Towards the Semantic Web: Design an Ontology and use it in Semantic Query

Samira I. Abu Salama, Tarig A. Mohammed

College of Science and Technology, Omdurman Islamic University, Sudan
 samiracisco@hotmail.com , tarig.abdo@gmail.com

Abstract

Today, the information on the Web is designed for human interpretation and it is not machined processable. Tim Berners-Lee is the inventor of the Web, and he believes that one of the goals of primitive Web being useful for machines not yet achieved. To achieve this goal, Semantic Web was introduced as a vision for the future of the Web. Accordingly, the researchers and scientists worked to develop the Semantic Web and to produce tools, rules, and technologies to become a fully semantic. One important component of the Semantic Web is the ontology. Ontology can provide semantic meaning through relations between concepts. In this paper, we introduce PLSTNO ontology to enrich the Semantic Web by reviewing the methodology and describing the process of building ontology to clarify relations between governorates, the cities, and villages in the administrative division of Palestine. Then inquire about this ontology using the appropriate tools. Finally, the research introduces the reader the techniques and methods currently in use and the open research questions in ontology and Semantic Web development.

Keywords: *Semantic Web, Ontology, Query, Relationship, Concept, Individual.*

1. Introduction

The Semantic Web [9] has recently attracted much attention, both from academia and industry, and is widely regarded as the next step in the evolution of the World Wide Web. It aims at an extension of the current Web by standards and technologies that help machines to understand the information on the Web so that they can support richer discovery, data integration, navigation, and automation of tasks.

Ontology is an important component of Semantic Web, which is a way of representing semantics and enabling them to be used by machines and specifically by web applications. Ontologies constitute a formal conceptualization of a particular domain of interest that is shared by a group of people [10].

An ontology is an explicit specification of a conceptualization [2]. The term is borrowed from philosophy, where an ontology is a systematic account of Existence. For knowledge-based systems, what "exist" is exactly that which can be represented. When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. This set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge.

The word "ontology" is used with different meanings in different communities. We distinguish between the use as an uncountable noun ("Ontology" with the uppercase initial) and the use as a countable noun ("an ontology" with the lowercase initial)[3].

Protégé is ontology editor, and it is an open-source platform written in Java's programming language, which enables Protégé to be run on many favorite operating systems. Protégé can be used as a standalone application or as a Java library (Protégé API) that provides access to knowledge bases. The Protégé platform was designed as plug-in architecture and is written itself as a collection of plug-inns that can be replaced to change the interface or behavior of Protégé. Core Protégé API provides only access to basic functionality of Protégé and support for frame-based knowledge bases. Protégé-OWL plug-in extends Protégé with OWL API and editor user interface to provide access to OWL ontologies[7].

This paper aims to increase enrich the Semantic Web by understanding what is an ontology and how it has been built. Furthermore, it aims to focus the use of ontology for the development of Semantic Web. It aims to formalize the relations between the governorate with city and village in a country. A description of the type of knowledge ontology will be given.

The paper is structured as follows: First, section 2 presents the related work. Next, section 3 focuses on the methodology followed to build ontology named PLSTNO that shows us the administrative divisions in concepts or classes and explains many relations between its components and explains its domain, components and queries using Protégé editor with two tabs: SPARQL Query tab and DL Query tab. This section presents another queries executed in Fuseki server. Finally, section 4 presents conclusions and further work, which illustrated the success of building ontology and its use.

2. Related Work

Geographic information used the ontologies, and it takes a wide area in several papers. [5] Presents creating ontology based markup of geographically referenced information. This ontology based approach to associate geographically referenced data to any other non-spatial information related to the geographic feature that is expressed on the Semantic Web.

According to[14], this paper introduces an ontology based approach to disambiguate geographical names in texts. The ontology defines the central conceptual basis to rank geographic features based on disambiguation rules that take into account structural information contained in the ontology (e.g. population of a town). They used classes as country and populated place to formulate ranking rules based on concepts and utilize the lexicalization of the ontology as a gazetteer.

[4] uses protégé to build Nile River Geo-Ontology. It describes the building of ontology, and a simple application of the ontology is shown using the Query tool. The ontology consists of some classes as country and city.

[1] formalizes the definition of city indicators using the technology of Ontologies as implemented in the Semantic Web. It develops the Global City Indicators ontology (GCI). The GCI ontology is built on a set of "foundational" ontologies that provide many of the basic concepts with which to construct the GCI terminology.

We have captured many of the ideas presented in the above-mentioned papers. All of them used ontologies to present geographic places, and they used city, country classes and population property. Since most countries contain governorates in administrative divisions, it is important touching them in Web technology to clarify its relationship with the city and the village. So, after searching and reading the papers above mentioned and other, we did not find any paper linked governorates with the cities and villages in any ontology. Thus, we found it is better to design an ontology includes this idea and illustrates this relationship using classes, individuals and relations and applied them with an example of a country of Palestine.

3. Methodology

We will use Protégé software to build our ontology about Palestine country with PLSTNO name who presents the administrative divisions in concepts or classes. According to the class type, we will choose data from Wikipedia to create individuals and properties for city and village class.

3.1 PLSTNO Ontology

As the information domain, Administrative divisions of the country Palestine were selected for the project because of its various interesting properties. Information about Palestine is widely being presented on the Web on a large number of Web sites. This makes it easy to find information related to governorates of Palestine and use these data when constructing the ontology.

Palestine country provides a useful context and structure to create a system relying on structured data. It is easy to classify the existing data and presents this classification with an ontology. Concepts such as classes, subclasses, properties and relations can easily be applied and demonstrated within this domain.

3.2 PLSTNO Components

PLSTNO ontology includes:

3.2.1 Classes

Classes, also called concepts, types or universals are a core component of most ontologies. A class represents a group of different individuals, that share common characteristics, which may be more or less specific [8].

In PLSTNO, we designed classes as shown in Table 1. As we watch, all the classes used in ontology and description for each of them.

Table 1. PLSTNO class description

#	Class	Description
1.	Palestine	The country of Palestine
2.	GazaStrip	The Gaza Strip is a narrow elongated piece of land of Palestine, bordering the Mediterranean sea [13].
3.	Palestinians48	Palestinian Arabs remaining in Israel after Nakba since 1948
4.	WestBank	Part of the proposed Palestinian country
5.	Governorate	Administrative division of a country
6.	City	Large or important town
7.	Village	Small town in the countryside

We used OntoGraf to focus the graph nodes (classes, individuals, relations). Figure 1 shows us a snapshot of the protégé screen with all classes in our ontology .
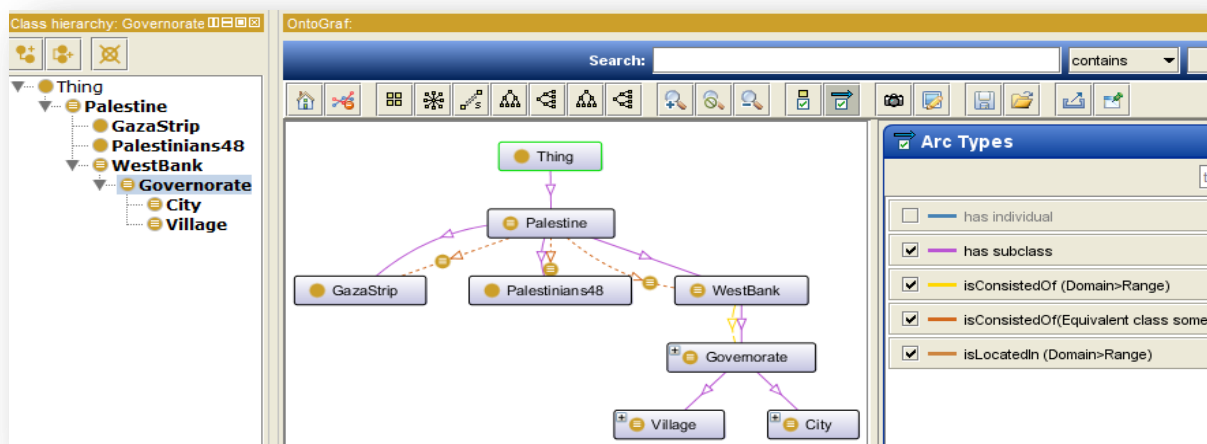

Figure 1. PLSTNO classes in Protégé

3.2.2 Individuals

Individuals are instances of classes, and properties may be used to relate one individual to another [8].

According to Wikipedia Information, we have provided (73) appropriate individuals of the concepts. For example, Table 2 shows the individuals in the class (City) and class (Village) for the Qalqilya Governorate in Palestine Ontology.

Table 2. Individuals of Qalqilya Governorate in PLSTNO ontology.

Qalqilya(Governorate class)	
City Class	**Village Class**
Qalqilya_c	Hajja- Azzun- Baqet_El_Hatab- Habla- Jayyus

In the following, Figure 2 presents the individuals of the Governorate class.
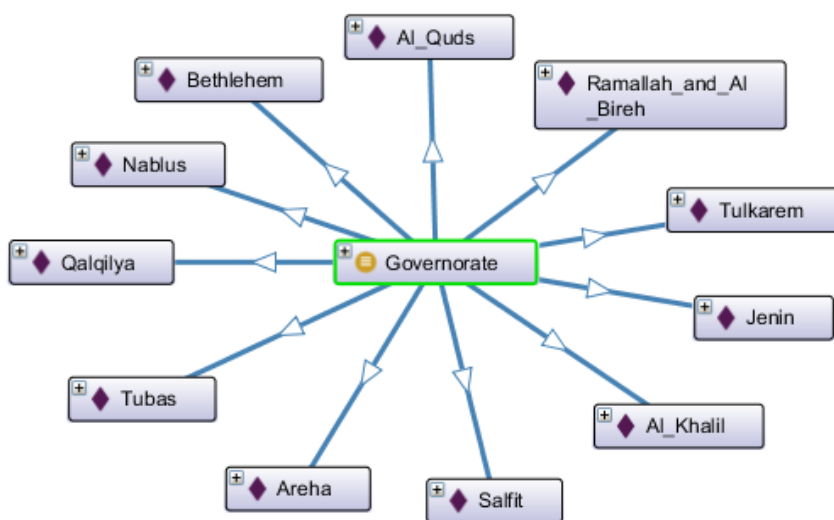

Figure 2. Individuals for (Governorate) class

3.2.3 Relations

According to [8], relations in an ontology describe the way in which individuals relate to each other.

For example, the relation between Qalqilia of Governorate individual and Hajja of Village individual is (isLocatedIn) object properties, which describes the relation as: "Hajja isLocatedIn Qalqilia" as shown in Figure 3.
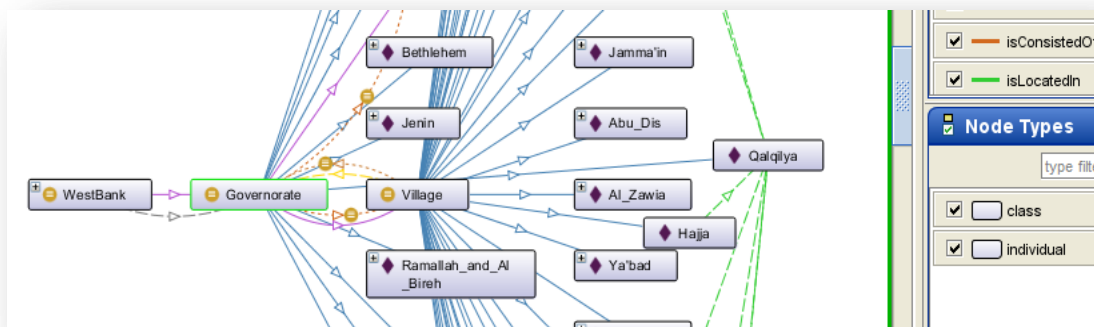

Figure 3. The relation "Hajja isLocatedIn Qalqilia"

3.3 PLSTNO Query

Ontology languages and corresponding query languages play key roles for representing and processing information about the real world for the emerging Semantic Web. Efforts have been made to develop various ontology languages. Each ontology language provides different expressive power and also computational complexity for reasoning. Ontology query languages were developed to query the information defined by these ontology languages and reasoning systems[15]. In this paper, we have implemented a query on the PLSTNO more

than one way of using more Software to make sure the effectiveness of ontology and evaluate it. The goal of the evaluation was to achieve quality of the work and get assurance that the model represents the PLSTNO in the correct way.

3.3.1 SPARQL Query

SPARQL is a query language developed primarily to query RDF graphs. The vocabulary for RDF graphs is three disjoint sets, and the union of these sets is called an RDF triple[12]. In our paper, we use several methods to query ontology.

Figure 4 illustrates the results of SPARQL query that presents all the relations between classes with type "subclassOf" in PLSTNO. This query was defined in SPARQL Query tab from Protégé interface.
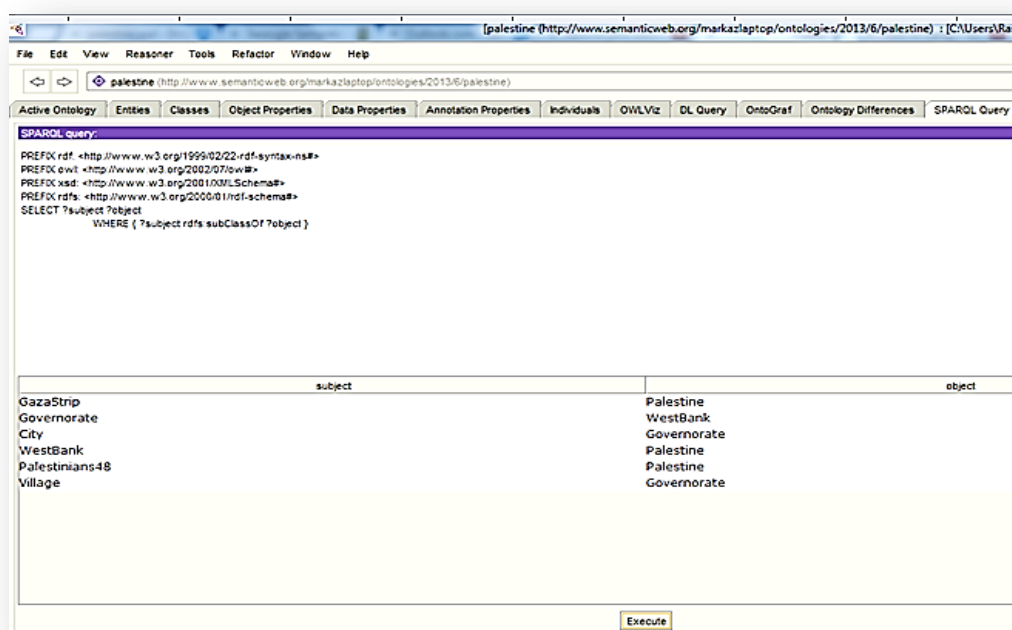

Figure 4. SPARQL Query in Protégé

Another query executed from Fuseki server worked as RDF server and one of the components of the Jena framework, Fuseki starts as standalone server and offers a web form for SPARQL queries and a HTTP implementation of the SPARQL protocol [6].

According to Figure 5, PLSTNO, uploading process in Fuseki server had been succeeded and results of (369) RDF triples.
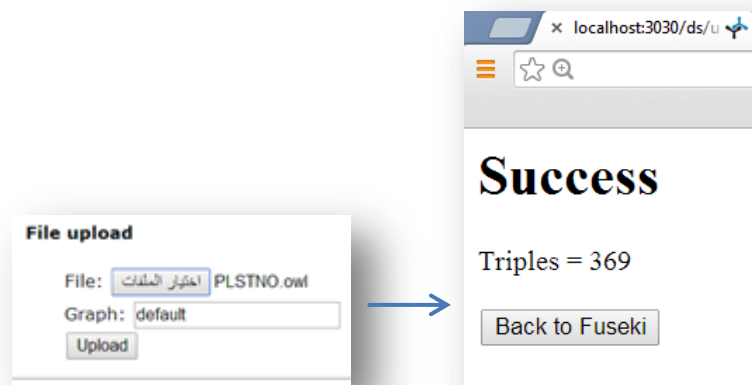
Figure 5. PLSTNO upload in Fuseki server and the count of triples in it.

Figure 6 illustrates the SPARQL query which wants all the RDFs in PLSTNO. Query used (?x ?y ?z) to express all the triples of relations used in PLSTNO.
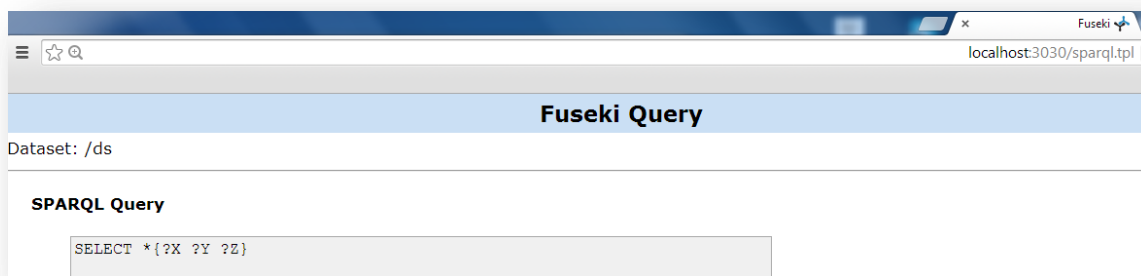

Figure 6. PLSTNO SPARQL Query in Fuseki server

Figure 7 illustrates the results of SPARQL query. As we see, the triple RDF as   URIs which describe the relation : (Al_Quds_c, Population, 252000)
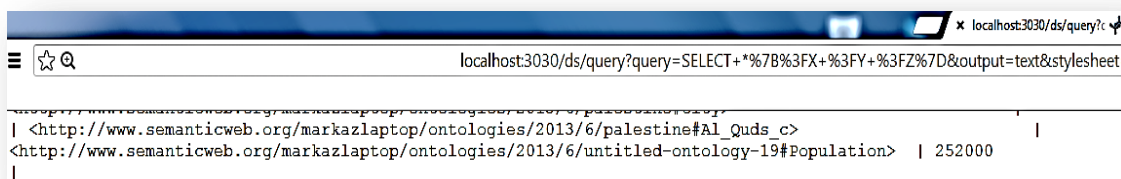

Figure 7. PLSTNO SPARQL Query results in Fuseki server

3.3.2 DL Query

We have used the DL Query Tab in Protégé 4 to verify competency questions. They help to show that the ontology has enough information to Palestine.

Table 3 shows an example of one competency question with a DL query and Figure 8 presents the results of executing the DL query in the Protégé editor.

Table 3. An example of a competency question and a DL query

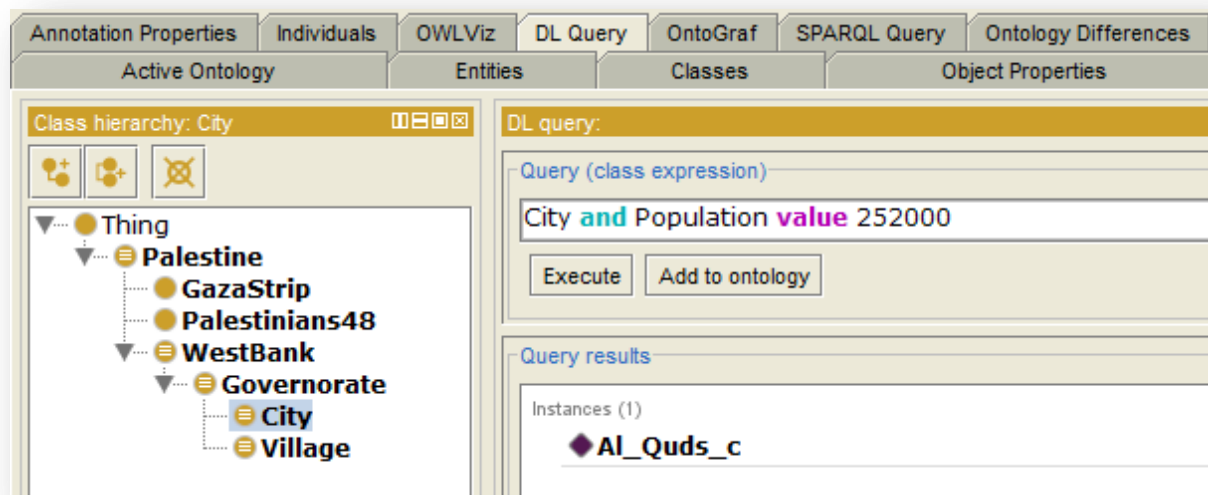| Competency question	DL query	Query results
What is the city has population of 252000?	City and Population value 252000	Al_Quds_c

Figure 8. PLSTNO DL Query in Protégé

4. Conclusions and Further Work

In this paper, we discussed the use of ontology and design within an important area of linking the administrative division of the country at the conceptual level. To illustrate our ideas, an ontology for software engineering has been used to describe a particular area and to query.We have built PLSTNO ontology in the protégé editor, and we have classified data to create individuals, and we made the possible relations to cover the most possibilities' search on the Web by increasing information retrievals about Palestine field. By reasoning and querying PLSTNO, we have made sure of the operation and accuracy ontology using Protégé editor and the tabs of SPARQL, DL query, and Fuseki server. The realization of the design is done.

As more work, and we intend to keep for the use of ontology to support the development of other Arab countries' description. We are also motivated to maintain the development and expansion of the project in different areas, for other areas and projects wider.

In the end, we are interested in establishing a culture of "Towards the Semantic Web", so that the use of the evolution of them by the wider community will be motivated to become the best reality.

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