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Similarity Measures for Building Binary Utility Trees in the Approximate Evaluation of Influence Diagrams

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Abstract. Influence diagrams are a class of probabilistic graphical models used to represent and solve decision problems with uncertainty. The efficiency of their evaluation can be improved if probability and utility potentials are represented with binary trees instead of tables. The method for building a binary tree representing an approximate potential requires a similarity measure for comparing two potentials. Here we propose different similarity measures for building binary trees representing a utility potential and we test them with some IDs from the literature.

Keywords: probabilistic graphical models, influence diagrams, approximate computation, contextual-weak independencies, binary trees

1 Introduction

Influence Diagrams (IDs) [1, 2] provide an efficient framework for representing and solving decision problems with uncertainty. The quantitative information that defines an ID is given by a set of conditional probabilities for single variables given some other variables (*probability potentials*) and by a set of utility functions depending on given sets of variables (*utility potentials*). Traditionally, these potentials are represented using tables. However, the evaluation of large IDs with tables becomes unfeasible due to its computational cost. One solution consists of using alternative representations such as *binary trees* (BTs) [3–5] which is an efficient data structure for storing and managing quantitative information. This data structure takes advantage of *contextual-weak independencies* [6, 7] so that identical values can be grouped into a single one offering a compact storage. Moreover, when BTs are too large they can be pruned and converted into smaller trees leading to approximate encodings.

Given a potential represented as a table, there might be more than one equivalent BT with different sizes. Thus the task of building a minimal BT becomes crucial for the efficiency of the evaluation. In previous works [3, 5] a heuristic algorithm for building BTs from tables and pruning them is proposed. This method uses a similarity measure or divergence for comparing each of the intermediate BTs with the exact potential (e.g. *Kullback Leibler divergence*, *Cosine similarity*, *Extended Jaccard coefficient*, *Euclidean* distance, etc.). When building a BT representing a probability potential, Kullback Leibler divergence can be used. By contrast, in case of utilities, it is not clear which is the most suitable similarity measure. Herein we study some of them and explain how they can be used in an efficient way for building and pruning BTs representing utility potentials. These alternatives are tested with some IDs from the literature.