Predicting Aging Transition Using Echo state Network

Contributed Talk

Biswambhar Rakshit

Amrita Vishwa Vidyapeetham, Coimbatore, Tamil Nadu, India

It is generally known that in a mixture of coupled active and inactive nonlinear oscillators, the entire system may stop oscillating and become inactive if the fraction of active oscillators is reduced to a critical value. This emerging phenomenon, called the "aging transition," can be analytically predicted from the view point of cluster synchronization. One can question whether a model-free, data-driven framework based on neural networks could be used to foretell when such a system will cease oscillation. Here, we demonstrate how a straightforward ESN with trained output weights can accurately forecast both the temporal evaluation and the onset of collapse in coupled paradigmatic limit-cycle oscillators. In particular, we have demonstrated that an ESN can identify the critical fraction of inactive oscillators in a large all-to-all, small-world, and scale- free network when it is trained only with two nodes (one active and the other inactive) selected from three different pre-collapse regimes. We further demonstrate that ESN can anticipate aging transition of the network when trained with the mean-field dynamics of active and inactive oscillators.