AN APPROACH TOWARDS DYNAMIC ASSEMBLING OF LEARNING OBJECTS

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ABSTRACT

With the energetic growth of internet usage in today's world, every user spends their time in internet, hence to make users interested in learning the eLearning technology are widely used. eLearning aims at replacing old-fashioned pre-determined learning with on demand process of learning. The learning objects are used for eLearning process, which are used as a reusable component and it is interoperable to make the learning environment easy and makes education content made available in any format the user needs. To have an effective courseware presentation, the ontologies are used to provide learners with the correct learning content. The learning objects are stored in a repository. The main objective of this work is focused towards providing efficient learning environment by assembling the Learning Objects (LO) dynamically for a given user query supported by domain, and pedagogy ontology to generate courseware. In this work granularity computation is applied to assemble the learning objects.

Keywords

Ontology, Pedagogy, eLearning, Learning Objects (LO), Learning Object Metadata (LOM), Learning Object Repository (LOR), Granularity.

1. INTRODUCTION

eLearning provides effective, task relevant and just-in-time learning for the new, dynamically changing, distributed business world [8]. The use of network technologies for learning contents facilitates learning anytime and anywhere and it also acts as a force for people and organizations to have competitive edge of the rapidly changing global economy.

Adoption of learning object has created a paradigm shift in web education. In today's world, learning has become an unavoidable activity to satisfy modern day needs. The learning objects are collection of content items, practice items, and assessment items that are combined based on a single learning objective, that enable and facilitate the use of educational content online.

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The ontology defined as specifications of the conceptualization and corresponding vocabulary used to describe a domain. They are well-suited for describing heterogeneous, distributed and semi structured information sources that can be found on the Web. For eLearning we need to have ontology for semantics description, some of the ontologies, available are Domain ontology or concept based ontology, Pedagogy ontology or context based ontology.

2. MOTIVATION

This work is focused towards creation of customized environment for the user to learn. The approach of considering the pedagogical characters for LO generation provides personalized service to the learners. Learning objects resides in Learning object repository, to extract the content from repository and management of LOR are needed for creating courseware generation.

3. RELATED WORKS

Some of the related works and its limitation are as follows. For assembling here in this work we are adopting blooms taxonomy for pedagogy level identification.

The IEEE (2002) defines Learning objects as "any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning." Rory McGreal [1] in Learning Objects and metadata explains Learning objects (LOs) enable and facilitates the use of educational content online. Internationally accepted specifications and standards make them interoperable and reusable by different applications and in diverse learning environments. In a work by Alfredo Zapata, et.al [2] describes the Learning Objects Usability Characteristics and the metadata in detail. They described some characteristic for learning objects, as they are Self-contained, Interoperable, Reusable for different contexts, Durable and upgradeable over time, Easy access and management, Sequence with other objects in the same learning environment, Concise and synthesized.

Ljiljana Stojanovic, et.al [4] describes about ontology and their different usages in eLearning environment. Some of the ontologies used for the eLearning purpose are domain, pedagogy and structured ontology. The formal definition for Ontology is defined as specifications of the conceptualization and corresponding vocabulary used to describe a domain (Gruber 1993). They are well-suited for describing heterogeneous, distributed and semi structured information sources that can be found on the Web. For eLearning we need to have ontology for semantics description, some of the ontologies, they available are Domain ontology or concept based ontology, Pedagogy ontology or context based ontology and Structured ontology or relation based ontology. The Domain ontology deals with the content or concept of a particular domain. We can distinguish with topic, sub-topic and child of a concept from ontology. The content description enables content-relevant searching for learning material according to the preferences of the user. Pedagogy ontology: Learning material can be presented in various learning or presentation contexts. We may e.g. distinguish learning contexts like an introduction, an analysis of a topic, or a discussion. The context description enables context-relevant searching for learning material according to the preferences of the user, egs. Introductions, illustration are the pedagogy terms.

The learning objects for this work are created using the work done by topic segmentation using hierarchical Latent Dirichlet Allocation (hLDA) for segmentation of eLearning material by k.Sathiyamurthy and T.V.Geetha [8]. In their work learning object were created from text segmentation consists of a topic in the domain ontology and also has specific pedagogical role. A work by Filip Neven, et.al [9] surveyed many Learning object metadata (LOM) - Based Repositories, A LOM repository or Learning Object Repository stores both Learning objects and their metadata, either by storing them physically together or by presenting a combined repository to the outside world, while the metadata or Learning objects actually stored separately. The metadata scheme a Learning Object Repository uses is based on the IEEE LOM standard, some of the different Learning objects repositories were analyzed, some of them were, ARIADNE is a Learning Object Repository consists of a hierarchical network of replicating nodes, where metadata of all objects are replicated, as well as the free Learning object's. SMETE supports searching and browsing resources in the domains of Science, Mathematics, Engineering and Technology. MERLOT covers all disciplines. Besides the MERLOT-Central Learning Object Repository, this provides access to the entire collection, a number of discipline specific websites offer modifications of the central functionality and interfaces to meet the requirements of specific disciplines. CAREO is a Learning Object Repository that holds links to Learning objects, as well as some Learning objects themselves. A personal profile gives access to a workspace with bookmarks. Users can access a history of objects they have downloaded. Due to the increasing use of information, there is a need to create new learning resources, to manage existing learning resources, and to aggregate learning content from a wide variety.

Before, assembling the learning objects from the repository are to be extracted, managed for duplication avoidance and granularity of the learning objects are to be managed. In a work by Aleksander Bułkowski et.al [11] proposes a searching and indexing mechanism for retrieval of data from learning object repository, using some design condition such as, Support wide and easy distribution of learning objects. Extend existing P2P applications for sharing, searching, and downloading learning objects. They changed the traditional hierarchical teaching model into a flat one in which anybody can teach anybody. Ankush Mittal et.al [13] gave information about the theory for building relational graph that depicts how concepts are linked to each other. By selecting to zoom on a particular concept, in addition to that to have efficient searching for desired topic, the system also enhances the understanding and the learning of the user.

The learning object management consists of two different steps such as duplication avoidance and granularity computation phases. In Short Text Classification Improved by Learning Multi-Granularity Topics by Mengen Chen et.al [14] proposed a model which precisely shorten the content of the learning documents they classified the document with multi-granular topic set, here they used LDA model to find the domain level of the content by segmenting it into smaller item sets they followed sequence of steps illustrated in multi-granularity framework they followed these steps, 1. Given a set of numbers empirically denoted by N, with the size |N|, we run LDA over the universal dataset to generate the topics with respect to each item in N. As a result, we obtain |N| different sets of topics. 2. Choose a subset of all the generated topics T automatically to form the topic space of multiple granularities. 3. Combine topic feature, obtained from multi-granularity topic space, with word feature to form new text feature, based on which we build classifiers.

A work by Sonal Jain and Dr. Jyoti Pareek [15] proposed the steps for granulating the learning document using the domain ontology, the definition for granularity they gave are Granularity as a general term is defined as the extent to which either a system itself or its description or observation is broken down into small parts. For this they used IEEE Learning Object Metadata (LOM), They proposed an automatic extraction of granularity level of a document, using the Aggregation level, Granularity level in simpler terms can be defined as "Number of topics/subtopics with enough intensity discussed in a learning material". The value of topic intensity will lie between 0 and 1. Higher topic intensity shows that substantial amount of concept under a certain topic/subtopic are exposed in a learning material.

4. PROPOSED WORK

The proposed work is designed to assemble the Learning object according the user query. The proposed system are designed using modules such as LO Repository analysis with LO Metadata (LOM), Learning Object Extraction, Learning Object Management, and assembling of Learning objects.

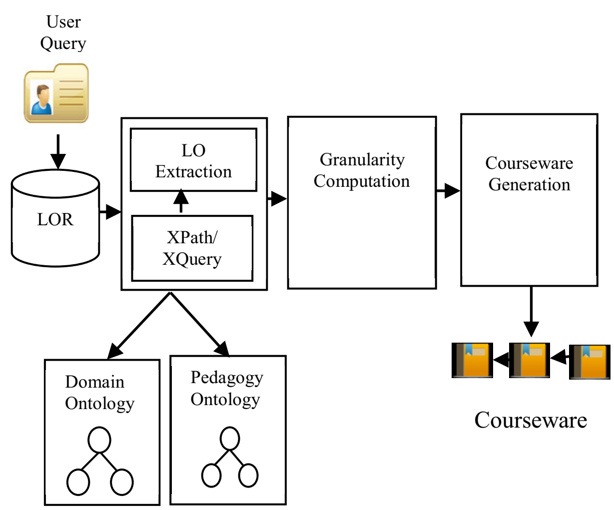

Figure 1: System Diagram for Proposed System

In this work learning object repository is created for computer science domain for the concepts in ACM ontology based on the work done by K..Sathiyamurthy and T.V.Geetha[8]. The Learning objects repository is the repository, where the LO are stored, from which the required Learning object will be retrieved. Each and every learning object will have a metadata of their own consisting of technical information about the LO.

4.1 Bloom's Taxonomy

Bloom's Taxonomy is a classification of learning objectives within education proposed in 1956 by a committee of educators chaired by Benjamin Bloom who also edited the first volume of the standard text, Taxonomy of educational objectives: the classification of educational goals. It refers to a classification of the different objectives that educators set for students (learning objectives). Bloom's Taxonomy divides educational objectives into three "domains": Cognitive, Affective, and Psychomotor.

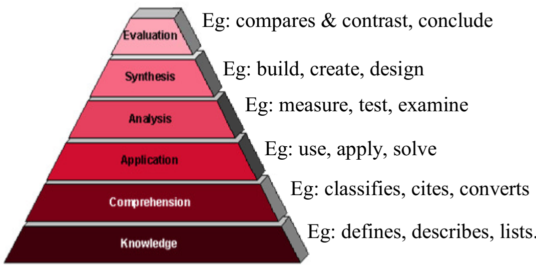

Figure 2 Bloom's Taxonomy

The cognitive domain consist of 6 phases in the taxonomy, such as knowledge level, defines the basic pedagogy level, some of the queries that can be got from knowledge level are defines, describes, list outs. Second level in the taxonomy is the comprehensive level denotes the classifies, cites, converts level of questions. Application level describes the use, apply and solution type of queries. Next level is analysis level denotes and measure, test and examine type of queries. The next stage in the blooms level is the synthesis level, gives the queries about design, create procedure, evaluation level gives the compare and contrast level of queries. If a person needs to master a particular domain, then he/she should move from first level knowledge level through the evaluation level of the taxonomy. In this proposed work, the blooms taxonomy has been adopted for composition of learning objects according to the pedagogy level of the learners was identified. In this phase knowledge level and comprehensive levels were implemented and its context terms were identified.

4.2 Learning Object Repository

Many LO collectively called as Learning object repository. The LO are created from a document, using hierarchical LDA mechanism [8], for each learning object generated there would be a LOM. The LOM is called Learning Object metadata, which contains the data about the Learning object. The standard given by IEEE committee for Learning object metadata as IEEE 1484.12.1-2002.

The IEEE **Learning Object Metadata** (LOM) standard specifies the syntax and semantics of Learning Object, learning object Metadata, defined as the attributes required to fully/adequately describing a Learning Object.

There are 6 main sections in LOM

1. General category
2. Lifecycle category
3. Meta metadata category
4. Technical category
5. Educational category
6. Classification category


```
- <General>
    <uniqueIdentifier id="1323052858229" />
  </General>
- <LifeCycle>
    <Date dt="07/10/2011" />
  </LifeCycle>
- <MetadataCategory>
    <Identifier id="1323052858229" />
  </MetadataCategory>
- <TechnicalCategory>
    <Format fmt="text" />
    <Size sz="94" />
    <Location loc="C:\LO" />
  </TechnicalCategory>
- <EducationalCategory>
    <LearningResourceType typ="illustration" />
    <GradeLevel lev="null" />
  </EducationalCategory>
- <ClassificationCategory>
    <Topic top="Data_Structure" />
  </ClassificationCategory>
```


Figure 3 Samples LO Metadata

The fig shows a sample learning object metadata. In which the general category gives the unique identifier of the learning object eg. uniqueIdentifier id="1323052858229". The Lifecycle category gives the date at which the LO was generated e.g. Date dt="07/10/2011". The Meta metadata category gives the identifier of the metadata e.g. Identifier id="1323052858229". The Technical category gives the format from which it got created; size and location were its got created e.g. Format fmt="text" and Size sz="94". The Educational category gives the Learning Resource type such as, the type to which LO belongs, example: Intro, Illustration, Explanation, References, Summary, etc. The Classification category gives the domain to which the LO belongs, such as Networks, data structure, software engineering, etc.

From the learning object repository, searching of the content is done with the user's query. Searching of learning objects have done with the LOM, using the query. From the query the keyword and pedagogy will be extracted, and for that the probabilistic value are to be calculated using the fuzzy repeat (μr) formula as,

$$\mu_r = \frac{\text{Number of keyword in the selected domain}}{\text{total number of keyword available in the selected domain}}$$

using this value the domain will be given preference, if the repeat μr value is high, then the domain will be taken and given primary priority, after that the topic in different domain will be matched and then appropriate learning objects will be retrieved. After searching the repository the learning object will be extracted and some of the management activities have to be performed.

4.3 Learning Object Extraction

From Learning Object Repository according to the user query, the user needed LO are to be searched and retrieved from the Repository, using the XPath [23] and XQuery operations, as the learning objects are in XML formats. The XPath is also called XML Path Language. XPath, the XML Path Language, is a query language for selecting nodes from an XML document. In addition, XPath may be used to compute values (e.g., strings, numbers, or Boolean values) from the content of an XML document. XPath was defined by the World Wide Web Consortium (W3C). By using the XPath language all the queries provided by the user, are searched with domain and pedagogy level in the LOM repository. Then corresponding unique identifier will be retrieved. Then it is matched with the repository and the corresponding learning objects will be retrieved. The learning objects were extracted using the

Educational category and classification category. After retrieving them the content has to check for the similarity.

4.4 Management of Learning Object

The duplication avoidance step is used to remove the similar content if anything retrieved from the LOR. To avoid duplication the similarity of the different content will be checked. Each learning object is a small segment of text from different sources. The similarity calculation will be done as a learning object as a whole text and also it will be checked for the sub string of the learning object.

$$\text{Similarity measure} = \sum_{i=1}^{n} (a_i \cap b_i)$$

Where, a_i and b_i ,denotes the learning objects, the learning objects will be considered as a whole string, hence the values will be compared for the substring availability, if the substring is available in the learning object then the similar value which reflects in the another string will be eliminated. If the similarity calculation value is high, then the learning content will be ignored, if not both the contents will be kept for user presentation.

The granularity were calculated with the log likelihood of the extracted content, and it can also calculated using the length of the extracted content, by calculating number of strings in the content, if it exceeds threshold value, then the content will be broke down into smaller pieces, without affecting the meaning of the learning object extracted, Another approach for the identifying the granularity, is by using the LDA model to find log likelihood values for each content and also the value with two or more content merged. The methods to make granularity calculation are: The distance of each domain concept of LO is calculated using ACM domain ontology. The distance of the topic is calculated using $d(T_i)$ is updated by

$$d(T_i) = d(x(T_i), nn(x)T_i) - d(x(T_i), hn(x)T_i)$$

Where xT_i is the topic distribution of x over T_i, inferred by Gibbs sampling in LDA, $nn(x)T_i$ denotes the neighbor domain and $hn(x)T_i$ denotes the topic set of home domain. The distance between the domains of the topic set will be calculated, if it found to be smaller in size, the algorithm for granularity computation using distance metrics is given below:

```
Algorithm: Granularity computation algorithm.
Input: Extracted Learning objects from Learning object repository
Output: Granulated Learning objects
if((content(likelihood)||(content(strength ))is high)
{//granular the content with distance calculation
 d(Ti)= ∑_{i=1}^{n} (d(X(Ti), nn(Ti) − d(x(TTi), hn(Ti)));
     if (d (Ti) is low)
     {granular the string by taking its substring with neighbor domain;
     check for number of string in the content,
if (string length is above threshold )
{    cnt_nw=cnt.split (cnt, threshold_value);
}}else
{ //Granular the content with substring;
cnt_nw=cnt.split (cnt, threshold_value);
}}
```

In the above equation the n is the number of related neighbor content. Another approach to find granularity is by applying likelihood values for each of the extracted contents. The log likelihood value for each learning contents as single or through combination can be calculated, so that with a threshold likelihood value the content can be broke down, else it can composed from different learning content's. The Likelihood of content is found by using a model called Latent Dirichlet Allocation (LDA). Using this LDA model the content semantic density is found, if the density found to be too low, then it is merged with next or previous content, but not exceeding the threshold for the content strength. The content strength is found to be as maximum of 140 words per content.

4.6 Assembling Of Learning Objects

After the granularity calculation, the LO are assembled by adopting domain, pedagogy ontology for the given user query. Domain gives the content levels of the topics; the pedagogy gives the context classification of the topics. The assembling is done after all the steps illustrated above, each and every content will be a unique, and will be a readable to learn, the LO Management functionalities are very much useful in dynamic generation of courseware.

5. EXPERIMENTATION RESULT

To have an effective generation of courseware for the domain and Pedagogy, the Learning object were created and Learning object Repository are analyzed and the information about the number of LO were stored with context and with ACM ontological concepts of the documents is provided in table1. The LOR analysis values are to be as follows

Table1. The LOR analysis

	DS	DE	Gen Com Sc.	N/W	H/W
Intro	103	65	89	153	95
Illust	198	152	250	344	268
Defi	120	98	451	114	68
Conc	13	18	24	38	65
Appl	241	298	157	457	124
Ref.	32	39	34	85	15
Summ	89	65	65	68	38
Expl.	297	138	198	379	298

Here, we are using two user interfaces to give input and to generate the output. Through the input user interface the domain and context to be searched are received as input from the user, and the output will be a courseware consisting of assembled learning objects which can be extracted and given in any output formats. The input user interface and the output interface are provided in Figure 4 and Figure 7.

In figure 4, the input received from the learner consists of domain as Tree and pedagogy level as intermediate pedagogy level. Accordingly from LOR concepts related to Tree consisting of the pedagogical role with Intermediate pedagogy roles are searched, retrieved and assembled to generate the courseware.

Figure 4 User interface to get the input from user

The assembled learning objects are granulated using likelihood value got from the LDA approach. Figure 5, shows the graph with log likelihood values and number of learning content in the courseware. From the graph it is inferred as the log likelihood of the first learning content is -3.458, second learning content is 0, and that of the 14th content is of -8.674, which indicates that the content strength is so small.

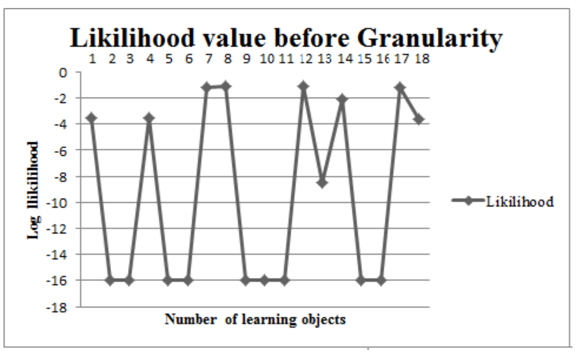

Figure 5 Log Likelihood value of content before Granularity

Figure 6, shows the log likelihood value after the process of granularity, as shown in figure 1, the log likelihood of the 14th content is so small, so that it is added with the next learning content and the log likelihood value is increased as -2.134, and the content strength is also increased, Here the threshold value to be set as -3.5000. So that the learning content is the courseware will be of a good content.

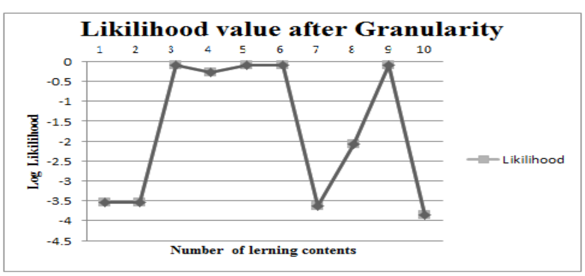

Figure 6 Log Likelihood value after Granularity

The output generated for the given user query after the learning object management functionalities is shown in figure below. The output shown below is for the domain term "Tree" and Pedagogy level as "Intermediate", which the covers the pedagogy terms such as illustration, summary levels.

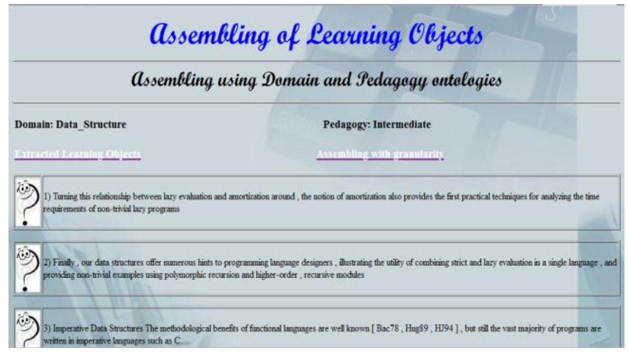

Figure 5 Assembled Learning object

To evaluate the system, a survey about learning object assembling and usage of learning objects were made from a group of students and lecturers based on the questioner for LO assembling proposed by Antonio Garrido and Eva Onaindia (2011). At the end of our survey the result obtained for different questioner is depicted in table 2.

Table.2. Evaluation of LO after assembling and LO usage

	Average	Above average	Fully Complete
Q1		7	8
Q2	2	4	9
Q3		4	11
Q4	5	3	7
Q5	7	8	
Q6		7	8
Q7		6	9
Q8	2	4	9
Q9	2	5	7
Q10	8	6	1
Q11		6	9

Q1. Is the sequence of Los consistent with objective?

Q2. Is the size of LO's appropriate?

Q3. Do you think the learning content adapted to the user input?

Q4. How much experience do you need to deal with LO's?

Q5. How much Background planning is necessary?

Q6. Do you consider this approach useful?

Q7. Would you recommend this approach to others?

Q8.Do you find eLearning as positive experience when compared to traditional teaching?

Q9. To which extent this work fit your needs and constraint's?

Q10. Would you suggest some changes to the structure?

Q11. Would you recommend this approach to your friends?

First 3 question are asked from a set of student about the content and quality of the LO's., next 4 question are about the LO usage in learning enquired with lecturers, and last 4 question deals with LO usage enquired with the students. From this evaluation it is inferred that the designed system performs better with the usage of domain and pedagogical ontology.

6. CONCLUSION AND FUTURE ENHANCEMENT

Assembling of learning object plays a vital role in generation of courseware suitable for the learners. In this work assembling of learning objects are carried using domain and pedagogy ontologies. The result of the proposed systems gives 86% for assembling of learning objects to the user needs. A method using LDA for granularity computation was done. The log likelihood values were very much effective to granularity the content. The Boringness of the courseware is eliminated using the duplication avoidance. By this dynamic courseware generation for domain and pedagogy the user can able to learn their interested domains deeper and efficiently.

In the future work structure ontology is need to be incorporated for assembling, so that the learners can be learn their interested domains with relation to sub topic relation and also with other domains. The performance of the learning object assembling for Structure ontology has to analyzed based on log likelihood value of the extracted learning contents. As the learning object repository size is big, mechanism such as indexing and ranking is to be incorporated, so that the search and retrieval time can be minimized.

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