Temporal Reasoning with Context-Sensitive Probability Logic

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Most of our knowledge about the world is highly contextual. The use of context facilitates reasoning by allowing an agent to focus its attention on that portion of its knowledge relevant to a given problem. In automated reasoning the need to use context becomes particularly acute when dealing with probabilistic knowledge. While Bayesian networks provide a relatively efficient method for representing and reasoning with probabilistic information, inference in Bayesian networks remains NP-hard. This complexity becomes particularly problematic as researchers seek to build large models such as those that arise in modeling temporal processes.

I define a language for representing context-sensitive temporal probabilistic knowledge. Context constraints allow inference to be focused on only the relevant portions of the probabilistic knowledge. I provide a declarative semantics for the language. I show how to construct Bayesian networks in order to answer probabilistic temporal queries over the language. I present soundness and completeness results for the process of constructing a network and performing belief propagation to compute the posterior probability of a query. I illustrate the theory with the medical problem of evaluating the effectiveness of treatments for acute cardiac conditions. A simplified version of the Bayesian network construction algorithm has been implemented. I demonstrate its application on the cardiac domain.