

Inference with Imprecise Measures for Systems Performance Management

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Abstract

From the second half of the twentieth century onwards, many new models have emerged to take a broader perspective of the nature of uncertainty into account, compared to the view provided by the probability theory. The large number of models reflects the recent acknowledgment that many aspects of imperfection exist and that probability theory, as good as it is, is not the only model applicable to all uncertain situations.

In this paper, a pattern of reasoning is developed for logical inferencing in the framework of evidence theory which is of special interest for dealing with imprecise probabilities in belief networks. The nodes in a belief network represent a measure of belief in hypothesis induced from evidence and the links are weighted by conditional probabilities of hypothesis given evidence. This is similar to directed Bayesian network while the probability functions are replaced by belief functions. Dependency can also be taken into account using the Frank's triangular norm as a measure of dependency as discussed in [1].

This rule is of special interest for inferring the belief on a hypothesis from the state of belief on the evidence, using the conditional knowledge of beliefs. There are practical applications for this rule in inferring the performance of a system from the way its sub-systems are performing. The advantage of this rule compared to the case of the Bayesian belief networks is that total ignorance on prior knowledge and on conditional beliefs can be modeled. This extended rule matches the forward propagation rule derived by Smets [3] using the Generalized Bayesian Theorem and also collapses to the Bayesian inference rule in case of crisp probabilities.

The developed inference mechanism is built within a performance management software tool developed in the Civil Engineering Systems group at the University of Bristol [2]. The software implementation with a graphical representation of belief functions have made the theory accessible to non experts in the field of engineering who have to deal with reasoning with uncertainty.

Keywords. Belief functions, inference, evidence theory, performance, conditional beliefs.

References

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