Spatial Point Patterns: Methodology and Applications with R (Chapman & Hall/CRC Interdisciplinary Statistics)

By Adrian Baddeley, Ege Rubak, Rolf Turner

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Modern Statistical Methodology and Software for Analyzing Spatial Point Patterns

Spatial Point Patterns: Methodology and Applications with R shows scientific researchers and applied statisticians from a wide range of fields how to analyze their spatial point pattern data. Making the techniques accessible to non-mathematicians, the authors draw on their 25 years of software development experiences, methodological research, and broad scientific collaborations to deliver a book that clearly and succinctly explains concepts and addresses real scientific questions.

Practical Advice on Data Analysis and Guidance on the Validity and Applicability of Methods

The first part of the book gives an introduction to R software, advice about collecting data, information about handling and manipulating data, and an accessible introduction to the basic concepts of point processes. The second part presents tools for exploratory data analysis, including non-parametric estimation of intensity, correlation, and spacing properties. The third part discusses model-fitting and statistical inference for point patterns. The final part describes point patterns with additional "structure," such as complicated marks, space-time observations, three- and higher-dimensional spaces, replicated observations, and

point patterns constrained to a network of lines.

Easily Analyze Your Own Data

Throughout the book, the authors use their spatstat package, which is free, open-source code written in the R language. This package provides a wide range of capabilities for spatial point pattern data, from basic data handling to advanced analytic tools. The book focuses on practical needs from the user's perspective, offering answers to the most frequently asked questions in each chapter.

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Editorial Review

Review

"The entire publication offers a wealth of information and will serve as an excellent manual and guide for the work of the point process statistician. One of the many strengths of the book is that it consistently considers point process statistics as a part of statistics in general and always to refer to general statistical ideas. The text is very accessible…There are a lot of interesting examples, which can be reproduced by the reader in R. The reader will appreciate the frequent discussions of caveats and the well-selected and well-answered FAQ's (frequently asked questions) at the end of each chapter…Overall, this publication presents an excellent introduction to and manual for the spatstat package, for which the community of spatial statisticians will be very grateful to the authors. For readers who use this software, it is an indispensable manual that the reviewer strongly recommends…The reviewer is sure that it will initiate a big step forward in the use of statistical methods for point patterns."
?Dietrich Stoyan, TU Bergakademie Freiberg, *Biometrical Journal*, January 2017

"In a nutshell, this book covers a large portion of the methods for the analysis of spatial point patterns and their implementation in the spatstat package… As spatstat has evolved with help from its users and the community, a list of frequently asked questions (FAQ) is included at the end of most chapters. This will help to clarify some of the contents and guide the user in the data analysis by pointing at different important points to consider. The book is also full of tips, clarifications and discussions on how to conduct the analysis, which clearly will benefit practitioners. It presents and discusses many applications from different fields, so that it will be of interest to a wide range of researchers…I really enjoyed reading this book and it has changed my views on spatstat. In addition to a package for the analysis of point patterns, I now regard this package as a toolbox that will allow the development of further methods and software for the analysis of point patterns, as the package provides a number of functions to rely on when developing new methods."
?Virgilio Gómez-Rubio, Universidad de Castilla-La Mancha, *Journal of Statistical Software*, December 2016

"Several books on analysing point pattern processes have been published in recent years; this is by far the largest, at least in part due to the inclusion of example scripts and output. Its central tool is the spatstat package in R. Chapters cover spatial point pattern statistics from first principles through to some of the more sophisticated techniques. Its audience is scientists looking to employ and interpret these tools, and while technical sections are included, they expand on the applied material rather than being core. This will prove a valuable reference and its guidance will improve standards in the field."
?Markus Eichhorn, *Frontiers of Biogeography*, 2016, Volume 8, Issue 3

"As the authors point out in their preface, the book is not intended to be an introduction to point process theory for mathematicians. Rather, they aim to focus on the principles of statistical inference for spatial data and to help researchers in application domains with the practicalities of the analysis and the interpretation of the results. In this, they have succeeded brilliantly...The book is written in a distinct, at times funny, always accessible style. General principles of every aspect of spatial point pattern analysis, from data collection to model validation, are discussed in great detail with pointers to the specialized literature for those who wish to gain a deeper understanding of the technicalities. The principles are illustrated by means of a wide collection of examples that can be reproduced by the reader in R. Moreover, a selection of frequently asked questions from spatstat users is answered at the end of each chapter...In summary, I warmly recommend the book to

anyone who wishes to analyze point patterns professionally."
?Marie-Colette van Lieshout, reviewed in *Biometrics*, June 2016

"Baddeley, Rubak, and Turner have written a uniquely comprehensive account of modern statistical methods for the analysis of spatial point pattern data, aimed firmly at users and, crucially, made accessible to users by explicit linkage of the methods to their own excellent R package, spatstat. Essential reading for anyone who needs to analyze spatial point pattern data properly or to teach others how to do so."
?**Peter J. Diggle,** Distinguished University Professor, CHICAS, Lancaster University Medical School, UK

"Baddeley, Rubak, and Turner's book on spatial point patterns is part of a revolution in statistics, and the reader is buoyantly swept along with it. From data handling, to exploratory data analysis, to advanced analytic tools, we are treated to the best in data science, where open-source software in the R language is used to integrate science and data through statistical thinking. This is an excellent book, founded on methodology derived from statistical models of spatial point patterns, but focusing on the practical needs of the applied scientist."
?**Noel Cressie**, Distinguished Professor, National Institute for Applied Statistics Research Australia, University of Wollongong

"*Spatial Point Patterns: Methodology and Applications with R* is a rich statistical feast. It is by turns humorous, serious, occasionally rather direct, but never talks down to the reader, who is taken as having a well-motivated interest in spatial point patterns. I would argue that applied statisticians not yet conscious of such an interest will also relish the book's stated intention of bringing its topical treatments back into mainstream statistical practice. Being able to try everything out in R, largely using the spatstat package is a clear advantage; this is coupled with numerous relevant example data sets. While cherry picking is possible?the index is more than adequate?all readers are advised to read at least whole chapters, best complete parts of the book, because the information to be found there is part of a tightly woven fabric. Much can be re-read several times with both profit and pleasure by statisticians and non-statistician practitioners. Sustaining this level of attention to detail through a long book is a splendid achievement."
?**Roger Bivand**, Professor of Geography, Norwegian School of Economics, and Author and Maintainer of Packages for Spatial Data Analysis, R Project

"The analysis of spatial point patterns and processes is an exploding field of applied research across many science and social science disciplines. This is thanks in no small part to the development of open-licensed, well-documented, methodologically sophisticated software implementations. For at least a decade, the authors of this book have been at the forefront of a statistical programming revolution. However, with wider academic access to these point pattern-and-process methods, there has also come a pressing need for clearer guidance on good practice for applied researchers at all stages from graduate studies onward. Expressed in an elegant and accessible style, with substantial references for those wanting directions into the more specialist literature, as well as an excellent set of reproducible, multi-disciplinary case studies, this book provides exactly what is needed. It is highly likely to become a classic."
?**Andrew Bevan**, Institute of Archaeology, University College London

About the Author

Adrian Baddeley is a professor of computational statistics at Curtin University and a fellow of the Australian Academy of Science. He has been a leading researcher in spatial statistics for 40 years.

Ege Rubak is an associate professor in the world-renowned spatial statistics group at Aalborg University. His research focuses on spatial statistics and statistical computing.

Rolf Turner is retired and an Honorary Research Fellow at the University of Auckland, where he has taught a graduate course on spatial point processes in the Department of Statistics. He has considerable expertise in statistical computing and has worked as a statistician in the Division of Mathematics and Statistics at CSIRO, the University of New Brunswick, and the Starpath Project at the University of Auckland.

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Nathan Weaver:

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