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# GAUSSIAN MARKOV RANDOM FIELDS

## THEORY AND APPLICATIONS

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**Leonhard Held**

UNIVERSITY OF MUNICH, GERMANY

**Comprehensive and computational,  
the perfect guide for beginners and experts  
in a wide array of statistical disciplines**

Researchers in spatial statistics and image analysis are familiar with Gaussian Markov Random Fields (GMRFs), and they are traditionally among the few who use them. There is, however, a wide range of applications for this methodology, from structural time-series analysis to the analysis of longitudinal and survival data, spatio-temporal models, graphical models, and semi-parametric statistics. With so many applications and with such widespread use in the field of spatial statistics, it is surprising that there remains no comprehensive reference on the subject.

**Gaussian Markov Random Fields: Theory and Applications** provides such a reference, using a unified framework for representing and understanding GMRFs. Various case studies illustrate the use of GMRFs in complex hierarchical models, in which statistical inference is only possible using Markov Chain Monte Carlo (MCMC) techniques. The preeminent experts in the field, the authors emphasize the computational aspects, construct fast and reliable algorithms for MCMC inference, and provide an online C-library for fast and exact simulation.

This is an ideal tool for researchers and students in statistics, particularly biostatistics and spatial statistics, as well as quantitative researchers in engineering, epidemiology, image analysis, geography, and ecology, introducing them to this powerful statistical inference method.

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### Features

- Provides a comprehensive treatment of GMRFs using a unified framework
- Contains sections that are self-contained and more advanced sections that require background knowledge, offering material for both novices and experienced researchers
- Discusses the connection between GMRFs and numerical methods for sparse matrices, intrinsic GMRFs (IGMRFs), how GMRFs are used to approximate Gaussian fields, how to parameterize the precision matrix, and integrated Wiener process priors as IGMRFs
- Covers spatial models as well as space-state models
- Describes various types of IGMRFs: on the line, the lattice, the torus, and irregular graphs
- Includes detailed case studies and an online C-library for fast and exact simulation



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