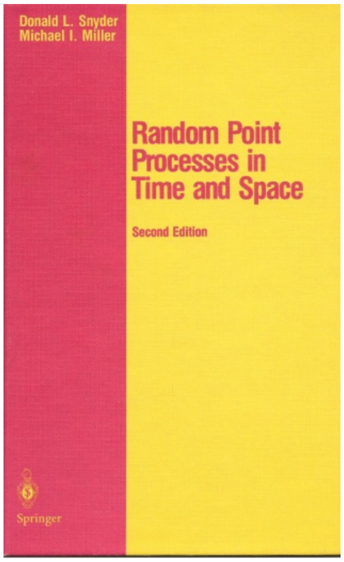

Preface

This book is a revision of *Random Point Processes* written by D. L. Snyder and published by John Wiley and Sons in 1975. More emphasis is given to point processes on multidimensional spaces, especially to processes in two dimensions. This reflects the tremendous increase that has taken place in the use of point-process models for the description of data from which images of objects of interest are formed in a wide variety of scientific and engineering disciplines. A new chapter, *Translated Poisson Processes*, has been added, and several of the chapters of the first edition have been modified to accommodate this new material. Some parts of the first edition have been deleted to make room. Chapter 7 of the first edition, which was about general marked point-processes, has been eliminated, but much of the material appears elsewhere in the new text. With some reluctance, we concluded it necessary to eliminate the topic of hypothesis testing for point-process models.

Much of the material of the first edition was motivated by the use of point-process models in applications at the Biomedical Computer Laboratory of Washington University, as is evident from the following excerpt from the Preface to the first edition.

> "*It was Jerome R. Cox, Jr., founder and [1974] director of Washington University's Biomedical Computer Laboratory, who first interested me [D.L.S.] in the aspects of random point processes that form the theme of this book. At the time I joined BCL in 1969, there was already an active project dealing with the computer processing of radioactive-tracer data obtained daily in clinical and research laboratories in the Mallinckrodt Institute of Radiology of the Washington University School of Medicine. There was then, as now, a sizable group of enthusiastic participants in this BCL effort: Carol S. Cobel, Rexford L. Hill, Kenneth B. Larson, Joanne Markham, Nizar A. Mullani, and Maxine L. Rockoff were all members of this group. BCL's effort was conducted in collaboration with E. James Potchen and Michael M. Ter-Pogossian, directors of the Divisions of Nuclear Medicine and Radiation Sciences, respectively, and John O. Eichling, Michael E. Phelps, and Roger H. Secher-Walker. My thoughts on point processes have been influenced to some extent by all these people who became my colleagues in 1969. But it was Jerome R. Cox, Jr. who suggested my using the statistical estimation and decision theory I had previously applied only to communication and control problems for the analysis of radioactive-tracer data.*"

The changes we have introduced in this revision are in large part an outgrowth of our research over the past seven years on the development of methods for quantitative image-formation. Our research at the BCL has been a major stimulus for the newly developed models for positron-emission tomography and electron-microscopic autoradiography, all presented in Ch. 3. We also include new work in astronomical imaging of faint objects. We are indebted to Dr. Lewis J. Thomas, Jr., Director of the BCL, for his encouragement and support in the biomedical imaging projects. We are also indebted to our coworkers who participated with us in this work, especially Timothy J. Holmes, John M. Ollinger, David G. Politte, Badrinath Roysam, and Timothy J.

Schulz, who contributed much to our understanding of the problems and the formulation of the new models we describe.

All the applications in which we have been involved are examples of nonparametric density estimation, which provides the major motivation for our new results on constrained estimation techniques. For these applications, the use of unconstrained maximum-likelihood estimation fails because the estimates are not consistent in the statistical sense; they do not converge, with increasing amounts of data, towards the quantity being estimated. Regularization of the estimates is, therefore, absolutely essential. There has been an explosion of methods for such regularization in nonparametric density estimation, including Grenander's method of sieves, penalized likelihood approaches, and Rissanen's description length complexity method. In the new Ch. 3, we focus on the use of Grenander's sieves and on Good's and Tapia and Thompson's work in penalized likelihood estimation. The application of these approaches for regularization is developed for point process estimation.

In Ch. 6, we also present new results for estimating hazard functions for self-exciting point-process models. This has been motivated by the recently developed models of neural discharge. We wish to express our appreciation to Dr. Charles E. Molnar for encouraging us to examine this problem. For solving the nonparametric problem of estimating a hazard function, we show how a Bayesian approach to selecting the model-order, from a family of hazard functions of varying orders of complexity, induces Rissanen's method of penalized likelihood estimation based on minimum complexity. We thank Kevin Mark for his help in Ch. 6 in describing his work on this problem.

Section 1.3 in Chapter 1 contains a detailed preview of this book. The strategy we have used starts in Chapter 2 with a detailed development of the Poisson process in time and space. Then, in subsequent chapters, a hierarchy of increasingly more complex point-process models is derived by making a series of modifications of the properties of the Poisson process. Each modification is introduced by indicating its usefulness in a real application. Thus, the approach is to start from the specific and work towards generality, with practical applications motivating the extensions along the way.

We are grateful to many students and colleagues who read the manuscript of this edition and made helpful suggestions for its improvement. Dr. Costas Georghiades of Texas A&M University, Dr. Joseph L. Hibey of Old Dominion University, Dr. Timothy J. Holmes of the Rensselaer Polytechnic Institute, and Mr. Abed Hammoud of Washington University all receive our special thanks for their help.

We owe thanks to the National Institutes of Health, through grant RR001380 from the Division of Research Resources and grant DC00333 from the Institute on Deafness and Other Communication Disorders, and the National Science Foundation, through grants ECS-8215181, ECS-8407910, ECE-8552518, and MIP-8722463 for support during the preparation of this text.

Donald L. Snyder
Michael I. Miller
St. Louis, Missouri January, 1991