Probability and random processes (Wiley Survival Guides in Engineering and Science)

Krishnan V., Wiley-Interscience, 2006. 723 pp. Type: Book (9780471703549)

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The characterization "survival guide" is most suitable for this book, in the sense that it can be used as a valuable reference for students, practitioners, and researchers working with probabilities and random processes in various scientific fields, such as engineering, computer science, mathematics, physics, and economics. The book's wide-ranging audience is justified by the wealth of topics it covers, extending from elementary set theory to advanced random processes.

The book is written to accompany any other textbook on probability and random processes, for quick reference to definitions, formulas, tables, and figures. Although the value of this work as a reference is obvious from its content and style, I personally found it useful for self-contained study, since it introduces all of its topics gradually, starting from basic definitions of probabilities and random variables, and proceeding to an in-depth treatment of the most complicated notions. It should be pointed out that the style is not friendly for beginners with a poor mathematical background; they will have to use for their main textbook another more introductory and elementary primer. However, even these readers can use this tome for reference.

The author's experience in teaching probability is reflected in the plethora of detailed information in the book, and in the systematic organization of its material. The book is organized into 23 chapters and seven appendices, spanning more than 700 pages. The understanding of the various concepts is facilitated by more than 300 worked examples, containing more than 400 illustrative figures of high quality.

Chapter 1 presents the basic definitions of set theory, connecting sets and fields with the notion of the event. Chapter 2 provides the definitions of probability space and measure, along with the Kolmogorov axioms and their corollaries. Basic concepts such as conditional probabilities, independence, and Bayes' theory are also presented. Chapter 3 presents the fundamental rules for counting, such as the addition and multiplication rule, permutations, combinations, and sampling, useful for understanding probabilities. Chapter 4 gives an account of all of the common discrete distributions, connecting each one with the combinatorial notions defined earlier. Each distribution is illustrated with examples and figures.

Chapter 5 is an introduction to the concepts related to random variables, such as the distribution and density functions. Chapter 6 is devoted to three of the best-known continuous distributions: uniform, exponential, and Gaussian. The presentation is thorough, and is enriched with topics such as the Poisson arrival process, the hazard rate, the Gaussian tails, and the Gaussian approximations to binomial distribution. Chapter 7 discusses several continuous distributions encountered in various probabilistic applications. Chapter 8 extends the concept of conditional probabilities to conditional distributions and densities. Chapter 9 introduces the joint discrete and continuous distributions. Chapter 10 defines the moments of distributions, and provides the means and variances of the most known distributions.

Chapter 11 provides the basic definitions and properties associated with characteristic and generating functions of discrete and continuous random variables. Chapters 12 and 13 address functions of one random variable and of multiple random variables, respectively, where the main problem is the determination of the new distribution. Chapter 14 provides many bounds and inequalities for probabilities, and also the basic limit theorems for random variables. Chapter 15 is about random variates, namely, random data for probability distributions generated by a computer.

Chapter 16 presents the fundamental concepts of matrix algebra, necessary for the treatment of random vectors. Chapter 17 discusses distributions of random vectors, and presents a first introduction to linear least squares estimation. Chapter 18 extensively presents various aspects of estimation theory, like regression, point estimation, interval estimation, and hypothesis testing. Chapter 19 is an introduction to stationary and ergodic random processes, and also to the estimation of parameters and power spectral density for continuous and discrete time processes. Chapter 20 studies the various types of random processes. Well-known processes, like the Poisson, binomial, Gaussian, Markov, and Martingale processes, as well as Brownian motion and others, are described in detail.

Chapter 21 discusses random processes through linear systems, considering aspects of linear filters and the theory of signal representation. Chapter 22 introduces the fundamentals of Weiner and Kalman filters. Chapter 23 reports on an application of Bayesian reconstruction algorithms for transmission tomographic images.

The seven appendices contain very nice and practical tables, including a table of Fourier transforms, with figures of the time and frequency functions, and tables for the Gaussian, chi-square, student, Poisson, and binomial distributions. The tables are complete, and offer accuracy up to nine decimal places. Finally, it is worth mentioning the complete index, which enhances quick referencing.

Overall, the book offers a systematic and comprehensive account of the subjects related to random processes and their applications. It is a valuable aid, suitable for any scientific library. It is recommended for students with an appropriate mathematical background, practitioners, teachers, and researchers in a wide range of scientific fields.

Reviewer: Lefteris Angelis Aristotle University,Thessaloniki, Greece Review #: CR133844 (0801-0027)