Ontology Mapping for Learning Objects Repositories Interoperability

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ABSTRACT

In order to deal with the need of sharing learning objects within and across learning object repositories most of the recent work argue for the use of ontologies as a means for providing a shared understanding of common domains. But with the proliferation of many different ontologies even for the same domain, it become necessary to provide mapping process to perform interoperability. Two key issues must be addressed: the first one is to provide help to users describing and searching resources by organizing the knowledge covered by the learning resources and the second one is to define educational systems interoperability mechanisms to create a virtual learning space. Although many efforts in ontology mapping have already been carried out, few of them use resources properties to generate relations between local concepts and discover mapping dynamically.

Categories and Subject Descriptors

Software/Software_Engineering/Interoperability.

General Terms

Algorithms.

Keywords

Ontology Mapping, Semantic Interoperability, Multi-Agent Systems, Semantic Web, Learning Resources, Web-Based Educational Systems

1. INTRODUCTION

Ontologies offer a great potential in higher education providing in particular the sharing and reusing of information across educational systems and enabling intelligent and personalized learner support. The increased functionality that ontologies imply will bring new opportunities to e-learning. Learners will be able to interact with distant educational systems easily and in a personalized way. An overview of ontologies for education field and an initial report on the development of an ontology-driven web portal O4E are presented in [2].

We propose in this paper an algorithm which is applied on an existing Web Based Educational Systems (WBES) - developed in our team [1] - that allows learners and teachers searching, adding and composing new resources in a local repository. To facilitate resources exchange with other WBES it becomes necessary to find solutions allowing the cooperation between various repositories of learning resources. The user may seek resources out of his/her private reference ontology. The problem is that the comprehension of a new classification (a new ontology) is expensive and does not constitute a justified investment. It is thus necessary to propose mechanisms to permit the user to access to resources of other repositories in a transparent way using his/her favorite WBES (and the associated shared reference ontology).

The particularity of the algorithm is that (i) it focuses on dynamic ontology mapping using a multi-agent system, (ii) it uses information on the resources to enrich the local ontology by generating semantic relations between local concepts (iii) it is based on inference rules to compare the ontologies' concepts. These inference rules may be general ones (i.e. domain independent) or more specific rules (i.e. domain dependent) added by an expert. This flexibility allowed the algorithm to be applied to other domains.

In this paper we introduce a dynamic mapping approach for bridging gaps between learning object repositories based on ontologies. Dynamic ontology mapping means that during a user interaction (query), the mapping system receives a sequence of external concepts and returns the most specific mapping for each concept.

2. ALGORITHM PRINCIPAL

The objective of our approach is to map ontologies dynamically, and only when needed. The system tries to find semantic relations between the user query concepts and the concepts in the target ontologies.

The algorithm to combines different similarity measures to find mapping candidates between two ontologies. We distinguish three main categories of similarity: linguistic similarity, structural similarity and rule-based similarity. Using these different similarities may increase the precision of the results.

In this section we describe the global architecture and the agents' behavior of the mapping process.

2.1 Architecture

The ontology interoperability needs to define mapping between ontologies. In our architecture (figure 1) the mapping process is split up into five levels: (i) resources level, (ii) ontology level, (iii) interface level where we can find, the user and the ontology agents (OA) which generate new ontologies enriched with additional relations, (iv) simulation level and (v) domain expert level.

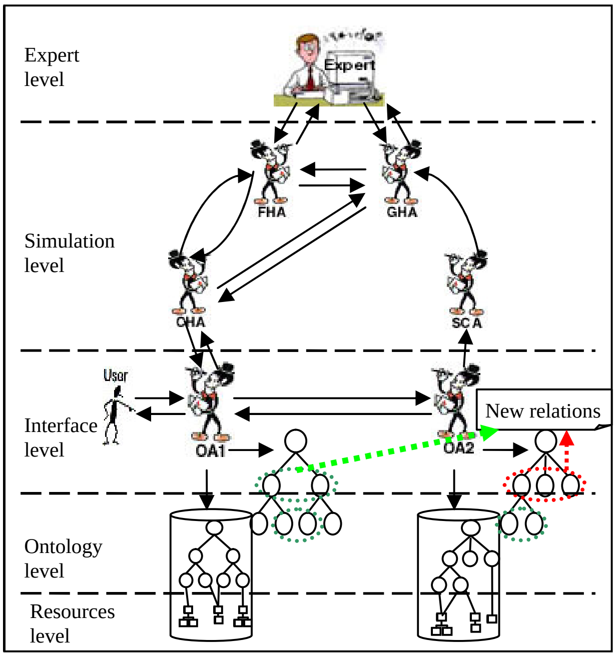

Figure 1. Architecture approach for mapping process.

2.2 Mapping Process

The algorithm begins by generating information from the ontology. The ontology agent OA uses the instances (resources) comparisons for deducing semantic relations between concepts (convergence, divergence) of the same ontology. The OA agent which intercepts a user query generates all possible relations between the query concepts and sends both concepts and these relations to all other OA agents.

The simulation level contains four agents: SCA (Similarity Computation Agent), GHA (Generation Hypotheses Agent), FHA (Filtration Hypotheses Agent) and CHA (Choice Hypotheses Agent). We describe in the following the general behavior of each simulation agent.

The SCA agent determines similarity values of candidate mappings via different matchers. The first iteration consists in providing a basic similarity between concepts. In this iteration we use linguistic tools [6, 7] to compare concepts' names. In the i^{th} iteration we use the similarity produced in $(i-1)^{th}$ iteration and we apply the inference rules. These inference rules are either rules inferred from structural similarity (deduction rules) or rules proposed by the domain expert (comparison rules).

The GHA agent receives all similarities sent by SCA and it generates hypotheses using inference rules. These hypotheses consist of new correspondences between concepts. The generation of an hypothesis at iteration (i) is based on either the mapping set or the similarities generated previously. Indeed, depending on the similarity value, we generate mapping hypotheses between the couple of concepts which have a similarity value enough important.

The FHA agent studies and filters all hypotheses generated by GHA. The hypotheses which do not verify certain constraints (e.g. structural constraints) are removed. The subset of filtered hypotheses is sent to CHA agent.

The CHA agent choices hypotheses which have the best similarity, using both existing mapping and user feedback.

The final mapping is sent to ontology agents. After several interactions, each OA acquires more knowledge about other OA(s) and defines a set of most relevant OA(s) (i.e. the OA(s) that answer to its needs). This set is called “agent’s accountancies”.

3. CONCLUSION

Various works [3, 4, 5] have been developed for supporting the mapping of ontologies. Most of them are based on syntactic and semantic matching heuristics given by an expert to generate static mapping. None uses deduction rules which can be generated for different application domains. In our mapping approach, we try to use as much as possible available information contained in the ontology to determine dynamically and if necessary the relationship between concepts. This information consists of identifiers names of concept, ontology structure, resources and manual/automatic rules. Resources properties generate new semantic relations between concepts (concepts of the same ontology). In future work, we plan to add other match and techniques in order to resolve more complex mapping problems.

4. REFERENCES

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