

Machine learning has become a widely popular and successful paradigm, including for data-driven science. A major application is forecasting complex dynamical systems. Artificial neural networks (ANN) have evolved as a clear leading approach, and recurrent neural networks (RNN) are considered to be especially well suited. Reservoir computer (RC) have emerged for simplicity and computational advantages. Instead of a fully trained network, an RC trains only read-out weights. However, perhaps why and how an RC works at all, despite randomly selected weights is the surprise. We explicitly connect an RC with linear activation and linear read-out to well developed time-series literature on vector autoregressive averages (VAR), which already perform well for short term forecasts. Thus also follows existence of the representation by the WOLD theorem. Even better, with a random network, linear activation and polynomial read-out RC, we explicitly connect to a nonlinear VAR (NVAR). This leads us to introduce a new best data-driven forecasting method that we call next generation reservoir computing, NG-RC. Further, we connect this random neural network approach to the now widely popular dynamic mode decomposition (DMD). Thus, these three are in a sense different faces of the same concept. Several examples will be shown.

Biography:

Erik Bollt, (PhD, University of Colorado, Boulder) is a Full Professor at Clarkson University and endowed as the W. Jon Harrington Professor of Mathematics with appointment to the Electrical and Computer Engineering, ECE, and serves as Director of C^3S^2 - the Clarkson Center for Complex Systems Science. Professor Bollt specializes in data-enabled science with machine learning and dynamical systems. Professor Bollt has recently published a book on these topics as applied to systems such as the Gulf of Mexico oil spill [Applied and Computational Measurable Dynamics, Book Publisher: Society for Industrial and Applied Mathematics, (2013)].

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