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Exploiting Web Based Ecosystems for Use in Web Based Learning

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Abstract: Web-based learning offers huge opportunities for learning and access to a vast amount of knowledge and information. Therefore, semantic web provides infrastructure enabling the semantic interoperability and dependability of web services. Web-based learning is one of the tool with which education is now being delivered. Semantic Web Services, which are services that are self-described and amendable to automated discovery, composition and invocation, will form the next generation of the Web. These services can be represented using ontology and rendered for use by end consumers. An increasing number of organizations are turning to Service Oriented Architectures (SOAs) to consolidate and re-purpose their applications. This can also be extended to include web-based learning applications. As the web service infrastructure matures and first-generation SOAs move to the mainstream, a new revolution in service-orientation is emerging. Web service providers are interconnecting their offerings in unforeseen ways, giving rise to 'Web Service Ecosystems'-a logical collection of web services whose exposure and access are subject to constraints characteristics of business service delivery. Web service ecosystems make explicit the notion of service procurement, separating it from that of conventional service supply. This study therefore, discusses the vision for web service ecosystems presents a framework design to support its application in the area of web-based learning.

Key words: Semantic web, semantic web services, service ecosystems service oriented architectures and ontology

INTRODUCTION

Communication and information organization has greatly improved through the introduction of the World Wide Web (WWW). In different fields (medicine, bioinformatics, oil and gas, tourism and business) large collections of distributed and heterogeneous information resources are collected and shared in the Web. Web ontologies which form the foundation of the semantic web were proposed as a means to solve the problem of sharing and integrating heterogeneous information resources in the web (Yuxin *et al*., 2005). Many of us use the internet or WWW as a source of information. Web Based Learning (WBL) is often called online or e-learning because it includes online course content. Discussion forums via e-mail, video conferencing live lectures (video streaming) are all possible through the web. Web based courses may also provide static pages such as printed course materials. The web is therefore a delivery medium as well as a provider of content and subject matter. As a model for distant learning, WBL has become an increasingly popular concept and a common activity in many countries. This new medium of learning offers many possibilities in approaching new groups of students (Pettersson *et al*., 2002). The main driving force for the rapid acceptance of WBL is the numerous advantages it offers to both students and teachers (Sorel, 2004).

Semantic Web is a web of meaningful contents and services, which can be interpreted by computer programs. Semantic web addresses the weaknesses of current knowledge management systems; such as extraction of un-integrated relevant information from different sources, inability to maintain structured sources of information leading to difficult updating processes and unavailability of machine processable semantic representation of information to enhance automation. Semantic Web Services are services that are self-described and amendable to automated discovery, composition and invocation are expected to form the next generation of the Web. These services can be represented using ontology and rendered for use by end consumers. An increasing number of organizations are turning to Service Oriented

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Architectures (SOAs) to consolidate and re-purpose their applications. This can also be extended to include web-based learning applications. As the web service infrastructure matures and first-generation SOAs move to the mainstream, a new revolution in service-orientation is emerging. Web service providers are interconnecting their offerings in unforeseen ways, giving rise to 'Web Service Ecosystems'. A Web Service Ecosystem is a logical collection of web services whose exposure and access are subject to constraints characteristics of business service delivery.

On the other hand, Ontologies provide a shared and common understanding of a domain that can be communicated between people and application systems; a way to cope with heterogeneous representations of web resources. The main issues and activities in WBL are discussed by Past (2004) and Pettersson *et al.* (2002).

ONTOLOGY

The term ontology has been in use for many years. Merriam Webster, for example, dates ontology circa 1721 and provides 2 definitions a branch of metaphysics concerned with the nature and relations of being and a particular theory about the nature of being or the kinds of existence. Huge amount of domain specific ontologies have been constructed and published in different domains on the web, yet limitations exist making current ontologies not suitable for high-level and large-scale applications (Yuxin *et al.*, 2005). Although, the term ontology has a philosophical origin; it has a separate and specific meaning in the field of computer science. There are 2 primary ways in which computer science ontologies differ from philosophical ontologies. First, unlike a philosophical ontology, computer science ontology must, if it is to be of any use, be expressed in a machine-readable format-that is, in a language with precise syntax that can be easily processed by a computer. Second, unlike philosophical ontologies, computer science ontologies are generally put forth not as theories per se, but rather as practical solutions to engineering problems; they are intended to be assessed in terms of usefulness rather than truth. For our purpose we use Gruba's (1993) widely accepted definition of ontology-a formal, explicit specification of a shared conceptualization. Michael and Michael (2004) further explained each of the terms formal, explicit, specification and conceptualization as follows:

A conceptualization refers to an abstract model of how people think about the world, usually restricted to a particular subject area or domain. Explicit means that the concepts and relations are given explicit names/ definitions (terms and definitions). The name is a term and the definition is a specification of the meaning of the concept or relation. Formal means that specification is encoded in a language whose formal properties are well understood.

Shared means that the main purpose of ontology is generally to be used and reused across different applications and communities.

Global ontology is virtually unrealistic and impossible, but for a specific domain it's possible and necessary to develop a global shared ontology (Mao *et al.*, 2005).

In summary, this definition can be expressed as a formal explicit description of concepts in a domain of discourse. This description is usually made up of axioms that define each thing, thus giving a model that represents the domain. This model can be used to reason about the objects in that domain and the relations between them. The use of ontology in representing knowledge and its relationship with epistemology is described by Williams *et al.* (2004).

Application of ontology: Although, ontologies have had a long history, they remained largely the topic of academic interest among philosophers, linguists, librarians knowledge representation researchers until somewhat recently. Currently, Ontologies have been gaining interest and acceptance among computational audiences (in addition to philosophical audiences). Guarino (1998) provides a collection of fields that embrace ontologies, including knowledge engineering, knowledge representation, qualitative modeling, language engineering, database design, information retrieval and extraction knowledge management and organization. That collection put together in early 1998 did not include the web emphasis that is seen today.

In particular, ontology, as the shared and common understanding of the domain that can be communicated between people and application systems, has a significant impact on areas dealing with vast amount of distributed and heterogeneous computer-based information. These application areas include World Wide Web and Intranet information systems.

SEMANTIC WEB AND SEMANTIC WEB SERVICES

Semantic web: The Semantic Web aims to add a machine tractable, re-purposeable layer to compliment the existing web of natural language hypertext. In order to realize this vision, the creation of semantic annotation, the linking of web pages ontologies the creation, evolution and interrelation of ontologies must become automatic or semi-automatic processes (i.e., in a distributed computation, semantic web aims at distributing data and services defined and linked in such a way that they can be used by machines, not just for display purposes, but for automation, integration and reuse of the data and services across various applications and heterogeneous users). Berners-Lee *et al*. (2001) summarizes semantic web as a vision of a web of meaningful contents and services, which can be interpreted by computer programs. The emergence of the semantic web allows answers/results to be given to specified queries in the Internet; people can now add new facts/ideas to the Internet because they will be structured and maintained in such a way that machines can reason about them. A number of languages such as Extensible Markup Language (XML), Resource Description Framework (RDF), RDF schema (RDF-S) recently Web Ontology Language (OWL), etc., have been developed to facilitate the implementation of the above concept.

Semantic web services (SWS): There are services on the web for users, defined through service ontology, which enable machine interpretability of its domain knowledge. A web service is a software or program identified by a Uniform Resource Locator (URL), which can be accessed through the Internet through its exposed interface. The interface description declares the operations, which can be performed by the service, the types of messages being exchanged during the interaction with the service the physical location of ports, where information should be exchanged. For example, a web service for calculating the exchange rate between two money currencies can declare the operation getExchangeRate with 2 inputs of type string (for source and target currencies) and an Output of type float (for the resulting rate). A binding then defines the machine and ports where messages should be sent (Grant, 2001).

Web service ecosystems: An increasing number of organizations are turning to service-oriented architectures (SOAs) to consolidate and reorganize their applications combine them with new applications. A vendor-driven push for middleware based on the Web Services standards stack is fueling this trend. This stack provides infrastructure for exposing application logic over the web using the software as a service metaphor.

Ecosystems are communities of interacting organisms and the physical environment in which they live (could also be combination and interacting of the planets). Different ecosystem types provide different combinations of services to societies. A new revolution in service-orientation has emerged, whereby web service providers interconnect their offerings, giving rise to web service ecosystems. A Web service ecosystem is a logical collection of Web services whose exposure and access are subject to constraints characteristic of business service delivery. In these ecosystems, service consumers procure service through different distribution and delivery channels, outsourcing service delivery functions such as payment and authentication. Web service ecosystems make explicit the notion of service procurement, separating it from that of conventional service supply.

ONTOLOGY BASED DESIGN OF WEB BASED LEARNING

Motivation and design of the WBL: Generally, ontologies can be used to communicate between systems, people and organizations, interoperate between systems support the design and development of knowledge-based and general software systems (Williams *et al*., 2004). Scientists continue to research on efficient ways of processing data and also teaching. The need for this and tools to use becomes even more important as the society becomes more complex with associated large volumes of data, communication of information and teaching in different cultures. A survey result of teaching tools and age carried out in the USA (Reisman, 2006) shows that the older you are, the less it is that your instructors used technology in the classroom. This shows that the learning and teaching methods have changed with corresponding improved results. These indicators form the driving force in carrying out this study.

We now use a domain; the web based learning to illustrate the application of ontology and SWS. In WBL, the internet links people world wide contains a highly diverse, easy-to-update source of information. The architecture of the proposed model is as presented in Fig. 1.

The architecture depicted in Fig. 1 shows two interface layers between the Student/Faculty and the Cyber Classroom. The Computing devices are used for communication and allow the user(s) to get services and run applications at any time and any place. Because the data/objects are distributed, users can have access at the same time at different sites. The ontologies provide a means of describing the structure of semantics of objects/transactions in the domain and provide interoperability between the computing devices of the student and the faculty. Between these layers are the possible transactions, which includes, register courses, administer lectures and exams, attend lectures, do exams, publish results and view results. The transactions are

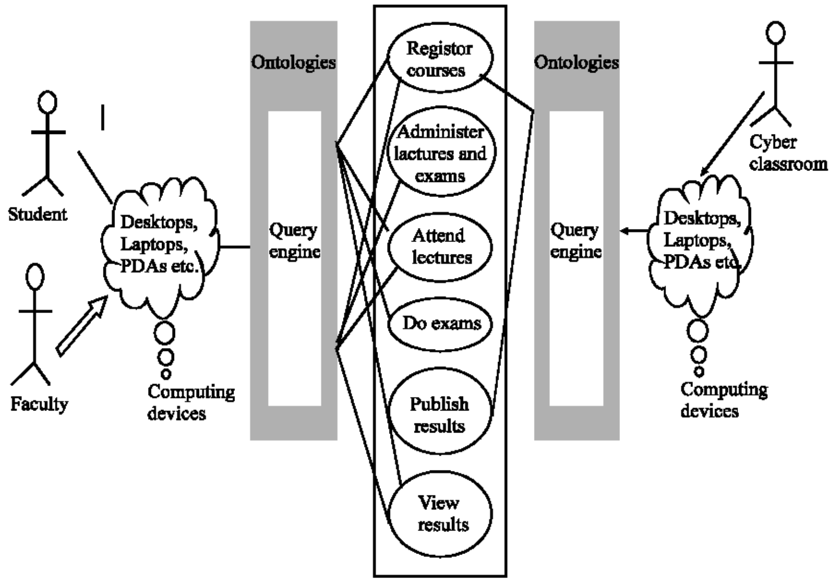

Fig. 1: A conceptualized model and use case diagram of WBL

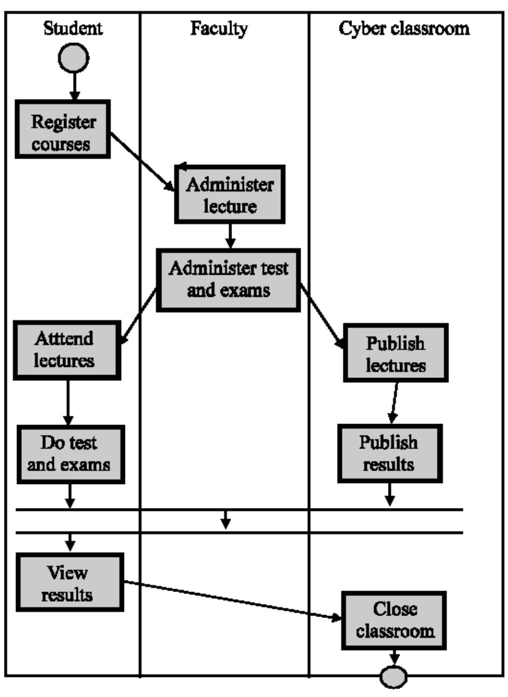

Fig. 2: Swim lanes for the design of web based learning

described with the use case diagram, which forms part of the design. The Use case diagrams describe what a system does from the standpoint of an external observer. The emphasis here is on what the system does rather than how it is done. The actors are the student, the faculty and the cyber classroom, which communicate through the specified Use Cases such as register courses, publish results, which depict some aspect of system functionality that is visible to an actor such as a student. A semantic web service is provided to actualize these processes. The student adds information to the semantic web to accept the admission offer and also provide details such as name, contact address and courses to register via computing devices. The student is notified of reception of his/her registration information leading to the completion of the registration process and the subsequent attendance of lectures online.

The type of ontology adopted in the design is the on2broker ontology described in Fensel *et al*. (2001). It has four main components: query engine, information agent, inference engine database manager. The query engine receives query from the user and answers them by checking the content databases that were filled by the information agent and inference engines. The information agent is responsible for collecting factual knowledge from the web. Facts and ontologies are processed to derive additional factual knowledge by the inference engine. The backbone of the entire structure is the Database Manager, which receives and stores facts/knowledge from the information agent, exchanges the facts as input and output with the inference agent and provides facts to the query engine. The student (and faculty) interacts with the query engine, through computing devices. The various activities possible on the cyber classroom are presented in Fig. 2.

The class diagram is depicted in Fig. 3. The activity diagram represents a fancy flowchart with additional enhancements. It shows three objects (student, faculty

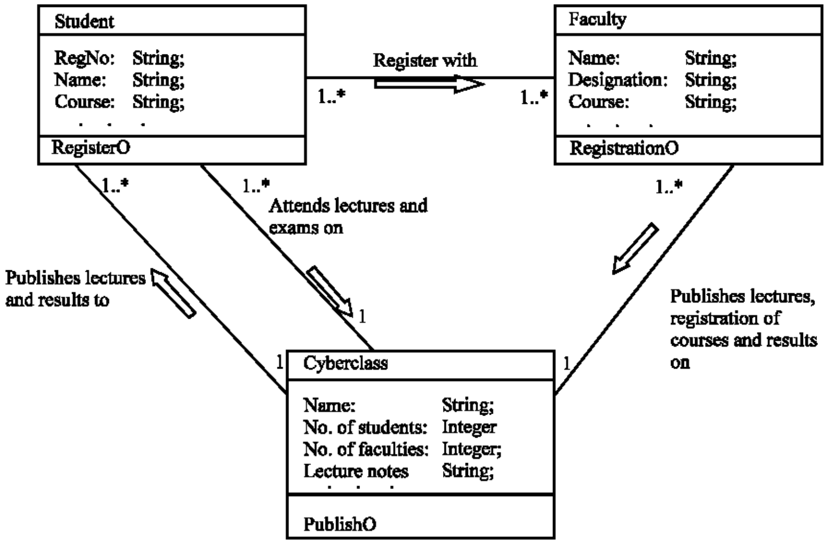

Fig. 3: Class diagram for web based learning

and cyber classroom) interacting with each other to accomplish the task of web based learning. The activity diagram uses swim-lanes to show which objects take responsibility for which parts of the process. This can be represented by ontology showing objects and their relationships. The 3 classes also involve student, faculty and cyber classroom performing activities represented with rounded rectangles. The process begins at the black start circle at the top and ends at the concentric white/black stop circle at the bottom. The student registers the courses tenable for a semester with the various faculties handling such courses. The registration process is followed by the delivering of lectures and administering tests and examinations, which the student must take part in. The faculty collates and publishes lectures and examinations figures on the cyber classroom, which the student access online. The completion of the process comes at the end of the semester when examinations are taken and results published on the web through the cyber classroom.

The class diagram depicted in Fig. 3 is used to describe the types of objects in a system and their relationships. Class diagrams give an overview of a system by showing the classes and the relationships among them, represented by ontology. It shows interaction between the student and the faculty as well as the cyber classroom.

The student class has a Register function of type Boolean that returns true if the student has registered for the required courses in a semester, otherwise returns false. A many-to-many relationship exists between the student class and the faculty class while a one-to-many relationship exists between the cyber classroom class and the student and faculty classes as well.

Each class has three parts:

- A name e.g., Student
- Attributes e.g., RegNo, Name Dept.
- Operations e.g., Register, Publish etc.

CONCLUSION

The Web is a delivery medium, as well as provider of content and subject matter. It is easy to use HTML, XML, RDF etc to deliver all of these offerings in text, graphics, sound video. The Internet links people world-wide contains a highly diverse, easy-to-update source of information. Web-based instruction is shown to be more useful for intellectual knowledge than effective knowledge is not appropriate if users do not have Internet connection, if the material requires large amount of audio or video, or if the subject requires the teaching of physical Skills (Stauffer, 1996). Therefore, one of the main barriers to the effective use of teaching materials is the technology (for example, poor access, slow downloading due to poor band width etc.) rather than the design of the learning materials themselves. However, it is vital that teachers seek expert help with reference to technical issues in the planning, design delivery of web based learning programmes. Through programming and the use of plug-ins (programs that can be downloaded from the Internet), designers can produce interactive course materials containing online activities (such as self assessments), animations simulations, these can improve learning and can make learning more enjoyable and meaningful for the learners.

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