Representing Uncertainty: Randomness vs. Incomplete Information

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Abstract:
The modeling of uncertainty is motivated by two concerns: taming the variability of external phenomena and facing incomplete information in decision processes. These two concerns are related by the fact that in the face of variability, it is difficult to predict what the next state of the world will be. Yet the two concerns are distinct in the sense that variability is far from being the only cause of uncertainty.

However, the development of probability theory, as witnessed by the Bayesian school especially, tended to blur this distinction, suggesting that a unique probability distribution is enough to account for both randomness and incomplete information.

The basic tool for representing information incompleteness is set theory: an ill-known quantity is represented as a subset of mutually exclusive values representing an epistemic state. Introducing shades of plausibility within set-representations of incompleteness leads the the use of fuzzy sets.

More recently, new theories of uncertainty have emerged where partial ignorance is acknowledged and represented separately from randomness: the theories of evidence, possibility and imprecise probabilities, respectively. The aim of this talk is to provide a unified glimpse of these approaches, and in particular position fuzzy sets, to which the late professor Janos Fodor significantly contributed, in this landscape.

The talk will briefly point out differences and convergences between uncertainty theories and explain their impact on applications such as risk analysis, decision evaluation, reasoning about uncertainty, and statistics.