Chapter V
An Ontology-Based e-Learning Scenario

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ABSTRACT

Selecting appropriate learning services for a learner from a large number of heterogeneous knowledge sources is a complex and challenging task. This chapter illustrates and discusses how Semantic Web technologies can be applied to e-learning system to help learner in selecting appropriate learning course or retrieving relevant information. It firstly presents the main features of e-learning scenario and the ontology on which it is based; then illustrates the scenario ontology with the training domain and the application domain. Finally, it presents Semantic Querying and Semantic Mapping approach.

INTRODUCTION

E-learning is a critical support mechanism for organizations and individuals to enhance their skills. The incredible velocity and volatility of today’s markets require just-in-time methods for supporting the need-to-know of employees, partners and distribution paths. New styles of e-learning are the new challenges for the next century and will be driven by the requirements of the new economy.

Recent advances in technologies for e-learning provide learners with a broad variety of learning content available. Numerous documents resources may be used during e-learning. Some are internal and made by several actors implied in the e-learning, others are available on the web: on-line courses, course supports, slides, bibliographies, frequently asked questions, lecture notes, etc. Learner may choose between different lecture providers and learning management systems to access the learning content. On the other hand,
the increasing variety of the learning material influences effort needed to select a course or training package. Adaptive support based on learner needs, background and other characteristics can help in selecting appropriate learning and during learning.

In order to better support humans in carrying out their various tasks with the web. Semantic web technologies are used to enable machines to interpret and process information. It could offer more flexibility in e-learning systems. Many of so far developed semantic web technologies provide us with tools for describing and annotating resources on the web in standardized ways, such as XML, RDF, XTM, OWL, DAML-S, and RuleML. These offer a way to make such components mobile and accessible within the wide sea of web information and applications. Personalisation is becoming increasingly important in the educational Semantic Web context by enabling shared content and services to be tailored to the needs of individual users (learners, content creators, providers, and instructors). The ambitious target is to offer manageable, extendable and standardised infrastructure for complementing and collaborating learning applications tailored to the needs of individual users.

Ontologies are a way of representing formal and shared information. They can be used to index data indicating their meaning, thereby making their semantics explicit and machine-accessible. They also can be used in e-learning as a formal means to describe the organization of universities and courses and to define services. An e-learning ontology should include descriptions of educational organizations (course providers), courses and people involved in the learning process. This paper represents our effort toward a problem of semantic solution in e-learning system. It is organized as follows: Section 2 reviews the related works, Section 3 describes Metadata and Ontologies concepts. Section 4 shows our e-learning scenario. Section 5 describes our ontology design and representation. Section 6 shows our semantic querying and semantic mapping approach. Section 7 gives conclusions and future works.

**RELATED WORKS**

Among the variety of modern trends in educational technology development, the application of ontological research is probably one of the most fashioned and rapidly evolving. After the first dedicated workshop in 1999, more and more workshops and special journal issues have been brought out. Numerous papers in related conferences, journals, and books have been published.

Kay (1999) and Chen and Mizoguchi (1999) noted the advantage of using ontologies for learner/user models. Mizoguchi and Bourdeau (2000) studied how ontologies can help to overcome problems in artificial intelligence in education. Razmerita et al. (2003) proposed a generic ontology-based user modelling architecture. Mitrovic and Devedzic (2004) proposed the M-OBLIGE model for building multitutor ontology-based learning environments. The model allows domain expertise to be shared and can be used as a framework for integrating multiple tutors on the web. Moreale and Vargas-Vera (2004) developed an e-learning services architecture offering semantic-based services to students and tutors, in particular, ways to browse and obtain information through WS.

**Metadata** is the Internet-age term for information that librarians traditionally have used to classify books and other print documents. It has been widely used to structurally describe learning resources so that they can be better reused. At its most basic level, metadata provides a common set of tags that can be applied to any resource, regardless of who created it, what tools they used, or where it’s stored. Tags are data describing data. Metadata tagging enables organizations to describe, index, and search their resources and this is essential for reusing them.
METADATA FOR E-LEARNING

Different communities have developed their own standardized metadata vocabularies to meet their specific needs. One of the most common metadata schemes on the web today is the “Dublin Core Schema” (DC) by the DCMI. The Dublin Core Metadata Initiative (DCMI) is an organization dedicated to promoting the widespread adoption of interoperable metadata standards and developing specialized metadata vocabularies for describing resources that enable more intelligent information discovery for digital resources.

Since Dublin Core is designed for metadata for any kind of digital resource, it pays no heed to the specific needs in describing learning resources. The “Learning Objects Metadata Standard” (LOM) by the Learning Technology Standards Committee (LTSC) of the IEEE was therefore established as an extension of Dublin Core. Each learning object can now be described using a set of more than 70 attributes divided into nine categories.

Metadata for Describing the Content of Learning Materials

Compared to traditional learning in which the instructor plays the intermediate role between the learner and the learning material, the learning scenario in e-learning is completely different: instructors no longer control the delivery of material and learners have a possibility to combine learning material in courses on their own. So the content of learning material must stand on its own. However, regardless of the time or expense put into creating advanced training material, the content is useless unless it can be searched and indexed easily. This is especially true as the volume and types of learning content increase.

The shared-understanding problem in e-learning system occurs when one tries to define the content of a learning document in the process of providing learning materials as well as in the process of accessing to particular learning material.

In an e-learning environment there is a high risk that two authors express the same topic in different ways. This means semantically identical concepts may be expressed by different terms from the domain vocabulary. For example, one may use the following semantically equivalent terms for the concept “Agent”: “agent”, “actor”, “contributor”, “creator”, “player”, “doer”, “worker”, “performe”. The problem can be solved by integrating a domain lexicon in the ontology and thus define mappings from terms of the domain vocabulary to their meaning. E.g. in our example “agent”, “actor”, “contributor”, “creator”, “player”, “doer”, “worker”, “performe” are symbols used in the real world and they are all mapped to the same concept “Agent” in the domain ontology.

Metadata for Describing the Context of Learning Materials

Learning material can be presented in various learning or presentation contexts. We may e.g. distinguish learning contexts like an “introduction”, an “analysis” of a topic, or a “discussion”. An example or a figure is some usual presentation contexts. The context description enables context-relevant searching for learning material according to the preferences of the user. For example, if the user needs a more detailed explanation of the topic, it is reasonable to find learning material that describes an example of the given topic. In order to achieve a shared-understanding about the meaning of the context vocabulary, a context-ontology is used.

Metadata for Describing the Structure of Learning Materials

Because e-learning is often a self-paced environment, training needs to be broken down into small bits of information that can be tailored to meet individual skill gaps and delivered as
needed. These chunks of knowledge should be connected to each other in order to be able to build up a complete course from these chunks. Learning material is usually more complex in its structure than continuous prose, so it requires greater care in its design and appearance. Much of it will not be read continuously. The structure isn’t a static one, because a course structure is configured depending on the user type, the user’s knowledge level, his or her preferences and the semantic dependencies that exist between different learning chunks, e.g. an example might depend on first giving the corresponding definition. But, again shared understanding about used terms is also needed for describing the structure of a learning course.

In order to standardize semantic metadata, specific ontologies are introduced in many disciplines. Typically, such ontologies are hierarchical taxonomies of terms describing certain topic. Figure 1 represents a subset of Education and Training Services according The ECCMA codes (http://www.eccma.org/unspsc/browse/86.html).

**OUR E-LEARNING SCENARIO**

While metadata is a starting point to describe content, as most of those metadata standards lack a formal semantics. Although these standards enable interoperability within domains, they introduce the problem of incompatibility between disparate and heterogeneous metadata descriptions or schemas across domains. This lack of a shared understanding between terms in one vocabulary as well as between terms in various metadata vocabularies might be avoided by using ontologies as a conceptual backbone in an e-learning scenario. Ontologies are a more sophisticated way of modelling metadata and knowledge is relevant information delivered at the right time and context. It can be seen as an improvement over metadata as they formally define not only keywords but also relationships among them.

In an e-learning situation, learners are often geographically distant. It is thus necessary for them to have an easy access to documents and more generally to resources they need. To illustrate our
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approach, we refer to a sample scenario. Mary is trying to improve her skills in English by looking for a training package. She wants to enroll in an English course in a University in Britain in Summer 2005. So Mary has an application to access and search a network of learning providers. The learning provider provides a routing and mapping between its scheme and the service identification schemes.

ONTOGRAPH DESIGN AND REPRESENTATION

Consider above E-Learning scenario, we define two classes: The first one (application ontology) specifies the individual who wants to choose the course to study. The second one describes the providers of the training domain, including courses (Chinese, English, French, German, Italian), location (USA, Britain, China), time (Fall_2005, Spring_2005, Summer_2005, Winter_2005).

We have following requests from Mary, and our ontology design is shown in Figure 2.

Request:  -enroll(Mary, English_course) & location(English_course,Britain) & time (english_course, summer_2005).

Approach

The process of achieving semantic solution here involve two basic operations: Semantic Querying and Semantic Mapping. We briefly describe each in the following subsections.

Semantic Querying

For above structure. We have the request from Mary and the corresponding OWL code is as following:

Figure 2. Ontology design and representation for our e-learning scenario (Screen shot using Protege 2000)
Semantic Mapping

In an e-learning environment there is a high risk that two authors express the same topic in different ways. This means semantically identical concepts may be expressed by different terms from the domain vocabulary. In the context of the Web, ontology provides a shared understanding of a domain. Such a shared understanding is necessary to overcome differences in terminology.
One application’s zip code may be the same as another application’s area code. Another problem is that two applications may use the same term with different meanings. In university A, a course may refer to a degree (like computer science), while in university B it may mean a single subject (CS 101). Such differences can be overcome by mapping the particular terminology to a shared ontology (shown in Figure 3) or by defining direct mappings between the ontologies.

For our scenario, Let \( \alpha \) be the set of all training provider in a given repository. For a given query \( Q \), the matchmaking algorithm of the repository host returns the set of all training providers that are compatible matches(\( Q \)):

\[
\text{matches}(Q) = \{ A \in \alpha \text{ compatible}(A, Q) \}
\]

Two descriptions are compatible if their intersection is satisfiable, the query from the requester:

Query = \((\text{trainingprofile}(\text{items Course:} \{\text{English} \}) \sqcap \text{Location } \{\text{Britain}\}) \sqcap \text{Time} \{\text{Summer_2005}\}\)

The intersection of this query with provider is satisfiable. Finally, matchmaking=matches(Query)

CONCLUSION AND FUTURE WORKS

In this paper we present an approach for implementing the e-learning scenario using Semantic Web technologies. It is primarily based on ontology-based descriptions of the learning materials and thus provides flexible and personalized access to these learning materials. However, in this paper, we are only concerned by the fact that a service is represented by input and output properties of the service profile, we still need do more research on other key operations necessary to support e-learning interactions in the future, such as negotiation, proposals and agreements. So that the Semantic Web can provides an ideal framework for the standardization of the e-learning. As the learner data are sensitive, the trust and security issues have to be further investigated. The technical infrastructure for this approach to personalization has to be investigated in more detail.

Mapping or mediating between different schemas should be investigated as well when we want to provide communication between different peers. Different identification schemes have to be investigated more deeply to support better exchange of learner profile fragments between distributed nodes.

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