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Semantic Web, Ontologies and E- Government: A Review

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Abstract: E-government is considered as the efficient way of Information &Communication Technology (ICT) to improve the system of government that is in place, and with a aim to provide better and useful services to the Citizens. Ontologies plays an important role in the deployment of various e-government projects and services as they enable matching, mapping and merging of various services of e-government and it also enables to facilitate the semantic integration and interoperability of various e-government services. This paper reviews the various methods and tools to implement the ontologies and how to test them using various reasoners.

Keywords: E-government, ICT, ontologies, semantic

1. INTRODUCTION

The main aspect of exchanging information among applications, systems, and various services is the development of a consistent and efficient model for representing the domain knowledge. It is essential for: sharing of knowledge, sharing information among organizations [1, 14], exchange of health information among clinics [2, 6, 14], and among heterogeneous systems [3, 9, 14]. For this, there is need to carefully model the knowledge of a specific domain while preserving its semantics [4, 5, 6, 14].

Most widely accepted definitions of ontologies in the field of computer science is that an ontology can be defined as an "explicit and formal specification of a shared conceptualization"[6,7].Ontologies are capable to provide shared vocabulary, which can be helpful in modeling a domain containing it's concepts, type of objects and their properties along with relationships.[8,9,10,11]. Ontologies can be created in various fields like artificial intelligence, biomedical informatics, e-government etc. to reduce the complexity and to represent the information an organized way. Ontologies are considered as the strong element of a growing concept i.e. semantic web which is considered as the extension of the current web [8].

Semantic web is an advanced concept which has generated a revolution in the current web technology of World Wide Web. It is the topmost root in the current web. The concept behind using the semantic web is to provide smart data integration, which creates a form of interoperability between the different agents. In the current web technology it is not properly handled. A common problem with current web is that the machine is not able to understand what it represents, for this semantic web provides machine understandable meaning and a standard way of achieving data integration in the current web. This is performed by developing a set of vocabulary that has the meaning coded inside its term [8, 12, 13].

In the semantic web a web page will markup the vocabulary with an objective to attain the meaning of the terms used in the vocabulary. This vocabulary is called the ontology in the context of the semantic web, as it is domain specific and it may be of specific area or subject [9, 10, 11]. As the domains contain their own vocabulary so it may cause redundancy of data. To avoid or reduce data redundancy semantic heterogeneity is to be maintained, ontology matching plays a crucial role in managing the semantic heterogeneity as it determines the correspondences between concepts of ontologies which are different in nature but semantically equivalent. It is an important operation which is used in many traditional applications like data translation, query answering ontology merging etc. [8, 9].The fundamental approach to use semantic web technologies is to have the semantic metadata, which exists at two levels:

Level 1: It describes a form of document or part of it e.g. a paragraph.

Level 2: It describes the entities of that document for example a person or a company [15, 16].

There are some additional services which can be performed by the use of metadata like we can organize and extract the information based on the information

not just text. By the use of semantics our system is capable of understanding that where the phrases or words are similar. When searching for "Narendra Modi" we may be provided with results referring to "The Prime Minister of India". It can also distinguish where the same word is used with different meanings. Semantic metadata also plays an important role to integrate the information from different sources whether from the same organization or the different organizations. With the help of semantic it is possible to create a unified view and this helps in achieving the interoperability between the processes which uses the information [16, 17].

2. ONTOLOGIES AND ONTOLOGY LANGUAGES

The definition of the ontology is generally based on two key points:

(a) That the conceptualization is formal and it permits the computer to perform task of reasoning.

(b) For a particular domain of interest a practical ontology can be designed.

Ontology consists of classes (also known as the concepts), axioms, properties (relations) and the instances or it can be represented as a 4-tuple{C, A, P, I} where C is the set of concepts, A is the set of axioms, P is the set of properties and I is the set of instances [11]. For creation of all the components of ontology: concepts, axioms, properties, instances, OWL language provides a mechanism. Two types of properties can be defined here:

(a) Object Properties: This property is used to relate instances to instances (I to I).

(b) Data type Properties: This property is used to relate instances to data type values (I to D).

On the other hand concepts are used to provide the mechanism of inheritance for the properties and a sub assumption of reasoning. Finally axioms are used to provide the information about the properties and the classes by specifying the equality of the two classes or defining the range of a property. OWL comes in 3 variants mainly:

(a) OWL Lite: It offers a restricted arrangement of features, in spite of the fact that it is helpful for a few applications. OWL Lite was initially expected to help those clients essentially requiring a characterization progressive system and straightforward requirements.

(b) OWL DL: It is considered as the superset of the OWL Lite and it is based on the form of FOL i.e. First order logic which is known as Description logic.

(c) OWL Full: It is the superset of OWL DL , which expels a few limitations accessible in the OWL DL like in OWL Full a class can be dealt with at the same time as an accumulation of people and as a person in its own particular right; this isn't allowed in OWL DL. OWL Full enables a cosmology to enlarge the significance of the pre-characterized (RDF or OWL) vocabulary.

Resource Description Framework allows to build OWL it is generally a data modeling language defined by W3C. It is graph based and consists of a triplet: Subject, predicate and object {S,P,O} [16,18,19].

3. ROLE OF KNOWLEDGE DISCOVERY IN ONTOLOGY

According to the definition of ontology, it is a structure which captures the semantic knowledge about a specific domain ensuring the relevant concepts and relation between them. Knowledge discovery helps the system to discover useful information within the data [20], more precisely knowledge discovery can be defined as the process to extract the implicit, nontrivial, and potential information from the data in large databases [21].

Semi- Automatic ontology Construction based on Knowledge Discovery

Knowledge discovery techniques support the construction of semi-automatic ontologies by efficiently utilizing the human interventions, by providing the suggestions and to perform the ontology refinement. There are following phases which are interrelated with each other supports the ontology constructions with respect to the knowledge discovery:

a) **Understanding of the Domain**: It incorporates the area for which the construction is to be done.

b) **Understanding the Data**: To check availability of the data and its relation with the ontology construction.

c) **Defining the task**: It defines the tasks which need to be addressed and it is based upon the data which is available along with its properties.

d) **Learning Ontology**: It is defined as the semi-automated process which addresses the tasks of a defined phase.

e) **Evaluation of Ontology**: It estimates the quality of the solutions provided to the tasks which were addressed.

f) **Refinement**: It is considered as the transformation which is needed for ontology improvement and as per the desire any previous steps can be accessed [20].

4. INFORMATION EXTRACTION (IE):

It is a form of natural language analysis which links the semantic web models for the metadata extraction. IE is different from IR i.e. information retrieval in the following manner [22]:

a) The IR systems are able to finds the relevant texts and there presentation to the user.

b) Whereas an IE system first analyze the text and presents only the specific information to the user.

5. ONTOLOGY - BASED INFORMATION EXTRACTION

Semantic annotation is a specific metadata [22] generation which aims to enable new methods of information access to enhance the existing ones. By using the External or the background knowledge, information can be connected to the formal descriptions i.e. ontologies, which provides the semantics and the connectivity to the web.

Ontology – Based Information Extraction (OBIE) is termed as the technology which can be used for the semantic annotation. The major difference between the semantic IE and the traditional IE is the fact that it not only finds the most specific type of extracted entity but it also performs the identification by linking it to the instance base.

The main challenges of OBIE are:

a) Identification of the instances in the ontology.

b) Updating the ontologies with new instances.

TABLE I. BRIEF INTRODUCTION OF ONTOLOGY-BASED IE TOOLS

Name of Tool	**Contribution**	**Limitation**
Mapgie [22, 23]	It can be used with different ontologies. Supports the interpretation of the webpages and automatically populates the ontology from relevant sources of the web	It is not able to populate the ontologies automatically with new instances.
Pankow (Pattern – based annotation through knowledge on the web) [24]	It helps to find the surface patterns and the redundancy on the web. It will automatically categorize the instances from the text with respect to the given ontology. It does not require any processing of the text or training data.	It is difficult to classify instances with the same name of different classes in different forms.
SemTag [25]	It offers high degree of parallelism. The need of such parallelism generated from the big volume of data to make semantic annotation a feasible option.	

6. ONTOLOGY MEDIATION

Ontology mediation enables the reuse of data across different application over the semantic web and provides a means of cooperation between different types of organizations. It enables the sharing of data between different knowledge bases and allows reusing the data from different knowledge bases [26], two types of techniques generally used by ontology mediation which are:

a) **Ontology mapping**: It is used for the representation of the correspondence between the two ontologies which are stored separately, it is considered as the declarative specification of the semantic overlap between two ontologies. There are 3 main phases for deploying ontology mapping:

   (i) Mapping Discovery

   (ii) Mapping Representation

   (iii) Mapping Execution.

b) **Ontology Merging**: It is the creation of a single ontology from more than two source ontologies. The resulting ontology will unify and replaces the original source ontologies. The following two approaches are used generally in ontology merging process:

   (i) *PROMPT* [26, 27]: It is an algorithm and an interactive tool which allows to merge two ontologies by identifying number of merge operations like: merge slots, merge classes and merge bindings between the slot and a class. It generates the possible conflicts like: name conflicts, dangling references,

   (ii) *Onto Merge* [28]: It is an online approach which is used to maintain the source ontologies after merge operation. It produces a bridge ontology which imports the source ontologies which consists of several bridging

Axioms or the translation rules which are used to connect the overlapping part of the source ontologies.

7. ONTOLOGY ENGINEERING

Ontology Engineering is the way to construct the ontologies by using different ontology engineering methodologies which provides the methods for creating the general systems for carrying out the work to be performed [29], Ontology Engineering Methodology primarily focuses on three types of activities which are as follows:

a) Management Activities: It defines the control mechanism and quality assurance steps, which includes the scheduling of the ontology engineering tasks.

b) Development Activities: It is important to define the procedures for the environment and the feasibility study. After taking the decision of building the ontology the ontology engineer needs the procedures to implement, formalize and specifying the ontology.

c) Support Activities: For the efficient development of the ontology various support activities like: evaluation, merging, integration, knowledge acquisition etc. should be taken care of.

TABLE II. BRIEF INTRODUCTION OF VARIOUS ONTOLOGY ENGINEERING TOOLS

Name of Tool	Contribution
Protégé [14, 29, 30,31]	Widely used in ontology creation. Supports numerous plug-ins form external sources. Supports the SPARQL for testing purpose along with various reasoners like Pellet RACER, HermiT FACT++ etc. for the generation of new facts from the existing ontologies. Compatible with RDF and OWL.
KAON [14, 29,32]	Provides easy integration. Highly scalable and follows advanced modeling approaches. Supports automatic ontology evolution.
Web ODE [29, 33]	It is purely web based. It uses prolog for inference. Provides translators to RDF and OWL.
Onto Edit [29, 34]	Supports OTK i.e. On-To-knowledge explicitly. Provides support for integration of inferencing capabilities.

8. ROLE OF ONTOLOGY IN E-GOVERNMENT

Ontology development is becoming[35] very popular in the area of electronic government (E-Government) for last few years as it helps in describing the services provided by the government to the citizens by enabling matching, mapping, and merging of various e-government services, and also it provides semantic integration and interoperability of e-government services. Following are the key reasons for the development of ontologies in E-Government: [36]

a) Provides a common way of understanding the structures among the peoples.

b) Gives the facility of extraction of information from different sources and processing of documents.

c) Gives support to the reuse of existing domain knowledge.

d) Provides an unambiguous contextual framework which enables the communication between complex and detailed concepts.

e) Provides a declarative description of the semantic information which is independent of data representation.

f) Offers the comparison of various objects which are integrated across various heterogeneous repositories.

9. CONCLUSION

As the technological developments getting enhanced from last few years and a large volume of data is a spread over heterogeneous repositories so to manage the data in an efficient manner is a challenging task. To overcome this challenge semantic web plays an important role extracting the data and to filter the appropriate content which is needed it also helps to establish a relationship between different forms of data. On the other hand role of ontologies is also crucial while considering the semantic web as it is quite helpful in enhancing the interoperability which is considered as the major challenge for various E-Government projects.

REFERENCES

[1] E. Brynjolfsson, H. Mendelson. “Information systems and the organization of modern enterprise” Journal of Organizational Computing, vol. 3, 1993, pp. 245-255.

[2] S. M. Huff, R. A. Rocha, B. E. Bray, H. R. Warner, P. J. Haug. “An event model of medical information representation” Journal of the American Medical Informatics Association, vol. 2, pp. 116-134.

[3] P. B. Bhat, C. S. Raghavendra, and V. K. Prasanna, “Efficient collective communication in distributed heterogeneous systems” 19th IEEE International Conference on Distributed Computing Systems, Proceedings, 1999, pp. 15-24.

[4] T. A. Halpin. “Information modelling and relational databases: from conceptual analysis to logical design” Morgan Kaufman Publishers, San Francisco, 2001.

[5] R. Wasserman. "The problem of change" Philosophy Compass, vol. 1, 2006, pp. 1- 10.
[6] Nelia Lasierra, Alvaro Alesanco, Jose Garcia. "Designing an architecture for monitoring patients at home: Ontologies and Web Services for Clinical and Technical Management Integration" Journal of Biomedical and Health Informatics, vol. 18(3), 2014, IEEE, pp. 896-906.
[7] R. Studer, V. R. Benjamins, D. Fensel. "Knowledge engineering: principles and methods" Data Knowledge Engineering, vol. 25(1-2), 1998, pp. 161-197.
[8] Tanni Mittra, Muhammad Masroor Ali. "Parallelized and distributed task based ontology matching in clustering environment with semantic verification" CSI Transaction on ICT, vol. 5, 2017, pp. 265-279.
[9] Euzenat J, Shvaiko. "Ontology Matching" Springer, Berlin, 2013.
[10] Maedche A. "Ontology learning for the semantic web" Springer, Berlin, 2002.
[11] Staab S, Studer R (eds). "Handbook on ontologies" International Handbooks on Information Systems, Springer, Berlin, 2004.
[12] Antoniou G, Groth P, van Harmelen F, Hoekstra R. "A semantic web primer" 3rd edition. MIT Press, Cambridge, 2012.
[13] Yu L. "A developer's guide to the semantic web" Springer, Berlin, 2011.
[14] Asad Masood Khattak, Rabia Batool, Zeeshan Pervez, Adil Mehmood Khan, Sungyoung Lee. "Ontology evolution and challenges" Journal of Information Science and Engineering, vol. 29, 2013, pp. 851-871.
[15] https://www.w3.org/2001/sw/
[16] Paul Warren, Rudi Studer, John Davies. (eds). "Introduction in semantic web technologies: trends and research in ontology-based systems" John Wiley & Sons Ltd, 2006 pp. 1-8.
[17] Davies J, Fensel D, Van Harmelen F. (eds). "Introduction in towards the semantic web: ontology-driven knowledge management" John Wiley & Sons Ltd., 2003, pp.1-8.
[18] https://www.w3.org/2004/OWL/
[19] https://www.w3.org/RDF/
[20] Marko GrobeInik, Dunja Mladenic. "Knowledge discovery for ontology construction" Semantic Web Technologies: Trends and Research in Ontology-based Systems, John Davies, Rudi Studer, Paul Warren (eds), John Wiley & Sons Ltd., 2006, pp. 9-25.
[21] Fayyad U, Piatetski-Shapiro G, Smith P, Uthurusamy R (eds). "Advances in knowledge discovery and data mining" MIT Press, Cambridge, 1996.
[22] Kalina Bontcheva, Hamish Cunningham, Atanas Kiryakov, Valentin Tablan. "Semantic annotation and human language technology" Semantic Web Technologies: Trends and Research in Ontology-based Systems, John Davies, Rudi Studer, Paul Warren (eds), John Wiley & Sons Ltd., 2006, pp. 29-49.
[23] Domingue J, Dzbor M, Motta E. "Mapgie: Supporting Browsing and Navigation on the Semantic Web" Nunes N, Rich C, (eds). Proceedings, Conference on intelligent User Interfaces (IUI), 2004, ACM, pp. 191-197.
[24] Cimiano P, Handschuh S, Staab S. 2004. "Towards the self – annotating web" Proceedings of 13th International Conference on World Wide Web, 2004, pp. 462-471.
[25] Dill S, et al. "Semtag and seeker: bootstrapping the semantic web via automated semantic annotation" Proceedings of World Wide Web, 2003, ACM.
[26] Jos de Brujin, et al. "Ontology mediation, merging, and aligning" Semantic Web Technologies: Trends and Research in Ontology-based Systems, John Davies, Rudi Studer, Paul Warren (eds), John Wiley & Sons Ltd., 2006, pp. 95-112.
[27] Noy NF, Musen, MA. "PROMPT: algorithm and tool for automated ontology merging and alignment" Proceedings, 17th National Conference on Artificial Intelligence, 2000, Austin, Texas, USA.
[28] Dou D, McDermott D, Qi P. "Ontology translation by ontology merging and automated reasoning" Proceedings, Workshop on Ontologies for Multi-Agent Systems, 2002, pp. 3-18.
[29] York Sure, Christoph Tempic, Denny Vrandecic. "Ontology engineering methodologies" in Semantic Web Technologies: Trends and Research in Ontology-based Systems, John Davies, Rudi Studer, Paul Warren (eds), John Wiley & Sons Ltd., 2006, pp. 95-112.
[30] N. Noy, R. Fergerson, M. Musen. "The knowledge model of Protégé - 2000: Combining interoperability and flexibility" Proceedings, 12th International Conference on Knowledge Engineering and Knowledge Management: Methods, Models, and Tools, 2000, pp. 17-32.
[31] Sunitha Abburu. "A Survey on Ontology Reasoners and Comparison" International Journal of Computer Applications, vol. 57(17), 2012, pp. 33-39
[32] T. Gabel, Y. Sure, J. Voelker. "KAON – ontology management infrastructure" D 3.1.1.a, SEKT Project: Semantically Enabled Knowledge Technologies, 2004.
[33] Arpirez J. C., Corcho O., Fernandez-Lopez M., Gomez-Perez A. "Web ODE: a scalable workbench for ontological engineering" Proceedings, First International Conference on Knowledge Capture, 2001, pp. 6-13.
[34] Y. Sure, J. Angele, S. Staab. "OntoEdit: multifaceted inferencing for ontology engineering" Journal on Data Semantics, vol. 1, 2003, pp. 128-152.
[35] Jean Vincent Fonou-Dombeu, Magda Huisman. "Semantic-driven e-government: application of uschold and king ontology building methodology for semantic ontology models development" International Journal of Web & Semantic Technology, vol. 2(4), 2011, pp. 1-20.
[36] Fathia Bettahar, Claude Moulin, Jean-Paul Barthès. "Towards a semantic interoperability in an e-government application" Journal of e-Government, vol. 7(3), 2009, pp. 209-226.