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Development of Ontology in Laptop Domain for Knowledge Representation

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Abstract

Large amount of information is available on the World Wide Web(WWW), which when searched through major search engines provides a lot of unwanted information, requiring relevant information to be extracted, consuming a lot of effort and time. Ontologies prove to be a technique for effective knowledge representation and information retrieval, which is the core concept in semantic web applications. Knowledge representation with ontologies helps in effective information retrieval as compared to other technologies of representation.

This paper discusses about the requirement for ontology development, different tools for ontology development and the query languages to handle the knowledge. Three ontologies are created in the domain of laptop to deal with the problem of effective information retrieval and its coverage domain is validated with a set of queries executed with DL (Description logic) language on the developed ontologies.

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1. Introduction

1.1. Ontology

Ontology is widely used for knowledge representation and knowledge management in a highly structured and hierarchical way in many areas – philosophy, biomedical, bioinformatics, web representation and many more areas. Ontologies are considered as first step in devising an effective knowledge representation system [2]. Ontology are represented as graph structure which consists of concepts represented as vertices in a graph and relationships between concepts as directed edges in a graph. Defining relationships between concepts enables the machine to inference underlying logic existing in the ontology. For such automatic knowledge acquisition, ontologies have been widely studied and developed in variety of domains, which increases the need for sharing and reusing available ontologies [7]. There are different definitions of ontology defined by different researchers-

- "Explicit specification of a conceptualization" [5].
- "Formal specification of a shared conceptualization" [9].
- "Formal, explicit specification of a shared conceptualization" [10].

The reasons for developing ontology are identified as [1, 17,]

To share common understanding of the structure of information among people or software agents
To enable reuse of domain knowledge
To make domain assumptions explicit
To separate domain knowledge from the operational knowledge
To analyze domain knowledge

1.2. Development of ontologies for domain

The basic steps for the development of ontology are [1, 6].

- **Obtain domain knowledge**: Determine the domain and scope where the developed ontology will be used and define the applicability of the ontology for the defined application.
- **Identify the key concepts**: Determine the key concepts which need to be identified to design ontology.
- **Build the taxonomy**: Construct the class and class hierarchy
- **Identify relationships between classes**: Determine the relation that exists between different classes and subclasses.
- **Consistency Check**: the developed domain ontology should be checked for consistency using reasoners tools that are available with development tool or as plug-ins.
- **Implementation of ontology**: The developed ontology should be implemented in the required application.

The paper is structured as: Section 2 describes different ontology development tools available. Section 3 specifies the problem description and three ontologies developed by in the domain of laptop in Protégé for the purpose of future research of annotation of this ontology and describe the query retrieval on ontology for a set of queries in the domain of "Laptop" to check the coverage of concepts on the laptop domain. Section 4 finally concludes with future work.
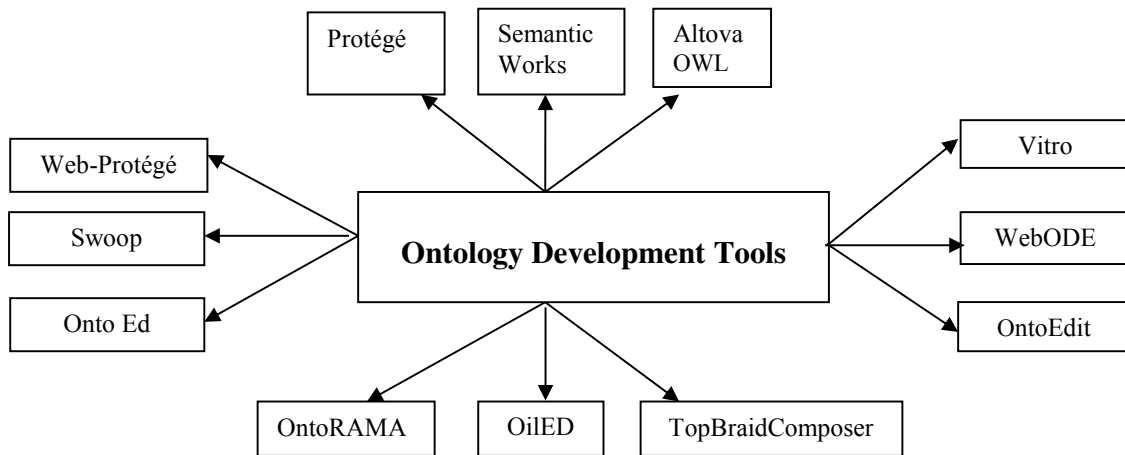
2. Different Ontology Development Tool

Fig. 1. Different Ontology Development Tools

There are lot of tools available for ontology editing[3], some of which have been summarized as in Fig. 1 and comparison of ontology editing tools have been done in different papers with each taking different parameters and different ontology editors: Michael Denny [12]; Buraga, Cojocaru & Nichifor[13]; Kapoor & Sharma[14]; Norta, Carlson, & Yangarber [15]; Funk, Tablan, Bontcheva, Cunningham, Davis, & Handschuh[16]; Emhimed Alatrish [11]. For this research Protégé tool developed by Stanford University for ontology development was used.

Protégé is an open source tool available for ontology. It contains a frame-based and an OWL-based ontology editor. Protégé OWL editor is a plug-in for the Protégé, which allows building and editing ontologies in OWL ontology language. OWL editor was used to construct the ontology for the research.

3. Ontology Development in Protégé

3.1. Problem Description

When a user wants to search for information on "specification of laptop" then he also gets the results for websites that deals with selling of laptop and sites showing the reviews on laptop, making the user to filter out the required contents consuming a lot of effort and time. Consider result analysis for precision rate for 10 WebPages for the described query. Result of analysis is as depicted in Table 1.

Table 1. Precision Rates for different Search Queries

Search query	Precision rate
Laptop specification	60%
Laptop Purchase	80%
Laptop Ratings	30%
Laptop feedbacks	40%

It was found that whatever query you give on laptop most result sets contained the links to the selling sites of the laptop. We have divided domain of laptop into three categories-

- Laptop specification
- Laptop Selling
- Laptop Reviews

Ontologies were developed for these domains and use of these ontologies will be extended for further annotation in future research. This paper deals with the development of ontologies in three categories and checking the consistency of ontology, and running DL (Description Logic) queries on the ontology to check the range of converge according to the set of query. For the research, three ontology are designed in the domain of laptop to support the research work which is utilized for information extraction.

3.2. Ontology Development

The Ontology developed for research purpose in the laptop domain are
I.   Ontology for Laptop_Review
II.   Ontology for Laptop_Specification
III.   Ontology for Laptop_Seller
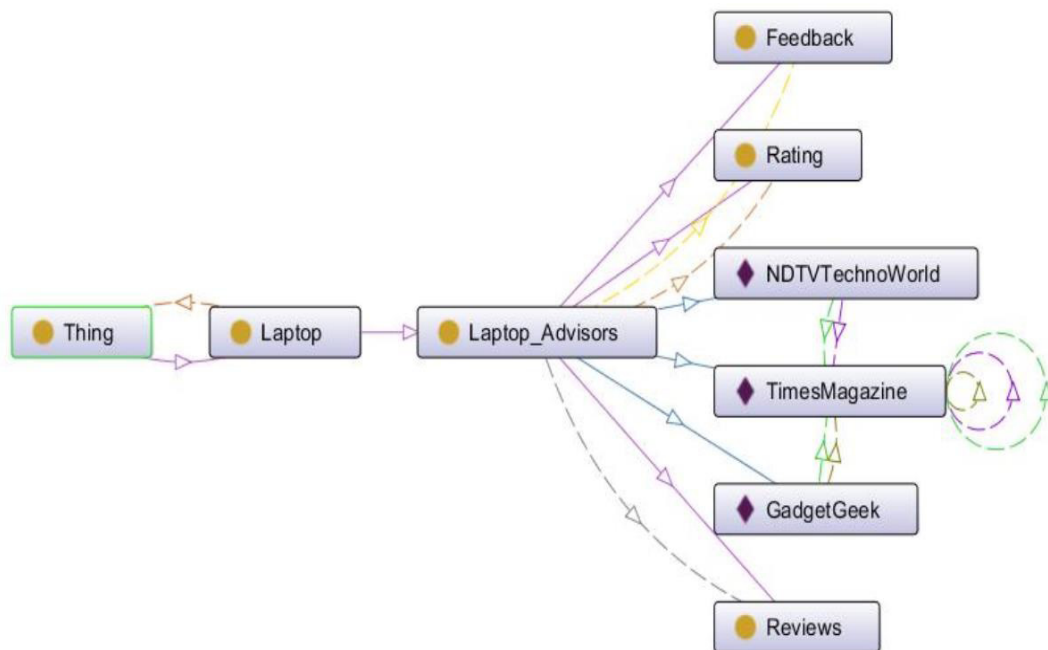
I.   Ontology for Laptop Review

Fig. 2. OntoVisualizer Result of Laptop_Review Ontology

Fig. 2. shows the OntoGraph Viz of Laptop_Review Ontology. In this Ontology the classes reviews, feedback and rating and the instances such as NDTV TechnoWorld, Times Magazine and GadgetGreek were developed which gives the reviews on the laptop.
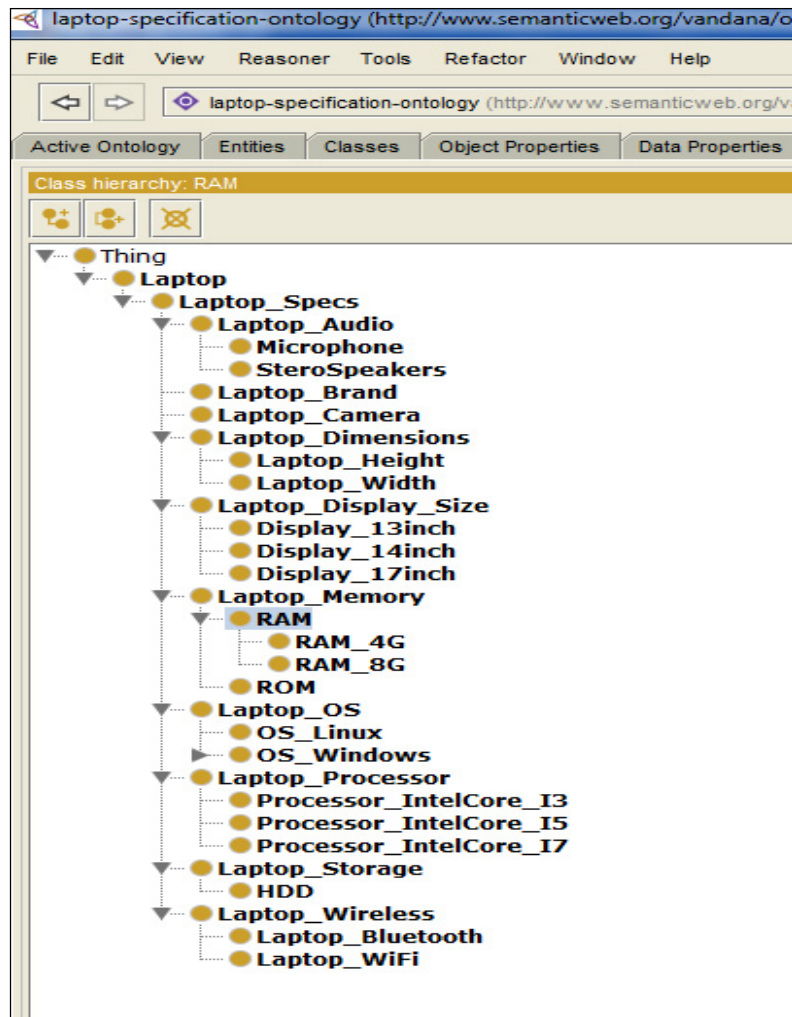
II.   Laptop_Specification ontology

Fig. 3: Laptop_Specification Ontology

Fig. 3. shows the Laptop_Specification Ontology in which the concepts related to laptop like storage, dimensions, memory, wireless features, camera, brand, OS, display_size are covered and the different object and data property relations between these classes followed by instances used were defined for these classes. The classes used in this ontology are as depicted in Fig 3.

III.   Ontology for Laptop_Seller

The ontology for Laptop_Seller covers concepts related to the selling sites. It covers the concepts like laptop availability, laptop price, laptop delivery charges, laptop payment mode, and different laptop selling sites. The instances are defined for different laptop selling sites.
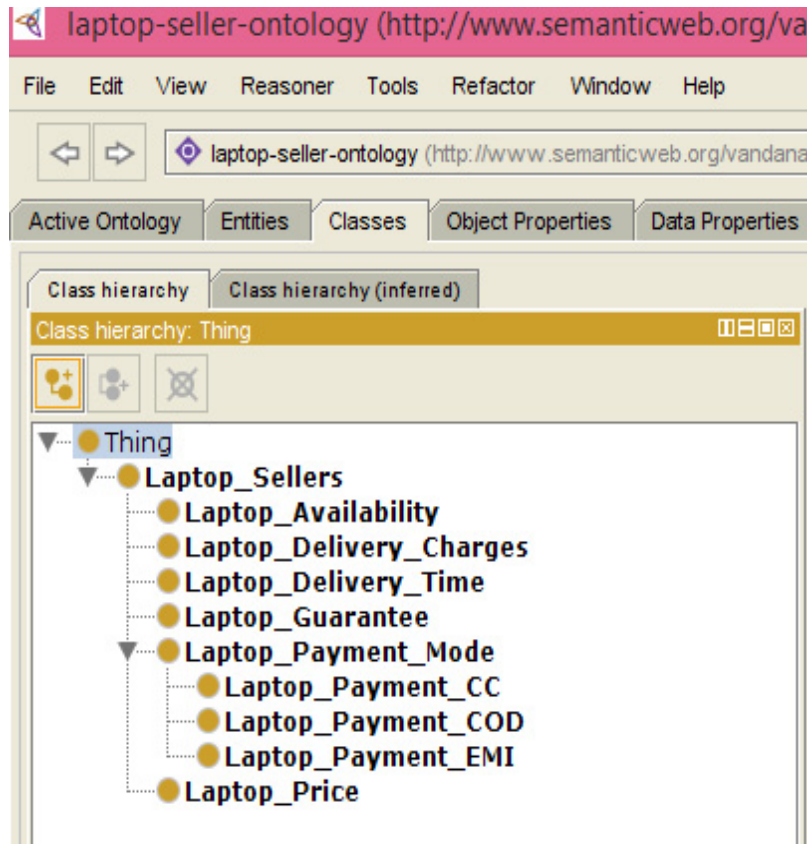
Fig. 4. Laptop_Seller Ontology

Fig. 4. Shows the development of Laptop_Seller ontology which covers the concepts related to selling of Ontologies and the individual instances covered in this ontology will be Flipkart, ShopClues etc. The classes covered in this domain are indicated in Fig.4.

3.3 Query Retrieval in Ontology

Query retrieval in Protégé can be done in two different ways
- DL Query [8]
- SPARQL Query [4]

DL Query tab is a plug-in feature for searching a classified ontology by using syntax specified by Manchester OWL. DL Queries works only when the ontology is consistent, hence we have checked all our ontologies for consistencies.

In order to verify and validate the ontology as regards to different competency questions, Description Logic (DL) was used. Table 2 indicates the set of queries designed for the ontology developed in the domain of laptop.

Table 2: Set of queries to be executed in the domain of laptop using three ontologies.

No.	Query	DL Query	Ontology used
1	Laptop with Display 13 Inches	Laptop and hasDisplay 13 inches	Laptop_Specification
2	Laptop with processor intel I3	Laptop and hasProcessor value " I3"^^string	Laptop_Specification
3	Storage capacity more than 1 TB	Laptop and hasstoragecapacity value "1TB"^^string	Laptop_Specification
4	Laptop with Price Range 30,000 to 40,000	Laptop_Price and hasrange30000 to 40000	Laptop_Seller
5	Costs less than 40,000	Laptop_Price and lessthan40000	Laptop_Seller
6	Payment Modes for Laptop Purchase	Laptop and haspaymentmode credit	Laptop_Seller
7	Laptop with Good rating	Laptop and hasrating " A"^^string	Laptop_Review

 Table 2 depicts the set of queries and the DL query format that was executed using protégé tool on a particular ontology.
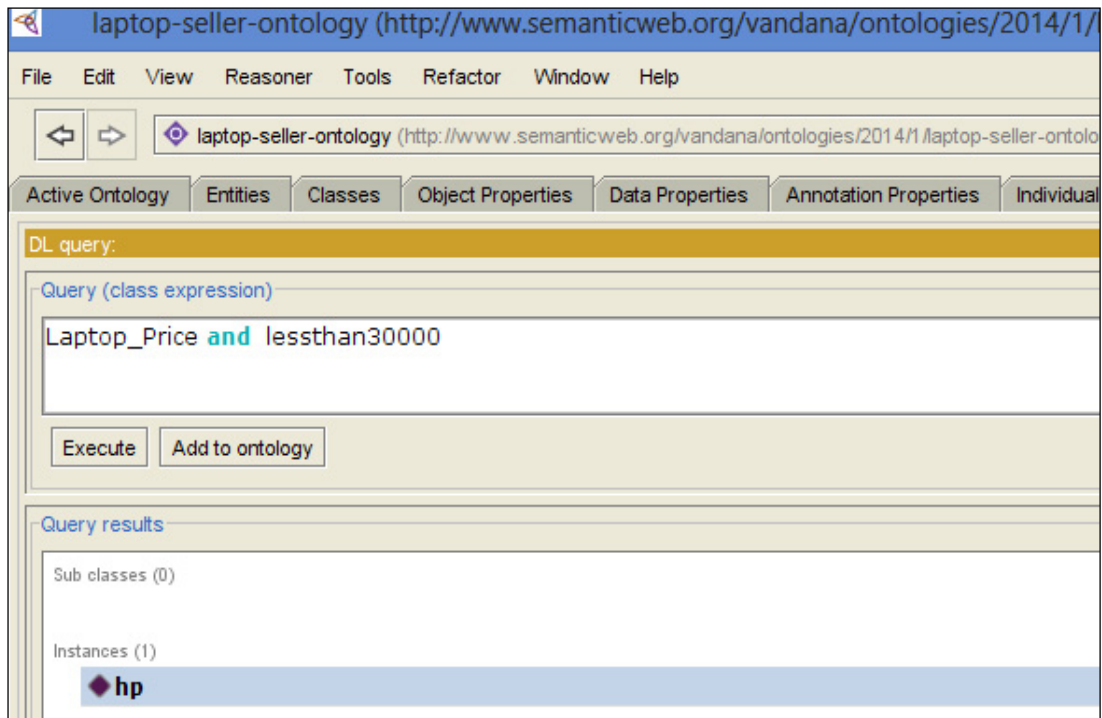

Fig. 5. Execution of DL Query Number 5 in Laptop Domain

Fig. 5. Shows the result of execution of query no 5 for Laptop_Seller Ontology where the result is hp(instance). These DL queries were executed with the set of these questions on defined ontologies in the laptop domain.

4. Conclusion

Building domain ontologies is not an easy task as it requires a lot of effort and time for domain conceptualization. Three ontology were designed in the domain of laptop following all the steps as described in [1] for ontology development and for checking the coverage of the concepts, set of queries were generated and implemented with the help of description logic. In future research work the developed ontology will be used for annotation that will help in information retrieval.

References

1. Noy N F, McGuinness D L. Ontology Development 101: A guide to creating your first ontology. Stanford University, Stanford, CA; 2001.
2. Chandrasekaran B, Josephson, J R, Benjamins, V.R. What are ontologies and why do we need them. *IEEE Intelligent Systems*; 1999, Vol. 14 No. 1, p.20-26.
3. Protégé Toolkit with software services. http://www. protégé.stanford.edu.
4. Seaborne A, Harris S. SPARQL 1.1 Query Language. W3C Recommendation; 2013. http://www.w3.org/TR/2013/REC-sparql11-query-20130321/.
5. Gruber T R. "A Translation Approach to Portable Ontology Specifications", *Knowledge Acquisition*; 1993, Vol. *5* No. *2*, p.199–220.
6. Malik S K, Prakash N, Rizvi S A M, Developing an University ontology in education domain using protégé for semantic web. *International Journal of science & technology*; 2010, Vol. 2 No. 9, p. 4673-4681.
7. Kwak J A, Yong H S. Ontology Matching Based on Hypernym, Hyponym, Holonym, and Meronym Sets in WordNet , *International journal of Web & Semantic Technology (IJWest)*;2010, Vol.1, No.2.
8. DL Query Tab, http://protegewiki.stanford.edu/wiki/DLQueryTab.
9. Borst W N. Construction of Engineering Ontologies for knowledge sharing and reuse. PhD Thesis University of Twente; 1997, The Netherlands.
10. Studer R, Benjamins V R, Fensel D. Knowledge engineering: Principles and methods. *Data & Knowledge Engineering*; 1998, Vol. 25 No. 1,p. 161–197.
11. Alatrish E S. Comparison Some of Ontology. *Journal of Management Information Systems*; 2013, Vol. 8 No. 2, p. 018-024.
12. Denny M. Ontology Building: A Survey of Editing Tools; 2002. *XML.com. Vol. 1.*
13. Buraga S C, Cojocaru, L, Nichifor O C. Survey on Web Ontology Editing Tools. *Transaction Autom. Control Comput*. Sci.Rom; 2006, p. 1-6.
14. Kapoor B, Sharma S. A Comparative Study Ontology Building Tools for Semantic Web Applications. *International Journal of Web & Semantic Technology (IJWest)*; 2010, vol. 1 no.3, p. 1-13.
15. Norta A., Carlson L, Yangarber R. Utility Survey of Ontology Tools. *Department of Computer Science, Department of linguistics*-University of Helsinki, Finalnd; 2010, Vol. 62, p. 63-65.
16. Funk A, Tablan V, Bontcheva K., Cunningham H, Davis B, Handschuh, S. Clone: Controlled language for ontology editing. Sixth International Semantic Web Conference, (ISWC) Berlin; 2007 p. 142-155.
17. Wang K . An Ontology of Manufacturing Knowledge for Design Decision Support. WiCOM'08 Dalian; 2008, p.1-5.