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Theory of Spatial Statistics: A concise Introduction.

M.N.M. van Lieshout. Boca Raton: CRC Press, 2019. ISBN 978-0-367-14642-9. 168 pp.

This book surveys the main topics in spatial statistics, including modeling random fields, variogram estimation, hierarchical models, and spatial point processes. The book is meant for graduate students in mathematics or statistics who have a solid background in probability and statistics, and would make an excellent textbook for a one semester graduate level spatial statistics course.

It is amazing how much information van Lieshout is able to convey so concisely and compactly. She is simply masterful at explaining very difficult, intricate, and important concepts, models and statistical methods in the most eloquent way. She runs through the most important topics in spatial statistics, from kriging and variogram fitting to Markov random field modeling to the estimation of log-Gaussian Cox point processes, and boils down each of these complex topics to its core elements and explains these most clearly and succinctly. The chapters are wonderfully well organized and cover an ideal list of core topics in the statistical analysis of the most common and important forms of spatial data.

Perhaps the best part of the book are the worked examples, which very substantially help inform the reader new to this material and help crystalize what these statistical models and methods are prescribing. The author even includes the R code necessary for students to create all the figures and results for themselves, which is extremely helpful so that students can imitate these analyses and perform similar analyses on their own datasets. It is clear that an enormous amount of effort went into these worked examples, though as with the theoretical topics, van Lieshout explains everything so clearly and concisely that she makes the applications and R coding look easy, and in some cases almost trivial. She also ends each chapter with beautifully written and extensively researched far-ranging summaries of the relevant literature, offering a history of the origins of the most significant contributions dating back many decades, such as Ising's 1924 text and Kolmogorov's 1933 treatise, and surveys of the most important modern developments such as various types of hierarchical models, Markov Chain Monte Carlo methods, and residual analyses for various types of spatial models including spatial point processes.

Like any book, this one is not for everyone, and some readers might be frustrated by how concisely topics are explained. In many cases, the dense writing and extensive mathematical notation in definitions would make many topics quite difficult to understand if one is using this book to learn about them for the first time. Also, while a few of the homework problems are very easy, most of them are extremely difficult and would likely be too tough for most graduate students. Curiously, solutions to *all* of the homework problems are given in the back of the book, so it is a bit unclear what the author intends instructors using the book to assign for homework. My only other criticisms are I would like to have seen some pointers to related developments in the statistical analysis of spatial-temporal data, and as with nearly every other text on spatial processes I have seen, the examples are far from compelling. Why exactly should I care about zinc concentrations in topsoil, or about the patterns in the locations of Beilschmidia trees in Panama, for instance?

Despite these very modest shortcomings, the book is nothing short of superb. It is a remarkable fusion of the most important topics in the field, both theoretical and applied, presented beautifully and eloquently with the utmost care and precision, and so concisely that it all fits into a small handbook. I would strongly recommend this book for anyone teaching a one-semester graduate level course in spatial statistics.

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