

Preface

This book developed out of my year-long course on asymptotic theory at Purdue University. To some extent, the topics coincide with what I cover in that course. There are already a number of well-known books on asymptotics. This book is quite different. It covers more topics in one source than are available in any other single book on asymptotic theory. Numerous topics covered in this book are available in the literature in a scattered manner, and they are brought together under one umbrella in this book. Asymptotic theory is a central unifying theme in probability and statistics. My main goal in writing this book is to give its readers a feel for the incredible scope and reach of asymptotics. I have tried to write this book in a way that is accessible and to make the reader appreciate the beauty of theory and the insights that only theory can provide.

Essentially every theorem in the book comes with at least one reference, preceding or following the statement of the theorem. In addition, I have provided a separate theorem-by-theorem reference as an entry on its own in the front of the book to make it extremely convenient for the reader to find a proof that was not provided in the text. Also particularly worth mentioning is a collection of nearly 300 practically useful inequalities that I have collected together from numerous sources. This is appended at the very end of the book. Almost every inequality in this collection comes with at least one reference. I have often preferred to cite a book rather than an original publication for these inequalities, particularly if the book contained many of the inequalities that I present. I also emphasize in this book conceptual discussion of issues, working out many examples and providing a good collection of unusual exercises. Another feature of this book is the guidance to the literature for someone who wishes to dig deeper into the topic of a particular chapter. I have tried to make the chapter-by-chapter bibliographies both modern and representative. The book has 574 exercises and 293 worked-out examples. I have marked the more nonroutine exercises with an asterisk.

I hope that this book is useful as a graduate text, for independent reading, and as a general and nearly encyclopedic research reference on asymptotic theory. It should be possible to design graduate-level courses using this book with emphasis on parametric methods or nonparametric methods, on classic topics or more current topics, on frequentist topics or Bayesian topics, or even on probability theory. For the benefit of instructors, I have provided recommended chapters for ten different one-semester courses, with emphasis on different themes. I hope that this provides some useful guidance toward designing courses based on this book.

Because the book covers a very broad range of topics, I do not have a uniform answer for what background I assume for a reader of this book. For most chapters, a knowledge of advanced calculus and linear algebra is enough to enable the reader to follow the material. However, some chapters require some use of measure theory and advanced analysis and some exposure to stochastic processes. One course on statistical theory at the level of Bickel and Doksum (cited in Chapter 3 of this volume) or Casella and Berger (1990) and one on probability at the level of Hoel, Port, and Stone (1971) or Durrett (1994) are certainly needed to follow the discussion in this book. Chapter 1 is essentially a review of somewhat more advanced probability should one need it. The more advanced chapters in this book can be much better appreciated if one has had courses on the two books of Erich Lehmann (Lehmann and Casella (cited in Chapter 16), Lehmann and Romano (cited in Chapter 24)) and a course based on Breiman (1992), Durrett (2004) or Billingsley (see Chapter 1).

My greatest thanks are due to Peter Hall for being an inspirational and caring advisor, reader, and intellectual filter over the last several years as I was writing drafts of this book. Peter has deeply influenced my understanding, appreciation, and taste for probability and statistics, and I have felt grateful that I have had access to him at all times and with unlimited patience. I have received much more from Peter than I could wish or expect. I could not have written this book without Peter's exemplary warmth and mentorship. However, all mistakes and ambiguities in the book are exclusively my responsibility. I would love to know of all serious mistakes that a reader finds in this book, and there must be mistakes in a book of this length.

I also want to express my very special thanks to John Marden and Larry Wasserman for repeatedly offering their friendly and thoughtful suggestions on various decisions I had to make on this book. I want to mention the generous help and support from Erich Lehmann, Peter Bickel, Rabi Bhattacharya, and Jon Wellner on specific chapters in the book. Numerous colleagues, and in particular C. R. Rao, Arup Bose, Persi Diaconis, Joe Eaton, Jianqing Fan, Iain Johnstone, T. Krishnan, Bruce Lindsay, Wei-Liem Loh, Peter McCullagh, Dimitris Politis, B. V. Rao, Bob Serfling, J. Sethuraman, Kesar Singh,

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I was an impressionable fifteen-year-old when I entered the Indian Statistical Institute (ISI) as a first-year student. I had heard that statisticians do boring calculations with large numbers using clumsy calculating machines. Dev Basu entered the lecture room on my first day at the ISI and instantly changed my perception of statistics. No one I met could explain so effortlessly the study of randomness and how to use what we learn about it to make useful conclusions. There was not one person at the ISI who didn't regard him as an incomparable role model, a personification of scholarship, and an angelic personality. I am fortunate that I had him as my foremost teacher. I am grateful to C. R. Rao for the golden days of the ISI and for making all of us feel that even as students we were equals in his eyes.

At a personal level, I am profoundly grateful to Jenifer Brown for the uniqueness and constancy of her treasured support, counsel, well wishes, and endearing camaraderie for many years, all of which have enriched me at my most difficult times and have helped me become a better human being. I will always remain much indebted to Jenifer for the positive, encouraging, and crystallizing influence she has been at all times. I have considered Jenifer to be an impeccable role model.

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