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Preface to the Second Edition

In the ten years that have passed since the first edition of this book, we believe the statistical landscape has changed substantially, even more so for analyzing space and space-time data. Apart from the remarkable growth in data collection, with datasets now of enormous size, the fields of statistics and biostatistics are also witnessing a change toward examination of observational data, rather than restricting to carefully-collected experimentally designed data. We are witnessing an increased examination of complex systems using such data, requiring synthesis of multiple sources of information (empirical, theoretical, physical, etc.), necessitating the development of multi-level models. We are seeing repeated exemplification of the hierarchical framework $[data|process, parameters][process|parameters][parameters]$. The role of the statistician is evolving in this landscape to that of an integral participant in team-based research: a participant in the framing of the questions to be investigated, the determination of data needs to investigate these questions, the development of models to examine these questions, the development of strategies to fit these models, and the analysis and summarization of the resultant inference under these specifications. It is an exciting new world for modern statistics, and spatial analysis is a particularly important player in this new world due to the increased appreciation of the information carried in spatial locations, perhaps across temporal scales, in learning about these complex processes. Applications abound, particularly in the environmental sciences but also in public health, real estate, and many other fields.

We believe this new edition moves forward in this spirit. The first edition was intended as a research monograph, presenting a state-of-the-art treatment of hierarchical modeling for spatial data. It has been a delightful success, far exceeding our expectations in terms of sales and reception by the community. However, reflecting the decade that has passed, we have made consequential changes from the first edition. Not surprisingly, the new volume is more than 50% bigger, reflecting the major growth in spatial statistics as a research area and as an area of application.

Rather than describing the contents, chapter by chapter, we note the following major changes. First, we have added a much needed chapter on spatial point patterns. This is a subfield that is finding increased importance but, in terms of application, has lagged behind the use of point-referenced and areal unit data. We offer roughly 80 new pages here, developed primarily from a modeling perspective, introducing as much current hierarchical and Bayesian flavor as we could. Second, reflecting the ubiquitous increases in the sizes of datasets, we have developed a "big data" chapter. Here, we focus on the predictive process in its various forms, as an attractive tool for handling reasonably large datasets. Third, near the end of the book we have added a new chapter on spatial and spatiotemporal gradient modeling, with associated developments by us and others in spatial boundary analysis and wombling. As elsewhere in the book, we divide our descriptions here into those appropriate for point-referenced data (where underlying spatial processes guarantee the existence of spatial derivatives) and areal data (where processes are not possible but boundaries can still be determined based on alternate ways of hierarchically smoothing the areal map. Fourth, since geostatistical (point-referenced) modeling is still the most prevalent setting for spatial analysis, we have chosen to present this material in two separate chapters. The first (Chapter 2) is a basic introduction, presented for the reader who is more focused on the practical side of things. In addition, we have developed a more theoretical chapter (Chapter 3) which provides much more insight into the scope of issues that arise in the geostatistical setting and how we deal with them formally. The presentation of this material is still gentle compared with that in many stochastic processes texts, and we hope it provides valuable model-building insight. At the same time, we recognize that Chapter 3 may be somewhat advanced for more introductory courses, so we mark it as a starred chapter. In addition to these four new chapters, we have greatly revised and expanded the multivariate and spatio-temporal chapters, again in response to the growth of work in these areas. We have also added two new special topics sections, one on data fusion/assimilation, and one on spatial analysis for data on extremes. We have roughly doubled the number of exercises in the book, and also include many more color figures, now integrated appropriately into the text. Finally, we have updated the computational aspects of the book. Specially, we work with the newest version of `WinBUGS`, the new flexible `spBayes` software, and we introduce other suitable `R` packages as needed, especially for exploratory data analysis.

In addition to those to whom we expressed our gratitude in the preface to the first edition, we now extend this list to record (in alphabetical order) the following colleagues, current and former post doctoral researchers and students: Dipankar Bandyopadhyay, Veronica Berrocal, Avishek Chakraborty, Jim Clark, Jason (Jun) Duan, David Dunson, Andrew Finley, Souparno Ghosh, Simone Gray, Rajarshi Guhaniyogi, Michele Guindani, Xiaoping Jin, Giovanna Jona Lasinio, Matt Heaton, Dave Holland, Thanasis Kottas, Andrew Latimer, Tommy Leininger, Pei Li, Shengde Liang, Haolan Lu, Kristian Lum, Haijun Ma, Marshall McBean, Marie Lynn Miranda, Joao Vitor Monteiro, XuanLong Nguyen, Lucia Paci, Sonia Petrone, Gavino Puggioni, Harrison Quick, Cavan Reilly, Qian Ren, Abel Rodriguez, Huiyan Sang, Sujit Sahu, Maria Terres, Beth Virnig, Fangpo Wang, Adam Wilson, Gangqiang Xia, and Kai Zhu. In addition, we much appreciate the continuing support of CRC/Chapman and Hall in helping to bring this new edition to fruition, in particular the encouragement of the steadfast and indefatigable Rob Calver.

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