Ontology for Coordinating Dialogs in Distance Learning Environments

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ABSTRACT

This paper discusses the role of ontology for an intelligent agent designed for coordinating domain dialogs among participants of a distance learning environment. The domain models used by the agent are centered on the ontological representation of the domain concepts. The agent's behavior as well as the adequacy of the domain models have been tested in actual distance learning situations.

1. INTRODUCTION

Distance learning environments are widely used to allow full distance courses or used as a complement to more traditional classes. Due to their inherent distributed nature, such environments have a large potential for agent architecture, either for delivering learning material or enabling communication among the participants in so-called discussion forums. In either aspects, the ontological representation of the domain plays an important role. We are developing an agent system capable of coordinating collective discussions in distance learning environments by using a set of specialized agents. Two of the major agents of this system are the *dialog agent* and the *knowledge base (KB) agent*.

The *dialog agent* coordinates the discussion by generating series of dialog cycles and maintaining an argumentation tree. The *KB agent* performs all domain-related tasks, being the ontology its central knowledge model. Considering the purposes of this workshop, we will give more emphasis to the KB agent.

2. THE DIALOG AGENT AND THE ARGUMENTATION STRUCTURE

In this section we briefly describe the dialog agent's behavior. This agent has the task of initiating, coordinating and closing the discussions by generating *dialog cycles*. Initially, given a set of questions (discussion elements, or DEs) and a set of participants, the dialog agent builds and distributes a set of questions to the participants. As soon as the questions are answered, the agent reshuffles the groups of participants and sends the questions with their answers to be analyzed and commented by the new groups. According to the level of agreement and the content of the comments, the system may decide upon triggering another discussion cycle (regrouping the participants and building new worksheets) or finishing the discussion. This process is continued until a satisfactory degree of collective agreement is achieved. The discussion is organized as an *argumentation tree* [1], where each node corresponds to a dialog argument. Most of the intelligent behavior featured by the system is the result of (i) the regrouping algorithm that takes into account structural and semantic parameters and (ii) the dynamic generation of discussion elements, both services being delivered by the KB agent.

3. THE KB AGENT AND THE ROLES OF THE ONTOLOGY

The role of the KB agent is thus to perform all domain-specific tasks, i.e. generate discussion elements, perform semantic matching and evaluate the semantic coverage of the discussion. The domain ontology, in our work, is the central representation that provides the KB agent with the required amount of theory-awareness.

3.1 Ontology for generating discussion elements

The generation of text-based questions in natural language (or content-expected interrogative speech acts [2]) starts up a discussion tree. We represent the domain by using two different models: the *domain ontology* and the *task structure*. The ontology relates domain concepts by means of *part-of* and *is-a* links, and is used to represent the concepts manipulated by the tasks of the task structure. The ontology is used to produce questions like: *what kinds of <concept> do you identify*, or *what are the composing elements of* <*concept*>? Such questions are produced so as to cover a certain number of concepts scheduled for the discussion.

3.2 Ontology for semantic matching

When a discussion element is generated, a central concept is identified. It is the one appearing in the text. All related sub-concepts that appear in the domain ontology are considered to be the sub-domains of this discussion element. By analyzing the occurrence of such concepts in other answers or comments, the agent can discover semantic relations and use them for further regrouping of the participants for the next discussion cycle.

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4. OUR EXPERIENCE IN DOMAIN MODELING

We have conducted experiences in domain modeling as part of a research project between the Technology University of Compiègne (UTC) and CEGOS, a French enterprise that provides on-line training. We chose a specific CEGOS course and built the knowledge models for it, i.e., the task model and the domain ontology. We are now designing the agents' mechanisms based on such models. The items below describe the major results from this project concerning the KB agent.

4.1 A "what-for" approach for designing the ontology

Given the problem, we started with analyzing what the ontology would be used for, and then we chose a representation for it. For the purpose of generating discussion elements the ontology, as well as the task model, should provide elements for building interrogative sentences. Such sentences are meant to investigate the domain along five different axes: (i) the nature of the concepts (ontology *is-a* links); (ii) the elements of a composed concept (ontology *part-of* links); (iii) the use of the concepts by a certain task (task models *resource* link); (iv) the decomposition of a complex task into sub-tasks (task model *sequence* link); and (v) different ways of performing a task (task model *type* link). The second use of the ontology is to perform semantic matching, a process by which the agent dynamically regroups the participants of the discussion according to the content of their answers or comments. To this purpose, mainly *is-a* and *part-of* links are used to measure the semantic distance between two text chunks.

4.2 Domain modeling

The course we modeled, named "Le responsable formation nouveau dans sa fonction", which can be roughly translated as "How to manage competence in an enterprise" covers several different domains, ranging from human resource administration, to teaching methodologies and legal aspects. The diverse nature of the course content lead us to organize the needed ontology as a collection of domains.

The strong "how-to-do" feature of the content lead us to make use of another model, the task structure, that represents the tasks of a training a manager in her daily work. The next obvious choice was to link the task structure to the corresponding domain ontology by means of specialized links, namely *output resource*, *input resource* and *implicit knowledge resource*, which specify how a certain concept is used by the task (see Figure 1).

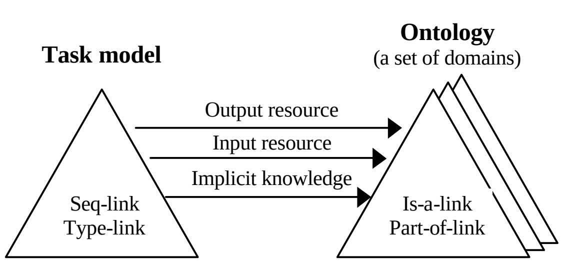

Figure 1: Link between the task model and the domain ontology

4.3 Implementation issues

We implemented both the ontology and the task model in LISP, as two independent structures linked together by a set of specialized links.

We also implemented an editor that allows the domain experts of CEGOS to build and edit their own ontologies (see Figure 2).

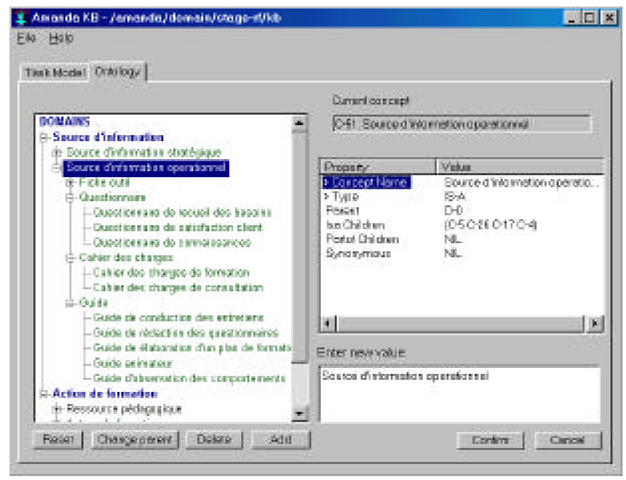

Figure 2: Ontology and Task Model Editor

5. CONCLUSION

In our work, we identified the need for an ontology and looked for an adequate representation for it. The complexity of an ontology, however, is related to the type of use we intend for it. Our problem requires a *terminological ontology*, i.e., a structured collection of terms. Other applications may need more powerful ontologies, like those containing formal definitions (interpretable ontologies), or even executable ontologies based on the notion of task ontology and abstract code [3].

6. REFERENCES

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