Fixed rank kriging for large spatial datasets

Noel Cressie
The Ohio State University
Gardar Johannesson
Lawrence Livermore National Laboratory

Abstract

Spatial statistics for large spatial datasets is challenging. The size of the dataset, n, causes problems in computing optimal spatial predictors such as kriging, since its computational complexity is of order n^3. In addition, a large dataset is often defined on a large spatial domain, so that the spatial process of interest typically exhibits nonstationary behavior over that domain. In this paper, a flexible family of nonstationary covariance functions is defined using a set of basis functions that is fixed in number, which leads to a spatial prediction method we call Fixed Rank Kriging (FRK). FRK relies on computational simplifications when n is large, for obtaining the spatial best linear unbiased predictor (BLUP) and its mean squared prediction error for a hidden spatial process. A method is given to find optimal estimators of the covariance-function parameters, which are then substituted into the FRK equations. The new methodology is applied to a large dataset of Total Column Ozone (TCO) data, observed over the entire globe, where n is on the order of hundreds of thousands.