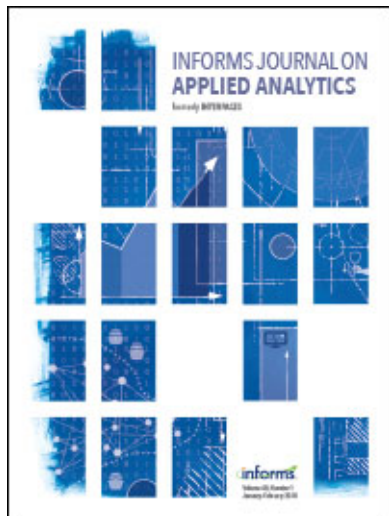




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Book Reviews

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Book Reviews

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Abstract. In *Book Reviews*, we review an extensive and diverse range of books. They cover theory and applications in operations research, statistics, management science, econometrics, mathematics, computers, and information systems. In addition, we include books in other fields that emphasize technical applications. The editor will be pleased to receive an email from those willing to review a book, with an indication of specific areas of interest. If you are aware of a specific book that you would like to review, or that you think should be reviewed, please contact the editor.

The following books are reviewed in this issue of *Interfaces* 48(3), May–June: *Computer Age Statistical Inference*, Bradley Efron and Trevor Hastie; *Straight Talk on Trade: Ideas for a Sane World Economy*, Dani Rodrik; *Reliability and Availability Engineering: Modeling, Analysis and Applications*, Kishor S. Trivedi and Andrea Bobbio.

BRADLEY EFRON, TREVOR HASTIE. 2016. *Computer Age Statistical Inference*. Cambridge University Press. 495 pp. \$74.99.

This lucid and well-structured book is written by two accomplished statisticians, Efron and Hastie. It tells the story of how the 250-year-old field of statistics, which began in 1763 with the publication of Bayes' rule, has evolved since the inception of electronic computation in the 1950s. As the authors elucidate, statistics has two aspects: algorithms and inference. Algorithms are what statisticians do (i.e., the actions they take) and inference is why they take these actions. A simple example follows: we usually calculate the sample mean by taking an average of a number of observed values to estimate the population mean, in which averaging is an algorithm. Meanwhile, we ask questions like "how accurate is the sample mean?" or "why is averaging good?"; both questions fit within the scope of inference. This book's title, *Computer Age Statistical Inference*, emphasizes the inference aspect of statistics. Distinguishing these two aspects will help us to better understand some concepts in the current big data era (e.g., data science) that emphasize algorithmic thinking rather than its inferential justification.

The book, which has three parts, proceeds historically. Part I, *Classic Statistical Inference*, reviews three themes of classical inference before the age of electronic

computation: frequentist, Bayesian, and Fisherian. During this period, statisticians usually dealt with small data sets, often a few hundred numbers or fewer, frequentist inference derives the probabilistic properties of a procedure of interest (e.g., the above averaging) and applies them to the procedure's output for the observed data. Orthogonal to frequentism, Bayesian inference requires a priori information about parameters (e.g., the above population mean) and provides the posterior distribution of parameters, which is an update of the prior knowledge after considering the observed data. In Section 3.4, the authors provide a comparison list of advantages and disadvantages of both frequentist and Bayesian inference. Fisherian inference is in the middle between frequentist and Bayesian. R. A. Fisher's key data analytic methods, including analysis of variance (ANOVA) and maximum likelihood estimation, were almost always applied frequentistically. Fisher's underlying ideas, however, are neither Bayesian nor frequentist in nature, and sometimes the two in combination.

Part II, *Early Computer-Age Methods* surveys statistical algorithms and their inferential justification from the 1950s through the 1990s. Fifteen major topics are examined in Chapters 6–13, including empirical Bayes, generalized linear models and regression trees, survival analysis, the bootstrap, cross validation, and Markov chain Monte Carlo (MCMC). This is a

transitional period when fast computation started to affect the progress of statistical methodology both in its theory and practice. As an example, one impediment for Bayesian application was the numerical calculation of a posterior distribution often involving intricate higher-dimensional integrals; however, the start of modern posterior computation algorithms in the 1980s, MCMC, including Gibbs sampling and Metropolis-Hasting, made Bayesian inference become more automatic. Chapter 14, the last chapter of Part II, provides a Bayesian-frequentist-Fisherian inferential triangle diagram, in which each of the 15 topics is placed within a triangle based on the relative influence by Bayesian, frequentist, and Fisherian (the three vertices) with colors indicating the importance of electronic computation in its development. For example, the bootstrap method that Efron invented is approximately on the frequentist-Fisherian edge and a bit far from Bayesian, and computation plays an important role in the bootstrap's development.

Part III, Twenty-First-Century Topics, addresses topics in twenty-first-century statistics. The changes in modern statistics have largely been demand driven, responding to the massive data sets (in terms of both the number of observations and the number of variables) that modern scientific equipment enable. Chapter 15 discusses large-scale hypothesis testing and its false-discovery rate implementation, which illustrate how developments in scientific technology, such as microarrays, can influence the progress of statistical inference. Chapters 16–19 cover some popular predictive modeling approaches that deal with big and wide data, including the lasso, random forests, boosting, neural networks, deep learning, support-vector machines, and kernel methods. Inference after model selection and empirical Bayes learning strategies are discussed in Chapter 20 and 21, respectively. The authors point out that one significant change in twenty-first-century statistics has been the increased acceptance of indirect evidence, which can be described as “learning from the experience of others” (pp. 104, 282) and carried out in both frequentist and Bayesian settings. For example, false-discovery rate theory discussed in Chapter 15 collects indirect evidence for hypothesis testing by means of Bayes’ theorem as implemented through empirical Bayes estimation; the computer-intensive prediction

algorithms discussed in Chapters 16–19 use regression theory to mine indirect evidence on a massive scale.

In the epilogue, a mathematics-applications-computation triangle diagram is provided to show developments in the statistics discipline over the past 100+ years, moving from pure applications to pure theory, then to a more computational focus, and winding around in the middle of the triangle. Prediction algorithms are the media stars of the big data era; however, notably missing from their development are parametric probability models, the building blocks of classical inference. It is interesting that a similar situation happened to the statistical field at the end of the 19th century, when some popular analyses (such as averaging and regression) were not well understood until R. A. Fisher put solid theoretical basis under estimation and Neyman and Pearson (1933) did the same under hypothesis testing. The book is not intended to predict the future of statistics. With the most recent data-analytic initiatives, the authors hope to see an increasing overlap between prediction algorithms and statistical inference.

In summary, this book offers a variety of statistical methods and a unity of ideas that motivate these methods and could be enormously valuable to graduate students, researchers, and practitioners. The authors use the open source statistical computing language R to illustrate the implementation of statistical methods for some examples, which will be beneficial to readers who are interested in gaining hands-on experience. I believe nonstatisticians will also enjoy reading this book because the connections between statistics and other modern concepts such as data science and machine learning are well integrated into the book.

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DANI RODRIK. 2018. *Straight Talk on Trade: Ideas for a Sane World Economy*. Princeton University Press. 316 pp. \$29.95.

In the past three decades, many prominent economists, journalists, and policy makers have championed

the cause of globalization. Although there have always been some doubts about the multilateral benefits of *cultural* globalization, there seemed to be little doubt about the proposition that increased economic integration between the nations of the world would be a win-win plan for all concerned. In this book, Dani Rodrik intelligently surveys the contemporary evidence on the effects of economic globalization and contends that “we could have constructed a more honest narrative on the world economy—one that would have prepared us for the eventual backlash and, perhaps, even rendered it less likely” (p. xiii). Rather than deliver a chapter-by-chapter review, I will sample selectively from the book’s contents. This should provide the reader with an adequate flavor for the intellectual contributions of this book.

The author begins by pointing out that although much has now been said about the seeming decline of nation-states, given the many dislocations caused by globalization, it is important to comprehend that the best way for nations to contribute to the global good in the economic sphere is by setting their own economic houses in order. In addition, nation-states need to take steps to ensure that the global agreements they sign are “democracy-enhancing” and not “globalization-enhancing” (p. 14). On a related note, we need to comprehend that in contrast to the writings of many observers, the nation-state cannot be downgraded “without compensating improvements in governance elsewhere” (p. 47).

Taking aim at authoritarian regimes, the author helpfully points out that such regimes cannot aspire to either continued economic innovation or global economic leadership. If this is the case, then how do we explain the rise of China? The author argues that China’s future economic success depends largely on whether this nation opens its *political* system to competition, in much the same way as it has opened its economy. Specifically, Rodrik claims that without this transformation, “the lack of institutionalized mechanisms for voicing and organizing dissent will eventually produce conflicts that will overwhelm the capacity of the regime to suppress” (p. 104). It is important to point out that this has been the hope of many Western commentators who believed and, in some cases, continue to believe that economic liberalization will eventually lead to political liberalization. However, not only has this *not* happened but, from a survey of the

contemporary evidence on this subject, one could plausibly claim that political liberalization is *not* inevitable. When faced with either disorganized or organized dissent, the task before the Communist Party in China is simply to determine how *ruthless* it would like to be to quash dissent. A sufficiently ruthless regime can survive for a very long time without taking any liberalizing steps that might ensure its own demise.

Focusing on the models that economists use to conduct their analysis, Rodrik tells us that economists should be more welcoming of alternate perspectives and be more careful in determining which model is best suited to a given situation. Specifically, he discusses the opposite findings of two prominent models about the net benefits of the ultimately unimplemented but much discussed trade deal, namely, the Trans-Pacific Partnership (TPP). Given this situation, we are told that “the only thing we can say with some certainty is that there would have been gainers and losers” (p. 126). This is fine; however, the discussion here would have profited from an explicit acknowledgment of the point that a key goal of the TPP was to contain the rise of China on the world stage. Once this noneconomic objective is recognized, it does *not* make sense to evaluate the usefulness of the TPP solely with economic models.

The author spends a considerable amount of time discussing the salience of ideas. As he puts it, even though economists pay a lot of attention to the interests of economic actors in their models, we need to comprehend that these interests are neither fixed nor predetermined. Also, these interests are themselves shaped by ideas about who we are, what we are attempting to achieve, and how our world works. This line of reasoning leads Rodrik to conclude that economic actors do not have interests. Instead, they “have *ideas* about what [their] interests are” (p. 163).

Does it make sense to view economics as policy innovation? The author contends that the answer to this query is an emphatic “yes” and he makes two noteworthy points. First, he maintains that even when pondering the occasionally quixotic behavior of politicians, vested interests can be overcome with novel policy ideas. In this regard, we learn that such “ideas can help the existing order’s challengers sidestep political constraints” (p. 181). Second, he claims that when pondering the propriety of giving policy advice to dictators, the foreign advisor should stay away if he believes that

the advice will be used to legitimize the dictator's rule. However, if the advisor believes that his work will "benefit those whom the leader effectively holds hostage, he has a duty not to withhold advice" (p. 192). This line of thinking is a little glib. The problem here is that it is typically *not* easy to determine how any given advice will be used and, in addition, it is also not clear that "legitimizing advice" and "beneficial advice" are mutually exclusive.

In his discussion of new rules for the global economy, Rodrik lays down seven principles that he believes will ameliorate global economic governance. One of these principles asserts that nations do not have the right to impose their institutions on others. In effect, this means two things. First, the rules of globalization should *not* force Americans or Europeans to consume goods that are produced in ways they deem unacceptable. Second, these same rules also should not permit either the United States or European Union "to use trade sanctions or other kinds of pressure to alter the way that foreign nations go about their business in labor markets, environmental policies, or finance" (p. 225). Is it not possible that these two things might, at least in some situations, be in conflict? If yes, then what happens when they are in conflict? Unfortunately, the author leaves these issues unaddressed.

In summary, this book contains a thoughtful and nuanced account of the problems created by globalization and how these problems might be addressed meaningfully. That said, the title of this book is misleading in that the book is not about trade *per se*. Trade is certainly an aspect of globalization; hence, the book would more accurately be called *Straight Talk on Globalization* or even *Straight Talk on Economic Globalization*. Readers who are interested in learning more about why nation-states continue to be important in this era of globalization and how nation-states can formulate policies to address some of the ills of globalization will profit by perusing this book.

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TRIVEDI, KISHOR S., ANDREA BOBBIO. 2017. *Reliability and Availability Engineering: Modeling, Analysis and Applications*. Cambridge University Press. 726 pp. \$79.99.

Having read books that Professor Trivedi authored or co-authored, such as Trivedi (2001), Sahner et al. (1996), and Bolch et al. (2006), I was eager to read this new book, which he co-authored with Andrea Bobbio.

Because Trivedi has authored or co-authored several books on reliability, it is natural to ask what is different about this latest book. The probability book (Trivedi 2001) is basic and covers both reliability and queuing. Its objective is to teach probability, stochastic processes, and statistics, illustrating these concepts via reliability, queuing, and computer science examples. For a deeper treatment of queueing systems and networks, Bolch et al. (2006) is a good reference. Similarly, the book being reviewed, *Reliability and Availability Engineering: Modeling, Analysis and Applications*, presents a deeper treatment of reliability and availability. It contains detailed algorithms and examples of most model types employed in reliability and availability modeling and includes actual system examples. For example, although Trivedi (2001) mentions fault trees and gives a few examples, this new book includes a full chapter on fault trees. Trivedi (2001) includes one simple example of a semi Markov process; in contrast, this book devotes an entire chapter to this topic. Similarly, Trivedi (2001) includes a few examples of multilevel modeling, whereas this book devotes three chapters to the topic. All examples used to illustrate probability concepts in Trivedi's earlier book are, necessarily, toy examples, while his new book discusses many real and large examples.

In this current book, the authors have produced an impressive volume, which consists of all existing methods of reliability and availability modeling with complete mathematical details and relevant algorithms. As one would expect from these authors, all mathematical concepts are illustrated using numerous examples and some examples are continued through multiple chapters to show the application of different techniques on the same basic example. Many (unsolved) problems are provided to allow readers to practice on their own.

The book covers both classical techniques, such as non-state-space methods (e.g., reliability block diagrams, network reliability, and fault trees) and state-space methods (e.g., continuous time Markov chains), and newer topics and analysis techniques, such as binary decision diagrams, dynamic fault trees, Bayesian belief networks, and stochastic Petri nets. More

advanced techniques to relax the ubiquitous assumption of exponential distributions are addressed in three chapters: one on nonhomogeneous Markov chains, the second on semi-Markov and Markov regenerative processes, and the third on the use of Phase-type expansions. The book illustrates how to combine different models into a multilevel model to take advantage of the capabilities of different techniques in different parts of the overall model. This avoids the complexity of generating, storing, and solving a large monolithic model. Two chapters are devoted to developing this idea and are subsequently used heavily in the section that includes case studies.

The authors develop and solve many real-life problems in detail. For example, they cast the current return network subsystem of the Boeing 787 as a network reliability problem and develop a bounding algorithm to solve this otherwise intractable problem. This algorithm is incorporated in the SHARPE software package (Sahner et al. 1996) and Boeing is using it for FAA certification for all planes that employ this subsystem. They also develop the IBM Blade Center availability model in detail. IBM's implementation of session initiation protocol (SIP) on WebSphere is analyzed for its availability, which includes both hardware and software failures, various stages of recovery, and imperfect coverage. In addition to system availability, they study defects per million (DPM), a metric that affects customers and accounts for various call-processing phases, their interactions with recovery following a component failure, and retry attempts. In addition, they develop in detail Sun Microsystems' high-availability platform and Cisco's router-availability models.

Although the book does not include any chapters dedicated solely to software reliability and availability, many examples address software failure and recovery.

Software aging and rejuvenation are also covered through examples. Other unique topics covered are combined performance and availability (performability), survivability, parametric-uncertainty propagation, and cybersecurity.

In preparing the book, the authors clearly had to make some choices because a single book cannot cover all aspects of a general discipline like reliability. They decided to concentrate their efforts on analytic models that can lead to quantifiable solutions via closed-form or numerical techniques. Throughout the book, they show how the proposed models are solvable by using a software package like SHARPE, whose practice they encourage in their problem solutions.

The book is organized into six parts: Part I (Introduction), Part II (Non-State-Space (Combinatorial) Models), Part III (State-Space Models with Exponential Distributions), Part IV (State-Space Models with Nonexponential Distributions), Part V (Multilevel Models), and Part VI (Case Studies). It can be used as a textbook for a course on reliability and as a reference book for researchers and practicing engineers. A solution manual and slides of all chapters are expected to be available soon.

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