Overview

• Definition of ontology
• Perspectives on ontologies
• Ontologies for the Semantic Web
• Design and development of ontologies – methods and tools

What is an ontology?

In practice…

• Simple concept hierarchies
• Semantic nets
• Frame systems
• Logical models

What is an ontology?

In theory…

"An ontology is a formal, explicit specification of a shared conceptualisation."

(Gruber, 1993)

What is an ontology?

In English...

An ontology provide a shared vocabulary, which can be used to model a domain, that is, the type of objects and/or concepts that exist, and their properties and relations

Types of ontologies

From general to specific

• Generic
• Core
• Domain
• Task
• Application
The anatomy of ontologies

- Terms
- Definitions of terms
- Axioms
- (Inference mechanisms)

Perspectives

- Philosophy
- Library and Information Science
- Artificial Intelligence
- Natural Language Processing
- The Semantic Web

Philosophy

- Objectives
  - Describe world, classify and categorise
- Examples
  - Aristotle, ..., Sowa

Library & Information Science (LIS)

- Objectives
  - Organise the bibliographic universe
  - Model universal & domain knowledge
- Usage
  - Provide access points to bibliographic entities
  - Collocation device
- Examples
  - Dublin Core, MARC
  - LCC, UDC, SAB

Artificial Intelligence

- Objectives
  - Model common sense and domain knowledge
- Usage
  - Knowledge representation and reasoning
- Examples
  - CYC, ...

Natural Language Processing

- Objectives
  - Model lexical and domain knowledge
- Usage
  - Machine Translation, Information Extraction, Q/A
- Examples
  - Wordnet, Generalised Upper Model, Dahlgren
The Semantic Web

- Objectives
  - Provide semantics for web resources
- Usage
  - Describe resources
    ...and their contents
- Examples
  - DC, DAML-library, ...

The Ontology Web Language - OWL

Goal
- Formally describe the semantics of classes and properties used in web documents.
- Go beyond the basic semantics in RDFS

Current status:
- use cases and their requirements on ontologies
- eight design goals
- 19 requirements
- ...and some objectives

Design goals

- Shared ontologies
- Ontology evolution
- Ontology interoperability
- Inconsistency detection
- Balance of expressivity and scalability
- Ease of use
- XML syntax
- Internationalisation

Requirements

- Ontologies as distinct objects
- Unambiguous term referencing with URIs
- Explicit ontology extension
- Commitment to ontologies
- Ontology metadata
- Versioning information
- Class definition primitives
- Property definition primitives

Requirements, cont.

- Datatypes
- Class and property equivalence
- Individual equivalence
- Local unique names assumption
- Attaching information to statements
- Classes as instances
- Complex data types
- Cardinality constraints

Requirements, cont.

- User-displayable labels
- Supporting a character model
- Supporting a uniqueness of Unicode strings
Design and development

• Design guidelines and principles
  • Guarino, Gruber,...
• Methods
  • Methodology, TOVE,...
• Tools
  • Protégé, KAON,...
• Libraries
  • Ontolingua server, DAML-library,...

Design and development approaches

• Inspirational
• Inductive
• Deductive
• Synthetic
• Collaborative

General development methodology

• Specify purpose and scope
• Capture, define, organise
• Formalise, implement
• Integrate existing resources
• Evaluate

Ontology learning

• ML and NLP techniques to facilitate capture and organisation
• Extend/Refine existing ontology
• Free or semi-structured text as source

Text-To-Onto (OntoEdit)

• Import and Reuse
• Extract
  • Lexical entry and concept extraction
  • Hierarchical concept clustering
  • Dictionary parsing
  • Association rules
• Prune
• Refine

Dublin Core

Goals
  • Provides a semantic vocabulary for describing the "core" information properties of resources (electronic and "real" physical objects)
  • Provide enough information to enable intelligent resource discovery systems

History
  • A collaborative effort started in 1995
  • Initiated by people from computer science, librarianship, online information services, abstracting and indexing, imaging and geospatial data, museum and archive control.
**Dublin Core - 15 Elements**

15 Elements related to a resource:

- **Content**
  - Title, Subject, Description, Type, Source, Relation and Coverage

- **Intellectual property**
  - Creator, Publisher, Contributor, Rights

- **Instantiation**
  - Date, Language, Format, Identifier

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**DC - Classes of qualifiers**

Two broad classes of qualifiers:

- **Element Refinement**
  - "...make the meaning of an element narrower or more specific."
  - HTML example from "www.kb.se":
    `<META NAME="DC.Date.Modified" CONTENT="1999-06-02">`

- **Encoding Schema**
  - "...identify schemas that aid in the interpretation of an element value."
  - HTML example from "www.kb.se":
    `<META NAME="DC.Subject" SCHEME="SAB" CONTENT="Nationalbibliotek">`

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**Questions and Research directions**

Design & development:
- Consensus / Collaborative v.s. Individual
- Level of granularity

Control & use:
- Centralised v.s. distributed
- Interoperability

The OWL objectives
- Layering, Commitment to portions of ontologies
- Default values, CWA, Procedural attachment
- ...