

## Semantic Web Agents

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## Ontology: Definition

Ontology is defined as a set of *knowledge terms*

- The vocabulary
- The semantic interconnections
- Some simple rules of inference
- Logic for some particular topic
- e.g. Ontology of cooking and cookbooks
  - Ingredients
  - How to stir and combine the ingredients
  - The difference between simmering and deep-frying etc.

## Ontology: Level of Description

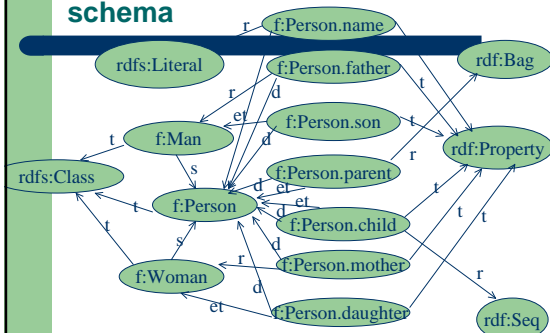
- Lexicon
- Controlled vocabulary
- Categorically organized thesaurus
- Taxonomy
  - Terms are given distinguishing properties
- Full-blown ontology
  - Properties can define new concepts
  - Concepts have named relationships with other concepts

## Ontology: Conceptual Scope

Ontologies differ in scope and purpose of content

- Domain ontology ; describing specific fields of endeavor, e.g. medicine
- Upper level ontology ; describing the basic concepts and relationships invoked when information about any domain is expressed in natural language.
  - E.g. WordNet, Cyc etc.
- Synergy: cross-referencing between upper level ontologies and various domain ontologies.

## Family Ontology in terms of RDF schema



## Instantiation

Terminological component

- Defines the terms and structure of the ontology; s area of interest

Assertional component

- Populates the ontology with instances or individuals that manifest that terminological definition.
- Implemented as a separate knowledge base.

Example

- Ford automobile
- 1965 Ford Mustang GT
- A Ford Mustang GT w/ license plate #AXL429

## Ontological languages

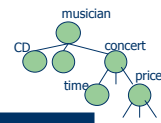
Ontology modeling languages:

- ; Concept Map, UML, OKBC, Entity-relation Model

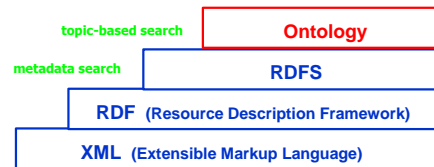
Ontology specification languages:

- ; Prolog
- ; KIF
- ; RDF, RDF Schema, XML Schema
- ; DAML+OIL
- ; OWL: Web Ontology Language standard

## Ontology



Sharable specifications of interesting topics  
The base of topic-based search



Adapted from Dieter Fensel

## DAML+OIL: an Ontology Language

Result of a Joint European + US/American Committee

Extension of RDF Schema

- ; Class Expressions (set operations)
  - Intersection, Union, Complement
- ; XML Schema data types
- ; Enumerations
- ; Property Restrictions
  - Cardinality Constraints
  - Value Restrictions

## Building Ontologies

Acquire domain knowledge

- ; Assembly information sources and expertise
- ; Define terms (w/ consensus and consistency)

Organize the ontology

Flesh out the ontology

Check your work

- ; Consistency checking: syntactic, logical, semantic

Commit the ontology

- ; Verification by domain experts
- ; Publication within intended deployment environment

[Survey of tools](#)

## Interoperability

Ontologies are for sharing

Proliferation of logic languages and information models yielded too many ontology forms and editing environments.

Specialized XML languages and controlled vocabularies are being adopted as standards in various industries.

Import/export ontologies in different language serializations, e.g. Ontolingua, WebODE

## Semantic Web Agent

- ; Machine-readable ontology



By Miguel Salmeron

## Web Services

Current web services  
Semantic Web services  
DAML-S  
Project: RETSINA calendar agent

## Power of Web Services

Universally accessible.  
It is better than DCOM, RMI, COBRA that require compatible architectures from all participants to succeed.  
Help simplify b2b transactions, Driving down costs and smooth the way to collaborate relationship.

## Problems

Discovery: The programs such as agents have no way to locate one that will perform a specific function. This process, called service discovery, can happen only when there is a common language to describe a service in a way that lets other agents "understand" both the function offered and how to take advantage of it.

• Jini: low level, syntactical based, standardized functionalities.  
Integration. The development of integrated services is still largely ad-hoc, time-consuming and requiring a considerable effort of low-level programming.

## Solutions:

The lack of high-level abstractions and functionalities for web service application has triggered a considerable amount of research.

- Industry focused on modularization of services layers-mostly for usability in the short term
- Academic Research has been mostly concerned with expressiveness of service description using Semantic Web technology.

## Web Service Architecture

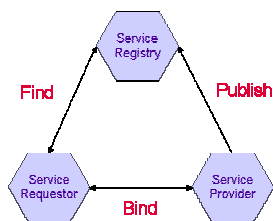


Figure 1: IBM web services architecture

## Web Service Standard

Traditional IT integration is build on many systems and protocols. By using a standardized way to find and use your services(WSDL), you eliminate the need to write new interface each time you integrate with another middleware.  
By using standardized Universal Description, Discovery and Integration(UDDI), you do away with manual point to point interface.  
By using Web Services Flow Language(WSFL), uses can define the business process and integration with other web services seamlessly.  
By using Simple Object Access Protocol(SOAP), you eliminate the need for the old ;one adapter per protocol; mechanism.

## Limits of Industry Effort

Little new really technology, using the standardized taxonomies and vocabularies that exhibit little flexibility and expressiveness and that restricts that usability of web services to human users rather than machine agents.

- E.g. UDDI: A Web Service user retrieves advertisement out of registry based on keyword search. UDDI search mechanism relies on pre-defined categorizations through keywords and does not refer to the semantic content of the advertisement. Search only for the on tModelkey, not every attributes. UDDI does not support Semantic description of Services.
- WSDL has not precondition, postcondition. It does not support the definition of logical constraints between its input and output parameters, limited in invoking.

## Toward Int'l Semantic Web Conference

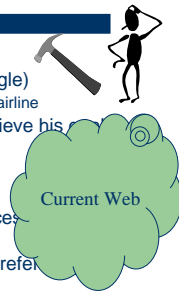


To attend ISWC 2003 in Florida; ..

## Current Web Services

A user has to

- Find the services (e.g. by Google)
  - Find the web sites of hotels and airline
- Compose the services to achieve his goal
  - Book tickets and hotels
- Invoke the services
  - Fill out the forms in each site
- Monitor the execution of services
  - Is the transaction done?
- Consider his constraints and preferences
  - Cheaper hotels but better airline

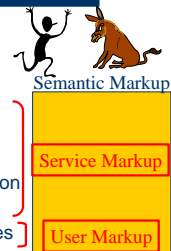


## Semantic Web Services

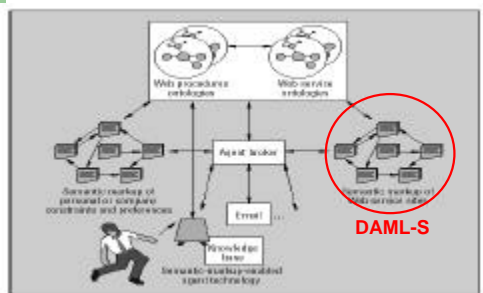
Agent-based technology

To automate

- Service discovery
- Service invocation
- Service selection and composition
- Service execution monitoring
- User constraints and preferences



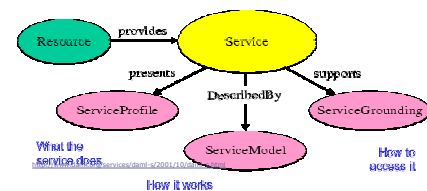
## A Framework



Adapted from IEEE Intelligent Systems

## DAML-S: Ontology

Service ontology



## RETSINA

Multi-agent system  
Developed by Katia Sycara et. al. (CMU)  
<http://www.daml.ri.cmu.edu/site/projects/RDFCalendar/>

## RETSINA Calendar Agents

- Meeting scheduling agents
- Meetings have several properties including:
    - Time/Duration
    - Attendee Information
    - Location
    - Description
- Functions:
- Allow user to browse schedule and events
  - Support meeting scheduling
    - Agents negotiate possible meeting times based on user's schedule and preferences
  - Import schedules into MS Outlook

## RETSINA Semantic Web Calendar Agents

- Use RDF to represent schedules and events
- Event concepts can refer to existing concepts on Semantic web
- Support additional actions based on available information
- Email or visit web page
- Support agent discovery (DAML-S) to locate other agents

## Services Beyond RETSINA

- Cooperation with other agents on Semantic web
- Reminding upcoming registration or submission deadlines
  - Booking a flight to a conference

## RETSINA Calendar Agent

To schedule meetings between individuals based on their schedules maintained in MS Outlook  
Distributed Meeting Scheduling Engine  
RETSINA Semantic Web Calendar Parser

