Very interesting examples are given throughout the book often involving serious applications of the methods presented. This aspect, combined with the interesting content of the examples and an encouragement of putting theory in practice, goes beyond typical textbooks with which I am familiar.

Overall, this book is a useful and highly intellectual addition to the literature on information theory, statistics, and neural networks.

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Stereology for Statisticians.

Adrian BADDELEY and Eva B. Vedel JENSEN. Boca Raton, FL: Chapman & Hall/CRC, 2005. ISBN 1-58488-405-3. 395 pp. $79.95.

Derived from the Greek *stereos*, "stereo" refers to a solid body, and in the modern tongue connotes simultaneous consideration of related, yet distinct entities so as to infer more than what is superficially apparent. For instance, stereophonic music presents two simultaneous (yet slightly different) signals to the ears that together produce a "depth of sound" not present in either signal alone. Stereolithography is a form of rapid prototyping that creates solid models by stacking hundreds or thousands of computer-generated cross-sections. Similarly, stereology is the study of solid, three-dimensional objects based on multiple two-dimensional cross-sections, and thus can be thought of as "quantitative microscopy."

Because there is a dearth of texts devoted solely to stereology, the authors begin with an introduction to the field (Chap. 1) as well as surveys of classical and modern stereology (Chaps. 2 and 3). By their own admission, the authors focus primarily on (nonparametric) *design-based* stereology, as opposed to (parametric) *model-based* stereology, although they give brief treatment of the latter in Chapters 3, 6, and 11. After introducing the main concepts in the first few chapters, the text delves subsequently into mathematical details ranging from calculus-based geometry to probability to statistical inference (Chaps. 4–6). The remainder of the book concentrates on the theory underpinning estimation of physical quantities (e.g., volumes, areas, numbers of particles) and concludes with discussions about practical issues and open areas of research.

The authors' motivation of the field is compelling, and the figures scattered throughout the text give the reader an idea of the topic's breadth and applicability. (Figures show, for example, metal and ceramic cross-sections, a rabbit's femur, and rat kidneys.) I was immediately able to see the relevance to a problem with which I am familiar, namely the analysis of ultrasonic testing (UT) C-scans, which are images produced by interrogating a volume of an engineering material by raster scanning using sonic pulses and recording the resulting echos. Too often, as statisticians we think of "data" as a spreadsheet or database filled with numbers and compartmentalized for analysis. For the technician, especially one familiar with the specimens and test procedures, "data" is the image or the cross-section. Therefore, it is often the case that real problems are not framed as statistical ones, and in some cases it is not even obvious what parameters are to be estimated, or even if parameter estimation is a realistic or appropriate goal, let alone how to accomplish the task.

To ease the transition from more "classical" statistical viewpoints, the authors present stereology as parallel to survey sampling, a subject with which many statisticians are somewhat familiar, and provide thought-provoking discussion. For instance, they note that subsubsample estimates (based on points in a solid) may have lower variance than those based on a complete sample (using the areas that contain those points). In Chapter 13 they provide a stereological version of the Rao–Blackwell theorem for such variance comparisons.

The intended readership is expected to have a statistical background, as indicated by the book's title. However, even with such familiarity, the text is laborious, in many cases using this assumed common knowledge as an excuse to forego numerical examples. Although there are copious pictures, figures, and diagrams, not a single example using numbers or data is included for which analysis is presented from start to finish. (Although, in fairness, there are a substantial number of conceptual examples.) This leads to tremendous difficulty in internalizing the main ideas. It is apparent that the authors invested much time in constructing their figures and framing their mathematical arguments. It seems a shame that comparable effort was not spent on examples.

The text is at times difficult, and to its credit, it does not shy away from complicated problems and mathematical progressions. Given the level of understanding required by the reader, however, the choice of some exercises seems capricious. It is perhaps odd that although there are no concrete examples in the text, one of the suggested exercises (Exercise 7.1, p. 168) involves cutting an arbitrary shape from graph paper and applying different counting methods to estimate its area. If the reader can follow the mathematical development to that point, then such an exercise is trivial. From that perspective, there is some ambiguity as to what skill set is expected of the readership.

For those well-versed in stereology, this text provides a mathematically rigorous and complete treatment and is suitable as a desk reference. In particular, the "advice to consultants" digressions found at the end of each chapter provide summaries of main ideas and list potential pitfalls. On the other hand, those unfamiliar with the topic, even those with substantial statistical training, may find the prose uninviting. Of course, not all books must be practical or immediately accessible. But by including so many pictures, the authors imply a level of practicality and familiarity that, unfortunately, they do not deliver. To wit, some of the pictures involve everyday items, such as a bowl of noodles (Fig. 2.26, p. 49) or a yam (Fig. 5.9, p. 125), that one can only assume are included because of their ubiquity, rather than any obvious scientific interest. In short, theoreticians looking for a precise mathematical reference to formalize intuitive geometric ideas will find *Stereology for Statisticians* up to the task. However, this text is inappropriate for the nonstatistical practitioner or even the applied statistician looking for concrete arithmetic examples. As the cliché goes, "in theory there is no difference between theory and practice. In practice, there is."

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Measurement Theory and Practice: The World Through Quantification.

David J. HAND. London: Arnold, 2004. ISBN 0-340-67783-X. x + 320 pp. $45.00.

Because the author has worked primarily within statistics, one may expect some form of a statistics book. In reality, this book involves statistics only tangentially, yet it should interest the statistician. In the Preface, the author confesses that he received his degree in mathematics but, acknowledging the realities of the job market, he then trained as a statistician. A reader might suspect such a mathematical pedigree, for early in the book (p. 29), the words "homomorphism" and "isomorphism" occur in the same sentence, which caused this reviewer to reach for a math book to refresh his memory. Fortunately, there was little need for further reaching (indeed, there are very few equations in the book). Whereas the bad news is that this book is not about statistics, the good news is that neither is it about mathematics. Rather, it concerns itself with "the theoretical principles underlying measurement and the construction of measurement systems and tools in certain areas" (p. 272). Entire volumes have been written about the chapters and even sections of this book, so the author paints with a broad brush, especially in the later chapters.

An introductory chapter (24 pp.) addresses the need for measurement and its origins. Chapter 2, "The Nature of Measurement" (58 pp.), is sometimes technical and somewhat slow reading, because terms used throughout the rest of the book are defined. Much space is devoted to "representational measurement" and "pragmatic measurement," these themes that recur throughout the book. At the risk of gross simplification, the former is about modeling relationships to understand the phenomenon under investigation, attempting to map an empirical relationship to the numerical realm, and the latter is concerned solely with prediction, which can be done well without any comprehension of the underlying pheneomenon, as shown by the successful use of Box–Jenkins time series models. Along the way, the author provides an elegant resolution to the "two-envelope problem," a paradox that has resulted in the unnecessary death of many trees (e.g., Nalebuff 1989; Linzer 1994). Hand shows that the seeming paradox results from a measurement problem and, once the proper scale is chosen, the paradox disappers. A similarly delightful example concerns the fuel efficiency of two cars. Viewed in terms of kilometers per liter, car A is more efficient; in terms of liters per kilometer, car B is more efficient. This time, however, the resolution is not so neat.

Chapter 3, "The Process of Measurement" (39 pp.), describes many scaling systems, including Thurstone, Likert, and Coombs scaling. Factor analysis, Poisson models, and binary response approaches to latent variables are presented, and the problem of quantifying categorical scales is addressed. Chapter 4, "Accuracy of Measurement" (28 pp.), distinguishes between the validity (bias) and reliability (variance) of measurements. Interrater agreement and "other aspects of reliability" are discussed before the final section, curiously titled "Squeezing the Pips." This section focuses on ways in which the act of measuring can affect the measurement, such as Heisenberg indeterminacy and Hawthorne effect.

Next, a sequence of chapters about measurement in various disciplines is presented. Chapter 5, "Measurement in Psychology" (30 pp.), will irritate psychologists with pretensions that their measurent systems are on a par with other disciplines, and will amuse all others. Chapter 6, "Measurement in Medicine" (21 pp.), analyzes various types of indirect medical measurement, including physical disability (how severely disabled is this person?), pain (how much does it hurt?), and quality of life. Measures of diagnostic accuracy (e.g., receiver operating characteristic curve) are also discussed. Chapter 7, "Measurement in the Physical Sciences" (44 pp.), will be of most interest to statisticians, because it stresses the importance of consistent modeling, that is, respecting the dimensionality of a problem. A fascinating example of what can happen when dimensional invariance constraints are violated will have many statisticians checking (or rechecking!) their models. Chapter 8, "Measurement in Economics and the Social Sciences" (24 pp.), misses the chance to irritate economists. The author discusses index numbers and the money supply, but does not mention that the Federal Reserve incorrectly measures the money supply—something shown conclusively and repeatedly by Barnett and his coauthors over the years (see, e.g., Barnnett and Serletis 2000). (In fairness, most economists are unaware of this, so the author can hardly be faulted.)

Chapter 9, "Measurement in Other Areas" (8 pp.), briefly touches on measuring probability, software metrics for reliability, and "informetrics," under which fall both "characterizing documents" and journals' impact factors, both of which are rife with measurement problems. A list containing some 500-plus references, an author's index, and a regular index close out the book.

Statisticians who engage in cross-disciplinary work will find much of value in this book, as will nonstatisticians who use statistical methods. The sophisticated user of statistical methods (i.e., one concerned with whether or not his data mean anything and if so, to what extent they can be used as a basis for statistical calculations) will enjoy this book. The tone of the book is lively, and engaging if not gripping (how can a book that is not entirely focussed on statistics be gripping?), and the book itself can fairly be considered entertaining bedtime reading.

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Multiple Analyses in Clinical Trials: Fundamentals for Investigators.

Lemuel A. MOYÉ. New York: Springer-Verlag, 2003. ISBN 0-387-00727-X. xxiii + 436 pp. $79.97.

The proper interpretation of multiple analyses in various experimental studies (including clinical trials) requires a suitable adjustment of individual tests to protect the overall type I error probability. Because the type I error rate represents the patient's risk in a clinical trials setting, regulatory agencies mandate that clinical researchers account for multiplicity in all important analyses. The problem of multiple testing has received much attention in both statistical and clinical trials literature. Recent books by Hochberg and Tamhane (1987), Westfall and Young (1993), and Hsu (1996) provide excellent reviews of statistical multiple decision theory with applications to clinical trials. Other books aimed at a general audience of clinical researchers (e.g., Piantadosi 1997) also discuss multiplicity issues in the analysis of clinical trials data. *Multiple Analyses in Clinical Trials* is the first nonmathematical book devoted solely to this subject.

The book is aimed at clinical investigators and researchers in the pharmaceutical industry and academia as well as regulatory scientists. It is written for nonstatisticians and generally assumes only a rudimentary exposure to statistics. The book introduces and discusses important statistical principles without relying on technical jargon. The reader will enjoy the conversational style of the first several chapters. The only exception is Chapter 6, which contains mathematical derivations that may confuse the novice reader. Examples from real clinical trials are used throughout the book to illustrate and help the reader understand statistical concepts and methods being discussed.

The book can be divided into two parts. The first part of the book (Chaps. 1 and 2) covers general issues surrounding the design of clinical experiments and interpretation of their findings. Topics reviewed include principles of randomization, fixed-sample and group-sequential designs, and basics of statistical inference. Chapter 2 provides good examples of misuses and abuses of p values, pitfalls of hypothesis testing, and other statistical concepts. It encourages clinical researchers to carefully consider various quantitative aspects of clinical trials, with an emphasis on multiple analyses.

The second part (Chaps. 3–14) focuses on multiple comparison procedures arising in clinical trials with multiple outcomes/multiple subgroups of interest and dose-finding studies. Although various multiple testing scenarios are reviewed in an easily understood, intuitive, and well-illustrated manner, the book does not provide an adequate description of popular multiple testing methods the reader is likely to encounter in clinical publications or regulatory reviews. Chapter 3 touches only briefly on sequentially rejective procedures (introducing Holm's test but not the popular Hochberg's and Hommel's tests). It spends less than a page on the discussion of resampling-based multiple procedures due to Westfall and Young (1993). Similarly, the widely used Dunnett test for treatment-control comparisons and O'Brien test for multiple endpoints are minimally covered. Moreover, the book does not always explain how and when to use a particular multiple-testing procedure and often fails to point out important features of these procedures. For example, it is well known that the Simes method cannot be used for testing individual null hypotheses (it was designed for testing a global null hypothesis), but Chapter 3 describes this method as a stepwise procedure for testing individual null hypotheses.

To introduce multiple analyses in clinical trials, the book relies on a family of procedures derived from the basic Bonferroni test. Chapters 3 and 4 apply these procedures to the simple case of independent clinical endpoints, and subsequent chapters introduce a more general method for handling correlated endpoints (e.g., total mortality and total hospitalizations in a cardiovascular trial). The method involves computing a quantity (termed *dependency parameter*) that measures the strength of dependence between two test statistics; this approach is later extended to the general case of multiple test statistics. The simple Bonferroni test is then modified to account for the correlation among the endpoints. The dependency parameter is closely related to the correlation coefficient, and thus the derived procedure is likely a version of known multiple testing procedures; however, this important relation is not emphasized in the book. The book does not study the statistical properties of the proposed procedure and does not directly compare it with well-established multiple tests.

Although the book provides a good overview of issues related to the design and application of clinical trials with a large number of informative examples, most statisticians will probably hesitate to recommend it to their medical colleagues who are interested in learning about multiple comparison procedures. Clinical researchers and scientists will need to find other references to better understand modern statistical methods for performing multiple analyses in a clinical trials setting. Also, the book attempts to teach the reader to think like a statistician, but rarely emphasizes the importance of teamwork between clinical investigators and statisticians. Most clinical researchers will agree that it is this collaboration that ultimately improves the design, execution, and analysis of clinical trials.

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