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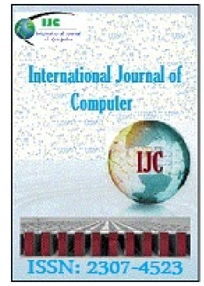

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Ontology Based E-Learning Systems in the Semantic Web

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Abstract

The Semantic Web is a collaborative movement led by the international standards body, the World Wide Web Consortium (W3C). Semantic web is an extension of the current web that provides an easier way to find, share, reuse and combine information. Ontology formally represents knowledge as a set of concepts within a domain, and the relationships between pairs of concepts. It can be used to model a domain and support reasoning about concepts. This work shows how Ontology takes an important place in E-learning System. Ontology is used to classify the things which are needed in E-Learning Systems. This work will be very useful for students those who are more interested in data mining. And I have used Very simple words to understand the concept of Ontology in E-Learning Systems.

Keywords: Class, Domain, E-Learning, RDF, RDFS, Semantic Web, Ontology, OWL, OWLIR.

1. Introduction

"The Semantic Web is a mesh of information linked up in such a way as to be easily processable by machines, on a global scale." "The Semantic Web approach develops languages for expressing information in a machine processable form. " These two sentences define the essence of the SW: its information in machine processable form; however in the same time first one defines SW as a global scale information mesh and the second sentence defines it as Framework for expressing information. Both citations demonstrate the main principle of the SW: **Information in Web should be more machine processable and understandable.** In this case SW can be the goal (mesh of information) as well as a tool (language for expressing). We use Web as a global database first of all for search. Today's search engines cannot search more precise that they do it now. May be the main reason is that the structure and size of current Web do not allow to make search more precise and efficient. The second reason cannot be eliminated: Web contains now a huge number of documents and this number has a strong tendency to double each one or two years. The structure of documents and Web itself, probably, can be changed in "a better – machine processable way".

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2. Ontologies in the Semantic Web

Ontologies play an important role in fulfilling semantic interoperability as described in the seminal article on the Semantic Web. W3C has standardized a layered stack of ontology languages that possess the advantages of both knowledge representation (KR) formalisms and conceptual modeling methods for databases. Standardization encouraged creating new ontologies and porting existing ontologies into the Semantic Web.

3. Ontology Types

Ontologies are classified in various ways using criteria such as the degree of abstraction and field of application:

1. ***Upper ontology*****:** concepts supporting development of an ontology, meta-ontology.
2. ***Domain ontology*****:** concepts relevant to a particular topic or area of interest, for example, information technology or computer languages, or particular branches of science.
3. ***Interface ontology*****:** concepts relevant to the juncture of two disciplines.
4. ***Process ontology*****:** inputs, outputs, constraints, sequencing information, involved in business or engineering processes.

4. Evolution of Semantic Web Ontology Languages

In the Semantic Web layer cake (see Figure 1), the semantic part is enabled by a stack of evolving languages: Resource Description Framework (RDF) offers a simple graph reference model; RDF Schema (RDFS) offers a simple vocabulary and axioms for object-oriented modeling; and Web Ontology Language (OWL) offers additional knowledge base oriented ontology constructs and axioms. Figure 2 shows similar evolutionary trends among three paradigms: KR formalisms, conceptual modeling methods for databases, and the Semantic Web. The built-in semantics increases in each paradigm along the vertical axis driven by the demand of porting implicit semantics into explicit representation. For example, *Semantic Networks*, developed between the mid-60s and early 70s, are highlighted by their simple but powerful relational reference model in supporting conceptualization; *Frame Systems*, which emerged in the mid-70s, incorporate additional constructs that model classes and instances in a user-friendly manner; *Description Logics*, which came out in the 80s as descendents of Semantic Networks and Frame Systems, are highlighted by their formal semantics and decidable inference. Similar evolutions can be observed in the development of the databases and the Semantic Web. RDF was proposed in 1998 as a simple graph model, followed a year later by RDFS.

5. Web Ontology Language (OWL)

The **Web Ontology Language** (**OWL**) is a family of knowledge representation languages for authoring ontologies. The languages are characterized by formal semantics and RDF/XML-based serializations for the Semantic Web. OWL is endorsed by the World Wide Web Consortium (W3C) and has attracted academic, medical and commercial interest. In October 2007, a new W3C working group was started to extend OWL with several new features as proposed in the OWL 1.1 member submission. W3C announced the new version of OWL on 27 October 2009. This new version, called OWL 2, soon found its way into semantic editors such as Protégé and semantic reasoners such as Pellet, RacerPro, FaCT and HermiT. The OWL family contains many species, serializations, syntaxes and specifications with similar names. OWL and OWL2 are used to refer to the 2004 and 2009 specifications, respectively. Full species names will be used, including specification version (for example, OWL2 EL). When referring more generally, *OWL Family* will be used.

6. OWLIR (Ontology Web Language Information Retrieval)

OWLIR is an example of the Semantic Web IR system. It is an implemented system for retrieval of documents that contain both free text and semantic markup. OWLIR is only a framework, which was designed to work with almost any local information retrieval system.

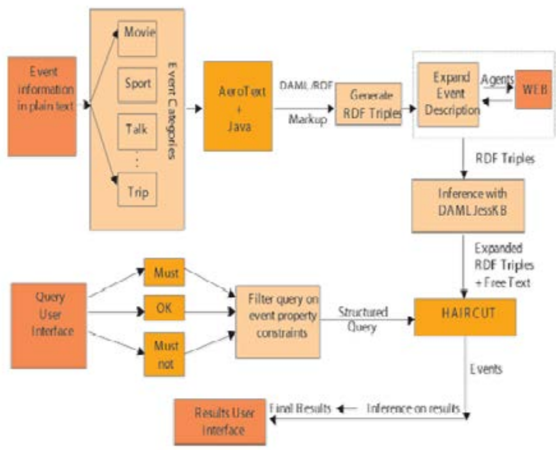


Fig: OWLIR dataflow diagram

7. RDF (Resource Description Format)

RDF offers a simple graph model which consists of nodes (i.e. resources or literals) and binary relations (i.e. statements). It is a type of Semantic Network and is very similar to the *Relational Model*. Such a simple model embodies a small amount Note that some auxiliary functional constructs are not included in this table: data type constructs (e.g. rdf:Literal, rdf:XMLLiteral); RDF reification (i.e. rdf:Statement, rdf:subject, rdf:predicate, rdf:object); collections and container (e.g. rdf:List, rdf:Alt, rdf:Bag, and rdf:Set). 5 of built-in semantics and offers great freedom in creating customized extensions; however, an extended or specialized semantic network is usually required in practice. John Sowa identifies six categories of semantic networks based on relation semantics: (i) *Definitional networks*, which build taxonomies for conceptualisms with inheritance (subclass) and membership (instance) relations; (ii) *Assertional networks*, which represent cognitive assertions about the world with modal operators; (iii) *Implicational networks*, which focus on implication relations, e.g. belief network; (iv) *Executable networks*, which focus on temporal dependence relations, e.g. flowchart, PetriNet; (v) *Learning networks*, which focus on causal relations encoded in numerical value, e.g. neural network; (vi) *Hybrid networks*, which combine features of previous types. In the Semantic Web, most ontologies are defined using RDF(S)/OWL and thus fall in the first category; the second category (assertional networks) emerges in the context of sharing instance data and evaluating trustworthiness of such data; and the third category (implicational networks) gains interests in ontology mapping study. A variation of definitional networks is natural language encyclopedia such as dictionaries and thesaurus which uses a different set of relations rather than class-property relation. Word Net 5 and Simple Knowledge Organisation System (SKOS) are their representative Semantic Web versions respectively.

8. RDFS (RDF Schema)

Under the influence of *Frame Systems* and the *Object Oriented Model*, RDFS has been used to RDF to provide better support for definition and classification. These models organize knowledge in a concept-centric way with descriptive ontology constructs (such as frame, slot, and facet) and built-in inheritance axioms. Frame Systems enable users to represent the world at different levels of abstraction with the emphasis on entities, and this aspect makes it quite different from the planar graph model offered by most semantic networks. In addition to inheriting basic features from Frame Systems, RDFS provides ontology constructs that make relations less dependent on concepts: users can define relations as an instance of *rdf: Property*, describe inheritance relations between relations using *rdfs:subPropertyOf*, and then associate defined relations with classes using *rdfs:domain* or *rdfs:range*.

9. Ontology Specification in E-Learning

Domain Ontologies

First of all we need to determine domain ontologies. Domain ontologies comprise usually classes (classifies objects from a domain) and relationships between them. One possible domain in hypermedia application can be a domain of documents and concepts described in an application domain. A simple ontology for documents and their relationships to other components is depicted in fig. 1. The class Document is used to annotate a resource which is a document. Documents describe some concepts. We use class Concept to annotate concepts. Concepts and documents are related through dc:subject property. Documents can be ordered by dcterms:requires relationship. Concepts and documents have a certain role in their collaboration in certain document. We represent these facts by instances of DocumentRole class and its two properties: isPlayedIn and isPlayedBy. Concepts, document roles and concept roles can form hierarchies. We define subRoleOf, subConceptRoleOf, and subConceptOf properties for these purposes. Concepts play a certain role in a document. We recognize Introduction and FullDescription concept roles.

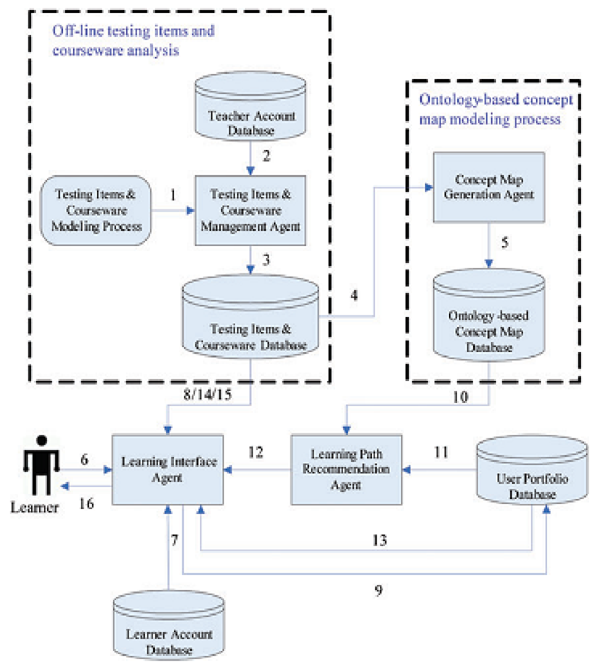


Fig: Ontology based E-Learning

Learner

Data about a user serves for deriving contextual structures. It is used to determine how to adapt the presentation of hypertext structures. Here we define an ontology for a user profile based on IEEE Personal and Private Information (PAPI) [IEEE, 2000]. PAPI distinguishes personal, relations, security, preference, performance, and portfolio information. The personal category contains information about names, contacts and addresses of a user. Relations category serves as a category for specifying relationships between users (e.g. classmate, teacherIs, teacherOf, instructorIs, instructorOf, belongsTo, belongsWith). Security aims to provide slots for credentials and access rights. Preference indicates the types of devices and objects, which the user is able to recognize. Performance is for storing information about measured performance of a user through learning material (i.e. what does a user know). Portfolio is for accessing previous experience of a user. Each category can be extended. Figure shows an example of ontology for a learner profile. The ontology is based on performance category of PAPI. We are storing sentences about a learner which has a Performance.

The Performance is based on learning experience (learningExperienceIdentifier), which is taken from particular document. The experience implies a Concept learned from the experience, which is maintained by learning Competency property. The Performance is certified by a Certificate, which is issued by a certain Institution. The Performance has a certain Performance Value, which is in this context defined as a float number and restricted to interval from 0 to 1.

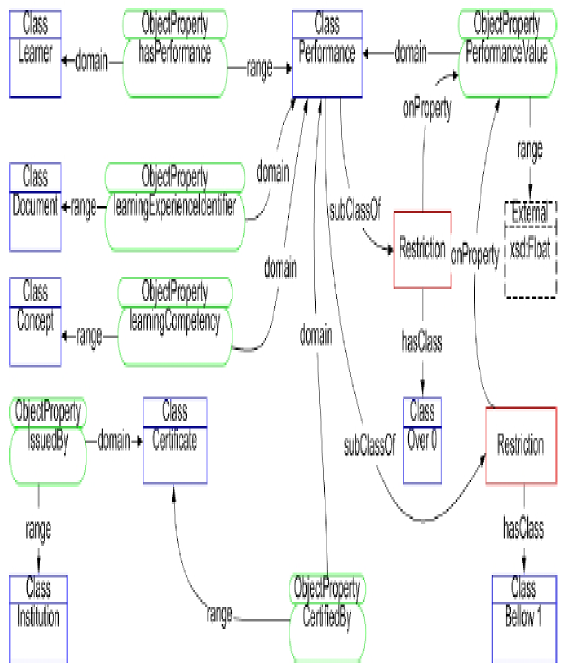


Fig: Ontology for learner performance

Another possibility to restrict the PerformanceValue is to define it with a range of LevelOf Knowledge. Then the instances of the class can be taken as measures of the learner performance.

User : user2[

rdf : type -> learner:Learner;

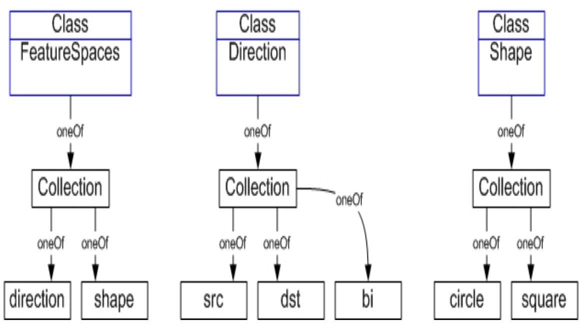
learner:hasPerformance -> user:user2P].

user:user2P[

rdf:type->learner:Performance;

```
learner:learningExperienceIdentifier->sun_java:'java/concepts/object.html';

learner:learningCompetency->doc:OO_Object;

learner:CertifiedBy->KBScerturi:C1X5TZ3;

learner:PerformanceValue->0.9

].

KBScerturi:C1X5TZ3[

rdf:type->learner:Certificate;

learner:IssuedBy->KBSuri:KBS

].

KBSuri:KBS[

rdf:type->learner:Institution

].
```

The learner user2 has the performance (user2P) record. The performance contains a learning experience about the KBS Java objects resource. The concept covered in the resource is stored in the performance as well. Then a certificate about the performance with performance value and institution who issued the certificate is recorded into the learner performance as well. And the following figure shows simple example for ontology.



(a) (b) (c)

Fig: Members of Collection of: (a) Feature Spaces, (b) Direction, (c) Shape.

10. Rules For Ontology

In this chapter we show how rules are employed to reason over distributed information sources (ontologies, user profile information, resource descriptions). The communication between reasoning rules and the open information environment will take place by exchanging RDF annotations. Rules are encoded in the TRIPLE rule language. For further examples on adaptation rules we refer the reader to.

In the following, we provide a set of rules that can be used to construct an example-relation between resources. Assume a user U is visiting some page D. An example, illustrating the content of this page, can be found by comparing the concepts explained on the current page with the concepts shown on an example page. Several grades of how good an example is can be derived. The easiest way for deriving an example-relation to a page D is by ensuring that each concept on D is covered by the example E:

FORALL D, E example(D,E) <-

studyMaterial(D) AND example(E) AND

EXISTS C1 (D[dc:subject->C1]) AND

FORALL C2 (D[dc:subject->C2] ->E[dc:subject>C2]).

The second line in the rule above ensures that D is StudyMaterial and E is an Example (according to the ontology of documents "docs"). The third rule is verifying that D really is about some measurable concept - thus there exists a metadata annotation like dc:subject. From the area of adaptive hypermedia, several methods and techniques have been provided to adapt the navigation and / or the content of a hyperspace to the needs, preferences, goals, etc. of each individual user. In [Henze and Nejdl, 2003] we have provided a logical characterization of adaptive educational hypermedia based on First Order Logic (FOL). There, an adaptive educational hypermedia system is described in FOL as a quadruple consisting of a document space - a hypermedia system which document nodes and their relations, a user model for modeling and inferencing on various individual characteristics of a user, an observation component which is responsible for monitoring a user's interaction with the system, and an adaptation component which consists of rules which describe adaptive functionality. A way to implement open adaptive hypermedia system is shown in [Dolog et al., 2003]. In this paper, we will use adaptive hypermedia to provide personalized associations. We can think of a personalized pedagogical recommendation of examples: The best example is an example that shows the new things to learn in context of already known / learned concepts: This would embed the concepts to learn in the previous learning experience of a user.

11. Conclusion

Ontology formally represents knowledge as a set of concepts within a domain, and the relationships between pairs of concepts. It can be used to model a domain and support reasoning about concepts. This paper showed some basic and important concept of Ontology in E-Learning Systems. I hope that readers definitely understand the importance of Ontology in semantic web. Ontology is used to classify the things which are needed in E-Learning Systems. This work will be used for students and researcher those who are more interested in data mining concepts. And I have used Very simple words to understand the concept of Ontology in E-Learning Systems.

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