Artificial and human cognition under uncertainty

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Abstract. This tutorial presents applications of coherence-based probability logic (CPL) to selected problems of philosophy and psychology as well as in the field of nonmonotonic reasoning. In particular, it illustrates how CPL can be used as a rationality framework for artificial and human reasoning under uncertainty. Normatively CPL prescribes how ideal cognition works under uncertainty. Descriptively, CPL allows for deriving testable psychological hypotheses. s

What is probability logic? In a nutshell, probability logic is about propagating uncertainties from the premises to the conclusion in a rational way. For example, the premises of the Probabilistic Modus Ponens $P(B|A)$ and $P(A)$ constrain the conclusion $P(B)$ by a lower bound $(P(B|A)P(A))$ and an upper bound $(P(B|A)P(A) + 1 - P(A))$, where it can be shown that these bounds are the best possible and hence rational bounds on the conclusion. Thus, a key inference problem is about finding rational bounds on the conclusion in the light of the premise set. For coherence-based probability logic, the key rationality criterion for the assessment of the premises and for the propagation to the conclusion is coherence. Coherence, going back to Bruno de Finetti, refers to the subjective approach to probability which interprets probabilities by degrees of belief. The avoidance of bets that lead to sure loss (i.e., Dutch books) allows for justifying coherence: probability assessments, which satisfy this rationality criterion of avoiding Dutch books are coherent and hence (formally) rational. Violations of coherence are irrational and yield bad inferences. Each probabilistic assessment within these bounds is coherent.

After a brief characterisation of CPL, I illustrate why CPL provides a unified rationality framework for investigating problems in philosophy and psychology. Specifically, I show that coherence allows for a better understanding of many philosophical problems in logic, like the understanding and proper treatment of conditionals (if-then-constructions), nonmonotonic reasoning (i.e., reasoning systems which allow for retracting conclusions in the light of new evidence), and Aristotelian syllogisms (one of the oldest logic systems in Western Europe). Moreover, I argue that CPL makes many interesting psychological predictions, some of which have been validated experimentally in recent years. For example, most people interpret beliefs in conditionals as conditional probabilities, draw coherent conclusions, reason nonmonotonic, and connexively.

The aim of my tutorial is to provide an overview on how CPL can serve as a unified rationality framework for studying diverse problems in different disciplines including the philosophy of logic, formal epistemology, and the psychology of reasoning.