World Wide Web

- Integration of different data types and services
- Simple and freely available standards and protocols
- Client-server architecture or peer to peer
- Compatible upgrades by W3C (World Wide Web Consortium)
- ICANN (Internet Corporation for Assigned Names and Numbers) coordinates the unique identifiers (domain names, IP addresses, etc.)
- Platform independent
- Decentralized resources (hardware and software)

Outline

- World Wide Web
- Web 2.0
- Semantic Web
- Data, Information, and Knowledge
- XML and OWL
- Ontologies in Practice
- Conclusions
World Wide Web

- Spam
- Security and privacy problems
- Energy intensive
- Currently around 80% of the world population cannot access the WWW
- Author or user?
- Web content mainly for humans

Web 2.0

- First Web 2.0 conference was held October 5-7, 2004 in San Francisco
- Services like weblogs, social bookmarking, wikis, etc.
Social Bookmarking

- Keep links to your favorite articles, blogs, music, reviews, recipes, and more, and access them from any computer on the web.

- Share favorites with friends, family, coworkers, and the del.icio.us community.

- Discover new things. Everything on del.icio.us is someone's favorite -- they've already done the work of finding it. So del.icio.us is full of bookmarks about technology, entertainment, useful information, and more.
From Folksonomy to Taxonomy ...

Websites like Yahoo! organize and present links in a fixed hierarchy (taxonomy)

Taxonomy directed folksonomies: Text analysis of the website using a lexical database like WordNet

- English nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets), each expressing a distinct concept with 206941 word-sense pairs.
- Synsets are interlinked by means of conceptual-semantic and lexical relations resulting in a network of meaningfully related words and concepts.
- WordNet is also freely and publicly available (http://wordnet.princeton.edu/)
- Tags could be suggested by using the lexical database

Using folksonomies to create simple ontologies

- Examine which tags are used in combination to estimate the relations among these tags
- Map the tags to a lexical database
- Learn additional relations based on the tag clouds and the lexical database

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The Semantic Web is a vision for the future of the Web [...] information is given explicit meaning, [...] machines automatically process and integrate information available on the Web.

If machines are expected to perform useful reasoning tasks on these documents, the language must go beyond the basic semantics of RDF Schema.

Ontology languages allow users to write explicit, formal conceptualizations of domain models.

The main requirements are:

- a well-defined syntax
- efficient reasoning support
- a formal semantics
- sufficient expressive power
- convenience of expression
Reasoning support is important for...
... checking the consistency of the ontology and the knowledge.
... checking for unintended relationships between classes.
... automatically classifying instances in classes.

Checks like the preceding ones are valuable for...
... designing large ontologies, where multiple authors are involved.
... integrating and sharing ontologies from various sources.

Reasoning in Practice

Semant Web Application FOAF

The Friend of a Friend (FOAF) project:
- is creating a Web of machine-readable pages describing people, the links between them and the things they create and do
- applies simple technology that makes it easier to share and use information about people and their activities (e.g., photos, calendars, weblogs)
- FOAF uses W3C’s RDF technology to integrate information from your home page with that of your friends, and the friends of your friends, and their friends...
- FOAF-a-matic is a simple Javascript application that allows you to create a FOAF (“Friend-of-A-Friend”) description of yourself
- Make file publically accessible (foaf.rdf) and link it on your website
• Some pieces of data
  \[ a := 15 \]
  \[ b := \text{"Huber"} \]

• A piece of information
  \[
  \text{<Region rdf:ID="CentralCoastRegion" />} \]

• A piece of knowledge
  \[
  \text{<owl:Class rdf:ID="ConsumableThing" />} \]
  \[
  \text{<owl:Class rdf:ID="NonConsumableThing" />} \]
  \[
  \text{<owl:complementOf rdf:resource="#ConsumableThing" />} \]
  \[
  \text{</owl:Class>} \]

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Definitions

• Data
  “input signals to sensory and cognitive processes”

• Information
  “data with an associated meaning”

• Knowledge
  “the whole body of data and information together with cognitive machinery that people are able to exploit to decide how to act, to carry out tasks and to create new information”
XML

- eXtensible Markup Language
- Foundation for the creation of purpose specific, XML-based markup languages
- Individually defined tags such as `<company_name>`
- Using Unicode (multi-lingual character-encoding system)
- Free, open standard recommended by W3C
- Two levels of correctness: Well-formed and Valid
- Namespace provide uniquely named elements and attributes (xmlns="http://www.w3.org/1999/xhtml")

From XML to OWL

- XML provides a surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents.
- XML Schema is a language for restricting the structure of XML documents and also extends XML with data types.
- RDF is a data model for objects (“resources”) and relations between them, provides a simple semantics for this data model, and these data models can be represented in an XML syntax.
- RDF Schema is a vocabulary for describing properties and classes of RDF resources, with a semantics for generalization-hierarchies of such properties and classes.
- OWL adds more vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.

OWL Lite Constructs: Simple Classes and Individuals

Simple Named Classes:
- Class
  - rdfs:subClassOf

Individual

Defining Properties:
- rdf:Property
  - subproperties:
    - owl:ObjectProperty (Instance - Instance)
    - owl:DatatypeProperty (Instance - rdfs:Literal / XML Schema datatypes)
  - rdfs:subPropertyOf

Properties of Individuals
- rdfs:domain
- rdfs:range
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  - rdfs:domain
  - rdfs:range

Properties of Individuals

An African Wildlife Ontology – Class Hierarchy

[Antoniou and van Harmelen, 2004]
An African Wildlife Ontology – Plants and Trees

```xml
<owl:Class rdf:ID="plant">
    <rdfs:comment>Plants are disjoint from animals.</rdfs:comment>
    <owl:disjointWith="#animal"/>
</owl:Class>

<owl:Class rdf:ID="tree">
    <rdfs:comment>Trees are a type of plant.</rdfs:comment>
    <rdfs:subClassOf rdf:resource="#plant"/>
</owl:Class>
```

An African Wildlife Ontology – Branches

```xml
<owl:Class rdf:ID="branch">
    <rdfs:comment>Branches are parts of trees.</rdfs:comment>
    <owl:Restriction>
        <owl:onProperty rdf:resource="#is-part-of"/>
        <owl:allValuesFrom rdf:resource="#tree"/>
    </owl:Restriction>
    <rdfs:subClassOf>
    </owl:Class>
```

An African Wildlife Ontology – Schematic Representation

```
branch
    isSubclassOf
toClass
```

An African Wildlife Ontology – Properties

```xml
<owl:TransitiveProperty rdf:ID="is-part-of"/>

<owl:ObjectProperty rdf:ID="eats">
    <rdfs:domain rdf:resource="#animal"/>
</owl:ObjectProperty>

<owl:ObjectProperty rdf:ID="eaten-by">
    <owl:inverseOf rdf:resource="#eats"/>
</owl:ObjectProperty>
```
An African Wildlife Ontology – Leaves

<owl:Class rdf:ID="leaf">
  <rdfs:comment>Leaves are parts of branches. </rdfs:comment>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#is-part-of"/>
      <owl:allValuesFrom rdf:resource="#branch"/>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

An African Wildlife Ontology – Carnivores

<owl:Class rdf:ID="carnivore">
  <rdfs:comment>Carnivores are exactly those animals that eat also animals.</rdfs:comment>
  <owl:intersectionOf rdf:parsetype="Collection">
    <owl:Class rdf:about="#animal"/>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#eats"/>
      <owl:someValuesFrom rdf:resource="#animal"/>
    </owl:Restriction>
  </owl:intersectionOf>
</owl:Class>

An African Wildlife Ontology – Herbivores

<owl:Class rdf:ID="herbivore">
  <rdfs:comment>Herbivores are exactly those animals that eat only plants or parts of plants.</rdfs:comment>
  ...<br/>
</owl:Class>

An African Wildlife Ontology – Herbivores

<owl:intersectionOf rdf:parseType="Collection">
  <owl:Class rdf:about="#animal"/>
  <owl:Restriction>
    <owl:onProperty rdf:resource="#eats"/>
    <owl:allValuesFrom>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#plant"/>
          <owl:Restriction>
            <owl:onProperty rdf:resource="#is_part_of"/>
            <owl:allValuesFrom rdf:resource="#plant"/>
          </owl:Restriction>
        </owl:unionOf>
      </owl:Class>
    </owl:allValuesFrom>
  </owl:Restriction>
</owl:intersectionOf>

An African Wildlife Ontology – Carnivores

<owl:Class rdf:ID="carnivore">
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    <owl:Class rdf:about="#animal"/>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#eats"/>
      <owl:someValuesFrom rdf:resource="#animal"/>
    </owl:Restriction>
  </owl:intersectionOf>
</owl:Class>
An African Wildlife Ontology – Herbivores

<owl:Class rdf:ID="giraffe">
  <rdfs:comment>Giraffes are herbivores, and they eat only leaves.</rdfs:comment>
  <rdfs:subClassOf rdf:type="#herbivore"/>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#eats"/>
      <owl:allValuesFrom rdf:resource="#leaf"/>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

An African Wildlife Ontology – Giraffes

<owl:Class rdf:ID="lion">
  <rdfs:comment>Lions are animals that eat herbivores.</rdfs:comment>
  <rdfs:subClassOf rdf:type="#animal"/>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#eats"/>
      <owl:someValuesFrom rdf:resource="#herbivore"/>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

An African Wildlife Ontology – Lions

<owl:Class rdf:ID="tasty-plant">
  <rdfs:comment>Plants eaten both by herbivores and carnivores</rdfs:comment>
</owl:Class>

An African Wildlife Ontology – Tasty Plants
What problem would emerge if we replace `owl:someValuesFrom` by `owl:allValuesFrom` in the definition of carnivores?
Verwenden Sie Web 2.0 Tools?

Hatten Sie schon mal mit Semantic Web zu tun?

Könnte Ihnen eine Ontologie, die Wissen über das Studium und die Technische Universität zur Verfügung stellt, nützlich sein?

Wenn Sie ein Semantic Web Tool entwickeln würden, welches fänden Sie nützlich und interessant?

References & Resources


