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On SPI 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 to perform a series of combinations and marginalizations with 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. The SPI algorithm considers the evaluation as a combinatorial factorization problem. In this paper, we describe how the principles of SPI can be used to solve Influence Diagrams. We also include an evaluation of different combination selection heuristics and a comparison with the variable elimination algorithm.

Keywords: Influence Diagrams, Combinatorial Factorization Problem, Exact Evaluation, Heuristic Algorithm.

1 Introduction

Influence Diagrams (IDs) [1,2] provide a framework to model decision problems with uncertainty for a single decision maker. The goal of evaluating an ID is to obtain the best option for the decision maker (*optimal policy*) and its utility.

Most of the evaluation algorithms proposed in the literature [3,4,5,6] require to perform a series of combinations and marginalizations with the probability and utility functions (potentials). Finding an optimal order for these operations, which is NP-hard [7], is an element of crucial importance for the efficiency of the evaluation. Thus the evaluation of an ID can be seen as a combinatorial factorization problem. This idea was already used to make inference in Bayesian Networks (BNs) with the first version of Symbolic Probabilistic Inference algorithm (SPI) [8] and with an improved algorithm in the SPI family called set-factoring [9]. In a related work [10] some experiments with SPI were performed to evaluate decision networks, however it was not given any detail of the algorithm. In this paper we describe the SPI algorithm for evaluating IDs taking into account the differences of an ID: two kind of potentials, the temporal order between decisions, etc. The experimental work shows how SPI can improve the efficiency of the evaluation on some IDs and different combination selection heuristics are compared.

The paper is organized as follows: Section 2 introduces some basic concepts about IDs and the motivation of this work; Section 3 describes how SPI can be used for evaluating IDs; Section 4 includes the experimental work and results; finally Section 5 details our conclusions and lines for future work.