Richard von MISES
b. 19 April 1883 - d. 14 July 1953

Summary. Von Mises was principally known for his work on the foundations of probability and statistics (randomness) which was rehabilitated in the 1960s. He founded a school of applied mathematics in Berlin and wrote the first text book on philosophical positivism in 1939.

As the Swedish probabilist Harald Cramér (q.v.) once put it sensitively, Richard von Mises was one of those men who have both the ability and the energy requisite for taking an active and creative interest in many widely different fields. He has made outstanding contributions to subjects as heterogeneous as literary criticism, positivistic philosophy, aerodynamics, and stochastics [Cramer (1953), 657]. Richard von Mises was born in Lemberg (now Lwiw, Ukraine) in the Austro-Hungarian Empire. He was the second of three brothers; the eldest, Ludwig, became an economist of international reputation. His father, Arthur von Mises, was a prominent railroad engineer in the civil service. Both parents were Jewish; his mother Adele was a nee Landau. Richard von Mises converted to Catholicism shortly before World War I but became an agnostic rather soon [Goldstein (1963), ix]. The family home was in Vienna, were Richard went to school and studied mechanical engineering at the Technical University until 1906. He became an assistant to the professor of mechanics, Georg Hamel, in Bruenn (now Brno, Czech Republic), were he obtained the venia legendi(Privatdozentur) in 1908. After only one year (at the age of 26), von Mises was called to the University of Strassburg as associate professor of applied mathematics, the field he made famous [Geiringer (1968), 382]. During World War I, von Mises joined the newly formed Flying Corps of the Austro-Hungarian Army (he had already a pilot's licence). The lectures on the theory of flight which he gave to German and Austrian officers constituted the first version of his Fluglehre of 1918, which went through many editions. At the end of the war, von Mises could not return to the now French Strasbourg. After short appointments in Frankfurt and Dresden, he became director of the new Institute for Applied Mathematics at the University of Berlin in 1920. Almost all papers by von Mises on probability and statistics are from the second part of his career. At the time of von Mises' two seminal papers "Fundamental Theorems of Probability" and "The Foundations of Probability" in the *Mathematische Zeitschrift* of 1919 [Von Mises, Selecta II] the conceptual foundations of

probability were still obscure. Von Mises' was unsatisfied with the "classical" definition of probability by Laplace (q.v.), based on the famous "equally possible cases" and perpetuated by his former teacher in Vienna, E. Czuber. There were, however, traditions within logics, psychology, philosophy, and statistics (J. Venn (q.v.), G. Fechner (q.v.), G. Helm, H. Bruns) to equate the probability of an event with the relative frequency of the event "in the long run". Richard von Mises, in his "Foundations", drew on these traditions, and borrowed the name "Kollektiv" from psychologist Gustav Theodor Fechner's "Kollektivmasslehre" (1897). Von Mises' concept of a collective, the definition of mathematical probability as the limit of a frequency ratio, and the two fundamental postulates, requiring the existence of the limiting values of the relevant frequencies, and their invariance under any place selection independent from the outcomes of the events, were soon to become familiar to all probabilists. In his "Foundations" he urged that "probability is a science of the same kind as geometry and theoretical mechanics ... which aims to reproduce observable phenomena not just as a reproduction of reality but rather as its abstraction and idealisation" [Von Mises, Selecta II, 58]. Thus, Richard von Mises ran into the fundamental philosophical and practical problems of the application of mathematics to reality, which he tried to address on a general level at about the same time in his programmatic paper on the "aims of applied mathematics" [Von Mises, Selecta II, 454 ff.] in the first volume of the *Zeitschrift für Angewandte Mathematik und Mechanik* (ZAMM), founded by him in 1921. In fact, one fundamental objection against von Mises' axiomatics of probability was, that the very existence of a collective could not be proven in a strict mathematical sense, since the requirement of the irregularity (randomness) of the collective precluded mathematical rules for its construction. In his book *Probability, Statistics, and Truth*, first published in German in 1928 and intended for nonmathematical readers, von Mises replied to various criticisms, and gave his comments on alternative systems proposed by others. Von Mises' position towards the foundations of probability was intimately connected to his philosophical positivism. Von Mises did not believe that statistical explanations in physics - and other domains of knowledge - are of transient utility while deterministic theories are the definite goal. Philosophers, von Mises thought, are apt to "eternalize" the current state of scientific affairs, just as Kant held Euclidean space as an absolute category. In contrast with these "school philosophers," he called himself a "positivist" [Geiringer (1968), 384]. In 1939 von Mises published an influential monograph on Positivism. Later editions of *Probability, Statistics,*

and Truth have a chapter with the expressive title "A part of the theory of sets? No!", which is explicitely directed against A.N.Kolmogorov's measure-theoretic approach to probability. In a sense, the conflict between von Mises and his enthusiastic and critical followers (J. Neyman (q.v.), A. Wald) and Kolmogorov was a difference in perspective, and one of the principle merits of von Mises' approach was the historical influence on sharpening the opposing standpoints. Mises pointed to the practical problems of finding the appropriate "collective" for a given statistical situation, warned against misinterpretations of statistical data and stressed the importance of Bayes' theorem (while strictly sticking to an "objective" interpretation of probability) as opposed to "fiducial probability", "maximum likelihood" and similar concepts in statistics. However, von Mises' insistence on the "collectives", especially on the infinity of events, prevented him from acknowledging the relative merits of approaches such as "small sample theory". More in the tradition of his first paper of 1919, the "Fundamentalsaetze", which deals mainly with the central limit theorem, are Richard von Mises' various single contributions to the theory and application of mathematical statistics. For the most part his results are collected in his book of 1931, which was, however, supplemented by later work on what he called "statistical functions" and on a differential calculus of asymptotic distributions. Among his earlier publications were the (S.N.) Bernstein-von -Mises theorem on (Bayesian) statistical inference and the Cramér - von-Mises-test in non-parametrical statistics, as well as important work on the statistical estimation of moments and expectation [Witting (1990), pp. 792-93]. As to the foundations of probability there is no doubt that Kolmogorov's approach had mathematical advantages in developing the theories of stochastic processes, martingales, even risk theory. But it was in a strange twist of events that von Mises foundation of probability proved fruitful again in the 1960s. It was Kolmogrov himself who wrote in a seminal paper on the algorithmic approach to information theory in 1963: "I have already expressed the view ... that the basis for the applicability of the results of the mathematical theory of probability to real 'random phenomena' must depend on some form of the frequency concept of probability, the unavoidable nature of which has been established by von Mises in a spirited manner" [Uspensky (1989), p. 57]. Kolmogorov "was interested in the precise nature of the transition from chaotic sequences, which have no apparent regularities, to random sequences, which exhibit statistical regularities and and form the domain of probability theory proper" [Lambalgen (1987), p. 734]. Kolmogorov's concept of chaoticness was further developed by L. Levin and

C.-P. Schnorr. The papers by Kolmogorov and others showed, firstly, that statistical regularities in von Mises' sense are not 'simple', that is, they do not lead to a significant decrease in complexity. Secondly, Mises' approach gives an opportunity to use substantially the notion of an algorithm. That opportunity was taken by A. Church and Kolmogorov. Thus, the notion of complexity within information theory, due to A.N. Kolmogorov in the early 1960s, with its attendant complexity-based definition of randomness, is the most important development issuing from von Mises' attempt to define Kollektivs.

Given von Mises' biography as a former professor in Strassburg and as a pilot in the war it is understandable that he harboured strong political feelings against the treaty of Versailles (1919) and the treatment of Germans and Austrians after World War I. He became skeptical of international scientific communication altogether and opposed aerodynamicist Theodor von Karman's efforts to organize an international congress for applied mechanics in 1922 with the following words: "You will not be surprised by the fact that I will not come, since my views about Tyrol and the Italians are well known to you... Furthermore I am a bit surprised at seeing that German professors feel the need to communicate abroad their theoretical researches on flight, while we are at the same time prevented from building real airplanes" [Battimelli (1988), 10]. On the other hand, philosophically, he did not belong to the mainstream of German academe, even not to the scientific part of it. His contacts to the Wiener Kreis and its Berlin branch Gesellschaft für Empirische Philosophie in the late 1920s as well as his insistence on the values of applied mathematics as opposed to the governing purism in mathematics set him at variance with more conservative and more nationalist colleagues in Berlin (L. Bieberbach, E. Schmidt). At the University of Berlin he had to fight for the teaching permit to be awarded to his assistant and later wife Hilda Geiringer [cf. Siegmund-Schultze (1993)]. Von Mises' colleagues never proposed his election as a member of the leading Prussian Academy of Sciences in Berlin, pointing to "blunders" in his work as in the axiomatics of probability, work which, as indicated above, proved far-sighted much later. When von Mises had to leave Germany as a Jew in 1933, his feeling of responsibility for the future of applied mathematics in Germany bordered on self-denial. He proposed the Nazi Theodor Vahlen as his successor as director of the Institute for Applied Mathematics and supported young "Aryan" mathematicians to fill the vacated positions [Mises Papers Harvard]. Von Mises left for Istanbul (Turkey) where he built another Institute for Ap-

plied Mathematics, before he felt the need to flee, once again, in 1939. Von Mises went to the United States where he became Gordon McKay Professor of Aerodynamics and Applied Mathematics at Harvard University in 1944. There he founded, together with von Karman, the *Advances in Applied Mechanics* (since 1948). His career in the United States was successful, if not without the usual struggles for the recognition of applied mathematics. One of his colleagues called it a scandal that von Mises was not elected to the National Academy of Sciences [Ludford (1983), 282]. When von Mises was finally proposed in 1950 as a member of the former Prussian Academy, which had become meanwhile the leading Academy in East Germany, he declined with the following words: "In the present circumstances ... the election could be interpreted and has been interpreted as having definite political implications. I made it a principle throughout my life to abstain from any kind of political activity and never to join any association or group concerned with matters of a political nature. Consequently, I feel compelled to desist from accepting the membership generously offered to me." [Mises Papers Harvard] That von Mises would indeed always abstain from active and organized political engagement, has to be understood in the context of his individualistic, elitist world view. The latter was intimately connected with the peculiarities of his biography as a repeatedly uprooted and wandering, socially well-to-do intellectual from the lower Austrian nobility. His world-view was reflected in von Mises' admiration of his countryman, the elitist and world-weary poet Rainer Maria Rilke, of whom he became a noted specialist (Von Mises' Rilke collection is now in the possession of Houghton Library in Cambridge, Massachusetts). Thus, von Mises was considered "truly aristocratic, seeming proud and haughty to many" [Goldstein (1963), xiii]. However, his conduct in many difficult situations, not least when he sent CARE-parcels to colleagues in Europe after World War II, showed what compassionate and loyal a human being he actually was.

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