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TECHNOLOGY****ANALYZING ONTOLOGY EDITING TOOLS FOR EFFECTIVE SEMANTIC
INFORMATION RETRIEVAL****Namrata Rastogi *, Dr. Parul Verma, Dr. Pankaj Kumar**

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ABSTRACT

Information retrieval is a prime concern when there is plethora of information lying on the Web. In order to retrieve meaningful information, Semantic web is the need of the hour. For developing the appropriate semantics, a good ontology has to be created. There are various ontology editing tools available in the market and much analysis on them has already been done so far. This paper shows the analysis of some latest ontology tools (TODE, OwlGrEd, Odase, OntoStudio 3.1) available both as desktop and online versions and compares it with the latest version of most popular tool Protégé 5.0. The analysis is done on the basis of features like architecture, storage, interoperability, library and GUI design. The result of the analysis is explored for each domain like E-government, tourism, transport, healthcare, etc. and ensures more understanding of these tools with respect to every domain.

KEYWORDS: Ontology Tools, Ontology Development, Protégé, OwlGrEd, Odase, TODE**INTRODUCTION**

The semantic web is considered to be a mesh of various inter-connected links that offer information in World Wide Web. The main target of creating a semantic web is to have an automated retrieval of information using these links which should be easily processed with machines. The Semantic web use ontologies to create such automatic links and provide knowledge representation for a particular domain.

Hence, Ontology engineering has become a prominent field inside knowledge management community. Creating these ontologies require the use of various ontology editing tools. While creating a new ontology for a specific domain, we often try to figure out which tool are the easiest, simplified and give the best support for ontology creation. This survey paper will answer most of such questions and will help in analyzing various ontology editing tools. But first, we see a brief introduction of few important terms.

Semantic Web

Semantic Web as described by Tim Berners Lee himself is an extension of the World Wide Web that talks about more structured data in the form of a mesh of interconnected links. These links make the Web more intelligent and intuitive about users' needs. Here the meaningful information is automatically gathered and reprocessed so that other machines may also use the information. Hence Semantic web in its true sense is much related to the meaning of data rather than its structure. Semantic Web has quite few names of its own like Web of Data, Web 3.0, or The Linked data Web. The semantic web in itself is distributed and heterogeneous and aims at providing reusability of information in the form of semantic links. Also semantic web offers various benefits like knowledge sharing, web automation, reducing redundancy, etc. [12].

Web Ontology

The semantic web is implemented using the Web ontology which describes information in the form of formal explicit description of concepts in a given domain. Ontology includes a set of distinct instances of classes that forms a knowledge base. Neches [13] who defined Ontology for the first time described it as "Ontology defines the basic terms and the relations that include the vocabulary of a specific area, in addition to the rules to combine terms and relations to define extensions to the vocabulary". Ontology is created to give a concrete

structure to the given domain and universe related to it. Waterson and Preece [14] defined ontology as “The specification of Shared Knowledge”.

Ontology tools

In order to create ontologies, various ontology editing tools are available in the market. Some of them are online while others are client server based tools. All these tools are efficient enough to create and manipulate ontologies for a specified domain. DUET, UBOT, OntoEdit (now OntoStudio), Protégé, Hozo, OilEd, WebOnto, OwlGrEd, Swoop, OntoLingua, Odase, Top Braid Composer, etc. are few names of available ontology editors. Each of these tools has its own features and performance levels based on which we pick the latest version of six tools and analyze their working environment

ANALYSIS ON ONTOLOGY EDITING TOOLS

There are various tools available in the market for ontology building for the past few years. These tools aim in providing specialized development environment for creating, testing and maintaining ontologies. In this paper, the latest ones are compared on the basis of following features of the software:

- **Application:** This refers to the fact that the tool is a generic or a special purpose tool which has been designed for a specific domain. Also it depicts if the tool is a university funded project or a government funded one.
- **Architecture:** This is the most important aspect while analyzing a tool. Architecture refers to extensibility and storage of ontologies in the form of databases, ASCII files, etc. The latest tools are now following modular design and extensible architecture. The storage in database is still a point to ponder in these ontology tools [1].
- **Interoperability:** Ontologies in itself are meant to have features of reusability and interoperability as the most important aspect; here we see how these tools are used well for sharing of knowledge. The tool should provide reusability of same ontologies in best possible way and also support varied ontology representation (importing & exporting in other ontology languages).
- **Usability:** This refers to the fact that how well an interface is user friendly and adaptable to the ontology developer. The recent tools are so much graphical that they allow drag & drop feature while adding new elements in the given tool and editing them in best possible way. It also covers using the ontology library which has its own rich set of features that help in extending the given ontology.

Ontology editing Tools under Evaluation

This section of the paper will provide description on various ontology editing tools that are considered for the survey. The most recent tools have been discussed here and we contrast it with the most popular ontology tool, Protégé. In order to bring novelty to the complete survey, Protégé 5.0 has been considered here which itself is the latest version of its own lineage.

OntoStudio 3.1: It is the part of the OntoPrise product suite which provides a complete Semantic Web infrastructure and supports all major W3C Semantic Web recommendations like OWL, RDF(s), RIF and ObjectLogic. The latest version of OntoStudio provides a professional development environment for creating, testing, maintaining ontologies. The tool also helps in integrating various heterogeneous data sources in the form of mapping them to ontologies[2]. Some salient features of OntoStudio 3.1 are:

- Standard language and full support for OWL, RIF, RDF(S), SPARQL, ObjectLogic
- Collaborative ontology development using Collaboration Server
- drag & drop conversion of ontologies between different languages
- Incorporating ontology queries using Web service deployment
- Easy integration of database information to your ontology

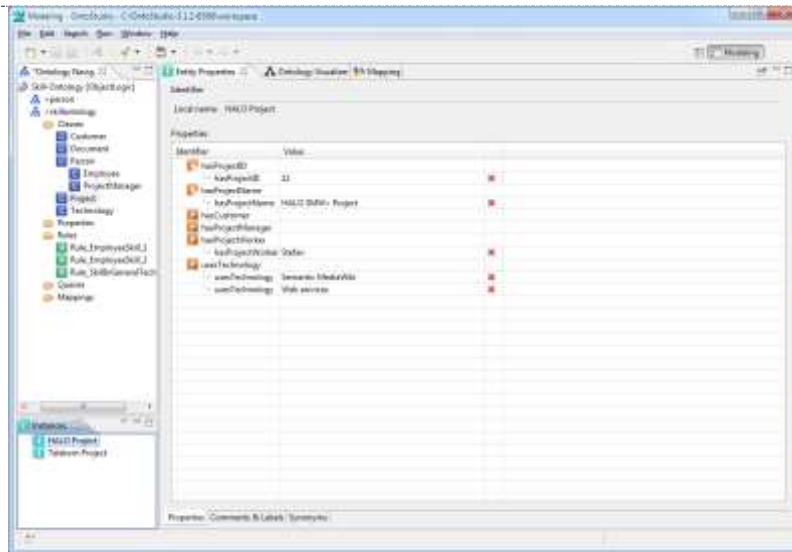


Figure 1: Screenshot of OntoStudio 3.1 [3]

Protégé 5.0: Protégé 5.0 has been released in two versions namely, WebProtégé and Protégé Desktop both providing the most updated technological inputs in the field of ontology building. The latest version of protégé is Protégé 5.2.0 which has just been released on March 15, 2017. We majorly focus on its desktop version that provides complete support in creating and editing more than one ontology for a particular problem using a totally user centric interface. The visualization tools permits to interactively navigate the ontology relationships. There is also an advanced explanation support which helps in finding the inconsistencies. Various refactor operations like merging ontology, rename of multiple entities, moving axioms between ontologies, etc. are also available. [4]. Some salient features of Protégé Desktop 5.2.0 are:

- Compliance of W3C standards and user centric interface
- Proficient visualization support
- Direct and clear interface to reasoners like Hermit and Pellet.
- Highly plug n play architecture with various ontology refactor operations
- Cross compatible with Web Protégé
- The latest release contains various enhancements and fixes like context sensitive help, entities tab improvements, general user interface improvements and few changes for developers [5].

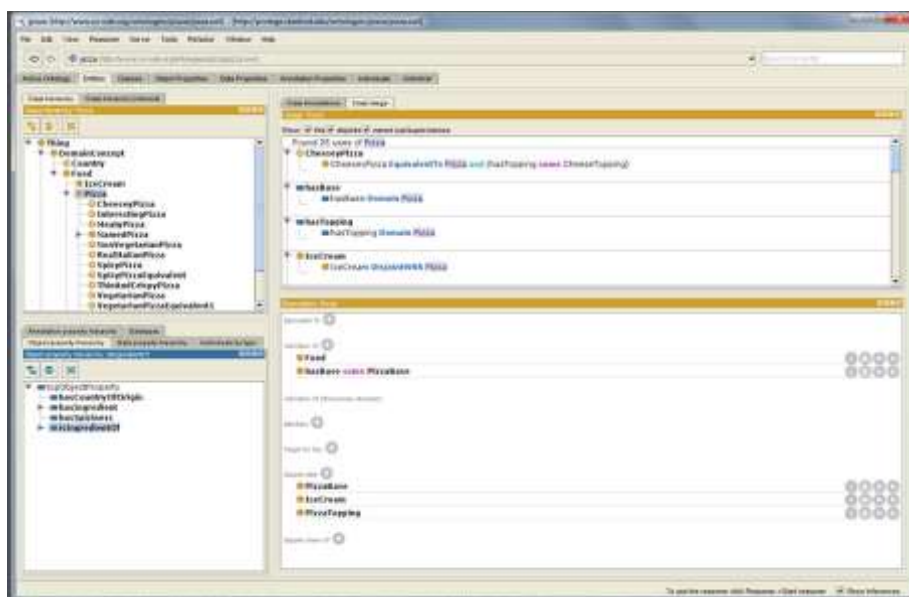


Figure 2: Screenshot of Protégé Desktop [4]

SWOOP: This tool is a hypermedia-based lite OWL Ontology Editor and browser. It has features of being simple and scalable and is programmed in Java. Semantic Web Ontology Overview and Perusal (SWOOP) was earlier maintained by University of Maryland only. It is now jointly developed by IBM Watson Research, Clark & Parsia and the University of Manchester [6]. Swoop gives a familiar look of a web browser with add-ons like an address bar, bookmarks, hyperlink navigation, history button, etc. There is another feature where entities, relationships of various ontologies can be compared, then edited and merged. Using HTML renderer, different color codes and font styles are used to depict editing of ontologies. Swoop is built on MVC (model-view-controller) design and architecture[8]. Some salient features of Swoop [7] are:

- Intuitive and clean graphical interface
- Search within various ontologies
- Check out bookmarks and advanced settings
- Tool for creating, editing, and debugging OWL Ontologies.
- It has a RDFS-like simple reasoner, a Description Logic Tableaux Reasoner and Pellet.
- Provides searching of multiple ontologies & 'find all references' of an entity called OWL.
- Debug Ontologies and Run "sound and complete" conjunctive ABox queries using Pellet.
- Crop Circles visualization of class hierarchy

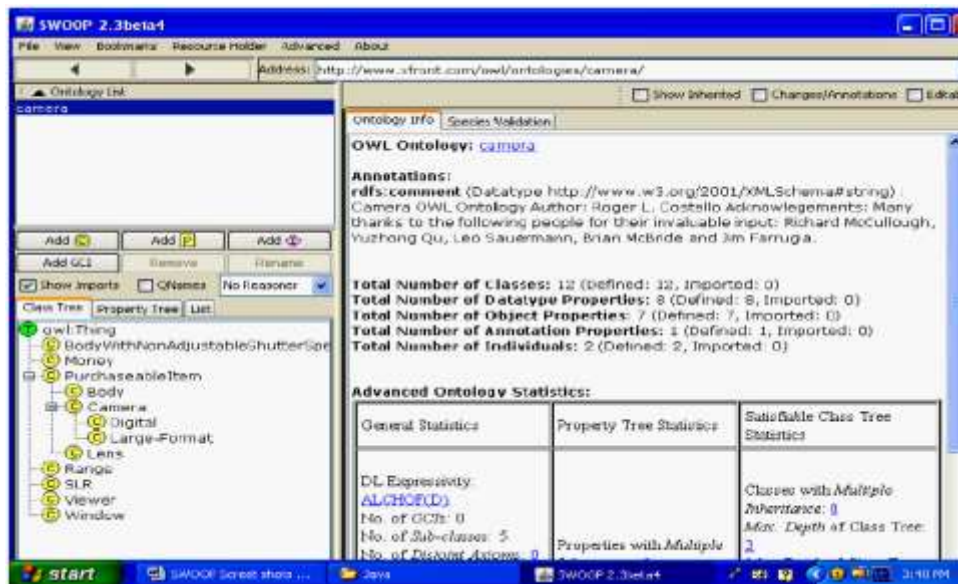


Figure 3: Screenshot of SWOOP 2.3 Beta4 [1]

TODE: The Tool for Ontology Development and Editing abbreviated as TODE is the first ontology editor based on Dot Net framework [9]. The editor is first of its kind and was proposed so that anyone interested in dot Net environment may not lack behind. It is believed by the developers who proposed this editor that it will work as a catalyst and will motivate others to develop more supporting software in Dot Net environment. TODE is developed using technologies like Telerik Test Studio .NET UI Controls, Dot Net 3.5, IKVM utility, JENA Semantic Web Toolkit to convert JENA code to C#. As the editor is based on AJAX, it works efficiently for low bandwidth clients too [9]. It has the following salient features [10]:

- AJAX based web environment
- User friendly, simple, W3C compliant interface
- Provision for OWL-Lite
- Inferencing, Reasoning, Visualization
- Import, Exports in ontology languages like N-Triples, OWL allowed.

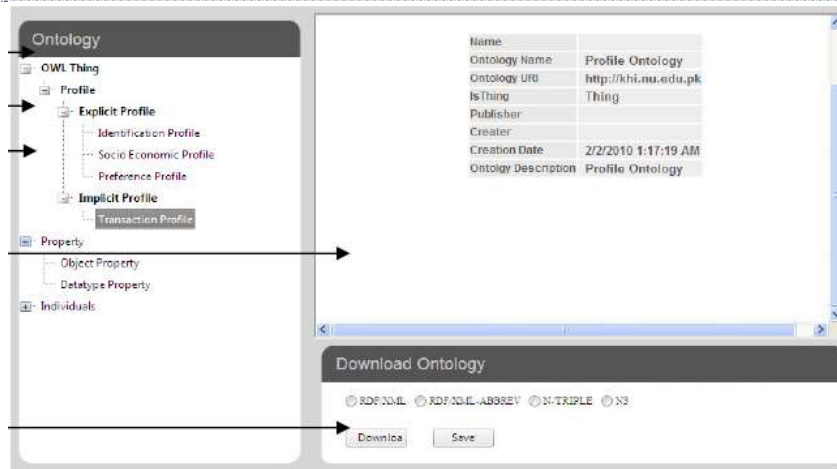


Figure 4: Screenshot of TODE [9]

OWLGrEd: OWLGrEd is a graphical ontology editor for OWL. With OWLGrEd one can see the whole ontology at a glance. The OWLGrEd ontology editor allows authoring of OWL 2.0 ontologies, graphical visualization with the help of compact presentation that combines UML class diagram notation with textual Manchester syntax for class expressions [11]. The latest version of OWLGrEd is 1.6.1 and it is free for anyone to use also.

OWLGrEd editor creates fragments of the ontology and divides it into sub-diagrams. But it doesn't support automatic portioning of the imported ontologies. Instead OWLGrEd delivers a full-fledged graphical notation for OWL which resembles UML class diagrams. The OWL classes are visualized as UML classes. Similarly, class attributes are visualized as data properties, objects as individuals.

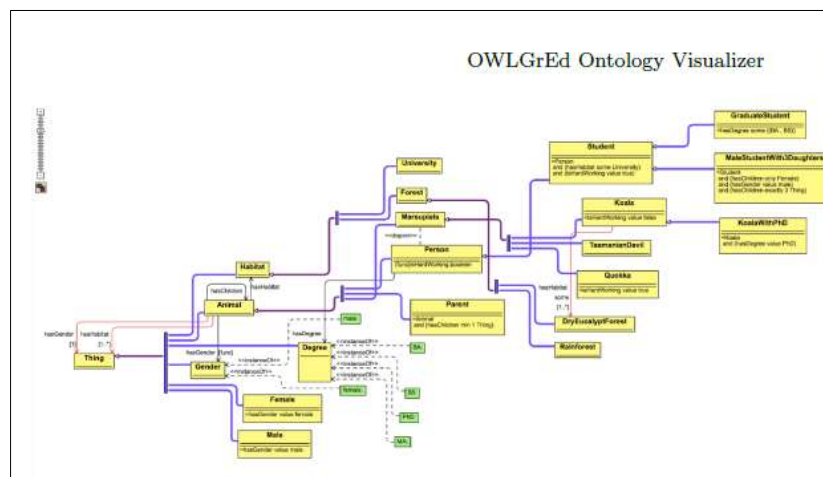


Figure 5: Screenshot of OWLGrEd

Odase: Odase ontologies provide us a web based platform called ODASETM, also called Ontology Driven Architecture for Software Engineering; having given set of tools that are developed to provide facility of creating applications from semantic business model (an ontology), using the open standards OWL, SWRL, RDF. As the business scenario keeps on changing rapidly, Odase provides very quick and adaptable solutions to keep pace with the ever changing business models. Some features of Odase are as follows:

- Odase provides flexible and adaptable solutions
- Enables business agility
- Converts business driven approach into successful projects.
- Reduced costs

- Improved quality

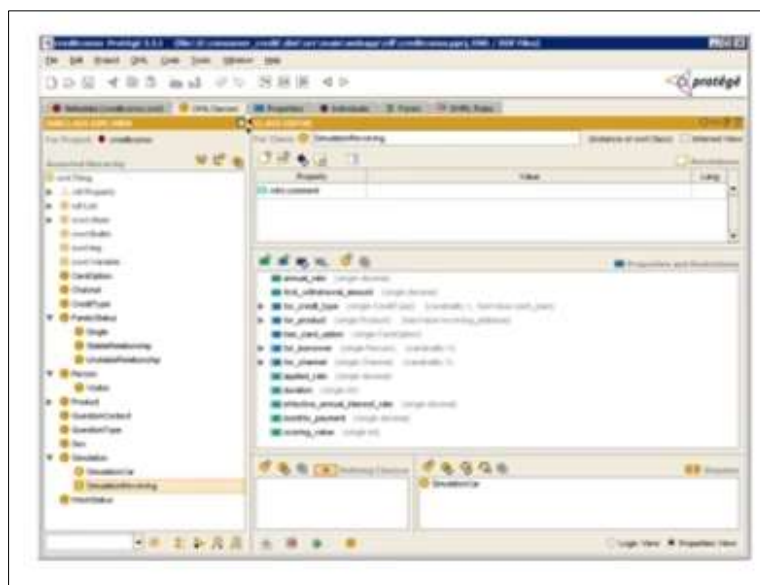


Figure 6: Screenshot of Odase [15]

RESULTS AND DISCUSSION

The result of the survey is displayed in the form of a table given below which explains a comparative analysis of all the ontology editors discussed above. The survey shows the analysis of some latest ontology tools (TODE, OwlGrEd, Odase, OntoStudio 3.1) available both as desktop and online versions and compared with the latest version of most popular tool Protégé 5.2.0. The analysis is done on the basis of a) architecture, b) storage, c) interoperability d) library and GUI design.

There is various ontology editing tools available in the market, some of which are specific to a particular domain also. Though, in this survey, we have focused on generic latest ontology editing tools.

Talking about architecture, in general, all the editors are mainly client/server based or stand-alone working software that also have their web based or desktop versions now. But storage of ontologies in an efficient manner is still a prime concern. Many tools are now depending upon Java and very few Dot net versions have also come in the market now.

Another area of concern is the interoperability with other ontology tools which is analyzed here. The integration of ontology in various applications is also governed by the import, export of translations to/from some ontology languages. Though there is enough facility of importing/exporting into different languages, but the quality of translation is still a question.

The library support is good in most of the ontology editing tools while the usability, user interface and visualization of ontologies is by far up to the mark in all the mentioned tools here. Though every ontology editor has its own look and feel, but still there is some amount of variation in the representation of ontologies. However, multiple tree view with expanded levels is the most common style of depicting ontologies.

Table 1: A comparison of ontology editing tools

Features	Protégé 5.2.0	Swoop 2.3 Beta 4	OntoStudio 3.1	TODE	OwlGred 1.6.1	Odase
Developers	Stanford University	University of Maryland	Ontoprise	N.Islam, M.S. Siddiqui, Z.A. Shaikh [9]	IMCS, University of Latvia	Odaseontologies

Release date	15-Mar-2017	4-Aug-2007	6-Jun-2011	2010	Oct-2011	Not reported
Semantic web Architecture	Web based, Client/server	Client/server, Web based	Eclipse based IDE, Client/server & Standalone	Dot Net & web based	Desktop & Web based	Web based
Ontology storage	Files, DBMS	HTML models	Files, DBMS	Files, DBMS	Files	Files
Interoperability with other tools	PROMPT, OKBC, FaCT & Jena,	No	No	No	Interoperability with Protégé	No
Import/Export to/from	XML, RDF, Owl, HTML, UML	OWL, XML, RDF, text formats, OIL+DAML	UML 2.0, Database schemas (DB2, MS-SQL, Oracle, MySQL), Outlook E-Mails, Excel tables, file system	RDF, N-Triple, RDBMS, OWL-Lite, N-3,	OWL, OWL2, UML, RDF/XML	OWL, SWRL, RDF
Ontology library	Yes	No	Yes	Yes	Yes	No
Graphical view	yes	yes	Yes	Yes	Yes	Yes

After analyzing the above ontology editing tools based on the given features, we finally come to the conclusion that every tool is nice, simple, user friendly in its own way. Making a choice of a right kind of editor entirely depends upon the type of user whether he is a beginner or expert and the size of his ontology whether big or small.

As per our opinion, Protégé is definitely the most popular and most suited editor for a beginner who has an individual home purpose work or academic level work. Next in line is SWOOP for similar reasons. OWLGrEd is best when the user wants UML notations or diagrammatic understanding of his ontology because of its better visualization. OntoStudio is excellent for developing large ontologies having complex orientation as it provides more professional touch to its users.

CONCLUSION

In this survey paper, we come across various existing ontology editing tools and pick five latest tools and compare its characteristics with the most popular ontology tool protégé (version 5.2.0). The survey is done on the basis of comparing features like architecture, storage, interoperability, etc. Some tools are considered to be best for beginners while others have rich features to work as a pro. We intend to develop test ontology in future and check the results in a more practical way.

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