Chapter 3
Applying Ontology Similarity Functions to Improve Software Agent Communication

Jairo Francisco de Souza
Federal University of Juiz de Fora, Brazil

Sean Wolfgang Matsui Siqueira
Federal University of the State of Rio de Janeiro, Brazil

Rubens Nascimento Melo
Pontifical Catholic University of Rio de Janeiro, Brazil

ABSTRACT
In order to perform its tasks on the Semantic Web, software agents must be able to communicate with other agents using domain ontologies, even when considering different ontologies. Thus, it's necessary to address the semantic interoperability issue to enable agents to recognize common concepts and misunderstandings. This work proposes the use of GNoSIS, a tool for composing ontology similarity functions, and specific modules in Goddard agent architecture in order for software agents to negotiate meanings of terms not defined in its ontology.

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 (Breitman 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 an approach that allows the harmonization of ontologies during the communication of software agents. The approach addresses how agents must encapsulate similarity functions to harmonizing ontologies during communication. This approach was implemented in GNoSIS system. The system evaluation (Souza et al, 2010) shows that the system can be used to reach similarity degrees very close to 1 (that is, close kinship) between concepts even with syntactic or structural differences.

The GnoSIS 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.

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Software agents communication languages, such as KQML, allow describing domain ontologies used in the message content. The negotiation of meanings for software agents takes place through the alignment of their respective domain ontologies. This negotiation of meanings is done immediately after the identification of (1) a term that does not exist in the ontology of the agent that receives the message or (2) homonymous terms.

As domains are denoted in ontology languages as `namespaces`, the terms described in ontologies as classes and that are in distinct `namespaces` are considered possible homonyms. Figure 1 shows two messages sent by two agents, A and B, us-
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