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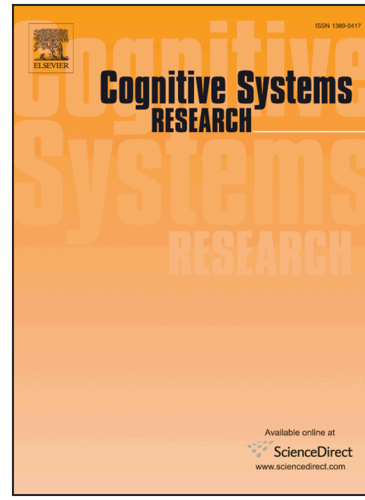

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ACCEPTED MANUSCRIPT

A Hybrid POMDP-BDI Agent Architecture with Online Stochastic Planning and Plan Caching

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Abstract

This article presents an agent architecture for controlling an autonomous agent in stochastic, noisy environments. The architecture combines the partially observable Markov decision process (POMDP) model with the belief-desire-intention (BDI) framework. The Hybrid POMDP-BDI agent architecture takes the best features from the two approaches, that is, the online generation of reward-maximizing courses of action from POMDP theory, and sophisticated multiple goal management from BDI theory. We introduce the advances made since the introduction of the basic architecture, including (i) the ability to pursue and manage multiple goals simultaneously and (ii) a plan library for storing pre-written plans and for storing recently generated plans for future reuse. A version of the architecture is implemented and is evaluated in a simulated environment. The results of the experiments show that the improved hybrid architecture outperforms the standard POMDP architecture and the previous basic hybrid architecture for both processing speed and effectiveness of the agent in reaching its goals.

Keywords: Autonomous Agents, POMDP, BDI, Satisfaction, Plans, Planning, Memory

1 Introduction

Imagine a scenario where a planetary rover has five tasks of varying importance. The tasks could be, for instance, collecting gas (for industrial use) from a natural vent at the base of a hill, taking a temperature measurement at the top of the hill, performing self-diagnostics and repairs, reloading its batteries at the solar charging station and collect soil samples wherever the rover is. The rover is programmed to know the relative importance of collecting soil samples. The rover also has a model of the probabilities with which its various actuators fail and the probabilistic noise-profile of its various sensors. The rover must be able to reason (plan) in real-time to pursue the right task at the right time while considering its resources and dealing with various events, all while considering the uncertainties about its actions (actuators) and perceptions (sensors).

We propose an architecture for the proper control of an agent in a complex environment such as the scenario described above. The architecture combines belief-desire-intention (BDI) theory (Bratman, 1987; Rao and Georgeff, 1995) and partially observable Markov decision processes

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