ISSN:0975-9646

Ontology Based Development of Learning System

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***Abstract*— Learning Objects (LOs) presents an effective approach in the organization of the educational materials. Thus their usage is growing continuously in the field of digital learning systems. Additionally, using ontology for modeling and representation of knowledge is also gaining a firm ground. Through this work we propose to model the domain knowledge of the education course using ontology. This ontology is further used to relate with the Learning Object Ontology. The Learning Object Ontology is used to effectively manage and retrieve the Learning Objects. The proposed ontologies can be integrated into an e-learning system to manage the educational resources.**

***Keywords*— Ontology, OWL , Learning Objects, Domain Ontology.**

INTRODUCTION

Nowadays, Education and training in universities and companies widely use e-learning systems because of their electronic course content access and virtual classroom participation [1]. However, with the rapid increase of learning content on the Web, it becomes time-consuming for learners to find contents they really want to and need to study. Aiming at enhancing the efficiency and effectiveness of learning, we propose an approach based on domain ontology creation and learning ontology creation for the development of learning system. The domain ontology helps in mapping of the courses contents and creating a hierarchy of core concepts and learning object ontology helps in structuring of the course materials.

Through this project, an attempt is been made to create ontology for representing the knowledge of a learning course. The knowledge domain of data structures is opted as an initial course, given that the learning of data structures is the common requisite by all study programs in Informatics.

The purpose of such an effort is the subsequent utilization of the produced ontological model by e-learning applications and hence the creation of advanced services for both learners and tutors. Our particular aim is to help learners by giving them the opportunity to interact with the core concepts in the curse domain and thus becoming able to better understand and perceive knowledge regarding the field of computer science [2].

DOMAIN EXPLANATION

A. Ontology:

Ontology defines the terms used to describe and represent an area of knowledge [3]. Normally an ontology can be described as a 3-tuple:
O = (C, I, R)
Where,
C is a set of Classes,
I is a set of Instances,
R is a set in relations on the set of classes.

B. Learning Objects:

The main idea here is to decompose the educational content into smaller chunks and construct self-contained learning units

C. Domain Ontology:

Domain ontology refers to the course domain.
For the purpose of our project we have taken the domain of data structures as our course domain [4]

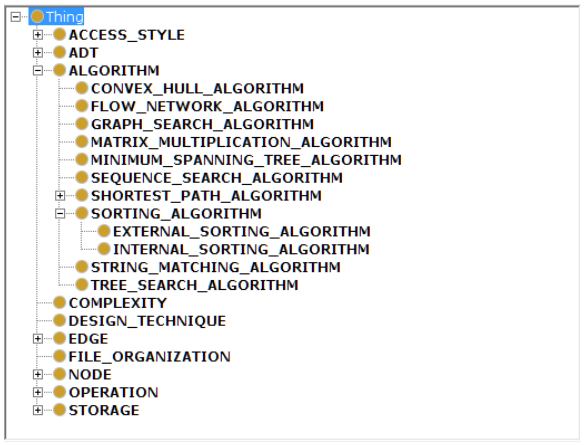

Fig 1. Example of Domain Ontology

D. Learning Object Ontology:

The Learning Object Ontology is used to organize the learning objects.The subject data property of the learning object ontology refers to the concepts in the domain ontology [5].

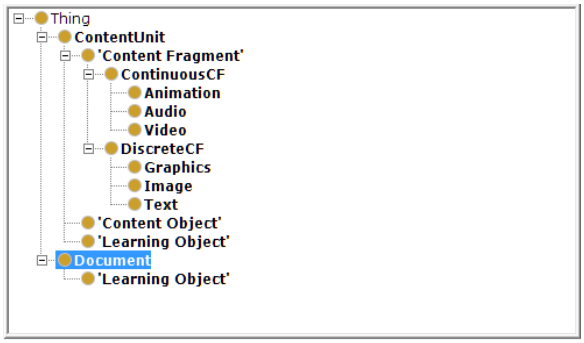

Fig 2. Example of Learning Object Ontology

ARCHITECTURE

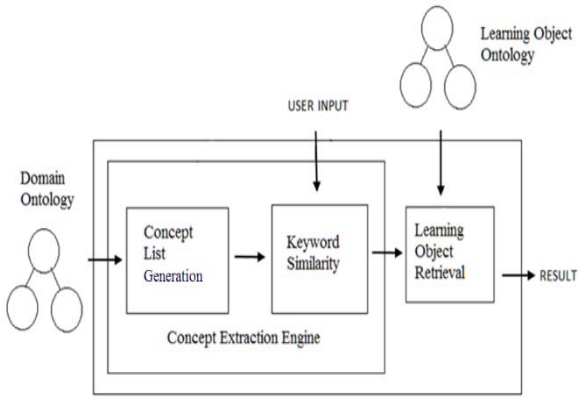

Fig 3. Proposed Architecture

1. The user enters the keyword, which is then feed to the concept extractor
2. The concept extractor retrieves the related concept from the domain ontology.
3. Domain ontology maintains the hierarchy of the concepts.
4. The retrieved concept are then mapped onto the Learning Object Ontology to get the Learning Objects. And the retrieved learning objects are then displayed as output to the user
5. The Domain Ontology and Learning Object Ontology both are constructed using protégé software.
6. Protégé is a free, open-source platform that provides a growing user community with a suite of tools to construct domain models and knowledge-based applications with ontologies.
7. For mapping, SPARQL query is used.
8. SPARQL is short for Simple Protocol and RDF Query Language, SPARQL defines a standard query language and data access protocol for use with the Resource Description Framework (RDF) data model. It works for any data source that can be mapped to RDF.
9. The learning object ontology stores the learning object which can be a presentation, text file, audio, video etc.

Stage 1: Concept Extraction Engine

1.1 Concept list Generation:

In Concept list all the concepts from the domain ontology are retrieved using the SPARQL query.

Concepts consist of all classes and sub-classes from the domain ontology.

1.2 Keyword Similarity:

We have employed a keyword similarity algorithm JVA to match the similarity between keyword and the retrieved domain concepts [6].

Algorithm Keyword_Similarity_JVA
{
Input : str1, str2
Output : similarity measure sjva where 0 < sjva < 1
p = JaccardSimilarity(str1,str2)
q = VectorSpaceSimilarity(str1,str2)
sjva = (p+q)/2
return sjva
}

1.2.1 Jaccard's algorithm:

Similarity measurement in Jaccard is decided on the basis of the ratio of intersecting words to all the word without repetition in the keyword and concept.

$$Jaccard = \frac{|A \cap B|}{|A \cup B|}$$

Jaccard's algorithm example:

User Keyword(K): Merge Sort Algorithm
Domain Ontology Concepts
-Concept 1 (C1) : Merge Sort
-Concept 2 (C2) : Insertion Sort

Jaccard(K,C1)=J1=2/3=0.66
K intersection C1 =2 & K union C1 = 3

Jaccard(K,C2)=J2=1/4=0.25
K intersection C2 =1 & K union C2 = 4

1.2.2 Vector Space Algorithm:

Similarity measurement in Vectorspace is decided on the basis of the concept vector and the keyword vector.

$$Vectorspace = \left(\frac{V_A}{len(A)}\right).\left(\frac{V_B}{len(B)}\right)$$

Vector Space Example

Keyword: Merge Sort Algorithm
Domain Ontology Concepts
-Concept 1 (C1) : Merge Sort
-Concept 2 (C2) : Insertion Sort

Words	Words in K	Words in C1
Merge	1	1
Algorithm	1	0
Sort	1	1

Fig 4. Table for C1

Vectors: a : [1,1,1] b : [1,0,1]
Vectorspace(V1)=(1*1+1*0+1*1) / [sqrt(3)*sqrt(2)]
Vectorspace(V1)=0.82

Words	Words in K	Words in C1
Merge	1	0
Algorithm	1	0
Insertion	0	1
Sort	1	1

Fig 5. Table for C2

Vectors: a : [1,1,0,1] b : [0,0,1,1]
Vectorspace(V2)=(1*0 + 1*0 + 0*1 + 1*1) / [sqrt(3) * sqrt(2)]
Vectorspace(V2)=0.41

SJVA1=(J1 + V1)/2=(0.66 + 0.82)/2
SJVA1=0.74
SJVA2=(J2 + V2)/2=(0.25 + 0.41)
SJVA2=0.33

Threshold SJVA is 0.6
So SJVA1 is selected
So Merge Sort i.e. Concept 1 is Considered for Next Stage

Stage 2: Learning Object Retrieval
In this phase the learning objects instances are extracted from the Learning Object Ontology. The instances of the concepts are searched in the Learning Object Ontology which is retrieved from the concept extraction phase. To retrieve the instances SPARQL query is used.
An example of such a SPARQL query is shown.

```
SELECT ?c WHERE  {
?a  rdfs:subClassOf :Algorithm .
?b  rdfs:subClassOf ?a .
?c  FILTER(?b= \"mergeSort\")" .
}
```

Stage 3: Output
The user is displayed the links of learning objects based on the keyword entered by him.

V. CONCLUSION

The main purpose of this work was to propose a novel approach in building a course that could alleviate the task of designing the learning process and probably lead to more effective learning paths. This approach is based on the notion of
a) ontologies, used to represent the network of concepts and relationships of the knowledge domain being covered by the course and
b) LOs, used as a mean to organize the educational material into self-contained learning units, which are directly correlated to ontology concepts.
The resulted ontologies for the knowledge domain of data structures provide tutors with a clearer picture about the domain concepts and their relationships. Therefore, by organizing the educational material into LOs and by correlating the LOs' subject with concepts in these ontologies, tutors can more easily discover useful and relevant educational material.

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