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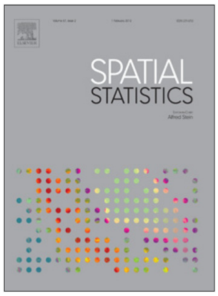

Computationally efficient spatial modeling using recursive skeletonization factorizations

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Computationally Efficient Spatial Modeling Using Recursive Skeletonization Factorizations

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Abstract

Recursive skeletonization factorization techniques can evaluate an accurate approximation to the log-likelihood for irregularly sited two-dimensional spatial data under a Gaussian process in $O(n^{3/2})$ time and $O(n \log n)$ storage. We demonstrate the application of these techniques to data on the surface of a sphere by fitting a Matérn model to approximately 87,000 total column ozone observations obtained from a single orbit of a polar-orbiting satellite. We then demonstrate that this fit can be improved by allowing either the range or scale parameters of the process to vary with latitude, but that the latter form of nonstationarity can be accommodated using skeletonization factorizations that do not need to be redone when optimizing over the parameters describing nonstationarity.

Keywords: Nonstationary processes, Ozone Monitoring Instrument, Kernelized Gaussian processes, Processes on spheres, Matérn model

1. Introduction

Environmental datasets collected by remote sensing can have millions of observations each day. Gaussian process models are commonly used to model such data, but, for n observations, exact likelihood calculations for such models based on the Cholesky decomposition of the covariance matrix require $O(n^3)$ time and $O(n^2)$ storage and become challenging to carry out on a desktop computer for n greater than about 10,000. A recent paper by

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