

Probabilistic Thinking

The Empire of Chance. How Probability Changed Science and Everyday Life. GERD GIGERENZER, ZENO SWIJTINK, THEODORE PORTER, LORRAINE DASTON, JOHN BEATTY, and LORENZ KRÜGER. Cambridge University Press, New York, 1989. xviii, 340 pp. \$44.50. Ideas in Context.

The increasing role of mathematical probability in modern life has finally attracted the attention of historians of science to the subject. Eight monographs and several collections of papers on the history of probability and statistics have appeared in this decade—more than during the preceding century. Six authors who have contributed to this burst of activity have now tried to summarize the results for a broader audience. Beginning with the inception of probability theory in the 1650s and speaking with one voice—they do not identify their contributions to individual chapters, and they used a lottery to determine the order of their names on the title page—the authors attempt to explain the ways in which probability and statistics have “transformed our ideas of nature, mind, and society.”

The first five chapters of this book will be useful to statisticians, philosophers, scientists, and other historians of science who want to understand the roots of the probability-based statistical methods we use so widely today. Chapter 1 summarizes Lorraine Daston's prize-winning *Classical Probability in the Enlightenment* (Princeton University Press, 1988), covering the philosophy and applications of probability from 1660 to 1840. Drawing heavily on Theodore Porter's *The Rise of Statistical Thinking, 1820–1900* (Princeton University Press, 1986), chapter 2 deals with 19th-century social statistics, Francis Galton's work in biometry and mathematical statistics, and aspects of the 19th-century discussion of determinism. Chapter 3 covers R. A. Fisher's work in agricultural experimentation and statistical theory, Jerzy Neyman and E. S. Pearson's mathematical elaboration of Fisher's work, and the institutionalization of this work in the modern statistical profession. This chapter is an unusually broad and judicious treatment of its topic, and it succeeds in presenting it in a less technical way than the other treatments of which I am aware. Nevertheless, the general reader will find it much more difficult than the preceding chapters. Chapter 4 is the most original and detailed in the book; it surveys the various ways in which chance and determinism cropped up in 19th-century biology. Chapter 5 covers the various roles of probability in physics, from Laplace to quantum me-

chanics. Its tone is philosophical rather than mathematical, but it will be even more difficult for the general reader than chapter 3.

The remaining chapters—which summarize parts of Gerd Gigerenzer and D. J. Murray's *Cognition as Intuitive Statistics* (Erlbaum, 1987), discuss impressionistically the role of statistics in contemporary life in the United States and wax philosophical on chance and determinism—are a good deal less valuable.

In the general introduction, the authors present their book as a coherent narrative for a general audience. The chapters are too uneven in style, level of difficulty, and purpose to hold the interest of many laymen, however, and the book will be most valuable as an entry point into the current literature for scholars. Unfortunately, in their attempt to provide a coherent narrative, the authors have weakened its value in this regard, as readers are given no clue which parts are summaries of earlier works and which represent new research.

In the general introduction the authors say they are less interested in the mathematical theory of probability and statistics than in its impact on broader thinking. This leads them to concentrate on their own work and to slight important recent writing of Stigler and Schneider. Yet the first three chapters are concerned more with the evolution of theory—a balanced account of which would have to include topics emphasized by Stigler, notably the invention of least squares—than with its impact on contemporary thinking.

This neglect of important authors extends to important topics as well, so the presentation as a whole is incomplete. The role of probability and statistics in psychology, biology, medicine, and physics is treated in some depth, but their role in other social sciences, meteorology, engineering, and business is treated shallowly or not at all. The authors seem to be unaware of the role probability has assumed in economic theory during the past three decades, and overlook the decisive influence of economic theory as an explanation for the recent interest in probability as a model of rationality in psychology.

Many of these problems might have been avoided, but I fear that overall the venture of producing a coherent general history of probability and statistics is premature. In the case of the 17th, 18th, and 19th centuries, we have a wealth of information about the evolution of the mathematical theory and much new information, from Daston, Porter, and Stigler, about the scientific and cultural context of this evolution, but these streams of inquiry have not yet fully merged. Consequently, a narrative at a distance from

the mathematical details, such as we do find in most of this book, becomes misleading. For instance, chapter 1 presents the early concept of mathematical probability as a legal concept, even though the mathematical structure of the theory was based on games of chance and owed little to the concept's connections to legal rhetoric. Non-specialist readers could not know that all the books written on mathematical probability during the first century of its existence were concerned almost exclusively with games of chance. When they move into applications of statistical theory in the 20th century, the authors have little historical research on which to draw, and consequently their discussion remains superficial and impressionistic. In chapter 3, for example, the authors note that our standard statistics textbooks present a compromise between Fisher's views and those of Neyman and Pearson, and they denounce this compromise as unsatisfactory. But they are not able to tell us anything about how it came to prevail.

Overall, *The Empire of Chance* is a valuable book, but its greatest contribution is its research agenda. The authors have asked the right questions, and their efforts to answer them show us how much more work there is to be done. Unprecedented as it may be, the activity of the past decade is only a beginning.

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Marine Protozoa

Modern Planktonic Foraminifera. CH. HEMLEBEN, M. SPINDLER, and O. R. ANDERSON. Springer-Verlag, New York, 1989. xiv, 363 pp., illus. \$98.

During my undergraduate years, earth science instructors often used the adage “The present is the key to the past.” For paleoceanographers, biological oceanographers, and geologists studying the planktonic foraminifera, this idea has never been more important. With a growing need to understand the environmental parameters responsible for global warming and the greenhouse effect, scientists have turned to the geological record in an attempt to understand the causes of climate change in the past. Research involving fossil planktonic foraminifera has played a key role in this effort. However, it has become clear that interpretation of data from the fossil record is dependent on numerous assumptions about the ecology and biology of the organisms as they lived in ancient oceans.

Given this impetus, a number of research-

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