Probability: modeling and applications to random processes

Article (Unspecified)

Book Review

Gregory K Miller. Probability: Modeling and Applications to Random Processes. Wiley Interscience. xxiii+459 pages ISBN 0-471-45892-9

This book is written to support a one-semester first course in probability, for students familiar with calculus and matrix algebra. The writing style is informal, the author's enthusiasm for his material being apparent. He seeks to be mathematically rigorous, while not invoking measure theory. Thus, while the "definition" of a random variable is as a function on *all* subsets of the set of outcomes, Dr Miller swiftly acknowledges that this cannot work when the outcomes form a continuum, and outlines the path forward in an Appendix (designed to be skipped over). This is a satisfactory compromise.

There is no shortage of books at a similar level, covering much the same ground. This one contains a wide variety of worked examples, and each chapter ends with a large number of exercises, without solutions. Most of them are direct applications of the theory that has been developed, but several contain useful general results.

The book begins with remarks about the place of modeling in mathematics. A number of useful probabilistic models are offered in context, while the language of the subject is formally introduced. But the author's anxiety to quickly establish the wide applicability of the models means that, later, the reader often experiences a sense of *déja vu*: the same material is presented, in virtually the same words, but merely more formally. (For example, peruse the widely separated discussions of both the continuous uniform distribution, and of the Exponential distribution.)

The claim in the Preface that mathematical correctness is placed "above all" is an unnecessary hostage to fortune. It would be safer to assure the reader that, with sufficient care, all the given formulae can be justified, and to confess that imprecise heuristic arguments have a place in the development of the subject. Then the work on page 170, where Δx is allowed to remain constant, while simultaneously tending to zero, would be more acceptable.

All the common discrete and continuous distributions are here, their derivations and background carefully given. Some useful but oft-neglected models are also found; the author under-sells his coverage by omitting the words arcsine, Beta, Laplace, lognormal, Pareto and Weibull from his Index. But in several places this good book should have been better. Too often, the presentation of general ideas is ignored, in favor of particular arguments for the immediate context.

For example, moment generating functions are used extensively, but the relation between the mgfs of X and $aX + b$ is buried in the exercises; thus, the demonstration that the parameters of a normal variable are its mean and standard deviation is far more complicated than necessary. Probability generating functions are hidden. Nearly all the worked examples for the geometric distribution are directed at the calculation of $P(X > k)$, evaluated each time as a sum, without using the simpler notion that the event $X > k$ occurs exactly when the first k trials are failures. The examples illustrating the multinomial distribution are often better treated directly with the Binomial. The general use of the notation $Y = kX$ to change the scale of a random variable is underplayed.

Many instructors will find this book a useful adjunct to their courses. It dips into Markov chains, renewal processes, queueing models, random walks, Brownian motion, time series, and makes many links with ideas from statistics. The connections between the hypergeometric and the binomial models are explored carefully and well, and the Figures are excellent. The author intends to set up a web site giving a list of minor misprints and glitches.

I look forward to a second edition that builds on the attractive features of the present version. Changes I would like to see include: incorporating the ideas of independence and identical distribution into the *definition* of a sequence of Bernoulli trials; allowing partitions of the sample space to be countably infinite *ab initio*; elimination of the repetition; greater emphasis on a general treatment of *sums* of random variables; more care in explaining Markov dependence (e.g., that the state at time $k + 1$ is not influenced by the state at time $k - 1$, *so long as* we know the state at time k); and a direct derivation of the hypergeometric distribution by a simple counting argument.

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