Developing University Ontology using protégé OWL Tool: Process and Reasoning

Naveen Malviya, Nishchol Mishra, Santosh Sahu

Abstract— The current web is based on html which can display information simply. Researchers are working towards the semantic web which is an intelligent and meaningful web proposed by Tim burner's lee. Ontology and ontology based application are its basic ingredients. With the ontology we can focus on only main concepts and its relationship rather than information. Protégé is a most popular tool for ontology editing and for developing ontology [1]. It has a GUI which enables ontology developers to concentrate on conceptual terms without thinking about syntax of an output language. Protégé has flexible knowledge model and extensible plug-in architecture. This paper explains the terms of university through university ontology. We will focus on creating an university ontology using protégé. Rajiv Gandhi Technical University Bhopal, India has been taken an example for the ontology development and various aspects like: super class and subclass hierarchy, creating a subclass instances for class illustration, query retrieval process visualization view and graph view have been demonstrated**.**

Index Terms - Semantic Web, Ontology, protégé tool, OWL, DL, Reasoning,Object.

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1   INTRODUCTION

Ontology is the main term in the semantic web. Protégé tool is the most popular and widely used tool for ontology development. Here we use this tool for developing unicersity ontology. Much ontology has been proposed for semantic web ocer past decade. In the university domain also much ontology developed. We focus on this paper a different relationship in different concepts which include in university. In this paper we include in the first section semantic web and ontology, in the seconf section detail of protege tool. Third section ecplain literature reciew of our work and than in the fourth section is for proposed work than finally in the fifth section is for result and analysis and section six for conclusion and future work.

1.1 Semantic Web

AS the use of web data increase day-to-day. It would also affect to web database. So there will be a very big problem is that to arrange data precisely. To solve this problem Tim burner's lee proposed a new version of web called semantic web [5].
As Tim burners lee say "the semantic web is an extension of the current web in which information is given well defined meaning [12]." It is the idea of having data on the web defined and linked in a way that it can be used for more effective discovery, common understanding, re use of particular knowledge across various applications.

We have witnessed a significant evolution of standards as improvements and innovations allow the delivery of more complex, more sophisticated and more far-reaching semantic applications.

For the Semantic Web vision to become reality in everyday life, it is indispensable at this stage to present a snapshot that will capture certain key trends in the Semantic Web, the current developments and determine how researchers and practitioners are using and interrelating semantic technologies. Therefore, the results of a survey are presented here, so that we may keep a finger on the pulse of our community and demonstrate the variability and dynamism of the work being done on the Semantic Web, by looking at the picture that this survey paints for us [5].

2.2 Ontology

Ontologies are becoming the corner stone of the semantic web. Ontologies aim as capturing domain knowledge in a generic way and provide a commonly agreed understanding of a domain. They are shared conceptualizations of a domain, and they possibly include the representations of these conceptualizations [14, 15]. Ontologies are independent from the applications that use them. This leads to easier software and knowledge   maintenance, and contributes to the semantic interoperability between applications [6]. Owl language has many advanced features rather than other languages of ontology like rdf, rdfs. Owl language is the advanced version of DAML+Oil (DARPA agent markup language) [7]. Owl language describes more vocabulary and more effective relationship of any particular domain.

The OWL (Web Ontology Language) language is divided into three syntax classes [8]:

OWL-Lite - OWL Lite supports those users primarily

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needing a classification hierarchy and simple constraints. For example, while it supports cardinality constraints, it only permits cardinality values of 0 or 1. It should be simpler to provide tool support for OWL Lite than its more expressive relatives, and OWL Lite provides a quick migration path for thesauri and other taxonomies. Owl Lite also has a lower formal complexity than OWL DL.

OWL-DL - OWL DL supports those users who want the maximum expressiveness while retaining computational completeness (all conclusions are guaranteed to be computable) and decidability (all computations will finish in finite time). OWL DL includes all OWL language constructs, but they can be used only under certain restrictions (for example, while a class may be a subclass of many classes, a class cannot be an instance of another class). OWL DL is so named due to its correspondence with description logics, a field of research that has studied the logics that form the formal foundation of OWL.

OWL-Full - OWL Full is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. For example, in OWL Full a class can be treated simultaneously as a collection of individuals and as an individual in its own right. OWL Full allows an ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full.

Particularly, OWL-Lite and OWL-DL belong to the description logics [4] from the existing tools (e.g. Web Onto, Onto Edit), Protégé is chosen for implementation because it enables the construction of domain ontologies, and customized data entry forms to enter data. Protégé allows the definition of classes, class hierarchies, variables, variable-value restrictions, and the relationships between classes and properties of these relationships.

This paper focuses on how Protégé can be used for constructing ontologies in OWL. The approach is illustrated through creating University ontology based on student, course and teacher relationship using owl visualization and DL query plug-in of protégé. Pellet reasoner is used here for checking consistency.

2 PROTÉGÉ TOOL

Protégé is an ontology and knowledge base editor produced by Stanford University. Protégé is a tool that enables the construction of domain ontologies, customized data entry forms to enter data. Protégé allows the definition of classes, class hierarchies, variables, variable-value restrictions, and the relationships between classes and the properties of these relationships. Protégé is free and can be downloaded from [17]. Protégé comes with visualization packages such as OntoViz; all of these help the user visualize ontologies with the help of diagrams. The main strong point of Protégé is that it supports at the same time tool builders, knowledge engineers and do-

main specialists. This is the main difference with existing tools, which are typically targeted at the knowledge engineer and lack flexibility for meta-modeling. This latter feature makes it easier to adapt Protégé to new requirements and/or changes in the model structure.

At present the construction of ontologies is very much an art rather than a science [13].This situation needs to be changed, and will be changed only through an understanding of how to go about constructing ontologies. In short what is needed is a good methodology for developing ontologies. Steps of developing ontology from ontology tools display in section 3.

2.1 Other ontology tools compare with protégé

Sir Jorge Cardoso [5] carried a survey on most widely used ontology editors and most widely used domain for ontology development and found that protégé tool had a market share of 68.2% followed by Swoop, Onto Edit, TextEditor,Altova Semantic Works ,Oiled, Onto Studio etc. Compare view of all the other mostly used ontology editing tools are described below.
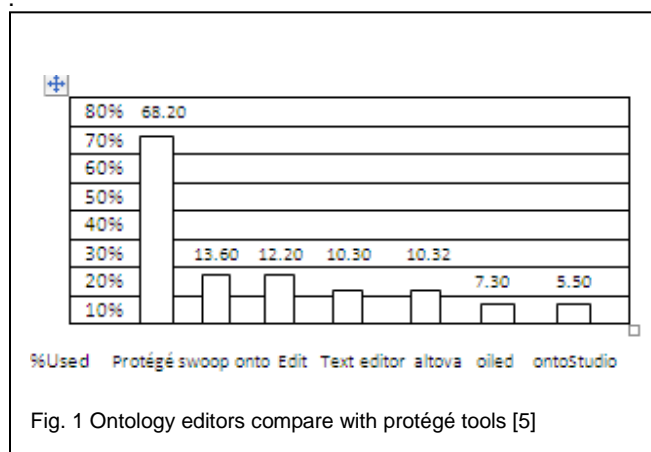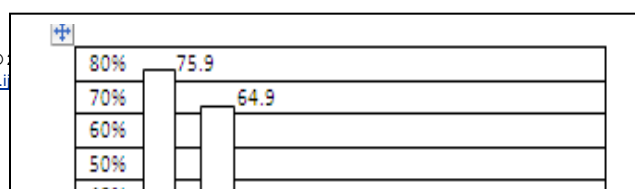
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Fig. 1 Ontology editors compare with protégé tools [5]

2.2 Ontology languages

Several ontology languages have been developed during the last few years. In 2002, Gomez-Perez and Corcho presented a study on Ontology Languages for the Semantic Web [1, 2]. The languages studied – XOL, SHOE, OML, RDF(S), OIL, DAML+OIL – were considered the most promising back then and it was thought that they would surely become ontology languages [9,10] in the context of the Semantic Web . Our study revealed something somewhat different. In. Fact, XOL (0.9%), SHOE (1.9%), and OML (0%) languages show extremely low adoption among oncologists. The language with the strongest impact in the Semantic Web is without a doubt OWL which is derived from DAML+OIL and builds upon the Resource Description Framework. More than 75% of oncologists have selected this language to develop their ontologies. OWL language is being used mostly for developing any ontology; here is the comparison of other used ontology language [5] with OWL.

student, course and teacher (professor, lecturer) that are important for university. Detail in next section about university ontology.

4 PROPOSED WORK

Illustrating ontology development using protégé 4.1 beta versions R.G.P.V. University, Bhopal, India has been taken as an example for the ontology development using the protégé editor (protégé 4.1 beta versions).

STEP- I
Classes and class hierarchy
The first step as illustrated in figure 4 gives the university related classes or concepts. All the concepts shows in the figure are mainly focus on the student, teacher and course based.

STEP – II
Object properties of ontology
We define object properties according to our relationship which we want to add between classes (as shown in fig. 4). Which show the relationship between individual to individual?

STEP-III
Data properties of ontology
In the step 3 here we display data properties of university ontology which show the relationship between individual to data literal (as shown in fig.5).

STEP -IV
Property and relationship
Only classes can't answer many questions so we also need to define link inside or between these classes (such as properties) we use property which show relationship between individual to individual (as shown in fig. 6).
Such as (property or lecturer as advisor of student)
Other property is data property which show link between individual to data type literal. Such as (takes course, Value 1) which student chooses which course for study? (About class diagram)
We also define object Properties Domain & ranges for example.

<owl: Object Property rdf: ID = "advisor">
<rdfs: domain rdf: resource="#student"/>
<rdfs: range rdf: resource="#faculty">
</owl: object Property>

In the top layer of university ontology includes: Person, publication, work, RGPV University etc
In Middle layer of university ontology includes: Employee, Student, article, book and subject, theses, Board of study, department and institute etc.
In Bottom Layer: Chair (Professor), Clerical Staff, Dean, Director, Lecturer and Professor Types, etc.

3 LITERATURE REVIEW

The education domain ontology gives some basic ideas of how classes are related to each other in ontologies. On an important concept such as "education" created on the basis of university. Since different groups of developers create their own university ontology. Many times they are different, furthermore there are always some missing concepts or relationship or even classes in different ontologies.

For example, in one ontology based on university controller of exam and other professor detail only, here he don't represent student relation with his subject, teacher, year etc. therefore , one might wont to be able to adjust , edit or combine ontologies concepts and add some other important concept related to university like student belongs to which years, experience of lecturer and professor and detailed about which teacher related to which subject and also student related to which course or subject and relation between all of them. To make university ontology more complete.

There are many ontology editors for example, protégé, onto Edit that allow developers to edit ontologies focusing on the protégé, currently there are two versions available to download and it is an open source developed using java. More detailed in section 2.

There are more than 150,000 users that help to develop ontologies and solve problem that may occur in protégé. In the case we find a more detailed ontology in a related topic of university in education domain such as developing university ontology, by Sanjay Malik in 2010 [1, 2]. Which focus on the university employee detail only based on date of joining , name, address etc. and ontology based on course, Ling Zeng, et al. 2009 [2]which focus on particular course to reuse of course for teaching purpose. We can add some extra features which is another important field of university. Like student relation with particular teacher, subject, year. So we can find more detailed about

For Example
<owl: object property rdf: ID = "has member">
<rdfs: domain rdf: resource = "#Person"/>
<rdfs: range rdf: resource = "# RGPV_ university "/>
</owl: object Property>.

Here we defined a object Property "hasMember" its domain is in Person and range in RGPV_university. It means that has member Property value will be only just opposite to the "isMember" property because has Property is always inverse to is Property.
If one attribute has many domain than its domain will be the intersection of its entire domain [3, 8].

STEP –V
The axioms of ontology

The axioms for classes
Axioms can be used to describe the relationship between classes, attributes and individuals. There are four axioms of classes, the existence of class, subclass, equivalent class and disjoint with And all the axioms describe by language using rdf: id, rdfs: subClassOf, owl: equivalentClass and owl: disjointwith.

The axioms for attributes
The axioms of attributes describe the relations between attributes, can be divided into: the relation of Inclusion (rdfs: subPropetyof), equivalent (owl: equivalentPropetry) and Inverse (owl: inverseOf), and The limitation of function (owl: FunctionalPropetry) and inversefunction (owl: InverseFunctionalProperty), the relation of symmetry (owl: SymmetricProperty) and transitive (owl: TransitiveProperty).

The axioms of instances
In OWL, there are two types' axioms between instances. One is the composition of members and value of attributes, first classify the information, and then describe the composition of each class and the value of its attribute. The other is two instances are whether equivalent those descriptions related to it are: owl: sameAs, owl: differentFrom and owl: AllDifferent etc.We applies in our ontology mostly axioms for providing more clear result of the university term by query search results. We apply characteristics functional property in object properties such as head, advisor, has member and teacher of etc. we know that is property is inverse of has property so is member object property are inverse functional according to rule. Teacher of object property are both functional and irreflexive characteristics .because we know one object property may be one or more characteristics [3, 16].

STEP –VI
The instance of ontology
Defining the instance (individual), first you should select the right class, and then create its instances for the class.

Use rdf: type to state its class, and one instance can belong to many classes or many class belong to same instances, for example:

</owl: thing rdf: id="CS102">
<rdf: type rdf: resource="#subject"/>
<rdf: type rdf: resource="#student"/>
</owl: thing>

Here it defined an individual or instance "CS102", which belongs to the class "subject" and "student". In which rdf: type has appeared twice, it shows that this instance belongs to two classes meanwhile [3].

STEP VII
The reasoning of ontology
For build correct and consistent ontology reasoning is most important part. Reasoner checks consistency and find the logic contradictions implicit in the definitions. The test of knowledge consistency includes detecting its reflexive, transmission and redundancy of knowledge [3].
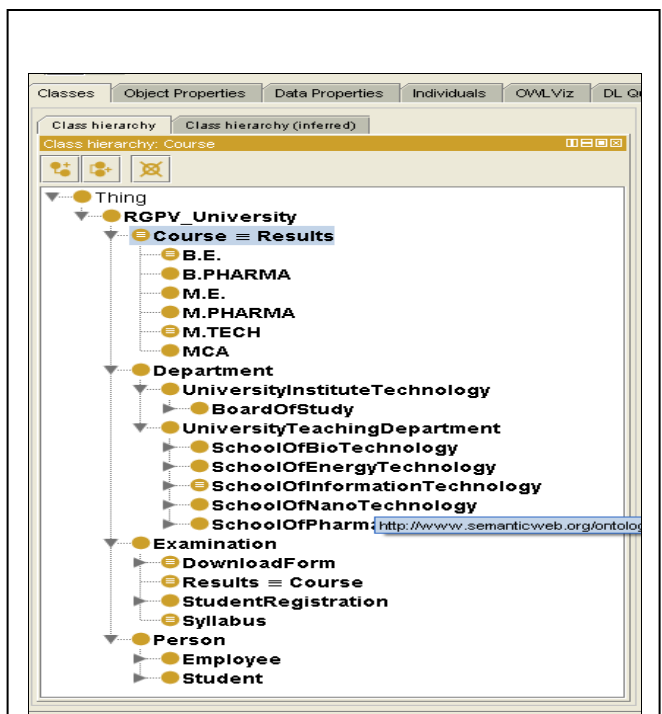

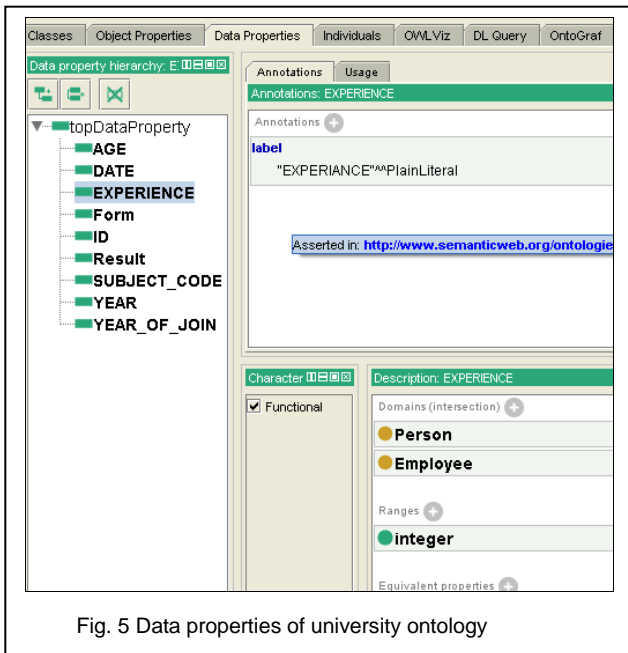Fig. 3 University ontology classes

Fig. 5 Data properties of university ontology

5 RESULT AND ANALYSIS

5.1 Visualization view –

Here we add important concepts or classes and add important subclasses of our university. Shows in the visualization view using OWLViz [17]. Which is visualization plug-in of protégé tool?

Here we display some visualization results of university ontology. Asserted view display classes graph which we define in the ontology and after reasoned protégé tool give its result according to our relationship (inferred view). Below we display asserted view and inferred view of concepts.
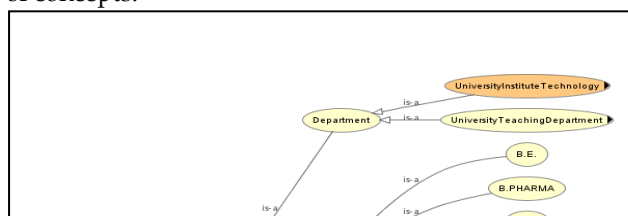
In this visualization view (as shown in fig. 6) two types of classes are showing. Yellow color class show primitive class which satisfy necessary condition only and orange color class show defined class which show both necessary and sufficient condition. In this view only university institute technology, M.Pharma, result, download form concepts are defined class and all the other classes are primitive classes. And arrow within concepts shows that class has some subclass and equivalent classes which are hidden. Like in the view university teaching department, university institute technology, M.Pharma, download form etc have more subclasses and equivalent classes which are hidden we describe this point details in class based visualization view.
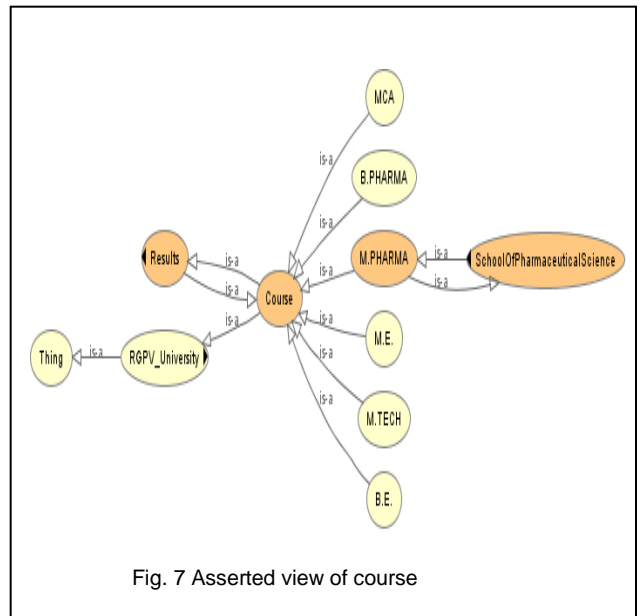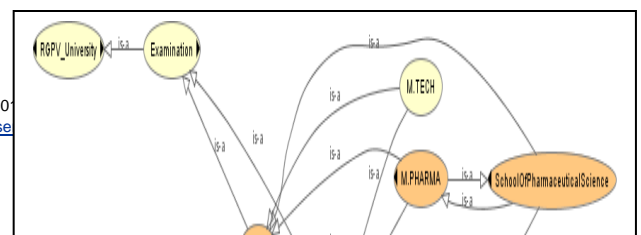
A. Course based

Fig. 7 Asserted view of course

In this view we show course based relationship, Thing is most super class which subclass is RGPV University RGPV University offers some courses which we include in course subclasses like display above B.E., MCA, B.PHARMA etc.(as shown in fig. 7)

School of pharmaceutical science class show backside arrow which indicates this class is subclass of some other class. We will display its super-class in the next section.
Results class also indicates backside arrow, so in both the class one particular point which is point out that both classes have double is-a relationship because both classes are equivalent to each other, every course have some result and M.Pharma relate to school of pharmaceutical science because school of pharmaceutical science is a department which offers M.Pharma which is a course.
In the inferred view of course (as shown in fig. 8) because we define course are related to the results so this will also relate all the subclass of course to the result. And both class and results relate with examination concepts .because result is closely related to the examination.

In the asserted view of person (as shown in fig. 9) RGPV University have both arrow backside and front side because it have both subclasses and subclasses which are hidden. Person is the subclass of Rgpv University and then it has also a subclass student and so on. Display in above view. We can search the list of student based on year
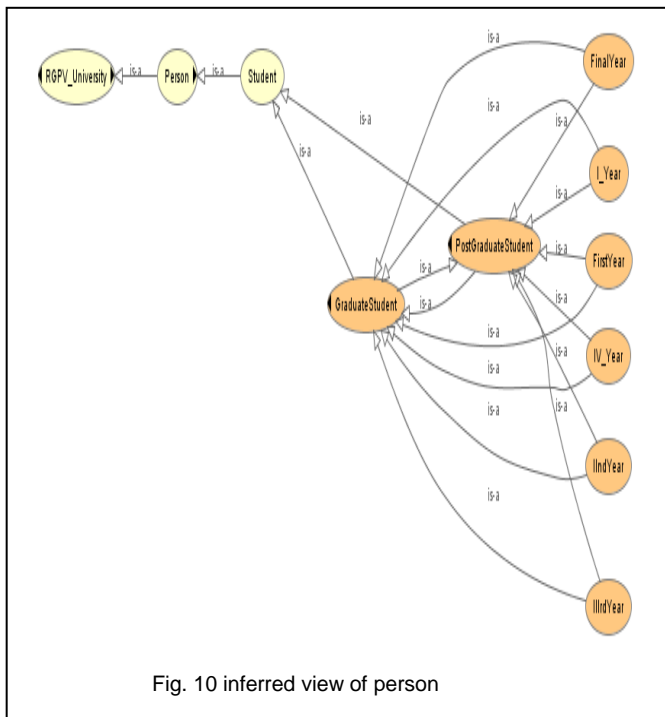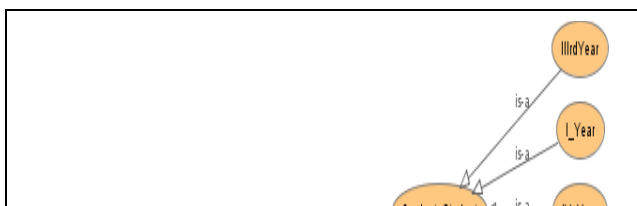

Fig. 10 inferred view of person

B.   <u>Person based</u>

In the inferred view of person class (as shown in fig. 10) we show that every postgraduate student link with graduate student because both read some same subject. So this type if

we relate any member to the other class member so that classes are also will relate to each other automatically.

C. Department based

RGPV University has two section of department one is university teaching department and other is university institute technology. In university institute technology (as shown in fig. 11) include subclass board of study which also has some subclasses like computer science engineering, information technology engineering, industrial production engineering, mechanical engineering, electrical engineering etc. and university teaching department offer master degree which include department like school of bio technology, school of Nanotechnology, school of energy technology etc. based on each department we can search members of any particular department.

In the inferred view course (as shown in fig. 12) M.Pharma is link to the school of pharmaceutical science automatically after reasoning because we link school of pharmaceutical science department equivalent to M.Pharma. Both members will be always same.

Fig. 11 Asserted view of Department
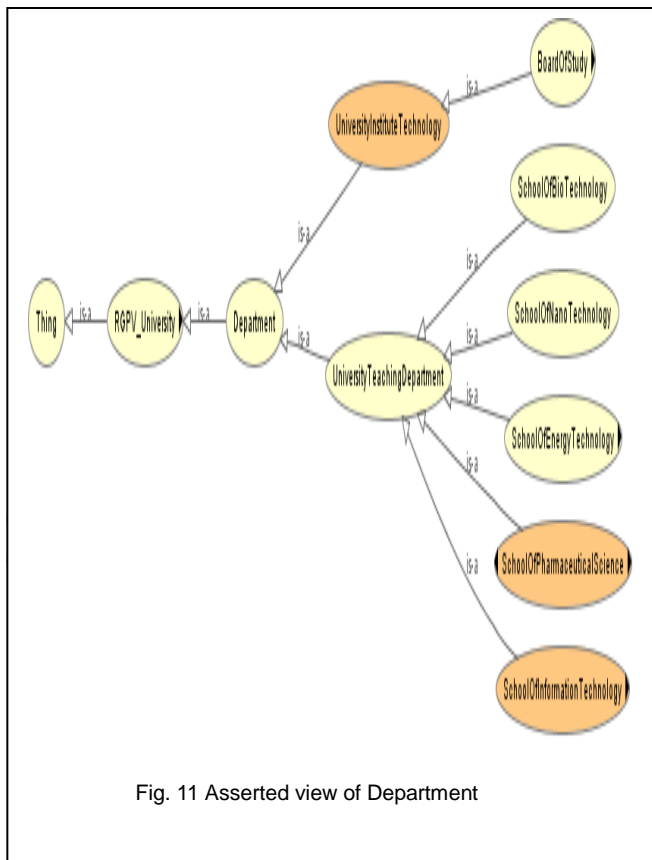
5.2 Query retrieval process –

Here we use DL query for search any information about our university we just enter the class name or object property name or data property name firstly confirm that reasoner start or not. Firstly start it and for checking your reasoner start or not check inferred class in the class tab option if in the inferred class not any class display it means that your reasoner is not start after checking such task you can type class or any property name correctly and then it will display related information about particular class or property. For example if we want to search Administrative staff of the university then we type name correctly with the particular case either upper case or lower case as we create in our ontology otherwise our query will not run[11].

For example if we search who will takes the particular course M1, then we will have to type only takes Course value and any subject name in the course . And result will display the detail of particular subject which students can take.
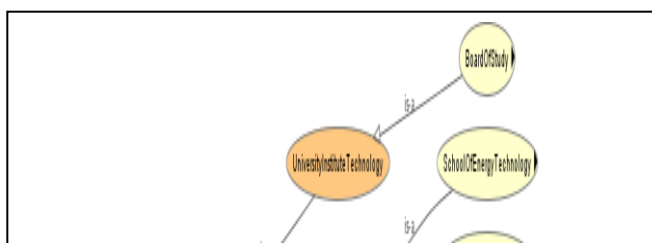
Course based search

web in to the state where machine also understand the about specific information and help to human for better results on the describe information intelligently. And in the semantic web vision ontology is main key concepts for perform such type of task. So we had focused on how ontology creates. Some basic steps regarding to screenshots display with most advance tool for ontology editing and creating that is protégé tool. We use protégé latest version for this task and also we had focus on the main plug-in of the tools which makes interest for the creating and editing ontology. This ontology will be useful for share common understanding of information among people.

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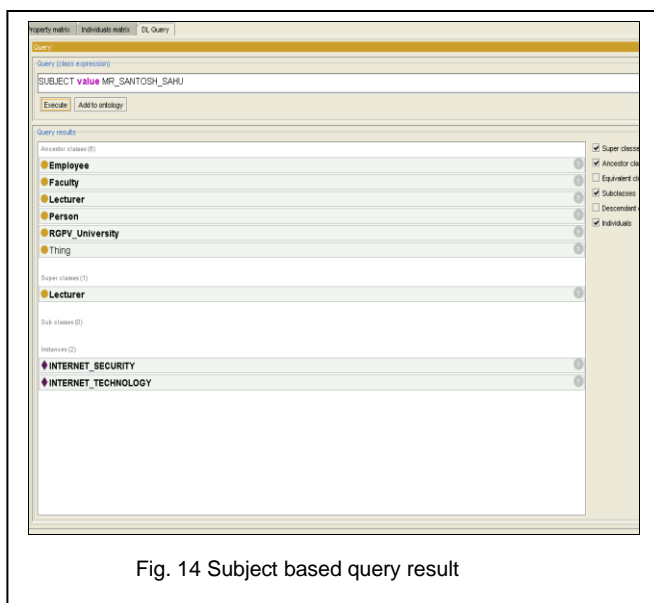
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Fig. 14 Subject based query result

5.3 Key Points

Some key points are our ontology-

We used protégé 4.1 beta version for creating this ontology and uses some protégé plug-in for more expressiveness of ontology , we used plug-in such as class tab, individual tab, object properties tab, data properties tab, cardinality view , owl viz tab and dl query tab , We used owl ontology language domain for developing ontology is education domain[1].

6 CONCLUSION

Our aim is to focus process to describe information not for only human readable but also to made information machine readable. What the process is of made such type of information like machine understandable format. This work fulfill by semantic web the semantic web aim is to be bring present