Knowledge Sharing

- If more than one person is building a knowledge base, they must be able to share the conceptualisation.
- A conceptualization is a map from the problem domain into the representation. A conceptualization specifies:
  - What sorts of objects are being modelled
  - The vocabulary for specifying objects, relations and attributes
  - The meaning or intention of the realtions or attributes
- An ontology is a specification of a conceptualization.

Semantic Web

- Ontologies are published on the web in machine readable form and are publically readable.
- Builders of knowledge bases or web sites adhere to and refer to a published ontology:
  - the same symbol means the same thing across the various web sites that obey the ontology.
  - if someone wants to refer to some other object or relation, the ontology is expanded. The community needs to agree to the new terminology.

Challenges of building ontologies

- They can be huge: finding the appropriate terminology for a concept may be difficult.
- How one divides the world can depend on the application. Different ontologies describe the world in different ways.
- People can fundamentally disagree about the appropriate structure.
- Different knowledge bases can use different ontologies.
- To allow KBs based on different ontologies to interoperate, there must be a mapping between different ontologies.

- It has to be in the user's interests to use an ontology.
- The computer doesn't understand the meaning of the symbols. The formalism can constrain the meaning, but can't define it.

Concept Hierarchy

- The core of an ontology are concept hierachies.
- A concept hierarchy is a tree (or trees) where
  - the nodes correspond to concepts or classes and
  - the parents of a node correspond to a more general concepts
  - children of a node are mutually exclusive

Example Concepts in an Ontology

The following are some of the concepts in an ontology for documents.

http://www.cs.umd.edu/projects/plus/DAML/onts/docmnt1.0.daml

homepage	correspondence	publication
letter	periodical	article
book	letter	magazine
journal	document	communication
workshopPaper	journalPaper	discussion
newspaper	personalHomepage	speech

Semantic Information Processing Based on the Semantic Web

- **Web information is linked to a web-based ontology by means of XML annotation**
- **An ontology defines semantic relations between identifiers:**
  - synonyms, subclasses, superclasses
  - classes vs. individuals
  - properties of classes and relations between classes
  - possible values for properties
- **An inference system processes web information based on the ontology and derives implicit knowledge**
- **For content-based information processing, applications make use of the inference system**

Ontology Definitions with DAML+OIL (1)

(http://www.daml.org/2001/03/daml+oil)

```
<daml:Class rdf:ID="Animal">
    <rdfs:label>Animal</rdfs:label>
    <rdfs:comment>
        This class of animals is illustrative of a number of ontological idioms.
    </rdfs:comment>
</daml:Class>

<daml:Class rdf:ID="Male">
    <rdfs:subClassOf rdf:resource="#Animal"/>
</daml:Class>

<daml:Class rdf:ID="Female">
    <rdfs:subClassOf rdf:resource="#Animal"/>
    <daml:disjointWith rdf:resource="#Male"/>
</daml:Class>

<daml:Class rdf:ID="Man">
    <rdfs:subClassOf rdf:resource="#Person"/>
    <rdfs:subClassOf rdf:resource="#Male"/>
</daml:Class>
```

Ontology Definitions with DAML+OIL (2)

```
<daml:Class rdf:ID="Person">
    <rdfs:subClassOf rdf:resource="#Animal"/>
    <rdfs:subClassOf>
        <daml:Restriction>
            <daml:onProperty rdf:resource="#hasParent"/>
            <daml:toClass rdf:resource="#Person"/>
        </daml:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
        <daml:Restriction daml:cardinality="1">
            <daml:onProperty rdf:resource="#hasFather"/>
        </daml:Restriction>
    </rdfs:subClassOf>
    <rdfs:subClassOf>
        <daml:Restriction>
            <daml:onProperty rdf:resource="#shoesize"/>
            <daml:minCardinality>1</daml:minCardinality>
        </daml:Restriction>
    </rdfs:subClassOf>
</daml:Class>
```

Ontology Definitions with DAML+OIL (3)

```
<daml:ObjectProperty rdf:ID="hasParent">
    <rdfs:domain rdf:resource="#Animal"/>
    <rdfs:range rdf:resource="#Animal"/>
</daml:ObjectProperty>

<daml:DatatypeProperty rdf:ID="age">
    <rdfs:comment>
        age is a DatatypeProperty whose range is xsd:decimal.
        age is also a UniqueProperty (can only have one age)
    </rdfs:comment>
    <rdf:type rdf:resource="http://www.daml.org/2001/03/daml+oil#UniqueProperty"/>
    <rdfs:range rdf:resource="http://www.w3.org/2000/10/XMLSchema#nonNegativeInteger"/>
</daml:DatatypeProperty>
```

Ontology Definitions with DAML+OIL (4)

```
<daml:Class rdf:about="#Person">
    <rdfs:subClassOf>
        <daml:Restriction daml:maxCardinalityQ="1">
            <daml:onProperty rdf:resource="#hasOccupation"/>
            <daml:hasClassQ rdf:resource="#FullTimeOccupation"/>
        </daml:Restriction>
    </rdfs:subClassOf>
</daml:Class>

<daml:UniqueProperty rdf:ID="hasMother">
    <rdfs:subPropertyOf rdf:resource="#hasParent"/>
    <rdfs:range rdf:resource="#Female"/>
</daml:UniqueProperty>

<daml:ObjectProperty rdf:ID="hasChild">
  <daml:inverseOf rdf:resource="#hasParent"/>
</daml:ObjectProperty>
```

Inferences Based on Ontologies - Example

Consistency check of E-business internet catalogue:

SPECIAL OFFER:

MMZ100, year 2000, à EUR 75,-

Elsewhere in the internet:

MMZ100 is a Multimedia Center

MMZ100 has a list price of DM 150,-

All entertainment systems built before 2002 are sold with 20% rebate on the list price

A Multimedia Center is a special TV set

A TV set is an entertainment system

1 EUR = 1,95583 DM