



Ontologies for multimedia: the Semantic Culture Web

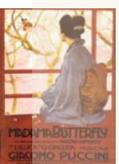
Guus Schreiber

Free University Amsterdam

Co-chair W3C Semantic Web Deployment WG

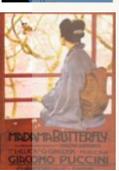
Overview

- My target: a Semantic Culture Web
- Ontology perspective:
 - Principles for ontology engineering on Web scale
 - Some remarks about web standards
- Technologies for realizing a Culture Web
 - Ontology-based methods
 - Image analysis
 - NLP / information extraction
 - Combinations are key!



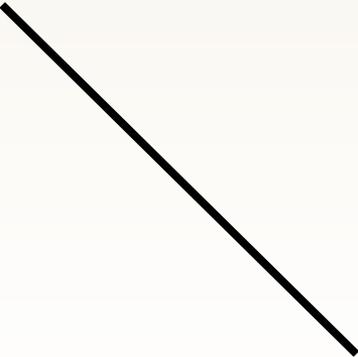
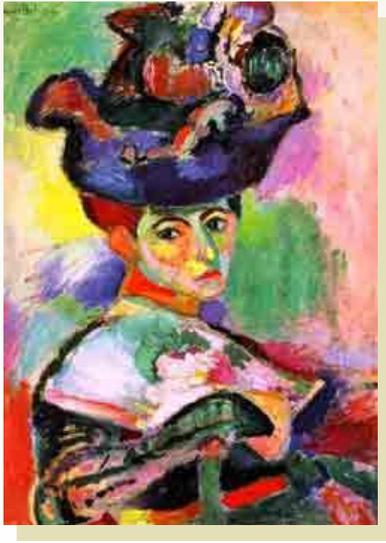
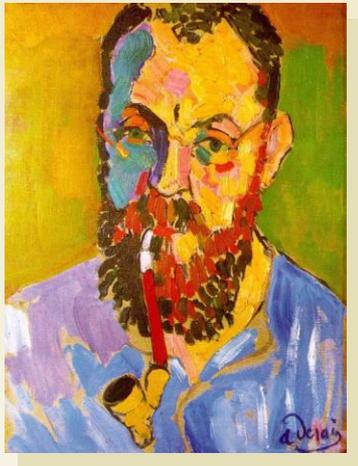
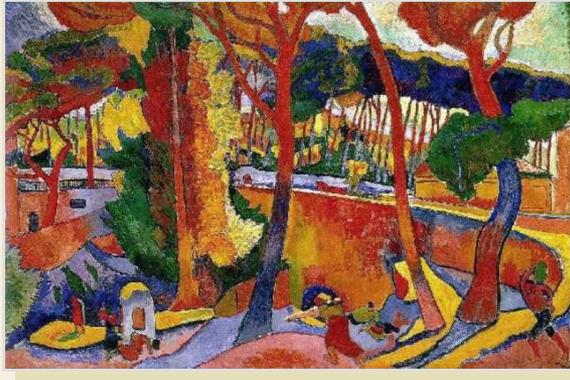
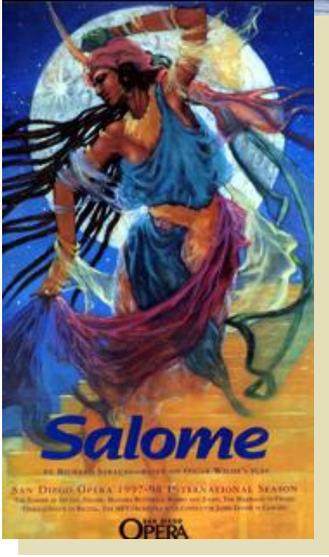
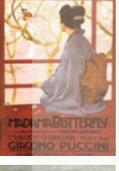
Acknowledgements

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 - Hennie Brugman, Luit Gazendam, Veronique Malaise, Johan Oomen, Mettina Veenstra
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 - Laura Hollink, Bouke Hunning, Michiel van Liempt, Johan Oomen Maarten de Rijke, Arnold Smeulders, Cees Snoek, Marcel Worryng,



Culture Web





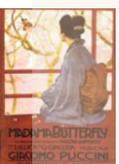




Principles for ontology engineering in a distributed world

1. *Modesty* principle

- Ontology engineers should refrain from developing their own idiosyncratic ontologies
- Instead, they should make the available rich vocabularies, thesauri and databases available in web format
- Initially, only add the originally intended semantics





RDF/OWL Representation of WordNet

W3C Working Draft 19 June 2006

This version:

<http://www.w3.org/TR/2006/WD-wordnet-rdf-20060619/>

Latest version:

<http://www.w3.org/TR/wordnet-rdf/>

Previous version:

This is the first published version

Editors:

[Mark van Assem](#), Vrije Universiteit Amsterdam

[Aldo Gangemi](#), ISTC-CNR, Rome



Implicit WordNet semantics

*“The **ent** operator specifies that the second synset is an entailment of first synset. This relation only holds for verbs.”*

- Example: [breathe, inhale] entails [sneeze, exhale]
- Semantics (OWL statements):
 - Transitive property
 - Inverse property: entailedBy
 - Value restrictions for VerbSynSet (subclass of SynSet)

Recipes for vocabulary URIs

- Simplified rule:

- Use “hash” variant” for vocabularies that are relatively small and require frequent access

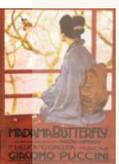
- <http://www.w3.org/2004/02/skos/core#Concept>

- Use “slash” variant for large vocabularies, where you do not want always the whole vocabulary to be retrieved

- <http://xmlns.com/foaf/0.1/Person>

- For more information and other recipes, see:

- <http://www.w3.org/TR/swbp-vocab-pub/>



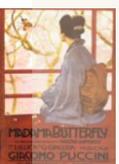
Query for WordNet URI returns “concept-bounded description”



```
- <rdf:RDF>
- <rdf:Description about="http://www.w3.org/2006/03/wn/wn20/instances/synset-bank-noun-2">
  <wn20schema:synsetId>108639924</wn20schema:synsetId>
  <rdfs:label>bank</rdfs:label>
  <rdf:type rdf:resource="http://www.w3.org/2006/03/wn/wn20/schema/NounSynset"/>
  <wn20schema:containsWordSense
    rdf:resource="http://www.w3.org/2006/03/wn/wn20/instances/wordsense-bank-noun-2"/>
- <wn20schema:gloss>
  (sloping land (especially the slope beside a body of water); "they pulled the canoe up on the
  bank"; "he sat on the bank of the river and watched the currents")
  </wn20schema:gloss>
  <wn20schema:hyponymOf
    rdf:resource="http://www.w3.org/2006/03/wn/wn20/instances/synset-slope-noun-1"/>
  </rdf:Description>
</rdf:RDF>
```

How useful are RDF and OWL?

- RDF: basic level of interoperability
- Some constructs of OWL are key:
 - Logical characteristics of properties: symmetric, transitive, inverse
 - Identity: sameAs
- OWL pitfalls
 - Bad: if it is written in OWL it is an ontology
 - Worse: if it is **not** in OWL, then it is **not** an ontology



2. *Scale* principle: “Think large!”



Doug Lenat

"Once you have a truly massive amount of information integrated as knowledge, then the human-software system will be superhuman, in the same sense that mankind with writing is superhuman compared to mankind before writing."



Applications require many ontologies

Research

Research Home » Conducting Research » Union List of Artist Names » Full Record Display

Union List of Artist Names® Online
Full Record Display

[New Search](#) [Previous Page](#)

Click the icon to view the

ID: 500017300

Matisse, Henri (French p...

Names:
Matisse
Henri M
Matisse
Matisse

Nationality:
French (

Roles:
artist (p
painter
printmak
sculptor
designer
writer

Related People or Corporate Bodies:
apprentice was [Jolin, Einar](#) 1911-1913
..... (Swedish painter, 1890-1990) [500014093]
parent of [Duthuit, Marguerite Matisse](#)
..... (French painter, born ca. 1900) [500075813]
patron was [Barnes, Dr. Albert C.](#)
..... (American collector, 1872-1951) [500057478]
student of [Cormon, Fernand](#)
..... (French painter and teacher, 1845-1924) [500115385]
student of [Moreau, Gustave](#)
..... (French painter, 1826-1898) [500115776]

Roles:
artist (**preferred**)
painter
printmaker
sculptor
designer
writer

Gender: male

Birth and Death Places:
Born: [Le Cateau-Cambrésis \(Nord, Nord-Pas-de-Calais, France\)](#) (inhabited place)
Died: [Nice \(Alpes-Maritimes, Provence-Alpes-Côte d'Azur, France\)](#) (inhabited place)

Gender:

3. *Pattern* principle: don't try to be too creative!



- Ontology engineering should not be an art but a discipline
- Patterns play a key role in methodology for ontology engineering
- See for example patterns developed by the W3C Semantic Web Best Practices group

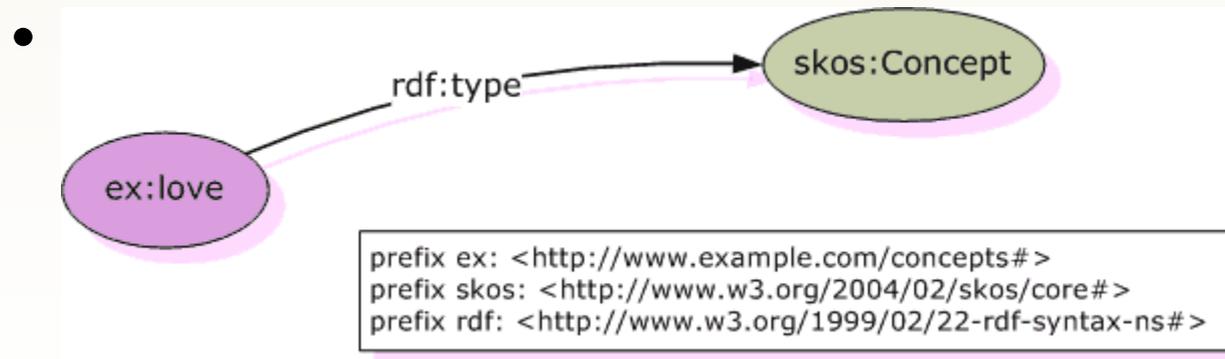
<http://www.w3.org/2001/sw/BestPractices/>



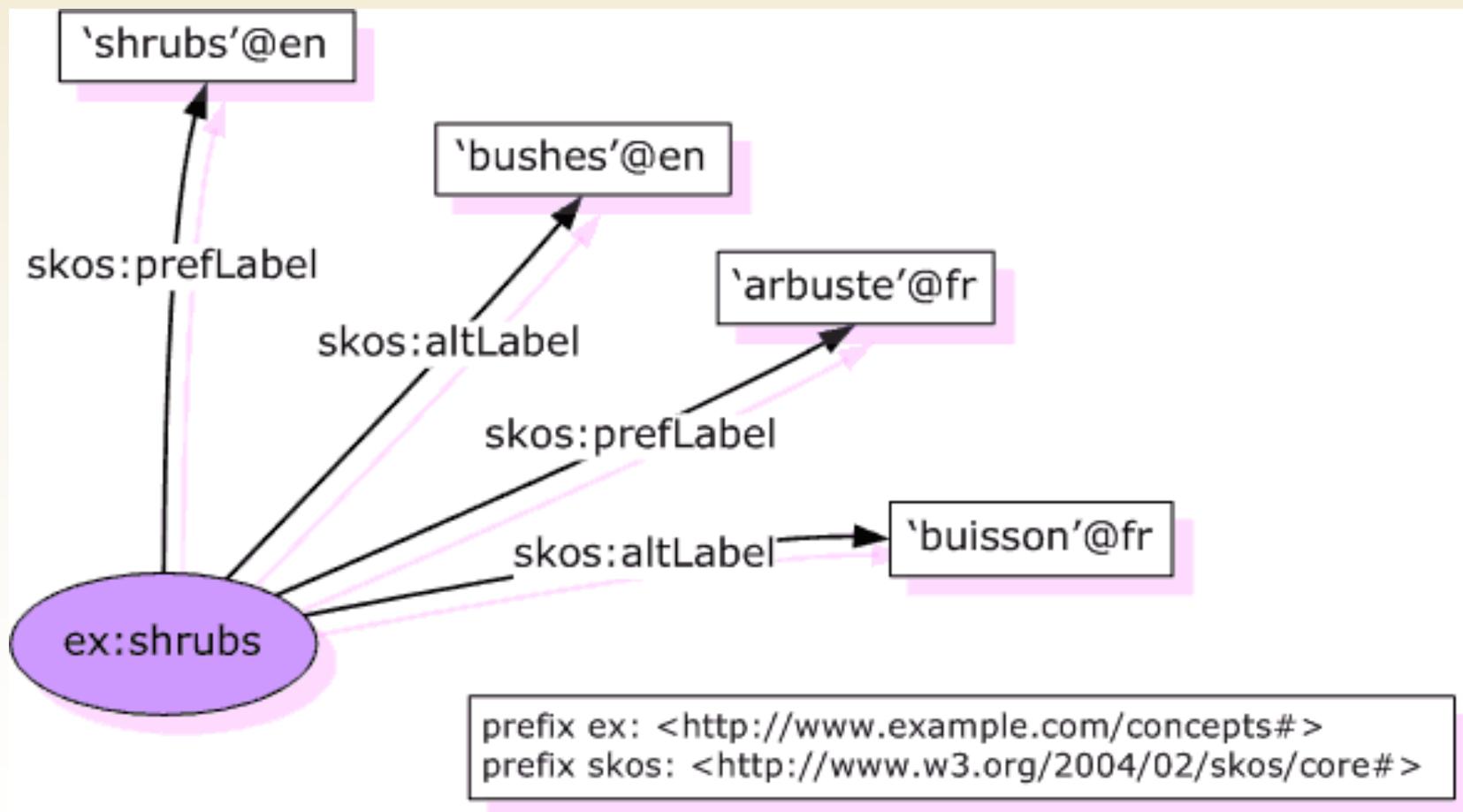
SKOS: pattern for thesaurus modeling

- Based on ISO standard
- RDF representation
- Documentation:

<http://www.w3.org/TR/swbp-skos-core-guide/>

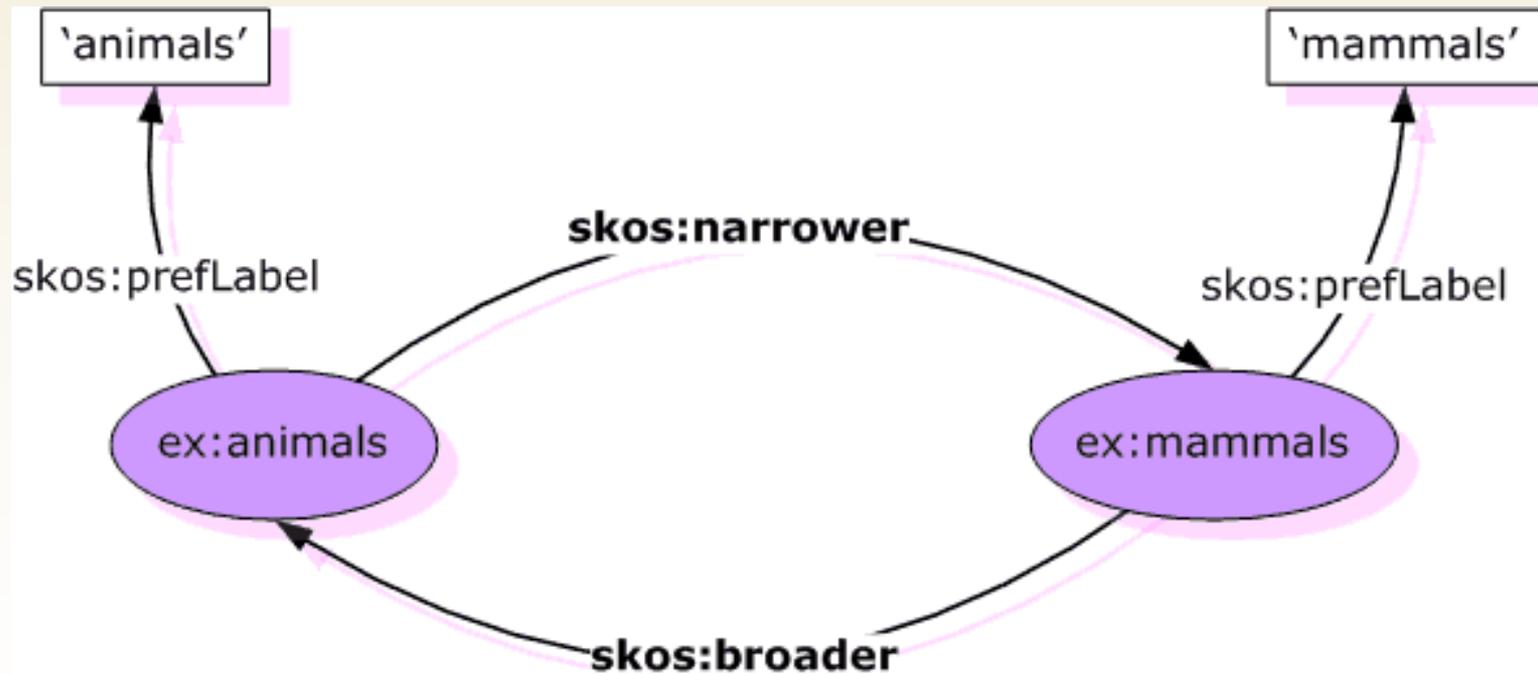


Multi-lingual labels for concepts



Semantic relation: broader and narrower

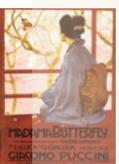
- No subclass semantics assumed!



prefix ex: <<http://www.example.com/concepts#>>
prefix skos: <<http://www.w3.org/2004/02/skos/core#>>

4. *Enrichment* principle

- Don't modify, but add!
- Techniques:
 - Learning ontology relations/mappings
 - Semantic analysis, e.g. OntoClean
 - Processing of scope notes in thesauri



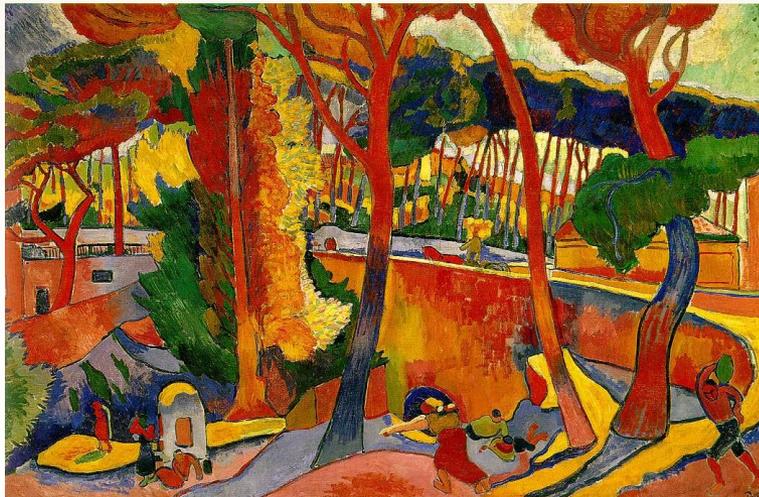
Example enrichment

- Learning relations between art styles in AAT and artists in ULAN through NLP of art0historic texts
- But don't learn things that already exist!



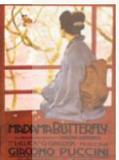


MATISSE, Henri
Le Bonheur de vivre



DERAIN, Andre
The Turning Road

Extracting additional knowledge from scope notes



Neo-Expressionist

Description:

- vp **descriptiveNote** Refers to the style of art, predominantly of painting, inspired by German Expressionism that gained popularity in Italy, Germany, and America in the late 1970s and early 1980s. The style is characterized by large, figurative works, crudely and rapidly painted, often with objects imbedded in their surfaces, such as broken plates or straw.;
- vp **id** 300022189;
- vp **labelNonPreferred** Energism;
- vp **labelPreferred** Neo-Expressionist;
- vp **preferred parent** **aat:post-1945 fine arts styles and movements**;

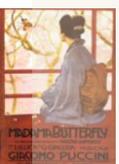


Hypothesis underlying Culture Web

- Semantic Web technology is in particular useful in knowledge-rich domains

or formulated differently

- If we cannot show added value in knowledge-rich domains, then it may have no value at all



Baseline architecture for a Semantic Culture Web

- Should be fully based on web standards
 - XML, RDF/OWL, SVG, AJAX
- OWL use is typically limited
- Methodology for metadata conversion
 - Information extraction
 - Should be professional service
- Scalability is key issue
 - 100+ collections is minimum
- New search paradigms
- Public annotation facilities
- Evaluation studies with stakeholders!



MultimediaN E-Culture Demonstrator

Cultural Heritage Data

Generic Multilingual Interfaces

Collections

Artchive.com	36K
Rijksmuseum	30K
Ethnographical	1.1M



...and growing

Vocabularies

SVCN (ethnographic)	65K
W3C Wordnet	2.2M
Getty: AAT	450K
TGN	500K
ULAN	1.5M



...and growing

Schemas

- Dublin Core
- VRA Core
- E-Culture Specific

web standards

HTML	OWL
SVG	RDF
AJAX	RDFa



SWI-Prolog

Semantic Web

Server (SPARQL support)

Triples 6,663,465 *and counting...*

Semantic Grouping

Works created by an artist with matching AAT style (214)



Works created by a teacher of an artist with matching AAT style (3)



Semantic Timeline



/facet browser

Culture Web demonstrator

<http://e-culture.multimediaman.nl>



MultimediaN N9C Eculture Project

MultimediaN

[en](#) [nl](#)

[Home](#)

[News](#)

MultimediaN N9C Eculture project homepage

[Posters & Publications](#)

Despite the amounts of public funding devoted to both cultural heritage and ICT infrastructure, online access to even the most important aspects of our past is still limited and highly fragmented. The objective of this project is the development of a set of e-culture demonstrators providing multimedia access to distributed collections of cultural heritage objects. The demonstrators are intended to show various levels of syntactic and semantic interoperability between collections and various types of personalized and context-dependent presentation generation. The demonstrators will all be developed as components of the portal [cultuurwijzer.nl](#) of DEN (Foundation Cultural Heritage Netherlands). This portal will serve as a joint application domain for the demonstrators. The portal provides access to a relatively large set of key culture-heritage collections in The Netherlands. The demonstrators will typically focus on subsets of the collections to demonstrate the use of semantic interoperability, semantic information access and visualization, and context-specific presentation generation. The project integrates results from computer science in the areas of: semantic Web technology, multimedia indexing and search, and web interfacing and data visualization to facilitate display of (part of) our cultural heritage. The team combines a balanced mix of internationally renowned academic expertise on Semantic Web and multimedia technology with industrial strength experience in Web design and user interface development.

[Online demo](#)

[FAQ](#)

[People](#)

[Credit](#)

[Internal](#)

[Contact us](#)

XHTML VALID

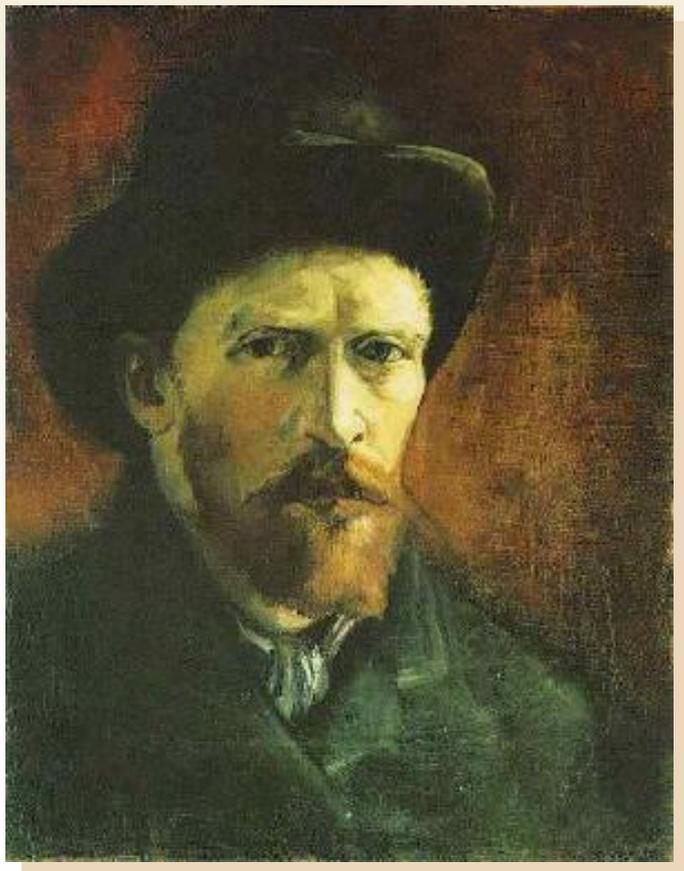
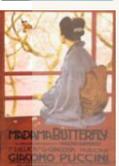


Small datasets already give scalability issues

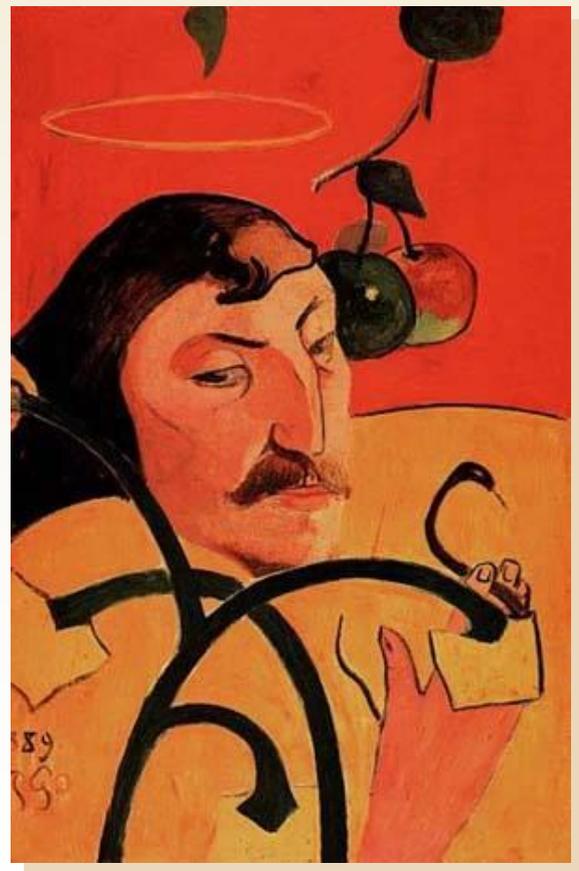
Document	# Sources	# Triples
Schemas		
RDFS/OWL	2	358
Annotation	6	769
Vocabularies	9	1,225
Collections	1	29,889
Vocabularies		
TGN	4	425,517
ULAN	16	1,896,936
AAT	1	249,162
WordNet	18	2,579,206
Collections		
Artchive	4	74,414
Rijkmuseum	1	27,933
RVM	1	3,662,257



New search paradigms: Relation search



?





RDFa Primer 1.0

Embedding RDF in XHTML

W3C Working Draft 16 May 2006

This version:

<http://www.w3.org/TR/2006/WD-xhtml-rdfa-primer-20060516/>

Latest version:

<http://www.w3.org/TR/xhtml-rdfa-primer/>

Previous version:

<http://www.w3.org/TR/2006/WD-xhtml-rdfa-primer-20060310/>

Editors:

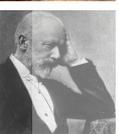
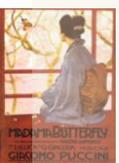
Ben Adida, Creative Commons [<ben@creativecommons.org>](mailto:ben@creativecommons.org)

Mark Birbeck, x-port.net Ltd. [<mark.birbeck@x-port.net>](mailto:mark.birbeck@x-port.net)

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 href="http://creativecommons.org/licenses/by-nc/2.5/">
Creative Commons Non-Commercial License
.

Search in digital media archives: typical use case

- A person searches for photos of an “orange ape”
- An image collection of animal photographs contains snapshots of orang-utans.
- The search engine finds the photos, despite the fact that the words “orange” and “ape” do not appear in annotations



Techniques that can be used

- Ontologies: explicit background knowledge plus semantic annotation: semantic link between annotated concept and vocabulary
- Natural-language processing: co-occurrence of ‘orange’, ‘ape’ and ‘orangutans’
- Image processing: e.g. detectors for ‘orange’ and ‘ape’

Observation: no single technique can solve every problem!



Supporting annotation of broadcasts through information extraction

- Current situation: mainly manual
- Not feasible for large-scale digital archiving
- Context documents for programs can be identified
- Can we generate candidate annotation?
- *Example from CHOICE project*



DAL DER ZUCHTEN
donderdag 1 september 2005, 23.00 – 23.52 uur,
Nederland 3
Herhaling: zondag 18 juni 2006, 13.10 - 14.05 uur,
Nederland 3

[Reageer op de uitzending](#)
[Relevante links](#)
[Bekijk stream](#)



Ergens in een kleine vallei, verscholen tussen besneeuwde bergtoppen van de Spaanse Pyreneeën, ligt het boerendorpje Plan. Elke oudste zoon erft er zijn ouderlijk huis, het land, het vee en de verantwoordelijkheid de eeuwenoude manier van leven in stand te houden. Het werk is zwaar en de winters zijn koud, maar daar klagen ze niet over. Het werkelijke probleem van de mannen uit Plan is, dat er nauwelijks huwbare vrouwen zijn. Al tientallen jaren zoeken de jonge vrouwen uit het dorp hun heil honderden kilometers verderop, in de moderne wereld. De mannen blijven alleen achter, mét de erfenis, maar zonder vrouw en nageslacht.



Ranking based on semantic distance In thesaurus



ranked keywords	rank
Governments	1
Soldiers	1
Prisoners of war	3
Ministers	3
Prime ministers	3
Prisons	4
Civil servants	4
Camps	5
Voting	5
Democratization	5
Missions	6
Agreements	7
Christians	8
Lakes	9
News papers	9
Writing	9

User study

Users keywords	N
Peace troops	6
Military operations	5
Armed forces	3
Government policy	2
soldiers	2
Peace troops	E
Military operations	E

Expert description

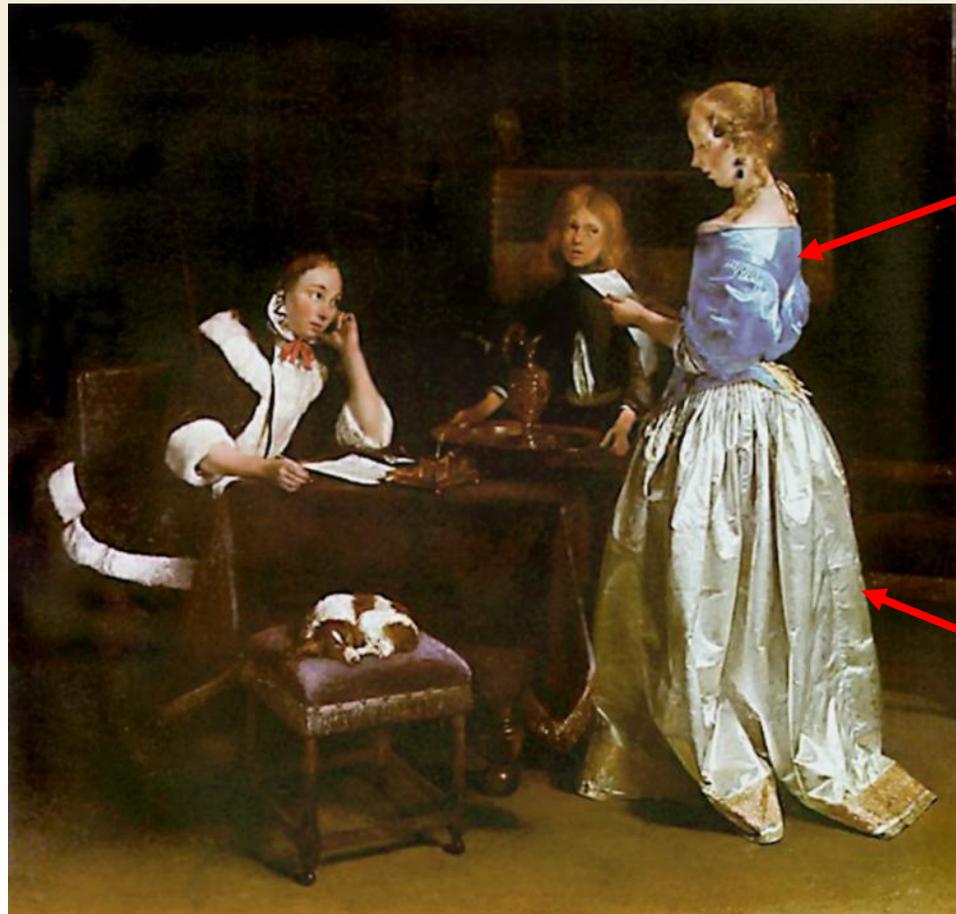
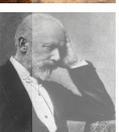
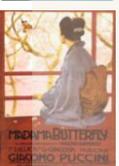
Supporting annotation: Automatically deriving spatial relations



Object1
left
Object2



Supporting annotation: Recognizing color of cloths



Color value
from AAT

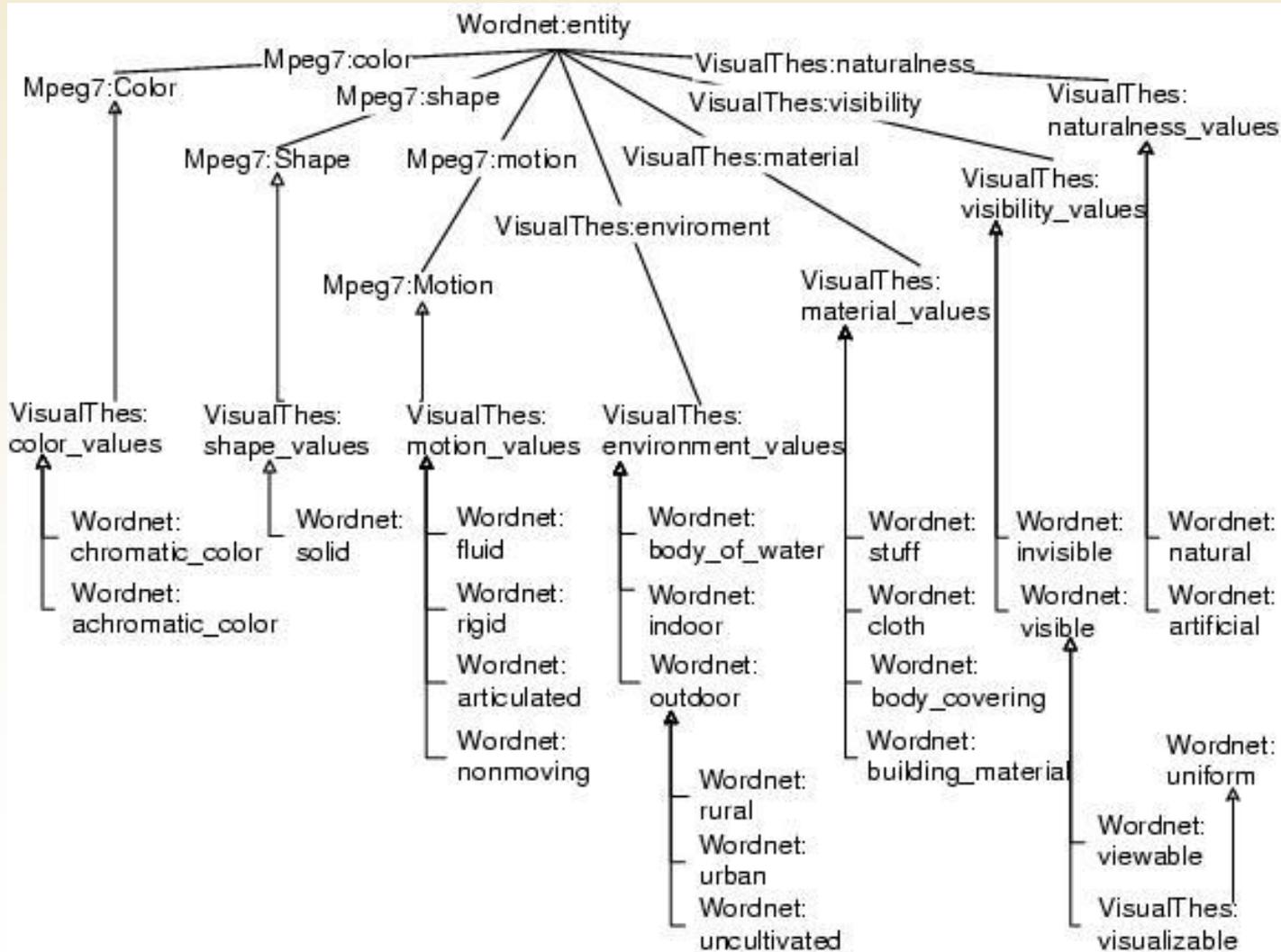
Requires
Reliable
segmentation

Visual WordNet (Stein et al.)

- Adding knowledge about visual characteristics to WordNet: mobility, color, ...
- Build detectors for the visual features
- Use visual data to prune the tree of categories when analyzing a visual object



Sample visual features and their mapping to WordNet



Experiment: pruning the search for “conveyance” concepts

Three visual features: material, motion, environment
Assumption is that these work perfectly



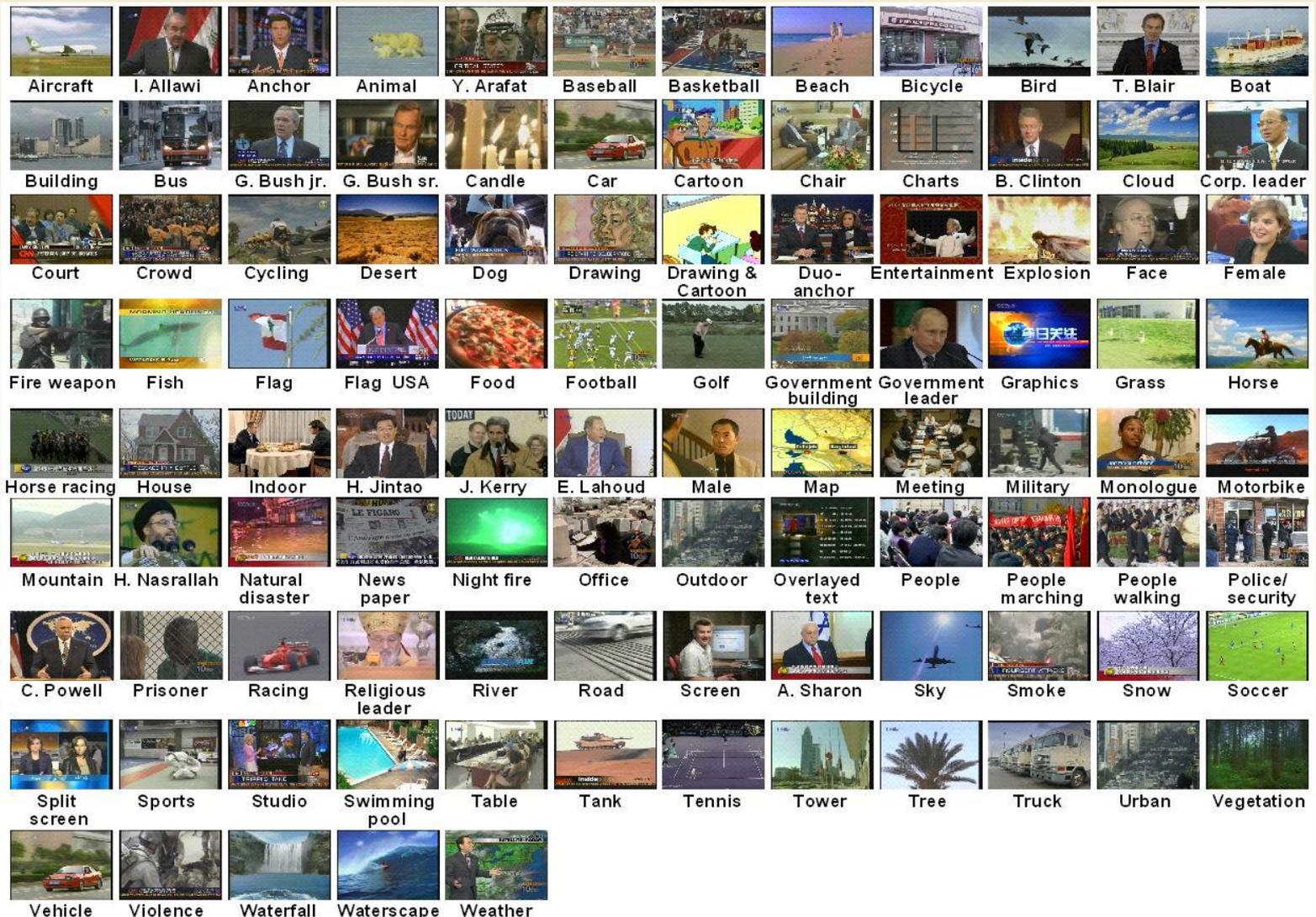
6 concepts found
Including taxi cab



12 concepts found
Including passenger train
and commuter train

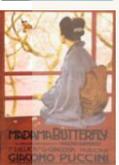


Concept detectors in video (Snoek et al)



Lexicon is specific for news domain

LSCOM lexicon: 229 - Weather



LSCOM enrichment: mapping to WordNet

- 365 concept detectors (MediaMil/LSCOM)
- Manual mapping process, 2 subjects per concept, 65% inter-subject overlap
- 273 matched to 1 WordNet concept
- 39 were union of 2+ concepts

Fish => wn:Fish OR wn:AquaticMammal

- 45 were intersection of 2+ concepts

MaleNewsSubject => wn:Male AND wn:Subject

- 8 were instances of a concept

John Kerry => wn:Senator



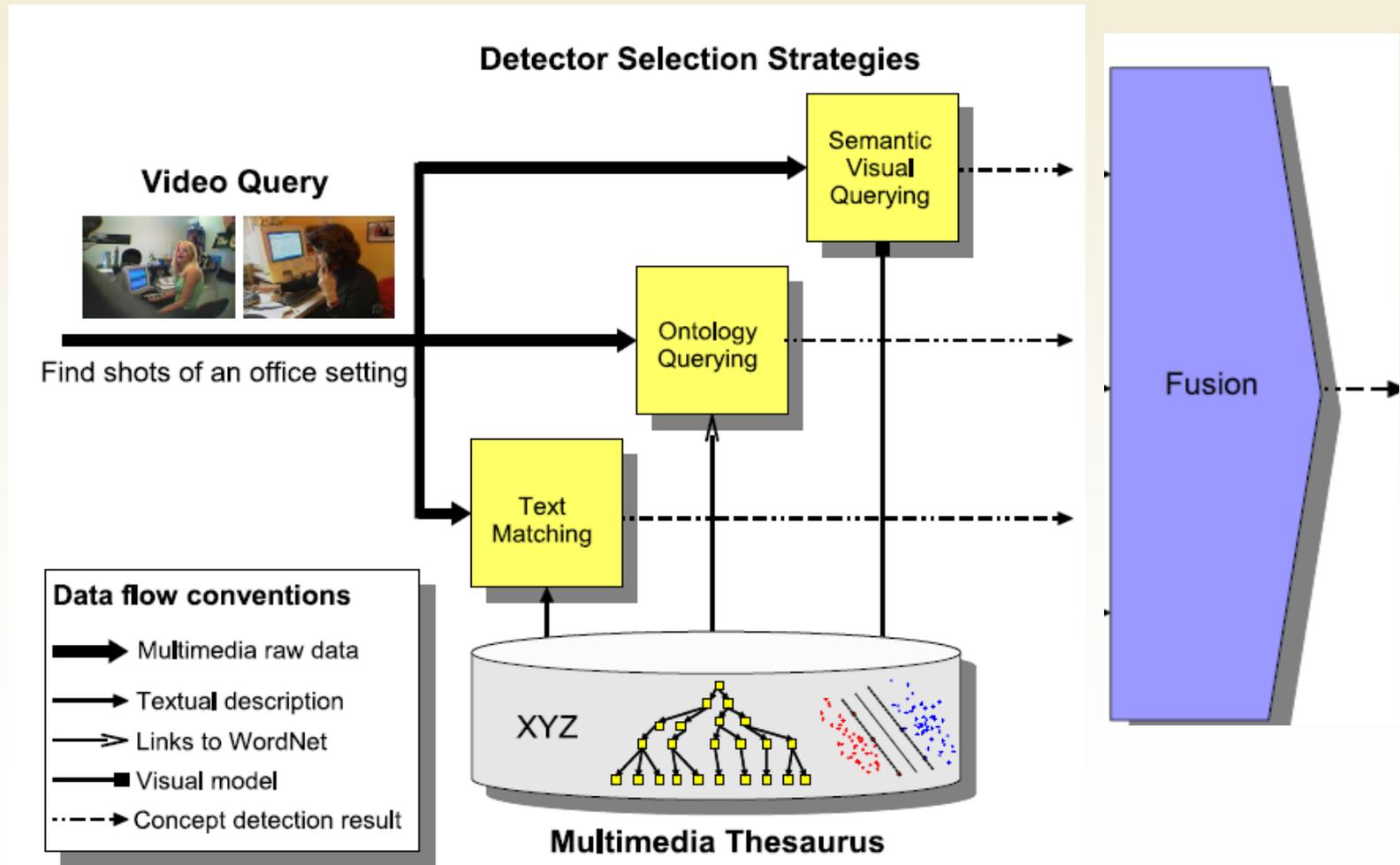
LSCOM lexicon: 110 – Female Anchor

- Combination of “Female” and “Anchor person”
- Link to WordNet enables use of WorldNet's semantic network for LSCOM concepts



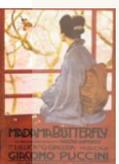
- ♦ **S: (n) anchor, anchorman, anchorperson** (a television reporter who coordinates a broadcast to which several correspondents contribute)
 - ◊ *direct hypernym* / *inherited hypernym* / *sister term*
 - ♦ **S: (n) television reporter, television newscaster, TV reporter, TV newsman** (someone who reports news stories via television)
 - ♦ **S: (n) reporter, newsman, newsperson** (a person who investigates and reports or edits news stories)
 - ♦ **S: (n) communicator** (a person who communicates with others)
 - ♦ **S: (n) person, individual, someone, somebody, mortal, soul** (a human

Combining NLP, image analysis and ontologies for selecting detectors



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



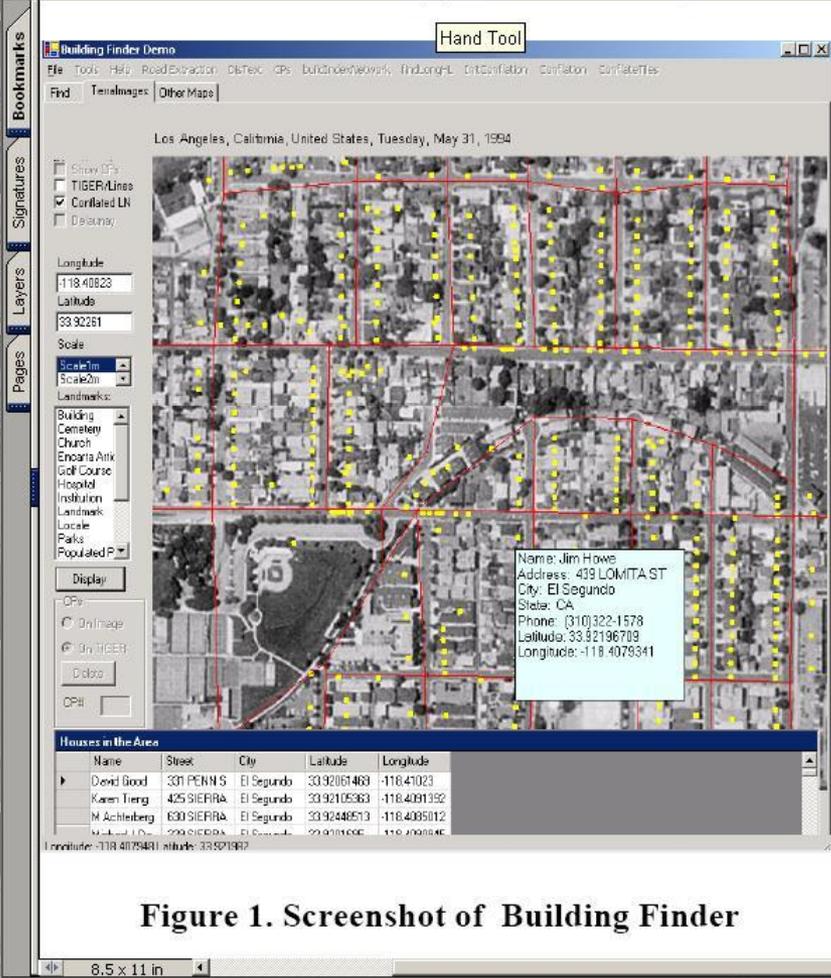


Figure 1. Screenshot of Building Finder

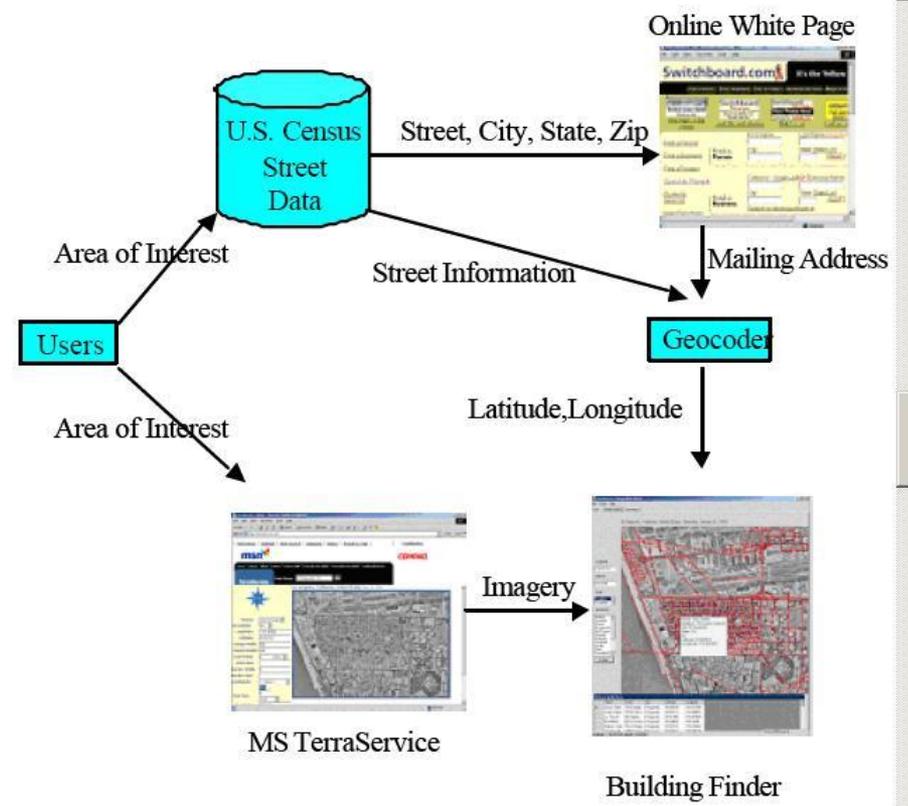


Figure 2. Building Finder application architecture

Take home message

- There's lots of existing semantics out there. Use it!
- Think multi-disciplinary!
 - Realistic applications require combination of techniques
- In open knowledge-rich environments there are lots of opportunities for SW technology
 - But we have to take them



Type Title Creator Style/Period Material Date Description Culture Measurements

Type	depicted place
Work 12	World
SVCN Concept	Europe
AAT Concept	France
Place	Île-de-France
Person	Ville de Paris, Départ ...
	Paris 12
	Montparnasse 1
	Montmartre 3
	facet options

Results grouped by depicted place

Paris (8)



Self-Portrait with Se ...
Chagall, Marc



Paris Through My Window
Chagall, Marc



Homage to Bleriot
Delaunay, Robert



A Glimpse of Notre Da ...
Matisse, Henri



Avenue de l'Opera: Mo ...
Pissarro, Camille

Montmartre (3)



Boulevard Montmartre: ...
Pissarro, Camille



Boulevard Montmartre: ...
Pissarro, Camille



Boulevard Montmartre: ...
Pissarro, Camille



kikvors-fetish
Pieter Hovens (RMV)



kikvors-fetish
Pieter Hovens (RMV)



kikvors-fetish
Pieter Hovens (RMV)



kikvors-fetish
Pieter Hovens (RMV)

Works created by an artist with matching name (95)



Head of a Woman (Olga ...
Picasso, Pablo



Self Portrait: "Yo Pi ...
Picasso, Pablo



Assemblage mounted in ...
Picasso, Pablo



The Young Painter
Picasso, Pablo



Self-portrait with Cloak
Picasso, Pablo

Works created by an artist who collaborated with an artist with matching name (31)

