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Improvements to Variable Elimination and Symbolic Probabilistic Inference for evaluating Influence Diagrams ☆

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ABSTRACT

An Influence Diagram is a probabilistic graphical model used to represent and solve decision problems under uncertainty. Its evaluation requires performing several combinations and marginalizations on the potentials attached to the Influence Diagram. Finding an optimal order for these operations, which is NP-hard, is an element of crucial importance for the efficiency of the evaluation. In this paper, two methods for optimizing this order are proposed. The first one is an improvement of the Variable Elimination algorithm while the second is the adaptation of the Symbolic Probabilistic Inference for evaluating Influence Diagrams. Both algorithms can be used for the direct evaluation of IDs but also for the computation of clique-to-clique messages in Lazy Evaluation of Influence Diagrams. In the experimental work, the efficiency of these algorithms is tested with several Influence Diagrams from the literature.

1. Introduction

Influence Diagrams (IDs) [3,4] are an effective modelling framework for analysis of Bayesian decision making under uncertainty. The goal of evaluating an ID is to obtain the best option for a single decision maker (*optimal policy*) and its utility.

The evaluation algorithms proposed [5–8] require performing several combinations and marginalizations on the potentials attached to the ID (probability and utility functions not necessarily normalized). Finding an optimal order for these operations is a NP-hard problem [9] and it is an element of crucial importance for the efficiency of the evaluation. The evaluation of an ID can be considered as a combinatorial optimization, that is the problem of finding an optimal order in which combinations are performed. This idea was already used to make inference in Bayesian Networks (BNs) with the first version of Symbolic Probabilistic Inference algorithm (SPI) [10] and with an improved algorithm in the SPI family called set-factoring [11]. In a related work [12] some experiments with SPI were performed to evaluate decision networks, however no details of the algorithm were provided.

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