Statistical analysis of time series using oscillation-related features

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In the investigation of nonlinear dynamics of oscillating time series, the interest is often in the investigation of long term correlations for times over one oscillation period, i.e. correlations between consecutive oscillations, as well as in the prediction of the peak magnitude and/or period of the next oscillation. For both of these problems, we confront the standard linear and nonlinear analysis on the scalar oscillating time series to the multivariate analysis of the time series of features extracted from the oscillations. Specifically, we consider in this work the maximum, the minimum, the period and the min-to-max time at each oscillation, assuming that the oscillations can be identified in the time series (possibly after low-pass filtering).

We show first that the analysis on the oscillation-related feature time series is more appropriate for statistical testing (using surrogate data) for the existence of correlation across oscillations, as opposed to the standard surrogate data test for nonlinearity on the oscillating time series [1]. Then we compare the standard linear autoregressive and local linear models on the oscillating time series to the respective linear and nonlinear dynamic regression models on the feature time series for the out-of-sample prediction of peaks (in magnitude and time order) [2, 3]. The results on well-known oscillating systems, such as the Mackey-Glass system, showed better predictability of the latter approach. This turned out to be mainly the case also when the same setting was applied to real-world data from electroencephalograms, optokinetic signals and sunspots.

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[2] Chao, J. et. al., *Macroeconomic Dynamics* **5**, 598–620 (2001).

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