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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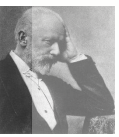
SALOME
METROPOLITAN OPERA
Salome
OPERA
LA DAME
CAMELIAS
Culture Web

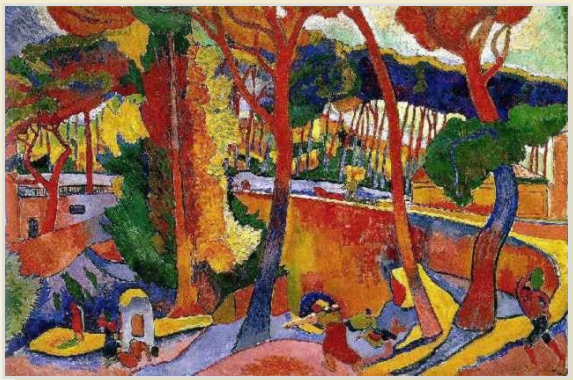
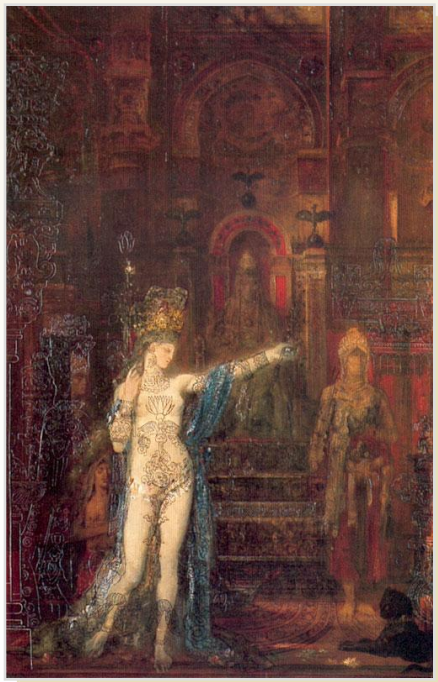
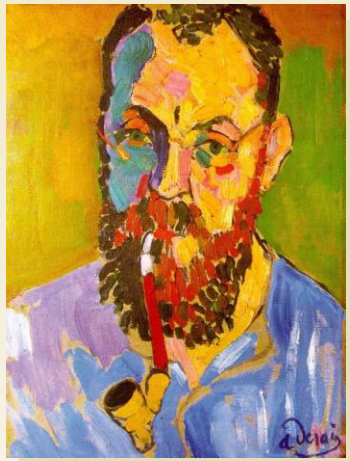






MADAMA BUTTERFLY
GIACOMO PUCCINI

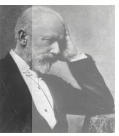

Salome
San Diego Opera 1997-98 International Season
San Diego Opera






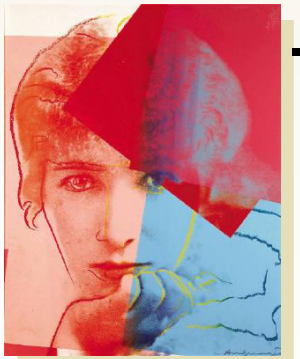







LA TOSCA
THEATRE-SARAH-BERNHARD




TOSCA
LIBRETTO DI V. SARDOU
L. ILLICA - G. GIACOSA
MUSICA DI G. PUCCINI
G. RICORDI & C. EDITORI


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

W3C Working Draft

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”

Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.w3.org/2006/03/wn/wn20/instances/synset· Go

```
− <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?

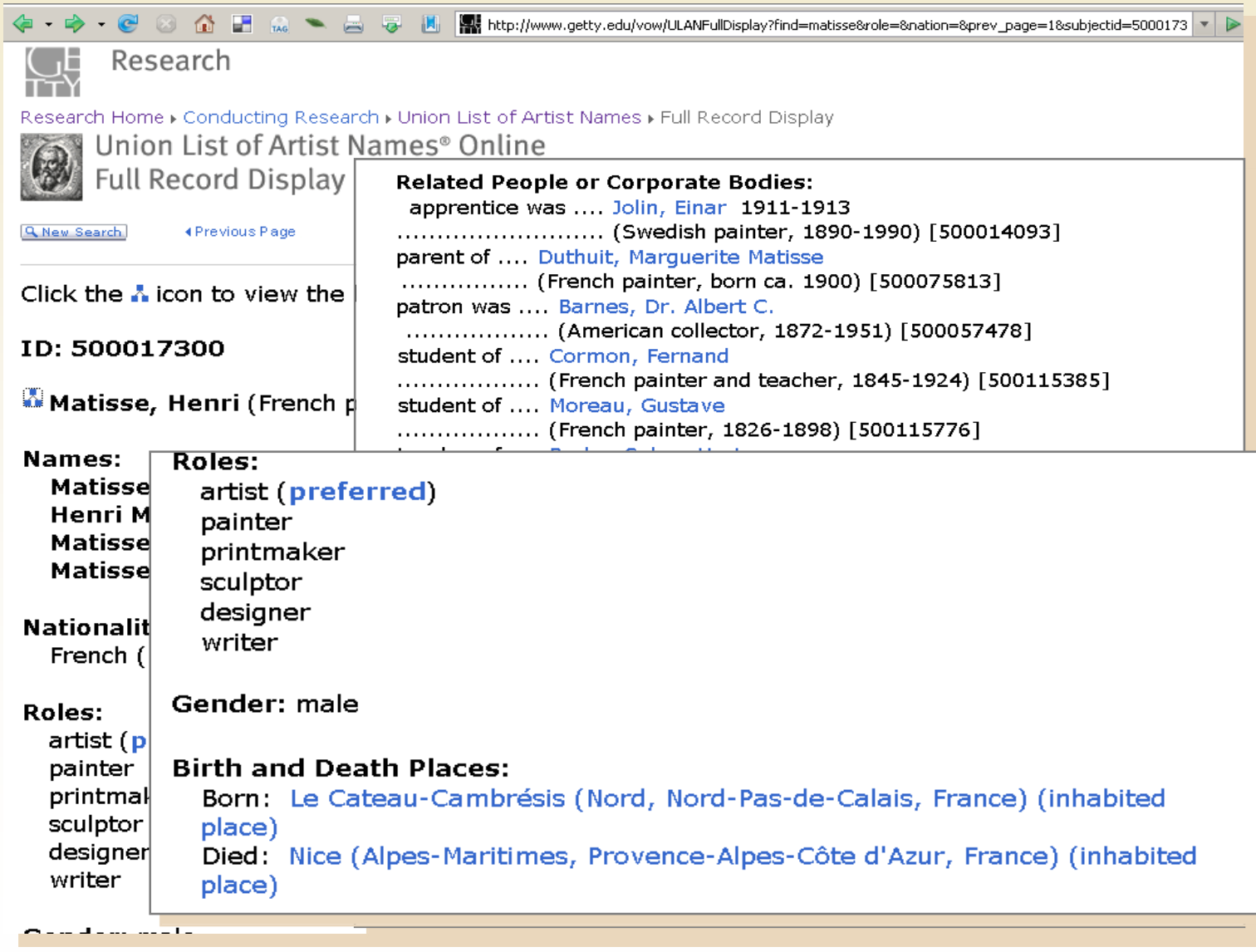
- RDF: basic level of interoperability
- Some constructs of OWL are key:
  - Logical characteristics of properties: symmetric, transitive, inverse
  - Identity: sameAs
- OWL pitfalls
  - Bad: if it is written in OWL it is an ontology
  - Worse: if it is **not** in OWL, then it is **not** an ontology

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



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

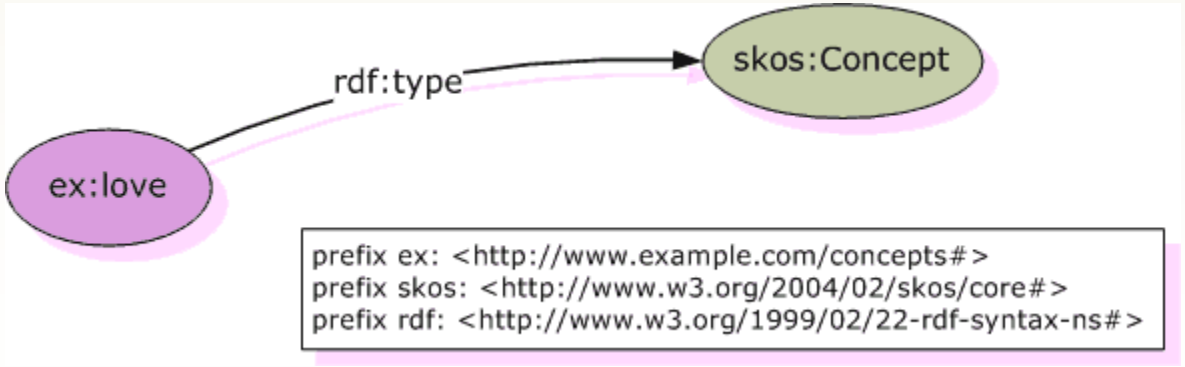
http://www.w3.org/2001/sw/BestPractices/

SKOS:
pattern for thesaurus modeling

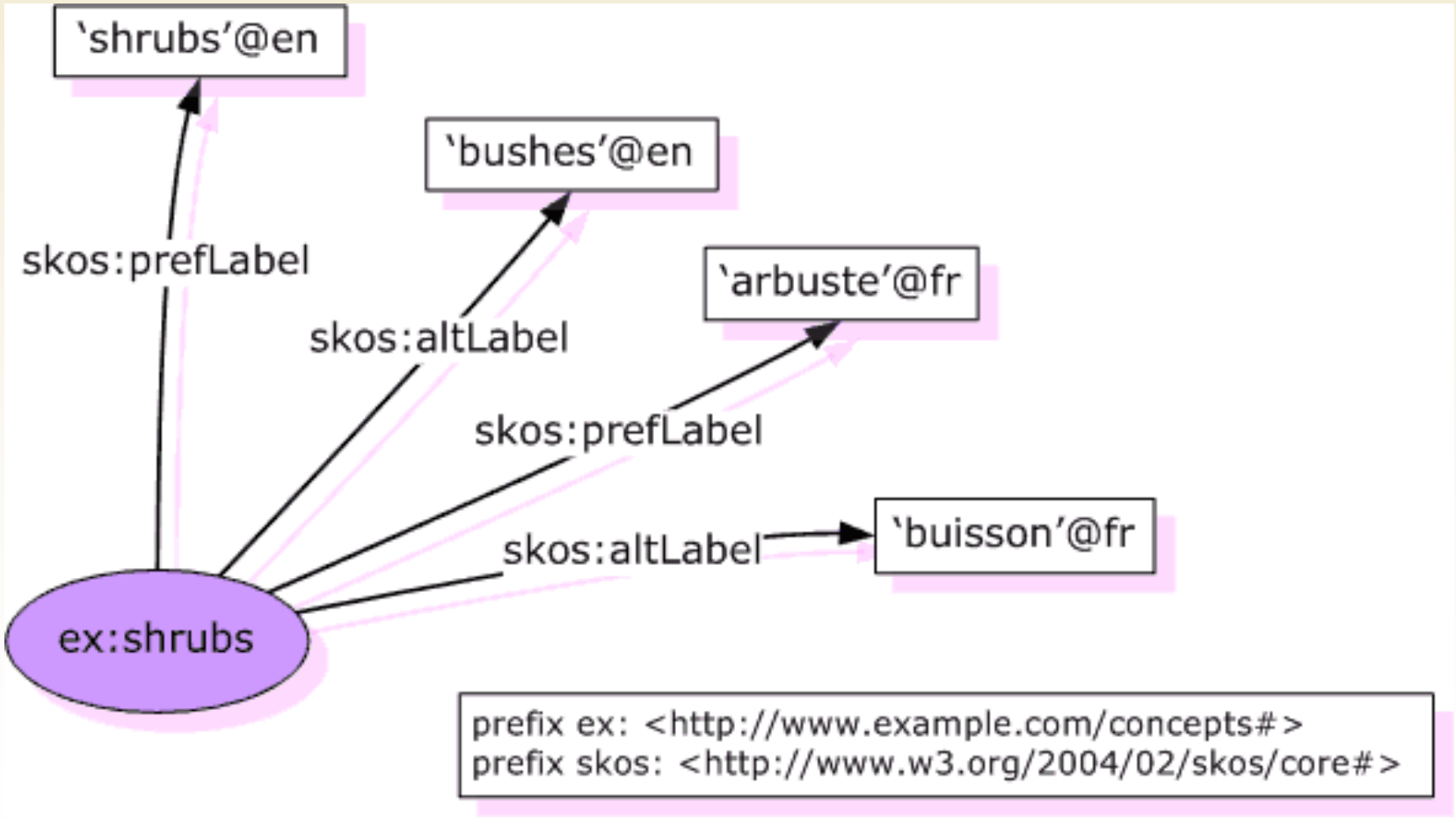
- Based on ISO standard
- RDF representation
- Documentation:

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

-

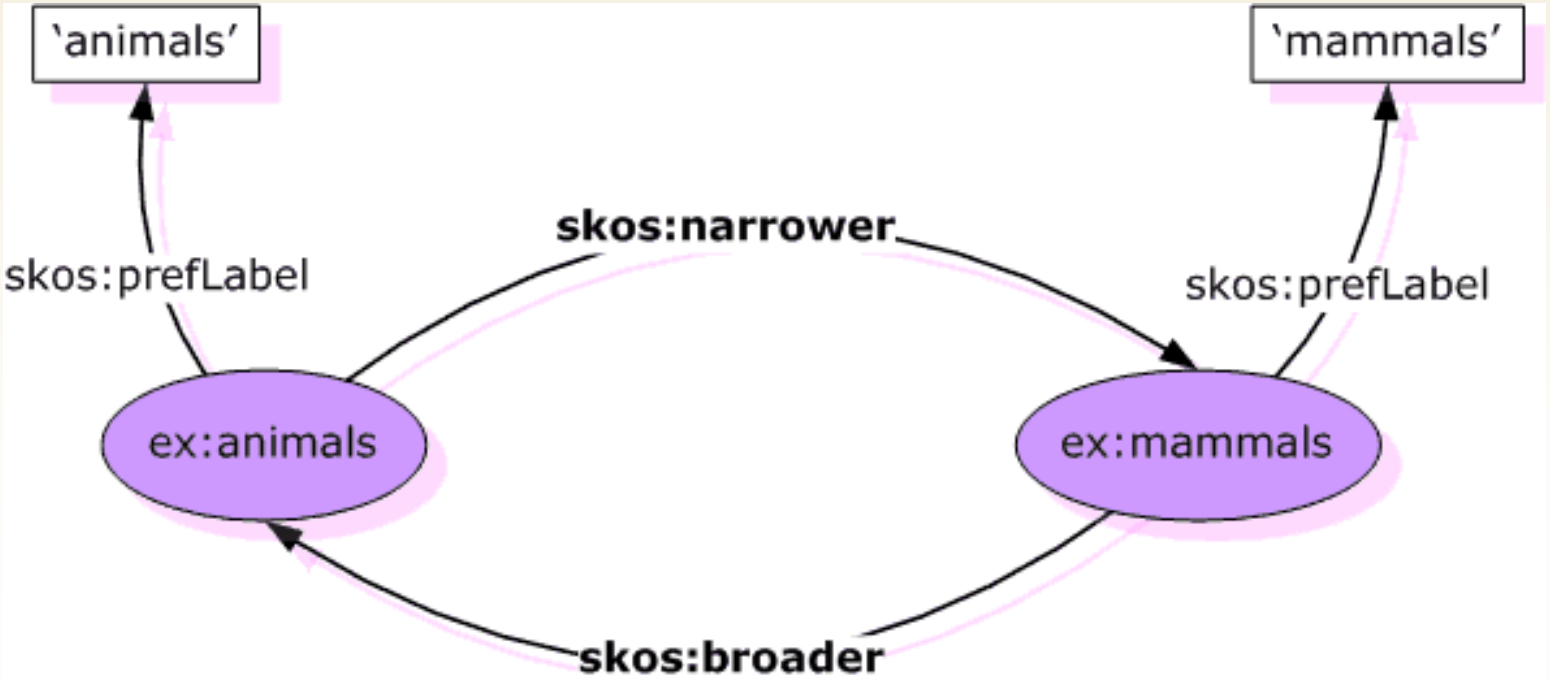


Multi-lingual labels for concepts



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

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

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

web standards

HTML OWL
SVG RDF
AJAX RDFa

SWI-Prolog

Semantic Web

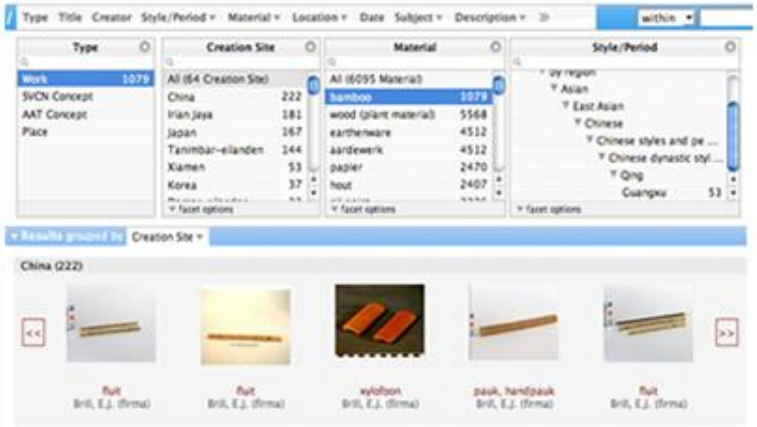
Server (SPARQL support)

Generic Multilingual Interfaces

Semantic Grouping

Semantic Timeline

/facet browser



Culture Web demonstrator

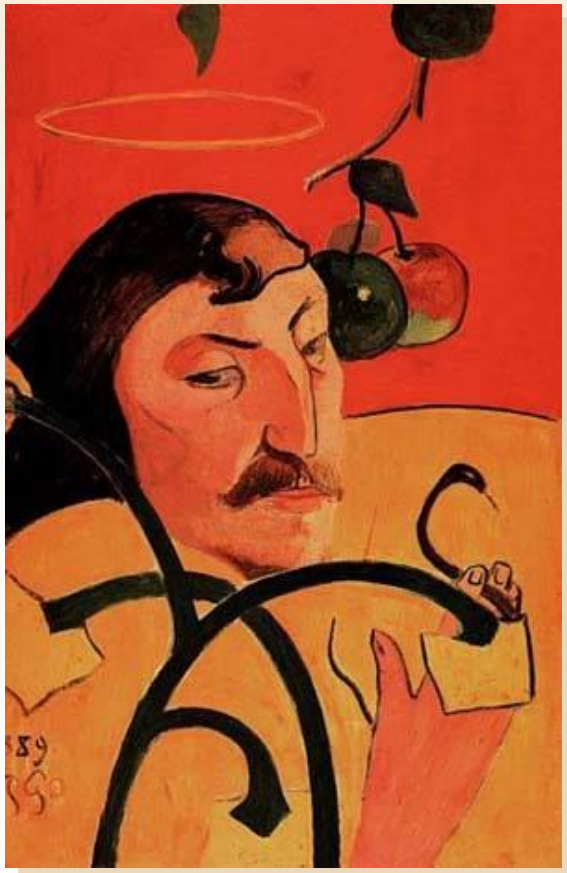
http://e-culture.multimedian.nl

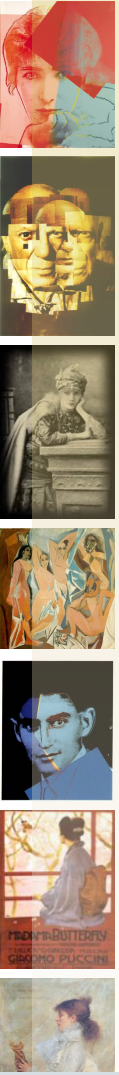
Small datasets already give scalability issues

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

?





W3C Working Draft

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>
Mark Birbeck, x-port.net Ltd. <mark.birbeck@x-port.net>

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*

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

Ranking based on semantic distance In thesaurus

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

Supporting annotation: Automatically deriving spatial relations

Object1
left
Object2

Supporting annotation: Recognizing color of cloths

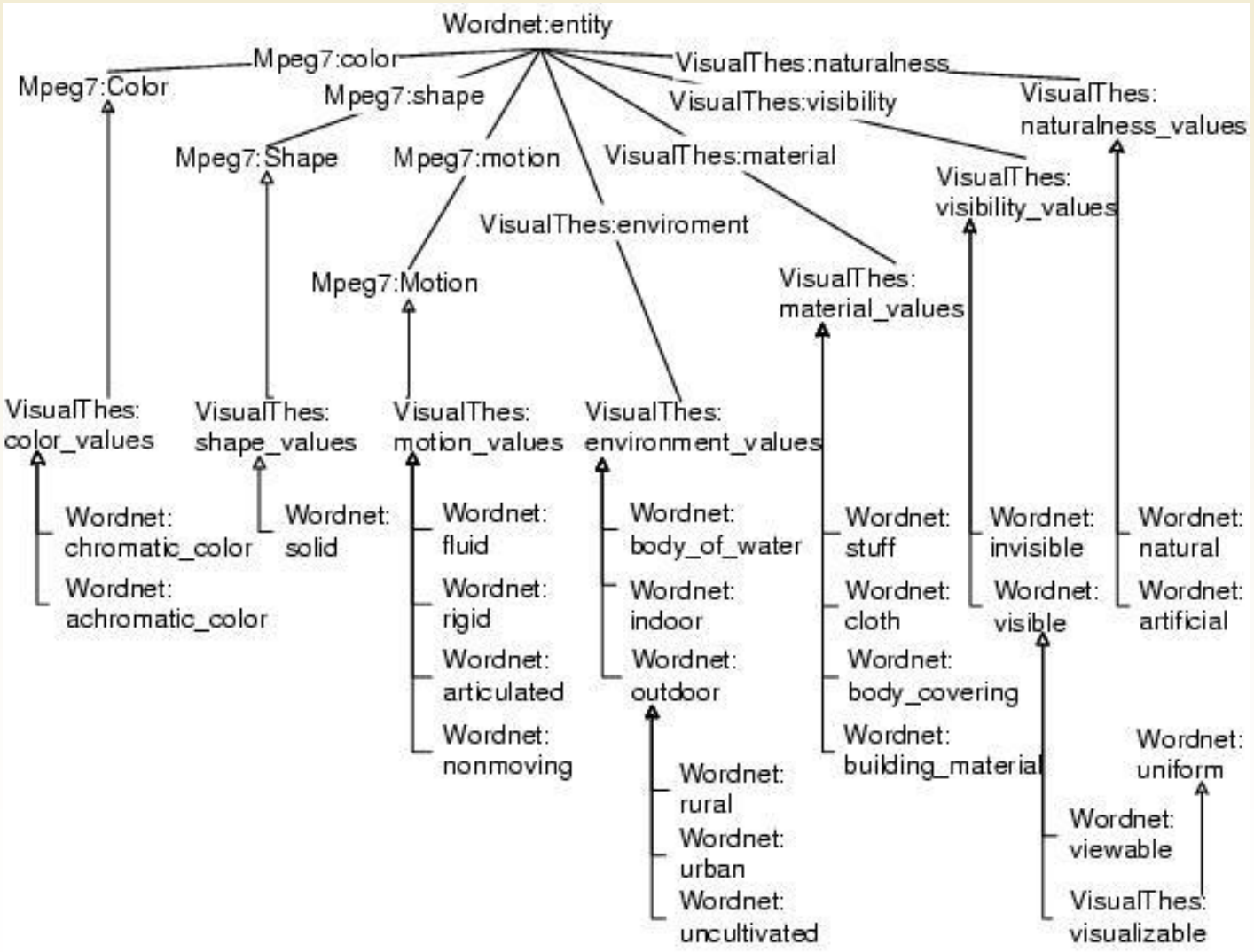
Color value from AAT

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



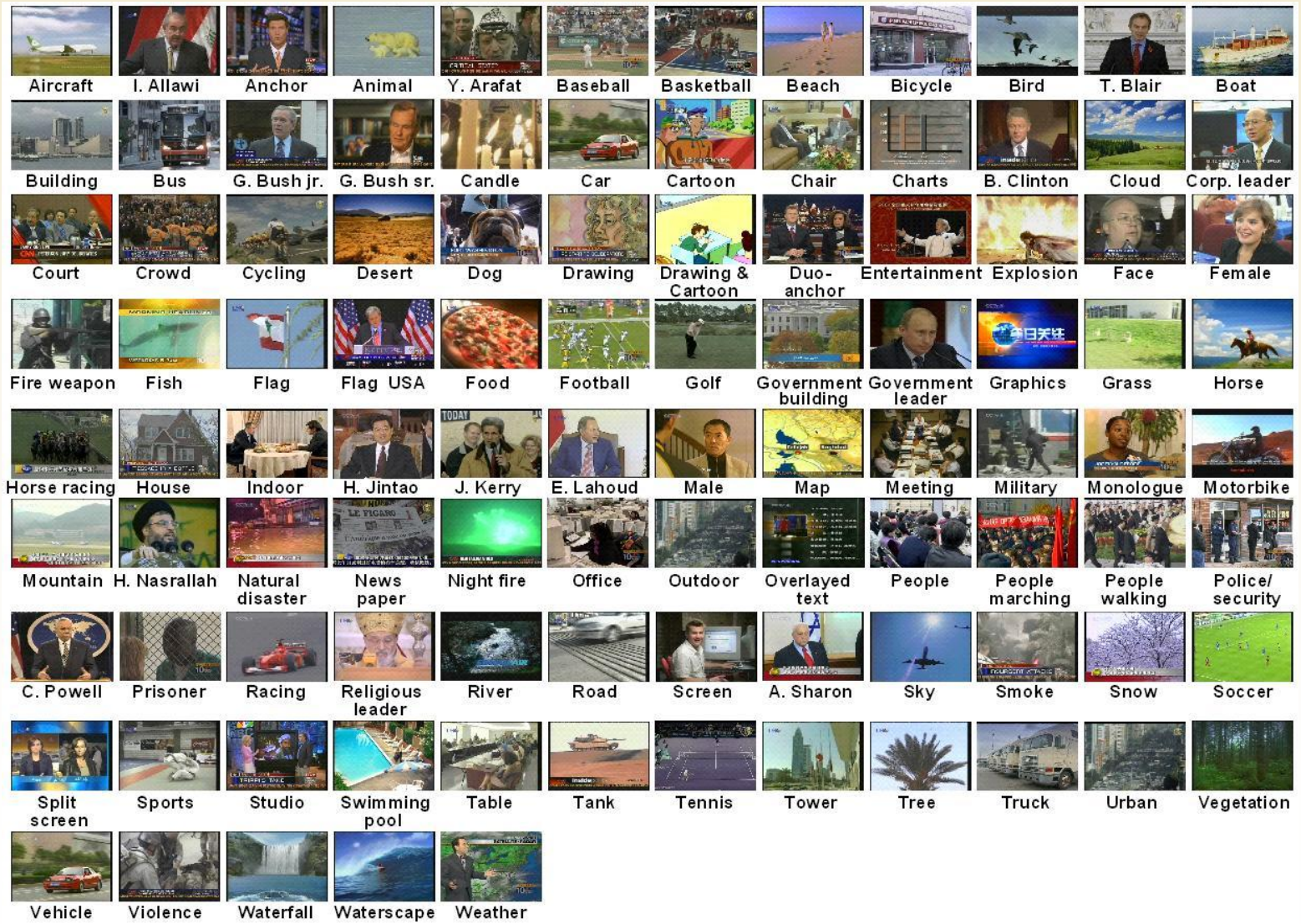
Experiment: pruning the search for “conveyance” concepts

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

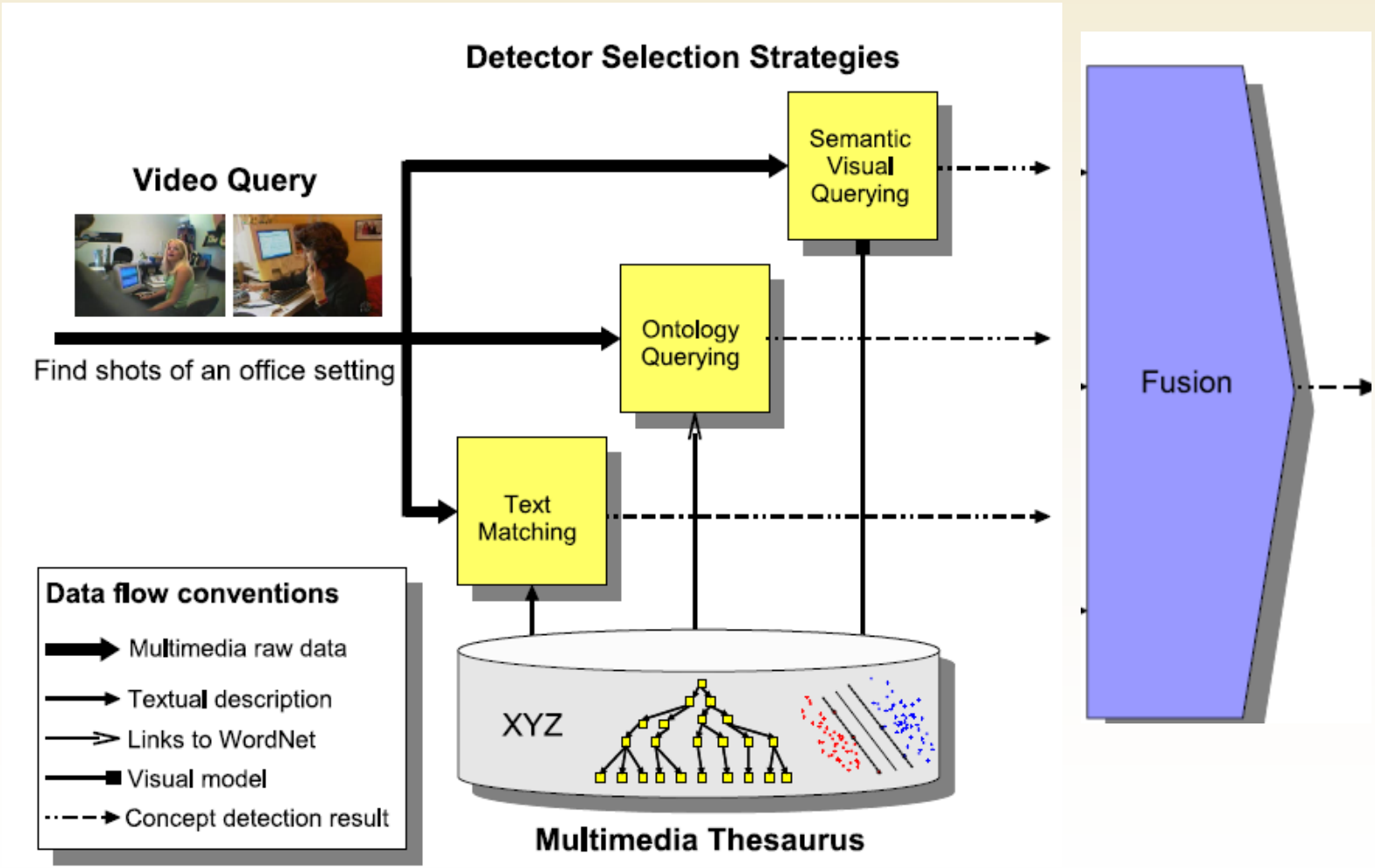
  John Kerry => wn:Senator

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

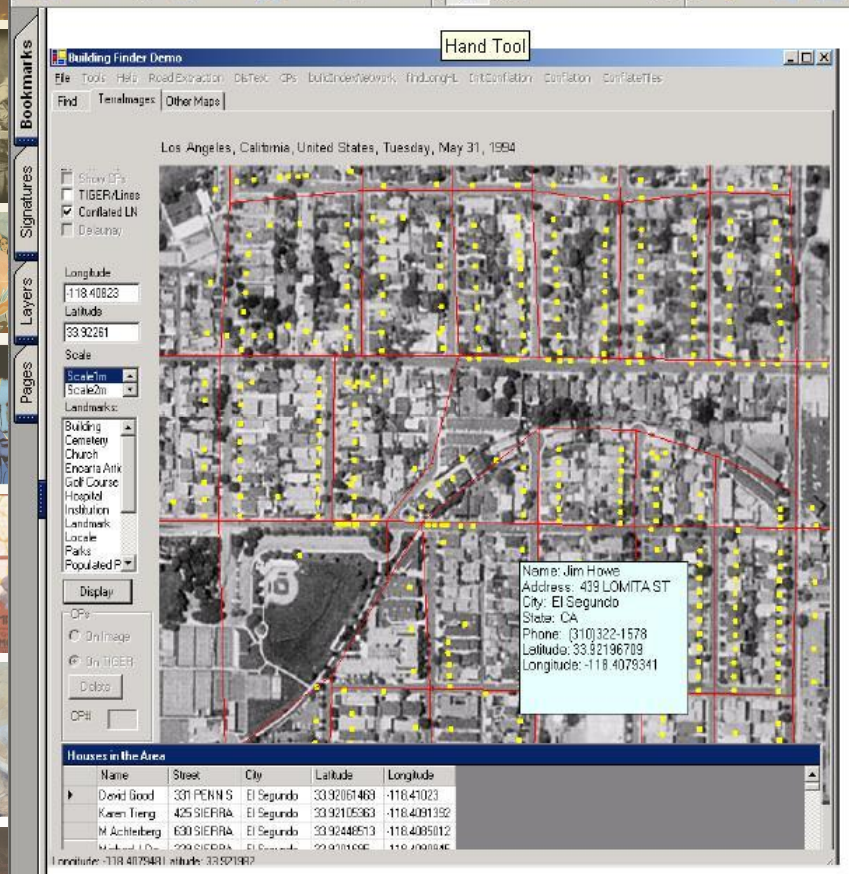


Figure 1. Screenshot of Building Finder

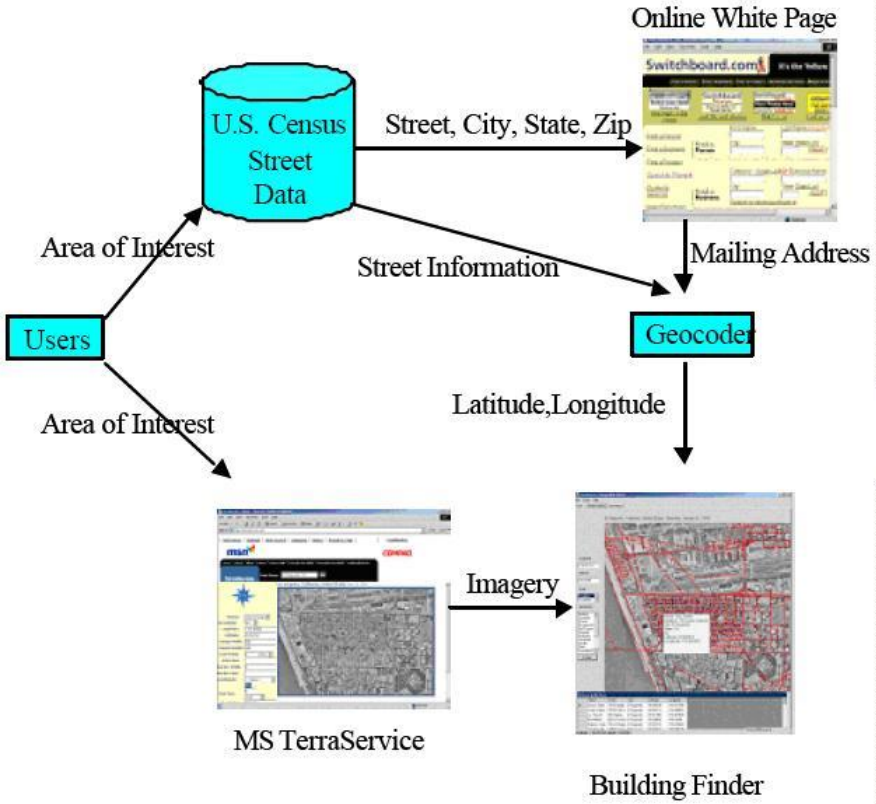


Figure 2. Building Finder application architecture

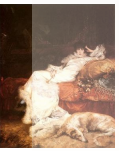
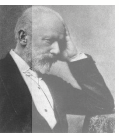
Take home message

- 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 loys of opportunities for SW technology
  - But we have to take them







Type | Title | Creator | Style/Period | Material | Date | Description | Culture | Measurements

Type

- Work 12
- SVCN Concept
- AAT Concept
- Place
- Person

depicted place

- World
  - Europe
    - France
      - Île-de-France
        - Ville de Paris, Dépar ...
          - 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)


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)