BOOK REVIEW

Random Phenomena: Fundamentals of Probability and Statistics for Engineers

By Babatunde A. Ogunnaike, CRC Press, Boca Raton, FL, 2010, 1015 pp., $129.95.

As stated in the Preface and repeated in the Prelude (Chapter 0), the organizing principle of *Random Phenomena* is that proper understanding and application of statistics first requires basic understanding of probability. The author introduces the theory by starting from well described engineering examples such that the resulting probability equations appear as the natural outcomes from engineering first principles and not as esoteric mathematics. Engineering significance is then reinforced with discussion of how the results apply to other problems. Hints toward the use in statistical applications are given. The latter half of the book on statistics is then able, by reference to the earlier probability results, to provide an understanding of why and when statistical methods apply, and equally importantly, when pitfalls lurk. The continual relating of probability and statistics throughout the book is one of its strongest features.

Another strength is the author's style. Concepts are clearly explained. A good balance is struck between the providing critical theoretical underpinnings without overwhelming mathematical detail.

Examples from many engineering and science fields illustrate ideas and methods throughout the book, especially in the statistics material. Three chapters (7, 11 and 20), one each at the end of the Parts on probability, distributions, and statistics, are devoted solely to detailed analysis of lengthier case studies. These examples allow the reader to obtain a sense of the limitations of theory and methods and of the practical judgments required in applications to move to a problem resolution.

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Each chapter (other than the case studies) is followed by review questions (606 total), example problems (332) that illustrate methods, and application problems (175) requiring integration of several ideas. A useful pedagogical feature is the repeated use of some data sets, allowing students to see how new material provides new understanding. An accompanying CD provides data sets as Microsoft Excel 2003 and Microsoft Excel 2007 worksheets and as Minitab® worksheets; with the exception of one large data set all data are also printed in the text.

Although aimed at the textbook market (several syllabus suggestions for 1 and 2-semester undergraduate and graduate courses are given in the Preface), *Random Phenomena* has much to offer the industrial practitioner. As a chemical engineer who came to statistics out of industrial necessity and not from formal training or a career plan, I found new insights despite more than 20 years of practice, which includes providing internal statistics consulting and training.

Part I, Foundations, which comprises Chapters 1–2, motivates the study of probability with some example data and a classic residence-time distribution example. Part II, Probability, comprises Chapters 3 to 7. Chapter 3 provides the set theory building blocks of probability. Chapter 4 formalizes the definition of a random variable and introduces the distribution function as the fundamental description of random behavior. Chapter 5 extends the ideas to multiple dimensions, and Chapter 6 introduces variable transformation.

Part III, Distributions, which comprises Chapters 8 to11, is for me the highlight of the book. Various distribution models for discrete (Chapter 8), and continuous (Chapter 9) variables are introduced, with many developed from first principles. This provides insight into where various distributions are likely to apply, which is important for the choice of appropriate statistical methods. Chapter 10 discusses information theory and entropy.

Part IV, Statistics, comprises Chapters 12 to 20. Chapter 12 covers descriptive statistics and provides the tie between probability and statistics, which is continually reinforced throughout Part IV. Chapter 13 discusses sampling and emphasizes that the sampling process is itself a random process with its own behavior, related to but distinct from the random behavior of the process being studied. Chapter 14 covers estimation and includes unbiasedness, efficiency, consistency, maximum likelihood, Bayesian estimation, and the differences in point and interval estimates. Chapter 15 covers hypothesis tests and includes material on non-Gaussian populations and likelihood ratio tests. Chapter 16 covers simple, multiple, and polynomial regression. Chapter 17 covers distribution model validation, a critical topic oft overlooked in practice. Chapter 18 discusses nonparametric methods, and Chapter 19, design of experiments.

Part V, Applications, comprises Chapters 21 to 23. Chapter 21 covers reliability and life testing. Chapter 22 covers quality assurance and control, including statistical process control. Chapter 23 introduces multivariate analysis and principal components analysis.

The broad coverage that is a strength of the book is also its drawback, although "drawback" is an unfair word, as one can not realistically expect the book to be longer. With material that is often the subject of complete books covered here in single chapters, there are practical issues that necessarily receive no mention. From my own experience I wish there was more emphasis on outliers, but in fairness I note that several exercises call for examination of data including and excluding suspected outliers; leverage in regression, alas, gets no mention. However, all the fundamentals needed for further study in any of its topics are certainly provided. In summary, *Random Phenomena* is an excellent choice for anyone, educator or practitioner, wishing to impart or gain a fundamental understanding of probability and statistics from an engineering perspective.

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