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Extracting indirect coupling by means of recurrences

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The identification of correct couplings from measured time series taking place in a group of interacting components is a non-trivial problem. This is also interesting for extracting the interacting topology of complex networks from real data sets, in particular with the driver-response relationships. We propose a method to uncover the coupling configuration by means of recurrence properties. The approach hinges on a generalization of conditional probability of recurrence, which was originally introduced to detect and quantify the weak coupling directionality between two interacting subsystems. Here, we extend this approach to the case of multivariate time series, where the indirect interaction is present. We test our method by considering three coupled Van der Pol oscillators contaminated with normal distributed noise. Furthermore, we extract the correct time delay information contained in the three coupled Lorenz systems. Our results confirm that the proposed method could be used to identify the indirectionality, which shows relevance for experimental time series analysis.