Imprecise Probabilities under General Information Structures

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Extended Abstract

Imprecise probability models differ from the usual modeling of probability in that agents may have a range of possible probabilities for any given event. When modeling decision problems, this allows for consideration of Knightian uncertainty, or ambiguity, in addition to risk. Two of the most common models of imprecise probabilities are the Multiple Prior Model as in Gilboa and Schmeidler (1989), and totally monotone capacities, or belief functions, as in Dempster (1967), Schafer (1976), and Gilboa and Schmeidler (1994). Each of these models requires that agents understand *modes ponens*, so that the probability of a specific event must be less than the probability of a more general event. This condition is violated empirically in, for example, Tversky and Kahneman (1983).

This work proposes a new model for imprecise probabilities based around the use of a general information structure for each agent, called the Behavioural Imprecise Probability. A strict separation of Knightian risk and uncertainty is used, where risk is described using a standard probability measure, and uncertainty is captured by the information structure of the agent. This model is appropriate when the agent knows the underlying probability of a given state of the world, but faces incomplete information about the true state of the world. An agent views an event as at least as likely as the probability they know the event happens, and at most as likely as the probability they think the event is possible. The results of Tversky and Kahneman (1983) are explained using behavioural imprecise probabilities.

The new model is compared to previous models of imprecise probabilities, in particular the multiple prior model, and totally monotone capacities. If each agents' information structure is sufficiently well-behaved, that is, if each agent is sufficiently rational, then the behavioural imprecise probability can be represented using multiple-priors or belief functions. When agents only understand *modes ponens*, a necessary and sufficient condition for representation of the behavioural imprecise probability in terms of belief functions is developed. As such, the behavioural imprecise probability is of particular use when agents have unusual information structures.

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