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RDF /RDF-S Providing Framework Support to OWL Ontologies

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***Abstract*— It is important to represent the contents of WWW in a structure which can render interpretability to both human and machine and make the WWW, semantic. Thus some taxonomy is needed to make representations of the web contents which can be machine readable and usable .This taxonomy can be thought of as ontology. This paper describes how RDF and RDF-S can act as a basic support to Web ontology language (OWL) based Ontology and demonstrate the hierarchical and structural frame work of an OWL ontology there by enabling the machine interpretability aspect of the ontology and rendering support to the Semantic web**

***Keywords*— RDF(Resources Description Framework), RDF-S(Resources Description Framework-Schema), Ontology, OWL (web ontology language).**

I. INTRODUCTION

Ontology primarily consists of the hierarchical structure (terminology) of a domain and its relationships. The ontology languages are the heart of Knowledge Representation systems. The basic elements of knowledge representation are Concepts which symbolizes the set of individuals and their role one being the unary and the other being the binary predicate respectively. RDF which has the feature of creating own tags as it is an extended/serialized form of XML, RDF thus enables the ontology developers to develop complex ontologies using RDF and RDF-S . RDF tags serve as the basic elements to render class definition, describe data and object properties, impose quantifier restrictions on the ontologies. All the above features of RDF and RDF–S functionalities can be viewed in any complex ontology, one such ontology developed by us is UnivPeopleProgramme .

The explanation of the entire ontology is beyond the scope of this paper however the significance of RDF and RDF-S is described in this paper. The code examples listed in this paper are the part of the UnivPeopleProgramme and the relevant aspects are explained.

"RDF is a language for representing information about the resources in the World Wide Web" [1] W3C also defines RDF data model and XML-based serialization syntax.

"RDFS was designed to be a simple data typing model for RDF " [2] RDFS as ontology language is intended for users who basically need to generate a class hierarchy and assigning properties for meta modeling purpose.

This paper is organized in the following seven sections: 1) introduction, 2) RDF: features to enable ontology description 3)RDF-S: describing resources of an ontology 4) RDF in ontology header 5) Ontology header defined using RDF and RDFS 6) RDF providing Data definition and relations in an OWL ontology 7)Conclusion.

II. RDF: FEATURES TO ENABLE ONTOLOGY DESCRIPTION

The Semantic web aims to integrate data from multiple sources and multiple applications into one data model. The data model definition should be such that it is machine process able and uniquely represented across the web. XML is a markup language that enabled data transfer across the web but it lacked the expressiveness feature which could support machine processabilty .

"RDF provides a data model that supports fast integration of data sources by bridging semantic differences." [3] Thereby W3C evolved a description framework for the resources that may be located at various locations and across various applications and adopted RDF as a W3C standard for the purpose of the above in 2004 superseding earlier version of 1999.

Terming RDF as

"RDF is a language for representing information about the resources in the World Wide Web" [1] W3C also defines RDF data model and XML-based serialization syntax.

The design of RDF is intended to meet the following goals:[4]

- Having a simple data model: so that other machine and applications can use them.
- having formal semantics and provable inference : a effective description and reasoning support
- Using an extensible URI-based vocabulary: vocabulary can be extensible through other resources indicated by URI references or URIrefs.
- Using an XML-based syntax : Xml data is serialized for information interchange between RDF .
- supporting use of XML schema datatypes & providing backward compatibility with XML datatypes
- Allowing anyone to make statements about any resource , thereby supporting open-ended assertion definitions by any one.

Resource description framework (RDF) is a graphical formation which in addition embodies the XML syntax also which helps in

- Annotating data and their resources.
- Describing the semantics in a manner in which it is machine accessible
- To give syntactic consistency between names
- To integrate data at low level.
- Represent simple data model

RDF assigns formalism to the metadata annotation and how we describe it, but it lacks the vocabulary definition such as subClassOf, Type or domain.

The above features are incorporated with help of RDFS(RDF Schema).This section will thus elaborated the need for RDF and RDFS

"The Resource Description Framework (RDF) is an XML-based language for describing information contained in a Web resource." [5]

"A resource can be a Web page, an entire Web site, or any item on the Web that contains information in some form" [6]

"RDF provides a XML –based syntax called the RDF/XML" [1].RDF is machine process able and it can link various pieces of information using the concept of URI's(uniform resource Identifiers) which are capable to identify any resource (any thing) on the web. This anything can be an information on the web page or the page itself or any website as the need be. That RDF is designed for knowledge, and not data, means RDF is particularly concerned with meaning.

III. RDF-S: DESCRIBING RESOURCES OF AN ONTOLOGY

RDFS describes the relationship of class and the objects of that class the first order predicate of RDFS is 'rdf:type'.

The use of 'rdf:type' predicate is to indicate what kind of thing a resource is

Like Professor is a type of Academic thus 'rdf:type' used to relate the entity Professor to another entity Academic.

The RDFS has other predicates, the important ones among which provide us more information about the predicate are 'rdfs:domain' and 'rdfs:range'. The 'rdfs:domain' rdfs:range' predicates relate a predicate to the class of resources that can serve as the subject or object of the predicate, respectively.

In a statements 'rdfs:domain' and 'rdfs:range' say that the subjects of academics can be Professor, Associate professor or Assistant Professor and objects of this predicate are literals like 'Rajiv' (string)and not date.

RDFS provides with concepts [2] to describe resources.

- rdfs:Resource rdf:type rdfs:Class (stating that resources is a type of Class)
- rdfs:Class rdf:type rdfs:Class (stating that Class is a type of Class)
- rdfs:Resource rdf:type rdfs:Class (stating that Property is a type of Class)
- rdfs:type rdf:type rdfs:Class (stating that type is a type of Class)

The utility of RDFS can be understood by the code snippet below retrieved from UnivPeopleProgramme ontology

```
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
]>
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:faculty="http://www.facultydesc.demo/AMITY#">
<rdf:Description rdf:ID="Academic">
<rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
</rdf:Description>
<rdf:Description rdf:ID="professor">
<rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
<rdfs:subClassOf rdf:resource="# Academic "/>
</rdf:Description>
</rdf:RDF>
```

It is to be noted that DOCTYPE of the above snippet has changed to XML Schema

It is also to be noted that the class Academic has been described as the Resource with an 'rdf:type' property and the value assigned is of Resource type 'rdfs:Class'. As shown below

```
<rdf:Description rdf:ID="professor">
<rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
<rdfs:subClassOf rdf:resource="# Academic "/>
</rdf:Description>
```

Thus Professor is also a class described as the Resource with an 'rdf:type' property and the value assigned is of Resource type 'rdfs:Class'.It is also emphasized that Professor is a subClassOf ,Class Academic.

It is thus known briefly that the purpose of RDFS is to define a class and group in instances of that class using 'subClassOf'.

The **R**esource **D**escription **F**ramework **S**chema is an ontology language [7] written in

RDF that supports the concept of:

– Resources and Properties
– Sub/super-classing,
– Instantiation,
– Inheritance,
– Domain/range Property restrictions.

IV. RDF: IN ONTOLOGY HEADER

The role of RDF in an ontology header will be explained using the screen shot shown in Figure 1

The Figure ! screen shot has been reproduced for better legibility

```
<rdf:RDF xmlns="http://www.w3.org/2002/07/owl#"
xml:base="http://www.w3.org/2002/07/owl"
xmlns:UnivPeopleProgramme="http://www.DemoUniv.edu/UnivPeopleProgramme.owl#"
xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
```

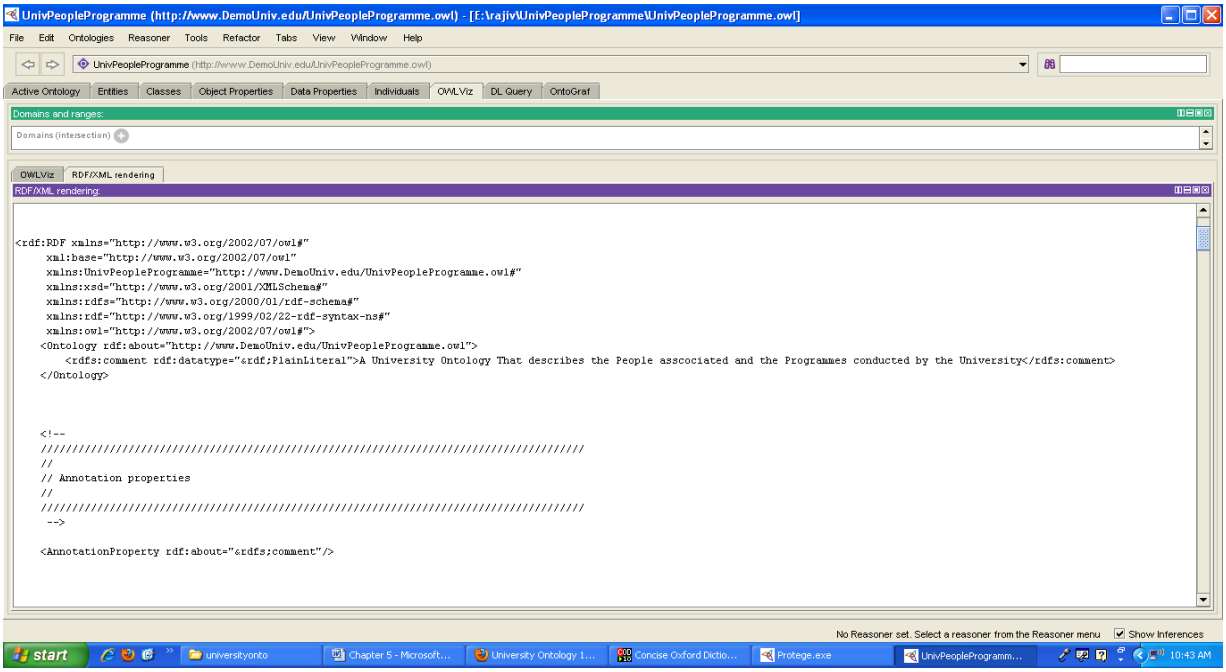

Figure 1 screen shot displaying the namespace section of the Ontology

xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:owl="http://www.w3.org/2002/07/owl#">
<Ontology rdf:about="http://www.DemoUniv.edu/UnivPeopleProgramme.owl">
<rdfs:comment rdf:datatype="&rdf;PlainLiteral">A University Ontology That describes the People asscociated and the Programmes conducted by the University</rdfs:comment>
</Ontology>

In the above it may be observed that the entire OWL definition is embedded in RDF tag. Which states that every OWL element is an rdf:RDF element or in other words OWL documents are RDF documents.

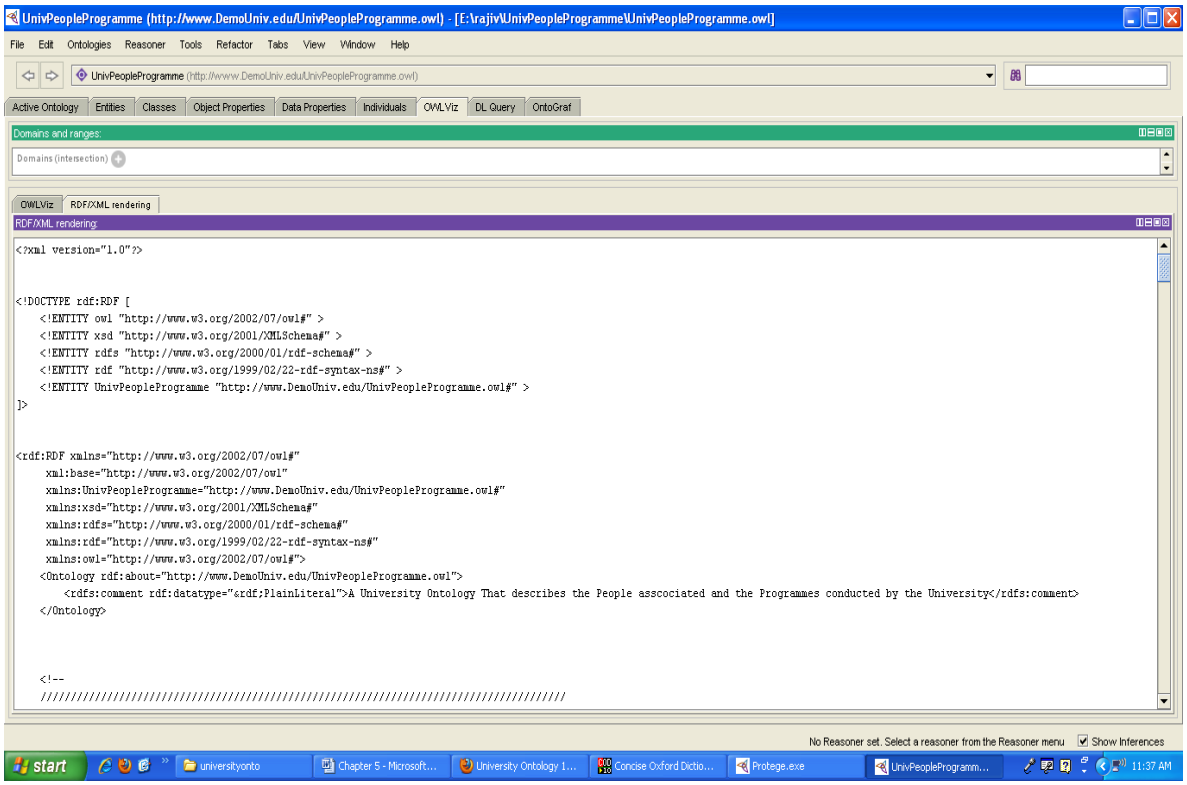

Figure 2 Screen shot demonstrating the DOCTYPE declaration

Code of Figure 2 is reproduced as below:

```
<!DOCTYPE rdf:RDF [
  <!ENTITY owl "http://www.w3.org/2002/07/owl#" >
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
  <!ENTITY UnivPeopleProgramme "http://www.DemoUniv.edu/UnivPeopleProgramme.owl#" >
]>
```

As an alternative to writing lengthy URL's ,during the reference in the ontology we can provide the ENTITY definition in the document type declaration portion of the OWL document using the keyword DOCTYPE and then through out the ontology definition that keyword precedes each definition . Each ENTITY is defined using RDF and RDF-S

As owl:Ontology would have to be otherwise written as

http://www.w3.org/2002/07/owl:Ontology

And each of the above would mean that the ontology refers to the name space defined by the URI 'http://www.w3.org/2002/07/owl'

It is important to state here that namespace and ENTITY definition in the DOCTYPE portion of the ontology may confuse to be performing the same purpose but it is not. Namespaces refer to the URI which supplies the syntax definition or schema and datatype support, but ENTITY definition helps to shorten the long URI reference and enable reusability of the prefixed keyword through out the OWL ontology.

V. ONTOLOGY HEADER DEFINED USING RDF AND RDF-S

Ontology headers solve the same purpose as the <head> tag of a web document in which the assertions of that particular web document is made ,thus the OWL document makes its assertions in the <ontology > tag. In the snippet below the contents embedded in the <Ontology> </Ontology> tag may signify that <rdfs:comment> is comment of plain literal datatype of rdf.

```
<Ontology rdf:about="http://www.DemoUniv.edu/UnivPeopleProgramme.owl">
  <rdfs:comment rdf:datatype="&rdf;PlainLiteral">A University Ontology That describes the People asscociated and the Programmes conducted by the University</rdfs:comment>
</Ontology>
```

- The headers of OWL ontology thus contain more of preprocessing information like the Namespace definition, ontology label annotation.

VI. RDF PROVIDING DATA DEFINITION AND RELATIONS IN OWL ONTOLOGY

The undermentioned part of the ontology is used to express relationship between the instances and properties of various types .It may include Annotating properties, Object properties and defining Classes along with the hierarchy definition.

ObjectProperty shown by the snippet below

```
<!-- http://www.DemoUniv.edu/UnivPeopleProgramme.owl#hasCoordinator -->
  <ObjectProperty rdf:about="&UnivPeopleProgramme;hasCoordinator">
    <rdf:type rdf:resource="&owl;FunctionalProperty"/>
    <inverseOf rdf:resource="&UnivPeopleProgramme;coordinates"/>
  </ObjectProperty>
```

Class definition as below stating that B.Tech.-CS is subClassOf computerScience:

```
<!-- http://www.DemoUniv.edu/UnivPeopleProgramme.owl#B.Tech.-CS -->
  <Class rdf:about="&UnivPeopleProgramme;B.Tech.-CS">
    <rdfs:subClassOf rdf:resource="&UnivPeopleProgramme;computerScience"/>
  </Class>
```

In the above code snippet of the UnivPeopleProgramme ontology the various property descriptions can be added to the ontology. The same are also represented by the RDF tags stating that ObjectProperty "hasCoordinator" is a functional property which has inverse property represented in the RDF tag by

"inverseOf rdf:resource= "&UnivPeopleProgramme; coordinates"

And

RDFS tag below helps to describe the subClassOf relation ship showing that B.Tech.-CS is subClassof computerScience

```
<rdfs:subClassOf rdf:resource="&UnivPeopleProgramme;computerScience"/>
```

VII. CONCLUSIONS

Despite the need being felt to make today's web more machine interpretable and knowledge extractable there is a lot desired to make the semantic web a reality. This paper prompts the importance of the Ontology and how RDF and RDFS can help serializing ontology development in the Web Ontology language (OWL) [9] .This paper described how RDF and RDFS can enable

- Role of RDF in namespace/header
- Class and instance description
- Describing data and object properties used to relate objects in an ontology
- Generating function and inverse properties

It is however stated that all aspects of the ontology and the description is beyond the scope of this paper thus the concept has been explained at an introductory level. This paper uses Protege_4.1_beta [8] for the purpose of Ontology development .Protégé is a free, open-source

platform [8] that provides a growing user community with a suite of tools to construct domain models and knowledge-based applications with ontologies. The screen shots are generated by the above tool

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