Semantic Web Applications

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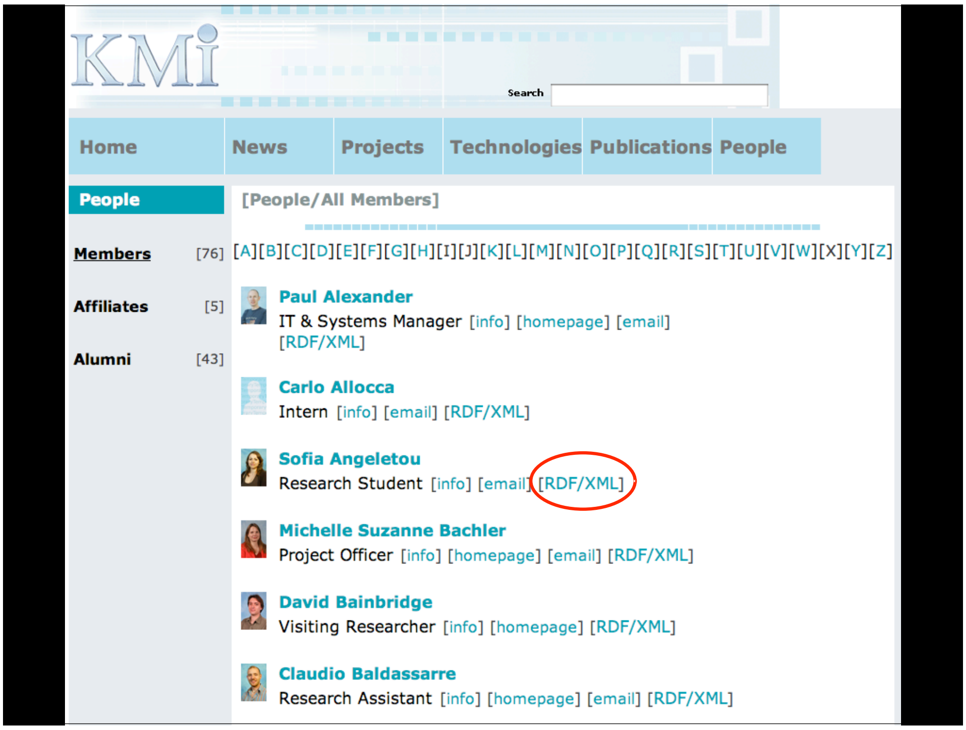
The Semantic Web

The collection of all formal, machine processable, web accessible, ontology-based statements (semantic metadata) about web resources and other entities in the world, expressed in a knowledge representation language based on an XML syntax (e.g., OWL, DAML, DAML+OIL, RDF, etc…)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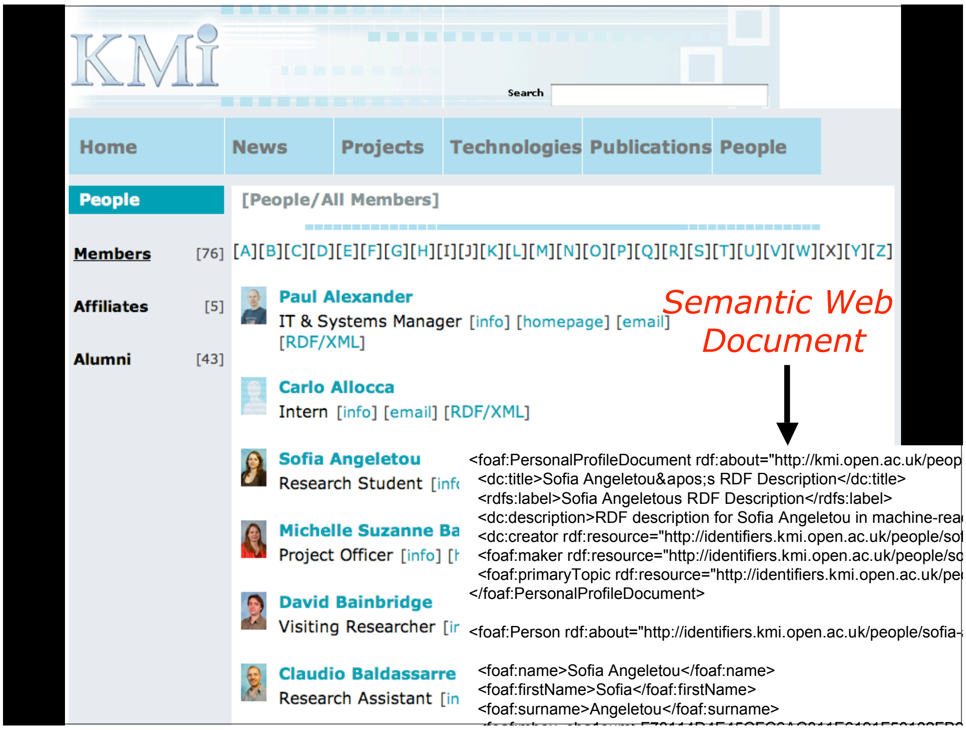
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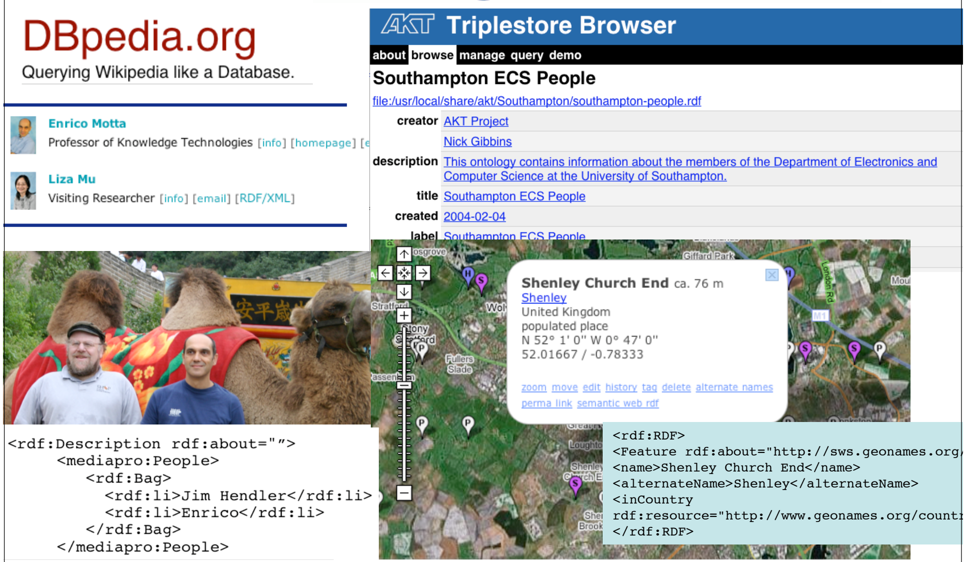
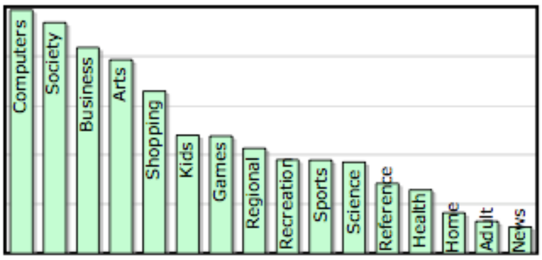
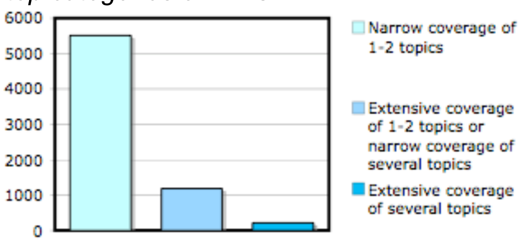
Semantic Content is Increasing….



Domain Coverage on the SW



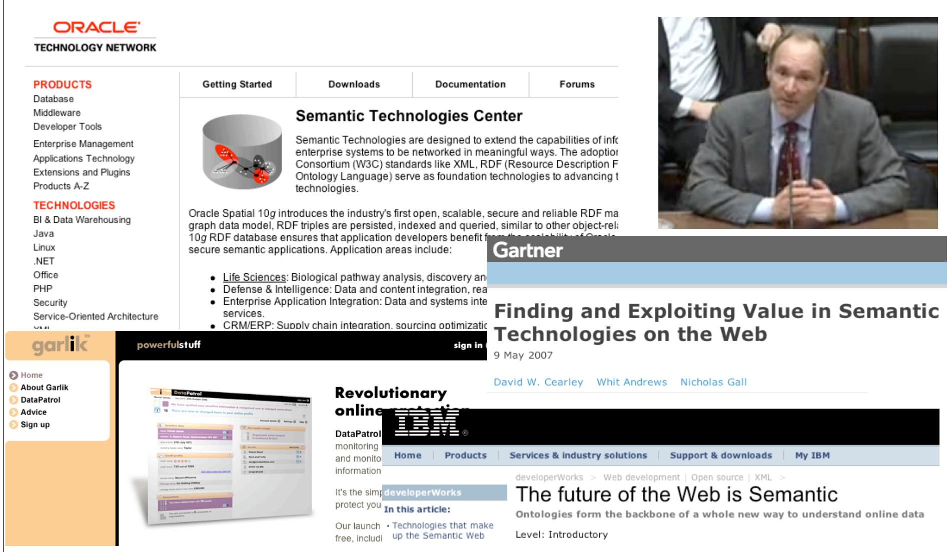
Distribution of documents in the 16 top categories of DMOZ



Distribution of the documents according to their coverage

- Great variety: Some topics are almost not covered (e.g. Health), while some are covered reasonably well (e.g. Society, Computers)
- As we can expect, a large number of narrow coverage documents and a small number of large coverage ones.

The Rise of Semantics



Key Points

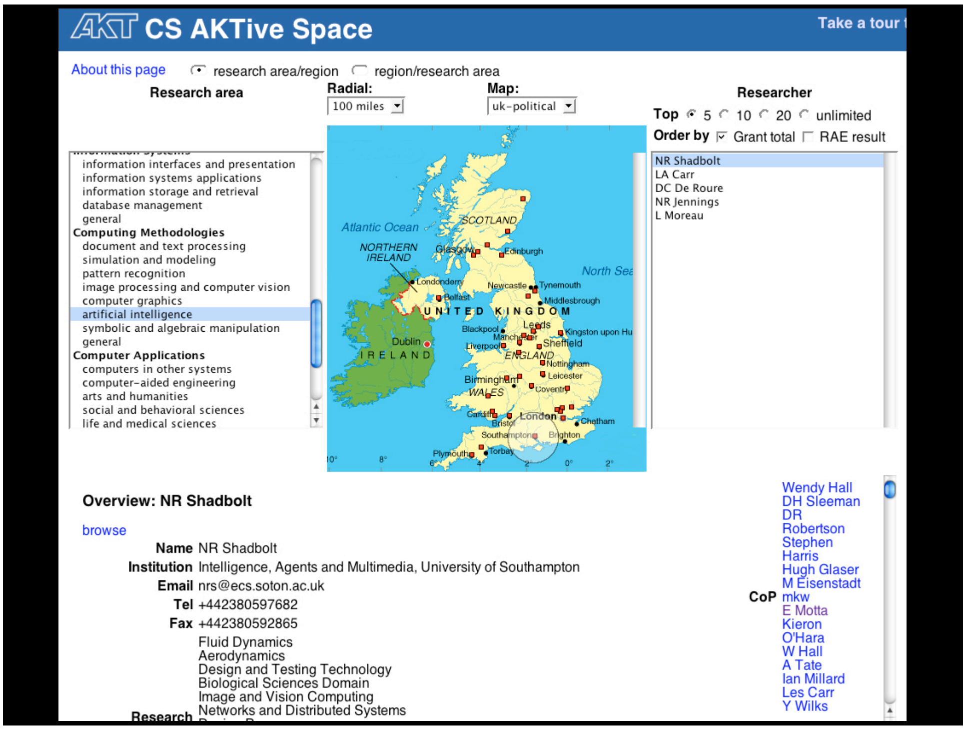
- The SW is less and less an aspiration and more and more a reality: there is already a large amount of semantic markup available on the web
- However the domain coverage of the semantic web is patchy. Some domains are well covered, others covered very little
- This emerging large scale semantics opens up new possibilities for building novel, knowledge-based applications
- In addition, it may also provide a solution to one of the holy grails of AI research: the availability of large-scale background knowledge to enable intelligent behaviour

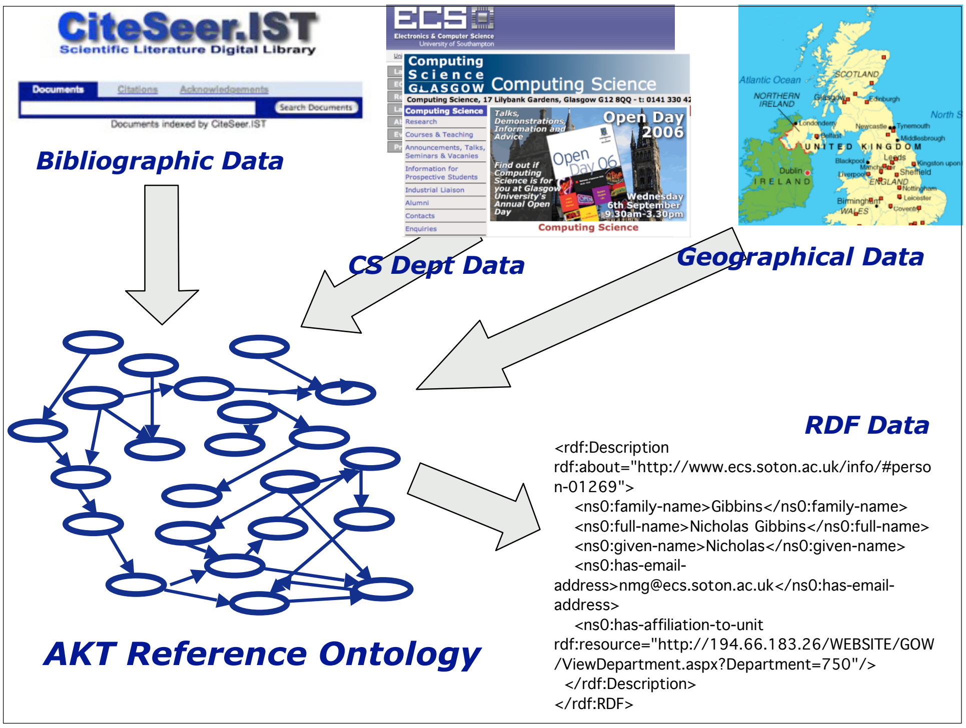
Semantic Web Applications

Application Types

- Lots of different types…diversity is increasing…see “Intro to SW” talk…..
  - Enterprise Information Integration
  - Web 2.0 like
  - Devices
  - Agents
  - Etc…
- Here we focus on two broad classes of applications
  - (Semantically) Closed SW Applications *(1st generation)*
    - Typically in the domain of Enterprise Information Integration
  - (Semantically) Open SW Applications *(2nd generation)*

Closed SW Applications

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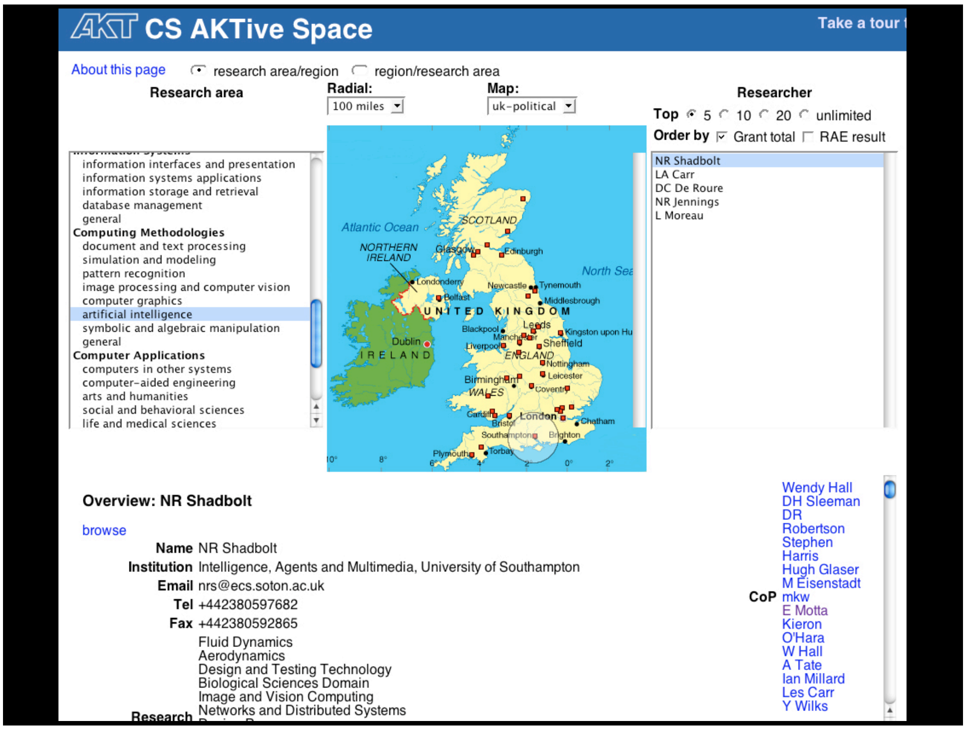
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E Motta
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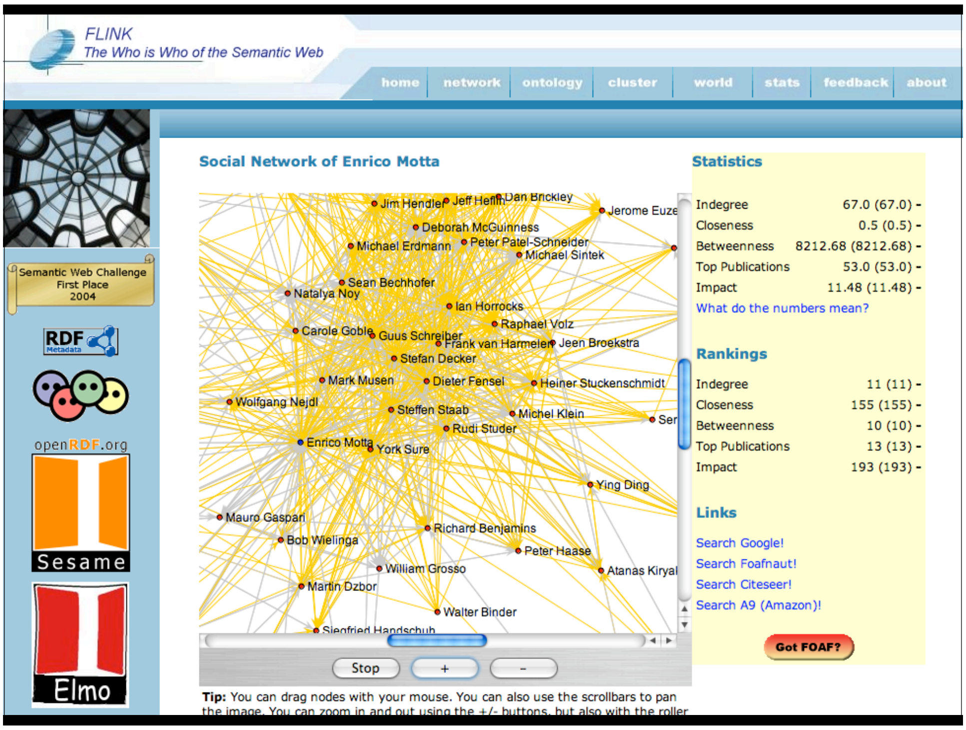
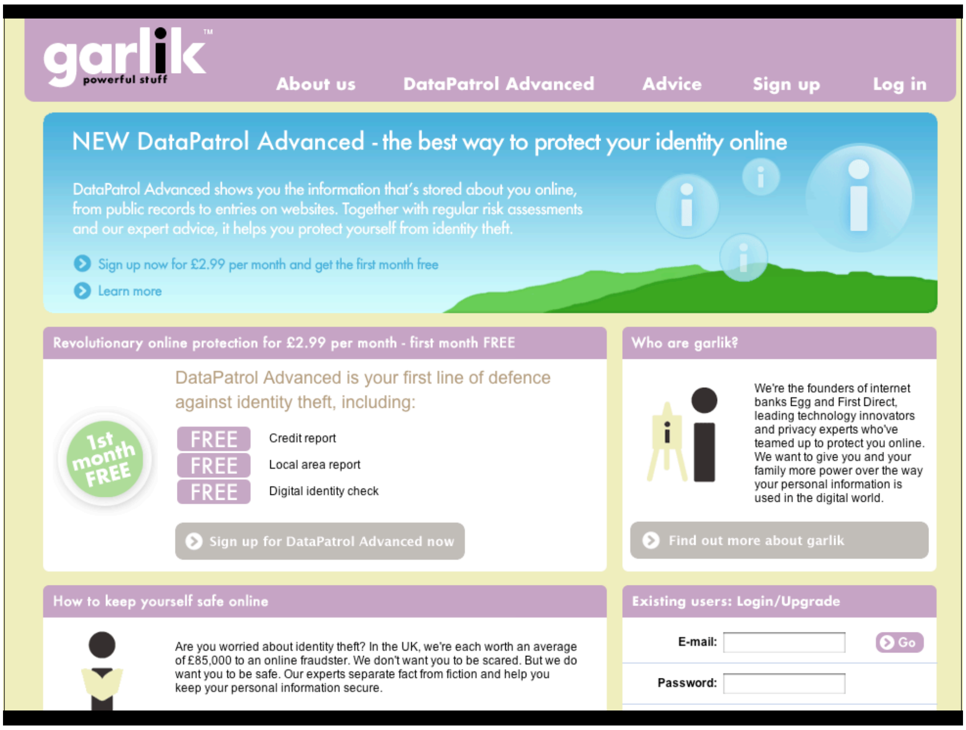
Ian Millard
Les Carr
Y Wilks



Closed SW Applications

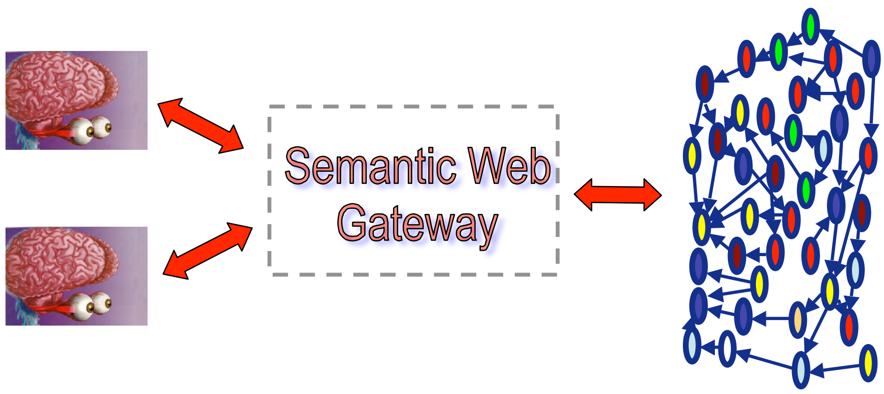
- A 'corporate ontology' is used to provide a homogeneous view over heterogeneous data sources.
- Limited use of existing SW data
  - Data are typically scraped from existing non-semantic sources
- Typically closed to additional (heterogenous) semantic resources
  - On-the-fly semantic data integration is usually not supported
- Often tackle Enterprise Information Integration scenarios
- Can be seen (to some extent) as the application of traditional knowledge engineering technologies in a web environment



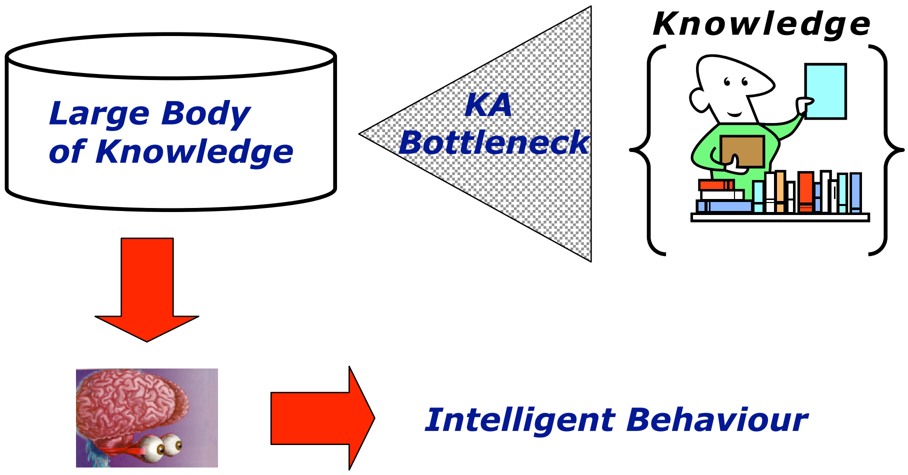
Open SW Applications

(2nd Generation SW Applications)

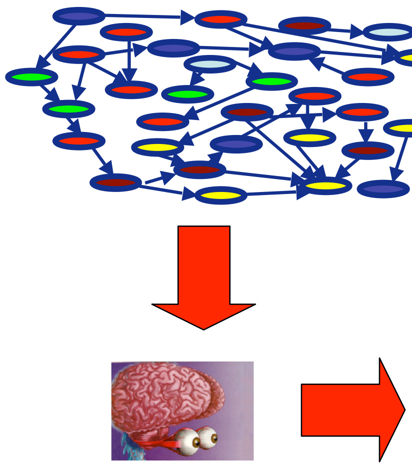
Architecture of OSW Apps



The Knowledge Acquisition Bottleneck

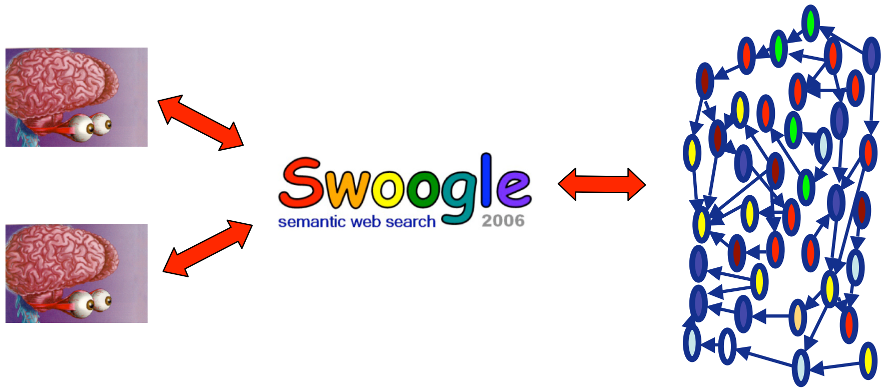


SW as Enabler of Intelligent Behaviour



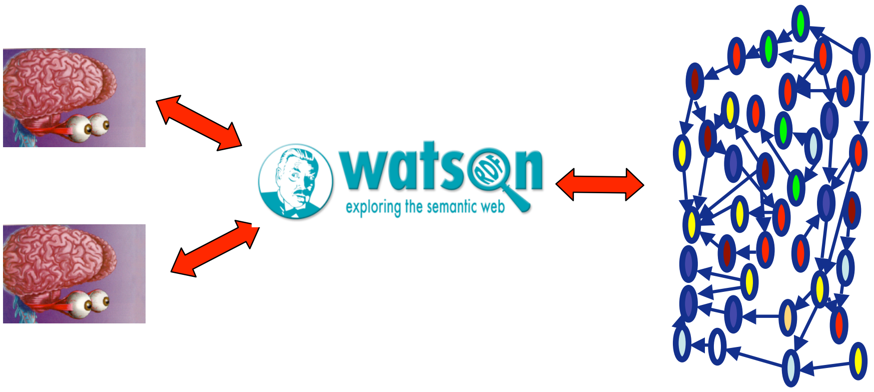
Intelligent Behaviour

Swoogle



http://swoogle.umbc.edu/

Watson

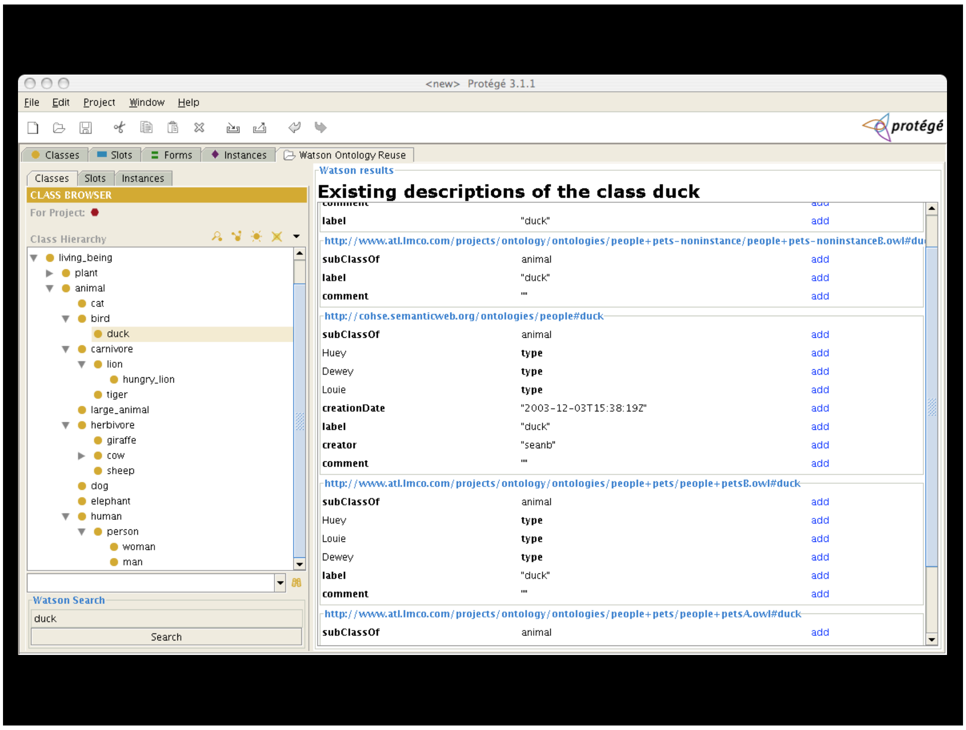


http://watson.kmi.open.ac.uk

watson

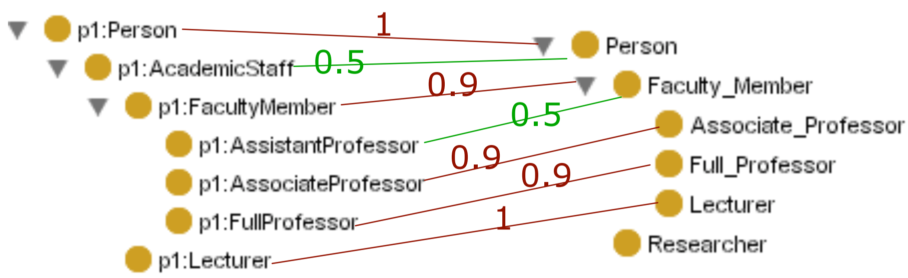
exploring the semantic web

- Sophisticated quality control mechanism
  - Detects duplications
  - Fixes obvious syntax problems
    - E.g., duplicated ontology IDs, namespaces, etc..
- Structures ontologies in a network
  - Using relations such as: *extends, inconsistentWith, duplicates*
- Provides efficient API
- Supports formal queries (SPARQL)
- Variety of ontology ranking mechanisms
- Modularization/Combination support
- Plug-ins for Protégé and NeOn Toolkit
- Very cool logo!



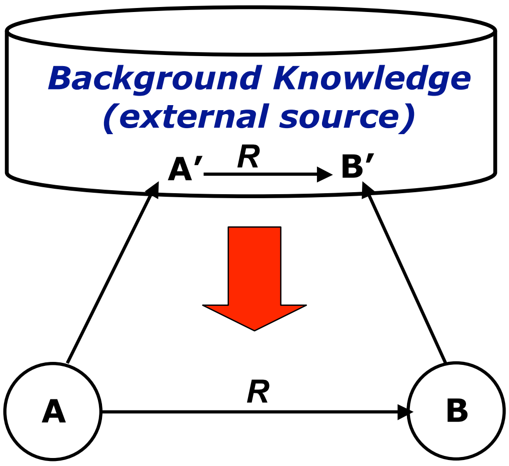
Example: Using the SW as Background Knowledge for Ontology Matching

Ontology Matching



- Label similarity methods
  - e.g., Full_Professor = FullProfessor
- Structure similarity methods
  - Using taxonomic/property related information

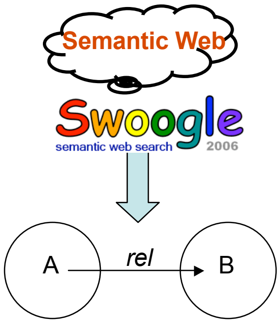
New paradigm: Use of Background Knowledge



External Source = SW

Proposal:

- rely on online ontologies (Semantic Web) to derive mappings
- ontologies are ***dynamically*** discovered and combined

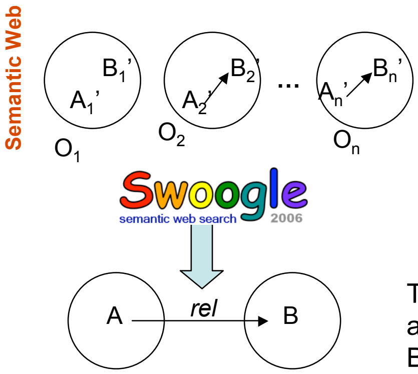


Does not rely on any pre-selected knowledge sources.

M. Sabou, M. d'Aquin, E. Motta, "*Using the Semantic Web as Background Knowledge in Ontology Mapping*", Ontology Mapping Workshop, ISWC'06. *Best Paper Award*

Strategy 1 - Definition

Find ontologies that contain equivalent classes for A and B and use their relationship in the ontologies to derive the mapping.



For each ontology use these rules:

$$A' \equiv B' \Rightarrow A \equiv B$$

$$A' \subseteq B' \Rightarrow A \subseteq B$$

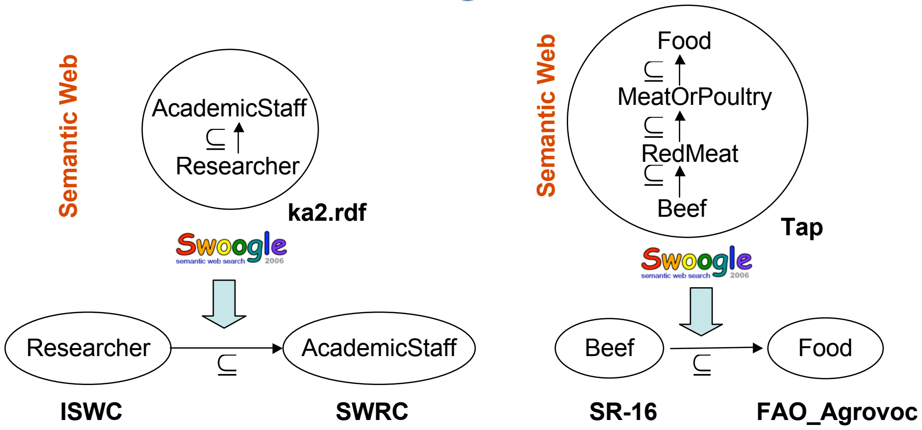
$$A' \supseteq B' \Rightarrow A \supseteq B$$

$$A' \perp B' \Rightarrow A \perp B$$

These rules can be extended to take into account indirect relations between A' and B', e.g., between parents of A' and B':

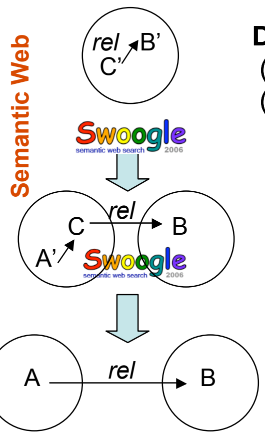
$$A' \subseteq C \wedge C \perp B' \Rightarrow A' \perp B'$$

Strategy 1- Examples



Strategy 2 - Definition

Principle: If no ontologies are found that contain the two terms then combine information from multiple ontologies to find a mapping.



Details:

(1) Select all ontologies containing A' equiv. with A

(2) For each ontology containing A':

(a) if $A' \subseteq C$ find relation between C and B.

(b) if $A' \supseteq C$ find relation between C and B.

$$(r1) A' \subseteq C \wedge C \subseteq B \Rightarrow A \subseteq B$$

$$(r2) A' \subseteq C \wedge C \equiv B \Rightarrow A \equiv B$$

$$(r3) A' \subseteq C \wedge C \perp B \Rightarrow A \perp B$$

$$(r4) A' \supseteq C \wedge C \supseteq B \Rightarrow A \supseteq B$$

$$(r5) A' \supseteq C \wedge C \equiv B \Rightarrow A \supseteq B$$

Strategy 2 - Examples

Ex1: $Chicken$ **Vs.** $Food$

$Chicken \subseteq Poultry$ **(midlevel-onto)**
$Poultry \subseteq Food$ **(Tap)**
(r1) ⇒ $Chicken \subseteq Food$

(Same results for Duck, Goose, Turkey)

Ex2: Ham **Vs.** $Food$

$Ham \subseteq Meat$ **(pizza-to-go)**
$Meat \subseteq Food$ **(SUMO)**
(r1) ⇒ $Ham \subseteq Food$

Ex3: Ham **Vs.** $Seafood$

$Ham \subseteq Meat$ **(pizza-to-go)**
$Meat \perp Seafood$ **(wine.owl)**
(r3) ⇒ $Ham \perp Seafood$

Large Scale Evaluation

Matching AGROVOC (16k terms) and NALT(41k terms)

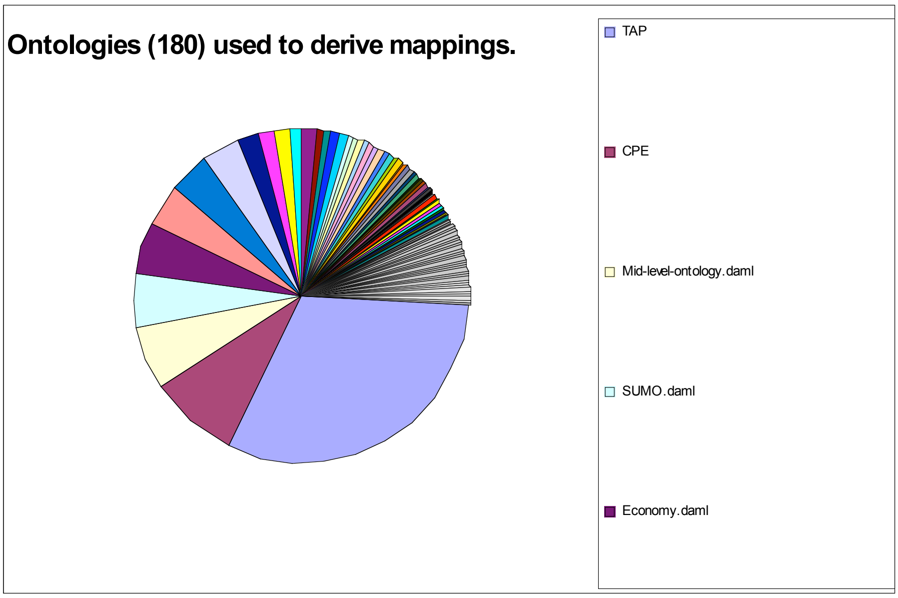
	Nr.	Examples
Subclass ($\xrightarrow{\sqsubseteq}$)	1477	$Lamb \xrightarrow{\sqsubseteq} Sheep$, $Soap \xrightarrow{\sqsubseteq} Detergent$, $Asbestos \xrightarrow{\sqsubseteq} Pollutant$ $Oasis \xrightarrow{\sqsubseteq} Ecosystem$, $RAM \xrightarrow{\sqsubseteq} ComputerEquipment$
SuperClass ($\xrightarrow{\sqsupseteq}$)	1857	$Shop \xrightarrow{\sqsupseteq} Supermarket$, $Spice \xrightarrow{\sqsupseteq} BlackPepper$, $Valley \xrightarrow{\sqsupseteq} Canyon$ $Infrastructure \xrightarrow{\sqsupseteq} Highway$, $Storm \xrightarrow{\sqsupseteq} Tornado$, $Rock \xrightarrow{\sqsupseteq} Crystal$
Disjoint ($\xrightarrow{\perp}$)	229	$Fluid \xrightarrow{\perp} Solid$, $Fluid \xrightarrow{\perp} Gas$, $Pond \xrightarrow{\perp} River$, $Plant \xrightarrow{\perp} Animal$ $Newspaper \xrightarrow{\perp} Journal$, $Fruit \xrightarrow{\perp} Vegetable$, $Female \xrightarrow{\perp} Male$
Total	3563	

(derived from 180 different ontologies)

Evaluation: 1600 mappings, two teams, 70% Precision

M. Sabou, M. d'Aquin, E. Motta. "Using the Semantic Web as Background Knowledge for Ontology Matching". To appear in the Journal of Data Semantics

Chart 2



Error Type	Nr./ %	Examples				
		AGROVOC Concept	Labels	Rel.	NALT Concept	Labels
Anchor	114, 53%	*c_6443*	Rams, Tups	$\sqsubseteq$	*memory*	memory
		O_1:ram $\sqsubseteq$ O_1:memory				
		O_1 = `http://www.arches.uga.edu/~gonen/qos_bilal.owl`				
Subsumption as generic relation	40, 18%	*c_3954*	Irrigation	$\sqsubseteq$	*agriculture*	agriculture
		O_1:Irrigation $\sqsubseteq$ O_1:SoilCultivation $\sqsubseteq$ O_1:Agriculture				
		O_1 = `http://sweet.jpl.nasa.gov/ontology/human_activities.owl`				
Subsumption as part-whole	16, 7%	*c_666*	Asia	$\sqsupseteq$	*Iran*	Iran
		O_1:Asia $\sqsupseteq$ O_1:WestAsia $\sqsupseteq$ O_1:Iran				
		O_1 = `http://islab.hanyang.ac.kr/damls/Country.daml`				
Subsumption as role	11, 5%	*c_11091*	Garlic	$\sqsubseteq$	*ingredients*	ingredients
		O_1:garlic $\sqsubseteq$ O_1:vegetable $\sqsubseteq$ O_1:ingredient				
		O_1 = `http://cvs.sourceforge.net/viewcvs.py/instancestore/instancestore/ontologies/Attic/pizza9.daml?rev=1.2`				
Inaccurate labeling	12, 5%	*c_1693*	Coal	$\sqsubseteq$	*industry*	industry
		O_1:coal $\sqsubseteq$ O_1:industry				
		O_1 = `http://www.aifb.uni-karlsruhe.de/WBS/meh/mapping/data/russia1a.rdf`				
Different View	12, 5%	*c_2943*	Fishes	$\sqsupseteq$	*lobsters*	lobsters
		O_1:Fish $\sqsupseteq$ O_1:MarineInvertebrate $\sqsupseteq$ O_1:Crustacean $\sqsupseteq$ O_1:Lobster				
		O_1 = `http://139.91.183.30:9090/RDF/VRP/Examples/tap.rdf`				

Conclusions

- Many ‘classic’ applications of SW technology use ontologies to support the integration of distributed data sources
  - These applications are typically ‘semantically closed’
- As more and more semantic information becomes available on the SW, researchers are also looking at ‘semantically open’ applications, able to exploit large scale semantics to support intelligent problem solving
- This approach is being used in a number of other scenarios, including:
  - Semantic Web Browsing
  - Question Answering
  - Integration of Folksonomies with the SW

Selected References

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  - Sabou, M., D'Aquin, M., Motta, E. (2006). ***"Using the semantic web as background knowledge for ontology mapping"***. ISWC 2006 Workshop on Ontology Mapping.
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  - L.Specia, E. Motta, ***"Integrating Folksonomies with the Semantic Web"***, ESWC 2007.
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  - d’Aquin, M., Sabou, M., Dzbor, M., Baldassarre, C., Gridinoc, L., Angeletou, S. and Motta, E.: ***"WATSON: A Gateway for the Semantic Web"***. Poster Session at ESWC 2007

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- Motta, E., Sabou, M. (2006). ***"Next Generation Semantic Web Applications"***. 1st Asian Semantic Web Conference, Beijing.

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