Building domain ontologies from lecture notes

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Introduction

It is borrowed from philosophy - the study of “The nature of being”.

It “consists of concepts, hierarchical organization of concepts”.

Domain Ontology

- Model which provides definitions and relationships of the concepts, and major theories, principles and activities in the domain.
- Domain ontologies provide shared and common understanding of a specific domain.

Necessity of Ontology

- To share common understanding of the structure of information among people.
- To enable reuse of domain knowledge.
- To analyze domain knowledge.

Applications of Ontology

- Knowledge management
- Web commerce
- Electronic business
- E-learning.

Ontology Development From Text[1]

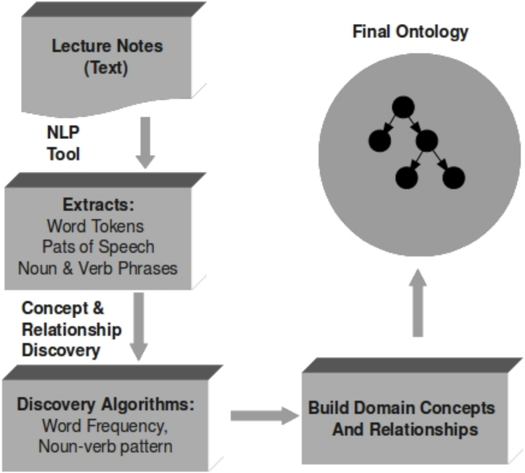


Figure: Ontology Development from Text, Taken from[1]

Steps to develop Ontology

- Defining classes in the ontology.
- Arranging classes in a taxonomic (subclass-superclass) hierarchy
- Defining slots and describing allowed values for these slots.
- Filling in the values for slots for instances.

Fundamental rules in Ontology design[2].

- There is no one correct way to model a domain. There are always alternatives.
- Ontology development is necessarily an iterative process.
- Concepts in the ontology should be close to objects (Physical or logical) and relationship in the domain of interest. There are mostly nouns (Objects) or verbs (relationships) in sentences that describe the domain.
- An ontology is a model of reality of the world and the concepts in the ontology must reflect this reality.

Various Methods for building Ontologies

1. Skeletal methodology
2. Seven-Step Method
3. Practical algorithm
4. Knowledge Engineering Approach

Skeletal Methodology[1]

Proposed by Uschold and King[1], It defines four main phases

1. Identifying a purpose and scope.
2. Building the ontology: Ontology capture, Ontology coding, integrating existing ontologies
3. Evaluation: verification and validation
4. Documentation

Skeletal Methodology

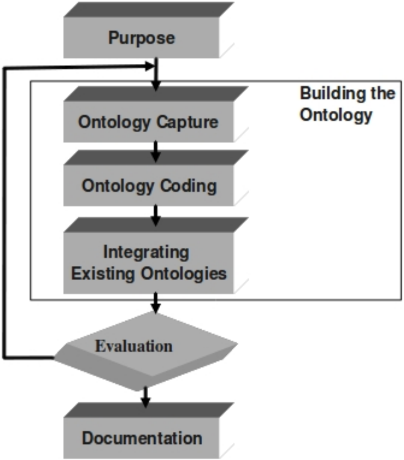


Figure: Skeletal Ontology Approach

Seven-Step Method[2]

It is proposed by Noy and Deborah, It describes the process of developing ontologies in following steps:

1. Determine the domain and scope of the ontology.
2. Consider reusing existing ontologies.
3. Enumerate important terms in the ontology.
4. Define the classes and the terms in the ontology.
5. Define the properties of classes slots.
6. Define the facets of the slots.
7. Create instances.

Seven-Step Method

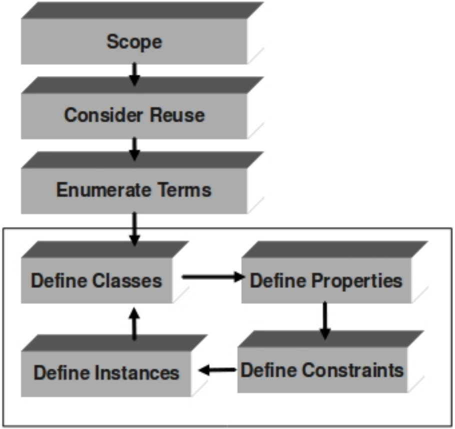


Figure: Seven-Step Ontology Approach

Practical Algorithm[3]

proposed by Gavrilova[3], It consists of 5-steps

1. Glossary development
2. Laddering
3. Disintegration
4. Categorization
5. Refinement

Practical Algorithm

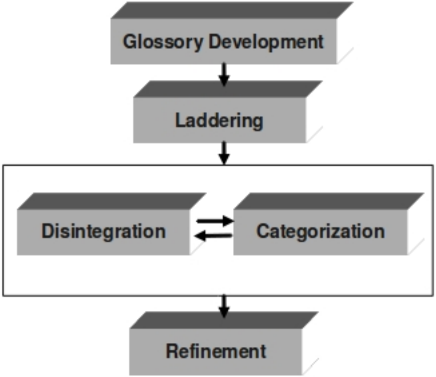


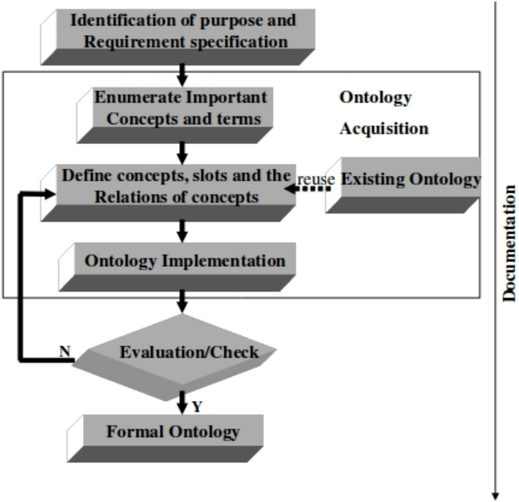
Figure: Practical Ontology Approach

Knowledge Engineering Approach[4]

proposed by YUN Hong-yan, XU Jian-liang, WEI Mo-ji, XIONG Jing.

1. Identify purpose and requirement specification Ontology acquisition.
2. Ontology acquisition: It involves
    1. Enumerate important concepts and terms in this domain
    2. Define concepts, properties and relations of concepts, and organize them into hierarchy structure.
    3. Consider reusing existing ontology.
3. Ontology implementation
4. Evaluation/Check
5. Documentation

Knowledge Engineering Approach


Identification of purpose and Requirement specification
Enumerate Important Concepts and terms
Ontology Acquisition
Define concepts, slots and the Relations of concepts
reuse
Existing Ontology
Ontology Implementation
Evaluation/Check
N
Y
Formal Ontology
Documentation

Ontology for Operating System

- **Scope and Domain:** To find out the dependencies between the course ware repositories for operating system.
- **Important Keywords:**

Table: Book Store

Types of computing	Types of Systems
Memory Management	Process Management
Secondary Management	File Management
Memory Allocation	Virtual Memory
Disk Scheduling	Threads

Ontology Development for Operating System

- **Identify the classes:**

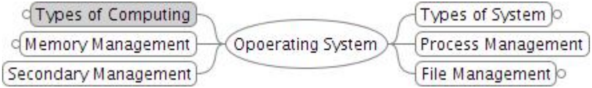


Figure: Classes

- **Define Properties:**

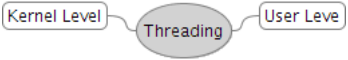


Figure: Propertis of Thread

Final Ontology using freemind [2]

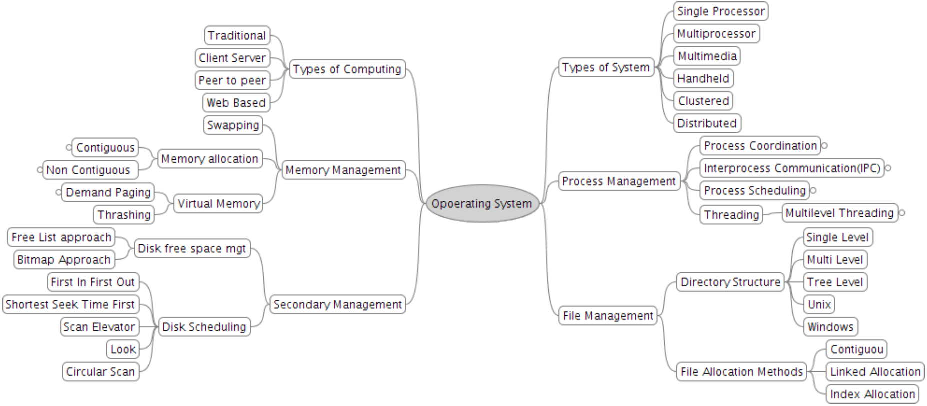


Figure: Ontology for Operating System

Ontology Languages

Ontology languages are formal languages used to construct ontologies.

- XML
- XML Schema
- RDF
- RDF Schema
- OWL

Ontology Languages

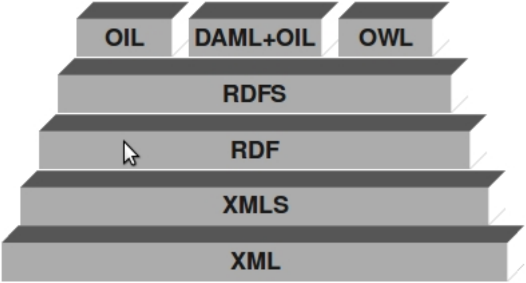


Figure: Stack of Ontology Languages [4]

XML(Emtended Markup Language)[5]

- XML is a markup language for delivery of documents containing structured information over the web.
- Structured information contains both content and some indication of what role that content plays.
- In HTML the tag semantics and the tag set are fixed. It does not provide arbitrary structure.
- There is no fixed tags in XML, and XML provides a facility to define tags and the structural relationships between them.

XML Code

Book Id	Title	Author	Year	Price
059600	XML	John	2005	30

For the above text the XML code is

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<bookstore>
<book Id="059600">
<title lang="en">XML</title>
<author>John</author>
<year>2005</year>
<price>30.00</price>
</book>
</bookstore>
```

XML Schema

- XML Schema[3] is a means for defining constraints on well formed XML documents.
- It provides basic vocabulary and predefined structuring mechanisms for providing information in XML.
- XML Schemas are extensible, because they are written in XML.

XML Schema

To	From	Heading	Body
John	David	Reminder	Meeting is cancelled.

for the above XML code the XML Schema will be <xs:element name="to" type="xs:string"/>
<xs:element name="from" type="xs:string"/>
<xs:element name="heading" type="xs:string"/>
<xs:element name="body" type="xs:string"/>

RDF (Resource Description Framework)[6]

- Resource Description Framework (RDF) is a graphical language used for representing information about resources on the web.
- RDF is written in XML
- It is a basic ontology language.
- RDF was designed to provide a common way to describe information so it can be read and understood by computer applications.
- RDF Schema provides Vocabulary for describing properties and classes of RDF resources.

RDF (Resource Description Framework)

Student Id	Name	Subject	Marks	Percentage
059600	John	Networks	40	80

```
<?xml version="1.0"?>
<rdf:RDF
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:st="http://www.cse.iitb.ac.in/st#">
<rdf:Description rdf:about="http://www.cse.iitb.ac.in/st/059600">
<st:name>John</st:name>
<st:subject>Networks</st:subject>
<st:marks>40</st:marks>
<st:percentage>80</st:percentage>
</rdf:Description>
</rdf:RDF>
```

OWL (Web Ontology Language)[1]

- Proposed by W3C working group called Web-Ontology (WebOnt).
- t is a revised version of the DAML + OIL web ontology language.
- OWL can be used to explicitly represent the meaning of terms in vocabularies and the relationships between the terms.
- OWL adds more vocabulary for describing properties and classes.

Ontology Editors

- Ontology editors are designed to assist in the creation or modification of ontologies and for the subsequent ontology usage.
- These editors are the applications which support one or more ontology languages.
- Some editors also have the facility to export from one to another ontology language.

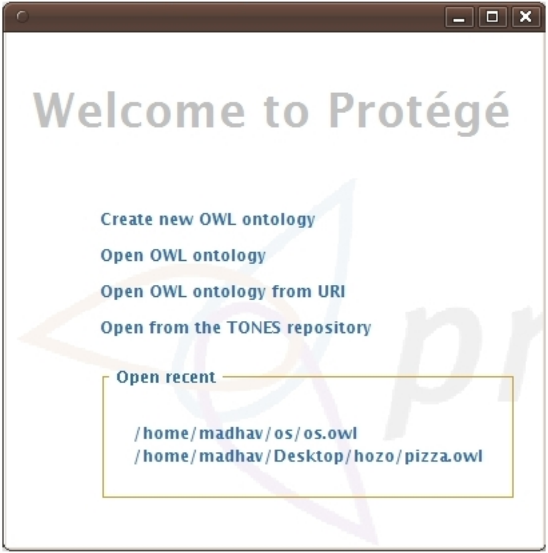
Ontolingua[2]

- The Ontolingua Server was the first ontology tool created.
- It was developed in the Knowledge Systems Laboratory (KSL) at Stanford University.
- It is a web based tool we must be registered in order to use this tool.

Protégé[3]

- Protégé is a free, open source ontology editor and a knowledge acquisition system.
- It was developed by the Stanford Medical Informatics (SMI) at Stanford University.
- It is an opensource, standalone application with an extensible architecture.
- Protégé ontologies can be exported into a variety of formats including RDF(S), OWL, and XML Schema.

Protégé Welcome Screen



Welcome to Protégé

Create new OWL ontology

Open OWL ontology

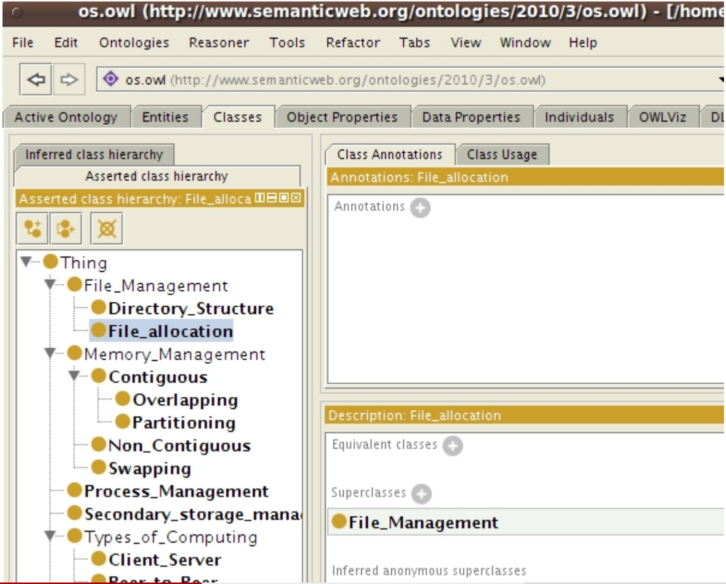
Open OWL ontology from URI

Open from the TONES repository

Open recent

/home/madhav/os/os.owl
/home/madhav/Desktop/hozo/pizza.owl

Protégé Ontology



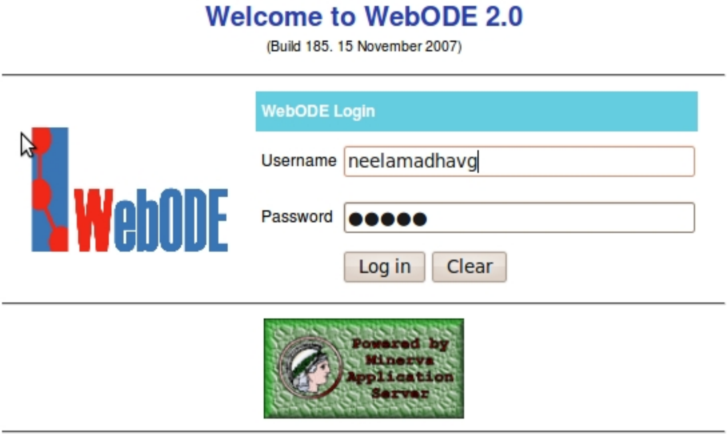
- Thing
  - File_Management
    - Directory_Structure
    - File_allocation
  - Memory_Management
    - Contiguous
      - Overlapping
      - Partitioning
    - Non_Contiguous
    - Swapping
  - Process_Management
  - Secondary_storage_mana
  - Types_of_Computing
    - Client_Server
    - Peer_to_Peer

Superclasses: File_Management

WebODE[5]

- WebODE is a tool for building ontologies in the World Wide Web
- It was developed in the Artificial Intelligence Lab from the Technical University of Madrid(UPM).
- WebODE is not used as a standalone application, but we can use it as a Web server with a Web interface.
- WebODE is based on a central ontology repository implemented using a relational database.

WebODE Login Screen



Welcome to WebODE 2.0

(Build 185. 15 November 2007)

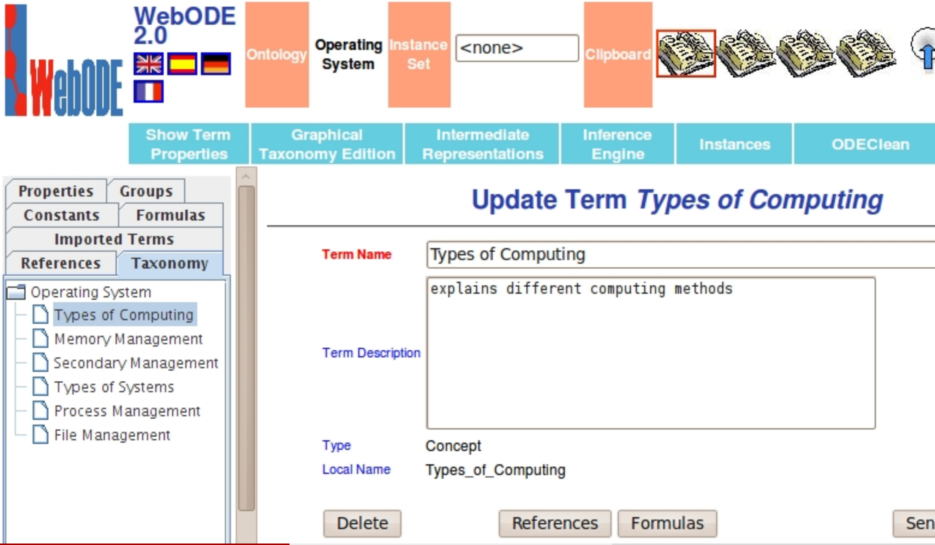
WebODE Login

Username neelamadhavg

Password ●●●●●

Figure: WebODE Login Screen

WebODE New Ontology



Update Term *Types of Computing*

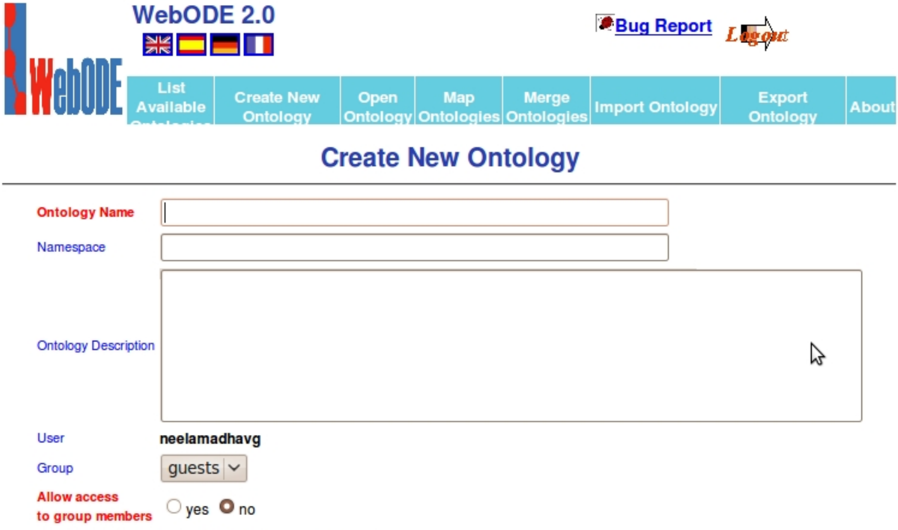
Term Name: Types of Computing

Term Description: explains different computing methods

Type: Concept

Local Name: Types_of_Computing

WebODE Ontology



Create New Ontology

Ontology Name

Namespace

Ontology Description

User neelamadhavg

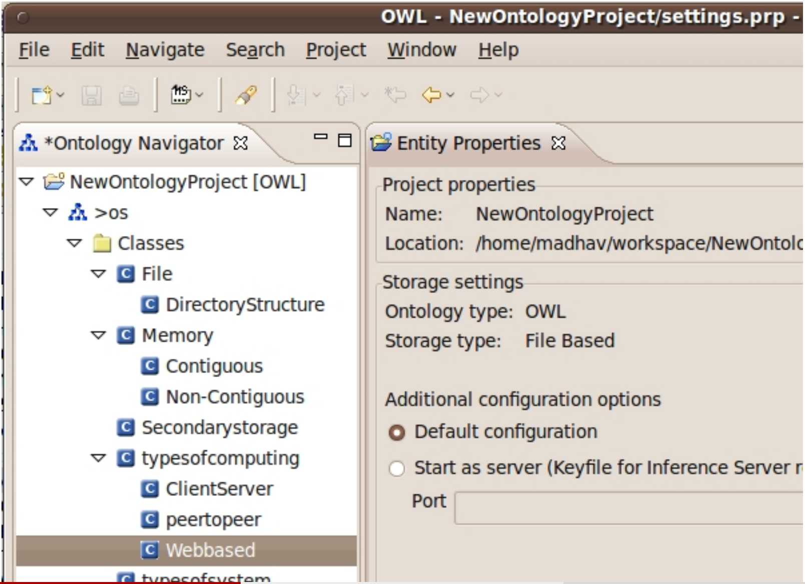
Group guests

Allow access to group members ○ yes ● no

OntoStudio[4]

- OntoStudio is an modeling environment to create and maintain ontologies.
- It was originally developed for F-Logic but now also includes some support for OWL, RDF, and XML.
- It is a Stand alone application which can be downloaded from the web and used to create Ontology.

OntoStudio Ontology


OWL - NewOntologyProject/settings.prp -

- NewOntologyProject [OWL]
  - >os
    - Classes
      - File
        - DirectoryStructure
      - Memory
        - Contiguous
        - Non-Contiguous
      - Secondarystorage
      - typesofcomputing
        - ClientServer
        - peertopeer
        - Webbased
      - typesofsystem

Project properties

Name: NewOntologyProject

Location: /home/madhav/workspace/NewOntolc

Storage settings

Ontology type: OWL

Storage type: File Based

Additional configuration options

● Default configuration

○ Start as server (Keyfile for Inference Server r

Port

Ontology Tools Summary

	Ontolingua	**Protégé**	**WebODE**	**OntoStudio**
Developers	KSL (Stanford University)	SMI (Stanford University)	UPM	Ontoprise
Current Release and Tools	0.1.45(Aug 2003)	4.1Alpha(Mar 2010)	2.0(Dec 2002)	2.3.3(Dec 2009)
Pricing Policy	Free Web Access	Free Ware	Lincences	Freeware & Licences
Mode of Access	Web Access	Stand Alone	Web Access	Stand Alone
Export to Languages	CLIPS CML, ATP CML	XML, RDF(S), XMLSchema, OWL	XML, RDF(S), OIL, DAML+OIL	XML, RDF(S), F-Logic, OWL
Import from Languages	IDL KIF	XML, RDF(S), XMLSchema, OWL	XML, RDF(S)	XML, RDF(S), F-Logic, OWL
Ontology Library	Yes	Yes	No	Yes

Conclusion

- Ontology development is necessarily an iterative process.
- There is no correspondence between ontology building methodologies and tools.
- Most of the tools just focus on few activities of the ontologyh lifecycle (Design and implementation).
- we cannot use the ontology developed by one tool in another tool.
- Ontology development languages are still in development phases, and they are continuously evolving.

Future Work

If a user wants to learn about a particular subject, the search tools typically just return a large number of links to the user in response to his/her query. Many of these are not directly relevant, so the user does not know which links to follow in order to enhance his knowledge. So the goal is to provide a system which not only provides the user with the most relevant learning module for his query, but also provides him/her with the relevant pre-requisite and follow-up modules also.

Future Work

- To construct a tool which will automatically constructs Ontology (Dependency Graph) from given text files.
- First transfrom the given text into verb-noun-verb relation using a NLP tool.
- Then find out the keywords from the text.
- Now figure out the dependencies between the keywords.
- Arrange the keywords in a hierarichical order and construct the Dependency Graph.
- Using some machine learning tools we can have an interface for user query input and output.

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- *WebODE:* http://webode.dia.fi.upm.es/WebODEWeb/Documents/usermanual.pdf