Time Series Analysis via Network Science

Large amounts of data index by time are becoming increasingly common in many organizations. Feature-based approaches have become common for exploring and understanding structures and patterns and to identify unusual observations in these large sets of time series. For univariate time series, there are well-define sets of time series features in the literature. This work introduces a new set of features for multivariate time series based on complex networks. First, we provide an overview of mapping approaches to represent univariate time series as single layer complex networks. Then, we introduce two new mapping methods appropriate for multivariate time series: the multilayer horizontal visibility graph that is based on the new concept of cross-horizontal and a quantile-based transition mapping. The topological measures extracted from the resulting multilayer networks constitute a set of multivariate time series features. The proposed mappings and topological measures are parameter-free, do not require data pre-processing and are applicable to any multivariate time series dataset. The features are evaluated and validate the proposed mappings. The results indicate that these features capture useful characteristics of multivariate time series.