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An Intelligent Learning Management System using Ontology

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***Abstract*: Ontology and Semantic is considered to the next generation of web that benefits many different fields like bio-informatics, Data transformation & integrations. Considering this, the E-learning plays a vital role in Learning Management System (LMS), which includes the modules like content development, assessment, feedback, course management and etc. The web application is developed with various LMS features integrated with Semantic Web. Typically, the application runs on Google Cloud Platform which is being served to all users anytime to access. This application is incorporated with semantic web to provide the LMS to the users that works mainly on the principle of extracting the knowledge from the user interaction via the assessments and analyze their behavior / actions on the level of the particular course content and translate them in to semantics which are represented as Ontologies. An intelligent workflow and learning plan for the user is derived and recommended to the user/ learner based upon the learner's performance on the previous assessments.**

Keywords : Semantic Web, Ontology, Learning Management System, Google Cloud

I. INTRODUCTION

Learning is the process of acquiring new/ enhancing the existing knowledge from different sources [1]. To teach and learn traditional or electronic methods are used by the faculty and students. The traditional teaching and learning process uses the teacher-centric way, where the teacher teaches the information and the student receives the information in the classroom. The electronic way of teaching and learning process uses the electronic devices, web technologies, and internet to teach and learn the content. Nowadays, the traditional teaching and learning process is replaced by the modern electronic teaching and learning.

There are many modern e-learning systems namely; Moodle, Dokeos, Ilias, Atutor, OpenOLAT Eliademy and etc. are used in many universities and colleges around the world. These systems allow the teachers/learners to provide/access the learning material from anywhere and anytime. Also helps the teacher/learner to organize the learning content in centralized location and reduces the learning content development time/cost. All these systems are lack to provide sophisticated features based on semantic web with ontologies.

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Semantic web was hosted by the father of the web "Tim Berners-Lee". It is the novel web technology that provides the services and information's to be understandable, processable and reusable both by the humans and machines [2]. The backbone of the semantic web is "Ontology". Ontology is defined as an explicit formal specification of shared conceptualization.

This article presents the features of semantic based LMS (SBLMS) application. The SBLMS was developed with semantic web and ontology to solve the issues of existing system. The application is hosted in Google cloud platform to provide high scalability, flexibility, high data storage and high security.

Further, the structure of the paper is as follows: Section 2; presents the related research work carried in the semantic learning management system. Section 3; elaborates the proposed SLMS framework. Section 4; deals with the features of SBLMS. Section 5; presents an algorithm for dynamic ontology creation for learning content. Finally, Section 6; proposes the conclusion.

II. RELATED WORKS

The individual learner desires are supports with a widespread approach "Courseware Watchdog" [3]. This approach fulfills the needs of the learners/faculty and helps the faculty to combine the learning resources based on their semantics.
Semantic based theoretical e-learning architecture was proposed with three different layers such as: Interface Layer, Service Layer and Knowledge Base Layer [4]. This architecture provides the common e-learning platform for the different users such as: learners, faculty and administrators.
A standard and accessible context –aware semantic learning framework was proposed [5]. The framework integrates the learning process and learning content in semantic e-learning pedagogy.
An ontological framework was proposed to integrate the learning objects [6]. The framework helps the learner to analyze learning content from the semantic annotations.
An ontology based e-learning system was prepared for the learners of Indonesia with the features Online Assignment, Online Assessment, Course Management and Expert Management [7].
The semantic web technology and ontology were used in Moodle e-learning platform to assess the knowledge level of the learners through online quiz and also provides the learning content [8].
User oriented ontology based Moodle architecture also proposed to enhance the Moodle platform as semantic Moodle platform.

A framework for ontology based E-learning Management system was proposed [9]. The heart of the framework was instances of web services, Resource Description Framework (RDF), Web Ontology Language (OWL), Extensible Markup Language (XML) and Learning Object Model (LOM). The framework helps to improve the efficiency and learner centric services of the learning applications.

The LMS was developed with two ontologies namely, Domain and Task ontologies [10]. The Domain ontology facilitates the learning content to the learners and the task ontology describes the functionalities of the system. With domain and task ontology the VARK learning model was used to personalize the data in the system. VARK learning model determines the style and preferences of the learning.

A standard SLMS framework is proposed with different web technologies. The framework is used to develop the SBLMS application. The application provides rich feature set and the cloud storage is used to store/retrieve the learning contents.

III. Framework for Semantic Learning Management System

The framework for Semantic Learning Management System (SLMS) contains seven different layers, which are depicted in figure 2. The User Management layer describes the different roles of user accesses the application. The access layer denotes the various access privileges for each user. The different web technologies such as HTML5, CSS3, Java Script and JQuery are used in Graphical User Interface (GUI) development of SLMS. UI service layer provides the various LMS features according to the user role. Ontology model is developed dynamically and which was represented in OWL/RDF format. The services of the application are offered to the users either by navigation/SPARQL query/ annotation. The seventh layer indicates the data storage by using Google Cloud platform.

IV. Features of SBLMS Application

The SLMS framework was used to develop the SBLMS application with set of features.

Course Management

The course management is handled by admin and super admin in order to add the new courses /theme to the SLMS tool and map the experts pertaining to the particular topic / course. The course management is integrated with Semantic web on the background, which is stored on the Google memcache and pushed to the blob store. Memcache is used for temporary storage on Cloud. The Blobstore API permits the application to store greater size of objects in the data store. Normally, the blobs are used to store the large files such as, image, audio, video and allow the user to upload greater data files.

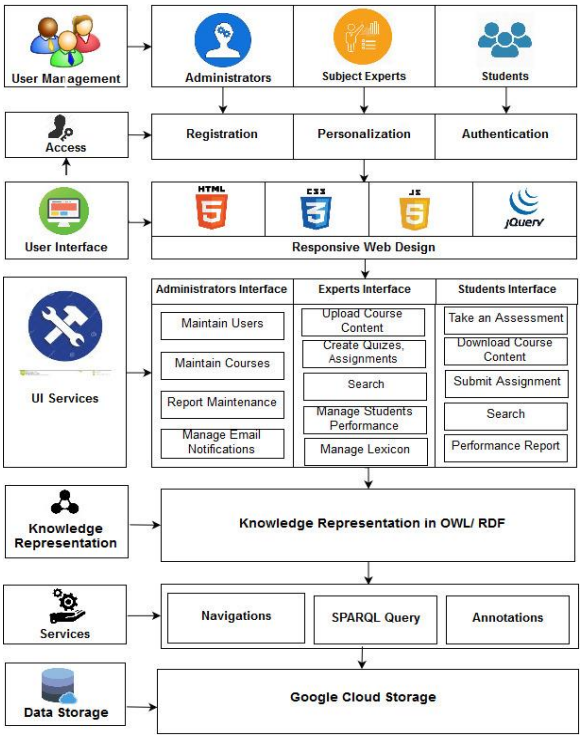

Figure 1: SLMS Framework

Ontology Model

The dynamic ontology model is created, once the course is created by the admin. The model is further incremented with its sub- classes based on the experts/mapping + Content Management + Questionnaire Creation + Assessment Creation + Assignment Submission. The sample developed Ontology Model is represented in figure 2.

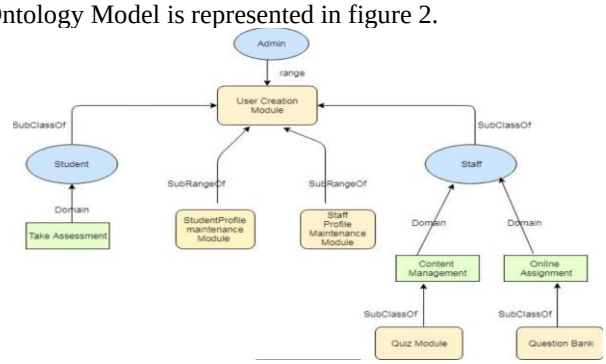

Figure 2: Sample developed Ontology Model

The ontology is integrated with this SBLMS application on top of JENA API that helps to create a dynamic ontology model. An ontology model provides additional capabilities to handle the ontologies. An ontology model is an enhancement of Jena RDF model. Ontology models are formed through the Jena ModelFactory. OntModel m = ModelFactory.createOntologyModel();

Once the course is created by the admin, an ontology subclass under the domain - > content management is created and waits on the memcache for the expert to fill the content on the questionnaire.

Online Assessment

The questionnaire is an extended subclass of content management -> course management where the key is pulled from the memcache if the session is enabled. If the session is not enabled, the key is pulled from blobstore.

Questionnaire is mapped with Experts of the particular course. The parameters are given as input namely, Duration, Threshold, Expertname, QuestionnaireName and Template Type. Duration deals with the total duration of the questionnaire. Threshold is depends on the complexity level of the questionnaire. Expert Name is the name of expert who is mapped with the Course. QuestionnaireName is an auto generated name of the questionnaire. Template Type is the subclass of Content Management.

Each time the ontology is dynamically extended as the workflow extended. This is handled by ontology document manager. Every ontology model has a connected *document manager* which contributes with the handling and processing of ontology documents, for suitability, there is one global document manager which is used by default by ontology models. The reference to this shared instance through OntDocumentManager.getInstance(). In many cases, it will be sufficient to simply change the settings on the global document manager based on the application criteria. However, for more fine-grain control, a separate document managers can be created and pass them to the ontology model when it is created through the model factory.

Once the questionnaire is created by the admin and submitted, the ontology model is created and waits for the content to be added to the course. An email notification is triggered to the Expert, where the role of the expert begins.

All the courses pertaining to the questionnaire is pulled via the Semantic Search and based on the keywords a spreadsheet template is provided to the expert to fill the content.

Step 1: The Expert fills the Questionnaire
Step 2: Setting threshold for the particular questionnaire
Step 3: Add Candidates to the Questionnaire
Step 4: Add course materials in ZIP, PDF and Txt file formats related to the questionnaire
Step 5: Submit for Admin Approval.

The ontology model is not created till the questionnaire is approved by the admin. Once the admin validates the questionnaire and the course, the ontology model is extended with the previous subclass.

The Assessment is again set to Admin. Once the questionnaire is validated, the conceptual map is created between the classes and subClasses of, Course and Questionnaire. Then the ontology map is extended with the assessment, where the admin roll out the assessment with the validated questionnaire associated with all the course ontology. The search appliance is initiated here to pull all the validated questionnaires matching with the particular courses.

Once the assessment is set by the admin, the user / students are sent an email notification to attend the assessment in the stipulated time period. The content to the assessment is pulled from the course ontology from blobstore.
The candidate is given permission to attend the assessment any time between the assessment times. All the answers for all questions are recorded dynamically.

Semantic based Reschedule

The semantic based rescheduling principles are proposed and used in the SBLMS application. The recommendation is set via mail to the particular candidate along with the course expert who created the course.

This is achieved via the ontology mapping between the topic and the answers which the candidate fails to answer on the assessment.
The rescheduling works on two principles.

1. It checks whether the candidate has taken the exam on the assessment period, if not, it simply reschedule the assessment only to that candidate after 2 days.
2. If the candidate has taken the exam and if the particular threshold is not met to pass the assessment, the proposed algorithm pull all the topics related to the failed answers and create the content with the maximum possibilities to improve the performance of the candidate in those weak topics/courses. Once the content is prepared, the recommendation is sent via mail to the admin and candidate to improvise the expertise on the weak areas and the rescheduling of that assessment is done based on the approval of course expert.

Semantic Search

The semantic search provides the search results semantically to user by using the Search API. The Search API delivers an exemplary for search documents. The API provisions complete text matching on the input string fields. Both the documents and search results are stored in separate tenacious store, which optimizes the search operations. Any number of documents can be searched through Search API. The App Engine Datastore may be more appropriate for applications that need to retrieve very large result sets. The Search API is processed based on four main concepts: documents, indexes, queries, and results.

Online Assignment

The expert of the particular course/theme delivers the assignment details to the learners. The learners are uploading their assignments in .txt/.doc/.pdf file format in the stipulated time period. Each time the ontology is dynamically extended as the workflow extended.

Search results

The search( ) method returns a inadequate number of matching documents. Every search discovers more documents in a single call to the search( ). Each and every call returns a search results that stored as instances of SearchResult class. The SearchResult class encompasses the evidence about how many number of documents were found as search result, how many number of documents were returned as search result. The same search can be repeated, using offsets or cursors to retrieve the full set of matching documents.

Fault Tolerance

Fault tolerance is provided in application, to make the users can continue the assessment/assignment/download the learning materials from the point they left due to network /computer/power issue.

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Data Analysis & Statistics for Online Assessment

The data analysis and statistics is performed for each individual via the content stored dynamically based on their answers and is represented in the figure 3 and 4. This operation is performed dynamically, whenever the candidate starts taking the assessment.

Figure 3: Assessment report of individual learner

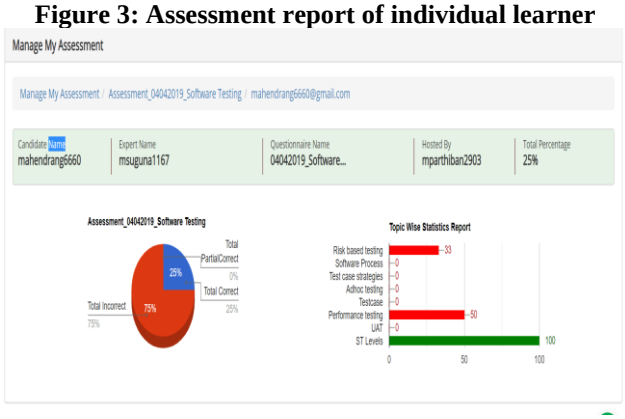

Figure 4: Statistical assessment report of individual.

V. ALGORITHM FOR DYNAMIC ONTOLOGY CREATION

An algorithm is proposed to prepare the dynamic ontology creation for learning content.

Step 1: Call setOntologyModel() on buffer string "{$currentOntologyModel$}"

Step 2: {$ $} sequence is found and currentOntologyModel becomes Current sequence Element

Step 3: Fetch the XSL for currentOntologyModel and execute using JenaAPI, currentOntologyModel is transformed to be {$variable_y$} = {$zero$}

Step 4: Set {$variable_y$} = {$zero$} to be a temporary buffer String, Call extendSubClass(temp buffer String) on temp buffer String in Google memcache.

Step 5: Once the variable is set, repeat step 3 and 4 for subelement.

Step 6: {$ $} pattern is found, and variable_y becomes first Sub Element need to be transformed

Step 7: Fetch the matching XSL for variable_y and execute it with JenaAPI, variable_y is now converted / transformed to be $variable_y

Step 8: Replace {$variable_y$} with $variable_y in the temporary buffer string and temporary buffer string becomes $variable_y = {$zero$}

Step 9: Recursively call extendSubClass(temporary buffer String) on temp buffer string till it is cleared.

Step 10: Repeat the previous same steps from 6) to 8), temporary buffer string becomes $variable_y = zero;

Step 11: Since there is no {$ $} pattern exists in the bufferString, extendSubClass() recursion is completed, temporary buffer string is sent back to convertCode() method and replace {$ currentOntologyModel $} with $variable_y = zero; now buffer string is $variable_y = zero;

Step 12: Now the currentOntologyModel property "NextElement" has the current value as "previousOntologyModel". Add previousOntologyModel to the end of buffer String. Buffer String become $variable_y = zero; {$ previousOntologyModel $}

Step 13: Call convertCode (bufferString) on the converted new bufferString on which the new buffer string now is $variable_y = zero; {$ previousOntologyModel $}

Step 14: previousOntologyModel is converted the new Ontology Current Object Element and successively the recursive parsing initiates again.

VI. CONCLUSION

The SBLMS application was developed and hosted in the URL: https://semantic-web-portal.appspot.com/ which is available for 24/7. This application is highly scalable and provides the high security, high performance, high data storage and automatic load balancing based on the network traffic. The application provides the learning content to be understandable/ processable/ reusable both by humans and machines.

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Poovizhi Magendiran completed her Master of Computer Applications and Master of Philosophy in Computer Science from Sacred Heart College (Autonomous), Tirupattur. Currently she is working as Assistant Professor in the Department of Computer Science and pursuing her Ph.d degree in Sacred Heart College. She is having 8 years of Teaching experience and 4 years of Research experience. She has published seven research papers in National, International journals and Conference proceedings. She has presented three research papers in National and International conferences. Her research areas include Knowledge Engineering and Ontological Engineering.

Ravi Lourdusamy received his Ph.D from Bharathidasan University, Tamil Nadu, India in 2012. Currently he is HOD and Associate Professor in the Department of Computer Science, Sacred Heart College, Tirupattur, India. His research areas include Software Engineering, Ontology and Knowledge Engineering. He has presented and published over 20 papers in international conferences and journals in these areas. He was awarded a couple of UGC funded projects. Currently he's guiding half a dozen research scholars.

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