REVIEWS

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Taking Chances: Winning with Probability. By John Haigh. Oxford University Press, 1999, xiv + 330 pp., $35.

Reviewed by **David Aldous**

The study of mathematical probability originated with games of chance, and the analysis of games of chance remains an interesting subject. This book consists mainly of short sections that verbally discuss problems involving probability, games of chance, and related material and derive solutions using only arithmetic and occasional elementary combinatorics and algebra. It covers an impressive breadth of topics: lotteries, dice and card games, casino games, television game shows, racetrack betting, some game theory (Prisoners Dilemma, Hawk-Dove games, Male-Female reproductive strategies), as well the basic laws of probability and the familiar birthday and coupon collector's problems. A small part of the content is distinctly British rather than American (cricket and snooker; premium bonds; British television shows).

"This book is aimed at the 'layman', interpreted as someone untrained in science or mathematics, but wishing to reason probabilistically with confidence" p. viii). What is, or should be, the difference between a textbook and a book for the layman?

We all know what textbooks are like. I have two requirements for popular science books for laymen. First, since I read such books (on cosmology, dinosaurs, human evolution, etc.) in bed before going to sleep, they have to be engagingly written, so that reading is a pleasure, not a duty. Second, I want to learn something. A recent genre of books on mathematics for the layman seeks to make mathematics seem exciting, important, or relevant by telling stories without including equations or concrete mathematical assertions. Within this gee-whiz genre, one of the better books is Peterson [**2**]; it deals with probability throughout the sciences.

Let's compare Peterson and Haigh on the dice game called craps. Peterson starts:

> The serious gamblers in casinos hang out at the craps tables. The basic rules of this two-dice game are simple, but the bewildering array of options for betting on various outcomes creates a fast-paced, insidiously seductive pastime in which a heady brew of chance, intuition, experience, calculation, and superstition come into play. The shooter tosses two dice . . . .

Haigh starts:

> There are many variants on the basic game, depending on the side bets that are allowed. Like many dice games, its roots are very old, but its modern

popularity is traced to its use as a pastime among soldiers in the First World War. You roll two dice . . . .

Each author next gives the rules of the game. Haigh then outlines the calculation that your chance of winning is 0.493, while Peterson instead goes off on a tangent (suppose we had non-standard dice . . .) and then moves on to Monopoly without any further word about craps.

These extracts indicate the different styles of the two books. Peterson has a vivid, engaging writing style that reads like a novel, but at the end of a piece of narrative you're not sure if you've learned anything. Haigh's sections have a beginning, a middle, and an end, and you learn some facts; the writing is careful and clear but retains a professorial lecture style. To my taste, Haigh's book requires a little too much concentration to make agreeable bedtime reading. It is more like the previous generation of mathematics for laymen books, requiring thinking while reading. At the same time, it is reminiscent of the well known textbook on non-technical statistics by Freedman, Pisani, and Purves [**1**]. While that work is definitely a textbook (it has many well-thought-out exercises, chapter summaries, and broad coverage of topics), it shares Haigh's style of carefully written prose, incorporating the mathematical argument into the prose and paying close attention to real-world aspects of the problem under study.

After teaching probability at various levels, I believe that existing introductory textbooks do a good job of preparing students for more advanced study, but no book succeeds as a first-and-only account of probability (as [**1**] does for statistics). The reason is that texts focus on the mathematical structure (random variables, properties of expectation, special distributions) rather than the implications probability has for the real world. Though Haigh evidently doesn't view his book as a textbook, to my taste it has the right style for a first-and-only course in probability, even though one would want considerably more breadth of material for such a course. Indeed, it meets my fundamental criterion for a textbook: it explains to the reader how to do calculations, rather than just citing results of calculations.

In addition to the familiar types of elementary probability calculations, such as the craps example, Haigh includes more elaborate stories and calculations involving strategies as games progress. I particularly liked the chapter that gives a gentle yet entertaining introduction to two-person game theory. I also enjoyed the marvelous story of "Dettori Day", September 28, 1996, when the jockey Frankie Dettori rode in all seven horse races at the Ascot race meeting. Haigh describes the reactions of gamblers, on-course bookies, and off-course bookies (legal in Britain) as Dettori won one race after another. The off-course payoffs reflect the "starting price" (odds) given by the on-course market, so the off-course bookies sought to hedge their liability by placing bets (which they hoped to lose!) with on-course bookies to drive down the starting odds. Dettori finally won all seven races; gamblers who had placed accumulator bets collected winnings many thousands of times their stakes; and the bookies lost an estimated total of 40 million pounds.

Every instructor of an introductory probability course should have this book. It provides a source of interesting non-technical material to leaven the usual rather dull textbook content. Many of the simpler calculations could be set as homework problems or examination problems. The intended readership is not mathematically sophisticated, but if games of chance intrigue you, then you will find plenty of interest here, both novel varieties of mathematical questions and details of real-world gambling. One can easily imagine reading, 50 years hence in a famous mathematician's autobiography, that the author's interest in mathematics was sparked by encountering this book in high school.

REFERENCES

1. David Freedman, Robert Pisani, and Roger Purves, *Statistics*, third edition, Norton, New York, 1998.
2. Ivars Peterson, *The Jungles of Randomness*, Wiley, New York, 1998.

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The Computational Beauty of Nature: Computer Explorations of Fractals, Chaos, Complex Systems, and Adaptation. By Gary William Flake. MIT Press, 1998, xx + 495pp., $45.

Reviewed by **Michael Frame**

Mathematics is about theorems. The job of a mathematician is to prove theorems and to explain the proofs to others. This was more or less the vision of the profession I got as an undergraduate and graduate student in the 1970s. Yet when I worked to understand a proof, and especially when I tried to produce my own proofs, I always kept examples close at hand. Slowly I began to realize that there is an experimental aspect of mathematics: conjectures are tested against examples. The more tests a conjecture passes, the more likely it is to survive the transition from conjecture to theorem. Moreover, studying an especially well-constructed example can reveal hints of a proof of a theorem.

This was not a profound discovery of a secret hidden from the uninitiated, a rite of passage through which every young mathematician must go. Indeed, many of my teachers emphasized again and again the importance of examples. But in the 1970s, in most fields there was little difference in the methodologies of constructing examples and proofs. To be sure, there were exceptions. Some finite-group theorists, for instance, embraced the computer early. I remember days as a graduate student, listening to Mark Benard enthusiastically describe his computer analyses. At the time, this seemed an anomaly: most people constructed examples and theorems by pure cogitation. An immense chasm appeared to separate mathematics from, say, experimental physics.

The landscape has changed over the last two decades. Now computer experiments are done in all fields of mathematics—certainly not by every practitioner, but so far as I know, every field has its experimentalists. If someone has a counterexample, I'd be happy to hear it. This addition of computer experiments to the standard tools of mathematics has not been painless. Not many years ago, a colleague objected, rather heatedly it seemed to me, to my statement that computer experiments would influence all fields of mathematical research: he proclaimed that he would never use a computer for anything other than calculating