Differents Types of Evidences in Bayesian Network

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Bayesian networks (BN) [1], [4] are powerful tools for knowledge representation and inference under uncertainty. They combine multiple sources of information to provide a formal framework within which complex systems can be represented and processed.

The different sources of information are not always perfect; therefore, the observation can be uncertain and imprecise. For the purpose of our work, we present five types of evidence [5]: hard evidence, virtual evidence (VE), also called likelihood evidence, that is evidence with uncertainty [4], soft evidence (SE) that is evidence of uncertainty [3], and two approaches of fuzzy evidence [2], [8].

A result of this work is to clarify the distinction between these different types of evidence. The presence of several soft evidences has to be treated using specific algorithms. Evidence in BN may be regular or uncertain.

Regular evidence, called also hard evidence specifies which value a variable is in. This is the usual way to enter an observation to be propagated in a BN [1], [4]. The drawback of discretization is that all values in the same interval are treated in the same way no matter their position in the interval.

Uncertain evidence specifies the probability distribution of a variable. We focus on two types of uncertain evidences. According to [3], [6], we use the terms virtual evidence and soft evidence as follows: virtual evidence [4] can be interpreted as evidence with uncertainty, and can be represented as a likelihood ratio. This kind of evidence is also called likelihood evidence. Soft evidence [3], can be interpreted as evidence of uncertainty, and is represented as a probability distribution of one or more variables.

Concerning fuzzy evidence, the observation can belong in the same time to more than one class with membership degrees.

Relating to the second approach of fuzzy evidence. This method allows to insert fuzzy evidence, to calculate the probability of fuzzy event, and to calculate the probability of fuzzy event conditional to a fuzzy observation. The advantage of this method is threefold. First, we can insert fuzzy observation; second, we can calculate the probability of a fuzzy event; finally, we can calculate the probability of a fuzzy event conditional to another fuzzy event.

We apply the junction tree inference algorithm [7] to different types of evidence. The successive stages of this algorithm can be summarized as follows:

- Construction process (or transformation of the graph): moralizing the graph, triangulating the graph, forming the junction tree.

- Initialization process: initializing the potential of cliques and separators.
- Propagation process: ordered series of local manipulations, called message passing, on the join-tree potentials. The result is a consistent join tree.
- Marginalization process: from the consistent join tree, compute the posterior probability P(V) for each variable of interest V .

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