An improved indicator for causal interactions in non-linear systems

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Employing methodologies from the field of empirical dynamic modeling of non-linear systems, we revisit the problem of inferring a causal relationship between two variables when a delay between cause and effect is present. Using time series obtained from numerical and experimental data we demonstrate that the usual cross mapping criterion for causality, between time-delayed embedded reconstructions of the state space, can be enhanced when one takes into consideration the similarity between observed and predicted embedded vectors. We apply these methods on weekly mosquito abundances in northern Greece in order to ascertain how various environmental variables affect mosquitoes as well as the degree of interaction between spatially separated populations. Since mosquitoes can be vectors of viral diseases these results indicate the usefulness of empirical dynamic modeling techniques in guiding the construction of more realistic forecasting models as well as vector control strategies and health policy assessments.