Chapter 53
The Implementation of DSSim: A Multi-Agent Ontology Mapping System

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ABSTRACT

This paper presents the decisions taken during the implementation of DSSim (DSSim stands for Similarity based on Dempster-Shafer) our multi-agent ontology mapping system. It describes several types of agents and their roles in the DSSim architecture. These agents are mapping agents which are able to perform either semantic or syntactic similarity. Our architecture is generic as no mappings need to be learned in advance and it could be easily extended by adding new mapping agents in the framework. The new added mapping agents could run different similarity algorithms (either semantic or syntactic). In this way, DSSim could assess which algorithm has a better performance. Additionally, this paper presents the algorithms used in our ontology alignment system DSSim.

INTRODUCTION

Multi-Agent Systems (Woolridge, 2001; Lesser, 1995) are based on the idea of having autonomous agents that interact and resolve problems that cannot be programmed at design time. In fact, the vision (Berners-Lee, 2000) of the Semantic Web predicts that "intelligent systems/agents" will process semantic data without or with minimal human intervention. Therefore, these systems must have in-built mechanisms to develop a certain degree of understanding of the available information regardless of the syntactic or semantic representation of the Semantic Web. Early practical implementations of multi-agent systems have a history of more than 20 years. Sycara introduced several issues and challenges of multi-agent systems and described some early successful applications from large and complex domains (Sycara, 1998). These include manufacturing (Dyke, 1987), process control (Jennings et al., 1995), air-traffic control (Ljungberg & Lucas, 1985) and information management (Sycara et al., 1996). The most challenging issues and motivating aspects according to Sycara (1998) were how to solve complex problems (i) using a "decentralised system where each entity has partial information", (ii) "without global control'' and (iii) with "inconsistent knowledge and beliefs." These challenges and motivating factors remain valid

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for Semantic Web applications because the World Wide Web and Semantic Web are isomorphic when taking certain aspects into consideration. For example, both are open, distributed and dynamic given the fact that millions of resources can appear and disappear any time. As a consequence, the Semantic Web viewed as a complex, large and dynamic domain should facilitate the development of systems where each agent is specialised within a well-defined, specific task. In this environment, agents should be able to establish their own interpretation of the information that is represented by ontologies, communicate with each other and combine their knowledge into a more coherent view. Furthermore, as Sycara (1998) pointed out, in large and complex domains agents that cannot have a global knowledge of the situation must be able to establish their own beliefs, even if these beliefs are based on incomplete knowledge. Aggregating such knowledge can lead to the emergence of some sort of "intelligent agent system". The use of a multi-agent system for ontology mapping has the potential to address various issues related to domain independence and scalability. Firstly, the literature review reveals that the mapping quality could be improved by combining similarity measures (Jean-Mary et al., 2009; Nagy et al, 2005; Nagy et al. 2008; Nagy & Vargas-Vera 2011).

Furthermore, most of the analysed mapping systems use similarity combination, which assumes that these assessments should work on an interpreted internal representation of the source and target ontologies, and that similarity assessments should be executed simultaneously. Parallel similarity assessments can be carried out without agents as well; however, a multi-agent approach provides a very flexible way to model complex and dynamic systems. For example, mapping agents can be created and added to the mapping system dynamically without terminating the mapping process, where agents can use pre-defined similarity methods. Each created mapping agent could interpret the ontology terms differently, depending on the background knowledge and could communicate with other agents to present results or resolve conflicts. Secondly, considering scalability issues, independent mapping tasks can be split up and distributed between agents that run on various physical network locations and depending on the complexity, additional agents can be created at run time in order to address performance issues. As a result, a multi-agent mapping approach can provide a dynamic, flexible and scalable solution that can establish domain independent results on large and complex domains like the Semantic Web.

Our main contribution is to conceive and develop DSSim an ontology mapping system which is generic framework. DSSim solve both uncertainty in a mapping and conflicting evidences by means fuzzy voting model. Our ontology mapping method (embedded in DSSim) is novel and it has been tested with large ontologies in the international evaluation of Ontology Alignment (OAEI). The paper is organized as follows: firstly, it presents the design decisions taken in the construction of our DSSim. Secondly, it gives details of the main algorithms implemented in DSSim and finally, it presents our conclusions.

RELATED WORK

Ontology Mapping: Early Approaches

Euzenat and Shvaiko (Euzenat & Shvaiko, 2007) explain that ontology mapping is a semantic integration approach where links (mapping) are created between concepts, properties and individuals of different ontologies. We believe that indeed, ontology mapping is more flexible approach than ontology merging as there is no need to create a global ontology. In the ontology matching approach the local ontologies can be used while they stay untouched and a mapping could be created and revised every time that the

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