Ontologies and Knowledge Sharing

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    - If not already defined, what can it be defined in terms of?

Knowledge Sharing

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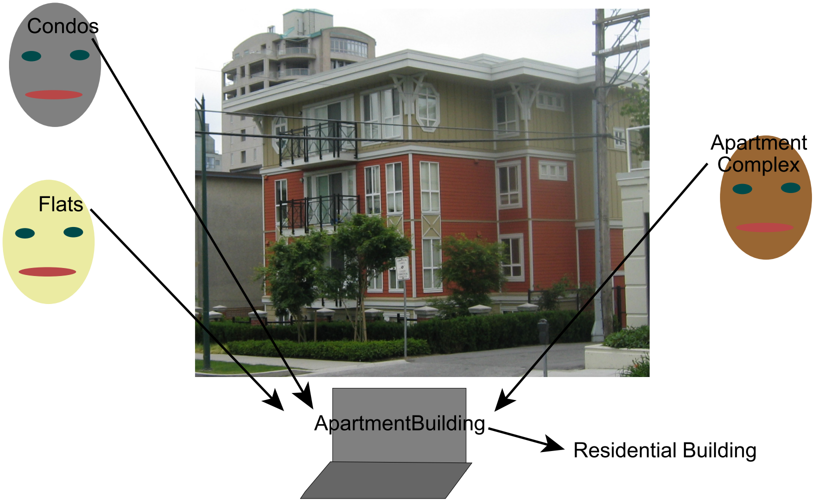
- If more than one person is building a knowledge base, they must be able to share the conceptualization.
- An ontology is a specification of a conceptualization. An ontology specifies the meanings of the symbols in an information system.

Mapping from a conceptualization to a symbol



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    In this way, ontologies evolve.
  - Separately developed ontologies can have mappings between them published.

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- It has to be in 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.

Semantic Web Technologies

- XML the Extensible Markup Language provides generic syntax.
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- RDF the Resource Description Framework is a language of triples
- OWL the Web Ontology Language, defines some primitive properties that can be used to define terminology. (Uses multiple alternative syntaxes).

Main Components of an Ontology

- Individuals the things / objects in the world (not usually specified as part of the ontology)
- Classes sets of individuals
- Properties between individuals and their values

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- Without the determining equality, we can't count!
- In OWL we can specify:

  owl:SameIndividual(i_1, i_2)

  owl:DifferentIndividuals(i_1, i_3)

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- Different classes are not necessarily disjoint.
  E.g., a building can be both a commercial building and a residential building.

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	email	magazine
journal	document	communication
workshopPaper	journalPaper	discussion
newspaper	PersonalHomepage	speech

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- An *ObjectProperty* is a property whose range is an individual.
- A *DatatypeProperty* is one whose range isn't an individual, e.g., is a number or string.
- There can also be property hierarchies:

  owl:subPropertyOf(*livesIn*, *enclosure*)

  owl:subPropertyOf(*principalResidence*, *livesIn*)

Properties (Cont.)

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- We can also state the minimum and maximal cardinality of a property.

  owl:minCardinality(*principalResidence*, 1)

  owl:maxCardinality(*principalResidence*, 1)

Property and Class Restrictions

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owl:subClassOf(homeOwner,person)

owl:subClassOf(*homeOwner*,
    owl:ObjectSomeValuesFrom(*owns*, *house*))

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owl:SymmetricObjectProperty $\equiv$ if xPy then yPx

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- OWL provides facilities for version control.
- Tools for mapping one ontology to another allow inter-operation of different knowledge bases.
- The semantic web promises to allow two pieces of information to be combined if
  - they both adhere to an ontology
  - these are the same ontology or there is a mapping between them.

Example: Apartment Building

An apartment building is a residential building with more than two units and they are rented.

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```
Declaration(ObjectProperty(:numberOfunits))
FunctionalObjectProperty(:numberOfunits)
ObjectPropertyDomain(:numberOfunits :ResidentialBuilding)
ObjectPropertyRange(:numberOfunits
                    ObjectOneOf(:two :one :moreThanTwo))

Declaration(Class(:ApartmentBuilding))
EquivalentClasses(:ApartmentBuilding
    ObjectIntersectionOf(
        :ResidentialBuilding
        ObjectHasValue(:numberOfunits :moreThanTwo)
        ObjectHasValue(:ownership :rental)))
```

Example: hotel ontology

Define the following:

- Room
- BathRoom
- StandardRoom - what is rented as a room in a hotel
- Suite
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- Hotel
- HasForRent
- AllSuitesHotel
- NoSuitesHotel
- HasSuitesHotel

Top-Level Ontology

A top-level ontology

- provides a definition of *everything* at a very abstract level.
- provides a useful categorization on which to base other ontologies.
- facilitates the integration of domain ontologies.

At the top is entity. OWL calls the top of the hierarchy thing. Essentially, everything is an entity.

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  E.g., 17, set of all mammals on Earth, an email, a course

Continuants vs Occurrents

- A continuant exists in an instance of time and maintains its identity through time.
  Examples: person, a finger, a country, a smile, the smell of a flower, an email, Newtonian mechanics
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Alternative: a four-dimensional or perdurant view where objects exist in the space-time.

- A person is a trajectory though space and time
- At any time, a person is a snapshot of the four-dimensional trajectory.

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  For example, the end of a lecture, the first goal in the 2022 FIFA World Cup final.

Some ontologies

- https://schema.org
- Smomed CT:
  https://www.snomed.org/five-step-briefing or
  https://browser.ihtsdotools.org/
-

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  - What processing has been done to the data?

FAIR data

FAIR principles for data:

- *Findable* – the (meta)data uses unique persistent identifiers, such as IRIs.
- *Accessible* – the data is available using free and open protocols, and the metadata is accessible even when the data is not.
- *Interoperable* – the vocabulary is defined using formal knowledge representation languages (ontologies).
- *Reusable* – the data uses rich metadata, including provenance, and an appropriate open license, so that the community can use the data.