

Workshop RPA

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Abstract 1:

Detection of deterministic transient signals in white Gaussian noise by statistical analysis of similarity matrix coefficients.

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Over the past decades, recurrence plot analysis has become a popular tool for analyzing dynamical systems. As recurrence plots show different patterns that depend on the state of the system (random, deterministic, chaotic), several approaches have been proposed in the literature to quantify and distinguish between these different states. Most of existing methods rely on metrics called recurrence quantification analysis (RQA), to decide whether the time series is random or deterministic.

In this presentation, we propose a new detection scheme that only relies on the analysis of the statistical distribution of the similarity matrix coefficients, to decide whether the measured signal is a white Gaussian noise or a deterministic transient. Our hypothesis is that if the measured time series is a white Gaussian noise, then the similarity matrix coefficients will follow a certain distribution, whereas if the measured time series contains a deterministic transient, the similarity matrix coefficients will follow another distribution.

First, we make some analytical development to derive the mathematical expressions of the expected distribution for the similarity matrix coefficients, when the input signal is a white Gaussian noise. Then, we compare this analytic distribution with the empirical distribution obtained for a given unknown measured signal. This comparison is equivalent to a goodness-of-fit test and is achieved using divergence measures. Finally, the value of this divergence measure is compared to a detection threshold in order to decide whether the analytical and empirical distributions look alike or not, and so if the measured signal is a noise only or deterministic.

The performances of the proposed detector are assessed by use of receiver operating characteristic (ROC) curves. Deterministic signals to be detected are pure cosine and impulses. Influences of parameters like the embedding m , the similarity measure and the divergence measure on the performances are discussed. Finally, the proposed detector is compared with that of the energy detector and the matched filter detector, which are commonly used in signal processing. Results of this performance analysis shows that the proposed detector outperforms the energy detector, giving a probability of detection 10% to 50% higher, and has a similar performance to that of a matched-filter detector.