Semiparametric Estimation and Selection for Nonstationary Spatial Covariance Function

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Abstract

We propose a method for estimating nonstationary spatial covariance functions by representing a spatial process as a linear combination of some local basis functions with uncorrelated random coefficients and some stationary processes, based on spatial data sampled in space with repeated measurements. By incorporating a large collection of local basis functions with various scales at various locations and stationary processes with various degrees of smoothness, the model is flexible enough to represent a variety of nonstationary spatial features. The covariance estimation and model selection are formulated as a regression problem with the sample covariances as the response and the covariances corresponding to the local basis functions and the stationary processes as the predictors. A constrained least squares approach is applied to select appropriate basis functions and stationary processes as well as estimates parameters simultaneously. In addition, a constrained generalized least squares approach is proposed to further account for the dependencies among the response variables. A simulation experiment shows that our method performs well in both covariance function estimation and spatial prediction. The methodology is applied to a U.S. precipitation data set for illustration.

Keywords: constrained least squares, least angle regression, positive Lasso, spatial prediction.

Supplementary Materials

The archive contains the precipitation data and the computer code used in Section 4. The data are downloaded from the National Atmospheric Deposition Program website (http://nadp.sws.uiuc.edu/nadpdata/annualReq.asp?site=Custom156). It is recommended to read the using condition (http://nadp.sws.uiuc.edu/useConditions.asp) before using these data. We acknowledge their generosity for the public acquiring data.

loc.txt: This file contains the longitudes and latitudes of the monitoring sites for the precipitation data.

train.id.txt: This file contains the id numbers for the training sites.

no3.txt: This file contains the NO_3 concentrations in precipitation.

cls.r: This file contains several R functions for implementing the constrained least squares.

no3.r: This file conatins the R script for estimating the parameters for the precipitation data.