Web-based Learning System based on Semantic Web Technology

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Abstract

Web based learning is a fast, just-in-time, and non-linear learning process, which is widely applied applications of semantic web technology in distributed and dynamic environments such as on the World Wide Web. The semantic web technology has the potentiality to be applied in different areas. As a result, this system takes into consideration by enhancing education from the teaching paradigm to learning paradigm. In addition, students are becoming more independent from the teacher. Moreover, for the evolution of learning paradigm, educational technologies are evolving constantly. Any learner learns Web-based course in accessing knowledge at any time, any place. In this paper, we present the Semantic Web-based model, RDF data model and OWL ontology language for Web-based learning system. This system is built by C#.NET.

Keywords: Web based learning, dynamic environment, semantic web based model, ontology language

1. Introduction

The World-Wide Web is an important learning technology platform today. Its accessibility has made a successful environment in particular for the publication of learning material. Learning resources can be provided in a standardized format that can be accessed at any time from any location. The Web, however, is still evolving. The current evolution of the Web can have an impact on educational technology. This will affect administrator and students alike.

Technology enhanced learning landscape is characterized by a high and growing number of heterogeneous educational service providers. For a user with a particular educational needs, a typical scenario involves the user visiting one or several online educational centers, browsing their offers, collecting information about the courses (study programs, requirements, needed tools, prices, etc), selecting the most appropriate course for his/her needs and preferences and finally, registering it. This manual browsing is too time consuming and typical, a user will visit just a very few online centers before making a decision.

The Web creates a space in which content developers, administrator and students contribute to and participate in learning processes. Knowledge is a central component in this space. The current WWW is a powerful tool for research and education, but its utility is hindered by the failure of the user to navigate easily the reputable sources for the information. The semantic web is an evolving extension of the WWW in which web contents can be expressed not only in natural language but also in the form that can be understood, interpreted and can be used by the software agents, thus permitting them to find, share and integrate information more easily.

On other hand, the semantic web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for uses. The Semantic Web is the emerging landscape of new web technologies aiming at web-based information and services that would be understandable and reusable by both humans and machines. The use of Semantic Web techniques, to effectively organize and manage available e-learning resources according to peculiar necessities of both teachers and students, has been advocated by many authors.

The semantic web appears as a promising technology for implementing Web-based learning. The semantic web constitutes an environment in which human and machine agents will communicate on a semantic basis. One of its primary characteristics shared understanding based on ontology backbone. Ontology enables the organization of learning materials around small pieces of semantically annotated (enriched) learning objects. Ontologies, generally defined as a representation of a shared conceptualization of a particular domain, a major component of the Semantic Web.

In order to achieve optimal efficiency in a learning process, this system performs that individual learner's cognitive learning style can be taken into account. Due to different types of learners or students, it is necessary to provide them with an individualized learning support system. In addition, it only regards keywords as index without relating to semantic information, making it difficult to really understand what the user intends to do. In the Web-based learning system, users could use sentences in daily life to raise questions and the system will return answers to users directly after analyzing and comprehending these questions.

The aim of this paper is to analyze application of reasoning mechanisms in the domain ontology, and to propose a framework for conceptual linking of educational resources. This paper is structured as follows: in Section (2) we present some related work. In Section (3) we give a brief overview about the Semantic Web and discuss a number of important

issues. In Section (4) we introduce the Semantic Web model for our web-based learning system. In Section (5) we describe the implementation of the system while we evaluate the system. The paper is finally concluded in Section (6).

2. Related Works

Recently, several researchers studied the issue of Web-based application. B. Matthnews [2] distinguished three basic levels in every web-based application: *the Web character of the program, the pedagogical background and the personalized management of the learning material*. They defined a web-based program as an information system that contains a Web server, a network, a communication protocol like HTTP, and a browser in which data supplied by users act on the system's status and cause changes.

The Web-based learning system in paper [1] is knowledge based that features three knowledge types for the delivery of individualized instruction. These knowledge types include domain ontology, content knowledge and student models. Domain ontology provides a shared language for the representation of content knowledge and student models. However, this knowledge-based approach is limited by the cost of developing domain ontology and content knowledge as well as the accuracy of the student models.

Otherwise, many works have combined and integrated several factors in web learning system, leading to standardization projects. Some projects have focused on determining the standard architecture and format for learning environment, such as *IEEE Learning Technology Systems Architecture* (LTSC), *Instructional Management Systems* (IMS), and *Sharable Content Object Reference Model* (SCORM). They mainly focus on the standardization of learning and teaching methods as well as on the modeling of how the systems manage interoperating educational data relevant to the education process [7].

However, the hierarchical contents structure is able to show the entire educational content, the available sequence of learning, and the structure of the educational concepts, such as the related super- or sub- concepts in the learning contents. Furthermore, some of semantic relationships among the educational contents such as 'data mining'. 'data preprocessing', 'data warehouse', 'classification' and 'prediction', can provide important and useful information for the intelligent web-based learning system.

For this purpose, ontology is introduced in our system. It can play a crucial role in enabling the representation, processing, sharing and reuse of knowledge among application in modern web-based learning systems. Moreover, the number of ontology-centered researches has increased dramatically because popular ontological languages are based on Web technology standards, such as XML and RDF(s), so as to share and reuse it in any web-based knowledge system [5, 8]. Thus, we have devised a system that provides the contents structure using an ontology for a web-based learning system.

3. Semantic Web Technologies

Semantic Web is the new vision of the Web who main goal is to make Web contents not only human readable but also machine readable and process-able. The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation. The semantic web can be thought of as an infrastructure for supplying the web with formalized knowledge in addition to its actual informal content. There are a number of important technologies related to the Semantic Web. They belong to four categories: Semantic Web languages, ontologies, semantic markup of Web pages and Semantic Web Services.

Semantic Web Languages: In order to represent information on the Semantic Web and simultaneously make that information both syntactically and semantically interoperable across applications, it is necessary to use specific languages. It is important for Semantic Web developers to agree on the data's syntax and semantics before hard-coding them into their applications, since changes to syntax and semantics necessitate expensive application modification.

There are a lot of such languages around, and most of them are based on XML (eXtensible Markup Language), XML Schemas, RDF (Resource Definition Framework), and RDF Schemas, all four developed under the auspices of W3C and using XML syntax [6]. An XML document consists of three parts: an XML declaration, a DTD or XML schema, and an XML instance (XML document data). An XML declaration and schemas are not mandatory for an XML document. An XML declaration specifies the version and the encoding of XML being used. A DTD or XML schema is a schema that constrains the structure of XML instances, and corresponds to an extended context-free grammar. An XML instance is a tagged document.

An XML instance is a hierarchy of elements, the boundaries of which are either delimited by start-tags and end-tags, or for empty elements, by empty-element tags. Character data between start-tags and end-tags are the content of the element. A start-tag is the token that encloses an element type with < and >, and end-tag is the token that encloses an element type with </ and >. Within start-tags, attribute names and attribute values can be specified. XML documents have two levels of conformance: valid and well-formed. A well-formed XML document follows

tagging rules prescribed in XML. An XML document is valid if it is well-formed and if document complies with the constraints expressed in an associated schema. [9, 12]

RDF is a framework to represent data about data (metadata), and a model for representing data about "things on the Web" (resources). It comprises a set of triples (O, A, V) that may be used to describe any possible relationship existing between the data: Object, Attribute and Value. RDF Schema (RDFS) defines the vocabulary of an RDF model. It provides a mechanism to define domain-specific properties and classes of resources to which those properties can be applied, using a set of basic modeling primitives (class, subclass-of, property, subproperty-of, domain, range, type).

Ontologies: Ontologies aim at modeling and structuring domain knowledge that provides a commonly agreed understanding of a domain, which may be reused and shared across applications and groups of people. Ontology comprises a set of knowledge terms, including the vocabulary, the semantic interconnections. Ontologies applied to the Web are creating the Semantic Web/ Ontologies provide the necessary armature around which knowledge bases should be built, and set grounds for developing reusable Web-contents, Web-services and applications. [11]

Semantic Markup: Ontologies merely serve to standardize and provide interpretations for Web content but are not enough to build the Semantic Web. To make Web content machine-understandable Web pages and documents themselves must contain semantic markup, i.e., annotations which use the terminology that one or more ontologies define and contain pointers to the network of ontologies. Semantic markup persists with the document or the page published on the Web, and is saved as part of the file representing the document/page. Services also must be properly marked-up, to make them computer-interpretable, use-apparent, and agent-ready. They must contain pointers to the corresponding service ontologies.

Semantic Web Services: Intelligent, high-level services like information brokers, search agents, information filters, intelligent information integration, and knowledge management are what the users want from the Semantic Web. They are possible only if a number of ontologies populate the Web, enabling semantic interoperation between the agents and the applications on the Semantic Web, i.e., semantic mappings between terms within the data, which requires content analysis. Services have their properties, capabilities, interfaces, and effects, all of which must be encoded in an unambiguous, machine understandable form, to enable agents to recognize the services and invoke them automatically. [10]

4. Design of Web-based Learning System

Semantic Web made the Web more understandable by machines. Semantic Web is about how to implement, reliable, large-scale interoperation of Web service, to make such service computer interpretable. We need the Semantic Web to express information in a precise, machine interpretable form, ready for software agents to process, share and reuse it as well as to understand what the terms describing the data mean. Semantic Web enables Web-based learning to interoperate both on the syntactic and semantic level.

Web-based learning has become a very important branch of learning technology. For learners or students, it provides access to information and knowledge sources that are practically unlimited, enabling a number of opportunities for personalized learning. The real value of Web-based learning lies not in accessing knowledge at any time, any place and for any one. But helping the right student acquires the right skills and knowledge at the right time in order to function as active, self-reflected and collaborative participants in information based society. The Web was built for human consumption, not for machine consumption, although everything on the Web is machine-readable, it is not machine-understandable.

The design of web based learning system has the following sections: the web-based services and ontology based model based on semantic web technology. We describe our proposed design for web based learning system in Figure 1.

Web based Services: Our design in Figure 1 provides the student with two kinds of contents, Learning content and Assessment content. Each content has different types of services for web based learning of students.

(i) Learning Content

It provides registration, online course, interactive tutorial, course documents (is a repository for files that the administrators have made available to the student as a part of the course), announcements (displays information to the students that the instructions of the course want them to know), links (displays a list of useful URL links that have been identified by the course information), student's questions (students can post/upload request files to the question database) and semantic search (helps the student to search for resources).

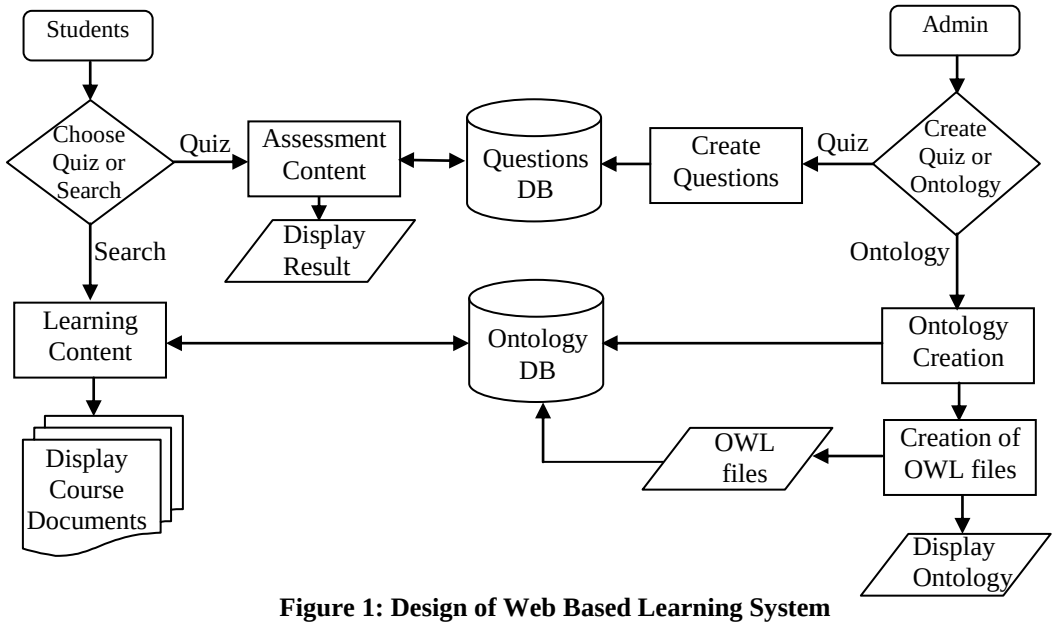

Figure 1: Design of Web Based Learning System

(ii) Assessment content

It provides exercises and questions for evaluation of the student knowledge. During the learning process, a dynamic selection presentation of both contents will be accomplished. On the other hand, our web based learning system allows administrator to create his course websites through a browser and monitoring the student's performance.

They have many services to the students such as manage a list of useful links, compose exercise/question. A student first searches for an online course such as Data Mining, Artificial Intelligence and Distributed System. The broker handles the request and returns a set of choices satisfying the query. Otherwise, the user may find a suitable course among the offering courses (Data Mining, Artificial Intelligence and Distributed System) and then makes a final decision about answering for the course.

Processing the registration can be seen as a complex service involving registering with the system, creating a confirmation notification, creating a student account (authentication/ authorization) and providing learning materials. Once all these are in place, the student can start the course. As part of the course, a student will be logging on and checking his learning agenda (e.g, assignment questions). This request is answered by combining several sources of information such as the markings on the course while student progress

Ontology-based Model: Before describing our ontology-based model, we will discuss learning environment for administrator. Course sequencing generally starts with the student entity component that receives the learning contents, while the student's behavior is being involved. The administrator sends queries to the learning resources to search for learning content that is appropriate for the student entity component. The ontological knowledge is added to the learning resources as a resource for contextual learning and it may be searched by means of queries. The student's performance is measured by the evaluation component and the student's performance is showed the result on the course.

Searching learning resources and sequencing a course can be done using a knowledge base of learning resources and a delivery component. To implement the knowledge base, first of all, the learning resources have to be described by means of metadata (HTML format). The metadata consists of the contextual knowledge of the learning resources, i.e., ontology in the model. It contains the general representation of the structural knowledge on specific domains, such as Data Mining, Artificial Intelligence and Distributed System. There are two types of ontology-based model: Ontology Creation and Creation of OWL files.

(i) Ontology Creation

Ontology-based navigation enables access to materials via links between parent and child nodes as concept hierarchy (e.g., parent nodes built as main sections and child nodes are subsections identical to contents) whereas ontology-based search provides a set of access points over the whole ontology as viewing in Figure 2. However, both of them are limited at providing navigation beyond the immediately linked topics. However, sometimes it is important for students to build up understanding about related topics over long distance (e.g., taught in different classes or under different circumstances). In this situation, with a comprehensive understanding of internal connections between different courses, the administrator can utilize the "relate to course", relationship in the ontology to explicitly markup the connection. Thus, an associated recommendation is provided when students access either of the courses.

With such relationship, learning materials in both courses are linked together across the ontology.

Figure 2: Ontology-based navigation for Web-based Learning system

(ii) Creation of OWL files

The ontology can be used for learning to retrieve the context of a course and to structure the contents. Also the metadata actually consists of the framing description of each learning object of a subject, i.e., the modularized of content, which is linked to the concept of the ontology. For administrator to be able to sequence courses and create exercises adaptively, the suitability of different approaches has to be analyzed based on the relationships between the resources and their descriptions. Figure 3 shows a portion of the ontology source in the OWL language.

```
<rdf:RDF xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:daml="http://www.daml.org/2001/03/daml+oil#"
xml:base="http://www.owl-ontologies.com/DataMining.owl"
xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns="http://www.owl-
ontologies.com/DataMining.owl#"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  <owl:Class rdf:ID="3.3.2 A Tree-Tier Data Warehouse
Architecture">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class" />
    <rdfs:subClassOf rdf:resource="#3.3 Data Warehouse
Architecture" />
  </owl:Class>
  <owl:Class rdf:ID="9.2.4 Mining on Social Network">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class" />
    <rdfs:subClassOf rdf:resource="#9.2 Social Network Analysis" />
  </owl:Class>
  <owl:Class rdf:ID="7.11 Outerlir Analysis">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#Class" />
    <rdfs:subClassOf rdf:resource="#7 Cluster Analysis" />
```

Figure 3: A Portion of the Proposed Ontology in OWL Language

5. Implementation

The main agents used in our system are Student and Administrator; both of them are implemented as ASP classes. The agents interact and communicate between each other by means of ASP, SQL database and using web server. One of the main distinction features of our system is the utilization of XML. This system (used to access the web-based learning and quizzes system) is divided into two application, called admin (or staff members) and students applications

5.1 Administrator Application

The staff members or administers application is used to provide the potential users with a simple tool to manage easily information of the web based learning and the quizzes. It saves much time in exams preparation as it can generate automatic quizzes, and provide the results. The following feature is available in the administrator application.

Add, update, and delete questions: Administrator can add, update or delete questions and answers for courses using the web as shown in Figure 4. The questions are inserted into the database dynamically, so new questions can be added during the configuration of a quiz or practice. For instance to insert a new question into learning resource ontology, the admin simply has to access the "Add", types in the question text, enters the answers and indicate the correct answers. After introducing the questions the admin can modify their questions and answers can delete them.

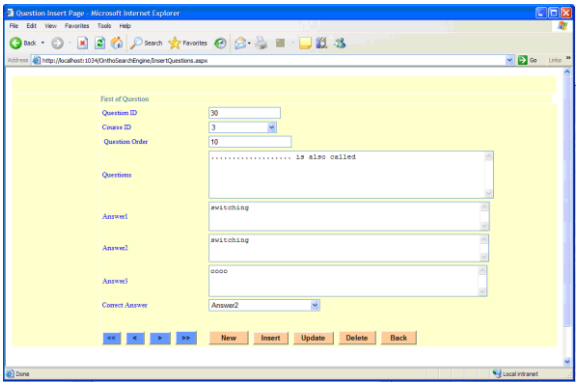

Figure 4: Administrator Application for Web based Learning System

5.2 Students Application

Students can access the Web based learning system and quizzes by using the students application. This application allows the student to take free practices and select quizzes. The following are the different set of web sites in the students' application:

Registration: Student must register to be able to take an on-line quiz. The contents of the registration page given, depends on the course type and the students registered in that course (allowed students).

Validation: Each field value in the registration form must be correct and matches with corresponding value stored in the database; otherwise an error message will be displayed. Whenever the student

completes his registration correctly, a validation message appears on the screen and thus the student can start the on-line quiz.

On-Line Quiz: After a student gets registered, he or she can select the type of the courses, and then the quiz where the questions will be selected randomly by our system from the database. Our system covers many questions as mentioned before such as: multiple choices. The quiz will be over either whenever the student finishes it and select the finish button. Finally, the system will calculate the number of correct answers; display the result in addition to today date.

Free Web-based Learning: The student application allows the student to take free web-based for the describe courses, and set the announcement and learn the lessons with the courses of three topics from the semantic search as shown in Figure 5.

Figure 5: Course Content Searching of the System

6. Conclusion

The main process of this system is using the Semantic Web technology. Our system includes various services in the content of a semantic search such as course registration, uploading course documents and student. The OWL language is used to develop our ontologies. In these ontologies, the actual resources and properties specified in the RDF models are defined.

In addition, we proposed a simple and easy to use learning system that is used currently in Computer University, Maubin by both students and teachers of the department of software. The administrator can set their courses, exams and quizzes at their convenient time. Similarly, the students can use this system freely and independently from their labs and home through the web. The present version of our web based learning system is developed using XML, HTML, OWL, and SQL database for search engine.

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