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Evaluating Asymmetric Decision Problems with Binary Constraint Trees

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Abstract. This paper proposes the use of *binary trees* in order to represent and evaluate asymmetric decision problems with Influence Diagrams (IDs). Constraint rules are used to represent the asymmetries between the variables of the ID. These rules and the potentials involved in IDs will be represented using binary trees. The application of these rules can reduce the size of the potentials of the ID. As a consequence the efficiency of the inference algorithms will be improved.

Keywords: Influence diagrams, asymmetric decision problems, binary trees, probability trees.

1 Introduction

Influence Diagrams (IDs) [11] are a tool to represent and solve decision problems under uncertainty. Their main advantage is that they can encode the independence relations between variables allowing a compact representation. However, they have weaknesses: decision problems are usually asymmetric in the sense the set of legitimate states of variables may vary depending on different states of other variables [1]. To be represented as an ID, an asymmetric decision problem must be symmetrized and a considerable amount of unnecessary computation may be involved. Several approaches have been made to solve this drawback. Call and Miller [4], Fung and Shachter [18], Smith et al. [21], Qi et al. [17], Covaliu and Oliver [7], Shenoy [20], Nielsen and Jensen [15], Demirer and Shenoy [8], Díez and Luque [9] have proposed modifications to the IDs framework in order to deal with asymmetries.

In this paper we propose representing the qualitative information about the problem (constraints, due to asymmetries) using *binary trees* (BTs). Constraints can be easily applied to potentials reducing the number of scenarios to consider. Moreover, if BTs are too large, they can be pruned and converted into smaller trees, thus leading to approximate algorithms. We compare BTs with a previous approach for representing constraints, *numerical trees* (NTs), and show that more efficient algorithms are obtained.

The paper is organized as follows: Section 2 introduces some basic concepts about IDs and trees; Section 3 describes key issues about asymmetries and how they can be represented using BTs; Section 4 describes the evaluation algorithm

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