BOOTSTRAPPING THE SEMANTIC WEB

by Developing a Multi-Agent System to Facilitate Ontology Reuse:A Research Agenda

Keywords: Semantic Web, Multi-agent systems, reuse, ontology, ontology engineering, reuse in ontology engineering, agents for reuse

Abstract: Ontologies are basic components of the Semantic Web but are difficult to build, and this acts as a bottleneck in the spread of the Semantic Web. Reuse is seen as one of the solution to this problem. This paper addresses the feasibility of a multi-agent system that will automatically identify the appropriate reusable ontologies and thereby greatly reduce the burden of its users. First, the area of automated software component reuse is reviewed and borrowed from in order to develop an appropriate framework. Next, a research agenda is proposed for developing this type of multi agent system for ontology reuse. Finally it is argued that the proposed multi-agent system will enable faster deployment of the Semantic Web by making the ontology development process efficient and developed ontologies, more robust and interoperable. This use of agents may help to bootstrap the Semantic Web itself by leveraging from the emerging Semantic Web architecture, and contributing to its growth.

1 INTRODUCTION

The emergence of the Semantic Web opens up boundless possibilities by enabling software agents to reason about its content and provide rational responses to unanticipated situations. However (Lassila et. al., 2001) observes that acceptance by the mass (people outside the technical community) is critical to the success of the Semantic Web. An obstacle to the successful deployment of the Semantic Web is that one of its main building blocks, ontologies, are difficult to build (Hovy et. al., 2001). Therefore it is critical that we explore techniques that ease the process of ontology development while maintaining its critical qualities, like extendibility, adaptability and interoperability.

Reuse is one such technique. Reuse saves time, effort and naturally lends itself to standardization. In some cases a whole ontology can be built just from assembling other ontologies. In other cases, the reused ontologies must be extended, specialized or adapted (Pinto et. al., 2000). Ontology engineering literature views reuse mostly as a manual activity that is dependent on the experience and skill of the ontologist(s). During an ontology development effort an ontologist will usually browse a few ontology repositories and based on her experience with the repository and her understanding of the ontologies that are available to her, will select ontologies that may be used as is, adapted with extensions or borrowed from. Although this is a simplistic version of a non-trivial task, this browse and select model can be characterized as the most common reuse effort that is being practiced in the field. The emergence of the Semantic Web will see ontology libraries grow in size and extent, with eventually the complete Semantic Web itself becoming a global repository of ontologies. The current surf and select mode by expert ontologists will become less effective, and simple search agents alone are not the answer.

In this position paper we introduce the feasibility of a multi-agent system that will automatically identify the appropriate reusable ontologies and thereby greatly reduce the burden of its users. To develop a basic framework for this type of system we examine a more matured area of automated software component reuse and borrow from it as appropriate. Next we propose a research agenda for developing this type of multi agent system for ontology reuse. In conclusion we postulate that this type of system will leverage from the emerging Semantic Web architecture, and will contribute to its growth.

2 USE OF AGENTS TO FACILITATE REUSE OF SOFTWARE ON THE WEB

There has been considerable progress in recent years in developing agents that will locate reusable software component on the Web. Although in the early nineties there may have been lack of guidance in the agency of reuse in

software development (Silverman et. al., 1995), since then considerable work has been done on agent based software reuse. Intelligent software agents like CodeBroker, (Ye et. al., 2000) and a multi agent system (Erdur et. al., 1999) will automatically search and retrieve reusable software components on the Internet. These are more advanced than the primitive passive and conversational interface-based reuse repository systems that supported the developer only when she knew that a relevant component already existed. We can borrow from their general system architecture and apply them to developing our multi-agent systems.

We have not identified a software reuse agent that exploits the Semantic Web architecture. However, this should not be an issue, as the machine processable nature of the Semantic Web will only make it easier for the agents to work effectively on the Semantic Web. We have seen some innovative use of agent technology leveraging the Semantic web, for example some researchers have developed agents in the agency of schedule browsing and conference calling (Payne et. al., 2002).

3 A RESEARCH AGENDA

We suggest a three-phased research program to develop a multi-agent system that facilitates ontology reuse. First we will conduct a survey of ontology development methodologies to characterize the agency of reuse specific to the ontology development process. Then based on the characterization, we will identify and develop an architecture for a multi-agent system and implement it in a closed world environment (for example DAML+OIL library at http://www.daml.org/ontologies/). We will use the results to develop the system to work on an open world environment (i.e. on the Semantic Web). We briefly discuss the highlights of our research agenda below. For details, we recommend that readers look at http://java-emporium.com.

3.1 Survey of Ontology Development Methodologies (focus on reuse)

(Gómez- Pérez, 1999) surveyed the current ontology development methodologies and highlighted the difficulty of reuse found in the current practices. He noted that the lack of standardized identifying features, different levels of details, different content formalization language etc. make searching for reuse not only difficult and time consuming, but sometimes futile. Despite the cost there is a large body of ontologists who support reuse in favor of its benefits. For example, (Heflin et. al., 2000) suggested the reuse of ontologies because it is important for interoperability.

To characterize the agency of reuse correctly we need to identify various interactions that an ontologist has with the repositories, the process or the heuristics that she follows in identifying the ontologies that can be adapted, extended or directly reused. We also need develop a cost benefit model to quantify the utility of reuse. (Uschold, 1998) made a cost benefit analysis on ontology reuse in developing ontology for a specific domain. The work can be generalized to develop standard models to estimate cost and benefit of reuse.

In addition to the survey of general ontology development methodologies we need to look at the few instances where agents have been used to perform ontology reuse. OntoEdit provides inference support in the ontology refinement phase where the semi-formal description of the ontology is extended. Ontolingua, Webont and Ontosaurus also provide some basic agent based support. The general knowledge editor SNARK from SRI also promises some advanced support for reuse (Duineveld et. al., 1999) (Thomere et. al., 2002) (Sure et. al., 2002).

3.2 An Initial Architecture of a Multi-agent System

The intelligent multi-agent system architecture offers many benefits if agent parameters are properly attuned to degree of intervention and control, purpose and intentionality, and knowledge of reuse processes/domains. We believe the system should have cooperating agents communicating with each other in a specified protocol (e.g. KQML (Finin et.al., 94)). Some of the agents of the systems will be as follows:

Interface agents: Agents that will assist the user in representing the queries in terms of ontologies in the system, present the results of the queries to

the user and contact the user to get additional information and user's confirmation when necessary.

Planner agents: Agents that will perform the problem solving tasks, i.e. locate reusable ontologies. They will generate plans after they receive the task specifications from another agent in the system. They will have a plan library where each plan will have a related sequence of actions. These actions are scheduled and executed and the results are sent back.

Library Agents: Agents that will interact directly with the ontology repository. They will answer single queries. They will also provide periodic information requests (for example, query periodically an ontology server to notify the user about a new version of an ontology)

3.3. Application in a Closed World – Evolution – and Final Deployment on the Semantic Web

The deployment phase as mentioned before is divided into three sub-phases. We will deploy the agents in a closed world situation. (Ding et. al., 2001) have identified some ontology libraries where agents can be deployed. The next sub-phase will be to collect the results in terms of previously defined cost-benefit model of reuse, make changes and finally deploy the agents on the Semantic Web.

4 CONCLUSION

The Web Ontology Language Requirements document by W3C makes extension and hence reuses a critical requirement (Heflin et. al., 2002). We will explore the role of intelligent agents in ontology repositories to build systems that will act on behalf of its users in locating reusable ontologies. This multi-agent system will enable faster deployment of the Semantic Web by making the ontology development process efficient and developed ontologies, more robust and interoperable. We postulate that the novelty of our approach is the use of agents (a component of the Semantic Web) to bootstrap the Semantic Web itself.

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