e-LEARNING AND SEMANTIC WEB

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Abstract: e-Learning is fast, relevant and just-in-time learning grown from the learning requirements of the new, dynamically changing and distributed educational world. The term "Semantic Web" encompasses efforts to build a new WWW architecture that supports content with formal semantics, which enables better possibilities for searching and navigating through the cyberspace. As such, the Semantic Web represents a promising technology for realizing e-Learning requirements. This paper presents an approach for implementing the e-Learning scenario using Semantic Web technologies. It is primarily based on ontology-based descriptions of content, context and structure of the learning materials and benefits the providing of and accessing to the learning materials.

1 INTRODUCTION

There are two main types of players in the learning economy: producers and consumers. Producers of learning material use various design tools and other software to produce different kinds of learning material. Consumers use learning material created by others (or themselves) to develop new content packages. Producers make their learning material available by placing them in different kinds of repositories accessible from the Internet. Typically, consumers are expected to search these repositories using metadata (way of searching for learning material, we define it better in the next sections). There may be copyright and payment issues associated with the reuse of learning materials.

Current development efforts with learning materials are mostly concerned about metadata and content packaging aspects (way of package the learning content). There has not been any significant work done so far in automating the discovery and packaging of learning objects based on variables such as learning objectives and learning outcomes. There has also not been a significant amount of work done in personalizing e-learning based on learning materials developed and stored at arbitrary locations on the Internet. This is largely because learning materials are a relatively new phenomenon. Automating these processes is also a knowledge-intensive activity likely to require the application of artificial intelligence techniques such as knowledge representation and reasoning.

2 BASIC INFORMATION ON e-LEARNING

A lot of attention has been devoted to educational systems and electronic learning ("e-learning") in recent years, due to the fact that content and tool support can now be offered at a widely affordable level, both with respect to technical prerequisites and pricing. Developed by researchers as well as practitioners, many e-learning systems use the Internet as an infrastructure to distribute content more efficiently even in remote places, to present it, and to ease administrative tasks.

But before continue analysing the distribution of this e-learning content, it is essential to focus on the content itself and how it is organised.

2.1 The Digital Resources

Digital Assets are the simplest form of Digital Resources and they serve as the starting point for an e-learning lifecycle. These assets can be of many different types (e.g. graphics, images of simple text documents) and can exist in several different formats.

The steps involved in the transformation of *Digital Assets* into a Learning Object are:

- **Digital Asset** A *Digital Asset* is defined as any piece of content that is created using technology (Angad, 2005).

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- **Compound Digital Assets** *Compound Digital Assets* can be best described as digital assets with contextualised information.
- **Learning Object** There are many different definitions for a Learning Object and there is no general agreement to what constitutes a Learning Object. We have defined a Learning Object as the aggregation of a *Digital Asset*, *Compound Digital Asset* and Metadata with a particular learning purpose. This definition incorporates a number of definitions by other **a**uthors (Hawryszkiewycz, 2002), (Dalziel, 2002), (Wiley, 2000) and (South, 2000).
- **Complex Learning Object** *Complex Learning Objects* are packages consisting of structured assemblies of zero or more *Digital Assets*, zero or more *Compound Digital Assets* and one or more *Learning Objects* (Dublin, 2003).
- **Metadata** in reality is data describing data and it can be used to describe any digital resource.

2.2 e-Learning

A general agreement seems to exist regarding roles played by people in a learning environment as well as regarding the core functionality of modern e-learning platforms (Husemann, 2002). The main players in these systems are the *learners* and the *authors*; others include trainers and administrators.

Content consumed by learners and created by authors is commonly handled, stored, and exchanged in units named as *learning objects* (LOs) as we said. The LOs can be accessed dynamically, e.g. over the Web (Vossen, 2002).

2.3 Metadata & e-Learning

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, meta-data on the objects become a critical factor. Indeed, meta-data are needed for an appropriate description of learning objects so that plug-and-play configuration of classes and courses is possible. As we saw, several standardization efforts have been launched, in order to reuse content from one system to another.

3 WEB SERVICES

In essence, Web services are independent software components that use the Internet as a communication and composition infrastructure. They abstract from the view of specific computers and provide a service-oriented view by using standardized stack of protocols. Web services can be combined to build new ones with a more comprehensive functionality. Even in terms of interoperation of business-to-consumer (B2C) systems, Web services are currently obtaining a growing importance.

In figure 1, the typical steps of an invocation of a Web service are shown. In a first step, suppose that a client needs to find a Web service which provides a specific functionality. This is done by contracting a UDDI registry (step 1), which returns the name of a server (service provider) where an appropriate Web service is hosted (step 2). Since the client still does not know how to invoke the desired service, a WSDL description is requested which contains the name and the parameters of the operation(s) of the service) step 3 and 4). The client is now able to invoke the service using SOAP protocol, which essentially puts the data in the envelope and sends it over the Web by using HTTP. The service provider receives the request and executes the desired operation(s) on behalf of that client. The results are finally sent back to the client by using SOAP over HTTP again (step 6).

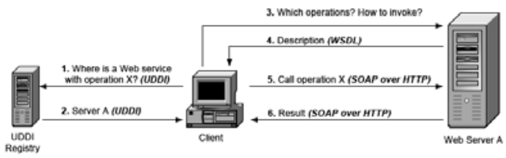

Figure 1: Invocation steps of web service.

4 SEMANTIC WEB SERVICES

4.1 Semantic Web Architecture

The term “Semantic Web” encompasses efforts to build a new WWW architecture that supports content with formal semantics. That means content suitable for automated systems to consume, as opposed to content intended for human consumption. This will enable automated agents to reason about Web content, and produce an intelligent response to unforeseen situations. Layers of the Semantic Web «Expressing meaning» are the main task of the Semantic Web. In order to achieve several layers are needed (Berners-Lee, 2000). They are presented in the figure 2, among which the following layers are the basic ones:

- the XML layer, which represents data;
- the RDF layer, which represents the meaning of data;
- the Ontology layer, which represents the formal common agreement about meaning of data;
- the Logic layer, which enables intelligent reasoning with meaningful data.

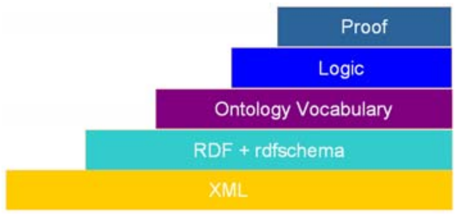

Figure 2: Layers of the semantic web architecture.

4.2 Ontology-based Metadata

The role of ontology is to formally describe shared meaning of used vocabulary (set of symbols). In fact, the ontology constrains the set of possible mapping between symbols and their meanings. But the shared understanding problem in e-Learning occurs on several orthogonal levels, which describe several aspects of document usage, as described in figure 3.

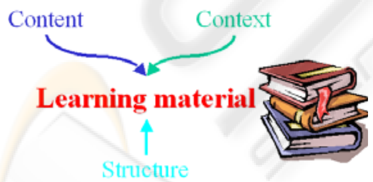

Figure 3: Aspects of document usage.

From the student point of view the most important things for searching learning materials are: what the learning material is about (content) and in which form this topic is presented (context). However, while learning material does not appear in isolation, another dimension (structure) is needed to encompass a set of learning materials in a learning course.

5 LEARNING SCENARIO

Based on the discussion in the previous section, this section presents overall architecture of our ontology based e-learning scenario. The architecture of the system is represented in figure 4. The knowledge warehouse acts as a metadata repository and the onto broker system (Decker, 1999) is a principal differencing mechanism.

The first phase is the production of learning materials that may be used or reused in the construction of training courses. In order to provide learning material, which could be suitable for metadata-searching, each learning material has to be described or "enriched" with the following metadata information:

- what is the learning material about (content annotation),
- which context has the learning material (context annotation) and
- how is it connected to other learning materials (structure annotation).

This "enriching" consists of explicitly adding to each learning material a set of metadata information referring to course ontology. Providing information is for now constrained on manually entering metadata information (facts) through automatically generated templates, based on the definition of concepts in the course ontology.

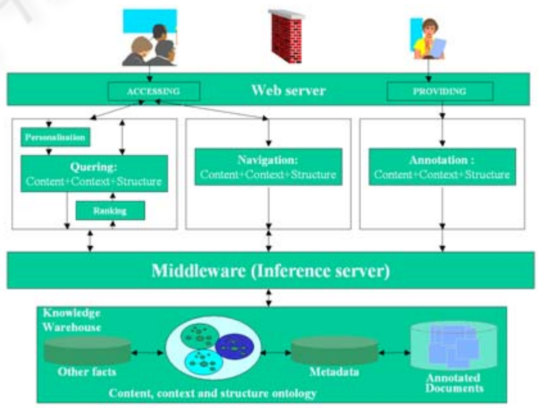

Figure 4: Architecture of an e-Learning portal.

6 CONCLUSIONS

"Making content machine-understandable" is a popular paraphrase of the fundamental prerequisite for the Semantic Web. In spite of its potential philosophical ramifications this phrase must be taken very pragmatically: content (of whatever type of media) is 'machine-understandable' if it is bound (attached, pointing, etc.) to some formal description of itself.

This vision requires development of new technologies for web-friendly data description. The Resource Description Framework (RDF) metadata standard is a core technology used along with other web technologies like XML. Ontologies are (meta)data schemas, providing a controlled vocabulary of concepts, each with an explicitly defined and machine processable semantics. By defining shared and common domain theories, ontologies help both people and machines to communicate concisely, supporting the exchange of semantics and not only syntax.

In the same time, promising areas for applying the Semantic Web are unlimited. In fact, each area, in which a lot of information should be provided and accessed in a distributed manner, searches for some semantic-based solution.

In this paper we presented an e-learning scenario that exploits ontologies in three ways:

- for describing the semantics (content) of the learning materials. This is the domain dependent ontology,
- for defining learning context of the learning material and
- for structuring learning materials in the learning courses.

This three-dimensional space enables easier and more comfortable search and navigation through learning material.

The purpose was to clarify possibilities of using ontologies as a semantic backbone for e-learning. Primarily, the objectives are to facilitate the contribution of and efficient access to information. But, in a broader or in Semantic Web's view, an ontology-based learning process could be a relevant (problem-dependent), a personalised (user-customised) and an active (context-sensitive) process. These are prerequisites for efficient learning in the dynamically changed business. This new view enables us to go a step further and consider or interpret the learning process as a process of managing knowledge in the right place, at the right time, in the right manner in order to satisfy business objectives - knowledge management. It means the merging of e-learning and knowledge management using the Semantic Web should be the promising integration.

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