Book #3184

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Statistical Inference and Simulation for Spatial Point Processes

Jesper Møller and Rasmus P. Waagepetersen. Boca Raton: Chapman and Hall/CRC, 2004. ISBN 0-0000-0000-X. xv + 237 pp. $69.95.

"Statistical Inference and Simulation for Spatial Point Processes" by Jesper Møller and Rasmus Plenge Waagepetersen is an extremely well-written summary of important topics in the analysis of spatial point processes. The text is an agreeable blend of technical and heuristic approaches, containing a thorough presentation of spatial point process models and a detailed survey of methods for their simulation and inference. The authors do an excellent job of focusing on those theoretical concepts and methods that are most important in applied research. While good books on spatial point processes currently exist, this is the first to tackle difficult issues of simulation and simulation-based inference for such processes, including methods based on MCMC and related techniques. As the authors correctly note, as computer power and speed increase, and since analytic expressions for expectations of statistics for complex point process models are often unavailable, simulation-based approaches for spatial point processes should become increasingly important and widespread.

Readers will find the text moderately difficult to read. It is about halfway between Brian Ripley's brilliantly simplistic "Spatial Statistics" and the far more theoretical "An Introduction to the Theory of Point Processes" by Daley and Vere-Jones, the latter of which deals little with spatial point processes but is widely (and correctly) considered the indispensable book on point processes in general. While Møller and Waagepetersen's book focuses on important practical topics such as simulation and inference, it is less a manual for applied statistics than a description of key concepts and mathematical results justifying important techniques used in applied research. Considering that the text states most results in their full mathematical precision and includes proofs of key theorems, it is remarkably easy to follow.

The book has appeal far beyond the realm indicated by its title. Following a brief introduction featuring some examples of spatial point process datasets, the book commences with a terrific summary of a wide variety of spatial point process models, and in fact hardly even mentions simulation and related topics until the seventh of its eleven chapters. Basic methods for the description, estimation, and display of key features of point processes, which are subjects described in great length in other texts such as Ripley (1981), Diggle (1983), and Cressie (1993), are all packed into chapter 4 under the heading of "Summary Statistics", which makes this 27-page chapter an appealing dense summary of such resources. The later chapters delve meticulously into simulation procedures for various models, including even detailed algorithms for simulation methods and their use in likelihood inference.

The authors have a very impressive knack for explaining complicated topics very clearly, and readers unfamiliar with the subject matter will benefit greatly from their expositions, some of which are quite innovative. For instance, most other authors start by describing a point process heuristically as a random countable collection of points in some space, but then proceed to define it instead as a random measure or stochastic process, so that the subject is embedded in a more general and more theoretically developed research area. Instead, Møller and Waagepetersen continue throughout to define a point process simply as a set, i.e. as a countable collection of points. This makes things considerably easier for the reader less familiar with measure theory, and it is remarkable how little difficulty the authors have in explaining rather sophisticated concepts or techniques using this definition. For instance, superpositions of point processes are expressed as unions of random sets, and the nearest-neighbor function in chapter 4 is defined using set differences. The more experienced reader may find these changes rather unconventional, but they do not cause any real problems and do often seem to simplify the exposition.

The book's main weakness is in its use of examples. The authors draw the inexperienced reader in with several rather nicely graphically depicted examples of spatial point process datasets, which illustrate the scope of the methods in the text. However, these examples are less than stimulating, and it is unclear what the questions of primary interest relating to these datasets are. Why, for instance, should the reader be interested in the locations of 1,382 weed plants in a Danish barley field? Perhaps in an effort not to distract attention away from the book's primary focus, the examples are not very thoroughly explained. The reader is provided little information on design and sampling issues, available covariates, and background scientific knowledge, all of which would be very important for actual applications. These omissions are very understandable: such information might seem tangent to the main topic in the book, and is not provided by other spatial point process books either. Unfortunately, however, the models and summary statistics applied to these datasets fail to inform the reader of much of profound interest, and so the reader may be left with the impression that the main purpose of such datasets is to facilitate the understanding and appreciation of spatial point process models, rather than the other way around.

The authors claim in the preface that the text is intended to be accessible to "senior undergraduate students and Ph.D. students in statistics, experienced statisticians, and applied probabilists." The book's mathematical rigor (as well as its lack of homework exercises) make it too difficult to use for an undergraduate course, but it could certainly be used for graduate students, especially if supplemented with a project involving some of the concepts in the text.

Møller and Waagepetersen's book will no doubt prove an outstanding resource for researchers and students interested in spatial point processes. Its excellent survey of the vast array of models is reason enough to own the book. As computer technology and speed advance and simulation continues to play an ever increasing role in statistical inference, the authors' clear, detailed, and comprehensive survey of simulation methods for spatial point processes will become increasingly important.

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