

Bayesian Analysis with Gaussian Random Functional Dynamic Spatio-Temporal Model

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Abstract: Discrete-time spatial time series data arise routinely in meteorological and environmental studies. Inference and prediction associated with them are mostly carried out using any of the several variants of the linear state space model that are collectively called linear dynamic spatio-temporal models (LDSTMs). However, real world environmental processes are highly complex and are seldom representable by models with such simple linear structure. Hence, nonlinear dynamic spatio-temporal models (NLDSTMs) based on the idea of nonlinear observational and evolutionary equations have been proposed as an alternative. However, in that case, the caveat lies in selecting the specific form of nonlinearity from a large class of potentially appropriate nonlinear functions. Moreover, modeling by NLDSTMs requires precise knowledge about the dynamics underlying the data. In this article, we address this problem by introducing the Gaussian random functional dynamic spatio-temporal model (GRFDSTM). Unlike the LDSTMs or NLDSTMs, in GRFDSTM both the functions governing the observational and evolutionary equations are composed of Gaussian random functions. We exhibit many interesting theoretical properties of the GRFDSTM and demonstrate how model fitting and prediction can be carried out coherently in a Bayesian framework. We also conduct an extensive simulation study and apply our model to real datasets. The results are highly encouraging.