CONDITIONAL RECURRENT PLOTS AND TRANSFER ENTROPY FOR OBSERVATIONAL CAUSALITY DETECTION

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Abstract

In many fields of the natural sciences, from biology to physics, information tools are acquiring more and more importance. For the analysis of information transfer between time series in particular, the use of the transfer entropy is spreading. A typical application is synchronization experiments, which involve coupled quantities, a "target" and a "source", with quasi-periodic behaviours. On the other hand, in complex systems very rarely a couple of quantities can be really considered fully isolated and immune from other influences. It is therefore important to consider not only the legacy of their past, but also the possible effects of additional factors. In order to tackle this problem, an advanced application of the recurrence plots, called Conditional Recurrence plots, has been developed. The innovative technique is corroborated by the application of the conditional transfer entropy. Preliminary results from experimental data of sawteeth pacing with radio frequency are very encouraging. Being quasi periodic, sawteeth occurs naturally and, especially in H mode plasmas, the effectiveness of the pacing with radiofrequency heating can be difficult to establish. The proposed data analysis procedure is aimed at better isolating the confounding factors, like natural sawteeth, providing both a more accurate quantification of the pacing efficiency and a deeper insight into the physical processes involved, thanks to a better understanding of the relevant causal relations.