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Peer reviewed

Spatial Linear Models for Environmental Data, Dale L. Zimmerman and Jay M. Ver Hoef, Boca Raton, FL: Chapman & Hall/CRC Press, 2024, xv+383 pp., \$110.00(H), ISBN: 978-0-367-18334-9

A couple of decades ago, the book by Noel Cressie, *Statistics for Spatial Data* would sit in the bookshelves of most statisticians as one of the few, if not the only book, on spatial statistics. As the topic of spatial statistics has become increasingly mainstream, a number of books have been added to shelf to keep good company to Cressie's classic. The book by Zimmerman and Ver Hoef, published in 2024 by Chapman and Hall/CRC is one of the most recent additions. The book reflects the fact that spatial statistics has become a topic that is regularly taught in most graduate programs in statistics. In fact it is structured as a set of lecture notes, and the material in the book will be naturally covered in a one semester course, without rushing the pace too much. Abundant exercises at the end of each chapter (with solutions available to instructors that register on the Routledge web site) facilitate the task of using the book as a textbook. The focus of the book is on geostatistical models, that is, observations corresponding to a continuous space index, and on observations indexed on a lattice. The third leg of the traditional spatial statistics trifecta: spatial point patterns, is not considered. Yet, the book contains a chapter on spatial sampling design, and one on the analysis and design of spatial experiments that are not usually considered in spatial statistics books. I found those chapters very interesting and insightful.

The book start with an introduction that presents some interesting spatial data examples. The actual data, as well as code to perform the analyses are available from a github. The introduction reveals that the authors are experienced spatial modelers, with good data exploration abilities, and deep understanding of the theory and practice of spatial statistics models. A testament to this is the fact that the chapter dedicated to exploratory spatial data analysis has a number of high quality insightful graphics. The book has a strong emphasis on the exploration, estimation and properties of spatial covariances. The development of this topic starts with the second chapter. Later on, in Chapter 6, the authors provide one of the most comprehensive accounts of parametric covariance functions I have read, extending the exploration of the properties of covariance functions to the anisotropic case. A parallel, and equally thorough development for lattice models is presented in the following chapter. The development of the theory is very clear, and the examples very illustrative.

The knowledge and experience of the authors regarding the topic of spatial statistics is reflected in the comprehensive and up to date list of references. Unfortunately, the lack of an author's index makes it difficult to find where in the book a given reference is cited, and in what context. Also, the list of publicly available software for spatial statistics is large and growing, yet there is no attempt at providing any systematic references. There are no coded examples in the book, just a reference to a github repository. In fact, the topics of computations and software are treated almost as an afterthought throughout the book.

In the last decade there has been a strong effort within the community of spatial statistics to develop methods that can handle large datasets, like the ones that are produced from satellite data. Yet the textbook puts little emphasis on these problems, with just a handful of pages dedicated to low rank models, NNGP, Vecchia approximations, and the like, in Chapter 8. Likewise, there are little developments of models for multivariate data and for non-Gaussian data, with a few pages on those topics in the final chapter of the book. Count data are the most common examples of lattice data and, thus, a robust development of count data models would have provided a natural complement to the Gaussian lattice models presented in the book. Yet, for me, the most glaring omission in the book is the lack of discussion of Bayesian methods. The authors acknowledge this in the preface. They argue that the development of likelihood-based spatial statistics models will be useful for a Bayesian approach. Unfortunately their book leaves out a whole field that has demonstrated the power, flexibility, interpretability, and scientific relevance of hierarchical structures that can handle different sources of uncertainty and heterogeneous information.

In spite of the above mentioned shortcomings, I found that the book is a very valuable addition to the literature of spatial statistics. I am likely to recommend it as a reference for my students the next time I teach a spatial statistics class, and I will gratefully draw from it to complement my notes and prepare the tests and homework for the class.

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