Savage, Leonard Jimmie | Encyclopedia.com

(*b*. Detroit, Michigan, 20 November 1917; *d*. New Haven, Connecticut, 1 November 1971)

statistics, *mathematics*, *philosophy*.

Jimmie Savage was the eldest son of Louis Savage, descended from a family of orthodox Jews, and Mae Rugawitz Savage. He was educated at Central High School in Detroit, and at the University of Michigan in Ann Arbor, where he obtained a B.S. in 1938, and a Ph.D. in 1941, both in mathematics. He had studied chemistry and physics before turning to mathematics. He was married to Jane Kretschmer in 1938; they had two sons, Sam Linton and Frank Albert. The marriage ended in divorce in 1964, and Savage married Jean Strickland Pearce the same year. Savage enjoyed good health, and was a vigorous walker, swimmer, and talker, although he had poor eyesight, suffering from a combination of nystagmus and extreme myopia.

Savage's doctoral dissertation, written under the direction of S. B. Meyers of the Department of Mathematics, was in the area of metric and differential geometry. Another mathematician at Michigan who influenced Savage was R. L. Wilder. After receiving the doctorate Savage spent an academic year, 1941-1942, at the Institute for Advanced Study in Princeton, still working in pure mathematics. While there he attracted the attention of John von Neumann, who considered Savage to be a highly gifted mathematician, but recognized that his true interests lay elsewhere. In 1944 Savage joined the Statistical Research Group at Columbia University, and it was there that he first became deeply interested in statistics, an interest that continued throughout his life.

Savage was author of two historically significant books: *The Foundations of Statistics* (1954) and *How to Gamble If You Must: Inequalities for Stochastic Processes* (1965, written with Lester Dubins). He also wrote a substantial number of extremely important articles in statistics, probability, and philosophy, centering on two main themes. The first theme concerns the foundations of statistics, how to understand and justify what statistics is about. These questions necessarily led him to ask deep philosophical questions about the various approaches to statistics, the sources of human knowledge, and the process of induction. Savage's second theme concerns the theory of gambling, which he viewed as a stimulating source of problems in probability and decision theory.

Savage's crowning achievement, which grew out of the work of the greatest mathematicians and philosophers, including Blaise Pascal, James Bernoulli, Daniel Bernoulli, the Marquis de Laplace, Carl Friedrich Gauss, Henri Poincaré, Frank Ramsey, John von Neumann, and Bruno de Finetti, was his book *The Foundations of Statistics*. Partly through the influence of von Neumann, who had developed the theory of games and formulated the basic ideas of decision theory, and partly through the influence of the English logician and mathematician Ramsey and the Italian mathematician and philosopher de Finetti, Savage developed in the first five chapters of his book the most complete version of the theory of subjective probability and utility that has yet been developed.

Starting with a set of six basic axioms, each of which he carefully motivated and discussed, Savage demonstrated the existence of both a numerical subjective probability and a utility function. Nothing quite like this had been done before for probability, although there were important predecessors. Von Neumann and Morgenstern in their *Theory of Games and Economic Behavior* (1947) had developed the existence of a utility function for the case in which probability was assumed to be objectively given. De Finetti, beginning in 1937 and culminating with his *Theory of Probability* (1975), had developed a theory of coherence and subjective probability, which, although it was partly axiomatic, did not fully develop utility theory within the system. Ramsey, in his "Truth and Probability" (1926), had developed an axiomatic system with a simultaneous derivation of subjective probability and utility; in spirit his work is very close to the later work of Savage, although with a different formulation of the axioms and a different mode of derivations.

Savage's other main contribution was the book *How to Gamble If You Must*, written with L. Dubins. This is a highly innovative development of probability theory in connection with its ancient origins in gambling, and it uses the finitely additive approach to probability. Savage and de Finetti had been the primary proponents of finitely additive probability, which was all that could be logically derived within their systems of thought.

Savage's articles include extremely important contributions to statistical inference, especially the application of the Bayesian approach. There is space only to mention a few of these. The article "Bayesian Statistical Inference for Psychological Research" (1963), written with W. Edwards and H. Lindman, is possibly the best article ever written relating to serious applications of statistical inference. In particular, the authors give the fullest development of the theory of Bayesian hypothesis tests, as originated by H. Jeffreys in his *Theory of Probability* (1939; 3rd ed., 1961). The article, "Symmetric Measures on Cartesian Products (1955), written with E. Hewitt, was a highly innovative mathematical generalization of de Finetti's

theorem. The monograph, *The Foundations of Statistical Inference* (1962), contains Savage's beautiful discussion of Bayesian estimation and hypothesis testing and his theory of precise or stable measurement, which clearly shows the role of so-called uninformative prior distributions. Another important article is "Elicitation of Personal Probabilities and Expectations" (1971), which contains an innovative development of the theory of scoring rules.

Savage exerted an enormous influence upon the development of statistics in the second half of the twentieth century. The resurgence of the subjective Bayesian approach, which Savage insisted was the only foundationally sound and sensible approach, thereby opposing the views of R. A. Fisher and J. Neyman, was largely due to Savage's efforts, especially in the United States. In his last years Savage wrote a number of articles on the philosophy of statistics, emphasizing the "objectivity" of the subjective Bayesian approach, as contrasted with the "subjectivity" of the so-called objectivistic approach. Savage had an intense and spirited curiosity about almost everything. He was extremely generous in dealing with younger researchers, such as myself, who crossed his path and no doubt affected us in multitudinous ways. He was uncompromising, both with himself and with others. In his honor many of his articles have been collected in *The Writings of Leonard Jimmie Savage: A Memorial Selection* (1981), along with reminiscences by several of his friends and colleagues. Savage's honors included the presidency of the Institute of Mathematical Statistics (1957-1958), the Fisher lectureship (1970), and the Wald lectureship (1972). He received an honorary degree from the University of Rochester in 1963.

BIBLIOGRAPHY

I. Original Works. Savage's two most important books were *The Foundations of Statistics* (New York, 1954; 2nd rev. ed., New York, 1972), and *How to Gamble If You Must: Inequalities for Stochastic Processes* (New York, 1965), the latter written with Lester Dubins. See also *The Foundations of Statistical Inference* (London, 1962; New York, 1962). Many of his articles are collected in *The Writings of Leonard Jimmie Savage: A Memorial Selection* (Washington. D.C., 1981). See, in particular. "Symmetric Measures on Cartesian Products", in *Transactions of the American Mathematical Society*, **80** (1955), 470-501, written with E. Hewitt; Bayesian Statistical Inference for Psychological Research", in *Psychological Review*, **70** (1963), 193-242, written with W. Edwards and H. Lindman; and "Elicitation of Personal Probabilities and Expectations", in *Journal of the American Statistical Association*, **66** (1971), 783-801, all of which are reprinted in the 1981 anthology of Savage's writings.

II. Secondary Literature. *The Writings of Jimmie Savage: A Memorial Selection*, cited above, includes the texts of the memorial service given for Savage at Yale University on 18 March 1972 and the memorial service tributes given by W. Allen Wallis. Frederick Mosteller, William and Esther Sleator, and Francis J. Anscombe; the volume also includes a reprint of D. V. Lindley, "L.J. Savage: His Work in Probability and Statistics", originally published in *Annals of Statistics*, **8** (1980), 1-24, and a bibliography of Savage's writings. See also Lester Dubins' preface to *How to Gamble If You Must*, cited above, and the preface to Bruno de Finetti's *Probability, Induction, and Statistics* (New York, 1972), for evaluations of Savage's work. For further information on his life and work, see D. A. Berry, "Letter to the Editor", in *The American Statistician*, **26** , no. I (1972), 47; S. Feinberg and A. Zellner, eds., *Studies in Bcivesian Econometrics and Statistics in Honor of Leonard J. Savage* (Amsterdam, 1975); W. Kruskal, "Leonard Jimmie Savage," in W. Kruskal and J. M. Tanur, eds., *Internal Encyclopedia of Statistics* (New York, 1978), 889-892: D. V. Lindley, "L. J. Savage", in *Journal of the Royal Statistical Society*, **A135** (1972), 462-463; and "Savage, Leonard Jimmie", in *International Encyclopedia of the Social Sciences*. *Biographical Supplement*, **18** (1979).

Bruce M. Hill