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Phase space reconstruction by nearest neighbor embedding with different time delays

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Phase space reconstruction is key for the analysis of dynamical systems from measured time series. The choice of the time delay is not discussed in the embedding theorems, because for infinitely long and arbitrarily precise data all reconstructions are equivalent. Nevertheless, the optimal estimation of the embedding parameters becomes essential for most experimental data sets. We propose an iterative method for the selection of time delays for phase space reconstruction by time delay embedding, based on nearest neighbor estimations and on the use of different time delays between successive delay coordinates. We compare the performance of this method to the commonly used time delayed mutual information, and we also access the disruptive effect of additive Gaussian white noise on the reconstruction. We further propose a multivariate embedding scheme based on an iterative selection of variables and time delays, using this nearest neighbor embedding with different time delays method. Numerically generated solutions of the Lorenz system are used for illustration.

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