Knowledge Representation with Ontology Tools & Methodology

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ABSTRACT

As a backbone of the Semantic Web, Ontologies provide a shared understanding of a domain of text. Ontologies, with their appearance, usage, and classification address for concrete ontology language which is important for the Semantic Web. They can be used to support a great variety of tasks in different domains such as knowledge representation, natural language processing, information retrieval, information exchange, collaborative systems, databases, knowledge management, database integration, digital libraries, information retrieval, or multi agent systems. Thus a fast and efficient ontology development is a requirement for the success of many knowledge based systems and for the Semantic Web itself. This paper provides discussion on existing ontology tools and methodologies and the state of the art of the field.

Keywords

Ontology, Knowledge, Knowledgebase, Rules

1. INTRODUCTION

During the last decade, ontologies have become an important means for knowledge interchange and integration. After the vision of the semantic web was broadcasted, ontology became a synonym for the solution to many problems concerning the fact that computers do not understand human language. Ontology is recognized in different research fields and area for knowledge representation and information retrieval and extraction. Ontology is defined as a conceptualization which means entities and relationships between them. These are implicit or explicit conceptualization for each information base. Ontology provides a means to classify the things, which are exists and also organized in a systematic manner which analyzes the existing things in a structured way. Ontology is a type of knowledge that is used by a knowledge based systems. In Ontology the specification of data is loaded into knowledgebase and any knowledge base system can consult for the ontology. Ontology is highly used in the retrieval of web documents where information retrieval is keyword-based searching and also retrieves some of the false matched results because there is only information retrieval not extraction. This knowledge comes only with the matching keywords, not by the meaning. Ontology provides a way for knowledge management efforts under a shared conceptual domain model that connect technical systems for storing, searching and interchanging the knowledge.

There are many Knowledge Based Systems about the domain and their symbols are used to perform reasoning by manipulating these symbols. Basically Ontology describes the domain knowledge of a Knowledge based system. Some examples of knowledge bases are KIF [Genesereth,1991], Ontolingua [Gruber,1993], CYC [Lenut & Guha 1990][17], EHCPR [Jain and Jain 2013]..

Ontology plays an important role to representing the knowledge and concepts. It gives the ways to manage unstructured information. Building ontologies is conceptualization technique that systematically organizes concepts, makes them transferrable between different actors, differentiates an abstraction level, can be executed on a computer.

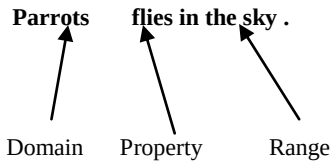
Ontology formally represents knowledge as a set of concepts within a domain and the relationships between pairs of concepts. It is a study to model a domain that is the type of objects and concepts that exist and their properties and relations. Ontology can be represented by hierarchical form that is called taxonomy. Taxonomy is ontology in the form of hierarchy.e.g. Taxonomy (biological classification) of life.

Life-→Phylum→Family→ Genus→Species.

After creating taxonomy the structure is in the form of classes and subclasses. Ontology is helpful to solve some common problems encountered while building representation of a large and complex domain like—

- Detection of redundant knowledge
- Detection of ambiguities
- Detection of inconsistencies and contradictions.

There should be a domain specific search but it produces always irrelevant data on web, like if the word is “Jaguar” or “Tank”, there will be many results. Some will be for cars and others will be for **cats.** There will be many results for Tank also some for fish Tank or some for Army Tank. So it is not a domain specific search. We can make it a domain specific search if we enter price, range and model of car with jaguar then it will follow the criteria of a domain. It will be done when our searching criteria will be more specific. By using Ontology it can be done. By using the concepts, relationships and properties we can specify their domains and ranges. Jaguar is car name and Jaguar is an animal also. But there will be muddiness when this word will be searched. Ontology needed domain of knowledge, properties, range, relations and instances for example:



Here domain is the subject of relation.

And Range is the object of relation.

"Sandy lives in London. He works-for TCS."

In the above sentence--

Sandy is a Person.

London is a Location.

TCS is an Organization.

Sandy and He has co-reference and same.

Relation 1 – lives_in

Relation 2 - Sandy employee of TCS.

Relation 3 - TCS located in London.

Now these statements can be explained with an Ontology. Ontology required a domain and properties of domain and also their ranges. In above example there are three properties:

Lives_in, Employee of, Located_in.

Although it is very difficult to linking words from naturally occurring text to entity & relationship classes in Ontology.

2. LITERATURE SURVEY

Yu[1] proposes a set of concepts which focus on strategic dependencies between actors. Such a dependency exists when an actor is committed to satisfying a goal carry out a take or delivers a resource. Using these concepts, one can create organizational model that provide answers for questions.

Knowledge Management is not consensual. Fonsea[2] differentiates ontologies of Information System from Ontologies for IS. According to him Ontology is used for conceptual modeling. According to Wilson [3] knowledge is what, the individual knows like experiences & underlying and learning. So knowledge cannot be managed. Ontology is a term that originated in philosophy and used in Information Science to describe a hierarchical structure based on concepts and relations. According to Frigg [4] one of the ways to classify models is to consider the semantic issue which deals with the functions of reforestation. The development of Ontology depends on following stages:-

- Determining the scope

- Data Collection

- Conceptualization and implementation.

Earlier work in computational ontologies the Cyc project (Lenat & Guha 1990) & the ARPA Knowledge sharing effort (Neches et al, 1991).

According to Smith (2003) [5], the term Ontology first appeared in the Information Science literature in 1967, in work on data modeling conducted by Mealy. In the 1990s, Web Semantic research increased the demand for ontologies for some kinds of applications, both to solve interoperability problems and to provide a common information structure.

First semantic model used in conceptual modeling appeared in the 1970s,within the work of the ANSI/X3/SPARC Committee for the standardization of (Abrial,1974) presents most remarkable are Semantic data model.(Jardin,1976) presents the three-schema architecture (Chen 1976) presents Entity Relationship.

Guizzardi [6]mentions seven interpretations available in the literature of the term *ontology*: 1) a philosophical discipline; 2) an informal conceptual system; 3) a formal semantic account; 4) a specification of a conceptualization; 5) a representation of a conceptual system via logical theory; 6) a vocabulary used by a logical theory; 7) a specification (meta-level) of logical theory.

Kaza and Hopkins [7] presents a set of concepts to formalize information ontologies used during urban planning process. Their information Ontologies show the different alternatives of a decision in a plan. Plans could present effective decisions, alternative decisions and realizations.

Lee and McMeel [8] propose to build an information ontology in order to ease the communication between the different actors groups involved in a construction project.

Bouattour et al.[9] propose also a new set of concepts for information ontologies adapted to architectural design. These concepts could be seen as an upper layer of IFC classes (see section "Example: Industry Foundation Classes" (Ferreira da Silva and Cutting-Decelle 2005, p. 9)). Their information ontology is composed of actors, objects, activities and documents.

Lenat[10] conceived his monumental enterprise to capture all of human common sense knowledge in Cyc (Lenat and Guha, 1990)

An ontology language should have an unambiguous well-understood meaning. The agents should be able to understand ontologies, and also be able to use them properly. One such system, the EHCPRs System is an underlying methodology for representation, reasoning, learning, etc., of live multilingual thinking machine [11]. Jain & Jain [12] presents learning techniques in the EHCPRs based ontology. Jain & Mishra [13] presents various tools and languages for knowledge representation using Ontology.

3. PROBLEM STATEMENT

In this paper there is a main problem that how to represent the knowledge which is hidden between the concepts. How to manage the knowledge between different relationships? We can make it possible by collecting entities and making a Ontology. It will be helpful on web searching where data is searched by keyword matching not by concepts or meaning. During in this research work the complex data and their corresponding time of searching is main bottleneck. The output of this research can be helpful in many areas like Healthcare, Marketing and Education etc where data is unstructured or complex to manage.

Ontology-based knowledge representation is relevant for stable, well understood problems with well-known problem-solving methods. Organizations have a huge requirement for database integration and machine-machine interoperability.

i) Description of methodologies, tools and languages for building ontologies

ii) Knowledge Extraction from Unstructured Data.
iii) Development of a reusable ontology using some ontology representation language.
iv) Designing and implementing a sound and complete problem solving method (as opposed to ontology inference engine).

4. ONTOLOGY COMPONENTS TO REPRESENTS THE KNOWLEDGE

Ontology is a knowledge representation language so there are different types of Ontology component can be defined like concepts,properties,instances etc.Concept is the main component of ontologies that can be defined in different manner:-

-From textual definition: the concept "parrot" is defined by the sentence "as individual animal being" like Bird.

-From a logical definition using formula:- the Bird is defined by the formula "Living entity U NonLiving Entity".

-From a set of properties :-A concept "Bird" can have the property like "type", "color", "food" and these property can be used for several concepts. Concepts can also be explained by the set of instances that belong to it. For example "Parrot" is an instance of a bird.

These concepts, instances and properties can be represented by symbols. Symbols are terms that can be easily understand by human with reading them. All these Ontology components are connected through relations.

There is an example that how to make a hierarchical structure for specific meaning of data. In this example a Fruit can be completely explained and more specific and also easy to find each category of fruit. In this Ontology suggested fruits are linked according to disease of patients. So anyone can prescribe the diet of fruit to the patient in the absence of doctor. There will be no more complex queries when we search the data.

There are many areas where human beings are unable to explain the hidden knowledge within the concepts and also between the relationships. Ontology is a best way to express this hidden knowledge between concepts. There are many examples where we make possible the things only using concepts like A fisherman didn't have study about fishes but he is able to differentiate between eatable fish and poisonous fishes, but how, because he has concept of eatable fishes by their color size and many other properties but he is unable to explain it. There is a knowledge which is hidden.

Another example a prescription of a doctor is not possible to understand by everyone but when it send to medical store he is easily understand it and releases the medicine. There is a concept in prescription of doctor which is understandable by medical store keeper. This knowledge can be explained very well by using Ontology.

4.1 How to Present Knowledge

Knowledge can be presented in many forms. Knowledge can be in the forms of graph or it can be a logical condition or in the form of rules. Ontology is a graph structure to present the knowledge. Knowledge-based systems have a computational model of some domain of interest in which symbols serve as surrogates for real world domain artifacts, such as physical objects, events, relationships, etc. [14].

A **Graph Structure** is also called semantic network where nodes represent concepts and arcs or lines presents relationships between concepts.

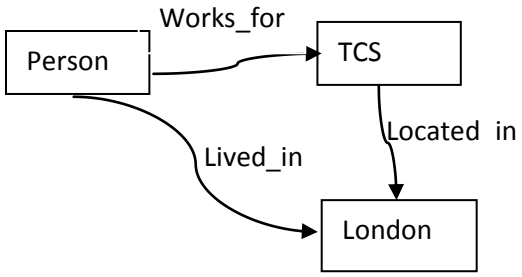


Fig 1: Relation between different concepts

This hierarchical structure presents the whole information in about his organization where he is working and also about his address. So it is very easy to get the information without using different databases and executing complex queries. Ontology is a perfect solution for the complex queries. There are some other methods for knowledge presentation.

4.2 Rules

By using Rules no one can define ontology classes and proper-ties, but can be define some application-specific relations.

Rules can be used to present the knowledge in the form of IF-THEN-constructs and also allow to explain different types of complex statements.

Rules are also found in logic programming systems, like the language Prolog [15], in deductive databases [16] or in business rules systems. Rules are not able to explain ontology but define some application-specific relations.

In the above example there may be three rules—

1- If animal flies then it is bird.

2- If it is bird then it can be carnivore or it can be omnivore..

3- Fact is the Bird B hastype Carnivor and Omnivore..

Rule-based knowledge representation systems are especially suitable for reasoning about concrete instance data, i.e. simple facts of the form Bird(B).

Most statements in natural language can be expressed in terms of **Logical Sentences** about objects of the domain of interest with an appropriate choice of predicate and function symbols.

Concepts are mapped to unary, relations to binary predicates. , for example, figure 1.1 can be directly expressed by a logical implication, which is illustrated in the following fragment.

Employee ------is a—>Person

$\forall y : (\text{Employee}(y) \rightarrow \text{Person}(y))$

Example:

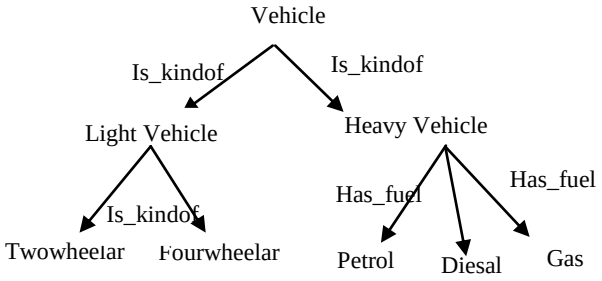


Fig 2: A hierarchy for concepts

While building an ontology, the first phase is Ontology Learning from text. Ontology development is based on the concept and relations between concepts. So before creating Ontology, there should be the collection of terms and concepts. There is an example for above hierarchy given below-

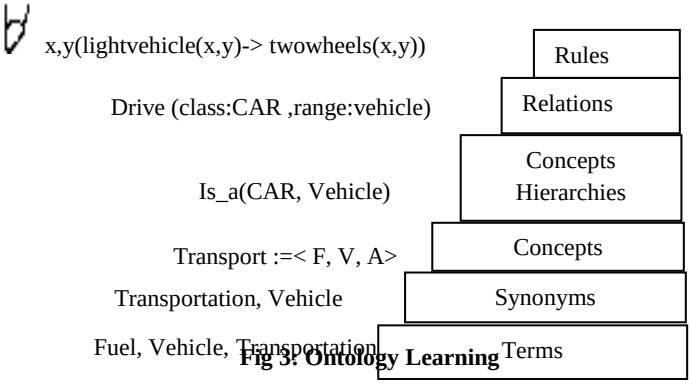


Fig 3: Ontology Learning

As common to most ontology development environments the visualization in Figure 2 presents to the knowledge engineer a taxonomy, i.e. a hierarchy, of the concepts in the ontology, which is indicated by is_a →-links.In the above example a taxonomy of Vehicle Ontology is described.

5. TYPES OF ONTOLOGIES

In the beginning of ontology research in Computer science, ontologies have been considered as a means of knowledge reuse within knowledge-based system engineering, and it turned out that different types of ontologies exhibit a different potential for reuse.

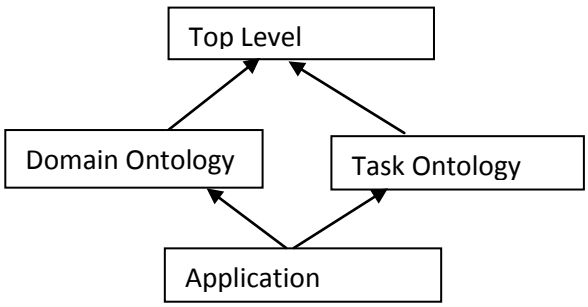


Fig 4: Types of Ontology

Top-level ontologies –are also called foundational ontologies or upper ontologies. They are used to describe very précis and general concepts that can be shared across many domains and applications. These ontologies are not directly used in applications due to their generality, but for other ontologies to be aligned to. Common examples for top-level ontologies are DOLCE [17] and SUMO [18].

Domain ontologies and Task ontologies are used to gain the knowledge within a specific domain such as medicine or geography, .These are also the knowledge about a particular task, such as diagnosing or configuring. They have been organized for scheduling and planning tasks, monitoring in a scientific domain and also for intelligent computer-based tutoring, missile tracking, execution of clinical guidelines, etc.

Application ontologies provide the specific vocabulary required to describe a certain task in a particular application context. They typically make use of both domain and task ontologies, and describe the role that some domain entity plays in a specific task for example, a particular physical entity.

6. ONTOLOGY LANGUAGES

Ontology languages are used in knowledge representation in terms of expressiveness and computational properties. These languages are basically important for Semantic Web. Some are explained here:

-XML

XML is a markup language for documents containing structured information.

-OWL

The Web Ontology Language (OWL) [19] has been standardized by the W3C consortium as a language for semantic annotation of web content and is widely accepted within the Semantic Web community.

- OWL-Lite
- OWL-DL
- OWL-Full

OWL is an expressive knowledge representation language, reasoning plays an important role, and there are a number of description logic reasoners available that can be used for querying OWL ontologies.

-RDF(S)

The Resource Description Framework (RDF) [20] is a language recommended by the W3C standardization body for representing information about resources in the World Wide Web.

-SWRL

Semantic Web Rule Language (SWRL)[21] based on a combination of the OWL DL and OWL Lite sublanguages of the OWL Web Ontology Language.

-WSML

The Web Service Modeling Language (WSML) family is the most recent ontology languages for the web, with a special focus on annotating Semantic Web Services. WSML is also have different variants like OWL and it also tries to cover all the major aspects of different knowledge representation.

7. ONTOLOGY TOOLS & METHODOLOGY

Methodologies	Tools	Languages
		OWL
Ushold & King	OILed	DAML+OIL
Gruningr & Fox	OntoEdit	OIL
SENSUS	Protégé-200	RDF
On-To-Knowledge	Ontolingua Server	XML

Table 1: Ontology Methodologies, Tools and Languages[22]

8. CONCLUSION

Ontologies are often viewed as the answer to the need for interoperable semantics in modern information systems. As stated in this paper, the knowledge is always hidden between the concepts and Ontology is a common way to represent the knowledge collected from different Autonomic systems. This paper has introduced an ontology-based knowledge-representation to present the data in a better way which can be understood by the user and machine in a friendly manner. It presents an overview on the topics of knowledge representation, ontologies and Semantic Web languages. These can be useful for future research and usability issues around the knowledge-based technologies.

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