Synchronization and memory in neural networks beyond their fixed point

Bicky A. Marquez, Laurent Larger, Maxime Jacquot, Yanne K. Chembo & Daniel Brunner

FEMTO-ST Institute, Optics Department,
15B Avenue des Montboucons, 25030 Besançon Cedex, France
bicky.marquez@femto-st.fr

We investigate the computational capabilities of Random Neural Networks (RNN)'s as predictors of chaotic time series. We employ a variation of common RNN models by using a sinusoid function as the network's activation function. This allows the RNN to have a broad range of autonomous dynamics, among which we find non-equilibrium states with remarkable computational performance. This comes as a surprise as operation close to the edge of stability is generally considered optimal. We show that spatial synchronization between neurons plays an essential role in preserving the information inside the RNN, which therefore still can be harnessed for information processing. The way how RNN's memorize input information is analysed by means of the mutual information between neuron responses and the input time series. Furthermore, a stability analysis based on maximal Lyapunov exponent is introduced, allowing to identify suitable states for information processing.