Time series central subspace

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Abstract: We develop a sufficient dimension reduction theory for time series, which does not require specification of a model but seeks to find a $p \times d$ matrix Φ_d with smallest possible number $d \leq p$ such that the conditional distribution of $x_t|X_{t-1}$ is the same as that of $x_t|\Phi_d^T X_{t-1}$, where $X_{t-1} = (x_{t-1}, ..., x_{t-p})^T$, resulting in no loss of information about the conditional distribution of the series given its past p values. We define the subspace spanned by the columns of Φ_d as the time series central subspace and estimate it using Kullback-Leibler distance. We show that the estimator is consistent when p and d are known. In addition, we propose a consistent estimate of d and a graphical method to determine the lag p. Finally, we present examples and real data analysis to illustrate the proposed theory, which may open new research avenues in time series data analysis.