Semantic Web Representation and Reasoning of Data using Ontology's

Silbia Mishra
Student
Amity University, Jaipur

B. Suresh kumar
Lecturer
Amity University, Jaipur

Abstract - To define what is the Semantic Web is very difficult as well as Web itself. "The Semantic Web is a mesh of information linked up in such a way as to be easily process able by machines, on a global scale." "The Semantic Web approach develops languages for expressing information in a machine process able form. "Ontologies allow users to organize information into taxonomies of concepts. Each with their attributes, and describe relationships between concepts. More recently, the notion of ontology has also become widespread in fields such as intelligent information integration, cooperative information systems, information retrieval, electronic commerce and knowledge management.

Keywords:-Ontology, Semantic web, Geo names, Web mapping, RDF, RDFS, OWL, Seamless connectivity, translation.

I. Introduction

The Semantic Web is an evolution of the current WWW and aims to establish meaning to data such that it can be shared, automatically reasoned with, and reused via machine-readable applications. It is a collaborative effort led by the World Wide Web Consortium, with participation from a large number of researchers and industrial partners. The crux of the Semantic Web representation and reasoning of data using ontologies. Thus, we will delve into different aspects of Ontology representation, creation, design, reasoning, programming and applications .

II. Definition

An extension of the current Web that provides an easier way to find, share, reuse and combine information. It is based on machine-readable information and builds on XML technology's capability to define customized tagging schemes and RDF's (***R**esource **D**escription **F**ramework*) flexible approach to representing data. The Semantic Web provides common formats for the interchange of data (where on the Web there is only an interchange of documents). It also provides a common language for recording how data relates to real world objects, allowing a person or a machine to start off in one database, and then move through an unending set of databases which are connected not by wires but by being about the same thing.

The vision of the Semantic Web is to extend principles of the Web from documents to data. Data should be accessed using the general Web architecture using, e.g., URI-s; data should be related to one another just as documents (or portions of documents) are already. This also means creation of a common framework that allows data to be shared and reused across application, enterprise, and community boundaries, to be processed automatically by tools as well as manually, including revealing possible new relationships among pieces of data.

III. History

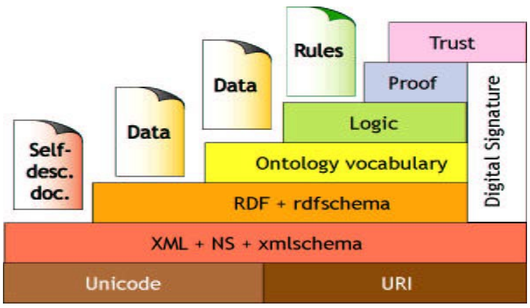
The concept of the *Semantic Network Model* was formed in the early sixties by the cognitive scientist Allan M. Collins, linguist M. Ross Quillian and psychologist Elizabeth F. Loftus in various publications, as a form to represent semantically structured knowledge. It extends the network of hyperlinked human-readable web pages by inserting machine-readable metadata about pages and how they are related to each other, enabling automated agents to access the Web more intelligently and perform tasks on behalf of users. The term "Semantic Web" was coined by Tim Berners-Lee, the inventor of the World Wide Web and director of the World Wide Web Consortium ("W3C"), which oversees the development of proposed Semantic Web standards. He defines the Semantic Web as "a web of data that can be processed directly and indirectly by machines."

Many of the technologies proposed by the W3C already existed before they were positioned under the W3C umbrella. These are used in various contexts, particularly those dealing with information that encompasses a limited and defined domain, and where sharing data is a common necessity, such as scientific research or data exchange among businesses. In addition, other technologies with similar goals have emerged, such as micro formats.

IV. Purpose

The main purpose of the Semantic Web is driving the evolution of the current Web by enabling users to find, share, and combine information more easily. Humans are capable of using the Web to carry out tasks. However, machines cannot accomplish all of these tasks without human direction, because web pages are designed to be read by people, not machines. The semantic web is a vision of information that can be readily interpreted by machines, so machines can perform more of the tedious work involved in finding, combining, and acting upon information on the web. The Semantic Web, as originally envisioned, is a system that enables machines to "understand" and respond to complex human requests based on their meaning. Such an "understanding" requires that the relevant information sources be semantically structured.

- Semantic web allowed the user to find, share and combine the information to transfer it from one place to another very easily.
- It allows the working of current web and makes it more secure and usable by showing the information.
- The users are allowed to use the Web for carrying out the tasks of finding the folder or categories and it just makes it easy.
- Semantic web provides the instructions for the machine to execute the tasks by providing the interpreter that can interpret it .
- Machines can perform the task provided by the Semantic Web and it involves finding, combining and acting on the information that is present on the web.



V. Challenges

Technical challenges:-

1. **Representational Complexity:** The first problem is that RDF and OWL are complicated. Even for scientists and mathematicians these graph-based languages take time to learn and for less-technical people

they are nearly impossible to understand. Because the designers were shooting for flexibility and completeness, the end result are documents that are confusing, verbose and difficult to analyze.

2. **The Natural Language Problem:** People argue that RDF and OWL are for machines only, so it does not matter that people might find them hard to look at. But even assuming that RDF and OWL are for machines only, the question arises: how are these documents to be created?

3. **The Bottom-Up Assumption:** Because there are vast amounts of existing information that need to be transformed, the classic semantic web approach is a bottom-up approach. Annotating information on the web-scale is a daunting task. If it is to be done be a centralized entity, then there will need to be Google-like semantic web crawler that takes pages and transforms them into RDF.

4. **The Standards Issue:** A distributed or self-organizing approach to the problem seems the most promising, but it runs into the classic technology issue of standards or the even more ancient human problem of common language. The history of technology is full of Tower of Babel examples - separate distributed systems that do not talk to each other. A common solution is to build an adapter or translator that maps concepts from one system to another.

VI. Scientific Challenges

1. **The Godel and NP-completeness:** The technical issues seem to be steep, but even if these issues are addressed there are much deeper and more fundamental problems. A famous mathematical system proved by Kurt Godel in 1933 states: *No logical system can ever be both consistent and complete*, which means that there are things that cannot be proved by logic.

2. Dealing with Uncertainty: Uncertainty is something that computers can't deal with but that we can handle very well. In fact, we thrive on it. Every day we make decisions without knowing all the facts. We do this by utilizing *iteration*.

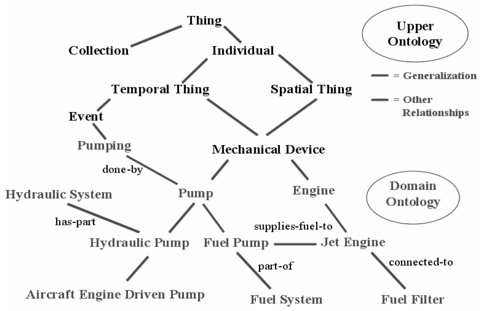
Some of the challenges for the Semantic Web include vastness, vagueness, uncertainty, inconsistency, and deceit. Automated reasoning systems will have to deal with all of these issues in order to deliver on the promise of the Semantic Web.

Ontology with semantic web:-

Ontology is a specification of a conceptualization.

The word "ontology" seems to generate a lot of controversy in discussions about AI. It has a long history in philosophy, in which it refers to the subject of existence. It is also often confused with epistemology, which is about knowledge and knowing.

It derives from the Greek onto (being) and logia (written or spoken discourse). It is a branch of metaphysics, the study of first principles or the essence of things. Ontologies play a prominent role on the Semantic Web. They make possible the widespread publication of machine understandable data, opening myriad opportunities for automated information processing. However, because of the Semantic Web's distributed nature, data on it will inevitably come from much different ontology. Information processing across ontologies is not possible without knowing the semantic mappings between their elements. Manually finding such mappings is tedious, error-prone, and clearly not possible at the Web scale. Hence, the development of tools to assist in the ontology mapping process is crucial to the success of the Semantic Web.



✦ Three important aspects:-

- Conceptualization. The language should choose an appropriate reference model, such as entity-relationship model and object-oriented model, and provide corresponding ontology constructs to represent factual knowledge, such as defining the entities and relations in a domain, and asserting relations among entities.

- Vocabulary. Besides the semantics, the language should also cover the syntax such as symbol assignment (i.e., assigning symbols to concepts) and grammars (i.e., serializing the conceptualism into explicit representation).

- Axiomatization. In order to capture the semantics for inference, rules and constraints are needed in addition to factual knowledge. For example, we can use rules to generate new facts from existing knowledge, and to validate the consistency of knowledge.

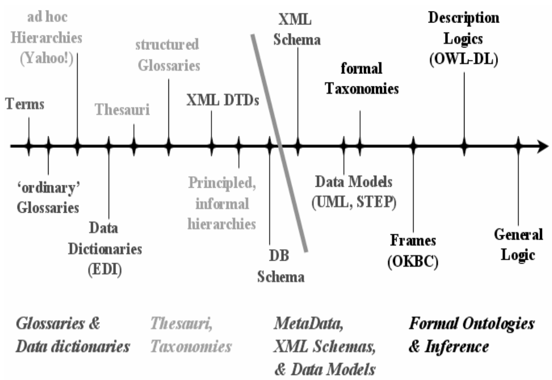
✦ Three important requirements:-

- Extensibility. In the context of the Web, ontology engineers should be able to develop ontologies in an incremental manner: reusing as many existing popular concepts as possible before creating a new concept from scratch. This requirement demands an expressive common reference model as well as distributed symbol resolution mechanisms.

- Visibility. Merely publishing knowledge on the Web does not guarantee that it can be readily understood by machines or human users. In order to make knowledge visible on the Web, additional common ontological ground on syntax and semantics is required between information publishers and consumers. This requirement is especially critical to machines since they are not capable of understanding knowledge written in an unfamiliar language.

- Inference ability. Ontology not only serves the purpose of representation, i.e. enumerating factual domain knowledge, but also serves the purpose of computation, i.e., enabling logical inference on facts through axiomatization. Hence, ontologies on the Web should provide constructs for effective binding with logical inference primitives and options to support a variety of expressiveness and computational complexity requirements.

Ontologies represent many different kinds of things in a given subject area (e.g. wing, physical object, wire). These things are represented in the ontology as classes (sometimes called concepts) and are typically arranged in a lattice or taxonomy of classes and subclasses. Each class is typically associated with various properties (also called slots or roles) describing its features and attributes as well as various restrictions on them (sometimes called facets or role restrictions). An ontology together with a set of concrete instances (also called individuals) of the class constitutes a knowledge base. The lattice or taxonomy of classes is a primary the focus of most ontologies.



Relation of web semantic and ontology:-

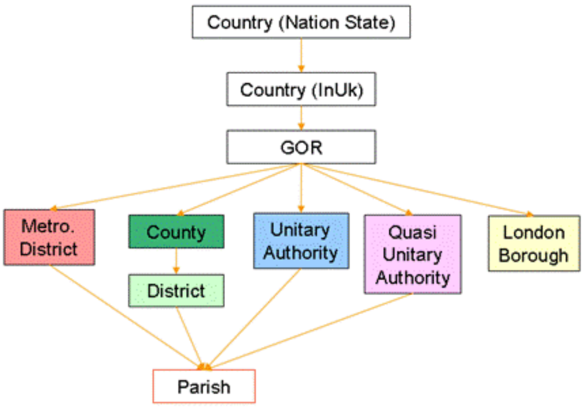
- The Geo Names Ontology:-

The Geo Names Ontology makes it possible to add geospatial semantic information to the World Wide Web. All over 8.3 million geonames troponins now have a unique URL with a corresponding RDF web service. Other services describe the relation between troponins.

a) Entry Points into the Geo Names Semantic Web

There are several ways how you can enter the Geo Names Semantic Web:

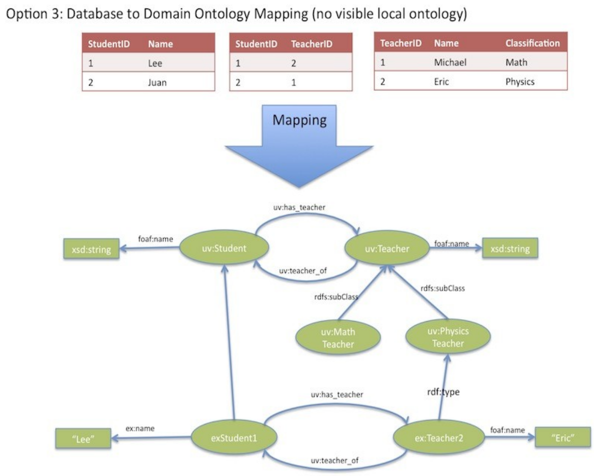
- Start from mother earth and follow the Linked Data links.
- Use the geo names search web service with the type=rdf parameter option.



- Semantic Mapping with ontology:-

A semantic mapping from a database schema to ontology defines a semantic relationship between the schema and the ontology. For example, a many-to-many relationship between a concept C1 and a concept C2 in ontology may be mapped to relational tables storing attributes of C1 and C2 and a linking table that maintains the association of the identifiers of C1 and C2. Such a semantic mapping can be expressed in a declarative language that encodes the formal semantics of the schemas.

In recent years, we are witnessing a growing demand for defining semantic mappings from database schemas to ontologies. For example, semantic mappings are integral part of ontology- based information integration systems, and data integration efforts in the context of the semantic web. The semantics of database schemas expressed in terms of semantic mappings from schemas to conceptual models/ontologies provide opportunities to improve the capabilities of traditional schema mapping tools, even when different databases schemas are associated with different conceptual models or ontologies.



✦ Ontology's and Semantics for Seamless Connectivity:-

Ontology's are a key part of a broader range of semantics based technologies which include the areas of knowledge representation (KR) and automated inference that arose within the Artificial Intelligence community. Many different representation formalisms have been explored, and reasoning engines developed. A key result is the proven existence of a trade-off between representational powers of a language (i.e. the ability to represent/express many different kinds of knowledge).

This architecture enables plug & play and cost effective interoperability, seamless connectivity and sharing of content between existing and newly developed services in all domains required for the independent living of older people and for the enhancement of their Quality of Life.

The project addresses the issue of direct re-usability of information across heterogeneous services and devices through the common understanding and sharing of contextual information. The goal of having networks of seamlessly connected people, software agents and IT systems remains elusive. Early integration efforts focused on connectivity at the physical and syntactic layers. Great strides were made; there are many commercial tools available, for example to assist with enterprise application integration.

✦ Ontology languages for the semantic web:-

The OWL Web Ontology Language is a new formal language for representing ontologies in the Semantic Web. OWL has features from several families of representation languages, including primarily Description Logics and frames. OWL also shares many characteristics with RDF, the W3C base of the Semantic Web. In this paper we discuss how the philosophy and features of OWL can be traced back to these older formalisms, with modifications driven by several other constraints on OWL. OWL is a vocabulary extension of RDF [RDF Semantics]. Thus any RDF graph forms an OWL Full ontology. Further, the meaning given to an RDF graph by OWL includes the meaning given to the graph by RDF.

OWL Full ontologies can thus include arbitrary RDF content, which is treated in a manner consistent with its treatment by RDF. OWL assigns an additional meaning to certain RDF triples. OWL's ability to express ontological information about individuals appearing in multiple documents supports linking of data from diverse sources in a principled way.

The OWL Language is described by a set of documents, each fulfilling a different purpose, and catering to a different audience. They are described and listed respectively as following in increasing degree of technical content.

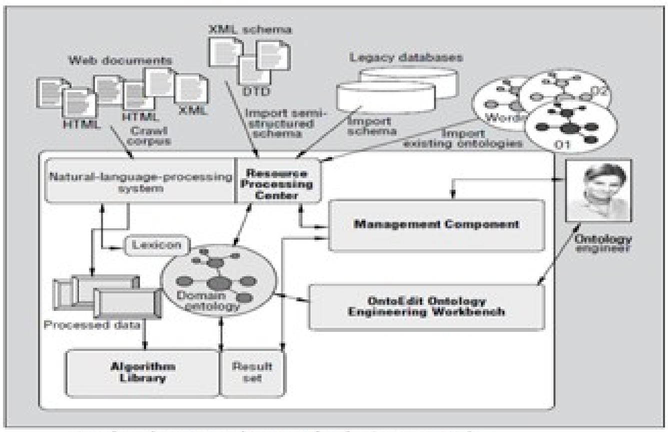
- The OWL Overview gives a simple introduction to OWL by providing a language feature listing with very brief feature descriptions;
- The OWL Guide demonstrates the use of the OWL by providing an extended example. It also provides a glossary of the terminology used in these documents;
- The OWL Reference gives a systematic and compact (but still informally stated) description of all the modelling primitives of OWL;
- The OWL Semantics and Abstract Syntax document is the final and formally stated normative definition of the language;
- The OWL Web Ontology Language Test Cases document contains a large set of test cases for the language;
- The OWL Use Cases and Requirements document contains a set of use cases for a web ontology language and compiles a set of requirements for OWL.

✦ Ontology learning for the semantic web:-

The Semantic Web relies heavily on formal ontologies to structure data for comprehensive and transportable machine understanding. Thus, the proliferation of ontologies factors largely in the Semantic Web’s success. Ontology learning greatly helps ontology engineers construct ontologies. The vision of ontology learning that we propose includes a number of complementary disciplines that feed on different types of unstructured, semi structured, and fully structured data to support semiautomatic, cooperative ontology engineering. Our ontology-learning framework proceeds through ontology import, extraction, pruning, refinement, and evaluation, giving the ontology engineer coordinated tools for ontology modelling.

Ontology learning for the Semantic Web explores techniques for applying knowledge discovery techniques to different web data sources (such as HTML documents, dictionaries, etc.), in order to support the task of engineering and maintaining ontologies. The approach of ontology learning proposed in Ontology Learning for the Semantic Web includes a number of complementary disciplines that feed in different types of unstructured and semi-structured data. This data is necessary in order to support a semi-automatic ontology engineering process.

Ontology learning for the Semantic Web is designed for researchers and developers of semantic web applications. It also serves as an excellent supplemental reference to advanced level courses in ontologies and the semantic web.



Ontology-learning architecture for the Semantic Web.

✦ Ontology Translation on the Semantic Web:-

B. Ontologies are a crucial tool for formally specifying the vocabulary and relationship of concepts used on the Semantic Web. In order to share information, agents that use different vocabularies must be able to translate data from one ontological framework to another. Ontology translation is required when translating datasets, generating ontology extensions, and querying through different ontologies. Onto Merge, an online system for ontology merging and automated reasoning, can implement ontology translation with inputs and outputs in OWL or other web languages. The merge of two related ontologies is obtained by taking the union of the concepts and the axioms defining them, and then adding bridging axioms that relate their concepts.

C. The resulting merged ontology then serves as an inferential medium within which translation can occur. Our internal representation, Web-PDDL, is a strong typed first-order logic language for web application. Semantic translation is implemented using an inference engine (Onto Engine) which processes assertions and queries in Web-PDDL syntax, running in either a data-driven (forward chaining) or demand-driven (backward chaining) way.

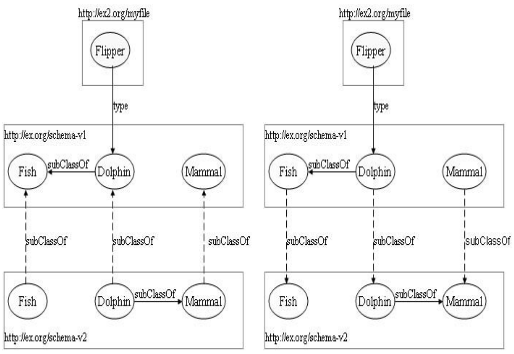
✦ Ontology versioning on the Semantic Web:-

To form a real Semantic Web, it is necessary that the knowledge that is represented in the different versions of ontologies is interoperable. It is therefore important to create links between ontology versions that specify how the knowledge in the different versions of the ontologies is related. These links can be used to re-interpret data and knowledge under different versions of ontologies. There are three important aspects to discuss when considering an version relation between ontologies.

First, this is the difference between version relations and conceptual relations inside ontology. Another issue to discuss about ontology updates is the possible discrepancy between changes in the specification and changes the conceptualization. A third, somewhat different, aspect of an update is the packaging of changes, i.e., the way in which updates are applied to ontology.

A situation in which versioning support is also necessary is the collaborative development of an ontology Onto View is also useful in this situation, especially because all the conceptual implications of versions have to be characterized individually by users. This integrates the conflict resolution in the update procedure. That is, because users specify the conceptual relation of their changes with the previous version while specifying the update, it is not necessary to resolve conflict between definitions afterwards. Every version of the definition has its own identifier and is conceptually related to the other versions.

A side remark about the use of a versioning system for collaborative ontology development is that this gives an evolutionary way of ontology building. Each person can have its own conceptualization, which is conceptually linked to the conceptualizations of others. In this sense, the combination of versions and adaptations in itself forms a shared conceptualization of a domain.



VII. ONTOLOGY APPLICATIONS:-

- Semantic Web: Ontology plays a key role in the Semantic Web in supporting information exchange across distributed environments. The Semantic Web represents data in a machine process able way, which is why it is considered to be an extension of the current Web.
- Semantic Web Service Discovery: In the e-business environment, ontology plays an important role by finding the best match for the requester looking for merchandise or something else. It also helps online travel customers obtain a response.

- Artificial Intelligence : Ontology has been developed in the AI research community, its goal here being to facilitate the sharing of knowledge and the reuse and enabling of processing between programs, services, agents or organisations across a given domain.
- Multi-agent: The importance of ontology in this area is that it provides a shared understanding of domain knowledge, allowing for easy communication between agents and thereby reducing misunderstandings.
- Search Engines: These use ontology in the form of thesauri to find the synonyms of search terms, which facilitates internet searching.
- E-Commerce: This application uses ontology to facilitate communication between seller and buyer through the description of merchandise, as well as enabling machine-based communication.
- Interoperability: The problem of bringing together heterogeneous and distributed systems is known as the "interoperability problem". In this area, the importance of applying ontology appears explicitly: it is used to integrate different heterogeneous application systems.

VIII. Problems with web semantic web and ontology:-

D. 1. Reduced anonymity on the Web
E. 2. Increased invasion of privacy
F. 3. Intelligent content scraping
G. 4. Value paradigm shifts
H. 5. Vocabulary incompatibilities

References

[1] T. Berners-Lee, J. Hendler, and O. Lassila. Thesemantic web. Scienti_c American, 284(5):34{43, 2001.

[2] C. Golbreich, S. Zhang, and O. Bodenreider. The foundational model of anatomy in OWL: Experience and perspectives. J. of Web Semantics, 4(3), 2006.

[3] Kalyanpur, B. Parsia, E. Sirin, and J. Hendler. Debugging unsatis_able classes in owl ontologies. J. of Web Semantics, 3(4):243{366, 2005.

[4] Maedche and S. Staab. Ontology learning for the semantic web. IEEE Intelligent Systems, 16(2):72{79, 2001.

[5] Motik, U. Sattler, and R. Studer. Query answering for OWL-DL with rules. J. of Web Semantics, 3(1):41{60, 2005.

[6] P. Shvaiko and J. Euzenat. A survey of schema-based matching approaches. J. on Data Semantics, IV:146{171, 2005

[7] R Mabubasha, B. Suresh, Sudeep Nair, GVK Kishore. Towards An Effective Fuzzy Keyword Search and Ranking Framework for File Information Management System, IJCST, 556-559, 2012

[8] Deepshikha Bhargava, Madhavi Sinha. Design and Implementation of Agent based Inter Process Synchronization Manager, IJCA, 17-22, 2012.

[9] Wikipedia

[10] Encyclopaedia