

ONTOLOGIES, VOCABULARIES AND VARIOUS TOOLS REPORT

An Environment Scan of Tools for Ontologies and
Vocabularies

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1 Introduction

This report records on the findings of an environmental scan of ontologies and vocabularies and the tools that can be used to create them. As will be seen in the report, there is a large number of tools that can be used. In preparing this report a very wide search has been carried out. However, it is possible and expected that there are more tools available than what are reported upon here. There are also a vast number of ontology and vocabulary tools that have been deprecated over time, tools that started as research projects and are no longer maintained. There are also tools that have been commercially developed and those companies are no longer in business.

In using this report, it is well advised that you are to check that the tool, ontology and/or vocabulary still exist and are also currently being maintained. In the words of Lonely Planet: **“Good places go bad, bad places go bankrupt”** and obviously new places open. This statement is an excellent description of what can happen with software tools, ontologies and vocabularies.

2 Ontology and Vocabulary

The Oxford Dictionary of English defines ontology as: “the branch of metaphysics dealing with the nature of being” (oxfordDictionary). In philosophy it is the study of being or an account of existence (gruber1995). Gruber (1993) defines ontology as ‘a specification of a conceptualization.’ The disciplines of Computer Science and Information Science have borrowed ontology from the philosophical field and now use it as a way to represent knowledge ().

The Oxford Dictionary of English defines vocabulary as: “the body of words used in a particular language” (oxfordDictionary). Controlled vocabularies are ways in which knowledge can be organised in order for it to be easily retrieved within some kind of system. Leise et al. (2002) state “A controlled vocabulary is a way to insert an interpretive layer of semantics between the term entered by the user and the underlying database to better represent the original intention of the terms of the user.”

When executing an information search within a computer system, over the Internet or World Wide Web, it is quite reasonable to assume that different words will be used to imply and assert the same meanings. This can mean that a computerised search for information on Jaguars may return links about cars as well as the animal. Therefore a controlled vocabulary within computing terms is important in order for searches to return relevant information.

A vocabulary has been considered a special type of ontology, and in many cases is simply a collection of URIs with a described meaning (semantic web.org). An ontology is a way in which data can be represented and vocabularies are a type of data.

The term ontology is one that is used with various different meanings and at different points in time these different definitions can be contradictory (citation). Bergmen (2007) listed more than 40 different terms that are used which all could be called types of ontologies or at least ontological frameworks. With this number of terms often used in reference to

ontologies it is quite understandable that there may be misunderstandings as well as misinformation about ontologies. Table 1 shows some of the various names that could loosely mean ontology.

Table 1. A listing of the different names that often refer to ontologies.

• Tag cloud	• Social bookmarking	• Ontology	• Topic Maps
• Controlled vocabulary	• Tags	• Microformats	• Concept Maps
• Thesauri	• Tagging	• Data dictionary	• Synsets
• Collaborative tagging	• Taxonomy	• OPML	• Glossary
• Folk taxonomy	• Folksonomy	• XOXO	• WordNet
• Directory	• Classification	• OWL	• Metadata
• Subject Map	• Categorization	• Subject Trees	• Facets
• Semantic Web	• RDF	• Information Architecture	• Structure
• Cladistics	• Metadata	• Data Reference Model	• Dublin Core
• Markup languages	• Systematics	• Phylogeny	• Typology

2.1 Preparing to Build an Ontology

When preparing to develop an ontology and in selecting tools to be used in that process, there are five general steps involved. They are:

- Gathering the domain knowledge: bringing together the information and experts of the domain to agree what needs to go into the ontology
- Organising the ontology: that is designing the overall ontology framework and the structure of it for the domain it will represent
- Building the ontology: creating the ontology itself using the selected tools
- Checking the work: having the work examined by experts within both the domain and in the area of ontology building in order to ensure that the work is correct both as a representation of domain knowledge and syntactically correct as an ontological structure
- Publish the ontology: for an ontology to be useful to a particular field it needs to be published in a manner in which it is easily accessible for all who need to use to be able to reach it. It is also important than in publishing it, those who will want and need to use it are informed about it.

Once the ontology is created and published it is important that it continues to be maintained and updated. Hence, creating an ontology is an ongoing process, not a once off effort. For an ontology to remain up-to-date it needs a team of people from the community that created it to continue to work with it.

3 Ontology Tools

The following tables are summaries of different tools that can be used in creating, editing and visualising ontologies. The tables were created following an environment scan of available ontology and vocabulary tools.

The tools listed in the tables do not form an exhaustive list. The tables contain a wide variety of tools and due diligence has been undertaken in order to make the list as relevant and as up-to-date as possible. However, it is expected that some tools have been omitted and some that are included no longer function, are maintained, have moved to different locations on the web or have been purchased but other companies and have been included into the purchasing company's own tools or removed from availability altogether in order for the purchasing company to maintain their own market advantage.

The table columns attempt to communicate the situation concerning each tool regarding its development status. The **Open Source** column contains several kinds of entries attempting to capture the availability of the source for other work and research to build upon the product's source code. The different possible entries and their meanings are described here:

- **Y:** yes, it is Open Source
- **N:** no, it is not Open Source
- **U:** unknown, it was not possible to determine from what was available on the web site
- **Jarfiles:** compiled Java files, maybe possible to extract the code from them
- **No response:** the web site no longer responded to enquiries regarding it
- **Web App:** a Web based application.

The **Comments** column generally contains a year that represents the last time that a product was updated. However, in examining the websites from different tools it was not always clear and hence in some cases it is listed with a year and a question mark. The entry of "Company" in this column indicates that it has been taken over by a company, morphed into a company or some kind of commercial entity is involved.

The Status column is a description of the software tool's current status in production. The different possible entries and their meanings are described here:

- **Active:** there is current active development occurring
- **Inactive:** there is no current development occurring
- **Alive inactive:** there is no current development occurring but it has an active user community that is reflected on the web site
- **Unsure:** it was not possible to determine from the web site the current development status.

The **Version** column is a record of the latest version number of the software. Where that column is blank, this indicates that there was no listing available regarding the version of the software.

Table 2 is a summary table of different tools that can be used to create and edit ontologies. This table was created.

Table 2. Ontology building tools summary.

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
1	Altova products	A suite of XML products.	N		Inactive		http://www.altova.com/products.html
2	Amine	Amine is a Java Open Source Platform suited for the development of different types of intelligent systems/agents. One element is the creation of Ontologies.	Y	2013	Inactive		http://amine-platform.sourceforge.net
3	Apelon	Is not a pure ontology management system, it does have plug-ins providing concept graph visualization of related functionality.	Y	2013	Unsure	4	http://apelon-dts.sourceforge.net/index.html
4	DOME - DERI Ontology Management Environment	Was developed by the Ontology Management Working Group (OMWG). The goal is to create a suite for efficient and effective ontologies management.	Y	April 2013, the web site news ended in 2006.	Unsure	0.2.0	http://dome.sourceforge.net
5	FlexViz	FlexViz is a graph based visualization tool. Users are able to browse a single ontology where the concepts are represented by nodes and the relationships between concepts are represented as arcs. It supports node and arc type filtering and has built-in searching capabilities.	Y	2010	Inactive		http://thechiselgroup.org
6	Intelligent Topic Manager (ITM)	ITM supports the management of multilingual taxonomies and ontologies, from authoring to delivery. Use it independently to store and manage complex domain-specific knowledge structures. Use it as a service to enhance enterprise search, knowledge discovery, and text mining solutions.	N	Company	Active		http://www.mondeca.com/Products/Intelligent-Topic-Manager
7	Mondeca Labs	The research group of Mondeca, illustrate the potential of semantic web technologies	N		Active		http://labs.mondeca.com/

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
7	Knoodl	A web-based, collaborative ontology editor. Functionality is exposed as Java Beans facilitating users to create their own semantic applications through Java Server Pages (JSP) and Java Script.	U		Inactive		knoodl.com (http://semanticweb.org/wiki/Knoodl)
8	NeOn	Is an open source multi-platform ontology engineering environment facilitating ontology engineering. It is based on the Eclipse platform providing more than 40 plug-ins in all aspects of ontology engineering activities.	Y	2011	Unsure	2.5.2	http://neon-toolkit.org/wiki/Main_Page
9	OntoStudio	OntoStudio a commercial modeling environment for creating and maintaining ontologies. It has a large number of functions for ontology modeling. It also provides an import feature enabling varied structures, schemas and models.	N	Company	Active		http://www.semafora-systems.com/en/
10	Protégé Desktop	A desktop ontology editing environment with full support for the OWL 2 Web Ontology Language. It has direct in-memory connections to description logic reasoners, such as HermiT and Pellet.	Y		Active	4.3	http://protege.stanford.edu
11	Web Protégé	A web based ontology development environment facilitating the creation, modification, uploading and sharing of ontologies.	Web App		Active		http://protege.stanford.edu
12	Sigma	An open source knowledge engineering environment. It facilitates ontology mapping, theorem proving, language generation in multiple languages, browsing, OWL read/write, and analysis. It also includes the Suggested Upper Merged Ontology (SUMO).	Y		Inactive	2.02	http://sigmakee.sourceforge.net
13	Topbraid Composer	Is an enterprise modeling environment for developing Semantic Web ontologies and building semantic applications. It is compliant with W3C standards. It is based on the Eclipse IDE with a free version for small ontologies.	N	Company	Active	4.6.0	http://www.topquadrant.com/tools/IDE-topbraid-composer-maestro-edition/

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
14	TwoUse	Is an open source tool assisting to bring together Semantic Web and Model Driven Software Development. It is an implementation of current OMG and W3C standards for developing ontology-based software models and model-based OWL ontologies. It allows graphical modeling of: OWL ontologies and OWL safe rules using OMG UML Profile for OWL and UML Profile for SWRL; OWL ontologies and OWL Safe Rules using the TwoUse Graphical Editor; and design patterns as templates as well as storing the ontology.	Y	2010	Inactive	1.0.0	https://code.google.com/p/twouse/
15	Wandora	Wandora is a general purpose information management application. The application is written in Java programming language. It contains an editor and a publishing system with support for automatic classification. It reads OBO, RDF(S), as well as multiple other formats, and exports topic maps to various different graph formats. It has a web-based topic maps browser and graphical visualization capabilities.	Y	2014	Active		http://www.wandora.org/wandora/wiki/index.php?title=Main_Page
16	PoolParty	PoolParty a semantic technology platform, that is a standards-based management of taxonomies and ontologies with text mining capabilities based on controlled vocabularies (and more). It can be a cloud-based service or also an enterprise software service behind the firewall.	N		Active	5	http://www.poolparty.biz
17	Visual Ontology Modeler	A visual application for building component-based ontologies. A UML-based modeling tool enabling ontology development and management.	U		Dispaned		http://www.sandsoft.com/products.html
18	Neologism	A vocabulary publishing platform for the Web of Data. It is a web-based RDF Schema vocabulary editor and publishing system. It can be used to create RDF classes and properties	U		Dispaned		http://neologism.deri.ie

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
19	Hozo	An ontology visualization and development tool. Very difficult to understand much about it from the documentation and appears that it may no longer be maintained.	N		Inactive	5.2.36	http://www.hozo.jp
20	Vitro	Is a general-purpose web-based ontology and instance editor. It's a Java web application that runs in a Tomcat servlet container. It facilitates: creation and loading ontologies in OWL format; editing instances and relationships; building public web sites for data display and enables data search with Apache Solr.	Y	2011	Alive inactive		http://vitro.mannlib.cornell.edu
21	IBM Integrated Ontology Development Toolkit	An ontology toolkit for storage, manipulation, query, and inference of ontologies and corresponding instances, based on Eclipse.	U	2006	Inactive	U	http://www.alphaworks.ibm.com/tech/semanticstk
22	Anzo for Excel	Can generate an ontology based on spreadsheet data and structure. It enables the conversion of Excel or CSV data to RDF. The data can then be published as Linked Data.	N	2015	Active	U	http://www.cambridgesemantics.com/products/anzo-express
23	EulerGUI	Is a GUI for the EulerSharp.sourceforge.net Euler/SEM/EYE reasoning engine. Euler GUI can be used to develop and test projects composed of N3, OWL, RDF(S) and UML ontologies and databases using N3 logic rules.	Jar files	2013	Inactive	2	http://eulergui.sourceforge.net
24	OWLGrEd	Is a graphical ontology editor for OWL. It allows for creating, editing, exporting, visualising and sharing ontologies. It has a Protégé plugin to allow for export for use in Protégé as well as importing from Protégé.	N	2014	Active	1.6.0	http://owlgred.lumii.lv

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
25	CmapTools Ontology Editor	It is a concept map based idea where a concept map is a graph diagram depicting the relationships among concepts. It is a suite of software tools for constructing, sharing and viewing OWL encoded ontologies.	N	2014	Unsure	5.0.3	http://www.ihmc.us/groups/coe/
26	Conzilla2	Is a knowledge management tool. It is a visual designer and manager of RDF classes and ontologies. It stores all data in RDF format.	Y	2013	Inactive	2.3.0	http://www.conzilla.org/wiki/Overview/Main
27	DL-Learner	Is a tool for supervised Machine Learning in OWL and Description Logics. It provides a DL/OWL based machine learning tool to solve supervised learning tasks and support knowledge engineers in constructing knowledge and learning about the data they created. It supports SPARQL endpoints, where it is able to extract knowledge fragments, enabling learning classes on knowledge sources such as DBpedia. It has an OWL API reasoner interface and Web service interface.	Y	2015	Active	1	http://dl-learner.org/Projects/DLLearner
28	DogmaModeler	An open source ontology modelling tool. It is for the non-technical person providing some understanding for naive ontology development.	Y	2013	Inactive		http://www.jarrar.info/DogmaModeler/index.htm
29	JXML2OWL API	JXML2OWL API is a library for mapping XML schemas to OWL Ontologies on the JAVA platform. It creates an XSLT which transforms instances of the XML schema into instances of the OWL ontology. JXML2OWL Mapper is GUI application using the JXML2OWL API.	Y	2006	Inactive	4 - Beta	http://projects.semwebcentral.org/projects/jxml2owl/
30	MindRaider	It is a semantic web note taker and outliner. It is attempting to connect outliners with emerging semantic technologies.	Y	2012	Inactive	1.12	http://mindraider.sourceforge.net/index.html

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
31	RDF123	RDF123 is an application and web service for converting data in simple spreadsheets to an RDF graph. Users control how the spreadsheet's data is converted to RDF by constructing a graphical RDF123 template that specifies how each row in the spreadsheet is converted as well as metadata for the spreadsheet and its RDF translation.	N	2007	Inactive		http://ebiquity.umbc.edu/project/html/id/82/RDF123
32	Rapid Ontology Construction	A tool build a vocabulary a domain that can re-use existing terminology. ROC gets a set of keywords from a domain expert that is central to the domain. It then queries remote sources for matching concepts. The resulting vocabulary (or 'proto-ontology', a SKOS-like thesaurus) can be used by a knowledge engineer.	N	2015?	Unsure		http://www.afsg.nl/InformationManagement/index.php?option=com_content&task=view&id=6&Itemid=51&lang=en
33	Atop	Is a Java topic map browser and editor that supports the XTM 1.0 specification.	Y	2013	Inactive	1.2	http://sourceforge.net/projects/atop/
34	The Model Futures OWL Editor	Is tree-based and has a "navigator" tool for traversing property and class-instance relationships. It can import XMI (the interchange format for UML) and Thesaurus Descriptor (BT-NT XML), and EXPRESS XML files.	N	2013	Unsure	0.2.0.36	http://www.modelfutures.com/owl
35	OBO-Edit	An open source ontology editor written in Java. Has an editing interface, a simple fast reasoner, and powerful search capabilities and is optimized for reading and writing ontologies in the OBO biological ontology file format.	Y	2014	Active	2	http://oboedit.org
36	OntoTrack	Is a browsing and editing ontology authoring tool for OWL. Has a GUI layout for editing features as well as for efficient ontology navigation and manipulation.	N	2004	Inactive		http://www.informatik.uni-ulm.de/ki/ontotrack/

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
37	SKOSEd	Is a plugin for Protege that allows you to create and edit thesauri (or similar artefacts) represented in the Simple Knowledge Organisation System	Y	2014	Active	2.0 alpha	https://code.google.com/p/skoseditor/
38	TemaTres	Is a controlled vocabulary server, a web application providing ways to manage, publish and share ontologies, taxonomies, thesauri, lists and multilingual vocabularies.	Y	2014	Active	1.8.1	http://sourceforge.net/projects/tematres/
39	ThManager	An Open Source Tool Java tool for creating and visualizing SKOS RDF vocabularies, such as thesauri, classification schemes, subject heading lists, taxonomies, and other types of controlled vocabulary. ThManager facilitates the management of thesauri and other types of controlled vocabularies, such as taxonomies or classification schemes.	Y	2012	Inactive	2	http://thmanager.sourceforge.net
40	SWOOP	Is a tool for creating, editing, and debugging OWL ontologies.	Y	2006	Inactive	2.3	https://code.google.com/p/swoop/
41	Coma 3	Is a schema and ontology matching tool aimed at identifying semantic correspondences between metadata structures or models such as database schemas, XML message formats, and ontologies. Is a vast tool with a significant architectural supporting framework.	Y	2013	Active	3	http://dbz.uni-leipzig.de/Research/coma.html
42	MapOnto	MapOnto is a research project aiming at discovering semantic mappings between different data models. The tool works in an interactive and semi-automatic manner.	Y	2006	Inactive		http://www.cs.toronto.edu/semanticweb/maponto/

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
43	S-Match	S-Match takes two tree like structures and returns a set of correspondences between the tree nodes that semantically correspond to one another. The process is a type of ontology matching technique that relies on semantic information encoded in lightweight ontologies to identify nodes that are semantically related.	Y	2013	Alive but inactive	2013	http://semanticmatching.org
44	VINE	VINE is a tool that allows users to perform fast mappings of terms across ontologies. The VINE mapping builder enables the creation and editing of mappings between concepts and terms in multiple ontologies or controlled vocabularies.	Web App				https://marinemetadata.org/vine

Table 3 is a summary listing of tools that can be used for the visualisation and analysis of ontologies. Some of the tools are actually taken from other disciplines such as molecular interaction visualisation but can be used for ontology visualisation because of the structure of ontologies and the way in which molecular interaction is visualised. As with Table 2, this table is not exhaustive as the author is fully aware that omissions may have occurred. Please check documentation of each tool to ensure that it is fit for the purpose that you require.

Table 3. A list of tools for visualising and analysing ontologies.

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
1	RDFScape	It allows to query, visualize and reason on ontologies represented in OWL or RDF within Cytoscape. RDFScape considers ontologies as a knowledge-base that can be interpreted through standard inference processes and through custom inference rules. The ontologies can be interpreted for specific analysis needs.	Y	2010	Alive but inactive	0.4.2	http://www.bioinformatics.org/rdfscape/wiki/
2	NetworkAnalyzer	NetworkAnalyzer is a Java plugin for Cytoscape, a software platform for the analysis and visualization of molecular interaction networks. The plugin computes specific parameters describing the network topology.	U	2015	Active	3.2.1	http://med.bioinf.mpi-inf.mpg.de/netanalyzer/index.php
3	Graphl	Graphl is a tool for collaborative editing and visualisation of graphs, representing relationships between resources or concepts of the real world. It builds upon RDF (the Resource Description Format). RDF specifies how to express the relationships in terms of concepts and grammar rules, Graphl focusses on visualising the networks of relationships, as well as allowing the networks to be visually edited.	Y	2004	Inactive	0.0.2	http://www.mediavirus.org/graphl/
4	Graphviz	Graphviz is open source graph visualization software. It presents a way of representing structural information as diagrams of abstract graphs and networks.	Y	2014	Active	2.38.0	http://www.graphviz.org

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
5	OntoGraf	OntoGraf supports the interactive navigation of relationships within OWL ontologies. It supports multiple layouts for automatically organizing the ontology's structure. Different relationships are supported including subclass, individual, domain/range object properties, and equivalence.	Y	2014	Active	2.38	http://protegewiki.stanford.edu/wiki/OntoGraf
6	owl2prefuse	OWL2Prefuse is a Java package that creates Prefuse graphs and trees from OWL files and Jena OntModels. This simplifies the way to then use the Prefuse graphs and trees in Semantic Web applications.	Y	2007	Inactive	1.2	http://owl2prefuse.sourceforge.net
7	RDF Gravity	A tool for visualising RDF/OWL Graphs/ ontologies.	U	2004	Inactive	1	http://semweb.salzburgresearch.at/apps/rdf-gravity/index.html
8	SNAP Stanford Network Analysis Project	SNAP Stanford Network Analysis Project: is a general purpose network analysis and graph mining library. It manipulates large graphs, calculates structural properties, generates regular and random graphs, and supports attributes on nodes and edges.	U		Active		http://snap.stanford.edu/index.html

Table 4 is a listing of different tools that enable the user to execute a variety of tasks upon ontologies. As with previous tables, this table is not exhaustive as the author is fully aware that omissions may have occurred. Please check documentation of each tool to ensure that it is fit for the purpose that you require.

Table 4. A summary listing of tools to execute various tasks upon ontologies.

#	Tool	Description	Open Source	Comments	Status	Version	Company/Web link
1	APOLDA (Automated Processing of Ontologies with Lexical Denotations for Annotation)	Is a plugin for GATE (http://gate.ac.uk/). It annotates a document like a gazetteer, but takes the terms from an (OWL) ontology rather than from a list. Apolda searches the document for OWL annotation properties (owl:AnnotationProperty) of the classes and instances of the ontology. The matches are annotated with the name of the class and the URL of the ontology.	Y	2011	Inactive		http://apolda.sourceforge.net
2	Jena	Open source Java framework for building Semantic Web and Linked Data applications. Work with models, RDFS and the Web Ontology Language (OWL) to add extra semantics to the RDF data. Can create and read Resource Description Framework (RDF) graphs as well as serialise triples using popular formats such as RDF/XML or Turtle.	Y	2015	Active	2.13.0	http://jena.apache.org
3	Hoolet	An implementation of an OWL-DL reasoner that uses a first order prover. The ontology is translated to collection of axioms (in an obvious way based on the OWL semantics) and this collection of axioms is then given to a first order prover for consistency checking.	Y	2015	Active	4.0.1	http://owl.man.ac.uk/hoolet/
4	ontop	A platform to query databases as Virtual RDF Graphs using SPARQL.	U				http://ontop.inf.unibz.it

5	OntoComP	A Protégé 4 plugin for completing OWL ontologies. It enables the checking of an OWL ontology as to whether or not it contains "all relevant information" about the application domain, and where needed to extend the ontology appropriately. It asks the user questions of the form "are instances of classes C1 and C2 also instances of the class C3"? If the user confirms such a question, then a new axiom of the application domain that does not follow from the ontology has been discovered, and it is added to the ontology.	N	?	Active	?	https://code.google.com/p/ontocomp/
6	FaCT++	Is an implementation of the well-known FaCT OWL-DL reasoner using the established FaCT algorithms.					http://owl.man.ac.uk/factplusplus/
7	Fluent Editor 2	A comprehensive editing and manipulating tool for complex ontologies that uses Controlled Natural Language. It uses Controlled English as a knowledge modeling language.	Y	2015	Active	2.2.2	http://semanticweb.org/wiki/Fluent_Editor
8	Enterprise Architect		N	2015	Active	12	http://www.sparxsystems.com.au

Table 5 has been partially reproduced from the article “Ontology Building: A Survey of Editing Tools” by Michael Denny (http://www.xml.com/2002/11/06/Ontology_Editor_Survey.html). The table is slightly dated now although many of the tools are still available but may no longer be being maintained.

Table 5 An older table of ontology tools (Denny, 2002)

Tool	Modeling Features/Limitations	More Information
Apollo	Classes with slots plus relations; functions; hierarchical views.	http://apollo.open.ac.uk/index.html
CIRCA Taxonomy Administrator	Maps designed taxonomies to built-in general lexical ontology using weighted concept clusters ("gist"). No definable relations.	http://www.appliedsemantics.com/as_solutions_autocat_taxadmin.shtml
CoGITaNT	Conceptual graph (CG) modeling with rules; nested typed graphs; projections.	http://cogitant.sourceforge.net/
Coherence	Roundtrip transformation of ontologies from XML Schema and RDB schemas. Class and property hierarchies; business rules.	http://www.unicorn.com/pr-overview.htm
Contextia	Basic concepts and relations with datatypes are represented in schemas.	http://modulant.com/products/
COPORUM OntoBuilder	Basic concepts and relations are represented with single inheritance. Representation of concepts and relations extracted from content may be extended with WordNet information.	http://ontoserver.cognit.no/
DAG-Edit	Mixed part-of and is a concept hierarchies are represented along with synonym and search facilities. No properties.	http://sourceforge.net/projects/geontology
DAMLImp (API)	DAML+OIL constructs. Basic Java library for analysis and manipulation of DAML+OIL ontologies.	http://codip.grci.com/Tools/Components.html
Differential Ontology Editor (DOE)	Creates lattice of concepts and lattice of relationships between concepts, plus a set of instances. Concepts cannot be defined intentionally with constraints. Only types of the domains of relationships can be specified. No axiom editor is provided.	http://opales.ina.fr/public/
Disciple Learning Agent Shell	Semantic network representation with functions, extended to allow partially learned entities. A hierarchy of objects and a hierarchy of features, with their descriptions, are represented as frames. Also, general problem solving rules can be expressed with terms from the ontology.	http://lalab.gmu.edu/

Tool	Modeling Features/Limitations	More Information
Domain Ontology Management Environment (DOME)	Concepts, relations and constraints are mapped to ER-like specifications.	http://more.btexact.com/projects/ibsr/dome/index.htm
DUET	Represents only UML static constructs available on class diagrams.	http://codip.grci.com/Tools/Tools.html
Enterprise Semantic Platform (ESP) including Knowledge Toolkit	Description models composed of hierarchical categories and attributes with named relationships. Type system for heterogeneous media content. Instances supported by simple constraints on entities (cardinality, range) and entity properties, as well as inferencing. Automatic assertion and maintenance of instances is possible.	http://www.semagix.com/
EOR	RDF models as sets of triples. Can be used to build, insert (infuse) and query instance knowledge bases for DAML+OIL, RDFS, etc. ontologies.	http://eor.dublincore.org/index.html
ExClaim & CommonKADS Workbench	Description logic modeling plus primitive problem solving actions.	http://www.ici.ro/ici/expoeng/prod/ici/prod_12_22/pag_excl0.htm
GALEN Case Environment (GCE)	Description logic terminological modeling without support for individuals. Composite concepts are automatically classified according to their criteria (relationships with other concepts). New concepts can be created interactively and according to user-defined rules.	http://www.kermanog.com/
ICOM	EER (extended entity relations) modeling plus inheritance hierarchies, multidimensional aggregations and multiple schema relations.	http://www.cs.man.ac.uk/~franconi/icom/
Integrated Ontology Development Environment	Distinguishes between properties and relations; allows contexts; default reasoning; temporal model relations; higher-arity relations; meta-properties and meta-relations.	http://www.ontologyworks.com/
IsaViz	Supports RDFS level specifications. Can specify any model based on RDF such as DAML+OIL.	http://www.w3.org/2001/11/IsaViz/
JOE	Basic concept and relations modeling ala ER.	http://www.cse.sc.edu/research/cit/demos/java/joe/
KAON (including	Extends RDFS with symmetric, transitive and inverse relations, relation	http://kaon.semanticweb.org/

Tool	Modeling Features/Limitations	More Information
OIModeller)	cardinality, meta-modeling, etc. Similar to F-Logic using axiom patterns. Editor currently only supports concept hierarchy.	
KBE -- Knowledge Base Editor (for Zeus AgentBuilding Toolkit)	Zeus ontology model of concepts, attributes and values; multiple inheritance; modularization within a closed world model. (Also defines agent interaction protocols.)	http://www.isis.vanderbilt.edu/Projects/micants/Tech/Demos/KBE/
LegendBurster Ontology Editor	Semantic network hierarchy of concepts, attributes, attribute values and explicitly represented truth-status flags. Inheritance within hierarchies with lateral links. Full reified relations; inverse relations (partial). Metadata for all entities (at node level). Separate tree list editor.	http://www.georeferenceonline.com/
LinKFactory Workbench	Description logic T-box (terminological) and A-box (assertional) model. Multiple inheritance over concepts and relationships; identification of necessary and sufficient criteria for concept definition. Manage multiple conflicting ontologies in one T-box. Versioning metadata.	http://www.landc.be/
Medius Visual Ontology Modeler	UML modeling of ontologies with frame systems support.	http://www.sandsoft.com/products.html
NeoClassic	Framework representation of descriptions, concepts, roles, individuals and rules. Concepts can be derived from necessary and sufficient conditions for individual membership. Subsumption and classification are inherent inference. (Command line editor only.)	http://www-out.bell-labs.com/project/classic/
OilEd	DAML constraint axioms; same-class-as; limited XML Schema datatypes; creation metadata; allows arbitrary expressions as fillers and in constraint axioms; explicit use of quantifiers; one-of lists of individuals; no hierarchical property view.	http://oiled.man.ac.uk/
OLR3 Schema Editor	Instantiation and editing of external or custom schemas conforming to RDFS. Concept-specific filtering to present choice of legal properties.	http://www.kbs.uni-hannover.de/~tkunze (German only)
OntoBuilder	Manages compilation of domain terms, their description, and contexts using natural language.	http://www.kompetenznetz-lymphome.de/KlinischeStudien/Qualitaetssicherung/DataDictionary/DataDictionary.html

Tool	Modeling Features/Limitations	More Information
Onto-Builder	Distinguishes "what contributes to the essence of things and what describes them", defining concepts by their "specific difference". Thus, logical and set-oriented semantics are derived a posteriori.	http://ontology.univ-savoie.fr/ ; http://www.ontologos.com
OntoEdit	F-Logic axioms on classes and relations; algebraic properties of relations; creation of metadata; limited DAML property constraints and datatypes; no class combinations, equivalent instances.	http://www.ontoprise.de/com/ont_oedit.htm
Ontolingua with Chimaera	OKBC model with full KIF axioms.	http://www.ksl.stanford.edu/software/ontolingua/ http://www.ksl.stanford.edu/software/chimaera/
Ontology Builder & Server	Classes with slots, datatypes and cardinality constraints; node documentation; inclusion. No axioms.	http://www.verticalnet.com/technology/components/process.html
Ontology Directed Extraction (ODE) Tools	Multiple inheritance subsumption class hierarchies. Support for typed attributes of classes and relations between classes. Supports schema and object information.	http://www.xsb.com/ode.asp
Ontopia Knowledge Suite	Constraint modeling specifically and solely for Topic Map representations.	http://www.ontopia.net/solutions/products.html
Ontosaurus	Rich KB browser with simple editing; contexts; same-class-as; metaclasses.	http://www.isi.edu/isd/ontosaurus.html
OntoTerm	Concept and property hierarchies with concept instances; properties distinguished as attributes or relations. Metadata (natural language definitions).	http://www.ontoterm.com/
OpenCyc Knowledge Server	FOPC extended with contexts, equality, default reasoning, skolemization, quantification over predicates. (Basic ontology editing via KB Browser Create Term tool.)	http://www.opencyc.org/
OpenKnoMe	Description logic terminological modeling without support for individuals or type system. Arbitrarily complex structures may be composed from primitive concepts and relations. Role hierarchy with inverses, and reasoning over relationships such as part-of. No formal negation, disjunction or conjunction. Limited support for cardinality. No reasoning	http://www.topthing.com/

Tool	Modeling Features/Limitations	More Information
	over numbers or ranges. Toolset for managing intermediate representations.	
PC Pack 4	Knowledge acquisition and modeling. Multiple inheritance; n-ary relations; rules and methods. User definable templates for modeling formalisms like CommonKADS and Moka.	http://www.epistemics.co.uk/
Protégé-2000	Multiple inheritance concept and relation hierarchies (but single class for instance); meta-classes; instances specification support; constraint axioms ala Prolog, F-Logic, OIL and general axiom language (PAL) via plug-ins.	http://protege.stanford.edu/index.html
RDFAuthor	Create RDF instance data against RDFS schemas.	http://rdfweb.org/people/damian/RDFAuthor/
RDFedt	Textual language editor only.	http://www.jan-winkler.de/dev/e_rdf.html
SemTalk	Subset of RDFS and DAML extended with inverse relations and process modeling.	http://www.semtalk.com/
Specware	Logical and functional axioms. (Text based language editor only.)	http://www.specware.org/
SymOntos	XML Schema modeling constructs with subsumption of classes and relations; specified relation types of isa, part-of, similarity and predicate. Business-oriented predefined classes such as: actor, process, event, and message.	http://www.symontos.org
Taxonomy Builder	General taxonomy of elements assigned data types and substitution groups. Predefined XBRL relation types via links.	http://www.semansys.com/about_composer.html
TOPKAT	Supports representation of the various models of CommonKADS (circa 1995). Underlying these models are dictionaries of concepts, properties, property values, inferences, and tasks. Production rules can be represented using a combination of these primitives.	http://www.aii.ed.ac.uk/~jkk/topkat.html
Visio for Enterprise Architects	Most object-role modeling (ORM) constructs, but imposes relational logical constraints on specification.	http://msdn.microsoft.com/vstudio/techinfo/articles/developerproductivity/orm.asp
WebKB	Basic conceptual graph modeling and manipulation that includes contexts, constraint checking and querying. Can derive new statements (e.g., relations) from necessary and sufficient conditions.	http://meganesia.int.gu.edu.au/~p_hmartin/WebKB/doc/generalDoc.html

Tool	Modeling Features/Limitations	More Information
WebODE	Concepts (class and instance), attributes and relations of taxonomies; disjoint and exhaustive class partitions; part-of and ad-hoc binary relations; properties of relations; constants; axioms; and multiple inheritance. Inference engine for subset of OKBC primitives and axioms.	http://delicias.dia.fi.upm.es/webODE/
WebOnto	Multiple inheritance and exact coverings; meta-classes; class level support for prolog-like inference.	http://kmi.open.ac.uk/projects/webonto/

3.1 Summary of Ontology and Vocabulary Tools

The vast expanse and variety of tools for creating, editing and visualising ontologies demonstrates that this is a field that has received a lot of research at different points in time. From the number of tools that are no longer maintained it indicates that in many instances the research has ceased and so has the maintaining and developing of many tools.

From a current research perspective it is important to understand what has already been developed and to examine whether or not it is something that is still fit for purpose as it, the code base is fit for the purpose of continuing the development of it or if it is simply no longer tenable for use.

The Protégé tool, created at Stanford University, continues to be maintained and developed and is emerging as one of the default ontology building tools. Its continued development throughout time has seen the emergence of a web based version of the tool being created, Web Protégé.

4 Ontologies and Vocabularies

Table 6 lists multiple vocabularies. There is a short description about the vast majority of them as well as a hotlink in the Name & Link column. Clicking on that link should take you to a web page related to the vocabularies. As with previous tables, this table is not exhaustive as the author is fully aware that omissions may have occurred. Please check documentation of each tool to ensure that it is fit for the purpose that you require.

Table 6. A list of different vocabularies and the links to their locations.

#	Name & Link	Description
1	ACT Sensors List	List of sensors developed by the Alliance for Coastal Technologies
2	Alexandria Digital Library (ADL) Gazetteer	Gazetteer services provided by Alexandria Digital Library from Map and Imagery Lab, Davidson Library, University of California, Santa Barbara (UCSB).
3	Argo Instrument List	Instrument code list from Argo
4	Argo Parameters and quality control code lists	List of parameter and quality control codes from Argo
5	Biodiversity Information Standards (TDWG): Vocabularies and Ontologies	Collection of vocabularies and ontologies from TDWG for biodiversity
6	BODC (British Oceanographic Data Centre) Units	The BODC units table, consisting of all the units codes used in BODC parameter lists.
7	BODC Instruments List	List of instruments used by the British Oceanographic Data Centre
8	BOG CTD Bottle Data Field Names	MBARI's Biological Ocean Group (BOG) CTD Bottle Data Field Names
9	BOG CTD Profiling Data Field Names	MBARI's Biological Ocean Group (BOG) CTD Profiling Data Field Names
10	British Oceanographic Data Centre Parameter Discovery Vocabulary	The BODC Parameter Dictionary has been completely overhauled during 2004 and now consists of an integrated data markup and parameter discovery vocabularies.
11	British Oceanographic Data Centre Parameter Usage Vocabulary	The BODC Parameter Usage Vocabulary may be used as a tool to label a measurement with information on what it is and how it was obtained or to describe parameters (phenomena in GML terminology) in 'use' metadata.
12	BUFR Parameters	World Meteorological Organization's Binary Universal Form for the Representation of meteorological data (BUFR) parameter codes.

#	Name & Link	Description
13	CDI Sea Search Sensor and Platform Vocabularies	Common Data Index vocabularies lists for the Sea-Search program. Vocabularies for platforms and sensors are included.
14	CF - Climate and Forecast Standard Names	Vocabulary for climate and forecast parameters
15	CMECS Habitat Classification System	Coastal and Marine Ecological Classification Standard system describing the habitats of the estuaries, coasts and oceans of North America.
16	CoRIS Glossary of Terms	NOAA's Coral Reef Information System (CoRIS) glossary of coral reef-related terms
17	CUAHSI Parameter Names Vocabulary	A comprehensive parameters vocabulary for hydrologic science
18	DAML Ontology Library	A collection of ontologies hosted by DAML web site
19	EPIC (NOAA, PMEL) Units	Example of units used in operational system (units are encoded in variable key, used in netCDF entries).
20	ESA SensorML Dictionaries	Set of dictionaries with ESA concepts for SensorML
21	EUNIS Habitat Classification System	The European Nature Information System (EUNIS) habitat classification system covers all types of natural and artificial habitats, both aquatic and terrestrial, in Europe.
22	eXtensible Address Language	This is an XML standard for addresses.
23	Fleet Numerical Meteorology and Oceanography Center - Interpolated Sea Level Pressure	
24	GCMD Data Center Keywords	Global Change Master Directory Data Center keywords, contains short names (3 to 30 character acronyms separated by forward-slashes) and long names with locations.
25	GCMD Location Keywords	Global Change Master Directory hierarchical list of Location Keywords
27	GCMD Platform Keywords	The Global Change Master Directory (GMCD) list of platform keywords, mainly satellites.
28	GCMD Project Keywords	Global Change Master Directory list of project keywords, short names (acronyms) and long names for each project.
29	GCMD Science Keywords	Global Change Master Directory list of Science Keywords in hierarchical order with no codes.

#	Name & Link	Description
30	GCMD Sensors Vocabulary	The GCMD list of sensor types (described as a list of sensor keywords).
31	GEMET - GEneral Multilingual Environmental Thesaurus	Multilingual thesaurus that aims to define a core terminology for the environmental domain.
32	Global Change Master Directory Keywords	Hierarchical list of keywords to the variable level, in 6 broad groups (e.g., science, projects, instruments...).
33	ICES Ship Names	International Council for the Exploration of the Sea (ICES) uses SeaDataNet codes for ship names.
34	ICES-SeaDataNet Platform Code	The ICES-SeaDataNet platform code contains a 2-character country code (from ICES/ISO country code) followed by 2-character vessel code.
35	ICES/IOC Country Codes	International Council for the Exploration of the Sea (promoting marine and fishery research of the North Atlantic) format for country codes.
36	IHO Feature Dictionary Register	Temporary (as of 2007) register for Hydrographic Features hosted by the International Hydrographic Organization (IHO)
37	International Scientific Units (NIST)	NIST references on international system of scientific units.
38	Internet (www) Country Code Top-level Domain	The internet (www) country code top-level domain (ccTLD) corresponds to ISO 3166 country codes.
39	IOC GF3 parameter codes	Listing of parameter codes, subsetted according to CTD data, moored current meter data, etc.
40	IOOS Parameter Vocabulary V.1.0	IOOS parameter vocabulary based on SEACOOS Data Dictionary V.2.0, COARDS CF V.13, and input from the NOAA IOOS Program Office and the 11 Regional Associations.
41	IRI Placenames	International Research Institute for Climate and Society Gazetteer
42	ISDM Code Lists	Integrated Science Data Management (ISDM, a branch of Canada's Federal Department of Fisheries and Oceans) code lists
43	ISDM Dictionary of Oceanographic Codes	Integrated Science Data Management (ISDM) Dictionary of oceanographic codes used by participating institutes
44	ISO 3166 Country Codes	ISO 3166 is the most widely used standard for coding country names. Also, contains information on ISO 3166-3 for coding formerly used country names.

#	Name & Link	Description
45	ISO Topic Categories	A brief list of the Topic Categories and Codes from ISO 19115:2003 is provided. For complete Topic Category definitions please refer to the published standard ISO 19115:2003.
46	ISO Units Standards	The ISO standards applicable to Units.
47	ISO/TC 211 Multi-Lingual Glossary of Terms	To encourage consistency in the use and interpretation of geospatial terms
48	ITIS Taxonomic Codes	Integrated Taxonomic Information System (ITIS) Database assigns a unique taxonomic serial number (TSN) to code each scientific name. Currently, there are over 400,000 scientific names with thousands of new names added each month.
49	Lipid Classification System	A May 2005 paper published in the Journal of Lipid Research describes a structured vocabulary intended to facilitate the systematization of lipid biology and enable the cataloging of lipids and their properties in a way compatible with other macromolecular databases. The paper describes work done by the LIPID Metabolites And Pathways Strategy (MAPS).
50	Master Environmental Library (MEL) Keyword Thesauri	An authoritative list of discipline-specific Keywords.
51	MBARI's Video Annotation Reference System	Video reference system for cataloguing thousands of hours of deep-sea video
52	MEDS Standard Codes	
53	MESH: Mapping European Seabed Habitats	A program intended to integrate access to the various European seabed habitat data.
54	MODIS Units	List of MODIS data items, including units for each.
55	Multiple Links at OceanTeacher	The UNESCO Ocean Teacher site references.
56	NASA Instrument Taxonomy	A collection of instrument types organized into a taxonomy.
57	NERC DataGrid Vocabulary Server	A Web Service providing live access to lists of controlled vocabularies for the marine community hosted by the British Oceanographic Data Centre (BODC)
58	NetCDF Dataset Discovery Attribute Convention	Draft NetCDF attributes recommended for describing a NetCDF dataset to discovery systems
59	NGA GEOnet Names Server	National Geospatial-Intelligence Agency Geographic Names Server.

#	Name & Link	Description
60	NGDC Marine & Geological Samples Database	Index to Marine and Lacustrine Geological Samples database at the National Geophysical Data Center
61	NOAA CO-OP Tide and Current Glossary	Alphabetical listing of terms with definitions
62	NOAA CoRIS Thesauri	NOAA's Coral Reef Information System (CoRIS) Thesauri include Theme, Place, and Discovery keywords used in metadata to help describe coral reef data sets. Includes mappings to GCMD.
63	NODC Codes for Biological Observations	This National Oceanographic Data Center (NODC) code list has a number of codes associated with biological observations.
64	NODC Country Codes	National Oceanographic Data Center country codes and sea names code list.
65	NODC Institute Codes	National Oceanographic Data Center (NODC) uses 2-character country codes followed by 2-character Institution codes.
67	NODC Platform Code	The National Oceanographic Data Center (NODC) platform codes are similar to ICES-SeaDataNet platform codes, a 2-character country code followed by 2-character vessel code.
68	NODC Platform Type Codes (copy)	The National Oceanographic Data Center (NODC) platform type codes are copied here from the original list.
69	NODC Project Codes	National Oceanographic Data Center assigns unique numerical identifiers from 1-999 to each project name.
70	NODC Sensors (Type) List	List of sensors used by NODC for classification
71	NODC Taxonomic Codes	The National Oceanographic Data Center (NODC) 12-digit code numbers contained information about taxonomy through the use of 2-digit couplets to represent one or more levels of taxonomic hierarchy.
72	NODC World Ocean Database Country Codes	National Oceanographic Data Center World Ocean Database 2005, country codes.
73	NODC World Ocean Database Institute Code	
75	NODC World Ocean Database Platform Code	The National Oceanographic Data Center (NODC) World Ocean Database (WOD) uses unique assigned index numbers from 1-8970 for platform codes.
74	Publication 47: WMO Codes for Instruments and Methods on Ships	Document containing the WMO codes for instruments and methods on ships.

#	Name & Link	Description
75	QARTOD II wave and current vocabularies	These are the essential metadata elements identified for waves and in situ and remote currents at the Quality Assurance for Real Time Oceanographic Data (QARTOD)II workshop, held in Norfolk, VA on 2/28-3/2/05. This is an effort to help advance IOOS DMAC.
76	Sea Surface Temperature Variables	GTS - Global Telecommunications System SST Temperature Variables from both fixed and stationary platforms such as ships and buoys.
77	SEACOOS Data Dictionary v2.0	The SEACOOS data dictionary provides terms, definitions and other useful metadata about each variable for implementation in the SEACOOS NetCDF specification.
78	SeaDataNet Platform Type	SeaDataNet uses 4-character assignments for platform type.
79	SeaDataNet Sensor Vocabularies	Vocabularies for sensors for the SeaDataNet program.
80	SEDRIS Environmental Data Coding Specification (EDCS)	An authoritative list of classifications and attributes of environmental objects.
81	SIO/GDC Vocabulary Terms	A found list of terms for platforms and instruments.
82	Species 2000 Catalogue of Life	The Species 2000 "Catalogue of Life" provides access to 50% of the world's species (plants, animals, fungi, and microbes). Species 2000 uses ITIS which assigns unique Taxonomic Serial Numbers to each name.
83	SSDS Sensor Types	Sensor categories used for MBARI's Shore Side Data System.
84	Standardized Region Names	List of marine regions, based on the NASA GCMD keyword list for locations
85	TAMU Glossary of Physical Oceanography and Related Terms	Alphabetical glossary of terms with definitions published by the Department of Oceanography at Texas A&M University.
86	Teledyne RD Instruments Glossary of Terminology	
87	U.S. Globec Instrument Names	List of Instrument names from U.S. Globec Data Thesaurus
88	U.S. Globec Thesaurus	U.S. Globec list of field names, units, and platforms
89	U.S. Joint Global Ocean Flux Study Parameters	List of parameter names, descriptions, and units according to multiple categories (e.g., Sampling attributes, Physical properties, Chemistries) from JGOFS
90	uBio	Universal Biological Indexer and Organizer
91	Unidata UDUNITS Units	A widely used software package to work with units.

#	Name & Link	Description
92	Unified Codes for Units of Measure (UCUM)	Extremely comprehensive system for presenting units
93	Units by Petroleum Open Standards Consortium (POSC)	Comprehensive system of units designed for software framework, includes problem statement, XML dictionary, and development background.
94	Vocabularies on NERC DataGrid	Vocabularies available through the NERC DataGrid Vocabulary Server.
95	WMO Codes for Temperature Sensors	WMO codes for temperature sensing devices.

Table 7

Table 7. A listing of ontologies with links to their location.

#	Name/Link	Description	Notes
1	Basic Geo (WGS84 lat/long) Vocabulary: http://www.w3.org/2003/01/geo/wgs84_pos#	a basic RDF vocabulary with a namespace for representing lat(itude), long(itude) and other information about spatially-located things, using WGS84 as a reference datum	Maintained
2	GML Ontology (https://www.seegrid.csiro.au/subversion/CGI_CDTGVocabulary/trunk/OwlWork/ogc-gml.owl)	Ontology for Geography Markup Language	Maintained
3	http://def.seegrid.csiro.au/	CSIRO's page containing links etc. def.seegrid domain is dedicated to delivering semantic information, such as vocabularies, ontologies, endpoints, and information resources to web users through the SISS Vocabulary Services interface (SISSVoc).	
	OGC, ISO ontologies listed at CSIRO:		
4	http://def.seegrid.csiro.au/isotc211/iso19107/2003/geometry/	An OWL representation of part of the model for geometry and space from ISO 19107:2003 Geographic Information - Spatial Schema.	Maintained
5	http://resource.geosciml.org/ontology/timescale/gts	An RDF/OWL representation of the GeoSciML Geologic Timescale model	Maintained

#	Name/Link	Description	Notes
6	http://def.seegrid.csiro.au/isotc211/iso19108/2002/temporal	An OWL representation of part of the model for Temporal objects and reference systems from ISO 19108:2002 Geographic Information - Temporal Schema.	Pending
7	http://def.seegrid.csiro.au/isotc211/iso19156/2011/sampling	An OWL representation of the Sampling Features Schema described in clauses 8-10 of ISO 19156:2011 Geographic Information - Observations and Measurements.	Pending
8	http://resource.geosciml.org/ontology/timescale/rank		
9	http://resource.geosciml.org/ontology/timescale/tors	This model is related to the model for TORS in ISO 19108:2002, except that boundaries between eras are first class objects, supporting multiple properties, rather than being just time coordinates. It is also linked to the ISO 19108 Temporal Topology model.	Maintained
10	http://def.seegrid.csiro.au/isotc211/iso19103/2005/basic	An OWL representation of (some of) the basic types described in ISO 19103:2005, required as primitives in other ontologies based on ISO 19100 series standards.	Pending
11	http://def.seegrid.csiro.au/ogc/dataType/OGC-SF/1.0/	This vocabulary is provisional, pending finalization of ISO 19150-2.	
12	http://def.seegrid.csiro.au/isotc211/iso19108/2006/temporalobject/		
13	http://def.seegrid.csiro.au/isotc211/iso19115/2003/dataquality	OWL representation of ISO 19115 (Geographic Information - Metadata - Data quality package)	Maintained
14	http://def.seegrid.csiro.au/isotc211/iso19115/2003/code/EvaluationMethodType		Maintained
15	http://def.seegrid.csiro.au/isotc211/iso19108/2006/temporalreferencesystem/		
16	MARINE METADATA INTEROPERABILITY PROJECT	Promoting the exchange, integration and use of marine data through enhanced data publishing, discovery, documentation and	

#	Name/Link	Description	Notes
		accessibility.	
17	A Universal Ontology for Sensor Networks Data	A prototype ontology using IEEE SUMO	Maintained
18	AGU Index Terms	Thesaurus for indexing AGU journal articles and meeting abstracts, covering earth science concepts	Maintained
19	All Ontologies hosted at MMI	List of all the ontologies hosted at (and/or referenced by) MMI	Maintained
20	Animal Behaviour Ontology	Ontology describing animal behaviour.	Maintained
21	Aquatic Sciences and Fisheries Abstracts (ASFA)	Aquatic Sciences and Fisheries Abstracts (ASFA) is a paid service providing references to international literature covering marine environments.	Maintained
22	Autonomous Mission Operations for Sensor Webs Ontology	An ontology being developed for software agents operating a Sensor Web	Maintained
23	Biodiversity Resource Information Ontology	An ontology describing resources important in biodiversity information management.	Maintained
24	BODC Parameter Ontology Project	The British Oceanographic Data Centre is creating an ontology to link the BODC Parameter Discovery Vocabulary, the CF Standard Names and the GCMD Science Keywords	Maintained
25	CIMA Ontology	CIMA, the Common Instrument Middleware Architecture, is developing ontologies for an instrument services architecture.	Maintained
26	DOLCE ROCKS: Integrating Foundational and Geoscience Ontologies	Integrating DOLCE foundational ontology with concepts from two geoscience knowledge representations, GeoSciML and SWEET.	Maintained
27	Earth System Grid Ontology	Primarily developed for adding metadata to datasets found in the Earth System Grid (ESG) portal.	Maintained
28	Ecological Concepts Ontology	Ontology describing concepts in ecology.	Maintained
29	Environment Ontology	Ontology on environmental features and habitats.	Maintained
30	Hydrology Units Ontology	Units for hydrology domain in an OWL ontology.	Maintained
31	Invasive Species Thesaurus	Invasive species management thesaurus.	Maintained
32	ITSC Ontologies	ITSC is building ontologies for specialized domains and software	Maintained

#	Name/Link	Description	Notes
		tools.	
33	MMI Device Ontology: A Community Development Project	MMI is coordinating a community project to develop an ontology of oceanographic sensors and devices.	Maintained
34	MMI Platforms Ontology	MMI project to develop a sensor and platform ontology.	Maintained
35	MMI Workshop Sensors Ontology	This is the sensors ontology developed at the 2005 MMI vocabulary mapping workshop	Maintained
36	OBO: Open Biological Ontologies	An umbrella web address for well-structured controlled vocabularies for shared use across different biological domains.	Maintained
37	OBOE: Extensible Observation Ontology	An ontology for ecological observational data.	Maintained
38	Observations and Measurements	OpenGIS Observations and Measurements Encoding Standard	Maintained
39	Ontologies for Volcanoes, Plate Tectonics and Atmospheric Science Data Integration	Generated volcano and plate tectonic ontologies and leveraged and augmented the existing SWEET (Semantic Web for Earth and Environmental Terminology) ontology	Maintained
40	Ontology and Knowledgebase of Fractures and Faults	Resource for finding information about fractures and faults, contains about 1,000 classes.	Maintained
41	OntoSensor Ontology	Ontology describing sensors by University of Memphis	Maintained
42	Quantities and Units Ontology	Quantities, Units, Dimensions and Data Types in OWL and XML	Maintained
43	Spire Ecological Concepts Ontology	Ontology describing concepts in ecology.	Maintained
44	Surface Water Model Ontology	Surface water model ontology.	Maintained
45	SWEET Ontologies	Ontologies represented in the Ontology Web Language, for various environmentally related domains (e.g., Earth Realms, Numerics, Phenomena, Time, Units...)	Maintained
46	SWEET Units Ontology	An ontology of units and unit concepts, the SWEET units ontology goes beyond a mere list to incorporate relationships between different terms.	Maintained
47	TaxonomicID Ontology	Ontology describing the hierarchy of taxonomic names.	Maintained
48	VRA Core Image Metadata	Image metadata for cultural images	Maintained

#	Name/Link	Description	Notes
49	W3C Semantic Sensor Network Incubator Working Group	W3C team working on device ontology and other semantic sensor elements	Maintained
50	SPARQL Endpoints listed at CSIRO:		
51	OWL representation of ISO/TC 211 Harmonized Model (part)	Currently unavailable. It appears that there are other available links.	Broken
52	OWL representations of some concepts defined for OGC	Currently unavailable. It appears that there are other available links.	Broken
53	Definitions identified by OGC URIs	Currently unavailable. It appears that there are other available links.	Broken
54	RDF version of GML Units schema, with SI Base Units and a few others to illustrate scope	Currently unavailable. It appears that there are other available links.	Broken
55	Water Data Transfer Format (WDTF) version 03	Currently unavailable. It appears that there are other available links.	Broken
56	WDTF Schema control list vocabularies	Currently unavailable. It appears that there are other available links.	Broken
57	International Stratigraphic Chart (ISC) 2010 edition	Currently unavailable. It appears that there are other available links.	Broken
58	ISC 2009 edition	Currently unavailable. It appears that there are other available links.	Broken
59	ISC 2008 edition	Currently unavailable. It appears that there are other available links.	Broken
60	ISC 2006 edition	Currently unavailable. It appears that there are other available links.	Broken
61	ISC 2005 edition	Currently unavailable. It appears that there are other available links.	Broken
62	ISC 2004 edition	Currently unavailable. It appears that there are other available links.	Broken
63	Geological timescale, based on ICS 2008 stratigraphic chart	Currently unavailable. It appears that there are other available links.	Broken

#	Name/Link	Description	Notes
64	OWL representation of Geologic Timescale model from GeoSciML v3	Currently unavailable. It appears that there are other available links.	Broken
65	National Virtual Core Library (NCVL) Vocabulary	Currently unavailable. It appears that there are other available links.	Broken
66	NVCL Scalar Definitions	Currently unavailable. It appears that there are other available links.	Broken
67	EarthResources Commodities Vocabulary	Currently unavailable. It appears that there are other available links.	Broken
68	http://www.onegeology.org/portal/home.html	OneGeology Portal	Maintained
69	http://srvgeosciml.brgm.fr/eXist2010/brgm/client.html	GeoSciML vocabularies: provides an interface to multiple vocabularies	
70	http://geovocab.org/spatial.html	A vocabulary for describing topological relations between features	
71	Units of Measure	An ontology for units of measure	Live @ MMI
72	Dublin Core Metadata	The Dublin Core Metadata Element Set is a vocabulary of fifteen properties for use in resource description.	Maintained
73	The SWEET Ontologies: Semantic Web for Earth and Environmental Terminology	“SWEET ontologies are written in the OWL ontology language. SWEET 2.3 is highly modular with 6000 concepts in 200 separate ontologies.” (http://sweet.jpl.nasa.gov/)	
74	human.owl		Maintained
75	humanCommerce.owl		Maintained
76	humanDecision.owl		Maintained
77	humanEnvirAssessment.owl		Maintained
78	humanEnvirConservation.owl		Maintained
79	humanEnvirControl.owl		Maintained
80	humanEnvirStandards.owl		Maintained
81	humanJurisdiction.owl		Maintained
82	humanKnowledgeDomain.owl		Maintained

#	Name/Link	Description	Notes
83	humanResearch.owl		Maintained
84	humanTechReadiness.owl		Maintained
85	humanTransportation.owl		Maintained
86	matr.owl		Maintained
87	matrAerosol.owl		Maintained
88	matrAnimal.owl		Maintained
89	matrBiomass.owl		Maintained
90	matrCompound.owl		Maintained
91	matrElement.owl		Maintained
92	matrElementalMolecule.owl		Maintained
93	matrEnergy.owl		Maintained
94	matrEquipment.owl		Maintained
95	matrFacility.owl		Maintained
96	matrInstrument.owl		Maintained
97	matrIon.owl		Maintained
98	matrIsotope.owl		Maintained
99	matrMicrobiota.owl		Maintained
100	matrMineral.owl		Maintained
101	matrNaturalResource.owl		Maintained
102	matrOrganicCompound.owl		Maintained
103	matrParticle.owl		Maintained
104	matrPlant.owl		Maintained
105	matrRock.owl		Maintained
106	matrRockIgneous.owl		Maintained
107	matrSediment.owl		Maintained
108	matrWater.owl		Maintained
109	phen.owl		Maintained
110	phenAtmo.owl		Maintained

#	Name/Link	Description	Notes
111	phenAtmoCloud.owl		Maintained
112	phenAtmoFog.owl		Maintained
113	phenAtmoFront.owl		Maintained
114	phenAtmoLightning.owl		Maintained
115	phenAtmoPrecipitation.owl		Maintained
116	phenAtmoPressure.owl		Maintained
117	phenAtmoSky.owl		Maintained
118	phenAtmoTransport.owl		Maintained
119	phenAtmoWind.owl		Maintained
120	phenAtmoWindMesoscale.owl		Maintained
121	phenBiol.owl		Maintained
122	phenCryo.owl		Maintained
123	phenEcology.owl		Maintained
124	phenElecMag.owl		Maintained
125	phenEnergy.owl		Maintained
126	phenEnvirImpact.owl		Maintained
127	phenFluidDynamics.owl		Maintained
128	phenFluidInstability.owl		Maintained
129	phenFluidTransport.owl		Maintained
130	phenGeol.owl		Maintained
131	phenGeolFault.owl		Maintained
132	phenGeolGeomorphology.owl		Maintained
133	phenGeolSeismicity.owl		Maintained
134	phenGeolTectonic.owl		Maintained
135	phenGeolVolcano.owl		Maintained
136	phenHelio.owl		Maintained
137	phenHydro.owl		Maintained
138	phenMixing.owl		Maintained

#	Name/Link	Description	Notes
139	phenOcean.owl		Maintained
140	phenOceanCoastal.owl		Maintained
141	phenOceanDynamics.owl		Maintained
142	phenPlanetClimate.owl		Maintained
143	phenPlanetOscillation.owl		Maintained
144	phenReaction.owl		Maintained
145	phenRecycle.owl		Maintained
146	phenSolid.owl		Maintained
147	phenStar.owl		Maintained
148	phenSystem.owl		Maintained
149	phenWave.owl		Maintained
150	phenWaveNoise.owl		Maintained
151	proc.owl		Maintained
152	procChemical.owl		Maintained
153	procPhysical.owl		Maintained
154	procStateChange.owl		Maintained
155	procWave.owl		Maintained
156	quan.owl		Maintained
157	quanCapacity.owl		Maintained
158	quanCharge.owl		Maintained
159	quanChemical.owl		Maintained
160	quanConductivity.owl		Maintained
161	quanCount.owl		Maintained
162	quanDiffusivity.owl		Maintained
163	quanDimensionlessRatio.owl		Maintained
164	quanEnergy.owl		Maintained
165	quanEnergyFlux.owl		Maintained
166	quanFraction.owl		Maintained

#	Name/Link	Description	Notes
167	quanFunction.owl		Maintained
168	quanIndex.owl		Maintained
169	quanMass.owl		Maintained
170	quanMassFlux.owl		Maintained
171	quanPressure.owl		Maintained
172	quanRotation.owl		Maintained
173	quanSpace.owl		Maintained
174	quanSpaceDirection.owl		Maintained
175	quanSpaceDistance.owl		Maintained
176	quanSpaceHeight.owl		Maintained
177	quanSpaceMultidimensional.owl		Maintained
178	quanSpaceThickness.owl		Maintained
179	quanSpeed.owl		Maintained
180	quanStatistics.owl		Maintained
181	quanTemperature.owl		Maintained
182	quanTemperatureGradient.owl		Maintained
183	quanTime.owl		Maintained
184	quanTimeAverage.owl		Maintained
185	quanTimeFrequency.owl		Maintained
186	realm.owl		Maintained
187	realmAstroBody.owl		Maintained
188	realmAstroHelio.owl		Maintained
189	realmAstroStar.owl		Maintained
190	realmAtmo.owl		Maintained
191	realmAtmoBoundaryLayer.owl		Maintained
192	realmAtmoWeather.owl		Maintained
193	realmBiolBiome.owl		Maintained
194	realmClimateZone.owl		Maintained

#	Name/Link	Description	Notes
195	realmCryo.owl		Maintained
196	realmEarthReference.owl		Maintained
197	realmGeol.owl		Maintained
198	realmGeolBasin.owl		Maintained
199	realmGeolConstituent.owl		Maintained
200	realmGeolContinental.owl		Maintained
201	realmGeolOceanic.owl		Maintained
202	realmGeolOrogen.owl		Maintained
203	realmHydro.owl		Maintained
204	realmHydroBody.owl		Maintained
205	realmLandAeolian.owl		Maintained
206	realmLandCoastal.owl		Maintained
207	realmLandFluvial.owl		Maintained
208	realmLandGlacial.owl		Maintained
209	realmLandOrographic.owl		Maintained
210	realmLandProtected.owl		Maintained
211	realmLandTectonic.owl		Maintained
212	realmLandVolcanic.owl		Maintained
213	realmLandform.owl		Maintained
214	realmOcean.owl		Maintained
215	realmOceanFeature.owl		Maintained
216	realmOceanFloor.owl		Maintained
217	realmRegion.owl		Maintained
218	realmSoil.owl		Maintained
219	repr.owl		Maintained
220	reprDataFormat.owl		Maintained
221	reprDataModel.owl		Maintained
222	reprDataProduct.owl		Maintained

#	Name/Link	Description	Notes
223	reprDataService.owl		Maintained
224	reprDataServiceAnalysis.owl		Maintained
225	reprDataServiceGeospatial.owl		Maintained
226	reprDataServiceReduction.owl		Maintained
227	reprDataServiceValidation.owl		Maintained
228	reprMath.owl		Maintained
229	reprMathFunction.owl		Maintained
230	reprMathGraph.owl		Maintained
231	reprMathOperation.owl		Maintained
232	reprMathRelation.owl		Maintained
233	reprMathSolution.owl		Maintained
234	reprMathStatistics.owl		Maintained
235	reprSciComponent.owl		Maintained
236	reprSciFunction.owl		Maintained
237	reprSciLaw.owl		Maintained
238	reprSciMethodology.owl		Maintained
239	reprSciModel.owl		Maintained
240	reprSciProvenance.owl		Maintained
241	reprSciUnits.owl		Maintained
242	reprSpace.owl		Maintained
243	reprSpaceCoordinate.owl		Maintained
244	reprSpaceDirection.owl		Maintained
245	reprSpaceGeometry.owl		Maintained
246	reprSpaceGeometry3D.owl		Maintained
247	reprSpaceReferenceSystem.owl		Maintained
248	reprSpaceRelation.owl		Maintained
249	reprSpaceScale.owl		Maintained
250	reprTime.owl		Maintained

#	Name/Link	Description	Notes
251	reprTimeDay.owl		Maintained
252	reprTimeSeason.owl		Maintained
253	state.owl		Maintained
254	stateBiological.owl		Maintained
255	stateChemical.owl		Maintained
256	stateDataProcessing.owl		Maintained
257	stateEnergy.owl		Maintained
258	stateEnergyFlux.owl		Maintained
259	stateFluid.owl		Maintained
260	statePhysical.owl		Maintained
261	stateRole.owl		Maintained
262	stateRoleBiological.owl		Maintained
263	stateRoleChemical.owl		Maintained
264	stateRoleImpact.owl		Maintained
265	stateRoleTrust.owl		Maintained
266	stateSolid.owl		Maintained
267	stateSpace.owl		Maintained
268	stateSpaceConfiguration.owl		Maintained
269	stateSpectralBand.owl		Maintained
270	stateSpectralLine.owl		Maintained
271	stateSpeed.owl		Maintained
272	stateSystem.owl		Maintained
273	stateThermodynamic.owl		Maintained
274	stateTime.owl		Maintained
275	stateTimeFrequency.owl		Maintained
276	stateTimeGeologic.owl		Maintained
277	stateVisibility.owl		Maintained
278	stateWave.owl		Maintained

#	Name/Link	Description	Notes
279	sweetAll.owl	This is a listing of all the SWEET ontologies listed above.	Maintained
280	http://def.seegrid.csiro.au	Dedicated to delivering semantic information: vocabularies, ontologies, endpoints, and information resources.	Maintained

5 Conclusions

The data in this report have attempted to achieve two goals:

1. Produce an overview of tools for creating, editing and visualising ontologies and vocabularies
2. Produce a list of ontologies and vocabularies that are available in both the market and research landscapes.

The tables indicate that there are a large number of ontology and vocabulary tools available for use. Throughout the creation of this report some tools that were available are no longer available or the maintaining of them has ceased. It is important to note this, as when selecting tools to be used both in research and in the market place it is crucial to get an understanding as to the availability of current support and future support.

The tables also indicate that there are large numbers of ontologies and vocabularies that currently exist on the Internet. Being able to find them and then know how to use them are two large challenges.

One other data repository needs to be mentioned, that is DBpedia. In the latest version of DBpedia it “consists of 3 billion pieces of information (RDF triples) out of which 580 million were extracted from the English edition of Wikipedia, 2.46 billion were extracted from other language editions” (<http://blog.dbpedia.org/>). This represents a large and significant amount of data that is structured into an ontology format using the RDF.

A strong focus of Program 3 is the search and discovery of spatial data along with the automation of processing this type of data. Ontologies and vocabularies are pivotal in this process, however generating the data above was a manual and painstaking process. The automation discussed in Program 3 will also aid in continuing to keep this document up to date in that much of the data in here could be automatically searched for and then added to this document through the creation of semantic web tools.