Activity 160. Read the article. Review your answers to the quiz in Activity 159.

Questions in betting and gaming provided much of the early impetus for the development of probability theory. In 1654 Chevalier de Méré, a French nobleman with a taste for gambling, wrote a letter to the mathematician Blaise Pascal (1623–62) seeking advice about divvying up stakes from interrupted games.

For example, suppose, in a friendly game of tennis, two players each lay down a stake of $100 in a gamble to win “best out of nine” games, but rain interrupts play after just four games, with one player having won three games, the second only one. What then would be the fair way to divide the $200 pot? Of course, the division of money should somehow reflect each player’s likelihood of winning the gamble if the series of games were to be finished.

Pascal communicated the concern of analyzing situations like these to his colleague Pierre de Fermat (1601–65), and their subsequent correspondences on the issue represented the birth of the new field of probability theory. Both mathematicians solved de Méré’s “problem of points” (using two entirely different approaches, incidentally) and then later worked together to generalize the problem and extend their analyses to other types of games of chance. Their discoveries aroused the interest of other European scholars. In 1656 the Dutch physicist-astronomer-mathematician Christiaan Huygens (1629–95) published “On Reasoning in Games of Chance” summarizing and extending the ideas developed by Pascal and Fermat. He phrased their work in terms of a new notion, that of expected value. It proved to be very fruitful.

The key principle behind probability theory is the idea that if a situation can be described in terms of possible outcomes that are equally likely, then the probability of any particular outcome occurring is 1 divided by the total number of outcomes. This principle was actually first recognized and discussed more than a century earlier by the Italian mathematician and physician Girolamo Cardano (1501–76) in his work “Book on Games of Chance”. This text, however, was not published until 1663, 9 years after Pascal and Fermat had solved de Méré’s problem. It is likely that Cardano would be known as “the father of probability theory” had the work been published during his lifetime. Cardano also recognized the law of large numbers.

The Swiss mathematician Jacob Bernoulli (1654–1705) of the famous Bernoulli family recognized the wide-ranging applicability of probability in fields outside of gambling. His book “The Art of Conjecture”, published posthumously in 1713, demonstrated the use of the theory in medicine and meteorology. It was also the first comprehensive text dealing with issues of statistics.

In some sense, probability and statistics represent two sides of the same fundamental situation. Probability explores what can be said about an unknown sample of a known collection. (For example, we know all possible numerical combinations from a pair of dice. What then is the most likely outcome from tossing a pair of dice?) Statistics explores what can be said about an unknown collection given a small sample. (If 37 of these 100 people brush their teeth twice a day, what can be said about teeth-brushing habits of the entire population?) The two fields remained closely intertwined during much of the 18th century and the early part of the next century.

In 1733 Abraham de Moivre (1667–1754) recognized the repeated appearance of the normal distribution in scientific studies and wrote down a mathematical equation for it. It first became apparent from the “randomness” of errors in astronomical observations and in scientific experiments.

The latter half of the 19th century saw significant progress in developing and understanding the theoretical foundations of probability theory. This was chiefly due to the work of French mathematicians-astronomers-physicists Joseph-Louis Lagrange (1736–1813) and Pierre-Simon Laplace (1749–1827), German genius Carl Friedrich Gauss (1777–1855), and the French mathematician Siméon Denis Poisson (1781–1840) who, among other things, mathematically proved the law of large numbers. The most important publication in this era on the theory of probability was Laplace’s 1812 text “Analytical Theory of Probability”. In it, Laplace collected and extended everything known on the subject at that time. Russian mathematicians Pafnuty Chebyshev (1821–94), Andrei Markov (1856–1922), and Alexandr Lyapunov (1857–1918) further developed the mathematical underpinnings of the subject in the late 19th century.

Basic statistical thought can be deemed as having developed considerably earlier. The ancient Egyptians compiled data concerning population and wealth as early as 3050 B.C.E., developing simple techniques to collate and record the numerical information gathered. The ancient Chinese undertook similar studies around 2300 B.C.E. A census was taken in 594 B.C.E. by the Greeks for the purpose of levying taxes, and Athens undertook a population census in 309 B.C.E. The Romans also kept census records, as well as records of births and deaths, and gathered significant quantities of numerical information from geographic surveys taken across the entire empire. Very few statistical records were kept during the period of the Middle Ages, however.

In 1662 John Graunt analyzed birth and death records and produced the first life table. The purpose of the table was to make general observations and predictions about life expectancy for classes of members of a particular population. This work represented a significant step toward analyzing data for the purposes of inference.

In 1790 the United States took its first decennial census, heralding the return of census taking. Several European nations followed suit soon afterward. The Belgian scholar Lambert Adolphe Quételet (1796–1874) analyzed the nation’s records and made important observations about the influence of age, gender, occupation, and economic condition on mortality. In 1835 he attempted to apply probabilistic methods to the study of human characteristics, both physical and behavioural. He used them to give what he hoped was a complete description of the “average man.” Although Quételet’s work was generally highly respected, his attempt to apply it to the field of behavioural science was met with criticism.

In the 1860s, the English scholar Francis Galton (1822–1911) attempted to apply statistics methods to the study of human heredity. His work was influential and helped define statistics as a mathematics discipline in its own right.

At the turn of the 20th century, the corporate world began to recognize the relevance and usefulness of statistics, especially in issues of quality control, economics, insurance, and telecommunications. Many large companies began hiring statisticians.

While working for an English brewing company, the industrial scientist William Sealy Gosset (1876–1937) developed the Student's t-test, allowing for the ability to derive reliable information from small samples. (Company policy forbade its employees to publish. Gosset did so in any case, writing under the pseudonym "Student"). The English mathematician Karl Pearson (1857–1936) developed the chi-squared test and is considered the founder of modern hypothesis testing.

Ronald Aylmer Fisher (1890–1962) is considered the most important statistician of the 20th century. His 1925 text "Statistical Methods for Research Workers" transformed statistics into a powerful scientific tool. He clarified many of the mathematical principles on which the discipline is based. Fisher also developed methods of multivariate analysis to properly analyze problems involving more than one variable.

In 1926, the pure and applied mathematician John von Neumann (1903–57) founded game theory — a mathematical framework for analyzing games of chance, such as poker, that involve strategy and choice on the parts of the players. Von Neumann recognized the applications of the theory to economics and social sciences. The work of Nobel Laureate John Forbes Nash, Jr., (1928–2015) took its applications to economics to a profound level.

(by James Tanton, from Encyclopedia of Mathematics)