Pragmatics of RDF/OWL

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Overview

- Why ontologies?
- OWL and its relation to RDF
- Ongoing work in W3C Semantic Web Best Practices & Deployment Working Group
- Sample applications

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Disclaimer

- This presentation describes work of many different people, including many participating in respective W3C Working Groups as well as others

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The notion of ontology

- Explicit specification of a shared conceptualization that holds in a particular context
- The Semantic Web needs sets of shared concepts.
- "I wrote my own ontology" is a contradiction in terms.

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Ontology types

- Domain-specific ontologies
  - Medicine: UMLS, SNOMED, Galen
  - Art history: AAT, ULAN
  - STEP application protocols
- Generic ontologies
  - Top-level categories
  - Units and dimensions

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Ontologies and data models

- Main difference with data models is not the content, but the purpose (generalizes over applications)
- You cannot see the difference by just looking at the syntax!
- A conceptual model written in a ontology language is not necessarily an ontology!

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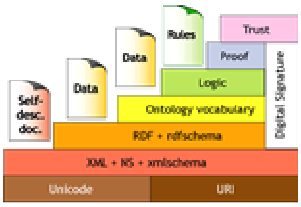
W3C Web Ontology Working Group

- Chartered to develop the Ontology Vocabulary for the Semantic Web.
- Nov 2001 - Feb 2004



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Bluffer's guide to RDF

- **Object ->Attribute-> Value** triples

- objects are **web-resources**
- Value can be an Object or a Literal

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Use Cases for OWL

- Web portal
- Multi-media collections
- Corporate Website
- Documentation engineering & design
- Agents & Services
- Ubiquitous computing

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Requirement: "classes as instances"

Ontology A

```
Class(Species)
Individual(Chimpanzee type(Species))
```

Ontology B

```
Class(Chimpanzee)
Individual(Joe  type(Chimpanzee)
```

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Reaching consensus

- Issue 5.3 Semantic Layering

OWL is expected to be semantically compatible with RDF(S). Problems were foreseen with aligning a DL-style model theory with the RDF model theory, as the latter allows more or less unlimited metamodelling.

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Consensus on Semantic Layering

- OWL Full ("Large OWL", "Great Horned OWL")
  - Free mixing of OWL and RDF = high expressivity
  - Non-standard formalization
  - Tractability not guaranteed
- OWL DL ("Fast OWL")
  - Maximize expressiveness while retaining tractability
  - Standard formalization
  - Same language constructs as OWL Full
  - Constraints on RDF/OWL vocabulary use
- Correspondence theorem links the two styles of semantics: entailments in OWL also hold in OWL Full.

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A piece of OWL in RDF/XML syntax

```
<owl:Class rdf:ID="MozartDaPonteOpera">
  <owl:equivalentClass>
    <owl:Class>
      <owl:oneOf rdf:parseType="Collection">
        <Opera rdf:about="#NozzDiFigaro"/>
        <Opera rdf:about="#DonGiovanni"/>
        <Opera rdf:about="#CosiFanTutte"/>
      </owl:oneOf>
    </owl:Class>
  </owl:equivalentClass>
</owl:Class>
```

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OWL presentation syntaxes

- UML Profile
  - ODM activity at OMG
- XML
  - More human-readable than the RDF/XML syntax
- Abstract syntax
  - See examples in this presentation
- N3 Turtle syntax

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RDF language constructs

- classes and individuals
- subclasses
- properties
- subproperties
- domain/range of properties
- XML Schema datatypes

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OWL language constructs

- equality, inequality
- inverse, transitive, symmetric, functional properties
- property constraints: cardinality, allValuesFrom, someValuesFrom
- conjunction, disjunction, negation of classes
- hasValue, enumerated type

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Example: transitive property

```
TransitiveProperty(subRegionOf
    domain(GeographicalRegion)
    range(GeographicalRegion))
```

- If Tuscay is a subregion of Italy and Montepulciano is a subregion of Tuscany, then Montepulciano is a subregion of Italy.

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Example: necessary and sufficient conditions

- Having a red color is a neessary and sufficient feature to becalled a red wine.

```
equivalentClass(RedWine
    intersectionOf(
        Wine
        Restriction(wineColor
                    hasValue("red"))))
```

- "intersectionOf" represents a AND condition

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Example: (in)equality of individuals

- No closed-world assumption in OWL!
- Used for ontology/vocabulary mapping

```
Ontology A
    Individual(Brunello, type(vin:Wine))
Ontology B:
    Individual(BrunelloDiMontalcino
        type(vin:Wine))
 sameAs(A:Brunello B:BrunelloDiMontalcino)
```

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Summary: RDF/OWL family of languages

- OWL Full is a vocabulary extension of RDF.
- The RDF restrictions in OWL DL are there for good technical reasons
- Time will have to prove whether there is a place for OWL Lite or some other OWL subset.
- RDF/OWL: one can view it as an historical artefact that these are not grouped under the same acronym.

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Is RDF/OWL just another datamodelling/KR language?

Key differences:
- All classes/properties/individuals have a URI as identifier
- RDF/XML exchange syntax enables interoperability

XML features
- UTF-8 character set
- Support for multilinguality
- Use of XML Schema datatypes: numeric, date, time, etc.

For the rest: RDF/OWL is state-of-the-art concept language

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OWL tools and tests

- OWL ontology editor
  - popular is Protege-OWL.
- Repository of tests is part of recommendation:

  http://www.w3.org/2002/03owlt/
- See also test results of tools:

  http://www.w3.org/2003/08/owl-systems/test-results-out

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Semantic Web Best Practices and Deployment Working Group

- Started 1 March 2004
- Co-chairs David Wood and Guus Schreiber
- 50 participants
- Objective: support for semantic-web application developer
  - Focus on “low hanging fruit”

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Issues for publishing ontologies: good and bad ontologies?!

- Good ontologies are used
- Good ontologies represent some form of consensus in a community
- Good ontologies are maintained
- Good ontologies do not need to be complex
- Good ontologies may contain “mistakes”

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Ontology engineering patterns

- Best practices for frequently occurring modeling problems
- WG documents outline alternatives with pros and cons
- Notes:
  - Classes as values
  - N-ary relations
  - Specification of value sets
  - Part-of

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Representing value sets

- Intuitive representation of **color** value set:
  class/datatype **color**
  with instances/values "red", "white", etc.
- But suppose we want to talk about a subtype of "red", e.g. "vermillion red"
- Pattern:
  - Represent values as subclass hierarchy of value type
  - This preserves flexibility
  - Use anonymous instances as property values
    "This porcelain vase has as color some value of vermillion red"
- See note by Alan Rector
  http://www.w3.org/TR/swbp-specified-values/

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Classes as values

- Common problem when using a hierarchy of concepts for indexing purposes
- Example: indexing books with concepts from the ACM computer-science subject hierarchy
- See draft technical note by Noy:
  - Four options with different merits
- See note by Natasha Noy:
  http://www.w3.org/TR/swbp-classes-as-values/

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Numeric constraints and user-defined XML Schema datatypes

- Example: "an elevated diastolic blood pressure is a diastolic blood pressure of 90 Hg or more"
- Currently no simple way to represent this in OWL
- User-defined XML Schema datatypes could provide a solution
- Currently not possible for detailed technical reasons
- SWBPD task force is active in trying to solve this problem (Jeremy Carroll, HP)

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Some task forces of W3C Best Practices WG

- Tutorial page
  http://www.w3.org/2001/sw/BestPractices/Tutorials
- RDF in XHTML
  http://lists.w3.org/Archives/Public/public-rdf-in-xhtml-tf/2004Oct
- Publication of vocabularies/ontologies
  - WordNet is first on the list
  - Units and measures is likely next target
- Applicatons weblog
  http://esw.w3.org/mt/esw/archives/cat_applications_and_demos.html

  Thesaurus/vocabulary management: see SKOS talk

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AKTive Space

- AKT project (Shadbolt et al.), winner Semantic Web Challenge 2003)
- Integration of heterogeneous sources
  - Public archives of papers, researchers, projects
  - 430 Mb in total
- RDF/OWL used for syntactic interoperability
  - Storage/access issues
- Schema mapping is required
- Referential integrity is a problem
  - Use automatic techniques in combination with user approval

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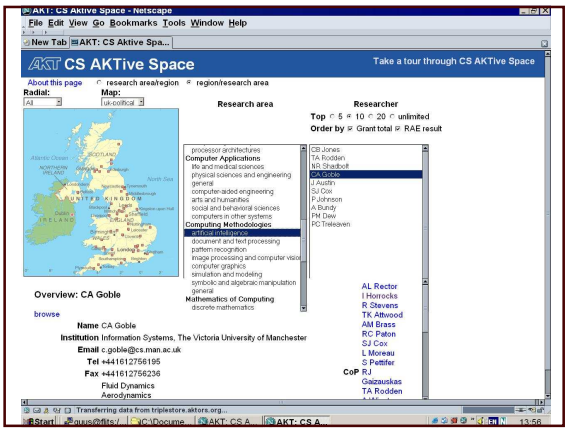

DOPE: thesaurus-based search of large document repositories

- Stuckerschmidt et al. (2003)
- EMTREE thesaurus (MeSH-based)
- Documents
  - 5M Medline abstracts
  - 500M of full-text articles
- Automatic document indexing
- RDF used for syntactic interoperability
  - RDF wrapper for SOAP-based access to documents
- Disambiguation of search terms
- Visualization of search results through semantic categories
  - Needed to prevent information overflow

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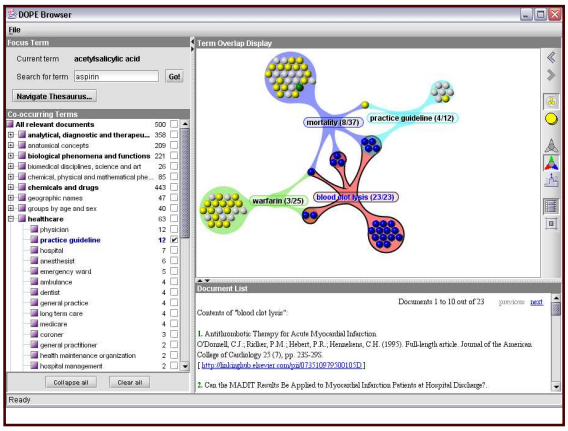

Building Finder: integrating image analysis and textual sources

- Knoblock et al. (USC/ISI)
- Multiple heterogeneous sources
  - Satellite images (Microsoft Terraservice)
  - Road map info (US)
  - Address information (white pages)
- Image analysis techniques to map satellite data to road map
- RDF used for syntactic interoperability

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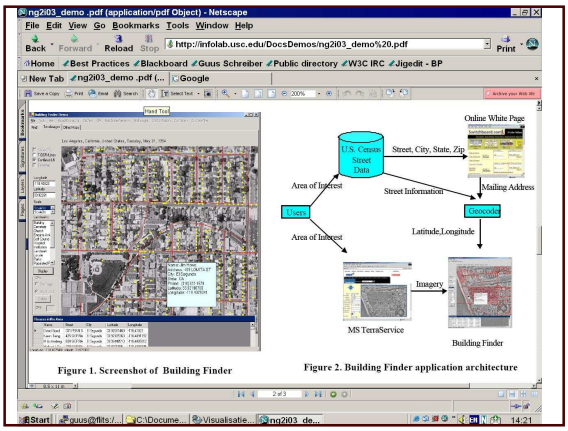

Application scenario: Paintings

Knowledge corpora
AAT ULAN
ICONCLASS
WordNet

Annotation Template
VRA 3.0
Scene descriptors

RDF Schema

Annotation & search tool → RDF image annotations

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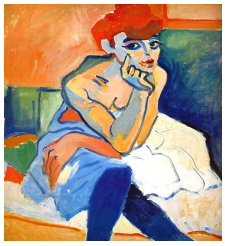
Semantic search in cultural heritage collections: use case

- A person is interested in Fauve paintings
- There is a digital collection with images of paintings of Andre Derain
- The Derain images match the query, despite the fact that "Fauve does not appear in the annotation.



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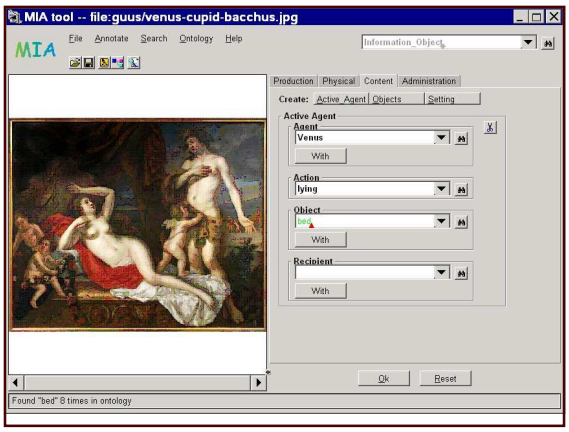

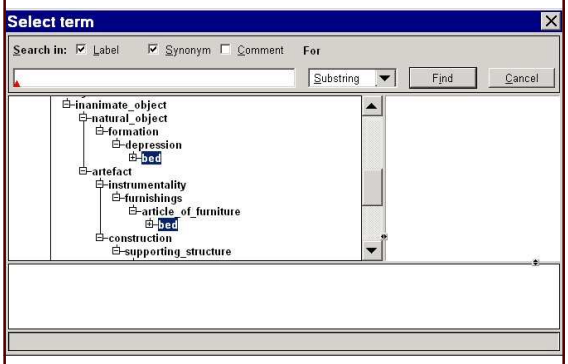

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Parsing existing textual annotations into semantic annotations

VAN GOGH, Vincent

Olive Trees with the Alpilles in the Background

1889

Oil on canvas

28 1/2 x 36 1/4 in. (72.5 x 92 cm)

Collection Mrs. John Hay Whitney

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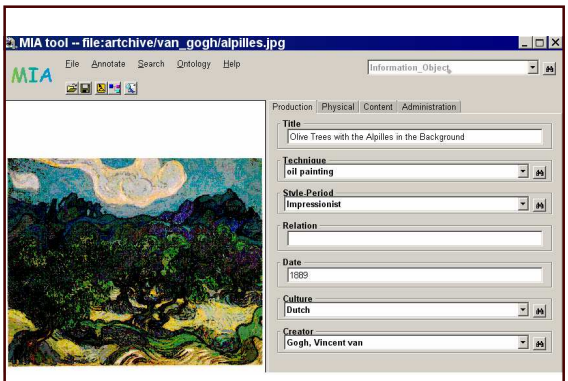

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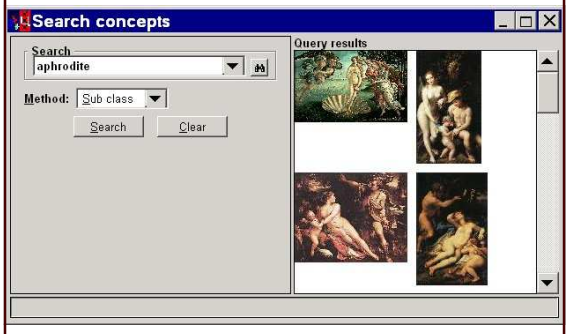

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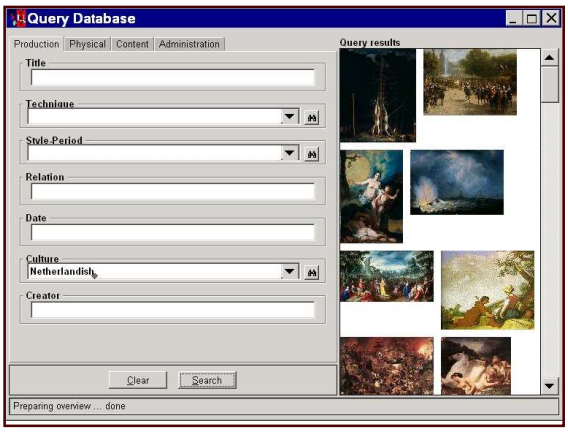

Issues in relation to vocabularies

- Public availability
- Concept mapping
  - Equivalence
    - Impressionism (AAT) = impressionism (WordNet)
  - Subclass relation
    - Artist (AAT) ⊂ Artist (WordNet)
  - Instance relation
    - Continent (WordNet) => Africa (TGN)
  - Domain-specific relations
    - Artist (ULAN) ⇔ Style (AAT)
- Vocabulary enrichment
  - Making implicit knowledge explicit
  - Adding additional knowledge

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Will the Semantic Web succeed?

- One big plus: there is a growing need for semantic search of information
- Availability of large amounts of semantic content is essential
  - But: there is a lot of content already out there
- First applications are likely to be in area of large virtual collections
  - E.g., cultural heritage, medicine
- Web services will not work without ontologies

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More information

- W3C Semantic Web page
  http:/www.w3.org/2001/sw/
- W3C Best Practices work
  http://www.w3.org/2001/sw/BestPractices/
- Semantic Web Challenge
  http://challenge.semanticweb.org
- European Network of Excellence Knowledge Web
  http://knowledgeweb.semanticweb.org

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