Survey on Ontology Construction Tools

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Abstract— This paper presents a detailed survey on ontology development tools. Ontology development tools used for building a new ontology from scratch or reusing existing ontologies. Some of the popular ontology construction tools are Ontolingua Server, WebOnto, OilEd, OntoSaurus, Protégé, SWOOP, TopBraid Composer, WebODE, OntoEdit and NeOn toolkit. This survey article briefly describes the ontology development and it presents comparison summary of the ontology tools with respect to their features.

Index Terms— Ontology, Types of Ontology Tools, Ontology Development Tools and Comparison of Ontology Development Tools.

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1 INTRODUCTION

Semantic Web is central to enhancing human or machine interaction through the representation of data in a machine-readable manner [1]. To represent data in machine readable format, ontology is a good technique. an ontology is a formal, explicit specification of a shared conceptualization [2]. Implementing ontologies in an ontology language is complex and time consuming task without any kind of tool support. To ease this task several ontology building environments were created by various research groups and software development organizations.

Tools that used for constructing, editing, annotating and merging ontologies are called ontology tools. Ontology tools are very important for both ontology development processes (ontology building, annotation, merge, etc.) and usage in applications [3]. There are several kinds of ontology tools, but this paper mainly focuses on ontology development tools.

The rest of the paper is organized as follows. Section 2 gives a short note on types of ontology tools. Section 3 briefly describes ontology development tools. Section 4 presents comparison result of ontology development tools. Finally section 5 concludes.

2 TYPES OF ONTOLOGY TOOLS

Gomez-Perez classified ontology tools in to the following groups [4].
- *Ontology Development Tools:* Environments and suites that can be used for building a new ontology from scratch or reusing existing ontologies.
    Eg: Protégé, NeOn, SWOOP etc.
- *Ontology Merge and Alignment Tools*: These tools are used to solve the problem of merging or aligning different ontologies on the same domain.
    Eg: Protégé with PROMPT [5], Chimaera [6] etc
- *Ontology Evaluation Tools*: They are used to evaluate the content of ontologies. Ontology content evaluation reduces problems when we integrate and use.
    Eg: OntoAnalyzer, OntoClean [7], RaDON [8] etc

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- *Ontology-based Annotation Tools*: Allow users to maintaining ontology-based markups in Web pages.
    Eg: NeOn with Cicero and OWLDoc [9] etc
- Ontology Querying Tools and Inference Engines: Allow users to infer and query ontologies easily. Generally these are strongly related to the language used to implement ontologies.
    Eg: Pellet, Racer etc.
- *Ontology Learning Tools*: Allow users to derive ontologies from natural language texts, semi-structured sources and databases through machine learning and natural language techniques.
    Eg: NeOn with ODEMapster, Protégé with OntoLT etc
Through several kinds of ontology tools, there are some ontology editors (E.g. Protégé, NeOn) that support all or more than one feature of the above mentioned either directly or through plug-in support.

3 ONTOLOGY DEVELOPMENT TOOLS

Asuncion Gomez-Perez, et al, also classified ontology development tools into two groups
- *Ontology Tools of Language Specific:* Knowledge model of these tools directly maps to specific language (s).
    E.g. Ontolingua server, WebOnto, OilEd, OntoSaurus, etc.
- *Ontology Tools of Languages Independent:* knowledge model is independent of an ontology language. Have an extensible architecture.
    E.g. Protégé, Swoop, TopBraid Composer, WebODE, OntoEdit, Neon Toolkit, etc.
  One of the important decisions to be taken in the ontology development process is to select an ontology editor that provides necessary features. We listed features to compare existing ontology editors and to select a good ontology construction tool for the current project. Following are the list of identified features in our survey.

3.1 Ontolingua Server

The Ontolingua server [10] was created by the Knowledge Systems Laboratory at Stanford University. It was the first ontology development tool. It provides a form-based Web interface to the user to build ontologies. The main features of Ontolingua are distributive and collaborative editing, browsing and creation ontologies. Ontolingua includes Webster, Open Knowledge Base Connectivity (OKBC) Server and Ontology merge tool.

3.2 OntoSaurus

Ontosaurus [11] has been developed by the Information Sciences Institute (ISI) at the University of South California. It consist two components ontology editor and browser. Ontology editor allows user to implement ontologies in LOOM ontology language. The browser module generates HTML pages dynamically for the existing ontologies. This HTML pages allows the user to search and browse the ontologies. OntoSaurus provides HTML forms to edit ontologies. It can also translate ontologies from LOOM to Ontolingua, KIF, KRSS and C++.

3.3 OILED

OILEd [12][13] has been developed by the University of Manchester. It allows user to develop ontologies in DAML+OIL. It offers a frame-like paradigm for modeling the rich expressiveness of DAML+OIL ontologies. The main functionalities of OILEd are creation and editing of large scale ontologies.

3.4 WebOnto

WebOnto [14] is one of the popular ontology editing tools. It has been developed by the Knowledge Media Institute (KMI) of the Open University, England. Its main features are collaborative browsing, creation of new ontologies, management of ontologies using a graphical interface, automatic generation of instance editing forms and consistency checking. "Fig. 1" presents WebOnto Architecture.
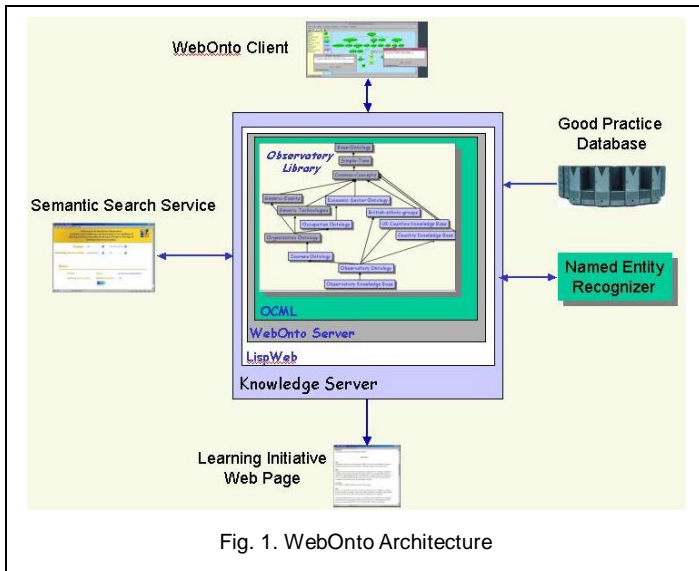

Fig. 1. WebOnto Architecture

3.5 Protégé

Protégé [15] is a very popular and well known ontology construction tool. It has been developed at Stanford University. It provides a user friendly java based graphical user interface to create and edit ontologies. Protégé has number of plug-ins to provide much functionality such as multimedia support, querying and reasoning engines, problem solving methods, etc. It can be extended with those pluggable components to provide additional services. Protégé allows users for creation, visualization, and manipulation of ontologies in various representation formats such as RDF/XML, OWL/XML etc. "Fig. 2" shows the architecture of protégé.
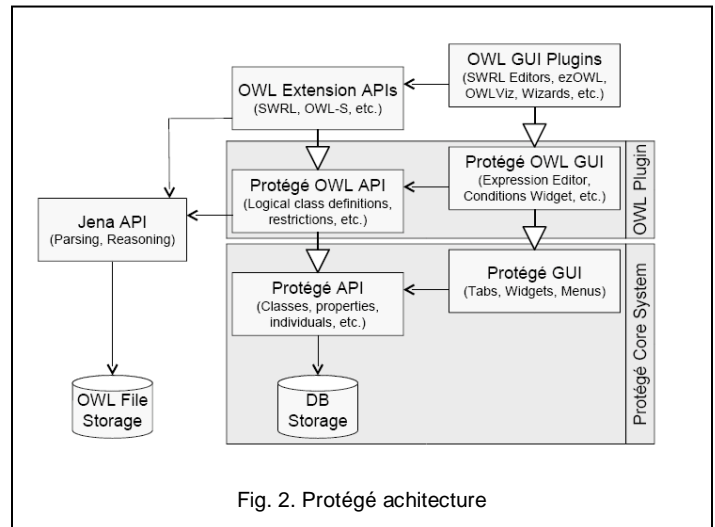

Fig. 2. Protégé achitecture

3.6 SWOOP

SWOOP stands for SemanticWeb Ontology Overview and Perusal [16]. It is a simple and scalable OWL ontology browser and editor written in Java. SWOOP has reasoning support from popular ontology reasoners Pellet and OWL inference engine. Its main features are creation, editing, comparison and merging of ontologies. SWOOP can import ontologies from OWL, XML, RDF and text formats. SWOOP architecture is based on MVC (Model-View-Controller) design pattern. "Fig. 3" shows SWOOP architecture.
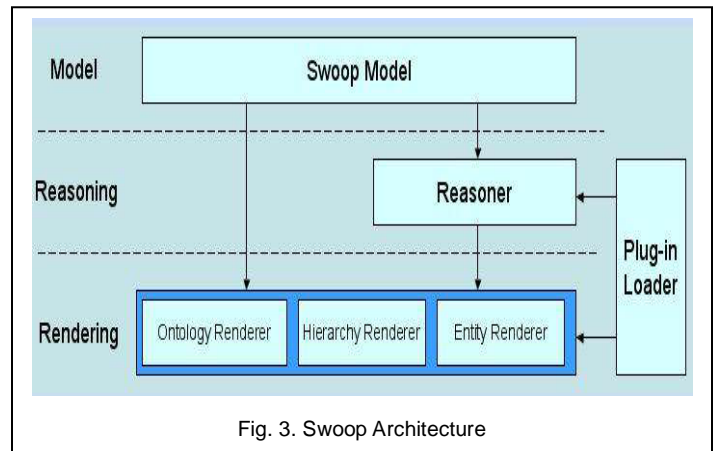

Fig. 3. Swoop Architecture

3.7 TopBraid Composer

TopBraid Composer [17] is a good environment for developing ontologies and building semantic applications. It provides comprehensive support to develop and manage ontologies. It also includes a flexible and extensible frame work with a published API for developing Semantic.

3.8 WebODE

WebODE [18] has been developed by the Ontological Engineering Group from the Artificial Intelligence Department of the Computer Science of University of Madrid. WebODE provides support to most of the activities involved in the ontology development process such as ontology edition, navigation, documentation, merge, reasoning, etc. WebODE provides export and import services for the ontologies of XML format. It also provides translation services to other languages. "Fig. 4" Pre-
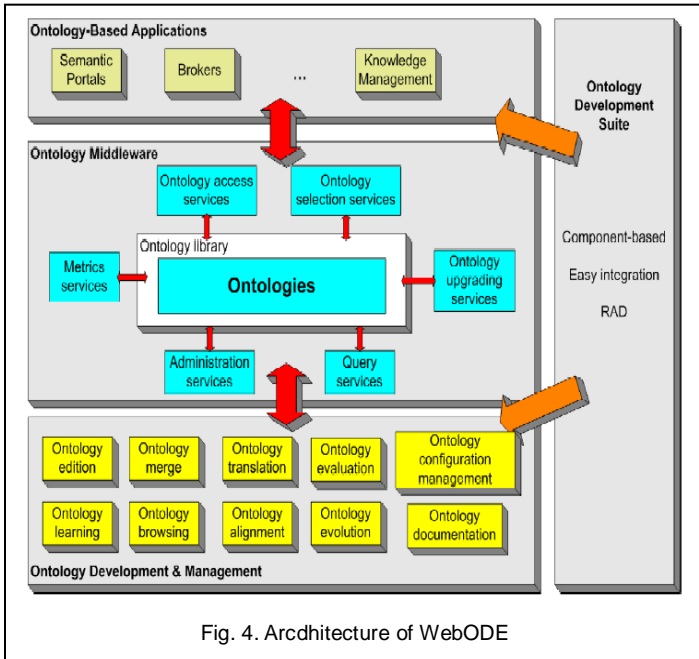
sents Architecture of WebODE.
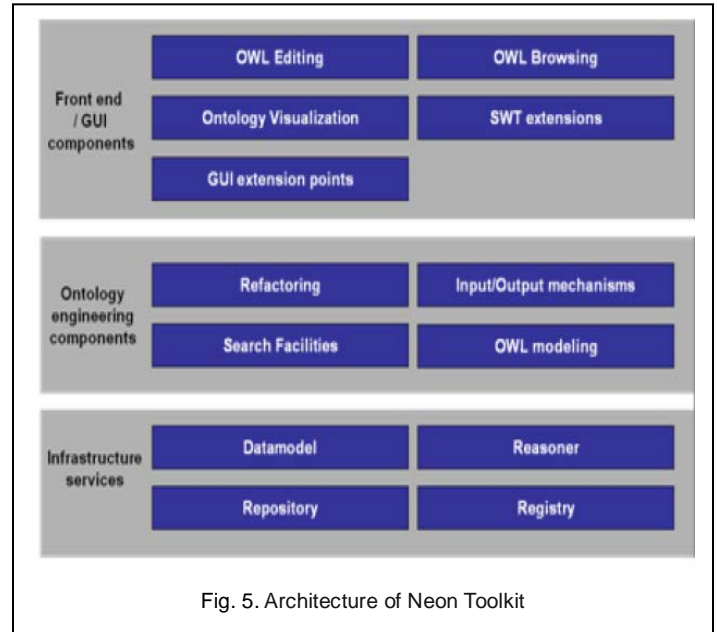

Fig. 4. Arcdhitecture of WebODE

Fig. 5. Architecture of Neon Toolkit

3.9 OntoEdit

OntoEdit [19] is an ontology engineering environment. It was developed by the Knowledge Management Group of the AIFB Institute at the University of Karlsruhe. It allows user to create, browse, maintain and manage ontologies. The environment supports the collaborative development of ontologies.

3.10 NeOn Toolkit

Neon Toolkit [20] is a open source multi-platform ontology engineering environment. It provides complete support for the ontology engineering life-cycle. The toolkit is based on the Eclipse platform "Fig. 5" shows the architecture of NeOn Toolkit. It provides an extensive set of plug-ins to provide additional features such as Annotation and Documentation ontology matching, Reasoning and interface and reuse. "Fig. 6" shows NeOn toolkit features. NeOn toolkit can be extended with its powerful plug-ins to enhance its functionality.

In the comparison we have identified that the tools Protégé and NeOn Toolkit are providing more features to develop ontology. The NeOn Toolkit provides an extensive set of plug-ins contributed by several partners inside and outside of the NeOn project, covering the complete life cycle of ontology engineering. User can easily interact with NeOn Toolkit interface to develop ontology and the functionality of the NeOn Toolkit can be easily extended with powerful plug-ins. Since NeOn Toolkit providing more features for the ontology development process, for the current project we have chosen it for developing and editing ontologies.

4   COMPARISON OF ONTOLOGY DEVELOPMENT TOOLS

After a detailed survey on ontology tools, we have compared the tools. "Table. 1" shows the summary of comparison, X-axis shows various ontology development tools and Y-axis shows their features.
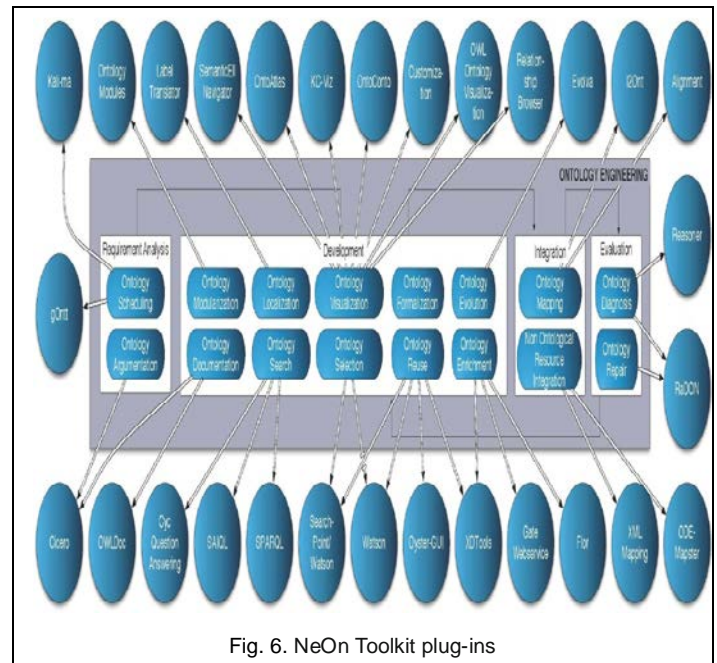

Fig. 6. NeOn Toolkit plug-ins

5   CONCLUSION

This paper has presented a comprehensive survey on ontology development tools and their comparison. From the comparison table many of the tools are open sources except TopBraid Composer. Only the tools SWOOP and NeOn toolkit provide versioning features. All most all the tools provide environment to build ontologies collaboratively except OilEd and OntoEdit. Only the tools WebOnto, WebODE and NeOn toolkit provide backup management functionalities. The main conclusion from this study is the tools protégé and NeOn toolkit provide many functionalities for developing ontologies.

TABLE 1
COMPARISON OF ONTOLOGY DEVELOPMENT TOOLS

Tool / Features	Ontolingua Server	OntoSaurus	OilEd	WebOnto	Protégé	SWOOP	TopBarid Composer	WebODE	OntoEdit	Neon Toolkit
Availability	Free	Free & Open	Free & Open	Free	Free	Free & Open	Commercial	Free	Free	Free & Open
Versioning	No	No	No	Y/N	Y/N	Yes	Y/N	No	Y/N	Yes
Collaborative	Yes	Yes	No	Yes	Yes (Collaborative Protégé)	Yes	Yes	Yes	No	Yes
Graphical Class/Property taxonomy	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Back up management	No	No	No	Yes	No	Y/N	Y/N	Yes	No	Yes
Support growth of large ontologies	Yes	Y/N	No	Y/N	Yes	Yes	Y/N	Yes	Y/N	Yes
Querying	No	No	No	Y/N	Yes	No	Yes	No	Y/N	Yes
User Interface	No	Y/N	Yes	Y/N	Yes	Yes	Yes	Yes	Y/N	Yes
Consistency check	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
OWL Editor	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Extensibility	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Ontology Libraries	Yes	No	Yes	Yes	Y/N	Y/N	Y/N	No	No	Yes
Architecture	Client/Server	Client/Server	Standalone	Client/Server	Standalone	Standalone	Client/Server	N-Tire	Standalone	Standalone
KR Paradigam of Knowledge model	Frames+, FOL	DL	DL	Frames+, FOL	Frames+, FOL+, Meta classes	DL	DL	Frames+, FOL	Frames+, FOL	DL
Import	Ontolingua, DAML+OIL, CLIPS	LOOM, IDL, KIF, C++	RDF(S), DAML+OIL	OMCL	RDF(S), OWL	RDF(S), OWL	RDBMS, OWL, RDF(S)	RDF(S), DAML+OIL, OWL	RDF(S), DAML+OIL	RDF(S), OWL
Export	Ontolingua, DAML+OIL, CLIPS	LOOM, IDL, KIF, C++	RDF(S), DAML+OIL, OWL	OMCL, Onto-lingua, RDF(s), OIL	RDF(S), OWL, CLIPS	RDF(S), OWL	OWL, RDF(S), XML	RDF(S), DAML+OIL, OWL, CLIPS	RDF(S), DAML+OIL, OWL	RDF(S), OWL
Storage	Files	Files	Files	Files	Files, DBMS(JDBC)	Files	Files	DBMS(JDBC)	Files	Files
Reasoner	JTP, Prolog, CML, Epikit	PowerLoom, Stella	FaCT	-	Pellet	Pellet	Pellet	Prolog	OntoBroker	Pellet2, Hermit, OntoBroker
Merging	Chimaera	None	None	None	Prompt, OWLDiff	Yes	Y/N	ODE Merge	Yes	Yes
Debug/Repair	No	No	Very Little	No	Very Little	Yes	No	No	No	Yes
Built-in Inference	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Y/N	Yes
Implemented in	Lisp	Lisp	Java	Lisp	Java	Java	Java	Java	Java	Java Eclipse

Note: Yes indicates a supported feature in the language, No indicates unsupported features, and Y/N indicates features that need further explanation.

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