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Why do Reservoir Computing Networks Predict Chaotic Systems so Well?[1] ZHIXIN LU, JAIDEEP PATHAK, MICHELLE GIRVAN, BRIAN HUNT, EDWARD OTT, Univ of Maryland-College Park — Recently a new type of artificial neural network, which is called a reservoir computing network (RCN), has been employed to predict the evolution of chaotic dynamical systems from measured data and without *a priori* knowledge of the governing equations of the system. The quality of these predictions has been found to be spectacularly good. Here, we present a dynamical-system-based theory for how RCN works. Basically a RCN is thought of as consisting of three parts, a randomly chosen input layer, a randomly chosen recurrent network (the reservoir), and an output layer. The advantage of the RCN framework is that training is done only on the linear output layer, making it computationally feasible for the reservoir dimensionality to be large. In this presentation, we address the underlying dynamical mechanisms of RCN function by employing the concepts of generalized synchronization and conditional Lyapunov exponents. Using this framework, we propose conditions on reservoir dynamics necessary for good prediction performance. By looking at the RCN from this dynamical systems point of view, we gain a deeper understanding of its surprising computational power, as well as insights on how to design a RCN.

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