Prior Knowledge Employment Based on the K-L and Tanimoto Distances Matching for Intelligent Autonomous Robots

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Abstract. Modern autonomous robots are performing complex tasks in a real dynamic environment. This requires real-time reactive and pro-active handling of arising situations. A basis for such situation awareness and handling can be a world modeling subsystem that acquires information from sensors, fuses it into existing world description and delivers the required information to all other robot subsystems. Since sensory information is affected by uncertainty and lacks for semantic meaning, the employment of a predefined information, that contains concepts and descriptions of the surrounding world, is crucial. This employment implies matching of the world model information to prior knowledge and subsequent complementing of the dynamic descriptions with semantic meaning and missing attributes. The following contribution describes a matching mechanism based on the Kullback-Leibler and Tanimoto distances and direct assignment of the prior knowledge for the model complementation.

Keywords: prior knowledge, world model, matching, Kullback-Leibler, Tanimoto, metric, intelligent, autonomous, robot.

1 Introduction

Modern autonomous robots are challenged by more and more complex tasks. Moreover, these tasks demand real-time handling in a real-life dynamic environment. Some of the tasks imply interaction or even cooperation with other robots or humans. Such complex activities require reactive and pro-active handling of arising situations. A basis for such situation awareness and handling is often a *world modeling* subsystem [1], which acquires information from sensors and fuses it into existing world description by means of *data association and fusion* [2], [1]. The world modeling subsystem serves then as a central information hub to all other robot subsystems, such as context recognition and

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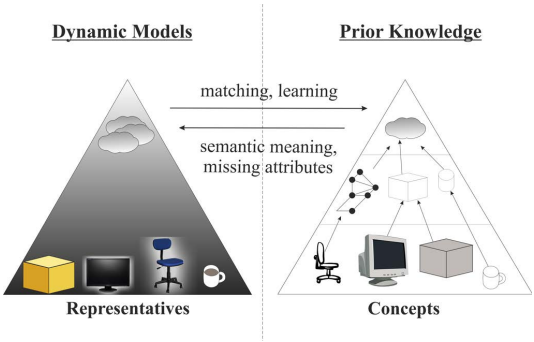

Fig. 1. Prior knowledge employment [1]

pro-active planning [3], [4]. The information acquired from sensors is affected by uncertainty and lacks for *semantic meaning*. Moreover, due to combinatorial complexity, the dynamic model should be as slim as possible, containing only vital information during the operational time. The solution to these issues is a *dynamic employment* of predefined information – *prior knowledge* – that contains concepts and descriptions of the surrounding world. This dynamic employment implies matching of the world model information to prior knowledge and subsequent complementing of the world model with semantic meaning and missing attributes as shown in Fig. 1. In this analysis we define a matching mechanism based on the *Kullback-Leibler* and *Tanimoto distances* for the matching process and direct assignment of the prior knowledge for the information complementation. The Kullback-Leibler distance is widely used in the classification domain (e. g., heart signals classification [5], similarity of ontology elements [6] or word clustering in text classification [7]) but is not employed for the direct connection of prior knowledge to dynamic models of autonomous systems. Similarly, the Tanimoto distance is widely used for comparison of finite sets (e. g., structural similarity search for biomolecule classification [8] or land cover detection [9]) but the prior knowledge employment in dynamic modeling of autonomous systems is left intact.

The rest of the paper is organized as follows: the Section 2 gives a short overview of a world modeling system. Next, a detailed analysis of the matching process between world model information and prior knowledge is given in the Section 3. A brief overview for a direct prior knowledge assignment is given in the following Section 4. An experimental set-up with an example workflow is described in the Section 5. A conclusion is presented in the last Section 6.

2 Information Representation

Before defining the prior knowledge employment mechanism, it is vital to describe the information representation used in this analysis. Each entity of a dynamic world model represents some element of the real world and thus is