

Logic, Probability and the Foundations of Uncertain Reasoning

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The relation between logic and probability is a fascinating one. Leibniz saw them as two sides of the same coin, whereas Boole and De Morgan thought of probability as the natural generalisation of logic to reasoning under uncertainty. This cross-contamination rapidly declined with the coming of age of “mathematical logic” which reached its climax at the end of the 1920s. Around that time, Kolmogorov was providing the definitive answer to Hilbert’s sixth problem: the axiomatisation of probability. By then, the research agendas of mathematical logic and probability were showing virtually no overlap: a narrow focus on the foundations of mathematics for the former, and the assimilation to measure theory and the emerging theory of stochastic processes for the latter. At that point, neither logic nor probability were particularly concerned with uncertain reasoning and its foundations.

Things changed again during 1980s, when the sodality of logic and probability was revived as a consequence of the pressing needs of artificial intelligence and formal epistemology. In this talk I will provide (a naturally biased) account of how this is currently affecting the foundations of reasoning and decision making under uncertainty. After providing some standard background, I will illustrate how the investigation of increasingly more expressive measures of uncertainty based on non-classical logics, and in particular many-valued, led to exciting research questions. I will conclude by briefly discussing how some of the ensuing answers provide interesting and to some extent surprising feedback on the classical notion of probability.