Matrix Autoregressive Spatio-Temporal Models

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Abstract

Matrix-variate time series are common nowadays in economic, medical, environmental and atmospheric sciences, typically associated with large matrix dimensions. We introduce a structured autoregressive (AR) model to characterize the temporal dynamics in a matrix-variate time series by formulating the AR matrices as a bilinear form. This bilinear parameter structure not only reduces the model dimension, but it also highlights the dynamic interactions among columns and rows in the AR matrices, making the model highly explainable. We further incorporate the spatial information and explore sparsity in the AR coefficients by considering spatial neighborhoods. In addition, we consider a non-stationary multi-resolution spatial covariance model for the innovation errors. The resulting spatio-temporal autoregressive model is flexible in capturing heterogeneous spatial and temporal features while maintaining a parsimonious parameterization. For inference, the maximum likelihood (ML) method is considered, and a fast algorithm is developed. We conduct a simulation study and present an application to a wind-speed dataset to demonstrate the merits of our methodology.