PREFACE

This book presents our view of what an introduction to mathematical statistics for students with a good mathematics background should be. By a good mathematics background we mean linear algebra and matrix theory, and advanced calculus (but no measure theory). Since the book is an introduction to statistics we need probability theory and expect readers to have had a course at the level of, for instance, P. Hoel, S. Port and C. Stone's *Introduction to Probability Theory*. Our appendix does give all the probability that is needed. However, the treatment is abridged with few proofs and no examples or problems.

We feel such an introduction should at least do the following:

(1) Describe the basic concepts of mathematical statistics indicating the relation of theory to practice.

(2) Give careful proofs of the major "elementary" results such as the Neyman-Pearson lemma, the Lehmann-Scheffé theorem, the information inequality and the Gauss-Markoff theorem.

(3) Give heuristic discussions of more advanced results such as the large sample theory of maximum likelihood estimates, and the structure of both Bayes and admissible solutions in decision theory. The extent to which holes in the discussion can be patched and where patches can be found should be clearly indicated.

(4) Show how the ideas and results apply in a variety of important subfields such as Gaussian linear models, multinomial models, and nonparametric models.

Although there are several good books available for this purpose we feel that none has quite the mix of coverage and depth desirable at this level. The work of Rao, *Linear Statistical Inference and Its Applications,* 2nd ed., covers most of the material we do and much more but at a more abstract level employing measure theory. At the other end of the scale of difficulty for books at this level is the work of Hogg and Craig, *Introduction to Mathematical Statistics,* 3rd ed. These authors also discuss most of the topics we deal with but in many instances do not include detailed discussion of topics we consider essential such as existence and computation of procedures and large sample behavior.

Our book contains more material than can be covered in two quarters. In the two quarter courses for graduate students in mathematics, statistics, the physical sciences and engineering that we have taught we cover the core Chapters 2 to 7 which go from modelling through estimation and testing to linear models. In addition we feel Chapter 10 on decision theory is essential and cover at least the first two sections. Finally we select topics from Chapter 8 on discrete data and Chapter 9 on nonparametric models.

Chapter 1 covers probability theory rather than statistics. Much of this material unfortunately does not appear in basic probability texts but we need to draw on it for the rest of the book. It may be integrated with the material of Chapters 2–7 as the course proceeds rather than being given at the start; or it may be included at the end of an introductory probability course which precedes the statistics course.

A special feature of the book is its many problems. They range from trivial numerical exercises and elementary problems intended to familiarize the students with the concepts to material more difficult than that worked out in the text. They are included both as a check on the student's mastery of the material and as pointers to the wealth of ideas and results that for obvious reasons of space could not be put into the body of the text.

Conventions: (i) In order to minimize the number of footnotes we have added a section of comments at the end of each chapter preceding the problem section. These comments are ordered by the section to which they pertain. Within each section of the text the presence of comments at the end of the chapter is signalled by one or more numbers, 1 for the first, 2 for the second, etc. The comments contain digressions, reservations and additional references. They need to be read only as the reader's curiosity is piqued.

(ii) Various notational conventions and abbreviations are used in the text. A list of the most frequently occurring ones indicating where they are introduced is given at the end of the text.

(iii) Basic notation for probabilistic objects such as random variables and vectors, densities, distribtuion functions and moments is established in the Appendix.

We would like to acknowledge our indebtedness to colleagues, students, and friends who helped us during the various stages (notes, preliminary edition, final draft), through which this book passed. E. L. Lehmann's wise advise has played a decisive role at many points. R. Pyke's careful reading of a next-to-final version caught a number of infelicities of style and content. Many careless mistakes and typographical errors in an earlier version were caught by D. Minassian who sent us an exhaustive and helpful listing. W. Carmichael, in proofreading the final version, caught more mistakes than both authors together. A serious error in Problem 2.2.5 was discovered by F. Scholz. Among many others who helped in the same way we would like to mention C. Chen, S. J. Chou, G. Drew, C. Gray, U. Gupta, P. X. Quang, and A. Samulon. Without Winston Chow's lovely plots Section 9.6 would probably not have been written and without Julia Rubalcava's impeccable typing and tolerance this text would never have seen the light of day.

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