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The Detection of Long-Range Dependence formulated as a Model Selection Problem

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Long-range dependence (LRD) indicates an algebraic, i.e. slow, decay for large lags τ of the autocorrelation function (ACF) of a stochastic process. This characteristic influences the estimation of statistical quantities from time series, such mean values, quantiles or trends. This makes its detection an important task in e.g. hydrology, climatology or econometrics.

LRD is an asymptotic property ($\tau \to \infty$) of a stochastic process and thus it is proximate to infer an underlying LRD process from an empirical time series by investigating the behaviour on large time-scales. This is frequently carried out with semi-parametric approaches, such as the log-periodogram regression or heuristic methods as the detrended fluctuation analysis (DFA). An alternative approach is the description of the ACF with a parametric model, such as the fractionally integrated auto-regressive moving average processes (FARIMA). The detection of LRD reduces then to testing the fractional difference parameter d for being significantly different from zero.

As a novel strategy for the detection of LRD, we suggest to formulate the problem as a model selection task: "find the most suitable short-range dependent (SRD) model and the most suitable LRD model and compare them by means of an appropriate model selection criterion". We illustrate this approach with a challenging example consisting of a realisation of a LRD and a SRD process which are not easily discriminated. We find this approach to be more specific than, e.g., DFA.