A Review on Semantic Ontology based E-Learning Framework

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Abstract— **E-learning plays the major role for gathering the best kind of knowledge through online. Semantic based E-learning methodology provides the rich learning content extracted from various web resources. It is most suitable and effective for content processing and retrieving methodologies. Ontology is defined as a representation of a shared conceptualization of a particular domain and is a major componenet of the semantic web. Semantic web-based E-Learning system focus on the RDF data model and improves the efficiency of the E-Learning system. The web data is mined by means of structured semantic process. The main problem in web-based data extraction is lacking in heterogeneous web services discovery. The E-learning content mostly focus on single domain ontologies and lacks in complex query matching process. This paper surveys about heterogeneous semantic based E-learning framework in order to improve the complex query data processing and query matching mechanism. This heterogeneous based E-learning framework incorporates content from various domains.**

Index Terms— **Ontology, Research Description Framework (RDF), Query matching, Semantic based E-learning.**

I. INTRODUCTION

With the rapid growth of electronic course contents and virtual classrooms, E-learning systems are efficiently used for education and training in academic and non-academic classes. It can be defined as the Internet-enabled learning to deliver a broad array of solutions that enhances the knowledge and performance. It has been adopted by small and medium organizations due to its flexibility to access, just-in-time delivery and cost effectiveness. Therefore, E-learning systems should not only provide flexible content delivery, but it should support content recommendation. For, better learning experience, and for the effective content a semantic based technology is used. Semantic web implements a promising technology for realizing E-Learning framework.

It provides better possibilities for searching and navigating through the cyberspace. It integrates available technology and provides an optimal path. The main part of the Semantic Web is domain ontologies, which provides a formal description for a shared domain conceptualization. It offers an opportunity to enhance the metadata associated with E-learning materials and expands the possibilities of the E - learning framework. The semantic based system creates a recommender system to define the personalized and recommendation algorithm. This system employs a semantic web parts to recommend some items to user. Semantic web implements reliable, large-scale interoperation of web services to make such computer services interpretable. The term semantic web contains efforts to build a new WWW architecture that supports content with formal semantics. It contains suitable content for automated systems. The semantic web layers comprise of various steps,

- The XML layer- represents data
- The RDF layer-denotes the meaning of data
- The ontology layer- presents the formal common agreement about the meaning of data
- The Logic layer- enables intelligent reasoning with meaningful data

XML allows everyone to create their own tags that annotate Web pages, or sections of text on a page. It permits users to add arbitrary structure to their documents. Research Description Framework (RDF) indicates a means for adding semantics to a document. It is an infrastructure that enables encoding, exchange and reuse of structured metadata. The role of ontology describes a shared meaning of used vocabulary. It comprises of a set of the possible mapping between symbols and their meanings. Semantic search for learning materials are based on the three dimensional searching space. An Automatic discovery of web service is a function of semantic, which automatically finds the location of web services. Automatic control of a web service helps the novices to know the status of officials of web service.

Semantic based web portal offers an integrated interface through which readers, as well as writers can download or modify the data. Semantic based E-learning framework are knowledge based and the metadata is placed within the document or some external repository metadata. Query processing in the semantic web is the process of transforming a query issued by a user into a different query based on the semantic application. The user provides a broad query due to a lack of knowledge of the contents and the structure of the database. User queries to the open

learning environment consists of several keywords related to the topic.

The users request is transformed into a query called RDF query language. This query language matches data to describe learning sources in the system. The semantic web based framework is lacking in identifying the heterogeneous wen services and focus on single domain ontologies. Some web-based services lacks in the complex query matching process in which it produces the invalid contents in terms of presence of logical operators or any data driven operator processes. A heterogeneous based E-learning framework is considered by integrating an efficient query matching mechanism. This framework handles all kinds of heterogeneous web-data contents and complex query data processing. The complex queries include the processing of data operators in order to give the effective semantic data retrieval of E-learning contents.

This paper is organized as follows section 2 describes the various techniques of integrating the heterogeneity in E-learning framework. Section 3 depicts results and discussion. Section 4 illustrates conclusion and future enhancement.

II. HETEROGENEOUS BASED SEMANTIC E-LEARNING FRAMEWORK

This section clearly explains about the benefits of heterogeneous based semantic E-Learning framework and the drawbacks of single domain ontology based E-learning framework. Heterogeneous based E-Learning Framework VS Single domain Ontology based E-Learning Framework

1) Heterogeneous based E-learning Framework

In heterogenous based E-learning framework, the contents are derived from various webservices. This framework allows users to share their learning materials in semantic level automatically [1]. The unified query services are discovered and processed. An unifying accesses to heterogenous repositories is generally delayed by the information environment. This function enables existing resources to be identified and re-purposed for learning network. Heterogenous E-learning framework involves complex query processing. Complex queries includes, processing of data operators in order to give the effective semantic data retrival of E-Learning content. An efficient match making mechanism is used for handling and acquiring all kinds of heterogenous web-data contents and complex query data processing. This framework provides high scalability and flexibility. It also improves the match making mechanisms and accuracy of the framework.

2) Context aware semantic E-Learning approach

This approach integrates content provision, learning process, and learner personality in a semantic E-learning framework [2]. It includes basic metadata entities and literal statements (eg, title, author, images, audio, and video). It includes three stages in a semantic E-Learning scenario

- Pre learning process
- Learning process
- Post learning process

Pre learning process, involves preparation of work from both the learners and the instructors. Instructors prepare online multimedia learning resources and design learning paths for different types of learners. It provides contextual descriptions of learning objects and learning environments. The second stage includes various kinds of learning activities such as locating learning materials, reading materials, writing reflections, and discussion with peers. Each learning activity is considered as a sequence or combination of simple activities. The last stage deals with reporting and evaluation of learning outcomes on both the learners and instructor sides [3]. After each learning session, agents generate a learning progress report against the predefined out goals and outcomes. This approach has less interoperability in other framework.

3) Semantic Grid based E-learning Framework (SELF)

An effective end-to-end E-Learning environment, which identifies the key enablers for realistic E-learning infrastructure [4]. The semantic grid merges the semantic web with grid computing. It is a layered stack at each Virtual Organization (VO) with two major segments. The end-user applications such as group and courseware managers are carried out by SELF VO in the top layer. The applications are dependent and organized by the specific requirements. It is very difficult to integrate all the components of SELF into a single framework because of interoperability. This approach lacks in security issues such as, authentication of individuals and confidentiality of contents.

4) Knowledge based Content navigation

It enables personalized access to hyper-linked information and this system is provided at two different levels

- Presentation-level
- Link-level

These levels provides a flexible learning environment. The link-level adaption provides key points to students through their learning path [5]. It deals with the discovery and display of relevant links to a given user. The basic mechanism for adapting content to each student is based on the representation of both domain knowledge. Fuzzy clustering algorithm is used to group data elements according to the similarity measure. These algorithms are very useful in identifying document relationships based on their metadata. The Resource Description Framework (RDF) and TopicMaps is used in this technique due to its flexibility. RDC represents data relationships and TopicMaps manages knowledge structures and information resources [6]. These two frameworks are very useful in knowledge based content navigation, which are used by the experts. This approach lacks in extraction of data from various sources.

5) Fuzzy Domain Ontology Extraction for adaptive E-learning

The fuzzy domain ontology extraction model automatically constructs the concept maps [7]. These maps are built based on the messages posted to online discussion patterns. By browsing the concept maps, instructor quickly identifies the progress of their students. The concepts are automatically generated, from a collection of online

messages posted to blogs, emails, chat rooms, and web pages. The collection of messages is called as a textual corpus. At the document parsing stage, the document parser scans each message to analyze the syntactic elements embedded in the message. The fuzzy domain ontology algorithm automatically extracts and visualize the concept maps representing an individual or a group of learners' knowledge structure [8]. The drawback of this model is the fuzzy conjunction operation is highly influenced by the weakest term attributes.

6) Multi-model ontology based E-Learning framework

This is a hybrid recommender system, which is driven by two types of recommendations, namely,

- Content-based model
- Rule-based model

The content based model represents the learning materials, where the ontology is built by a hierarchy of concepts and sub-concepts [9]. Rule based ontology model represents a subset of domain ontology and cluster based recommendations are added as additional semantic recommendations to the model. A recommender system in an E-Learning context is a software agent that tries to intelligently recommend actions. Those recommendations are based on previous learners that are discovered from their navigation patterns. This approach is based on a search engine based recommender system. The search is finally personalized through query expansion using the recommender system. This system measures only a limited number of learner's semantic profile.

7) Abstract Learning Object Content Model (ALOCoM)

This model provides a comprehensive description of different granularity levels, which are present in current content models and their interrelationships [10]. A top-down approach is used to define the granularity levels. Learning objects components are subdivided into content fragments and defined as individual content components such as text, images, audio and video fragments. ALOCoM distinguishes between Content objects (Cos), Content fragments (CFs) and Learning objects (LOs). CFs are content units in the basic form, like, text, audio and video [11]. These elements are regarded as raw digital resources. COs aggregate CFs and add navigation. Navigational elements enable sequencing of content fragments in a content objects. This model concentrates only on reusability of learning objects and does not concentrate on accuracy of the framework.

8) Ontology Driven E-Learning System (O-DEST)

This model comprises of an ontology for the E-Learning process, such as course syllabus, teaching methods, learning activities and learning styles [12]. O-DEST helps teachers, students and administrative personnel to set up and maintain the course material as well as the course administration. O-DEST provides a unified platform for logging, assessing, planning, delivering content, managing records and reporting. These activities help both the self-paced and instructor-led-learning process. All these activities are represented to the end user as web-based applications. The course represents an integrated structure of many learning resources that is hosted on different web locations. The same resources are combined with others to set up different courses. This is designed with three basic modules

- Tools for the teachers
- Tools for the students
- Tools for the administration

The first tool consists of functions, which helps the teachers in creating learning objects, connecting the objects to existing ones. The second tool enables the students to master the learning material and meet the learning goals of the course. The third tool supports different management functions and tasks of the system [13]. O-DEST is a highly structured learning modules, which are transparent and accessible through the web. It does not introduce the automatic allocation of the learning contents according to the student's knowledge.

9) Sharable Content Object Reference Model (SCORM)

The SCORM standard specification allows instructors to elaborate the benchmark tests for evaluating the E-Learning framework [14]. This model denotes a comprehensive picture of how a learning management system serves with web-based learning. It describes a specific way to deliver the E-learning content. The main features of SCORM are

- The CAM (Content Aggregation Model)-defines a model for packaging learning content.
- The RTE (Run Time Environment) that defines an interface for enabling communications between the learning content and system.

This model permits the instructor to identify the needs and requirements in the learning process. It audits the available tools and detect whether the tools meet the specified requirements. This evaluation model organizes the functionalities of any learning platform and facilitates the evaluation process. This model is inherently insecure and very complicated format. The learning interaction takes a longer time to download.

10) Navy Content Model (NCOM)

This model refines the SCORM content model, and provides more specific content definitions for granularity levels that are identified as critical for the Navy Interactive Learning Environment [15]. This Navy content model distinguishes between learning object aggregations, terminal learning objects (TLOs), enabling learning objects (ELOs), and assets. A learning objects aggregation is the top-level grouping of related content, containing TLOs and ELOs. A TLO is an aggregation of one or more ELOs. A TLO satisfies one terminal objective and correlates to an SCORM activity. Terminal learning objectives are typically associated with lessons. An ELO is an aggregation of one or more assets and satisfies one enabling objective and correlates to an SCORM SCO [16]. An asset is a single text element or a single media element (e.g. an assessment object, a video, and other data elements) It correlates a single enabling objective to an SCO and a single terminal objective to an SCORM activity. It lacks in accuracy and does not handle the query efficiently.

Table 1 Relationship between the SCORM and NCOM hierarchy

SCORM	NCOM
Content aggregation	Learning object aggregation
Activity	Terminal learning object (TLO)
Sharable content object (SCO)	Enabling learning object (ELO)
Asset (with metadata)	Asset

11) Learning Object Context Model (LOCO- model)

This model influences a range of other kinds of learning ontologies to capture the information about the real usage of a learning object inside a learning design [17]. It identifies the information objects within a learning objects with the goal of making each component of the learning object directly accessible. It represents a specific context of use and it is maintained as the central item of the ontology. This system helps the instructors to rethink the quality of the learning content and learning design. This model formally identifies the information objects within a Learning Objects (LO) with the aim of making each component of the LO directly accessible. This framework is useful for generating the feedback in the learning process. The main issue of the LOCO system is, it incorporates with other system.

12) Advanced Distributed Architecture for Personalized Teaching and Training (ADAPT^2)

This employs a higher-level mechanism for ontology-based interoperability of self-contained web based systems [18]. It establishes a general framework for distributed education. The component of this framework is

- Learning portal- organizes the learning material and provides student and teachers with the facilities necessary for participating in the learning process.
- User Model (UM) -this server stores the student activity and infers the knowledge about the learning characteristics. This forms the basis for personalization on learning portal or on side applications compatible with the protocols.
- Ontology server- stores the ontological structures of the domains. It also resolves the possible conflicts in the domain models of specific applications. It forms the platform for exchange of higher-level information about a student's knowledge and calculated by different user model servers.

It cannot accomdate a larger variety of adaptive components and does not rely on reusability.

13) OntAWare system

This model provides an environment consisting a set of software tools that supports learning content authoring, management and delivery [19]. It contains a tool that accepts an RDF/S-based ontology file and generates as output, which comprises of static course files, both interactive and non-interactive learning objects. This system contains a knowledge and courseware delivery

environment. It also offers free ontology navigation and allows the user to specify increasing degrees of constrained navigation based on the generated courseware lesson plans. It does not automatically generate the learning objects.

Table 2. Semantic Web Technology Stack

Technique	Description
XML	XML Schema language provides the basic syntactic interoperability for an ontology definition.
RDF	RDF schema introduces semantics and allows the definition of classes.
OWL	OWL is an ontology language that extends RDF combined with a reasoning tool, which provides logical facilities for reasoning and inference.

14) Personalized E-Learning Scenario

This scenario is based on aggregate usage profiles and a domain ontology. This process also includes offline tasks, such as data preparation, ontology creation and usage mining [20]. The online tasks considers about the production of recommendations. It manages the content related to a given course or lesson. This framework distinguishes between the offline tasks and online personalization components. This approach doesn't add new recommendations in the initial recommendation set and only reorders and exclude items according to the thresholds. This approach does not provide the best results.

15) Karlsruhe Ontology and Semantic Web Framework (KAON)

This framework offers abstractions for ontologies and text corpora, an ontology editor and application framework, inferencing and persistence mechanisms [21]. The KAON ontologies are also called as OI models (ontology-instance-models). It comprises of concepts, properties relating concepts, instances and property instances, which refers to the entities. The features of KAON ontologies are

- OIModel inclusion mechanism- This model can be nested, which means an outer model refers to any entity in another model. This facilities modularization of modeling tasks as well as ontology reuse.
- Lexical layer- this layer models multilingual labels, word stems, and documentation of entities.

The KAON cannot able to handle large numbers in cardinality statements. It depends not only on the used numbers, but also on other ontology axioms.

16) Open Source E-Learning Taxonomy (OSEL)

This is used to classify the learning object that can be used in LCMS platforms and can be re-used [22]. It is useful in the organization of a heterogenous repository of LO. The fitting of the repository is made by external and extemporary contributions via web form. It is necessary that the compilation of the web form is made by the owner of the rights on the use and the distribution of LO. The OSEL taxonomy classifies the LO through an ontological definition related to their domain of competence and through the relationship that eventually exist among the learners without delegating subjective opinions to the

author. It classifies in a standardized way in order to eliminate any ambiguity. There occurs crisis due to the inevitable integration of the learning content.

17) Semantics of Learning Objects based on folksonomies (SOAF)

This model combines the automatic techniques of information retrieval with collaborative tagging of documents made by users [23]. It uses a folksonomy based technique to capture the users annontation, testimonies of real learning experiences with a concrete learning resource. It uses Natural Language Processing technique, which implies that the documents are classified using interpretable concepts. These automatic methods for semantic indexing do not gurantee the reliability of the extracted concepts. This algorithm usually introduces the errors in the final information. It does not gurantee the reliability of the extracted learning concepts and produces errors.

III. RESULTS AND DISCUSSION

Various techniques for semantic E-Learning framework are depicted. The results of the survey are shown in Table 3. The heterogenous based semantic E-Learning framework improves the processing of complex query data. From the survey, it is proved that the Heterogeneous based semantic framework provides better results than the single domain E-learning framework. Heterogenous based E-learning framework, efficiently handles and acquires all kinds of heterogeneous web-data contents and complex data query processing. The complex queries include the processing of data operators in order to give the effective semantic data retrieval of E-learning contents.

TABLE 3 HETEROGENEOUS BASED E-LEARNING SYSTEM VS SINGLE DOMAIN ONTOLOGY BASED FRAMEWORK

Authors	Year and Reference	Technique	Performance
Huang, et al	2006 [2]	Context-aware semantic E-learning approach	It integrates Context-aware semantic e-learning approach to content provision, learning process.
Abbas, et al	2005 [4]	Semantic Grid based E-Learning Framework	It identifies the key-enablers for a realistic E-learning infrastructure. It manages the workflow of the E-learning system in a secured manner.
Mendes, et al	2003 [5]	Knowledge-based Content navigation	It enables personalized access to hyper-linked information and discovers the adaptive knowledge.
Lau, et al	2009 [7]	Fuzzy Domain Ontology Extraction	It automatically constructs concept maps based on the messages posted to an online discussion board.
Zhuhadar, et al	2009 [9]	Multi-model based ontology	It consists of a hybrid recommender system to measure the effectiveness of re-ranking based on the learner semantic profile.
Verbert and Duval	2008 [10]	Abstract Learning Object Content Model (ALOCoM)	It defines the different granularity levels that are present in current content models and their interrelationships.
Snae and Brueckner	2007 [12]	Ontology-Driven E-learning system (O-DEST)	It enables the students to master the learning material and meet the learning goals of the course.
Gracia and Jorge	2006 [14]	Sharable Content Object Reference Model (SCORM)	It allows the instructors to set up a benchmark test for evaluating an E-Learning platforms.
Jovanovic, et al	2007 [17]	Learning Object Context (LOCO)	It is a collection of metadata and promotes the integration and reuse of learning objects.
Brusilovsky, et al	2005 [18]	Advanced Distributed Architecture for Personalized Teaching and Training (ADAPT^2)	It employs a higher level mechanism for ontology-based interoperability of self contained E-Learning framework.
Holohan, et al	2005 [19]	ontAWare system	It is a tool that accepts as input an RDF/S-based ontology file and generates as output.
Markellou, et al	2005 [20]	Personalized E-Learning scenario	It integrates the semantic web vision by using ontologies in order to provide better service for the learners.
Tane, et al	2004 [21]	Karlsruhe Ontology and Semantic Web Framework (KAON)	It offers abstraction for ontologies and allows both the browsing and the querying of the resources available.
Convertini, et al	2006 [22]	Open Source E-Learning Taxonomy (OSEL)	It classifies the learning objects through an ontological definition and eliminates ambiguity.
Cernea, et al	2008 [23]	Semantics of Learning Objects based on folksonomies (SOAF) model	It classifies the learning objects in a repository by combining the emergent semantics with the users
Garrido and Morales	2014 [24]	Content personalization in E-learning	It extracts metadata information from the E-Learning contents and form a reusable learning objects.
Zouaq and Nkambou	2008 [25]	Domain ontologies	It is a semiautomatic framework,which produces a domain concept maps from text and reduces the gap between e-learning and intelligent tutoring systems.
Qwaider	2012 [26]	Semantic Web Portal concept	It is used in blended E-learning to describe the formal organization of universities and training courses to identify services.
Khribi, et al	2008 [27]	Automatic personalization approach	It provides an online automatic recommendation for active learners without requiring the explicit feedback.

IV. CONCLUSION AND FUTURE WORK

In this paper, an overview of Semantic ontology based E-Learning framework is presented. From the survey, it is proven that Heterogenous based E-learning framework efficiently handles and acquires all kinds of web contents and complex query data processing. It also includes the processing of the complex query data processing in heterogenous E-learning framework. The heterogeneous E-learning framework incorporates content from various domains.

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