Improving Software Agent Communication with Structural Ontology Alignment Methods

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ABSTRACT

To perform tasks on the semantic web, software agents must be able to communicate with other agents using domain ontologies, even when considering different ontologies. In this regard, it is necessary to address semantic interoperability to enable agents to recognize common concepts and misunderstandings. In this paper, the authors propose the use of negotiation concepts in business scenarios for addressing concept compatibilization problems in communication between software agents and present an algorithm developed in the GNoSIS system. A validation of this approach is presented.

Keywords: Negotiation Concepts, Ontologies, Semantic Interoperability, Similarity, Software Agent

INTRODUCTION

Dealing with systems interoperability has been a research issue for some time, but the use of a knowledge structure to allow system interoperability - whether in communication between agents, in database integration or still in other scenarios – has still several problems. Interoperability is compromised when different knowledge structures are used and overlapping domain concepts can become a computing issue.

According to O’Hara (2004), the highest layers of the Semantic Web architecture contain social phenomena that cannot be overlooked in computational solutions (such as the trust layer). As the structuring of knowledge is present in the upper layers of the Semantic Web, a genuinely social phenomenon that can be observed is related to the achievement of consensus for the creation and compatibilization of these knowledge structures (in our case, ontologies).

To execute their tasks, software agents need to be interactive and adaptive, that is, they should be capable of receiving and sending...
messages to other agents or to the environment and should be capable of understanding these messages. The understanding of the messages takes place through a standardization of the vocabulary of the agents. The attaining of such compatibility can be made with the use of domain ontologies. In open environments, however, software agents are subjected to receiving messages from agents that do not share the same standardized vocabulary, which characterizes one of the challenges in this area. The software agents will be responsible for dealing with the harmonization of ontologies (Breiman et al., 2007), discovering similarities between concepts or the wrong interpretation of some concept during the communication with other agents, to execute some task that requires interaction between agents.

However, harmonizing ontologies is a hard task and stills an unsolved issue. The ontological divergences can be divided into (1) divergences on the level of language (differences caused by the use of different formalisms) and (2) divergences on the level of conceptualization (differences related to the structuring of the concepts in the ontology) (Klein, 2001).

Divergences on the level of language are solved with the changing the formalism of one or of the two ontologies. The changing of the formalism also generates new problems, such as those caused by the difference in expressiveness of a formalism in relation to the other but even then this is the most adequate solution to solve this type of divergence. In this work, we adopted OWL language as the standard for ontology description and thus do not deal with divergence issues of this level.

Divergences on the level of conceptualization occur, amongst other cases, due to a difference in coding, use of synonyms, use of distinctive generic ontologies, difference in granularity between the ontologies, etc. These cases demand a comparison of the structure of the concepts and of the context, that is, a semantic comparison. Syntactic comparisons can add good results to semantic comparisons by finding semantic relations between terms, as it happens in many algorithms that mine text corpus (Chakrabarti, 2000; Faatz & Steinmetz, 2002).

This work presents a general architecture that allows the harmonization of ontologies during the communication of software agents. The architecture addresses how agents must encapsulate alignment functions to harmonizing ontologies and also explores negotiation concepts commonly applied in the business scenario and validated in the context of negotiation of meanings with human users (Oliveira et al., 2007; Souza et al., 2006).

In order to deal with ontology compatibility issue in this communication we propose an algorithm that uses both syntactic and semantic techniques in a structural approach, according to the classification proposed in Shvaiko and Euzenat (2005). This algorithm uses resemblance functions and calculates the degree of similarity between the concepts in a recursive manner, calculating the degree of similarity between two concepts based on the degree of total similarity between the concepts that have close kinship.

This algorithm was implemented as part of the GNoSIS system (Oliveira et al., 2007; Souza et al., 2006), created to allow groups of domain specialists to negotiate meanings of concepts as described in ontologies and produce the mappings between the ontologies. The GNoSIS recommends mappings based on the calculation of similarity between concepts and after that the domain specialists negotiate the validity of the mapping and the differences in conceptualization.

NEGOTIATING TO REACH CONSENSUS

Negotiation can be defined as a process through which a group of agents communicates with one another to try and come to a mutually-acceptable agreement on some matter (Lomuscio et al., 2003). This cooperative negotiation is classified as Win/Win. In the definition, the stress is placed on words such as ‘agent’, ‘communicate’, and ‘mutually acceptable’. The parties taking part
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