

REVIEW PAPER

Semantic Web-driven e-Learning System

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ABSTRACT

E-learning is an important domain which can be benefitted from the Semantic Web technology. The aim of Semantic Web is to provide distributed information with well-defined meaning, understandable for humans as well as machines. Semantic Web applications should be able to satisfy the individual needs and requirements of the users by providing them optimised access to information. This paper focuses on the uses of Semantic Web technology in e-learning. A conceptual architecture of semantic e-learning is proposed which offers various semantic-based services to the students and the instructors.

Keywords: Semantic services, e-learning, Semantic Web, ontology

1. INTRODUCTION

The concept of Semantic Web has greatly influenced the Web. Semantic Web has enabled intelligent access to Web services and resources. Semantic Web will eventually prove to be beneficial to e-Learning as well. The concept of ontology is the basic framework for Semantic Web. Ontologies assign a vocabulary of terms with their specific meanings. Ontology is popular because it provides a shared and common understanding of a domain that can be communicated between people and application systems¹. Standards and tools for the Semantic Web are under development by the World Wide Web Consortium (W3C)². These tools aim at providing unambiguous meaning to the Web content which can be processed by software agents in contrast to the content that is only intended for human consumption. This enables automated software agents to reason about Web content, thereby producing an intelligent response to unknown situations. The Semantic Web consists of an environment in which humans and machine agents will communicate on the basis of semantics³. Semantic Web technology can enhance the process of e-Learning to a great extent. e-Learning has replaced the location and content-specific learning with a customised and on-demand process of learning at any place and at any time.

The aim of Semantic Web is to add structure or meaning to content residing on the Web, thereby

allowing intelligent navigation, personalisation, querying, and retrieval. To fulfil the goal of Semantic Web, the e-Learning system must have access to structured collections of information and a set of inference rules that can be used to perform automated reasoning⁴.

2. RELATED WORKS

According to Schwartz⁵, the Semantic Web is meant to enable an environment in which independent, Internet-connected information systems can exchange knowledge and action specifications. Lara and Olmedilla have given a proposal for a Web services modelling ontology in distributed environments, which aims at providing the basis for a flexible and scalable definition of the service layer in the e-learning domain⁶. Crampes, and Ranwez have developed the system Karina⁷ which enables the user to dynamically build his learning courses according to his preference. It is based on the conceptual description of the learning material and some (prerequisite) strategies to fulfil the users' objectives in the searching process. The ontology-based intelligent authoring tool⁸ uses an intelligent training system in the e-Learning scenario. It uses four ontologies (domain, teaching strategies, learner model and interfaces ontology) for the construction of the learning model and the teaching strategy model, but it fails in exploiting modern Web technologies. Considerable amount of research on knowledge-based systems and intelligent systems moves towards concepts and ontologies focuses on knowledge sharing and reusability⁹.

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3. PROPOSED E-LEARNING MODEL

The proposed e-learning model provides various services to the students (Fig. 1). Once a new student registers or an existing user logs in. Students can view the syllabus, track any extra classes, study the course documents hosted by the instructor, refer books, view various useful URL links provided by the instructor, and perform semantic search for resources. Students can also submit their assignments and tutorials, assess themselves by various exercises and quizzes, and view their progress reports as well. Browsing allows students with varying levels of knowledge to easily navigate through the resources. Semantic browsing locates the

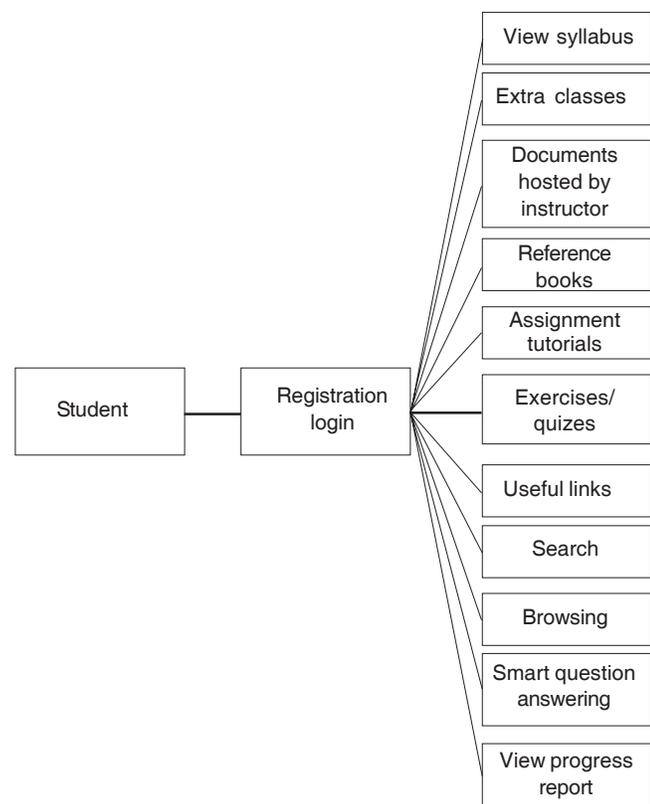


Figure 1. Student services.

metadata and collects interfaces from a combination of relevant information. Search refers to the semantic search, a step ahead of simple keyword matching, and delivers only relevant information from the result set. Smart question- answering provides precise answers to a specific question. For instance, given a question, “Which state in India had the highest literacy rate in 2010?”, the system would directly return the name of the state, with a little summary about the result instead of the list of webpages consisting of the words in the query. Thus, students can perform semantic querying for learning materials. Students can also compose their own course with specific contents.

On the other hand, through our e-learning model, the instructor can make various announcements, set up a session plan, host various documents and resource files for students, manage URL links, compose exercise and assignments for students and control their submissions, and compose the weekly progress report of the students (Fig. 2). The instructor can keep a track of the students' searches and the manner in which students compose their own course. The instructor provides annotations, which comprise content, context, and structure. All the contents of the database need not be created by the same person, the content can be frequently updated from time-to-time, and data can also be exported between different learning systems.

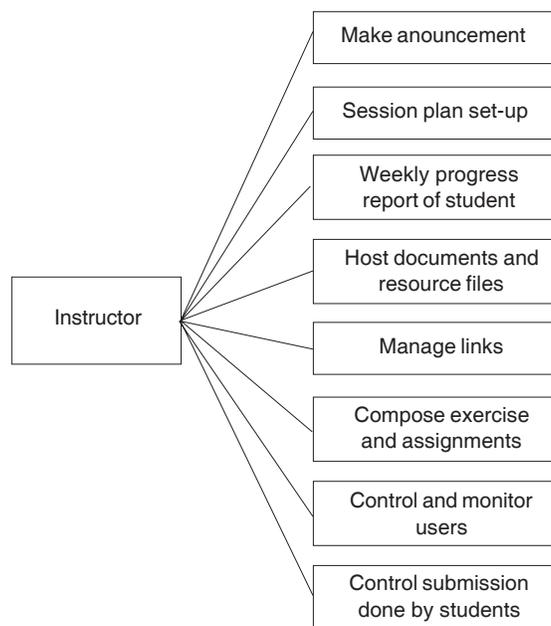


Figure 2. Instructor services.

4. ONTOLOGY

The ontology is defined as a hierarchy of relevant domain concepts, relations between these concepts, further properties of concepts (attributes with value ranges), and the derivation rules to imply new knowledge. The student entity component searches and receives the learning contents, while the students' performance is being evaluated. The learning content is searched by sending queries to the learning resources (i.e., ontology-based knowledge, RDF and database).

The ontological knowledge added to the learning resources is searched by means of queries. The students' performance is measured by the evaluation component, and the result is stored in the student records database. The instructor component can locate a new content in the database. To perform the searching of learning contents, a knowledge base is required. The knowledge base is constructed by adding metadata to the learning content. The metadata consists of the contextual knowledge of the learning resources and the general representation of the structural knowledge on particular domains (Fig. 3).

5. ANNOTATION

Using Extensible Markup Language (XML) users can add arbitrary structure to their document by creating tags

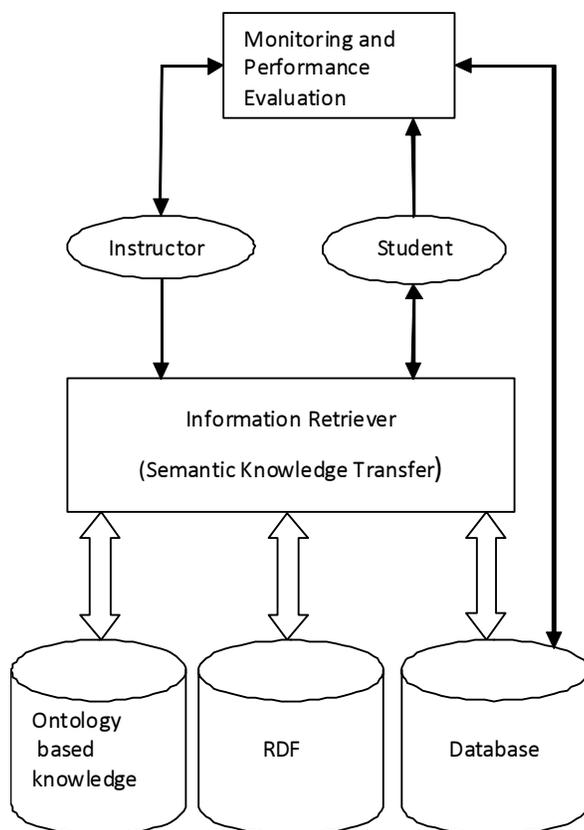


Figure 3. Proposed e-learning model.

to annotate a webpage or text section. Tag names do not provide semantics by themselves¹¹. XML (XML-Schema, www.w3.org/XML/Schema) is used as a "transport mechanism". Resource Description Framework (RDF)^{12,13} and RDF services¹⁴ provide a basic framework for expressing metadata on the web. DAML+OIL and OWL (build on RDF) offer better knowledge representation support².

The text documents written in plain ASCII or HTML are annotated with a set of tags that consists of names of the slots of the selected class in ontology. The ontology can include a class named Course. This class contains different slots such as "name" (name of the course), "type" (video or document), "has-level" (difficulty level of the course), "institute" (educational institute providing the course), and objectives (indicating learning outcomes). The documents can then be annotated using any of the above slots. Various annotation tools are available like Annotea¹⁵; SHOE Knowledge Annotator¹⁶ MnM¹⁷ Melita¹⁸ and OntoMat-Annotizer¹⁹.

6. LIMITATIONS

If interoperability is an issue, then standardisation is required. There are some useful standards for specifications on the learning resources, such as the "Learning Objects Metadata Standard" (<http://ltsc.ieee.org/wg12/>) by the Learning Technology Standards Committee (LTSC) of the IEEE, established as an extension of Dublin Core. A related standard is the SCORM, the Sharable Content Object Reference Model (<http://www.adlnet.org/>). Both these standards attempt to assist the creation of reusable learning objects, in a similar manner to that of the Semantic Web. Moreover, standardisation of the user (learner) information also needs to be maintained by a (learning) system. Two standards emerged for this are Public and Private Information (PAPI) for Learner (<http://ltsc.ieee.org/wg2/> and <http://edutool.com/papi/>) and IMS Learning Information Package (LIP) (<http://www.imsglobal.org/profiles/index.cfm>). These standards define several categories for information about a user (learner)²⁰.

7. CONCLUSION AND FUTURE WORK

Various aspects of e-learning in the emerging Semantic Web have been illustrated. It contains a hierarchical contents structure and semantic relationships between concepts. Thus, it can provide useful information for searching and sequencing learning resources. It can help the instructor in understanding the learning process of the students. e-learning in Semantic Web is a more flexible learning structure and is different from the traditional teacher-student model in which the students take responsibility for their own learning and

determine their learning patterns. Future work may include students discussion forums to be included in the above system in which the students can discuss among themselves about the learning activities and helping each other in composing better courses.

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