Swift Journals

Swift Journal of Mathematics and Computer Science Research
Vol 1(1) pp. 001-007 November, 2016.
http://www.swiftjournals.org/sjssh
ISSN: 2986-9900

Original Research Article

Design of Intelligence Gathering Model: a Semantic Web Approach

Agbo, Friday Joseph[1], R.G. Jimoh (PhD)[2] , Sunday, Kissinger[3]

[1,2]Department of Computer Science, University of Ilorin, Ilorin
[3]Department of Mathematic, Computer Science Unit, Usmanu Danfodiyo University, Sokoto,Nigeria

Accepted 8th November, 2016.

ABSTRACT

Intelligence Information Gathering (IIG), investigation and analysis are vital components of security management in any society. The ability to know What, Where and When an event occurs is a key element of the investigation process, especially in a large data set. This is a Thematic, Spatial, and Temporal reporting issues. Semantic Web technologies such as Resource Description Framework (RDF), Resource Description Framework Schema (RDFS) and Web Ontology Language (OWL) have been discovered to be a good approach to solving these issues. This research paper proposed a semantic web based approach for modeling IIG. The paper uses OWL ontology, which has more expressivity than RDF to design knowledge-based ontology of a university that could be used to model IIG in campuses. We discuss the various results gotten from the designs which are generated from protégé application.

Keywords: Semantic Web, Thematic, Spatial and Temporal, Intelligence Gathering, Knowledge Base.

INTRODUCTION

One of the major issues facing many countries of the world today is the security challenges at different quotas. However, there is a lack of consensus on how to deal with the problem. Hence, the problem is degenerating.[1]

The advent of the internet and the World Wide Web (WWW), with all its enormous benefits, have broadened the scope of the security challenge. In 1993, Tim Berners-Lee, the director of the World Wide Web Consortium (W3C) developed the World Wide Web or the web technology to the public[2]. Little was known about it then and soon it became a great platform for commercialism, socialism, and networking all around the world. The web has now being categorized into Web 1.0, Web 2.0, Web 3.0 and 4.0. Web 3.0's peculiarity lies with the use of Semantic web technology. The Semantic web is a project that intends to provide a universal platform for information exchange and by so doing provides a computer-processable meaning on the www[3].

The concept of Semantic Web was born out of Berners-Lee's dream that the Web becomes a platform where the computers are capable of analyzing all the data on the Web – the content, links, and transactions between people and computers [4]. The semantic provides technologies such as eXtensible Markup Language (XML), Resource Description Framework (RDF), Resource Description Framework Schema (RDFS), and Web Ontology Language (OWL). XML was the first among all these technologies that enabled developers to organize data around tags that are well formed or well nested based on a rule written in Document Type Definitions (DTDs) or XML Schema. RDF is often seen as a data model in which data is represented in an object-attribute-value pattern called a statement. RDF has been given XML syntax and it is domain independent- that is, its applicability covers any real world domain. But users of RDF may choose to define their own terminology by using a schema called RDF Schema (RDFS). RDF/RDFS enabled us to model particular domains such as the products/services. Another language for modeling concepts is the Web Ontology Language (OWL).

RELATED WORK

The importance of spatial and temporal data in analytical domains such as national security and a criminal investigation

**Corresponding Author:* Agbo, Friday Joseph, *Department of Computer Science , University of Ilorin, Ilorin*
Email: freddy4uagain@hotmail.com

was highlighted in[5]. Often, the analytical process requires uncovering and analyzing complex thematic relationships between disparate people, places, and events. A description of a framework built around the RDF metadata model for analysis of thematic, spatial and temporal relationships between named entities was done while presenting a set of semantic query operators. A major achievement in their work was the modeling of spatial, temporal and thematic data using ontologies and temporal RDF graphs. This research work leveraged on the existing work and enhances on it by employing OWL ontology with more expressive power over RDF.

According to the decision model proposed by [6], a three layered architecture working concurrently will provide and improve the technology of information retrieval (IR) and information extraction (IE) from a large dataset. The model is believed to present a high filtering technique for information gathered from different sources in order to achieve reliability, efficiency, cost-effectiveness and decision making, which has been a huge challenge for human to carry out manually[6].

Sustainable knowledge management and more intelligent decision support are beneficial to collect, consolidate, store and share experiences in a form of a knowledge base or domain ontology in medical emergency management for mass gathering[7]. This paper describes the process of developing and evaluating a Domain Ontology for Mass Gatherings (DO4MG) with a focus on medical emergency management.

One of the issues facing Semantic Web Computing is the creation and adoption of standardized ontologies in OWL for the various industry domains to precisely define the semantic meaning of the domain-specific concepts. The additional modeling effort incurred by ontologies must result in savings elsewhere[8]. Figure 1 depicts the different Semantic Web technologies stack and their relationships.

SEMANTIC WEB IIG ARCHITECTURE

The paper first presents the proposed model and went further to develop the OWL ontology based on the architecture of the system. A brief introduction to the tools employed in the design is also given in this section. The architectural design of the model is given in figure 2 which shows that the components of the system are subdivided into three levels of abstraction. They includes

1. Users Level of Abstraction
2. Server Level of Abstraction
3. Security Analyst Level of Abstraction

User Layer contains interfaces for users to login through the computer and or mobile device, a form to capture the security report to be forwarded to the chief security officer (CSO) and a confirmatory message of successful submission. All users are authenticated to ensure their valid identity.

Server Layer contains three tiers. The knowledge based (KB) tier, reasoner tier, and logic tier. Each contains components that are interacting with one another or with another tier. The KB consists of MySQL and the domain ontology, which both interact with the database server. The database holds all the information about the domain and the users. The reasoners are tools like the Jess or Pellet used for reasoning the ontology. The last component in the server layer is that of the logic tier. This part of the server ensures that the connection between the client and the server is established to create a communication line between the two entities. The rule engine, SQWRL, SWRL and the OWL API ensures the implementation of rules written by the users. Security Analyst receives the intelligence report from the system and also run queries to ascertain the thematic, spatial and temporal element of the report before carrying out further investigation or action.

ONTOLOGY DESIGN

The domain of this paper is intelligence gathering and investigation, hence the researcher limits the scope of the ontology domain to a university community. The design and description of the required ontologies have three major entities; the students, the staff, and the visitors.

4.1 Steps in designing an ontology

Fundamental steps are required in designing ontology, this was highlighted by [9], who suggested the following relevant steps needful in the process of developing and designing an ontology:

a. Determine the domain and scope of the ontology.
b. Consider the reuse of existing ontology.
c. Enumerate important terms in the ontology.
d. Define the classes and the class hierarchy.
e. Define the properties of the classes.
f. Define the facets of the properties.
g. Create instances.

The highlighted steps were followed in creating the university ontologies using Protégé.

Protégé

Protégé is a free, open source ontology editor and a knowledge acquisition system. Protégé provides a graphic user interface for defining ontologies by clicking tabs presented on the menu.

The first thing to do after opening a protégé application program is to save the model through the File menu. When saving the ontology model, the file must be saved with .owl as the extension. This is illustrated in figures 4a-c below.

RESULTS AND DISCUSSION

As mentioned earlier, the domain of the ontology is the students, staff, and visitors while the scope is the university. Figure 5 shows how classes are created while figure 7 demonstrates the classes in their hierarchy.

The reasons why this paper chooses to design the ontology in OWL instead of RDF/RDFS are first, OWL has more expressivity than RDF/RDFS. Some requirements that OWL provides against RDF/RDFS are; rdfs:range constructs. RDFS allows property ranges to be specified for all classes, there is no provision for giving restrictions that apply to some classes. OWL however, makes provision for this. DataProperty and ObjectProperty can be created in OWL and specifying its scope with respect to some classes. Secondly, there are no means to use RDF/RDFS to specify disjointness of classes, but this can be done with OWL. Thirdly, building new classes from a Boolean operation on existing classes is possible with OWL and not with RDF/RDFS. Placing restrictions on how many distinct values a property may have is not expressible with RDF/RDFS except with OWL

Lastly, some particular features of properties, say, for example, a property or relation such as transitive, symmetric, functional or inverse are not implementable with RDF/RDFS, hence, OWL is a better choice.

Relationships between Classes and Individual of the Domain Ontology

Classes are the entities in the domain under discuss while individuals are the instances of the classes. The relations (properties) are created to connect entities or classes and literal values. There are two types of properties that are used in OWL. These are DataProperty and ObjectProperty. Some of the DataProperties used in the design are hasAge, hasName, hasSex and livesIn while some of the ObjectProperties used are admitedTo, belongsTo, isStaffOf, isStudentOf, studiesIn, memberOf and teachesIn. Figure 6 and 8 shows some of the ObjectProperties and DataProperties created in this ontology respectively.

In ontology design, all classes are subclass of Thing. This means that in the hierarchy of classes, the root class is class Thing. As shown in figure 9a and 9b, visitor, staff and student are all subclasses of class Person which is, in turn, a subclass of Thing.

OWL Visualization and Ontology Graph

One of the benefits of using protégé in designing ontology is the fact that it provides many plugins that make the work flexible and easy to develop. Some of them are the pellet reasoner, OWLViz, OntoGraph etcetera. These plugins were used in this our to make the work presentable. Figure 9a & b, and 10 shows the OWLViz and OntoGraph of the ontology respectively. A pictorial representation that shows all the classes, subclasses, individuals and their relationships is generated via a protégé plugin called Jambalaya. These graphs are presented as snapshots in figure 11.

CONCLUSION AND FUTURE WORK

This research work presented a model for thematic, spatial and temporal intelligence gathering with a university ontology designed based on OWL technologies. The proposed model in figure 2 gives the building block for designing knowledge based system and particularly intelligence information gathering system. Though the domain of the ontology can be improved upon to include other public domains, we have developed an ontology in the domain of university, which can be adopted for other designs or future research. Figure 6, 7 & 8 shows the hierarchical construct of the data properties, the classes and the object properties of the domain ontology respectively. A better visualization of the designed ontology is shown in figure 11, where the hierarchy starts from the root class Thing and flow down to other sub-classes. Also, full implementation of the proposed design could be carried out to make intelligence gathering and investigation process more efficient.

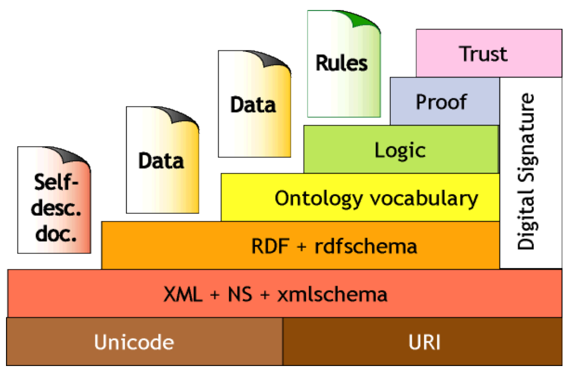


Figure 1. Semantic Web technologies stack [12]

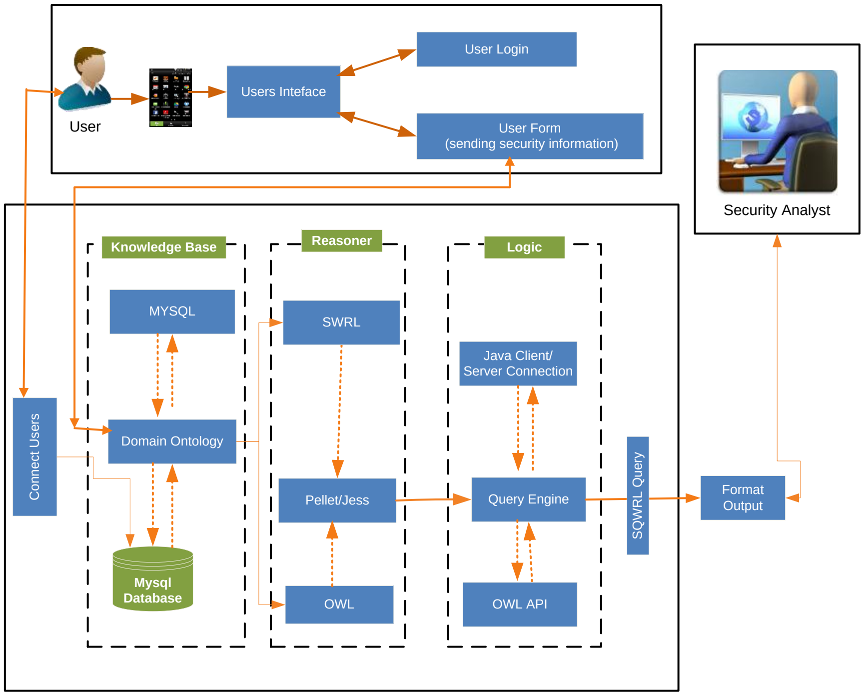


Figure 2: Model Architecture

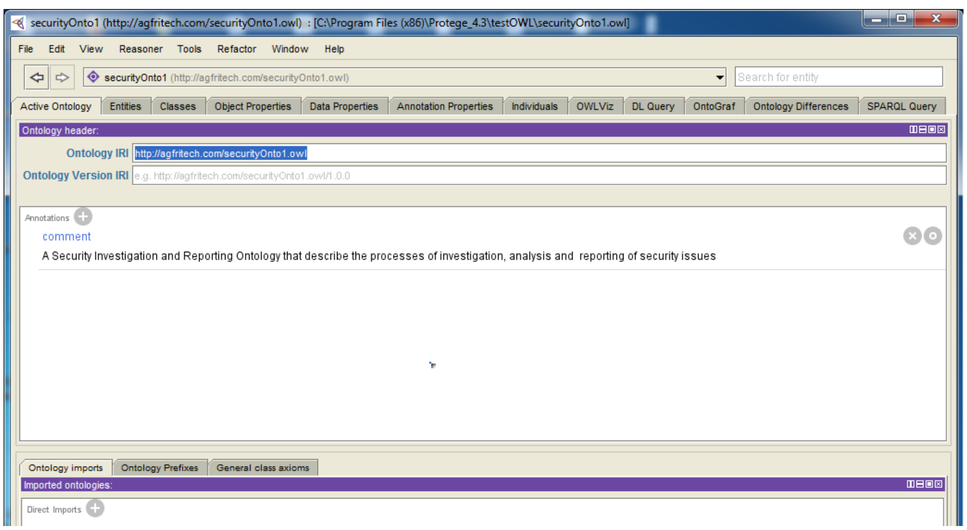


Figure 3: Graphic Users Interface of Protégé Application

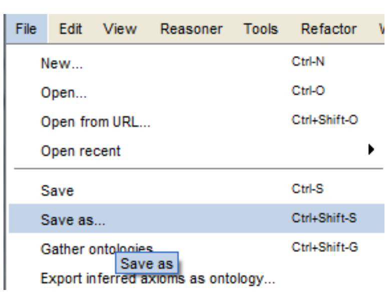
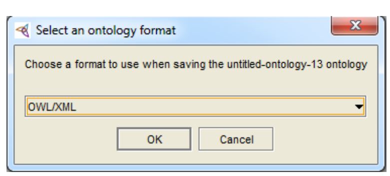
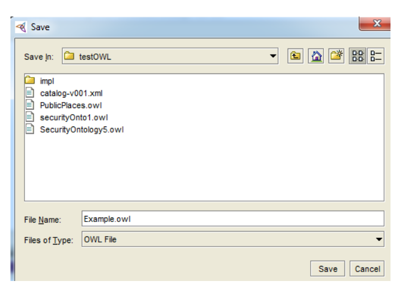


Figure 4a: Saving Ontology Model



4b: Selecting Ontology Format



4c: Saving Ontology with .owl file extension

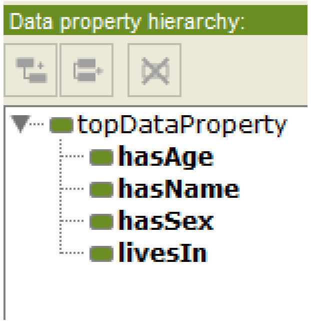


Figure 6: Data property hierarchy

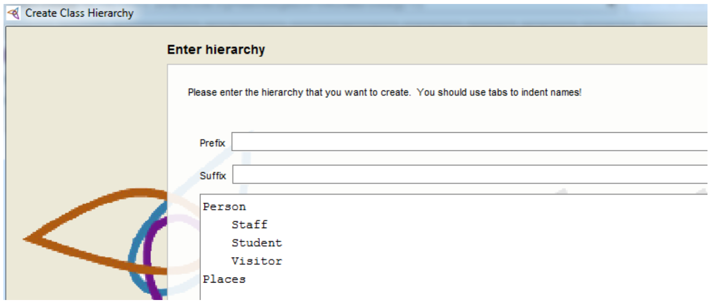


Figure 5: How to create classes

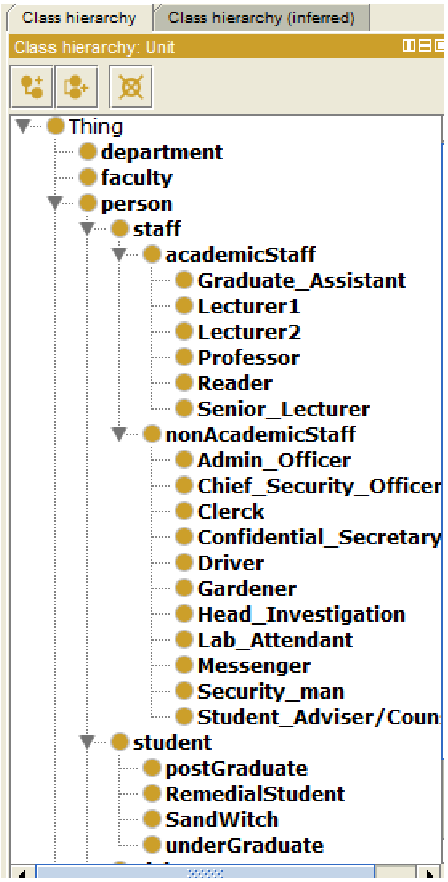


Figure 7: Domain Classes and their hierarchy

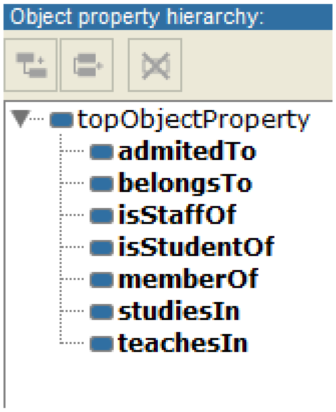


Figure 8: Object property hierarchy

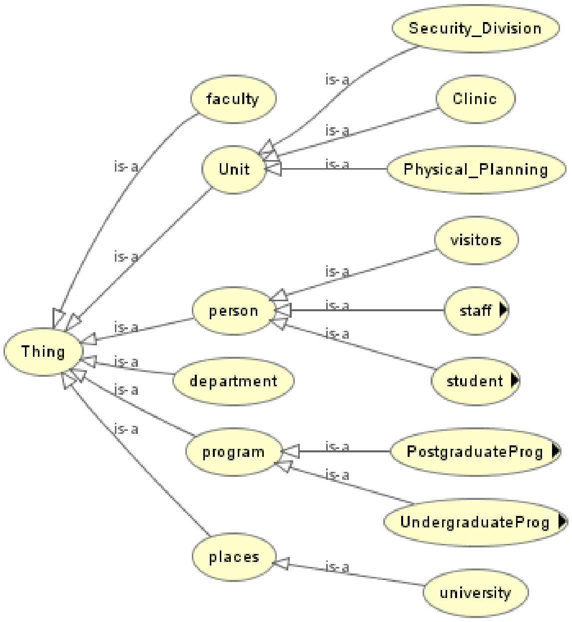


Figure 9a: Compact Classes & Sub-classes Hierarchy

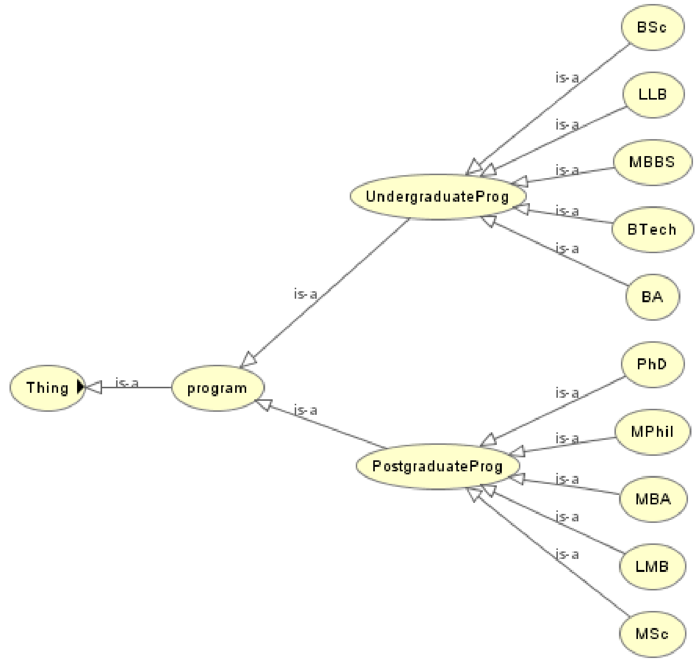


Figure 9b: Class Person & Sub-classes

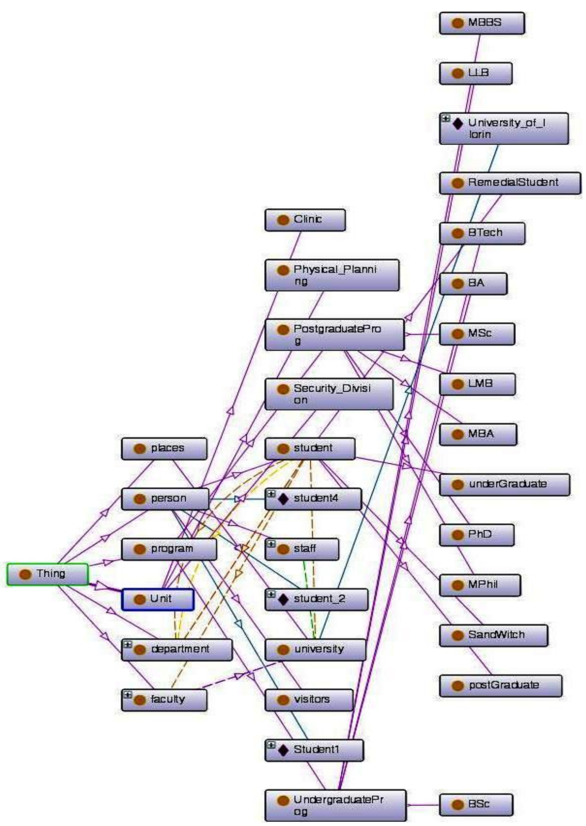


Figure 10: OntoGraph showing detailed classes and Individuals

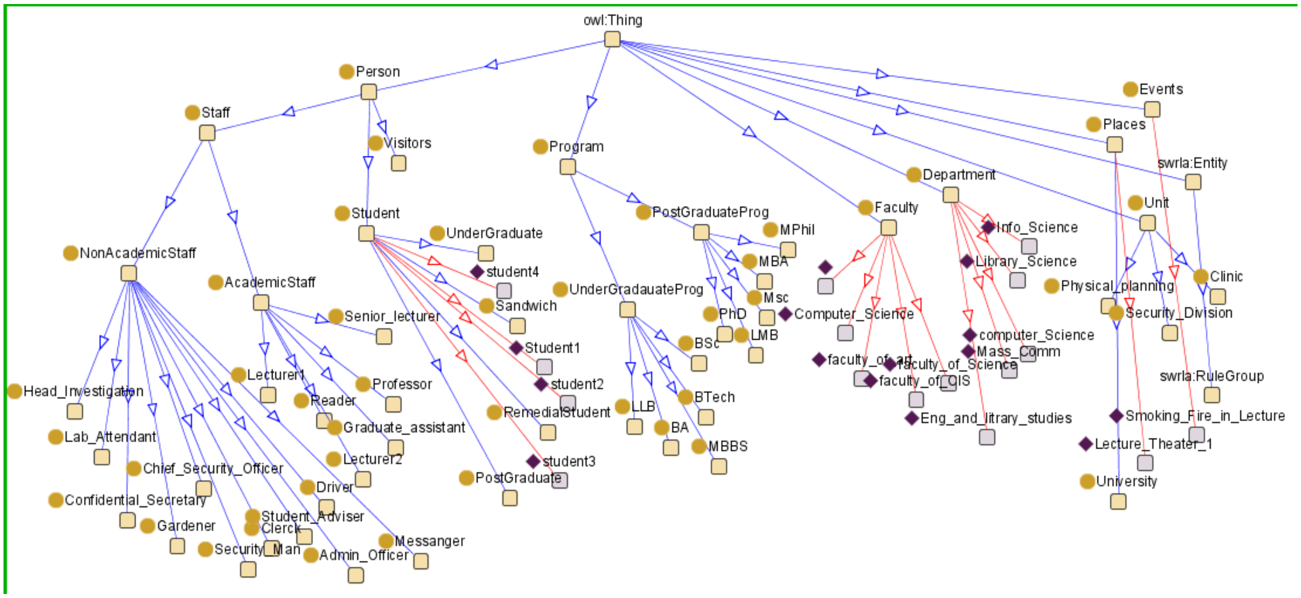


Figure11: Jambalaya graphical representation of the ontology

REFERENCES

[1] Isaac Olawale Albert, "Explaining the Security Challenges in Contemporary Nigeria," Institute of African Studies, University of Ibadan, 2012.

[2] Thomas R. Gruber, "A Translation Approach to Portable Ontology Specifications," KNOWLEDGE SYSTEMS LABORATORY, Computer Science Department, Stanford University, 1993.

[3] O. Nathaniel Oyelade, S.B. Junaidu, and A.A. Obiniyi, "Semantic Web Framework for E-Commerce Based on OWL," International Journal of Computer Science Issues, Vol. 11, Issue 3, No 2, 2014.

[4] T Berners-Lee, "Weaving the Web," The MIT Press, Cambridge, 1994.

[5] Matthew Perry, Amit P. Sheth, Farshad Hakimpour, and Prateek Jain, "Supporting Complex Thematic, Spatial and Temporal Queries over Semantic Web Data," in Ohio Center of Excellence in Knowledge-Enabled Computing, Kno.e.sis Publications, Ohio , 2007.

[6] Lesser Zilberstein and Victor Shlomo, "Intelligent Information Gathering Using Decision Models," Computer Science Department, University of Massachusetts at Amherst, 1996.

[7] Delir Haghighi Pari, Burstein Frada, Zaslavsky Arkady, and Arbon Paul, "Development and evaluation of ontology for intelligent decision support in medical emergency management for mass gatherings," Elsevier, 2012.

[8] U. Dinger, R. Oberhauser, and C Reichel, "Leveraging Web Service-based Software Engineering," Proceedings of the International Conference on Software Engineering Aadvances (ICSEA'06), 2006.

[9] Raja A. Mohan and G. Arumugam, "Constructing Railway Ontology Using Web Ontology Language and Semantic Web Rule Language," 2011.

[10] G. Wolfgang. (2010, August) Semantic Web, Part of business world. [Online]. http://www.semanticweb.rs/Article.aspx?iddoc=32&id=65&lang=2

[11] Semantics Cambridge. (2015) Cambridge Semantics. [Online]. http://www.cambridgesemantics.com/semantic-university/introduction-semantic-web

[12] T. Berners-Lee and J. Hendler, "The Semantic Web: A new form of Web content that is meaningful to computers will unleash a revolution possibilities.," Scientific American, 2001.

12. Weinstock D.M., Case, Jr C., Bader J.L., Chao N.J., Coleman C.N., Hatchett R.J., Daniel J. Weisdorf D.J., and Confer D.L. Radiologic and nuclear events: contingency planning for hematologists/oncologists Blood. 2008; 111(12): 5440–5445. Prepublished online Feb 20, 2008. doi: 10.1182/blood-2008-01-134817 PMCID: PMC2424146