Marquis de CONDORCET
b. 17 September 1743 - d. 29 March 1794

Summary. Condorcet applied mathematics in precocious and philosophically argued fashion to humanistic and social problems. His probabilistic work is full of interesting ideas on mathematical expectation, inverse probability and taking into account evolution over time, amongst others.

Marie Jean Antoine Nicolas Caritat, Marquis de Condorcet was born in Ribemont, Picardy, in the north of France. His father, a military man from a Dauphiné family, died when Condorcet was only a few weeks old. The boy was raised by his mother's family in Picardy in a bourgeois legal setting accustomed to economic and political reponsibilities. Following his studies with the Jesuits at Rheims, then at the Collège de Navarre in Paris, he devoted himself to pure mathematics, with the direct goal of obtaining general results in the integral calculus. His early work, begun towards the end of the the 1750's in collaboration with his friend and first teacher, the Abbé Girault de Keroudou, were both praised and criticized by Fontaine and D'Alembert (q.v.) who found fault with the often confused and excessively general style. Nevertheless, his research on the integral calculus resulted in his election to the Academy of Sciences at the age of 26. It culminated in the early 1780's in a treatise (regrettably unpublished) containing in particular a theorem on the integration of differential equations in terms of a finite number of explicit functions, 40 years before Liouville.

Starting in 1767-1770 Condorcet wrote several papers on law, political arithmetic and the calculus of probabilities; but these were dated and published only in 1994. After seriously considering d'Alembert's doubts on the foundations and relevance of the calculus of probabilities, and stimulated by Beccaria, the young mathematician discovered the likelihood principle before Laplace. This principle in its so called Bayesian interpretation allows us to go from effects to causes within a probabilistic framework. He did the same with what is now referred to as the rule of sucession of Bayes-Laplace, in which if an event occurs m times in n trials, its probability may be estimated as $(m+1)/(m+n+2)$. Note that Bayes' (q.v.) works became known on the Continent only towards 1780. Condorcet's first researches, concerned with regular arrangements and the theory of mathematical expectation, were thus already noteworthy for his wish to make the calculus of probabilities useful in the political and moral sciences.

Following his active participation in Turgot's ministry (1774-1776), Condorcet, already an adjunct secretary of the Academy of Sciences, took up the position of permanent secretary until the most violent episodes of the French Revolution. He continued his research both in pure mathematics and in the calculus of probabilities. It was mostly after 1783 that he developed in detail and published his mature work on probabilities, including their "inverse" problems, as they are now referred to in mathematical statistics and the philosophical and practical conditions of their use. His *Essai* of 1785 contained a theory on the motive for belief, and the famous paradox of votes, but mainly an attempt to prove by an example (that on judgments) "that the truths of the moral and polical sciences are subject to the same certainty as those which form the system of physical knowledge". This is true, he believed, so long as one introduced a quantitative basis for the different types of possible errors. In particular, the simultaneous evaluation of the probabilities of acquitting a guilty person and condemning an innocent one was at the basis of later works of Laplace. J. Neyman (q.v.) found inspiration for his theory of statistical tests with errors of the first and second kinds in the latter.

At the same time, Condorcet published six papers on the calculus of probabilities and articles in the *Encyclopédie méthodique*. These contained remarkable innovations: a theory of mathematical expectation with a solution of the St. Petersburg problem for a finite horizon, a theory of complexity of random sequences in regard to regular arrangements, a model for probabilistic dependence, which is none other than what are now called "Markov chains" and even "semi-Markov processes", and solutions to the problem of statistical estimation in the case of time-dependent probabilities of events. One might say that this foreshadows, perhaps clumsily and not very practicably, the concept of time series. He also produced a definition of probabilities starting from classes of events, and a theory of individual economic choice in a setting of universal risk and competition. Unfortunately, he was too daring in his writing, which suggested research programmes rather than concrete theorems; and the exposition of his ideas was so unclear and impractical that his original contributions were not understood in his lifetime or even in the two following centuries.

Strongly involved in the encyclopedic movement and a friend of D'Alembert, Turgot and Voltaire, Condorcet was the last of the "encyclopédistes" and the only one who lived through the French Revolution. He committed himself deeply to it, developing and illustrating his scientific vision of politics, while

having little inclination to a romantic view of populist participation. This enabled him to work out some very fertile ideas on education, women, slavery,and the rights of man, but he often had little influence on current events. However exchange of ideas of political kind influenced developments in the U.S. through Thomas Jefferson and James Madison.

During the Terror, Condorcet went into hiding, writing his famous *Esquisse d'un Tableau historique des progrès de l'esprit humain*. He was arrested on 27 March 1794, and was found dead in the prison of Bourg-Egalité (Bourg-la-Reine) two days later. It is not known whether he committed suicide or died of apoplexy.

Much esteemed during his lifetime, Condorcet was considered a mediocre mathematician during the next one and a half centuries. It is only gradually, since 1950, thanks to G. Th. Guilbaud and D. Black that his scientific work has been reappraised, first in connection with the summing of preferences related to Arrow's theorem, and later perceived as that of a "mathematician-philosopher" who critically studied the conditions necessary to found the human and social sciences. His mathematical works, were in fact only rediscovered in the 1980's.

References

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P. Crépel