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Advanced Statistics with Applications in R
Eugene Demidenko, 2020
Wiley Series in Probability and Statistics, John Wiley and Sons USA

This book has many hundreds of applied examples that are very interesting. These include Sudoku, insider trading and using Benford's law to detect fraud. Despite the numerous engaging examples, I am delighted that the author is relentless in ensuring that the underlying theoretical concepts are presented and discussed in detail. Only with this solid theoretical grounding is the power of modern computing then taken advantage of by using the popular programming language R.

The word "advanced" in the title is a reference to understanding fundamental topics at an advanced level. While I wish that all students studying statistics understood it at this level, it is not an introductory book for those who are not mathematically inclined. It is also not a book that covers esoteric specialised advanced statistical topics. It is, however, possibly the best intermediate statistics text that I have come across. It is well-suited for intermediate statistics courses and a graduate course, and it contains many problems for the reader to attempt. Further, I suspect that many researchers and practitioners might also benefit from (and enjoy) recapping some of the concepts they already know at the level of detail presented in this book.

This book comprises nine chapters. The first two cover the introductory concepts of random variables, discrete then continuous. The first chapter also provides a concise, but informative, introduction to R that will be excellent for a reader who is familiar with the basics of programming in another language, but it might not be enough for a reader who has never coded before. Chapters three and four then build on the introductory univariate topics to cover multivariate random variables and multivariate distributions. Chapter five then discusses visualisation, which has become a very topical issue in statistics. Chapter six then deals with estimation, including common topics such as properties of an estimator and maximum likelihood estimation, as well as less frequently covered, but very valuable, issues such as sufficiency. Chapter seven goes on to introduce interval estimates and hypothesis testing, including an insightful critical discussion of the concepts of p-value and the level of statistical significance without overly simplifying the issues. The final two chapters cover the linear model and non-linear regression, including dummy variables, one- and two-way ANOVA and the basics of generalised linear models. The book also includes an Appendix with an excellent presentation, including practice questions, of important prerequisite mathematical concepts such as matrix algebra, matrix calculus and optimisation. Many students lack such knowledge, so this appendix is a valuable addition to the book.

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Overall the book is very well-written and structured. It emphasises understanding key concepts but also provides many practical applications and R code examples. I recommend it for library purchase as an excellent intermediate-advanced book in statistics. It fills the gap between introductory statistics books that gloss over important theoretical details and advanced books that only cover specific specialised topics. It covers the fundamentals at an advanced level, and I recommend it for quantitatively inclined undergraduate students and graduate students, as well as being a useful resource for researchers and practitioners.

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