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Efficient Content Retrieval in E-Learning System using Semantic Web Ontology

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Abstract—*E-learning system focuses on how the content is learnt by the learner and pays attention to learning activities. The semantic web-based educational systems are to exchange content or re-use functionality once made available. This paper speaks on an E-Learning System based on semantic web technologies. Web-based courses suggest clear advantages to learners by allowing very fast, just-in-time, relevant, and at any time or place access to educational systems. This paper describes the main role of ontologies in the context of e-learning. This work is to create domain ontology that plays an important role in representing concepts required for higher education and to assist specialized e-Learning systems. Use of Concept Reusability for Content Retrieval in e-Learning System using Ontological approach is attempted with sample content from 'Rough Set Theory'. Direct and Ontological approaches have been performed to observe the efficiency in terms of Page Load Time for content retrieval with different media of input from web server. Comparison of measurement of load time was done for normal and ontological approaches and the important conclusions have been drawn. It is observed and noted that by using ontological approach, the web page load time with respect to the server processor and the response time with respect to the end user can be brought down by 10% to 15% of maximum time taken and 10% to 12% of minimum time taken. Thus, the objectives of this research has been examined, experimented, established and validated.*

Keywords: *E-learning, Semantic Web, Ontology, Content Retrieval, Content Reusability, Page Load Time.*

1. INTRODUCTION

World Wide Web plays an important role in different kinds of societies such as education, health, business, commerce, government, etc. Drastic growth of information available on web is leading us to develop proper mechanism to organize and represent these data and information in meaningful way. Information retrieval, communication, storage, computing through clouds and many more processes can be done with the advent of current web services available. Advances in digital world and technologies help the e-learning community to learn without any barriers like space and time. E-Learning has become the basic for the current rapidly growing education community when computation and information are ubiquitous and always available. The advantage of technology improved learning and teaching methodologies teachers and students can interact without restrictions of space, time, convenience etc**.**

Semantic web allows for data to be read, processed and understood by machines precisely and intelligently. Ontology [4, 1] plays an important role in Semantic Web, and the definition of ontology is an explicit and formal specification of a shared conceptualization. It may be useful to apply ontology description languages such as Web Ontology Language (OWL) [10] for special management information. The OWL language is used to develop ontology. In these ontologies, the actual resources and properties specified in the Resource Description Framework (RDF) models are defined. The protégé ontology editor can be used to create the e-learning ontology classes and properties for the subject Rough set. Ontology represents conceptual explanation of the specific learner as they help to identify appropriate items and relationships in a given set of knowledge domain.

In the e-learning system, ontology can easily manage the knowledge domain of a course Rough set and allow a more detailed organization and adaptation of the learning path of students. Building ontologies is difficult, time consuming, and expensive". The aim of this paper is to summarize how to develop the Ontologies and how they can be integrated and reused contents in e-Learning application. In the ontological approach of E-learning system, the content reusability is the main role for reducing the time complexity for the retrieval of e-learning application in the web.

2. SEMANTIC WEB ONTOLOGIES IN EDUCATION

Semantic web is existing above the web and allow the users to interact with the web in a meaningful way. Semantic web is to extend the current web technology to allow the development of intelligent agents, which can automatically and unambiguously process the information available on millions of web pages. The term "ontology" can be defined as an *explicit specification of conceptualization*. This includes the model of the domain with possible restrictions. The conceptualization describes knowledge about the domain, not about the state.

The vision of the Semantic Web is to extend principles of the Web from documents to data. Data should be accessed using the general Web architecture using, e.g., URI-s; data should be related to one another just as documents (or portions of documents) are already. This also means creation of a common framework that allows data to be shared and reused across application, enterprise, and community boundaries, to be processed automatically by tools as well as manually, including revealing possible new relationships among pieces of data [3].

Semantic Web technologies can be used in a variety of application areas:

- Data integration
- Resource discovery and classification
- Cataloging
- Intelligent software agents
- Content rating Collections
- Intellectual property rights

The purpose of authoring ontologies is also reusing of knowledge. Once ontology is created for a domain, it should be (at least to some degree) reusable for other applications in the same domain.

The educational domain can greatly benefit from the possibilities offered by semantics. Semantic systems can positively affect the access of people to learning materials. They can offer a rich set of services that personalize the way content is made available to the user, by providing a well-structured database that allows better knowledge handling by machines. Ontologies and the Semantic Web offer a new perspective on intelligent web-based e-learning systems by supporting adequate representation of used concepts. Such e-learning systems provide curriculum sequencing, analysis of the student's solutions [2].

The educational ontology model presented in this paper was implemented using the Protégé-OWL ontology editor, an application developed at the Stanford Center for Biomedical Informatics Research of the Stanford University. The Protégé-OWL editor is an extension of Protégé that supports the Web Ontology Language (OWL). OWL is the most recent development in standard ontology languages, endorsed by the World Wide Web Consortium (W3C) to promote the Semantic Web vision [11].

3. APPROACHES TO E-LEARNING SYSTEM

For recent years, Content Retrieval of e-learning has many approaches [5]. Prerequisites for reusing prepared learning materials typically involve finding relevant documents and context-based retrieval of content elements which is referred to as lecture fragments. [9].

Issues during Content Retrieval:

1. Finding relevant document sources within the context of recent topics learnt and of the nature of audience.
2. Selecting more specific parts of documents that could be reused, based on the pedagogical semantics of definitions, examples, graphics, tables, and images.
3. Defining the sequence in which document elements for selected concepts should be accessed or presented.

An ontological approach to handling such issues is to define reusable chunks of documents that can be retrieved, adapted and assembled in a coherent way for a given educational purpose [6]. Using Ontological approach, Resource Description Framework (RDF) should be generated for e-learning system [7]. RDF to be generated based on concept reusability using protégé tool [8]. Many researchers have already diversified and end up with a new tool to overcome the lacuna found by them in the tools available that are used for generating RDF. Therefore, the research problem here is to reduce the Page Load Time. Reduced Time to retrieve Content from server is possible using Content Reusability. This research aims to measure and compare the load time in respect of page size under normal content retrieval method over the improved method (i.e. ontological approach).

4. OBJECTIVES OF THE RESEARCH

1. Generate an e-learning system with e-content for Rough set theory using normal approach.
2. Generate RDF for ‘Rough Set Theory’ in an e-learning system using protégé tool with ontological approach.
3. Measure the load time for content retrieval using normal approach through experiments.
4. Measure the load time for content retrieval from an e-learning system using ontological approach through experiments.
5. Compare the measurements observed from above step 3 and 4.
6. Draw findings and conclusions from the results observed.

5. CONCEPT REUSABILITY BASED CONTENT RETRIEVAL SYSTEM

Literature surveyed and reported has supported in formulating certain major parameters that are to be considered for the design of the proposed model.

They can be broadly grouped into two parts, namely

- RDF rule generation using Protégé tool.
- Content retrieval using concept reusability expresses the methodology and presents the proposed system.

CBIR (Content Based Image Retrieval) algorithm uses the visual content to retrieve images from storage in large scale and when many interacting components present. By reusing the existing concepts, time could be reduced for retrieving contents from the web. Concept reusability in ontology offers easier access to the information for the users. Developing an e-learning system with ontology for a course ‘Rough Set Theory’. This research work uses CRBCRS (Concept

Reusability Based Content Retrieval System) algorithm to generate the learning material. In protégé tool, the classes, properties and relationships are to be created for the content.

CRBCRS ALGORITHM

1. Start Protégé tool.
2. Protégé dialog box appears, press the 'Create New OWL Ontology'.
3. A 'Create Ontology URI wizard will appear'. Every ontology is named using a Unique Resource Identifier (URI). Replace the default URI with the created page.
4. Create classes and subclasses for e-learning system of Rough set theory.
5. Create Object Properties for Rough set theory.
6. Disjoint the subclasses under the main class.
7. Create Relationship for class of subclass to another class of the same subclass.
8. Select RDF/XML rendering from Ontology views in the views menu.
9. Read the RDF using Jena libraries in the e-learning application.
10. Attach the RDF URI's to the webpage of hyperlink to URL of the relevant document.

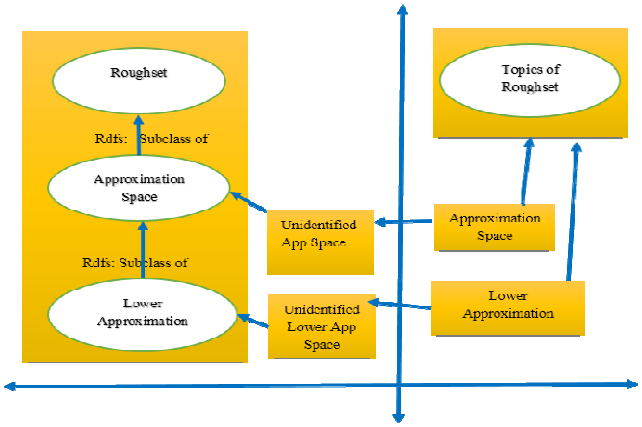

Fig. 1: Roles of classes and subclasses of Domain Concepts

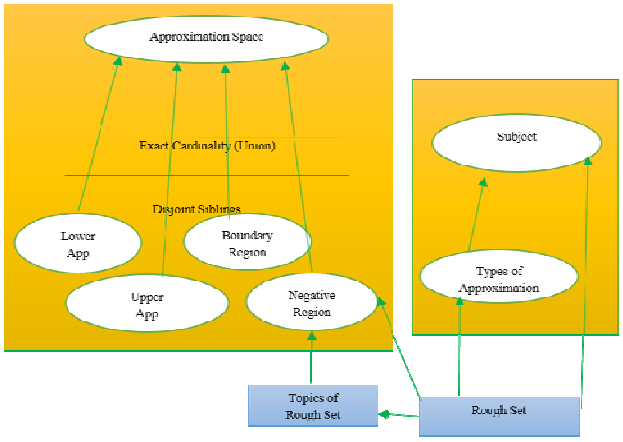

Fig. 2: Roles of relationships among the classes of Domain Concepts

Here, Fig. 1 and 2 represents the Generic Class Hierarchy (GCH) and Domain Class Hierarchy (DCH).GCH refers to a set of classes organized in any hierarchical structure. DCH refers to any GCH that contains the classes corresponding to the domain concepts that the ontology is intended to represent.

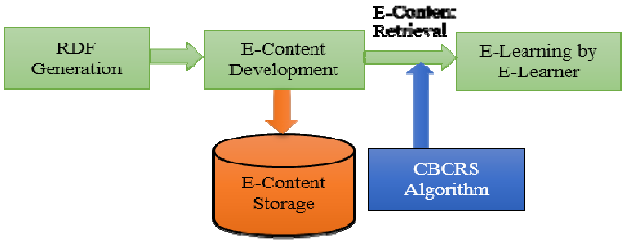

Fig. 3: System Flow Diagram

Here the Fig. 3 shows the content created is generated as an RDF and is visually stored as image in the storage could be verified at any time later. The concept-reusability-based content retrieval algorithm can be implemented to save storage. Hence the experiments would be conducted using simple and ontology-based approaches on the e-content generated using these approaches.

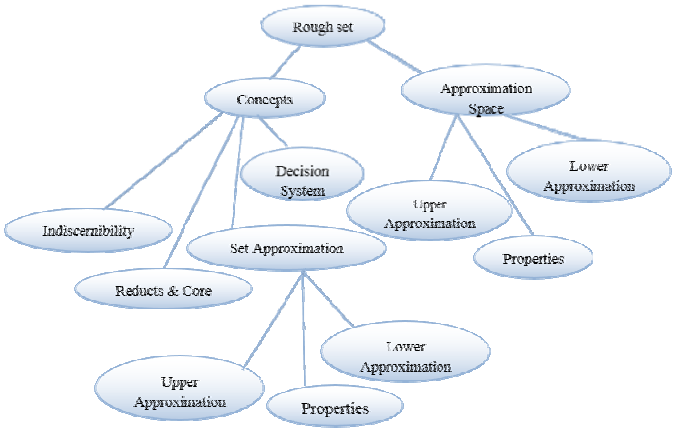

Fig. 4: Hierarchical Structure of Normal Approach

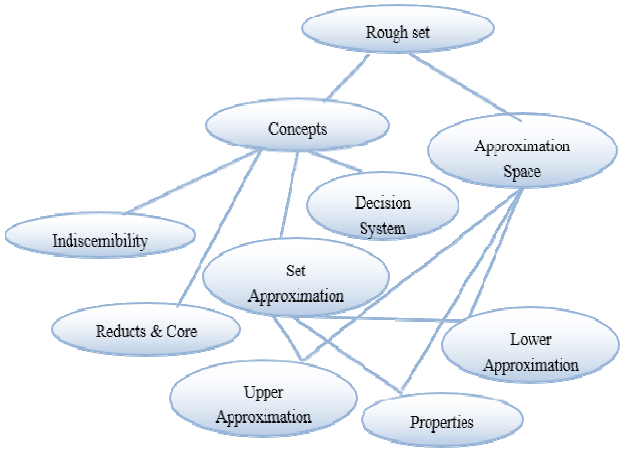

Fig. 5: Hierarchical structure of Ontological Approach

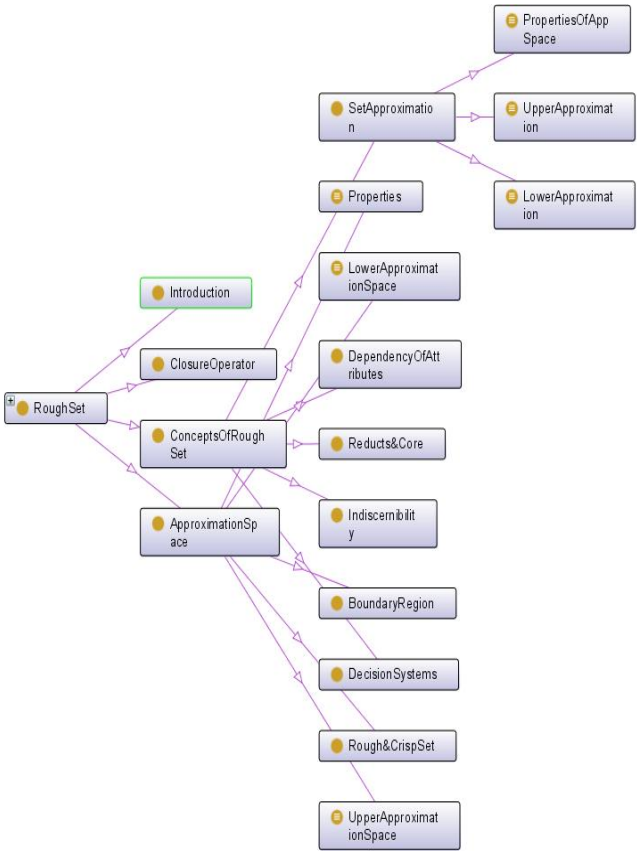

Fig. 6: Visualization of an Ontological Graph

Here the Fig. 4 presents the hierarchical structure of hyperlink of web pages. It is very evident that the pages retrieved are afresh every time as they are not interlinked for reuse. Every item of content need to be accessed with its unique path of links. There is no possibility of reusing the content of some link at various pages. The Fig. 5 shows the hierarchical structure of hyperlink of web pages for ontological approach. It is very evident that the pages retrieved are not afresh every time as they are interlinked for reuse. Every item of content to be accessed with its interlinked path of links. There is a possibility of reusing the content of some link at various pages. So the page load time will be reduced because of reuse of the page contents and paths.

Fig. 6 shows the ontological graph generated using Protégé tool for above mentioned content.

6. EXPERIMENTAL MEASURES

Table 1: Minimum and Maximum Retrieval Time

Content Type	Direct Approach		Ontological Approach	
	Max (in ns)	Min (in ns)	Max (in ns)	Min (in ns)
Text	11.546	8.125	10.112	6.473
Text and Image	11.546	8.553	10.081	6.569
Text and video	11.546	7.697	10.081	6.473

Hence, it brings out a conclusion that ontological approach is the efficient way for retrieving contents, image and video because reusing the content page that has to reduce the page load time.

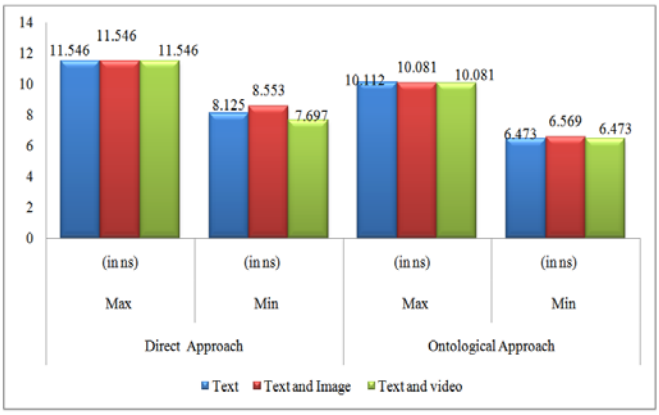

Fig. 7: Retrieving pages with different content types

The chart corresponding to Table 1 shown in Fig. 7 indicates that the time taken in ns (nano seconds) to retrieve the page of textual content and page of text with video reflects similar responses amongst the trial runs and the page with text and image had a difference in trial runs. This graph reveals the fact that same page of content will be retrieved with different load time based on the present workload of the server.

Table 2: Minimum and Maximum Retrieval Time

Content Type	Direct Approach		Ontological Approach	
	Max %	Min %	Max%	Min%
Text	60	40	60	30
Text and Image	70	50	60	30
Text and video	80	60	60	40

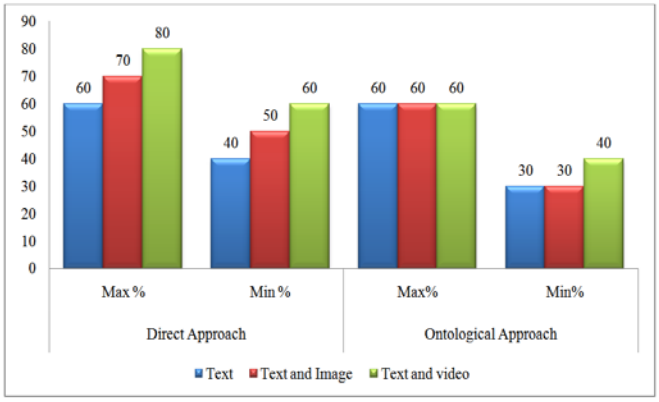

Fig. 8: Percentage of Minimum and Maximum time consumed

Table 2 summarizes the minimum and maximum time taken by each page during experimental runs under direct approach and ontological approach. The results recorded reveals that the maximum time has drastic down to the tune of 1.5ns and the

minimum time difference falls to difference of 1.2 ns. The overall performance has also improved with ontological approach is very evident from the corresponding graph represented in Fig. 8. The time taken at direct approach is little higher between direct max and ontology max and also between direct min and ontology min.

7. CONCLUSION

This paper describes on comparing the load time of content retrieval of e-learning system based on normal approach and the ontological approach. It is observed that Ontological approach not only saves time but also the best method for retrieving contents from the web server over the direct approach for retrieving pages with Text, image and video contents. This research work can be further extended or diversified in various directions, such as: comparative study can be carried out using compression algorithms for reducing the page load time during retrieving pages with content such as text, image and video. Instead of theoretical courses, problem-based or mathematics kind of courses can be worked out. This research takes only one video format for measuring the page load time; instead different video formats may be considered

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