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Semantic Web Representation in RDFSchema: A Practical Approach

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***Abstract*—The World Wide Web has dramatically changed due to the availability of data. Web contains around 3 billion static documents which are accessed by over 500 million users. The current knowledge management techniques are with the issues like information overload, the inefficiency of keyword searching, the lack of authoritative (trusted) information, the lack of natural language processing computer systems and poor content aggregation. These problems are resolved by Semantic Web, which is referred as the future of the current Web by Tim-Berners-Lee, Director of the World Wide Web Consortium. The Semantic Web is an extended web of machine readable information and automated services that simplify the Web. Ontology is used to make the data smarter. The objective of this paper is to provide with an overview of Semantic Web and Ontology with a working example. This paper details the problems in traditional knowledge management systems , Semantic Web architecture , development process involved in Ontology, operations and relations that are performed on Ontology , overview of Ontology languages and Semantic publishing. Finally this paper provides an example of semantic representation for book publisher.**

***Key words*- Semantic *Web, Ontology, RDFS*.**

I. INTRODUCTION

The Word Wide Web has enormous data and they are maintained in natural language form which can be understandable only by humans not by machines. The current Web supports only keyword searching in which the information has to be extracted by users which consumes more time and effort. There is a gap between the tools that are used for the interpretation and analysis of data and the representation of the information. The information is inconsistent and the removal of the outdated information has not done properly. Semantic Web is the extension of the current Web which is used to allow much more advanced knowledge management system. In Semantic Web the information are represented in the format which can be understandable by both machines and humans. The Semantic Web does not replace current Web, but it varies in certain characteristics. The Table I provide the comparison between Web and Semantic Web.

Ontology forms the backbone of the Semantic Web and used to represent the information which is used by machines not only for displaying, but also for automating, integrating and reusing the same across various applications. The Ontology is represented in various formats like OWL, RDF and XML for easy access across machines.

This paper describes the architecture of Semantic Web and the development and components of Ontology. Section II discusses the Semantic Web architecture followed by an overview of ontology in Section III. In Section IV lists the basic RDF Schema tags. Section V discusses the semantic representation in RDFschema with a use case scenario. Section VI describes how ontology can be published in the Web. Section VII draws the conclusion.

TABLE I
COMPARISON BETWEEN WEB AND SEMANTIC WEB

Feature	**WWW**	**Semantic Web**
Basic Component	Interlinked documents	Interlinked data
Resources	Web pages, photos and videos	Web pages , photos and people
Language used	Natural language	Machine targeted language
Usage of links	Defines a relationship between the pages	Defines a relationship between the data
Goal	High responsive websites	Automate the integration of distributed information
Users	Humans	Humans and applications
Search Engines	Google , Yahoo etc.	Tabulator, VisiNav etc.

II. SEMANTIC WEB ARCHITECTURE

The Semantic Web is the extension of the current Web and it is a machine processable web of smart data. Tim Berner Lee (Inventor of Web, HTTP, & HTML) quoted that Semantic Web will be the next generation of Current Web and the next IT revolution [1].The aim of Semantic Web is to resolve several key problems facing by current Knowledge Management System like Content Aggregation, Information Overload. In Semantic Web, the processing of Web information is done by the following ways

- Knowledge is organized according to its meaning.
- Knowledge extraction is done by automated tools support.
- The search is carried out by query answering instead of keyword based search
- The requested knowledge are retrieved, extracted and presented in a user friendly way.

The current Web has links and resources as its components where as in Semantic Web, standards and languages are introduced. Fig.1 shows the core components of the Semantic Web architecture.

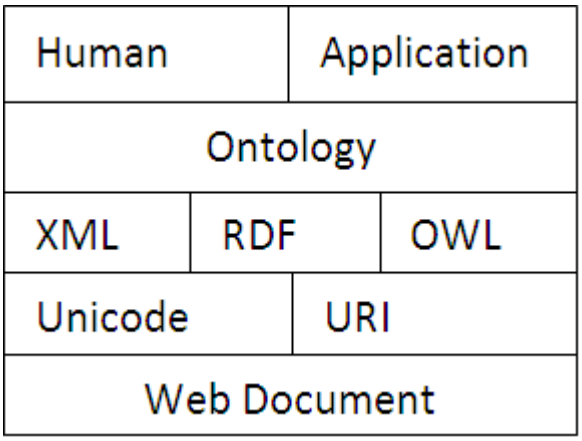

Fig. 1 Semantic Web Representation

A. Unicode and URI

Unicode provides a unique number for every character, independently of the underlying platform, program, or language.

A Universal Resource Identifier (URI) is a formatted string that serves as a means of identifying abstract or resource. A URI can be further classified as a locator, a name, or both.Uniform resource locator (URL) refers to the subset of URI that identifies resources via a representation of their primary access mechanism.

B. *XML*

XML is the syntactic foundation layer of the Semantic Web and allthe other technologies providing features for the Semantic Web will be built on top of XML.XML (extensiblemark up language) with XML namespace and XML schema definitions makes sure that there is a common syntax used in the semantic Web. XML namespaces allow specifying different markup vocabularies in one XML document. XML schema serves for expressing schema definition of a particular XML document. When it comes to semantic interoperability, however, XML has disadvantages.

C. *RDF*

RDF is a basic data model for web objects. It provides a common way to represent information about resources that can be understand by computers. RDF documents are written in RDF/XML language.RDF defines objects by their properties and value for properties. These resources are identified by URIs.RDF describes the resources in triple format, subject , predicate and object. The subject denotes the resource to be described . The predicate refers the property of the resource and the object tells the value for that property. The RDF elements like RDF:class, RDF:property, RDF:domain and RDF:range are used for the representation.

D. *OWL*

OWL has a rich vocabulary for capturing knowledge and also basis for describing metadata. In addtion it also includes the features torepresent cardinality, localised range and domain constraints and characteristic of properties such as transitive , inverse and symmetrical. OWL provides OWL Full, OWL DL and OWL Lite as its sublanguages. OWL Lite is less expressive but easier to implement and provides more terms for describing relationships. OWL DL and OWL Full have same vocabulary but OWL DL has some restrictions like type separtions and property type.

E. *Ontology*

Ontology describes the semantics of the data, providing a uniform way to enable communication by which different parties can understand each other.The Ontology is used to represent the relationships and constraints for the resources represented by XML,RDF or OWL to provide data integration . For example, the publishers database is converted to a RDF Model. The author of the publication may be termed as author or creator or owner. When thesemodels are integrated a notation to be added to mention these terms are same. This type of notation is known as Ontology. Ontology can be added using RDF Schema and OWL Languages. In this paper Section III expalins Ontology.

F. Semantic Web challenges

The central idea of Semantic Web is to extend the current human- readable web to machinereadbale web by introducing some semantics to the data. This conversion has two major difficulties (a) conversion of more data in the current web to semantic and (b) Common Ontology creation and maintenance atleast for the particular domain.

III. ONTOLOGY

This section briefly describes components of ontology, development process involvesin ontology construction, operations on Ontology, relations between Ontologies and classification of Ontologies.

Ontology is the key concept of Semantic Web, interweaving human understanding with machine process ability. Ontology is defined as "a formal explicit specification of a shared conceptualization". The above definition can be elaboratedas: Machine readable and explicitly defined concepts,properties,functions and abstract model of some phenomena in the world.

A. OntologyComponents

Ontology components can be classified into two main types.The Components that describe the entities of the domain - Concepts, Individuals, Properties and Relationships; and those that describe theOntology itself - Documentation and Ontology Meta data.

Concept represents a set of entities that share common characteristics within a domain. This can be also known as Classes, Types or Universals.Individuals also known as Instances or Particulars are the base unit of Ontology. It indicates the concrete example of concepts and also model

more abstract objects such as a job or a function. Relations specifies the way in which the concepts or individuals relate to each other.

In addition to the above, many Ontology languages supportother components as non ontological components. Documentation, also called as formal definition provides plain definitions for each concepts, individuals and relations. They are used to ensure that the intention of the entity is exactly reflected in the Ontology, and also useful for users to understand these intentions. Ontology metadata provides the documentation of the Ontology as whole,such as purpose and scope , author and release date.

B. Development Process

The Ontology development process includesthe following steps [4]

- *Determination of the Domain , Purpose and Scope of ontology*
  The main objective of this phase is to identify the need, the purpose for Ontology construction and the range of the users. This phase takes care of identifying whether it has to be built from the scratch or an existing ontology can be reused.
- *Enumerate important terms and Define Classes , Properties and Class Hierarchy*
  In this phase, the key concepts and their relationships in the domain are identified. The concepts are modelled as classes or the sub classes, the relationships are represented as hierarchy relationship.
- *Ontology Encoding*
  This phase mainly concentrate on selecting an Ontology representation language.Some of the languages are SHOE (Simple HTML Ontology Extensions), OWL (Web Ontology Language), RDF (Resource Description Framework), XOL etc.
- *Ontology Integration*
  The Ontology Integration is to combine the constructed ontology with the existing one
- *Ontology Evolution*
  The constructed ontology should be evaluated by taking some evaluation criteria. The two types of criteria are generic criteria and specific criteria. The generic criteria deals with factors like clarity, consistency, reusability. The specific criteria check the generated ontology against the purpose and user requirements.
- *Documentation*
  This phase is very important because ontologies can be reused only if it is properly documented. Documentation should be done with at most care and must record all the assumptions that are made explicitly.

C. Operations on Ontology

It is possible that one application can use more than one Ontology and integrate with the systems that use other Ontologies. In this case, some operations have to be done on Ontologies. The Table II lists the basic operations that are perfomred on Ontology.

TABLE III
OPERATIONS ON ONTOLOGY

Operation	**Description**
Merge	Creates new Ontology by linking up the existing one as the whole or only selected knowledge.
Mapping	Translates the concepts and relations from One Ontology to another
Alignment	Process of mapping in both directions
Refinement	Maps the concepts from one Ontology (A) to another (B) so that every concept of A has equivalent in B.
Unification	Aligns all of the concepts and relations in Ontologies so that inference in One Ontology can be mapped to the inference in other Ontology
Integration	Process of looking for the same parts of two different Ontologies
Inheritance	Inherits everything from one Ontology to another

D. Relations between Ontologies

Identifying the relationship between Ontologies is important for transformation of one ontology to another and the selection of ontology for particular purpose. The Table III provides the list of relations between Ontologies.

TABLE IIIII
RELATIONS BETWEEN ONTOLOGIES

Relation	**Description**
Extension	Ontology O1 extends Ontology O2 , means that all symbols (with restrictions , meanings and relations) that are defined within O2 can be found in O1
Identical	Ontology O1 and Ontology O2 are identical means that Vocabulary, relations and the language are identical , but the name can be different
Equivalent	Ontologies O1 and O2 are equivalent means that logically they are same , but language is different
Strongly Translatable	Ontology O1 can be translated to Ontology O2 without any loss of information and no inconsistency after the transformation
Weakly Translatable	Ontology O1 can be translated to Ontology O2 with some loss of information and no inconsistency after the transformation
Approx. Translatable	Ontology O1 can be translated to Ontology O2 with some inconsistencies like some of the relations become invalid

E. Ontology *Languages*

Ontology languages are used to write explicit, formal conceptualizations of domain models.

TABLE IVV
ONTOLOGY LANGUAGES SOURCE:AUTHOR

Languages	Usage
Ontolingua	It is a distributed collaborative environment and frame ontology, supported for the design and specification on ontology.
CycL	Cyc based on first-order predicate calculus & knowledge based CycL is a modelling language for ontology.
Frame Logic /F-Logic	It is a knowledge representation. it has a sound and complete resolution based proof theory.
LOOM	LOOM based on description logic; represents the knowledge developing & reasoning.
XML	It is a Mark-up Language, used as a web standard for the information.
RDF	RDF is used to define the vocabularies for RDF data and it is visualized as a directed graph.
OIL	Based on description logics, frame based language & web standards. It is designed for describing & exchanging ontology.
OWL	OWL is representing on the Semantic web, influenced by description logic & RDF. It is three types, OWL FULL, OWL DL, and OWL LITE.

IV. INTRODUCTION OF BASIC RDF AND RDFS TAGS

RDF is a foundation for processing meta-data, which is used in machine-understandable applications areas, such as resource discovery, knowledge sharing and discovering. In RDF the statement is written in format "subject predicate object". RDFS provides the framework for application specific classes and properties by specifying the resources as instances and subclasses of the class. The Table V lists the basic tags of RDF and RDFS.

TABLE V
BASIC RDF AND RDFS TAGS

Tag	Description
<rdf:RDF>	Root element of an RDF document. It contains a reference to the RDF namespace.
<rdf:description>	Contains the element that describes the resource. It uses “about” attribute to identify the resource.
<rdf:about>	Sets the subject URI of the statement. It can be absolute or relative to the base document.
<rdf:resource>	Sets the object URI of the statement
<rdf:ID>	Sets the subject URI of the statement within the same document.
<rdf:type>	Defines the relationship of an instance with class
<rdf:property>	Sets the property to specific resource
<rdfs:Class>	Defines the resource
<rdfs:subClassOf>	Relates a class with its base class
<rdfs:domain>	Associates the classes with a property's subject
<rdfs:range>	Associates the classes with a property's object
<rdfs:subPropertyOf>	Relates a property with its base class
<rdfs:literal>	Class of strings
<rdfs:container>	Base class for all containers
<rdfs:label>	Uses to give user-friendly name to a resource
<rfds:comment>	Describes the recource
<rdfs:seeAlso>	Relates a resource to another resource

V. SEMANTIC REPRESNTATION – AN USECASE

This section explains the semantic representation using RDF for representation of book. Consider the scenario for book publisher.

The publisher A has his book information as

```
<Book>
<Title> Ontology Engineering<Title>
<CreatedBy> A</CreatedBy>
<CreatedOn> 01-Jun-14</CreatedOn>
<Book>
```

And publisher B‘s information is

```
<Book>
<Heading> Ontology
Maintenance<Heading>
<Author>A</Author>
<WrittenOn> 05-Jun-15</WrittenOn>
<Book>
```

If the bookseller searches the Web with the keyword “Ontology Books + Author A” then the result will display only publisher B’s information. The publisher A’s information will not be displayed since the author name is tagged as “CreatedBy”. XML represents the structure of the data and the relationship could not be defined.

The search will display the both only if it knows “Author” and “CreatedBy” both are same. In XML the data modeling can be represented in many forms.

But in Ontology languages, there is only one way to represent the model so that application can easily interpret the distributed information without any loss of information. The book, author and publisher information are represented in RDFas

```
<rdfs:Classrdf:ID="Book">
    <rdfs:comment>Book Class</rdfs:comment>
    <rdfs:subClassOf
    rdf:resource="http://www.w3.org/1999/02/22-
    rdf-syntax-ns#Resource"/>
</rdfs:Class>
```

```
<rdf:Propertyrdf:ID="author">
<rdfs:Comment>Author of the book
</rdfs:Comment>
<rdfs:domainrdf:resource="#Book"/>
<rdfs:range
rdf:resource="http://www.w3.org/1999/02/22-rdf-
syntax-ns#Literal"/>
</rdf:Property>
```

```
<rdf:Propertyrdf:ID="Title">
        <rdfs:Comment>Title of the
        book</rdfs:Comment>
        <rdfs:domainrdf:resource="#Book"/>
        <rdfs:range
        rdf:resource="http://www.w3.org/1999/02/
        22-rdf-syntax-ns#Literal"/>
</rdf:Property>
```

```
<rdf:Propertyrdf:ID="WrittenOn">
        <rdfs:Comment>Written date of  book
        th</rdfs:Comment>
        <rdfs:domainrdf:resource="#Book"/>
        <rdfs:range
        rdf:resource="http://www.w3.org/1999/02/
        22-rdf-syntax-ns#Literal"/> date syntax
</rdf:Property>
```

By using the above representation, the information about book can be represented as

```
<book:Bookrdf:ID="Ontology Engineering">
<book:author>A</book:author>
<book:publisher>A</book:publisher>
<book:writtenOn>01-Jun-14</book:writtenOn>
</book:Book>

<book:Bookrdf:ID="Ontology Maintenance ">
<book:author>A</book:author>
<book:publisher>B</book:publisher>
<book:writtenOn>05-Jun-15</book:writtenOn>
</book:Book>
```

VI. SEMANTIC PUBLISHING

Semantic publishing refers to the publishing information on the Web as Semantic markup documents. Semantic publication provides a way for computers to understand the meaning of the published information, making information search and data integration more efficient. Researchers could directly self-publish their experiment data in "semantic" format on the web and Semantic search engines could make these data mostly available. There are open source tools and services available to publish semantic information. Some of these are listed below

- Ambra Project is open source software designed to publish open access journals with RDF. Used by PLoS.
- Semantic MediaWiki: An extension to the wiki application MediaWiki that allows users to semantically annotate data on the wiki, and then publish it in formats such as RDF XML.
- D2R Server: Tool for publishing relational databases on the Semantic Web as Linked Data and SPARQL endpoints.
- Utopia Documents Interactive documents

VII. CONCLUSION

In Semantic Web, the information is represented in the format which can be understandable by both humans and machines. Semantic Web is considered as a Web with knowledge representation. The knowledge representation is done by Ontology. This study produces a detailed survey of Semantic Web representation and Ontology with a use case of semantic representation for a book seller. And finally discusses the publishing of Semantic information to Web. In this study we have explored the Semantic Web architecture and Ontology development, Components, operations on Ontology, relations between Ontologies and Ontology languages.This paper provides use case of book seller to understand the Ontology representation.

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