On the Potential of Time Delay Neural Networks to Detect Indirect Coupling between Time Series

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Abstract:

Determining the coupling between systems remains a topic of active research in the field of complex science. Identifying the proper causal influences in time series can already be very challenging in the trivariate case, particularly when the interactions are non-linear. In this paper, the coupling between three Lorenz systems is investigated with the help of specifically designed artificial neural networks, called time delay neural networks (TDNNs). TDNNs can learn from their previous inputs and are therefore well suited to extract the causal relationship between time series. The performances of the TDNNs tested have always been very positive, showing an excellent capability to identify the correct causal relationships in absence of significant noise. The first tests on the time localization of the mutual influences and the effects of Gaussian noise have also provided very encouraging results. Even if further assessments are necessary, the networks of the proposed architecture have the potential to be a good complement to the other techniques available in the market for the investigation of mutual influences between time series.