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Book Reviews

Editor: Ananda Sen

Statistics in Toxicology Using R
L.A. Hothorn
Chapman and Hall/CRC, 2015, 234 pages, £61.99, hardback
ISBN: 978-1-498-70127-3

Readership: Toxicologists and statistical practitioners, research students.

The book contains nine chapters with an Appendix documenting the R codes. The introductory chapter lays out the principles followed by a relatively long chapter that undertakes a discourse on simultaneous comparisons with respect to a negative control. Chapters 3–5 delve into evaluations of various forms of assays. Chapter 6 describes toxicity testing, while dose–response models are discussed in Chapter 7. Some additional methodology are described in Chapter 8 with the book concluded with a short Chapter 9.

This book has the potential to become the go-to text for those working at the intersection of statistics and toxicology. It assumes familiarity with the content of an introductory statistics course and ideally a second one on experimental design and analysis. The book is very thorough in its coverage of toxicological tests, how to carry them out and how to interpret them in R, with over 400 references. However, the chapters are very unbalanced in weight, with Chapter 2 occupying over 70 pages, Chapters 6–8 together occupying fewer than 30 pages and Chapter 9 consisting of three paragraphs! That said, most readers will probably be dipping in to access examples and code for particular situations.

The author is not afraid to state his dislike for some statistical practices, in particular one dubbed the ‘decision tree’ approach. An example of this is testing for equality of variances then deciding between a pooled or unpooled two sample t-test on the basis of the first test. The author is also not afraid to state his support for other statistical practices, for instance, the arcsine transformation, in certain situations.

Use is made of a wide array of R packages, from coin to WinProb, most of which appear in CRAN. The key package SiTuR, which provides access to the example data and selected functions in the book, is available on Github.

I found about 10 typographical errors in the text, more in the latter half of the book. The style of the English expression is also somewhat unusual, and I think the book will benefit from a revised edition. This should be easily achieved as the author points out in the Preface that the book exists as a knitr document.

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Extreme Value Modelling and Risk Analysis
Dipak K. Dey and Jun Yan
Chapman & Hall/CRC, 2016, 540 pages, £69.99, hardback
ISBN: 978-1-498-70129-7

Readership: This book has a broad readership, and it will be useful to graduate students and researchers in the field of statistics, finances, insurance, economics, geosciences, etc.

This book provides a comprehensive overview of statistical modelling of extreme events. It covers various aspects of extreme value analysis, including univariate and multivariate analysis, max-autoregressive and moving maxima models, time series and spatial extremes, threshold selection, composite likelihood, non-parametric estimation and Bayesian inference.

In addition to the conceptual background and theoretical details, the book also provides a variety of applications of extreme value modelling, including financial investments, insurance and financial risks, weather and climate disasters, safety data in clinical trials, sports statistics.

The book is effectively structured. It starts with two review chapters, one on univariate extreme value analysis and the other on multivariate extremes. These are followed by a discourse on various extreme value models and associated inferential methodologies (Chapters 5–18). Chapters 19–24 discuss various applications. The final chapter reviews computational software for extreme value analysis.

An extremely nice feature of this book is the inclusion of accompanying computing codes for many chapters. This will facilitate understanding of the discussed topics. Further, the readers can use these to initiate implementation of the methodology in the context of their own research projects.

This is an impressive and useful book, one which gives an effective account of statistical methods and theory used in extreme value analysis, as applied to problems arising in a variety of fields. It serves as an excellent, contemporary reference text in the area.

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Fundamental Concepts for New Clinical Trialists

Scott Evans and Naitee Ting

Chapman & Hall/CRC Biostatistics Series, 2015, 348 pages, £52.99, hardback
ISBN: 978-1-420-09087-1

Readership: Graduate students, clinical trialists and statistics researchers.

This book covers real-world topics and offers practical perspectives of clinical trials. It describes fundamental clinical trial design, data monitoring, associated analysis and reporting of results. It does not present detailed statistical methodology (no complex statistical notation), however. Instead, it discusses the practical aspects of trials that are not typically part of statistical methodology courses, providing guidance for avoiding potential pitfalls and addressing the various challenges encountered in typical trials.

The book is very well structured. It has two sections. Section I provides background information, including introduction to clinical trials, product development process and a description of the regulatory processes along with some advice and suggestions for clinical trial statisticians. Section II addresses scientific issues related to trial designs. These include topics such as data monitoring, analyses of efficacy, safety, risk-benefit and reporting of trial results.

The book focuses on important concepts and promotes 'thinking clinical trials', and it is very readable. This book targets both statisticians and non-statisticians and wishes to facilitate better communication between them. I found that some chapters are especially useful for statisticians involved in clinical trials. Chapter 4 discusses the roles of statisticians in clinical trials and describes attributes and habits they can develop to prepare them for the breadth of these responsibilities and optimise their contribution to clinical trials. Chapter 10 describes suggestions for proper reporting of clinical trials in the medical literature, providing a unique reference that is not typically found in other books.

This book offers complementary experiences and perspectives to existing books. Dr Evans uses this book as part of his ‘Principles of Clinical Trials’ course at the Harvard School of Public Health. Overall, it is an exciting book!

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Monte Carlo Methods and Stochastic Processes – From Linear to Non-Linear
Emmanuel Gobet
Chapman & Hall/CRC, 2016, xiii + 310 pages, £44.99, hardback
ISBN: 978-1-498-74622-9

Readership: Statistics and applied mathematics master and PhD students, PhD students in computer science, engineering, physics, chemistry, biology and economics.

The book targets graduate students in applied mathematics and statistics at the Masters and PhD level to introduce them to the Monte Carlo method for continuous time stochastic processes. However, due to the significance of the subject in scientific and engineering applications, it should also be of great interest to PhD students and researchers in other fields including computer science, engineering, physics, chemistry, biology and economics. The book focuses on computational and mathematical aspects of simulation of random processes, while applied contexts are treated to some lesser extent. For this reason, it should have a special appeal to researchers outside the arena of mathematical sciences who are interested in understanding theoretical foundations of the Monte Carlo methods.

The text starts with a general introduction to the Monte Carlo method by reviewing different concepts of random simulations. Then, it turns to some fundamentals from the probability theory that are essential for presentation of the main theme. The two central parts of the book deal with the simulation methods for continuous time stochastic processes. The first of these is on linear models while the second is devoted to some selected non-linear ones. Overall, the material covers an impressive range of the advanced methods, and the author succeeds in delivering it in a coherent manner without burying the presentation under technical details. That said, however, the level of mathematical sophistication required from the reader is fairly high, and guidance of an expert in the field is highly recommended. This particularly applies to the exercises that aim at extending the content of the book rather than reinforcing the content of the chapters.

As appropriate for a book on computational method, theoretical discussion of the simulation methods is accompanied by several algorithms that are explicitly presented in the text. Moreover, on the author’s webpage, a number of algorithms implemented in Python are made available so that a reader can utilise them for simulations of the models for his own use.

In the part on linear stochastic models, the author starts with a rather standard while compact presentation of stochastic differential equations. This is made through brief but self-contained sections on stochastic integral, Itô formula and Feynman–Kac formula. In the second part, the focus is on approximation of the solution using the Euler scheme. The part concludes with the discussion of statistical error in the simulation.

Elements of non-linear dynamics are discussed in the final part of the book. Four generic types of non-linearities are presented: backward stochastic differential equation, branching diffusion processes, empirical regression and non-linear diffusions in the McKean sense (stochastic differential equations with interactions). Chapter 8 in this final part of the book discusses fundamentals of empirical regression and gives an overview of data mining approach. This chapter seems to be of a slightly different character than the other parts of the book. However, this deviation from the main theme seems to be justified by the recent popularity of the topic. One could possibly argue for a more complete treatment of the subject.

In conclusion, the book provides mathematically solid introduction to the Monte Carlo methods in the context of continuous time stochastic modelling. In this vast field, a single book can only cover a very small number of topics. The ones treated in the text were motivated by the author's research interest. Nevertheless, they illustrate well the main features of the Monte Carlo method. The selection of exercises mostly enhances the contents of the covered topics. From a pedagogical point of view, adding simpler examples that would help to digest some of the material included in the chapters would make the book easier to adopt in a course on the topic.

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Stochastic Volatility Modelling
Lorenzo Bergomi
Chapman & Hall/CRC, 2016, xvi + 522 pages, £57.99, hardback
ISBN: 978-1-4822-4406-9

Readership: Statistics, mathematical finance and applied mathematics researchers and PhD students.

The book provides an in-depth and comprehensive discussion of stochastic volatility models. The author combines his exceptional theoretical expertise with the experience he has gained as a quant in *Société Générale* to write an insightful treatment that should be appreciated by both the mathematical finance researchers and the practitioners willing to use volatility models when dealing with actual financial and risk management problems.

The writing style is very accessible and lively for such a technical subject, which makes for a smooth and enjoyable reading. The mathematical theory is interlaced with commentaries that relate to its practical aspects. This keeps a reader interested in following sometimes rather complex arguments and notation. Each chapter (except the Introduction) is recapped by the so-called *Reader's Digest* that allows to review the covered material in a less formal manner. There are a great many examples through which practical consequences of discussed models are highlighted. Numerous graphs help visualise the empirical results and their connection to the theory.

The contents, after a fairly extensive introduction to the financial modelling of volatility, focus on a number of continuous time stochastic volatility models. It is assumed that a reader is familiar with fundamentals of mathematical finance and probabilistic tools that the theory requires. This includes knowledge of the theory of martingales and the properties of Lévy processes. Nevertheless, on several occasions, appendices to chapters assist efficiently in providing some review of the required theory as well as some additional details of the used methods. Alongside presentation of the main topic, some guidance is offered by the author about what is the prerequisite for understanding the chapter's contents.

The topics covered by the book include variance swaps, the Heston model and forward variance models. There is also a short chapter on multi-asset stochastic volatility and a very efficient introduction to local-stochastic volatility models. The book also discusses the equity smile as well as the linkage between static and dynamic properties.

If there is one missing component of the book that limits enjoyment of reading, it is the lack of a computational toolbox that would allow following the presented examples of applications by *hands on data* analysis. Such a treatment would have clearly enhanced experience and enforced understanding of the practical implications of the theory while also enabling verification of the theory in new empirical contexts. The examples presented in the text are very illuminating, but there is no reference to any computational tools that have been used to obtain the conclusions and the graphs.

In summary, the book is strongly recommended, possibly a must, for both theoretically and practically oriented financial analysts. The main reason for this strong recommendation is that the book, in a unique fashion, succeeded in presenting mathematically advanced volatility models while keeping financial analyst practice as the main driving force of the presentation.

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Time Series Econometrics
Klaus Neusser
Springer International Publishing, 2016, xxiv + 409 pages, \$99.00, hardcover
ISBN: 978-3-319-32861-4

Readership: Advanced bachelor, master, or beginning doctoral students, or applied researchers.

This book addresses the broad topic of econometric time series, beginning with the fundamentals of stochastic processes and progressing through all the main applications to economic data. It presumes that readers already have a familiarity with economic theory and the fundamentals of mathematical statistics, though technical appendices are given to refresh readers' minds. There is a good balance of empirical knowledge, illustrated through economic data, and theoretical developments. The range of topics is essentially complete, for the author touches upon ARMA models, forecasting, estimation, model fitting, spectral analysis, filtering, unit-root testing and volatility, as well as the important multivariate topics of VAR, co-integration and state space models. There is enough depth in each topic for a student to learn the essential core ideas; the applied researcher will find the treatment useful as well, the main facets having been distilled.

Overall, I like the book, for several reasons. First, the book is a successful attempt to pull together a broad range of topics in one place. Second, the book provides sufficient depth (and breadth) while avoiding an exhausting and overly meticulous treatment. Third, the book strikes a good balance between empirical applications and theoretical derivations. And although many other time series textbooks can be found, the perspective here of an econometrician is especially valuable; it helped me (a mathematician) to understand how an economist thinks about a VAR model. The author does not merely present the material but also motivates developments through data and a brief historical discussion – this is often missing from statistical texts, but is helpful in building understanding of which methods fail and succeed, and why. I would not hesitate to use the book in a classroom, and have already recommended it as reading for my own PhD students.

However, the book does have some minor flaws. There are scant exercises. The book seems to have been rushed to publication, with some grammatical flaws present on almost every page. More amusing are the lapses into the author's native German, apparent on axes labels on some of the figures. I trust these can be rectified in a future edition; they offer little impediment to the diligent student, but must be mentioned.

The book begins with lists of notation, figures and technical results. The contents are split into univariate and multivariate sections, and these portions are written in such a way that they could each reasonably constitute a separate course. The introductory chapter gives time series plots of several important datasets, and the basic ideas needed to understand stochastic processes. Then the book moves rapidly to ARMA processes, covering causality, invertibility and computation of the autocovariance function. Although the theorems are stated with rigour, proofs may or may not be furnished according to whether there is pedagogical value – this is in keeping with the stated goals of breadth and depth.

The third chapter discusses forecasting, including the classic projection theory, as well as more ad hoc procedures such as exponential smoothing. There is a single theoretical exercise here, so those instructors desiring a text with actual forecasting exercises (writing code, analysing data) will need to supplement the book with external material. Chapter 4 covers the basic elements of estimation theory: sample mean, sample autocovariance and sample partial autocorrelation. There is also a nice discussion of long-run variance estimation. The treatment here is sufficient while not getting bogged down with extensive mathematical minutiae.

Chapter 5 discusses the estimation of our favourite models, with treatment of the Yule–Walker estimator, ordinary least squares estimation of autoregressive models and maximum likelihood. The essence of the innovations algorithm is there, but not the finer computational details of the Durbin–Levinson algorithm. Order selection via information criteria is treated, along with a practical discussion of model fitting, evaluation and selection, with illustration on Swiss GDP. The author takes space to discuss the magnitude and angular portion of autoregressive roots and explain their ramifications on understanding the process.

The sixth chapter treats the frequency domain: spectral density, periodogram and estimation. A discussion of filtering from a frequency domain perspective – so vital in econometrics and yet so often omitted in econometrics curricula – is happily included. Again, there are not enough exercises here, in terms of developing student skills for data analysis.

Chapter 7 discusses integrated processes, with a substantial treatment of the important problem of unit-root testing, as well as the Beveridge–Nelson decomposition. The material nicely distils an immense literature into a lucid account, which maintains a pragmatic perspective of the topic. The final chapter of the first section examines the modelling of financial time series, covering ARCH models and the major variants thereof.

For the multivariate section, there is a nice introductory chapter that synthesises the historical development of macroeconomics going back to Keynes. Chapters 10 and 11 quickly rehash notions of stationarity and covariance for the multivariate case, and Chapter 12 treats VARMA processes. This is a 10-page discussion, whereas some textbooks devote several chapters to all nuances of VAR and VARMA. Some additional detail is given in Chapter 13, focusing on the fitting of VAR models.

Chapter 14 provides forecasting methods for VAR, with a nice extended example on the US economy – but again, no exercises here. A long 15th chapter on interpretations and applications of VAR has a lot of interesting material, some of it quite recent. I learned quite a bit. There is Wiener–Granger causality, and a solid introductory treatment of structural VAR, with the identification challenges and the concomitant interpretations.

Chapter 16 wades into co-integration, providing a readable account of VEC models and their connection to co-integrated VAR models – and also the connections to Beveridge–Nelson and common trends formulations. The 17th chapter introduces state space models, the Kalman filter and state space smoother and the method's applications. Again, there are econometrics texts devoting hundreds of pages to state space – this is a concise, 30-page primer on the topic. Finally, Chapter 18 provides a brief foray into non-linear models, accommodating structural breaks or switches of regime.

In my opinion, the book accomplishes its own purported objectives. Of course, there are omissions – a Bayesian will be disappointed. Yet the text is successful at providing a broad overview of the majority of topics in time series econometrics, leading historically from the field's foundation up to current research being conducted by the author and his peers. The substantial bibliography can facilitate deeper probing of particular topics, at the level of a graduate school seminar; the book's depth of treatment is just right for a first/second course.

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