

Programming Agent Deliberation

An Approach Illustrated Using the 3APL Language

Mehdi Dastani Frank de Boer Frank Dignum John-Jules Meyer

University of Utrecht, P.O.Box 80089, 3508 TB Utrecht
{mehdi, frankb, dignum, jj}@cs.uu.nl

Abstract

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1. Extended Abstract

For many realistic applications, a cognitive agent should have both reactive and deliberative behavior [1]. The first type of behavior concerns the recognition of emergency situations in time and provides rapid responses whereas the second type of behavior concerns the planning of actions to achieve its long-term goals. In order to implement an agent's deliberative behavior, its mental attitudes such as goals and beliefs as well as the interaction between these attitudes should be implemented. Issues related to the implementation of the agents' mental attitudes can be considered as object-level concerns while issues related to the implementation of agent deliberation and the interaction between mental attitudes form meta-level concerns [2].

Agent deliberation is not limited to the planning of the tasks, but it includes various types of decisions at each moment of time [3] such as how to select a goal from a set of possible goals and whether revising a plan or executing it. These types of decisions, which constitute the agent's deliberation process and determine the types of agent behavior, are usually implemented statically in an interpreter and are not explicitly and directly programmable in an agent module. For example, the decision on goal selection is usually based on an assumed predefined ordering of the goals such that the interpreter always selects the goal that has the highest rank. Of course, it may still be possible to implement some of these decisions implicitly in the agent's mental attitudes (object level) despite

the way the interpreter is implemented. For example, the decision on goal selection can be implemented by making goals conditional on beliefs, but as we will argue, this type of approach shifts the problem rather than solves it. Moreover, we believe that doing so violates the basic programming principle called *separation of concerns*. Therefore, we aim to distinguish the object-level concerns, which are related to the mental attitudes of agents, from the meta-level concerns, which are related to the agent's deliberation process.

In this paper, we present the specification of a programming language to implement the deliberation cycle of cognitive agents. Although this programming language is designed to implement the deliberation cycle of 3APL agents [4], it can be used for other types of cognitive agents by some modifications related to how mental attitudes are represented. The 3APL programming language provides a set of programming constructs to implement agents' mental attitudes such as its beliefs, goals, basic actions, and planning rules. The aim of this paper is to extend this language with a second set of programming constructs by means of which the deliberation cycle becomes programmable. This extension should make 3APL a programming language for cognitive agents that respects the separation of concerns principle.

References

- [1] G. De Giacomo, Y. Lespérance, and H. Levesque. *ConGolog, a concurrent programming language based on the situation calculus*. Artificial Intelligence, 121(1--2):109--169, 2000.
- [2] F. Brazier, B.D. Keplicz, N. Jennings, and J. Treur. *Desire: Modelling multi-agent systems in a compositional formal framework*. International Journal of Cooperative Information Systems, 6:67-94, 1997.
- [3] D. Kinny. *The psi calculus: An algebraic agent language*. In J.-J. C. Meyer and M. Tambe, (eds), Intelligent Agents VIII, Agent Theories Architectures and Languages, LNAI 2333, 32-50. Springer-Verlag, 2001.
- [4] K.V. Hindriks, F.S.D. Boer, W.V. der Hoek, and J.-J.C. Meyer. *Agent programming in 3apl*. Autonomous Agents and Multi-Agent Systems, 2(4): 357-401, 1999.