Preface

This exercises-and-solutions book contains exercises and their detailed solutions covering statistical theory (from basic probability theory through the theory of statistical inference) that is taught in courses taken by advanced undergraduate students, and first-year and second-year graduate students, in many quantitative disciplines (e.g., statistics, biostatistics, mathematics, engineering, physics, computer science, psychometrics, epidemiology, etc.).

The motivation for, and the contents of this book, stem mainly from the classroom teaching experiences of author Lawrence L. Kupper, who has taught graduate-level courses in biostatistical theory for almost four decades as a faculty member with the University of North Carolina Department of Biostatistics. These courses have been uniformly and widely praised by students for their rigor, clarity, and use of real-life settings to illustrate the practical utility of the theoretical concepts being taught. Several exercises in this book have been motivated by actual biostatistical collaborative research experiences (including those of the three authors), where theoretical biostatistical principles have been used to address complicated research design and analysis issues (especially in fields related to the health sciences). The authors strongly believe that the best way to obtain an in-depth understanding of the principles of biostatistical theory is to work through exercises whose solutions require nontrivial and illustrative utilization of relevant theoretical concepts. The exercises in this book have been prepared with this belief in mind. Mastery of the theoretical statistical strategies needed to solve the exercises in this book will prepare the reader for successful study of even higher-level statistical theory.

The exercises and their detailed solutions are divided into five chapters: Basic Probability Theory; Univariate Distribution Theory; Multivariate Distribution Theory; Estimation Theory; and Hypothesis Testing Theory. The chapters are arranged sequentially in the sense that a good understanding of basic probability theory is needed for exercises dealing with univariate distribution theory, and univariate distribution theory provides the basis for the extensions to multivariate distribution theory. The material in the first three chapters is needed for the exercises on statistical inference that constitute the last two chapters of the book. The exercises in each chapter vary in level of difficulty from fairly basic to challenging, with more difficult exercises identified with an asterisk. Each of the five chapters begins with a detailed introduction summarizing the statistical concepts needed to help solve the exercises in that

chapter of the book. The book also contains a brief summary of some useful mathematical results (see Appendix A).

The main mathematical prerequisite for this book is an excellent working knowledge of multivariable calculus, along with some basic knowledge about matrices (e.g., matrix multiplication, the inverse of a matrix, etc.).

This exercises-and-solutions book is not meant to be used as the main textbook for a course on statistical theory. Some examples of excellent main textbooks on statistical theory include Casella and Berger (2002), Hogg, Craig, and McKean (2005), Kalbfleish (1985), Ross (2006), and Wackerly, Mendenhall III, and Scheaffer (2008). Rather, our book should serve as a supplemental source of a wide variety of exercises and their detailed solutions both for advanced undergraduate and graduate students who take such courses in statistical theory and for the instructors of such courses. In addition, our book will be useful to individuals who are interested in enhancing and/or refreshing their own theoretical statistical skills. The solutions to all exercises are presented in sufficient detail so that users of the book can see how the relevant statistical theory is used in a logical manner to address important statistical questions in a wide variety of settings.

Lawrence L. Kupper
Brian H. Neelon
Sean M. O'Brien