A Software Architecture for an Argumentation-Oriented Multi-Agent System

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Abstract. This paper proposes the materialization of a complete argumentation system ready to be built in conventional agent software platforms. In particular, an example for the Jadex agent platform is shown. The platform uses the BDI (Belief, Desire, Intention) model of agency. The main goal of this work is to foster usability of argumentation frameworks. The approach followed here to achieve it is the proposal of a formal representation for the dialogs that can occur, a specification of how to build the application domain model (i.e. the universe of discourse) and the necessary guidelines to manage these elements when building BDI agents.

1 Introduction

In the last years, knowledge-based multiagent systems (KBMAS) [6] have shown to be useful in complex scenarios such as traffic control or network administration. In these systems, cooperation and competition between agents to augment knowledge and to impose some beliefs, respectively, are the two main approaches. Both proposals need global techniques in order to detect and resolve potential knowledge or opinion conflicts on the different agents’ beliefs.

Knowledge conflicts can be divided into two types: semantic-independent conflicts, so-called contradictions, which appear independently of the domain modeled, e.g. a positive and negative assertion on the same information; and semantic-dependent conflicts or differences, tightly related to a specific domain. For example, classifying an object as square and as rectangular is not a priori conflictive. However, the constraint that an object must be described with a unique shape could be elicited from the domain. In this case, the two classifications would be in conflict. In this work, a conflict-aware KBMAS is proposed in order to cope with both types of conflicts. This proposal consists of a software architecture that combines BDI agents, a formal knowledge representation model and a mechanism to solve conflicts based on argumentative persuasion dialogs. They are briefly introduced here.

Firstly, the universe of discourse (i.e. the domain knowledge) is described here by means of a formal and explicit model, based on Semantic Web [1] technologies. They provide an appealing vision about how to represent the agent’s knowledge in distributed environments. More precisely, we refer to OWL ontologies [5], which offer a logical language to supply an exact description of any domain. These ontologies present
a standardized means of exchanging and reusing knowledge, with a semantic enrichment of it. Due to the addition of this meta-information, agents can support reasoning operations, e.g. deductive processes or consistency checking.

Secondly, by integrating this formal knowledge into BDI (Belief-Desire-Intention) agents [11], they are provided with an explicit model where beliefs are related to the domain knowledge, desires amount to the motivations of the agent (e.g. to win an opinion discussion), and intentions are the agents’ goals (e.g. to establish a belief in a competition). In particular, BDI agents are a specialization of deliberative agents, which allow for the definition of plans to achieve those goals. By means of the plans, the rationality of the agents can be extended with conflict management strategies.

Finally, one alternative to reach an agreement about the status of a conflict resides in establishing a persuasion dialog between agents [10]. Persuasion dialogs are one of the six basic types of dialogs defined by Walton and Krabbe [13]. They claim that each dialog tries to resolve an undesired situation (conflict of opinion, lack of information, etc.) by defining a set of protocols and rules. Specifically, persuasion dialogs consist of an exchange of opinions among agents that are for/against an issue, with the aim of clarifying which one is the most acceptable.

Argumentation [3] is considered as a promising materialization of persuasion dialogs in multi-agent systems. In this way, a negotiation protocol is defined via argumentation, that leads to a persuasion dialog in which an agent tries to convince others about a concrete proposal. But in this case, not only are the proposals exchanged. Furthermore, arguments (i.e. premises and rules used to derive those proposals) are also communicated. Thus, conflicts may be resolved more efficiently.

This work introduces an argumentation system based on ontologies (ASBO henceforth), which rests on the BDI agency model. The ASBO theoretical model has been published elsewhere [8], but enough details to introduce it are mentioned throughout the paper. An implementation of agents equipped with ASBO has been developed in a BDI agent system, the Jadex platform[1]. The particularity of this approach resides in an OWL-based domain representation.

The rest of the paper is structured as follows. Section 2 discusses the related work and our contribution to the state of art within argumentation literature. Section 3 introduces the argumentation system proposed here as a software architecture ready to be used. Its employment is illustrated in section 4 through a persuasion scenario in which ASBO is applied to build and exchange arguments in order to solve conflicts. Finally, section 5 summarizes our contribution and points out the future work.

2 Related Work

Argumentation deals with several fields in knowledge engineering [3]. Consequently, an abstract and generic framework for reasoning under incomplete and inconsistent information has been defined [2]. We have instantiated such a generic framework by using the Semantic Web information model approach. As a result, all the knowledge managed in ASBO, including arguments and rules themselves, is represented by means

1 http://vsis-www.informatik.uni-hamburg.de/projects/Jadex/