

Implementation of **Ontology** in Intelligent **E-learning System** Development based on **Semantic Web**

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Abstract :

It is visualized that Ontologies and Semantic Web technologies will influence the next generation of E-learning environment. Ontology provides flexible educational platform architecture for E-learning environment. The success of the Semantic Web depends on the procreation of ontologies. In general, Ontology based Learning supports the construction of ontologies by an ontology engineer. It takes over the ability to act in a genuinely intelligent manner by assessing the learners initially and providing personalized suggestions to the learners indicating their strengths and weaknesses. This ontology learning framework proceeds through ontology importing, extracting, pruning, refinement, and evaluating giving the ontology engineer a wealth of coordinated tools for ontology modeling. This tool has been developed with the view of providing software based training to potential engineers and educating them. We introduce our ontology model and propose an effective method for enhancing learning effect of students through construction of subject ontology. This paper focuses on the development of ontology-based E-learning support system which allows learners to build dynamic learning paths. We also present an approach for developing a Semantic Web-based intelligent E-learning support system, which focus on the Web Ontology Language RDF and OWL. Additionally an automated and an intelligent e-learning service system have been developed.

Keywords – E-learning, Semantic Web, RDF, OWL, Ontology.

I. INTRODUCTION

E-LEARNING, refers to online learning or distance learning, allows users to access electronic learning contents delivered over internet or intranet. It is concerned with the development of efficient computer-aided education system. Our aim is to use Semantic Web for the provision of distributed information with well-defined meaning, understandable for different parties based on Ontology combines the of context, content and structure of the learning materials, providing flexible access to these learning materials. Development of Ontology-based E-Learning support system by using a Semantic Web allows learners to build dynamic learning paths and how the Semantic Web resource description formats can be utilized for automatic generation of hypertext structures from distributed metadata.

This project focuses on the development of ontology-based E-learning support system which allows learners to build dynamic learning paths. We also present an approach for developing a Semantic Web-based E-learning system, which focus on Web Ontology language RDF and OWL. Additionally an automated learning service system has been developed. Our e-learning support system project aims at creating, integrating and interfacing of multiple ontologies on different layers, such that all are grouped together under a single ontology called domain ontology. This tool has been developed with the view of providing industry-oriented training to potential engineers and educating them. It gives flexible educational platform architecture for E-learning system.

The proposed work includes:

- ⇒ Structured E-Learning Websites – with relationship.
- ⇒ Effective Search engines with exact result. (along with dynamic keyword prediction)
- ⇒ Includes Semantic Web that makes searching user-friendly (Directly tied to the specificities of the web environment).

- ⇒ To build Dynamic Learning Paths through understanding curriculum.
- ⇒ Tests for the levels or courses completed and Score cards mailed to the test takers.
- ⇒ Best material for people preparing for the placements since it takes them across a tour to the necessary subjects.
- ⇒ Making use of OWL(“Semantic Web Vision”) increases the machine interpretability.
- ⇒ YouTube videos with online or offline streaming and External Website Contents.

E-Learning content are directly tied to the specificities of the web environment as shown in the architecture diagram. All the Semantic Web technologies are used in this paper.

II. SYSTEM ARCHITECTURE

The architecture of the developed e-learning system consists of four important parts namely :

- Learning environment
- Semantic web
- Repository
- administrator

LEARNING ENVIRONMENT:-

The learning environment consists of all the events that prevail in the system for students. The registration work consists of the process where the students who wish to take up their learning have to first register themselves with all the required details and information. This will gain them an entry to view the system that contains the course details. The course details consist of all the necessary details that the student wishes to take. It will contain the list of courses and the subjects available. From the list, the desired subject is selected. Also the different modes of learning will also be mentioned which makes them to select their necessary course. The internal tutorial is the place where the students can find the availability of notes from various faculty members and from reputed colleges and also people who have knowledge about the various courses. The external links is where there is the availability of various types of resources namely the PDFs, videos related to all the courses present both online and offline

SEMANTIC WEB:-

Semantic web is the main part of the system where the search process takes place. It contains parts such as learning XML, learning paths, learning servers and metadata. Metadata consists of various data about the data that is present. The search process by the semantic web includes making search with the feature of more machine interpretability.

REPOSITORY:-

Repository is the database of the entire system. It is the place where the RDF files, OWL files are present. It contains the entire details of data present. It is the heart of this ontology system where there is complete presence of the entire data. Any information required will be fetched only from this repository. It also includes the student database which contains all the required details of the students who enter into this system. Any student's complete details will be present in this student repository.

ADMINISTRATOR:-

The administrator is the sole person who controls the entire functioning of the system. The administrator appoints people to take the sub functions namely evaluator, instructor, advisor where they perform roles like evaluating the performance of the students based on the tests they take, instructor instructing the students with the functionality of the system.

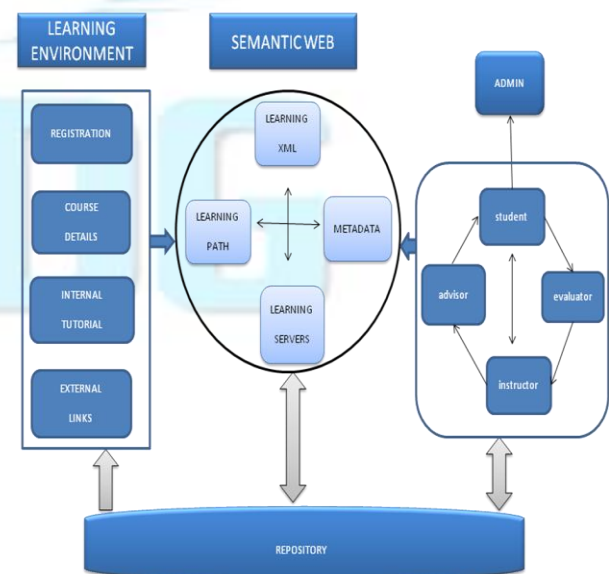


Fig. 1. The System Architecture of our ontology-based learning support system.

III. STRUCTURE of ONTOLOGY MODEL

The hierarchical structure of subject ontology is depicted in Fig 3. Subject ontology is constructed from one or more of learner-based ontologies, teacher-based ontology, several domain based ontologies and learning materials. Teacher-based ontology contains learning concepts and knowledge structure based on several domain ontologies.

Also, teacher-based ontology is schema ontology to be referred by learner-based ontologies. Learner-based ontology contains concepts and knowledge structure created by students. When a teacher presents learning subjects, students investigate the subjects and extract meaningful concepts and knowledge structure to create a new learner-based ontology or extend existing learner-based ontology during their learning process.

Subject ontology is described as following 5-tuples, $\langle C, P, I, RH, RC \rangle$. The symbol C, P, I, RH and RC represent class, property, instance, hierarchy relation between classes and association between classes individually. We explain the structure of teacher-based ontology and learner-based ontology based on above 5-tuples in following some paragraphs.

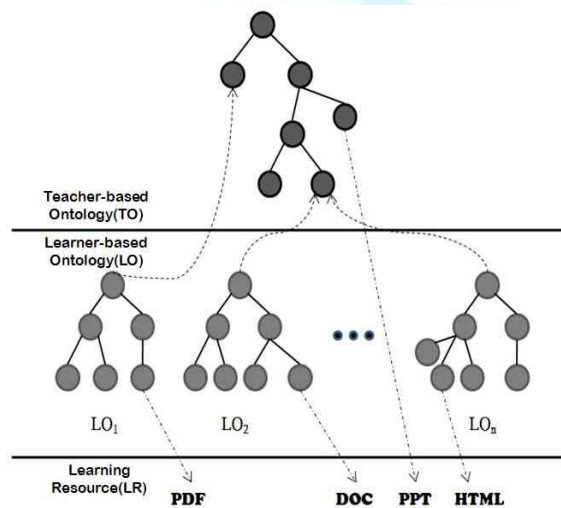


Fig. 2. The Structure of Domain Ontology Development Model

Entities of teacher-based ontology are classified into following 3 categories:

- ❖ Learning Concept – Main topics will be described in a class for a semester. This category includes fundamental concepts, advanced concepts, related concepts, examples and exercises.
- ❖ Learning Structure – Learning concepts organized as a semantic network to describe knowledge structure of topics. In addition, learning path and schedule represented in syllabus added to the learning structure.
- ❖ Learning Material – Teacher collects useful resources like web pages, images, audios, and videos and creates lecture notes using the resources. These lecture notes have connections to relevant concepts.

IV. DESIGN FLOW DIAGRAM

Any user who needs to search for a topic can input for a keyword for the domain through the web based interface of the tool. The User Interface uses an ontology search engine to retrieve ontology files from the repository which contains the keyword that is mentioned. The ontology search engine performs a string search on class names, sub-class names and property names using the specified keyword in the ontology files containing various data of various languages. The relevant ontologies are kept in the repository.

The user interface present has another important function to do namely finding the synonyms for the given keyword. The main reason behind is that the keyword may not exactly match the terms that are present in ontologies. The synonyms found is given to the User (designer). The class extractor then processes the relevant ontologies that are in the repository and extracts the class names. With these class names returned the process of searching can be returned again until the refined required class is obtained. Since the above search leads to many new keywords on refining the User (designer) should maintain a data set that includes the knowledge about the domain in a wider sense. The User (designer) chooses the most relevant concepts that becomes the classes in the class diagram.

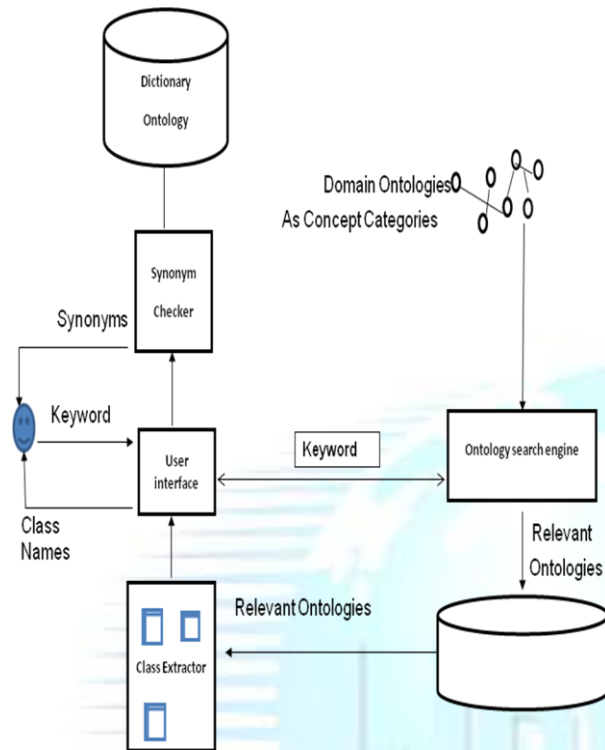


Fig. 3. Data Flow Diagram

V. EXAMPLE

Following instance is the Central Conservatory of Music - Traditional Music - Curriculum - Solo Case study. We make semantic description for this case. It has the following information:

Solo musical instrument has three categories: blow instrument, string instrument, play instrument.

- Blow instrument contains flute, sheng, xiao.
- String instrument contains erhu, jinghu, sihu.
- Play instrument contains guqin, guzheng, lute.

Each has the information about history, play method, and music score.

In OWL, a concept is composed by definitions of classes, object properties, data properties, individuals and axioms. Class is an important element in OWL. Object properties reflect the relationship between two class instances. Individual is the member of class. OWL has a very powerful reasoning capability, which is based on class. It provides a mechanism to describe the class that individual belongs to and the properties that individual inherits by the relationship between class members and then it can be used to reason. The network structure of this case is shown in Fig 7.

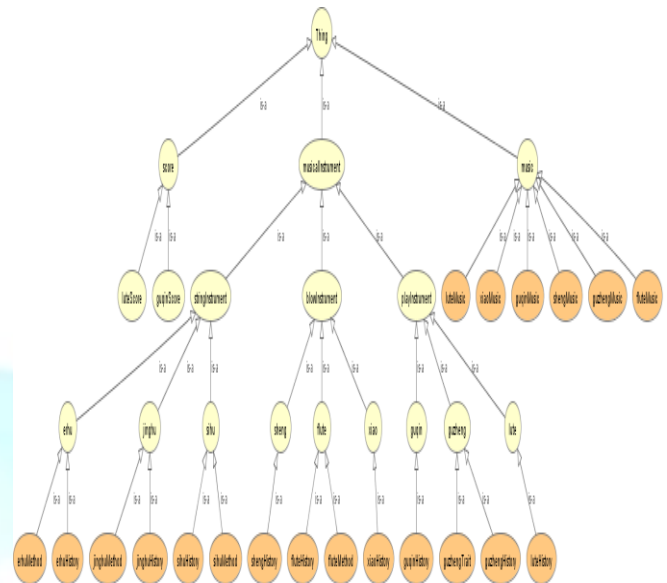


Fig 7. Relations of instances

All the classes are the subclass of class owl: Thing. We define three subclasses of the root class owl: Thing: score, musical Instrument, music. And then we define corresponding subclasses of these classes. Take the “flute” class for example; it is the subclass of the “blow Instrument” class, which is expressed by the symbol “rdfs: subClassOf” in the source code, and it contains two subclass: “flute History” and “flute Method”.

The “flute” class and the related class defined by OWL are shown in TABLE 3.

TABLE 1. OWL source code - Definition of the “flute” class and its related class

```
<owl:Class rdf:about="#flute">
<rdfs:label>flute</rdfs:label>
<rdfs:subClassOf
rdf:resource="#blowInstrument"/>
</owl:Class>
<owl:Class
rdf:about="#fluteHistory">
<rdfs:label>fluteHistory</rdfs:label>
<owl:equivalentClass>
<owl:Restriction>
<owl:onProperty
rdf:resource="#hasContent"/>
```

```

<owl:someValuesFrom
rdf:resource="&rdfs;Literal"/>
</owl:Restriction>
</owl:equivalentClass>
<rdfs:subClassOf
rdf:resource="#flute"/>
</owl:Class>
<owl:Class
rdf:about="#fluteMethod">
<rdfs:label>fluteMethod</rdfs:label>
<owl:equivalentClass>
<owl:Restriction>
<owl:onProperty
rdf:resource="#hasContent"/>
<owl:someValuesFrom
rdf:resource="&rdfs;Literal"/>
</owl:Restriction>
</owl:equivalentClass>
<rdfs:subClassOf
rdf:resource="#flute"/>
</owl:Class>

```

In order to describe the relationship between the “music” class and the “musical Instrument” class, that is “music” is played by “musical Instrument”. The object property is used, which is expressed by the symbol “owl: Object Property” in the source code as in TABLE 4.

TABLE 2. OWL source code - Relationship between the “music” class and the “musical Instrument” class

```

<owl:ObjectProperty
rdf:about="#isPlayed">
<rdf:type
rdf:resource="&owl;AsymmetricProperty"/>
<rdf:type
rdf:resource="&owl;FunctionalProperty"/>

```

```

<rdf:type rdf:resource=
"&owl;InverseFunctionalProperty"/>
<rdf:type
rdf:resource="&owl;IrreflexiveProperty"/>
<rdfs:label>isPlayed</rdfs:label>
<rdfs:domain
rdf:resource="#music"/>
<rdfs:range
rdf:resource="#musicalInstrument"/>
</owl:ObjectProperty>

```

In the source code, the domain of the object property “is played” is defined as “music”, and the range is defined as “musical Instrument”, so it links the “music” class and the “musical Instrument” class. The link is also reflected through the definition of the “flute Music” class, which expresses the relation that “flute Music” is played by “flute” as in TABLE 5.

TABLE 5. OWL source code- Definition of the “flute Music” class

```

<owl:Class rdf:about="#fluteMusic">
<rdfs:label>fluteMusic</rdfs:label>
<owl:equivalentClass>
<owl:Restriction>
<owl:onProperty
rdf:resource="#isPlayed"/>
<owl:allValuesFrom
rdf:resource="#flute"/>
</owl:Restriction>
</owl:equivalentClass>
<rdfs:subClassOf
rdf:resource="#music"/>
</owl:Class>

```

In addition to describing the classes, we also need to describe their members, which are individuals as we generally considered. In this case, “short flute” and “long flute” are defined as different individuals. In the source code, rdf: type is a RDF property that links

individuals (“short flute”, “long flute”) and the class that they belong to (the “flute” class). The element “All Different” declares different individuals.

After such ontology is established, if we want to acquire the knowledge about “flute”, the ontology inference machine can help return the information of related knowledge including subclass “flute History”, “flute Method” and the super class “blow Instrument” and so on. Users can choose accurate learning content from the information returned or get further information such as the “flute Music” class by retrieval, or continue to make in-depth reasoning.

VI. CONCLUSION

Active learning is one of methods to obtain higher learning outcomes of students in class. In this paper, we propose a method to lead active learning and self-leading learning of students. Existing models for the e-learning process involves having the searching process to be done manually by the user. This is concerned with the user’s knowledge in the subject. In our project we implement ontology using the semantic web that ultimately provides results by searching along with the machine increasing machine interpretability.

Learning or gaining knowledge is one of the key aspects for a student. So the basis for the creation or any innovation we do comes only when we learn the concepts in depth. This site allows students to learn the concepts easily in which each concept is well organized based on their classifications. It is very common that people understand a concept or the basis from which it has been derived when given in the form of a flow chart. That is what we have implemented – ONTOLOGY in E-LEARNING. This website is implemented for engineering students to learn their subject.

We applied our method to a class, Understanding Data Structure, to evaluate the effectiveness E-Learning support system. We found that this system enhances the learning outcomes of students through interviewing from students, defining specific outcomes, and comparing outcomes of students before and after applying ontology to the class.

VII. REFERENCES

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