in the other) develop explicit equilibrium models for the early evolution of the oceans and by examining post-depositional changes in sedimentary rocks illustrate probable long-term controls of ocean chemistry. Thermochemical data were used to predict the sequence of weathering of the "average igneous rock," and the process was modeled by computer simulation. The results indicate that a very rapid degassing with equally rapid assumption of chemical equilibrium at a composition close to the present composition of seawater is a distinct possibility. Subsequent recycling through geologic time merely stirs the system.

With respect to *paleoclimatology*, the possible influence of Pleistocene changes is mentioned by various authors. In *paleobiology*, Berggren and Hollister present a fauna-by-fauna account of the changes in the biotic provinces that existed during the evolution of the Atlantic Ocean. And the chief point of Worsley's chapter is to explain the Cretaceous extinctions as due to the rapid migration of the carbonate compensation depth.

As is typical of SEPM special publications, no index is provided, and the papers appear about 3 years after they were given in a symposium. All in all, however, this is a very useful series of "studies" which will encourage the development of paleooceanography as a recognized discipline in university curricula.

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A History of Probability

Probability Theory. A Historical Sketch. L. E. MAISTROV. Translated from the Russian edition (Moscow, 1967) and edited by Samuel Kotz. Academic Press, New York, 1974. xiv, 282 pp., illus. $22.50. Probability and Mathematical Statistics, vol. 23.

The history of the history of probability is curiously simple. There is only one major work; Todhunter's detailed *History of the Mathematical Theory of Probability* appeared in 1865 and is still in print. Todhunter reports everything then known, devoting a 150-page review to the giant of that time, Laplace. Maistrov's new account, while only a historical sketch, effectively fills some of the gaps in Todhunter's book and works at bringing us up to date.

Maistrov's book divides roughly into three sections, the first being a workmanlike overview of the early period from prehistory to Laplace. The author thinks that the classical approach linking probability and gambling "neglects the whole prehistory of the subject." His argument is unconvincing, since gambling predates other aspects of prehistory, and, furthermore, he gives no reasonable alternative explanations of the origins of probability beyond brief mentions of census and insurance. Important sources not considered at all are the mentions of probability in Jewish writing about A.D. 200 (discussed, for example, by N. Rabinovitch, *Probability and Statistical Inference in Ancient and Medieval Jewish Literature*, University of Toronto Press, 1973) and the randomization in early religious rituals (discussed by F. N. David, *Games, Gods and Gambling*, Griffin, 1962, and by F. Van Der Blij, *Scripta Math.* **28**, 1 [1967]).

Maistrov makes a novel contribution in his tabulation of several hundred throws of each of over a dozen very old dice. An analysis of the data I have made for this review shows that ancient dice are very far from being uniform. Most of the bias can be explained if the dice are assumed to be rectangular solids instead of cubical.

Maistrov carefully presents Bernoulli's original proof of the law of large numbers and most of Bayes's paper, but otherwise his examples complement those in Todhunter's work. For instance, he pulls together little-known aspects of Galileo's thoughts on errors in measurement in astronomy and gives Buffon's motivation for studying geometrical probability.

As the translator points out in footnotes, the author perpetuates an old myth concerning the Demoivre-Laplace theorem. This theorem places the normal curve of error in its position of prominence as the limiting distribution of sums of random quantities. We are told several times that Demoivre obtained the limiting distribution for tosses of a fair coin with probability of heads $p = \frac{1}{2}$ and that "later, Laplace extended Demoivre's theorem to arbitrary values of $p \neq 0, 1$." Actually, the case of general p was dealt with by Demoivre in the third edition of *The Doctrine of Chances*.

Laplace deserves to have his name linked with the theorem for a different reason. He first understood the normal curve in the way we do today as a continuous probability distribution with wide applications. Laplace proved that the sum of independent but not necessarily identically distributed random quantities can be renormalized to converge to a normal distribution. Demoivre nowhere writes as if he considered the normal curve as a probability distribution. He derived it as a numerical approximation for the problem of independent repetitions of an experiment with a yes or no outcome.

In the middle section, Maistrov pays homage to Gauss, who is barely mention by Todhunter, and gives some details of his work on least squares. It is strange that no one has yet presented a thorough analysis of Gauss's contribution to probability and statistics.

The author writes with new authority in his discussion of probability in Russia. He discusses the introduction of probability in the Russian universities (around 1830) and gives examples of very early course curricula. The probabilistic work of Revkovskii, Davidov, Lobachevskii, Zernov, Bunyakovskii, and Ostrogradskii will be new to most readers. Both Chebyshev and Markov are treated in detail; we learn not only about Markov chains but also about Markov's detailed statistical analysis of the poem "Eugene Onegin."

The last part of the book deals with modern probability. The author limits the scope of his inquiry to a single topic: the problems of the axiomatic foundation of probability. Thus, with the exception of a short, confused section on sums of independent random variables, there is no mention of the great probabilists of the 20th century, such as Cramér, Feller, Gnedenko, Lévy, or Wiener.

The author seems not to recognize subjective probability in this survey. This leads him to almost ridicule statements of Condorcet, Laplace, Borel, Poincaré, and others that have clear, well-defined meanings in the modern subjective framework.

The translator has preserved the readable style of the original, corrected numerous mistakes, and provided many useful comments, definitions, and new references.

The older literature of probability contains much that is new from the perspective of a research worker in probability or statistics. Sections of books by Bernoulli, Demoivre, and

Laplace contain ideas and problems not well understood today: for example, Bernoulli's work with nonadditive degrees of belief in part 4 of his *Ars Conjectandi* and Demoivre's proof of an L^1 limit theorem in *The Doctrine of Chances*. Work by G. Shafer, O. B. Sheynin (cited in Maistrov's bibliography), and S. Stigler affirms that probability theory is a rich field for creative historical research.

Maistrov's book tends to be a careful repetition of known material drawn from a collection of sources both extensive and peculiar. Its many references to more detailed specialty studies are particularly useful and it fills the need for a readable overview of this large field.

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Precocity at Mathematics

Mathematical Talent. Discovery, Description, and Development. JULIAN C. STANLEY, DANIEL P. KEATING, and LYNN H. FOX, Eds. Johns Hopkins University Press, Baltimore, 1974. xx, 216 pp., illus. Cloth, \$10; paper, \$2.95.

Extraordinary talent of any kind is inherently fascinating. Consequently this report of a project in the state of Maryland to identify and develop mathematically precocious 12- to 14-year-olds—the upper one-half of 1 percent of this age range—will interest anyone concerned with the nurturance of talent, especially scientific talent.

The mathematical prowess of the students described here seems almost incredible, until one realizes that miracles must be occurring daily within every area of talent in the upper tail of the normal curve. The bell-shaped distribution of talent is an immutable law, guaranteeing that someone is going to be up there, five or six standard deviations above the average, whether it be a 7-foot-tall high school basketball star or a 12-year-old seventh grader who scored 800 on the SAT-Math test, 800 on the CEEB Math I Achievement test, and 800 on the CEEB Math II Achievement test. A 12-year-old!

This project ferreted out such people, then energetically intervened in their education to make further mathematics training available for them.

It was not a "gifted child" project in the usual sense because these extraordinary precocious students differed as much from the gifted child as usually defined (say, the upper 5 percent) as the gifted child does from the average. In fact, these precocious children differed as much from each other as the gifted differ from the average. One of the interesting facts you can learn by inspecting the normal curve is that there is as much variation within the upper one-half percent of the population as there is within the upper one-third of the usual classroom. Consequently, when dealing with this rare group educators must use a wide range of techniques.

The techniques used here ranged from suggesting a year's acceleration in grade, to providing accelerated courses in mathematics and science only, to offering junior college courses at night, to making arrangements for university-level courses during the summer, to, finally, arranging for early university admission.

This project, which was supported by the Spencer Foundation of Chicago, had three aims: "to discover, describe, and develop" mathematically precocious youth. The discovery was achieved by a large testing program designed to locate highly able students in the state of Maryland. In an energetic program, several dozen were identified, probably the largest such group ever assembled in one place. The description was accomplished by systematically studying these boys and girls by means of psychological tests and inventories. This was the weakest part of the study, partly because the investigators were not very comfortable with measures other than performance on mathematics and IQ tests (which they used in abundance, usually giving four or five to each child), and partly because the investigators were too "scientific" to let much human flavor of these extraordinary children show through. For example, although this entire book is about extremely gifted young mathematicians, there is not a single instance reported of the application of this talent, other than test scores. With several bright 12- to 14-year-olds taking a university computer science course, at least one of them must have used the computer to play backgammon, or to design a perpetual calendar, or to tally the word counts in the Watergate transcripts—or were these students merely savvy test-takers with no original thoughts?

The third phase of the study, to develop these students, was easily the most important; the staff carried this portion far beyond the activities found in most studies of talent. By their accounts, they really made a difference in the rate of development of the students by smoothing their way into accelerated courses and onto university campuses. They did this by working with each student personally, suggesting a prescription that best fit his or her talents, social skills, and motivation. Stanley and his colleagues clearly cared about these budding Ph.D.'s as individuals.

In one area they cared too much about being decent; they worked too hard at avoiding a possible charge of male chauvinism. Males score higher on mathematical aptitude tests than do females; that is well known. (Females score higher on measures of verbal aptitude—neither sex excels in any general sense.) In this testing program, about five times as many boys as girls scored high. Further, the boys were more intense in their mathematical interests and more persistent in seeking further training. These findings pained the investigators, and in their anguish to be sexually fair they talked themselves into statements such as, "An unexpected and disconcerting finding . . . was an inescapable sex difference." And they asked two prominent female psychologists, Helen Astin and Anne Anastasi, to write chapters for them, one supposes to further document their fairness toward women.

Both Astin and Anastasi point out that the male superiority on the math tests is not surprising; as the latter says, "It is certainly consistent with the published research accumulated over many decades."

All the writers, in attempting to explain the sex difference, point to the different socialization patterns of boys and girls, and one of the regretable lapses in the study is the failure to accumulate any systematic data on this issue. If early socialization is an important factor in mathematical precocity, this would have been the perfect sample with which to document that. However, in the few comments made about the families, there is no hint that these children were treated much differently from other bright children.

The lengthy agonizing over sexual differences is even more puzzling when compared with the treatment of racial differences; even though this study was carried out in Baltimore, which is 46 percent black, there is not a mention of race in the entire book.

In the last chapter, Keating, Wiegand,