Design and Development of a University Human Resource Ontology Model for Semantic Web

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Summary
To help retrieve appropriate information from the web the use of semantics based on ontologies is gaining momentum. Ontologies help group linked concepts and therefore can be used by a search engine to locate information that do not contain the keywords entered by a user. So the word "rubber" maybe linked to office supplies or school supplies in addition to products that are directly made using rubber. In this paper we launch the idea of having an ontology based dictionary for the human resources and human beings involved in a university system. So we explore and present how students and university support staff can be linked through ontology definitions. The model developed in this paper can be used for managing human resources of any university.

Keywords:
ontology, semantic web, university ontology

1. Introduction

Modern era is the era of internet where people usually turn to web for searching any kind of information and retrieving information intelligently from these huge number of sources has become a great challenge. Unfortunately current web technologies are still not enough convenient or efficient to extract information just according to users need [1]. Semantic web is an approach that is developing to overcome this problem and this intelligent web offers users to share meaningful knowledge represented on the web [2] and ontology is considered the main term of semantic web [3] which describes concepts in the domain and also the relationships that holds between the concepts [4]. On the other hand university is a kind of organization that deals with lots of data. Considering the amount of data that needs to be used intelligently in universities we decided to develop a ontology model for university human resources. The aim of this paper is to present an ontology model for university human resource. A literature review was done at the beginning to observe what others have done while developing university ontology and later our model was presented followed by its description.

Manuscript received January 5, 2017
Manuscript revised January 20, 2017

2. Semantic Web and Ontology

Tim Burners Lee, the inventor of World Wide Web has already mentioned that semantic web is an extension of current web technology [7] as current web is not able to retrieve data intelligently. There are lots of data in the web stored in the format of html, pdf, docs and various types of images. While searching anything often we don't get the most relevant data that we need which definitely shows that current keyword base search technique is not working properly. At the same time it a waste of our valuable time and a major dissatisfactory event of the current system. An example may illustrate the idea more clearly. In a keyword search we may consider any word and search it in any search engine. Let us consider the word "grape" and search it in Google which is considered the most popular search engine at world at present. What did the search engine do? It actually matches the word "grape" in a website from billions of websites hosted in the World Wide Web. Sometimes a website assigns preferred keywords in the website. These are known as Meta tags which the search engine uses to identify the website. In this way, search engine tries to index the web pages using Meta tags.

To overcome this problem Lee Barnes himself has proposed the idea of semantic web [8] where data will be stored according to the knowledge domain and the related domain will be connected with each other based on ontology [4]. Ontology is used for knowledge engineering to which is extensively used in the field of intelligent information integration, cooperative information systems, information retrieval, electronic commerce, and knowledge management for reasoning about the properties of the domain and at times to describe the domain [4]. A great advantage of the ontology is that it is independent from the applications that use it which leads to easier software and knowledge maintenance and at the same time to contribute to the semantic interoperability between applications [9].

Musen, M. A [10] and Grubber, T. R. [11] mentioned ontology as an approach of sharing common understanding of the structure of information among people or software agents. As a result a common ontology used by different

web sites may help an agent to extract and aggregate information to answer user queries or as input data to other applications.

Noy and McGuiness pointed reusability as one of the unique features of ontology which means that if one group of researchers make an ontology then another group can easily use it or can change it as per their needs [12]. Theyalso claimed that ability of making explicit domain assumption is also an advantage of using ontology.

Mcguiness and Wright described that ontology can be used because of its capability of separating the domain knowledge from the operational knowledge [13]. Besides it helps to analyze domain knowledge if its declarative specification of term is available [14].

3. Related Works

Linda, B in her work mentioned how the current web or keyword base search works. She mentioned various method of clustering words some of which are highly complex and rely on sophisticated linguistics and artificial intelligence. According to her opinion some numerical approaches and software may used to determine meaning by calculating the frequency with which certain important words appear. When several words or phrases that are tagged to signal a particular concept appear close to each other in a text, the search engine concludes, by statistical analysis that the piece is "about" a certain subject [15].

Direct matching of keywords, as Linda mentions in her website, that keyword searches have a tough time distinguishing between words that are spelled the same way, but mean something different (i.e. hard cider, a hard stone, a hard exam, and the hard drive on your computer). This often results in hits that are completely irrelevant to the given query [20].

Parul and Sharma mentioned two types of limitation of existing keyword based search. They are related with word polysemy (means a word has multiple meaning) and synonyms (means the multiple word have same meaning). So, according to them the significance of term for building the index would be reduced and they emphasize the benefits of context based searching which is known as ontology based searching [16].

Various experiments have been done to develop semantic web based on ontology and a survey shows that 31% of the ontology was developed in the field of education [8]. Rajasurya, S et al [5] developed a search engine SIEU (Semantic Information Extraction in University Domain) which uses ontology as a knowledge base for the information retrieval process and presented in their paper that it works better than Google. Malik S. Kumar et al [2]mentioned in their paper thatontology is a broad term including a wide range of activities and issues in which ontology development is one of the most fundamental and significant concern. In their work they have considered the education domain and demonstrate the development of a university ontology using protégé 3.4.

Malviya et al [3] explained the terms of university through university ontology and eventually created a university ontology by using protégé. Bawany N. Shawoo and NoumanNazish [1] presented a case study for the derivation and implementation of ontology in higher education domain by discussing the key concepts of the domain. Their model was implemented in OWL 2.0 using protégé 4.0.

All the above work has focused on how to develop university ontology to retrieve information in a better and in an efficient way. None of them has focused on what should be the outcome of a university. Habib, M and Pathik B. Banik [6] mentioned in their paper that the outcome of a university is their graduates and the research done by them. Bearing this gap in mind we decided to develop an ontology that consists of research as a subclass of the ontology.

4. Proposed Model

Building Ontology is often divided into three steps: ontology capture, ontology coding and possible integration with existing Ontology [17]. Creating a well-structured and contradiction free is measured as good quality ontology and it often requires ability to conceptualize and articulate ideas and a skill for modeling abstractions. Good knowledge of the syntax of the ontology languages to express the model correctly is also prerequisite for the designer [18].

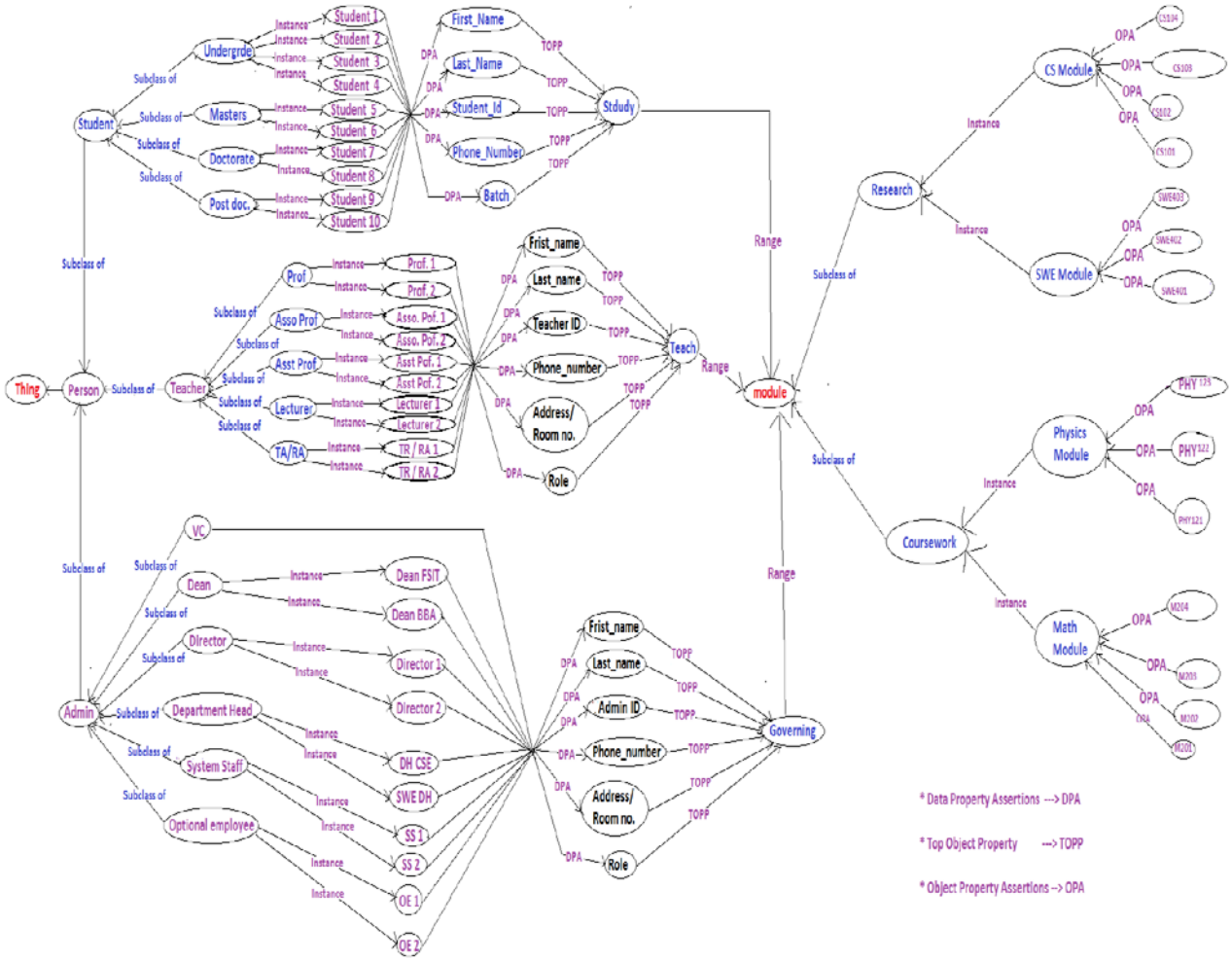

Fig. 1 Human Resource ontology for University

To develop ontology we have taken Daffodil International University as a test case. Protégé 5.0.0 [19] was used as development editor to develop the ontology and an OWL file was generated from protégé. Later using Apache Jena Fuseki SPARQL server [20] in local machine the ontology was tested. The ontology is shown in Figure 1.

4.1 Designing the ontology

To design the ontology model for human resource management for university we have started the idea from a person. It is considered as the parent class of student, teacher and admin those who are the resources of a university. Students are later categorized as Undergraduate, Masters, Doctorate, Post Doc and are presented as child classes of Student class. Each of them has instances with data properties First_Name, Last_Name, Student_Id, Phone_Number and Batch who are the top object property of Study. Study is a range of Module class. Module has two sub classes Research and Coursework. In our case we have shown two instances for Research class and they are CS Module and SWE Module. The subjects taught in these instances are mentioned as their object properties with respective course code. Similar approach is also practiced for coursework. The example code for Research with CS Module sub class is:

```
<!--
http://www.semanticweb.org/tourist800/university.owl#CS_Module
--><owl:Class rdf:about="http://www.semanticweb.org/tourist800/university.owl#CS_Module">
<rdfs:subClassOf rdf:resource="http://www.semanticweb.org/tourist800/university.owl#Research"/>
</owl:Class>
```

While expanding teacher class Prof, Assoc Prof, Asst Prof, Lecturer, TA/RA were considered as the subclass of teacher. Each of the subclass has instances and their data

properties. Every data property is a top object property of Teach class which is a range of Module and the subclasses of Module is as like as Student class. Some sample code for data type of Student class is:

<first_name
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">josef</first_name>
<last_name
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Baker</last_name>
<Phone-number
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">+8801739165943</Phone-number>

Similarly VC, Dean, Director, Departmental Head, System Stuff, Optional employee are the sub class of Admin. Except VC each of them has instances and each of them has data properties First Name, Last Name, Admin Id, Phone Number address and role. Each of this data property is a top object of Governing class and which is again is a range of module consisting with similar subclasses like Student or Teach.

4.2 Developing the ontology

A survey carried out by Sir Jorge Cardoso pointed out that protégé is the most commonly used Ontology editors and they have a market share of 68.2% [8]. The reason for its popularity is its customizable user interface and output file format, ability to redefine representational primitives and the ability to integrate with other applications. In our case also we have used protégé 5.0.0 to develop the ontology model we designed for university HR management. We have also visited web sites [22][23] for OWL tutorials and for better understanding of ontology.
Following steps are figured out as the fundamental steps for developing ontology [21] while using a tool:

- Obtain domain knowledge
- Identify the key concepts
- Build the taxonomy
- Identify relation between classes
- Consistency checking
- Implementation of ontology

Keeping all these steps in mind we tried to develop our ontology which is shown in Figure 2.

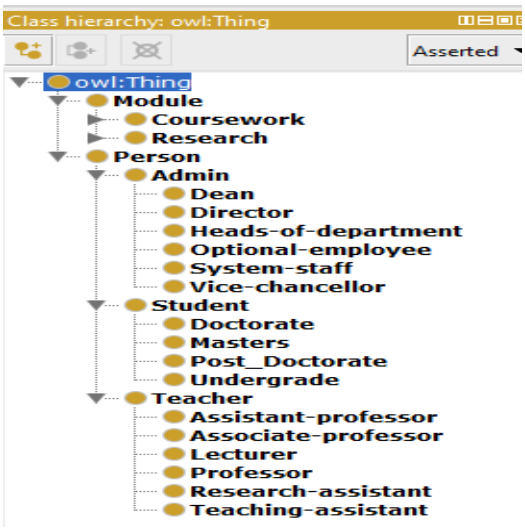

Fig. 2 Ontology classes developed in protégé 5.0.0

4.3 Implementation and testing of developed ontology

Developed ontology was then tested in a local machine using Apache Jena Fuseki SPARQL server and queries were tried to check the output. A sample query and its output is shown in the figure below.

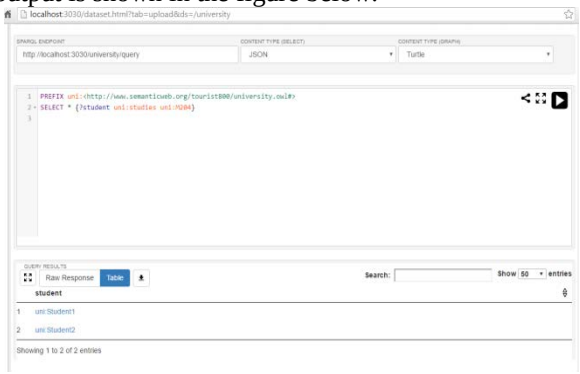

Fig. 3 output of a test query

5. Scope and limitation of the work

Aim of the research was to check whether ontology based semantic web can be used to manage a university human resources. To serve this purpose one special data property “role” was assigned for both Teacher and Admin class. Purpose of this data property is to store the list of responsibilities of both Teacher and admin class. Another notable feature of ontology is that one can add new concept to it any time. For example if anyone wants to add a data property for student class he or she can add it any time. In the same any class or sub class can be added as per the requirement. However, a major drawback of the

research is that it was tried only in a local machine and not in World Wide Web.

6. Conclusion and future scope

Semantic web is the ultimate destination of World Wide Web and definitely ontology is going to play a key role in revolution process. Our research is a small step towards that path but it can be implemented to any university for managing human resources. As it was not tested in web, research can be continued further to analysis user satisfaction after implementing the model in online for a particular university.

Acknowledgements

This research was supported by Daffodil International University. We thank our Honorable Vice Chancellor Professor Yousuf M. Islam. His insight and expertise greatly assisted the research, although he may not agree with all of the interpretations or conclusions of this paper.
We would like to show our gratitude toDrNouredinSadawi from Brunel University London, who assisted us to overcome the technical problems that we faced while developing ontology. We also thank Dr Mamun Habib from Brac University for his advices that encouraged us to continue the work.

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