

Semantic Web

Methods, Tools and Applications

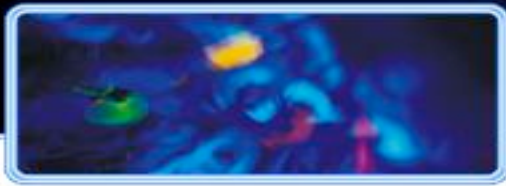
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**Asian Autumn School for the Semantic Web
AASSW 2007**

Busan, Korea



Introduction

■ Dr. Peter Haase

- Researcher at AIFB, University of Karlsruhe
- Project leader: NeOn – Lifecycle support for networked ontologies
- Interests and expertise: Semantic technologies and Semantic Web Infrastructure

■ Denny Vrandečić

- Researcher at AIFB, University of Karlsruhe
- Developer of Semantic MediaWiki
- Interests and expertise: Social Semantic Web, Ontology Evaluation



Agenda

- **Motivation**
 - Semantic Technologies and Ontologies
 - Ontology Lifecycle

- **Methods and Tools**
 - Ontology Development
 - Ontology Learning
 - Ontology Mapping
 - Ontology Evaluation and Evolution
 - Ontology Management: Repositories and Reasoners

- **Applications**
 - Content Management / Information Search and Retrieval
 - Expert and Assistance Systems
 - Social and collaborative applications
 - Web Applications

Information Search Example

Problem: What does the available information really mean?

Find all companies specialising in semantic technologies in Europe.

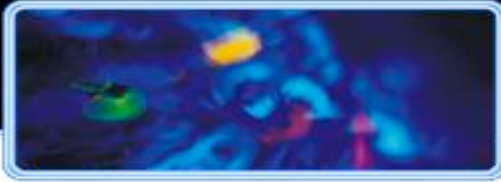
Could he find a company related to RDF?

...semantic technology...

companies...

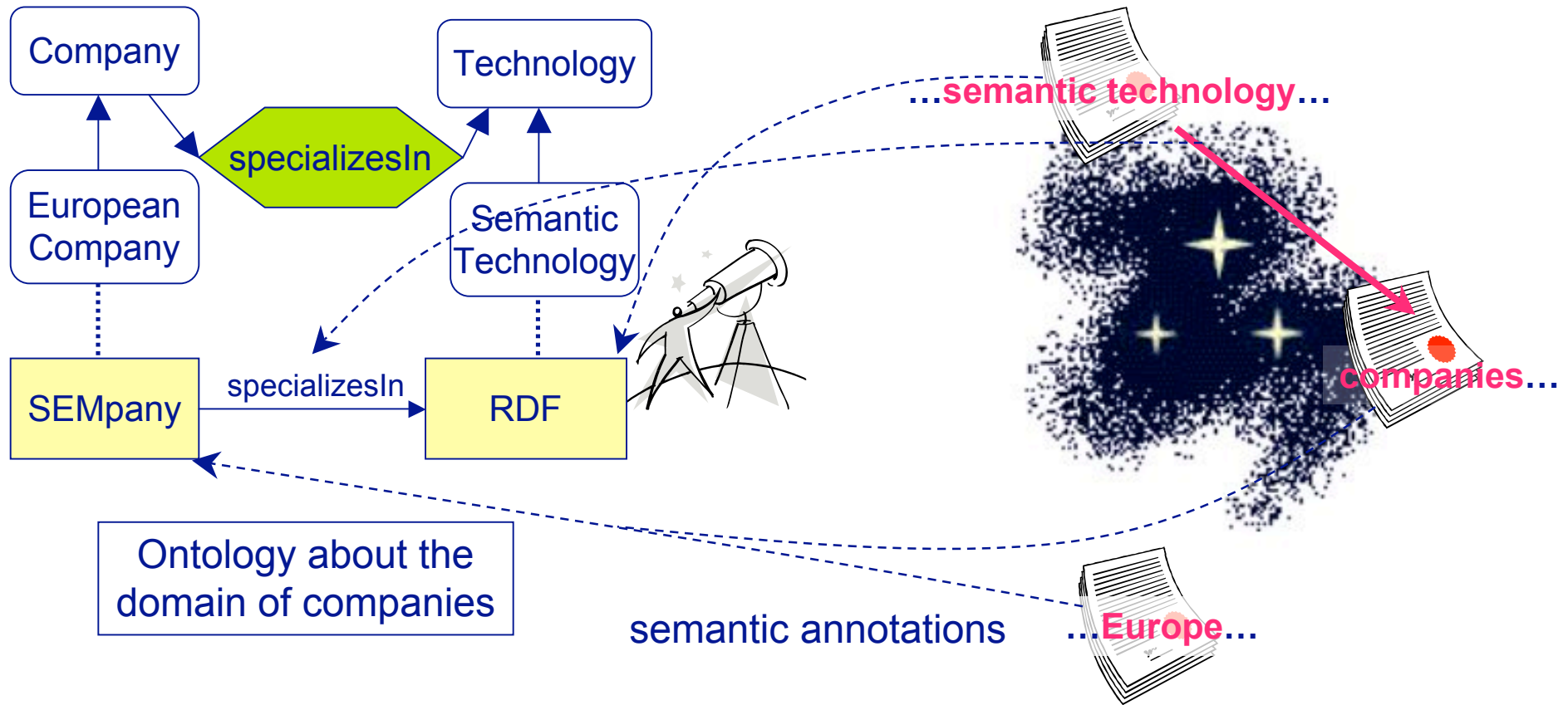
...Europe...

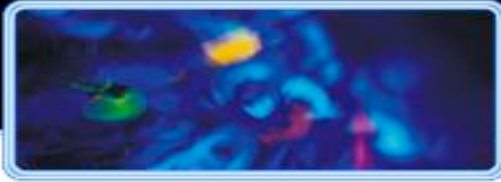
Search is based on **keywords**, and not on the actual meaning/**semantics**.



Information Search Example

Approach: Annotate information elements (including links) with information about their meaning

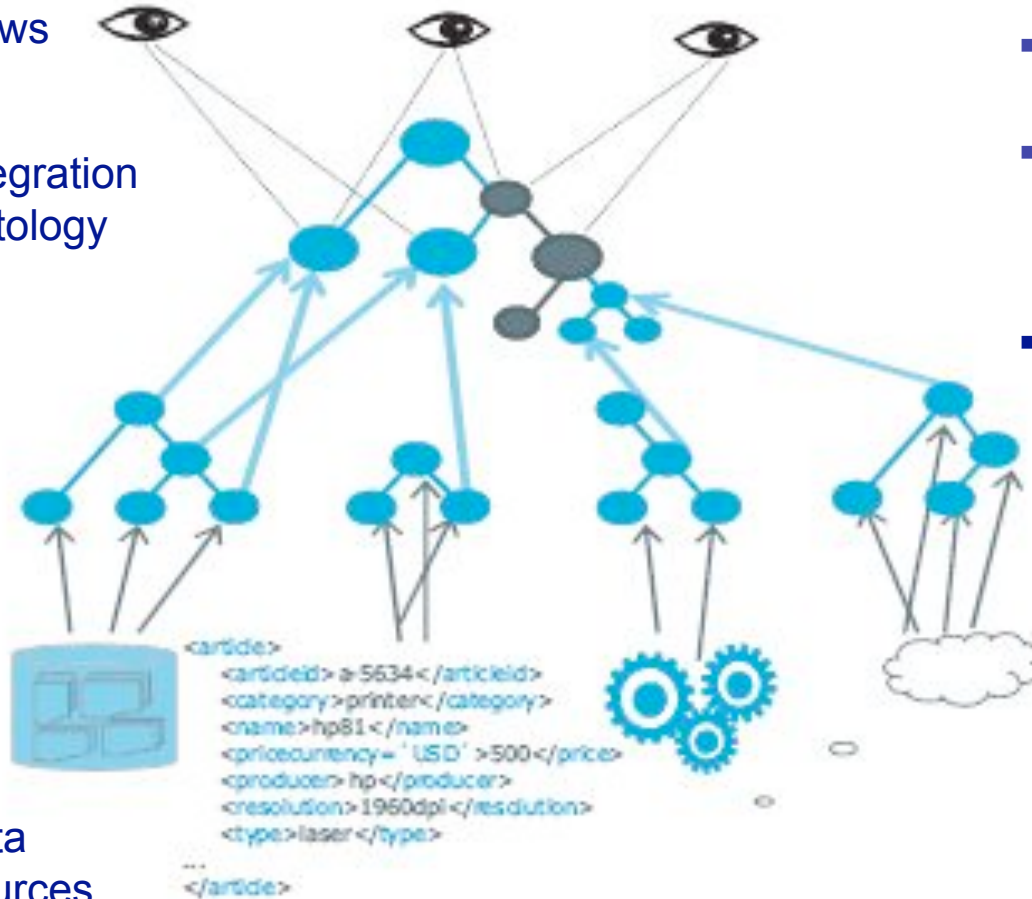




Semantic Technologies Provide Dynamic Integration Solutions to EII

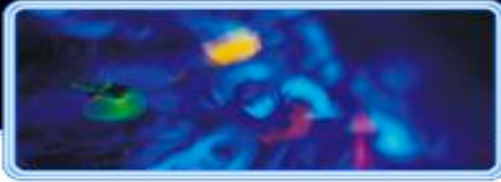
User Views

Integration Ontology



Data Sources

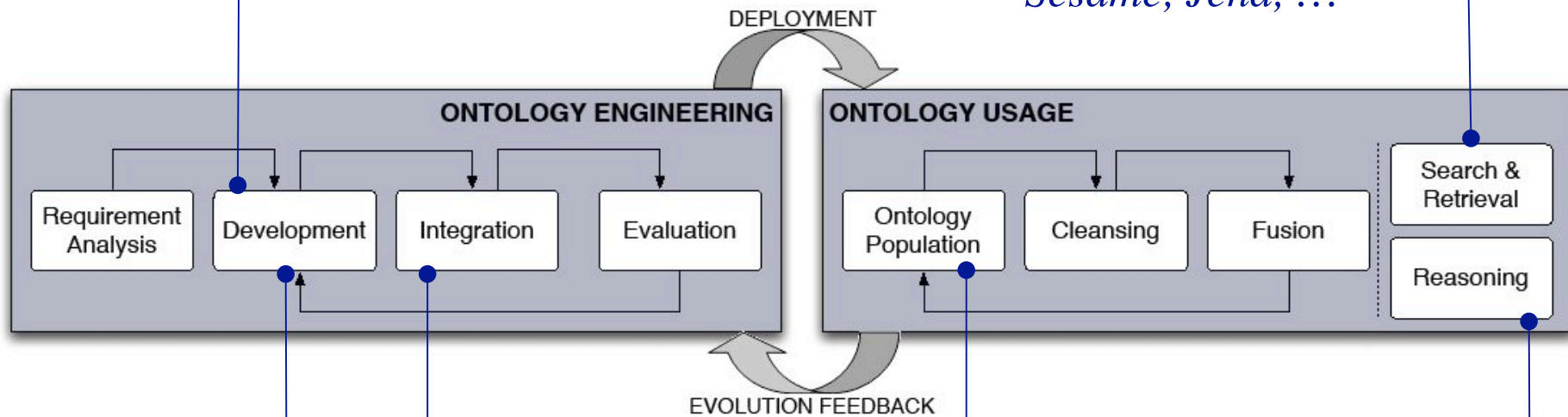
- Data Integration **most costly** and challenging task for enterprises
- E.g. up to 80% of migration costs due to data integration
- Semantic technologies enable dynamic integration solution which federate queries and merge data from heterogeneous data sources
- **Benefits** of ontologies
 - **Shared interpretation** of distributed data
 - **Conceptually adequate** and **expressive** data model to integrate heterogeneous data
 - **Ease of maintenance** because of declarative specification of integration rules



Lifecycle Activities and Tools

• *Ontology Development Environments*
Protege, NeOn Toolkit

Ontology Repositories
Sesame, Jena, ...



• *Ontology Mapping Tools*
Prompt, OntoMap...

• *Ontology Learning Tools*
Text2Onto, OntoLT, ...

Ontology Reasoners
Pellet, KAON2, Racer, ...

Ontology Development with Protege OWL

The screenshot displays the Protege 3.1 ontology editor interface. The main window title is "travel Protégé 3.1 (file:C:\protege-owl\owl\travel.pprj, OWL Files (.owl or .rdf))". The menu bar includes File, Edit, Project, OWL, Code, Window, Tools, and Help. The toolbar contains various icons for file operations and editing. The interface is divided into several panes:

- Subclass Relationship:** Shows the asserted hierarchy for the project "travel". The hierarchy starts with `owl:Thing` and includes classes like `Accommodation`, `Activity`, and `Destination`. `FamilyDestination` is currently selected under the `Destination` class.
- Class Editor:** Shows the editor for the class `FamilyDestination` (instance of `owl:Class`). It includes tabs for Name, SameAs, and DifferentFrom. The name field contains "FamilyDestination". The `rdfs:comment` field contains the text: "A destination with at least one accommodation and at least 2 activities."
- Annotations:** A table showing annotations for the class. The table has columns for Property, Value, and Lang. One annotation is visible: `rdfs:comment` with the value "A destination with at le...".
- Asserted Conditions:** Shows the asserted conditions for the class. It includes a section for "NECESSARY & SUFFICIENT" conditions: `Destination`, `hasAccommodation ≥ 1`, and `hasActivity ≥ 2`. There is also a section for "NECESSARY" conditions.
- Properties:** Shows the properties defined for the class. The properties listed are `hasAccommodation` (multiple Accommodation, cardinality ≥ 1), `hasActivity` (multiple Activity, cardinality ≥ 2), and `hasPart` (multiple Destination).
- Disjoints:** Shows disjoints for the class. The disjoints listed are `RetireeDestination`.

At the bottom right, there are radio buttons for "Logic View" (selected) and "Properties View".

Ontology Development with the NeOn Toolkit

The screenshot displays the NeOn Toolkit interface for editing an ontology. The main window is titled 'Schema - NeOn Toolkit' and contains several panes:

- Ontology Navigator:** A tree view showing the ontology structure. The selected path is 'AASSW > AIFBPortal.owl > Concepts > Person > Student > Graduate > PhDStudent'.
- Entity Properties View:** The central pane for editing the 'PhDStudent' entity. It shows:
 - Name:** PhDStudent
 - Namespace:** swrc.ontoware.org/ontology#
 - Attributes Table:**

Attribute	Range	Min	Max
address	string	0	N
email	string	0	N
fax	string	0	N
homepage	string	0	N
name	string	0	N
phone	string	0	N
 - Relations Table:**

Relation	Range	Min	Max
publication	Publication	0	N
studiesAt	University	0	N
supervisor	AcademicStaff	0	N
worksAtProject	Project	0	N
 - Representations:** A table with columns for different languages (de, en, fr).
 - Description:** A dropdown menu set to 'de'.
- Instance View:** A list of instances for the 'PhDStudent' entity, including 'id12instance' through 'id2053instance'.
- Properties:** A table for editing instance properties, with columns for 'Property' and 'Value'.

The status bar at the bottom indicates 'Datamodel: RAM'.



Ontology Development Tools

	<i>Protégé OWL</i>	<i>Semantic Works</i>	<i>TopBraid Composer</i>	<i>IODT</i>	<i>SWOOP</i>	<i>OntoStudio (NeOn Toolkit)</i>
Developer	Stanford	Altova	TopQuadrant	IBM	Univ. of Maryland	Ontoprise (NeOn Found.)
Primary Ontology Language	OWL	OWL	OWL	OWL	OWL	F-Logic (+OWL)
View	Form Text	Form Text Graph	Form Text (UML-like) Graph	(UML-like) Graph	Browser- like	Forms
Platform	Java	.NET	Eclipse	Eclipse	Browser + Java	Eclipse
Supported Reasoner	Via DIG	None	Pellet, (built-in) Via DIG	RACER, Pellet	Pellet	OntoBroker (+ KAON2)
Repository	Files, RDBMS	Files	Files, RDBMS	RDF on RDBMS	Files	Files, RDBMS

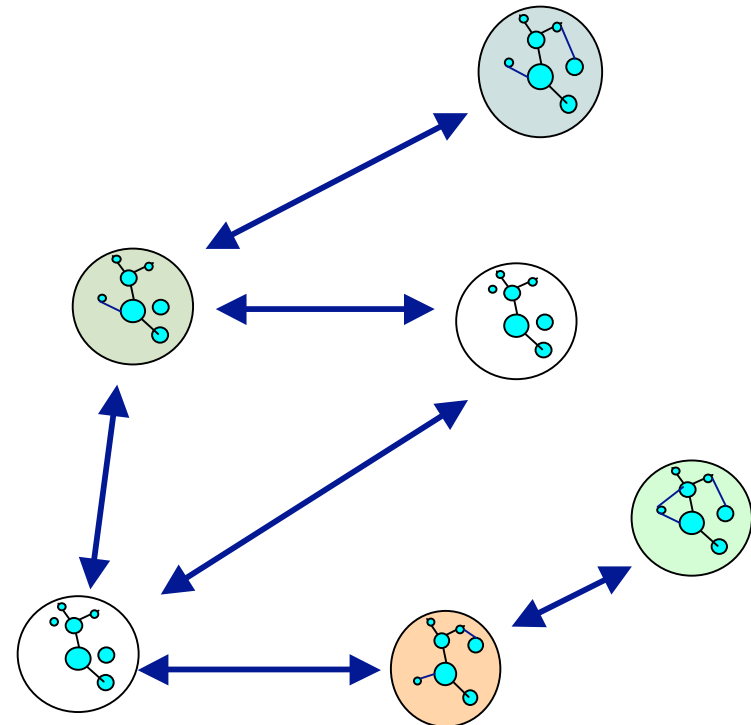
Ontology Mapping – Problem and Scope

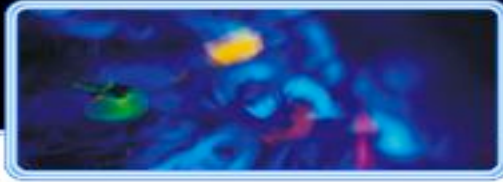
■ The Problem

- ***Heterogeneous ontologies require mappings for interoperability***
- Numerous independent Ontologies
- No single Domain Model
- Modeling same or overlapping Knowledge

■ Main challenges

- Identifying mappings (correspondences between Entities)
- Representing these Relations
- Utilizing Mapping for querying, reasoning, ontology integration, translation and exchange





Ontology Mapping – Techniques and Tools

- Great number of Techniques
 - Syntactic, Semantic, External
 - Element-Level, Structure-Level
 - Schema or Instance Level mapping

- Mapping Tools
 - Several mapping systems already available
(*GLUE, PROMPT, FOAM, ONION, MAFRA*)
 - Manual, visual creation of mappings between ontologies
 - Integration of (relational databases): automated ontology lifting and query answering
(*OntoMap, ODEMapster*)

- Best results
 - Find best approximate Matches -> Similarity
 - Semi-automatic
 - Requires human Domain Expert

Ontology Mapping with OntoMap

The screenshot displays the OntoMap interface, divided into several sections:

- Entity Properties View:** Shows the current mapping configuration for the entity `FK_titles_pub_id_014935CB`.
- Sources:** A table listing the source ontology's properties.
- Target:** Fields for the target ontology's name, domain, and type.
- Transformation:** A dropdown menu for selecting a transformation function.
- Mapping View:** A central diagram showing the mapping between the source and target ontologies. A green arrow highlights a specific mapping from the source's `FK_titles_pub_id_014935CB` to the target's `has_Publisher` property.
- Ontology Hierarchies:** Two tree views on the left and right showing the structure of the source and target ontologies, respectively.

Source	Name	Domain	Module	Type
Source1	FK_titles_pub_id_014935CB	titles	"http://www.pubs.de#"	Relation

Target:

Name:

Domain:

Type:

Transformation:

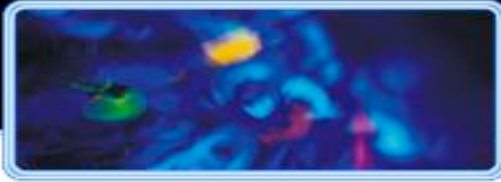
Mapping View:

Source Ontology: "http://www.pubs.de"

- authors
- publishers
- titleauthor
- titles
 - titles_advance
 - titles_notes
 - titles_price
 - titles_pub_id
 - titles_pubdate
 - titles_royalty
 - titles_title
 - titles_title_id
 - titles_type
 - titles_ytd_sales
 - FK_titles_pub_id_014935CB

Target Ontology: "http://www.NewOnto1.org"

- Book
 - ISBN
 - Title
 - has_Author
 - has_Publisher
 - has_Topic
 - Cook_Book
 - Scientific_Book
 - Travel_Guide
- Person
 - Name
 - is_expert_in_Topic
 - Author
 - Professor
 - Publisher
 - Name
 - is_expert_in_Topic
 - Topic



Ontology Learning

Challenge: Ontology development is a bottleneck!

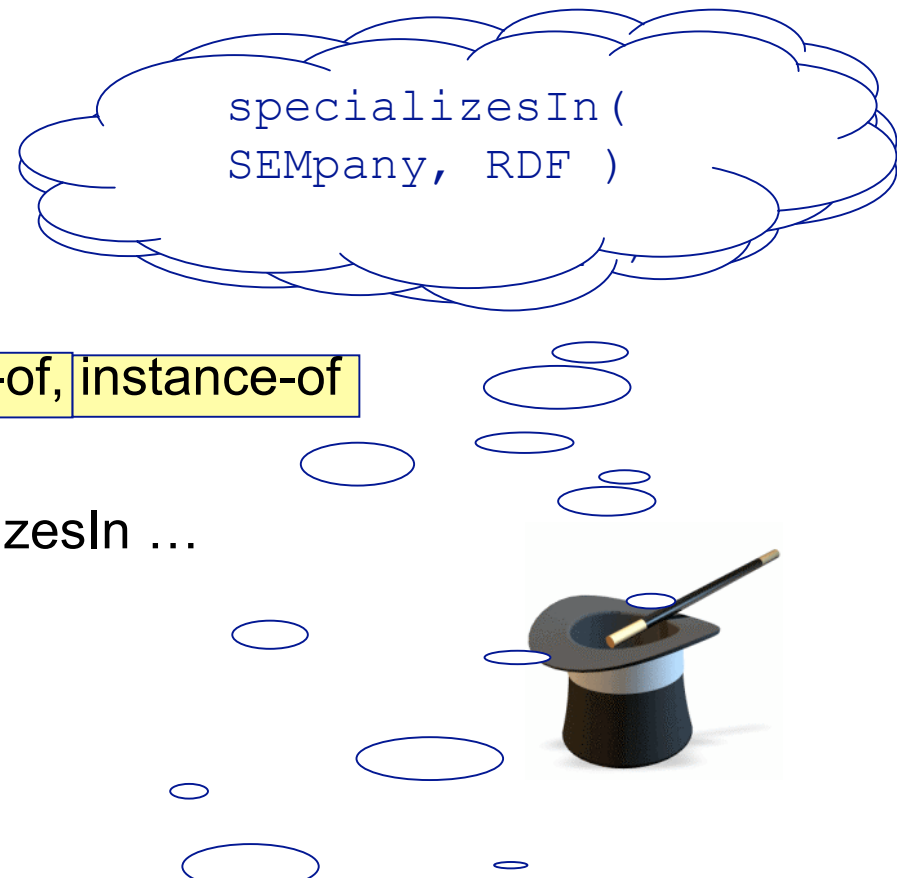
- **Solution: Extraction** of (domain) ontologies from natural language text

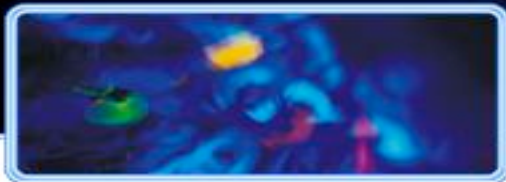
- Natural Language Processing
- Machine Learning

- **Ontology Learning tasks**

- **Concepts, instances**
- Taxonomic relations: **subclass-of, instance-of**
- **Relations:** specializesIn ...
- **Relation instantiations:** specializesIn ...

- **Ontology Population**





Text2Onto

- Ontology Learning framework developed at AIFB since 2004 (successor of TextToOnto by Alexander Mädche)
- Available at <http://ontoware.org/projects/text2onto/>
- Explicit change management and incremental learning
- Implemented algorithms:
 - Concept extraction
 - TFIDF, entropy ...
 - Instance extraction
 - TFIDF ...
 - Similarity extraction
 - Context vectors
 - Concept classification
 - Heuristic, WordNet, patterns
 - Instance classification
 - Patterns, context similarity
 - Relation extraction
 - Subcategorization frames

File

- Algorithm
 - Concepts
 - Instances
 - Similarity
- Corpus
 - Hierarchy
 - Instances
 - Similarity

Domain	Range	Confidence
fusion process	process	1.0
paper extract	extract	1.0
method	knowledge	1.0
template	model	1.0
datum	information	1.0
contents	information	1.0
internet	system	1.0
datum	knowledge	1.0
template	knowledge	1.0
template	content	1.0
contents		
internet		
contents	communication	1.0
user	individual	1.0
task	work	1.0
page	individual	0.8333333333333334
document	communication	0.75
documentation	communication	0.6666666666666666
network	system	0.6
member	part	0.6
report	communication	0.5714285714285714
software agent	computer program	0.5
software agent	technology	0.5
technique	method	0.5
technique	knowledge	0.5
technology	knowledge	0.5
computing	knowledge	0.5
language	communication	0.5
technology	application	0.5
hierarchy	organization	0.5
management	organization	0.5

[subclass-of(internet, network), 1.0]

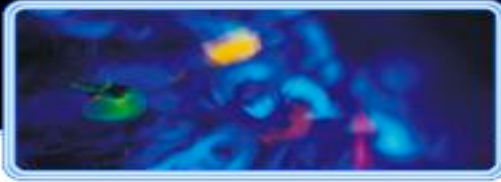
Corpus

- Hierarchy
- Instances
- Similarity

```

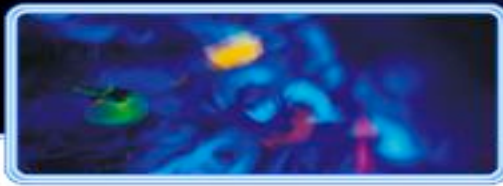
modeling, representation, meta model, fact, process expert, glossary, factor, experiment, device, mod
d, knowledge management process, interface engine, modeling approach, student, staff, health insurance
process modeling, configure, category, uniform, process, iphus, suit, note, group filesystem, label, st
oline, interaction, solution, browsing, personal, integration, idea, paper extract, datum source, auth
agreement, format, world view, fusion process, creator, diary entry, access structure, categorization
ation scheme, mail, designer], class org.ontoware.text2onto.pom.POMInstanceOfRelation=[instance-of( s
), extension ), instance-of( semantic web, layer ), instance-of( word, product ), instance-of( busines
ng, modeling world ), instance-of( metada, tool )])

rithm: SimilarityExtraction( combiner=org.ontoware.text2onto.algorithm.combiner.AverageCombiner algor
textSimilarityExtraction] )
    
```

Ontology Learning Tools

<i>Organization</i>	<i>System</i>	<i>Ontology Learning Subtasks</i>					
		<i>Terms</i>	<i>Synonyms</i>	<i>Concepts</i>	<i>Concept Hierarchy</i>	<i>Relations</i>	<i>Other Axioms</i>
AIFB, Univ. Karlsruhe	TextToOnto/Text2Onto	X	clusters	X	X	X	X
Amir Kabir Univ., Teheran	HASTI	X			X	X	X
CNTS, Univ. Antwerpen	OntoBasis		clusters	clusters		?	
DFKI	OntoLT / RelExt	X			X	X	
Economic Univ. Prague	TextToOnto Extensions					labels	
ISI , USC	CBC / DIRT		clusters	clusters			
Keio Univ.	DOODLE		similar pairs			X	
Univ. Paris-Sud	ASIUM/ Mo'K		clusters	clusters	X	X	
Univ. Rome	OntoLearn	X	X	X	X	X	
Univ. Salford	ATTRACT	X	clusters	clusters			



Ontology Learning - Conclusions

- Ontologies can not be learned automatically, especially not from text
 - Techniques for lexical acquisition too bad?
 - No, it is an inherent problem...
 - Ontologies can not be “learned” because they represent a way of viewing things and thus a process of reflection and agreement
- Ontology learning needs procedures for (formal) self-evaluation
- Ontology learning and reasoning strictly interact with each other
- Ontologies and the world evolve, so ontology learning should address the evolution of data and knowledge



Ontology Evaluation

■ Evaluation

- User Guidance Tools for Design Support
- Consistency checks during development process
- Support for error recovery and debugging

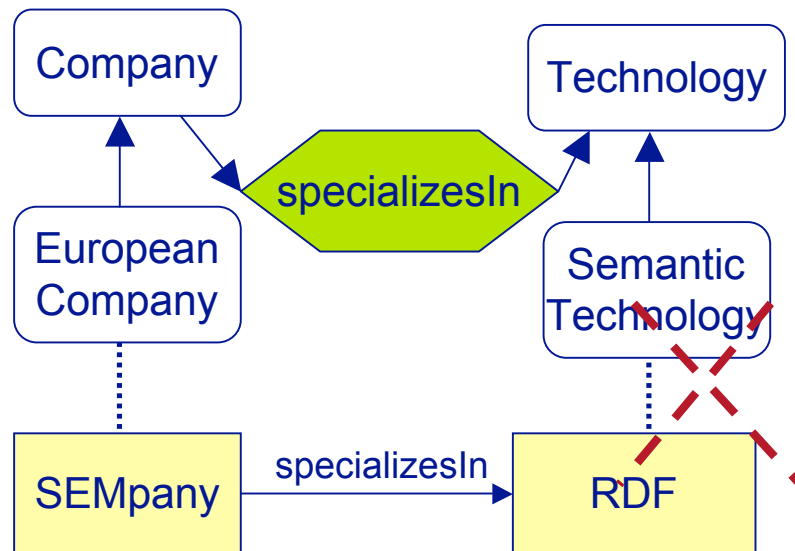
■ What is a 'good' ontology?

- Usage, application performance, data coverage, corpus fit, reasoning adequacy ?
- Well-known: [OntoClean](#) (formal evaluation of taxonomic relationships), developed by Guarino and Welty
- System of conceptual tags (Rigidity, Unity, Identity, Independence) + constraints on possible subsumption relations (e.g. $\sim R$ can't subsume $+R$)
- OntoClean is based on philosophical principles and is even hard to understand for experts
- AEON approach tries to (automatically) approximate the tagging with OntoClean

Ontology Evolution

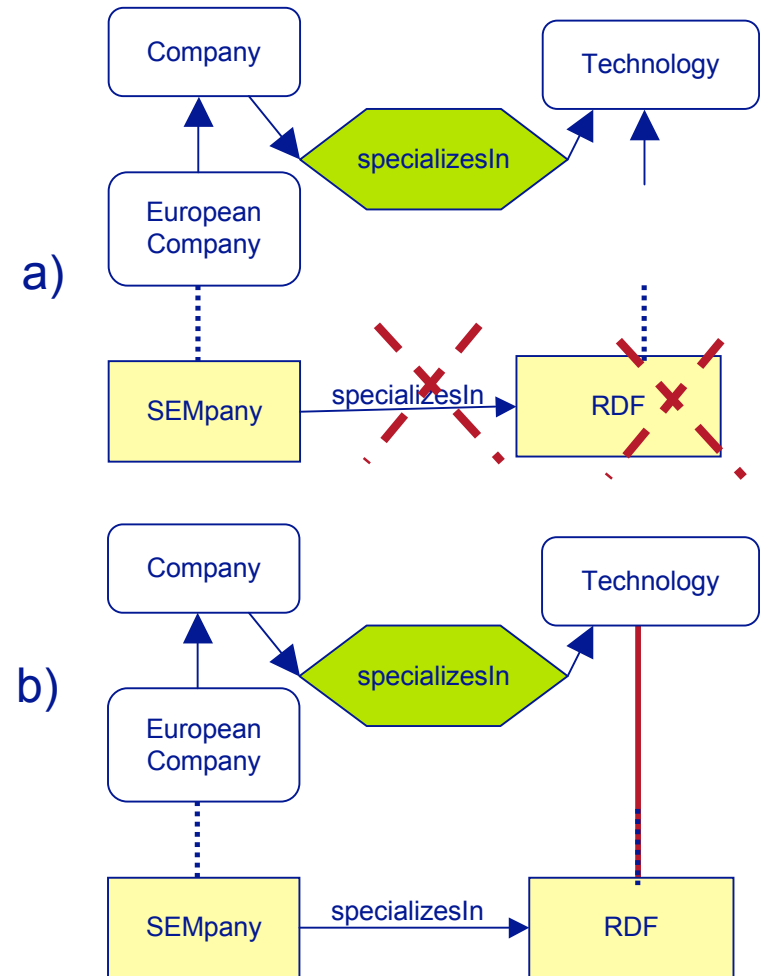
Challenge: Domain ontologies are ever changing!

- **Solution:** A systematic method to handle the resolution of changes is needed



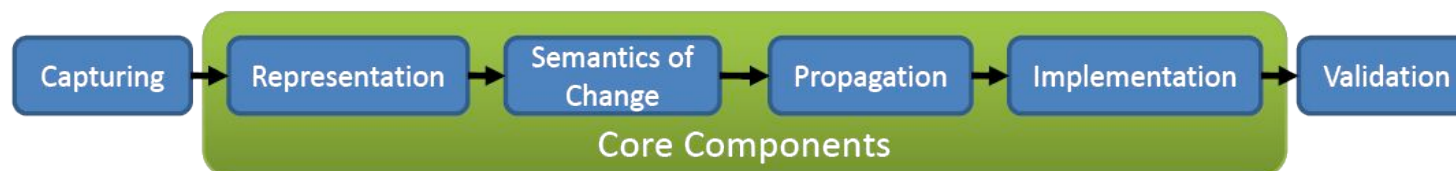
- Traceability (of changes)

- which change to the ontology was performed by whom and when, possibly why?
- if the change has been generated as a byproduct of updating the corpus, keep a reference to the segment in a corpus which triggered the change

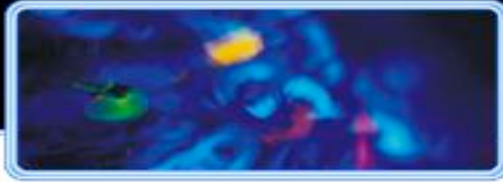




Ontology Evolution (Process)

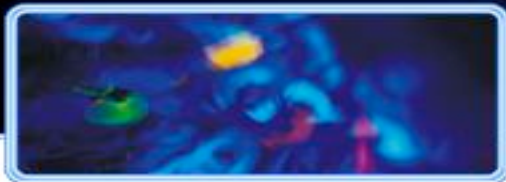


- **Capturing**
 - Explicit changes – intended by Ontology Engineer
 - Implicit changes: *usage-driven, data-driven, structure-driven*
- **Representation**
 - Fine grained (simple) change operation
 - Coarse grained (complex/composite) change operations
- **Semantics of change**
 - Consistency: *structural consistency, logical consistency, user-defined consistency*
 - Verification: *a posterior, a priori*
 - Realization: *declarative, procedural*
- **Change propagation**
 - Pull based, Push based
 - also: Ontology Dependent Consistency, Replication Ontology Consistency
- **Change Implementation**
 - Change Notification, Change Application, Change Logging
- **Change validation**
 - Justification / redoing based on user request



Ontology Management Infrastructure

- **Ontology Repositories**
 - Focus on storing, manipulating and retrieving large sets of data
 - Typically, with some query language (e.g. SPARQL)
 - File system vs. DBMS backend
- **Ontology Reasoners**
 - Reasoning tasks (standard / non-standard)
 - Reasoning methods
- **Often, repository and reasoning are combined, sometimes via the same API**



Ontology Repositories

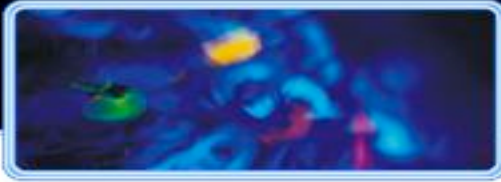
■ Jena Framework

- OWL and RDF API
- Reading and writing RDF in RDF/XML, N3 and N-Triples
- In-memory and persistent storage
- SPARQL query engine

■ Sesame

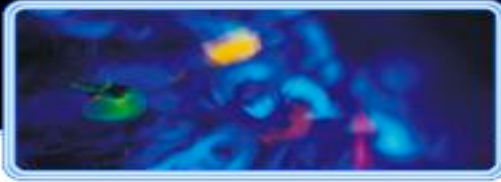
- RDF API
- Native store for scalable storage and querying with reliable persistence
- Support for several back-end stores
- Support for several RDF query languages including SPARQL and SeRQL

■ Others: YARS, Kowari, OWLIM



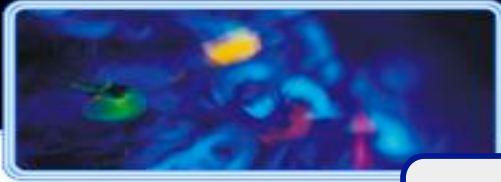
Standard Reasoning Tasks

- ...check whether an ontology is consistent
 - satisfiability checking: does the ontology have a model?
- ...check if a class C is consistent
 - i.e. whether C can have non-empty extension
- ...check if a is an instance of C : $C(a)$
 - basis for query answering
- ...check for class inclusion of two classes: $C \sqsubseteq D$
 - i.e. whether instances of C are always instances of D
 - subsumption checking
 - equivalent to query containment
- Selecting the right reasoner depends on many aspects
 - Reasoning task
 - Complexity of ontology (underlying logical language)
 - Size of ontology (ABox vs. TBox)



Overview of Reasoners

	<i>Cerebra</i> (Web Methods)	<i>FACT++</i> (U of Manchester)	<i>KAON2</i> (ontoprise)	<i>Pellet</i> (U of Maryland)	<i>Racer</i> (Racer Systems)	<i>Ontobroker</i> (ontoprise)	<i>OWLIM</i> (ontotext)
Interfaces	OWL API	DIG	KAON2 API	DIG, OWL API, Jena API	DIG, OWL API	KAON2 API DIG	Sesame API
Reasoning Approach	Tableaux	Tableaux	Resolution	Tableaux	Tableaux	Datalog	Forward Chaining
Supported Logic	OWL DL	SHOIQ	SHIQ + DL safe rules	SROIQ + DL safe rules	SHIQ	F-Logic	OWL DLP
Based on	C++	C++	Java	Java	Lisp	Java	Java



What is the NeOn Toolkit?

Ontology

Engineering

Environment

Supports the lifecycle of networked ontologies

Modeling

Collaboration

Modularization

Documentation

Integration

Verification

Testing

Deployment

Dual language

approach

Modular

Extensible

Platform

**F-Logic rules
Frame-like**

modeling

Based on

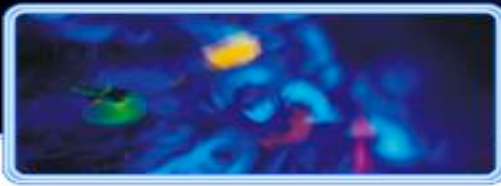
Eclipse

OWL-DL

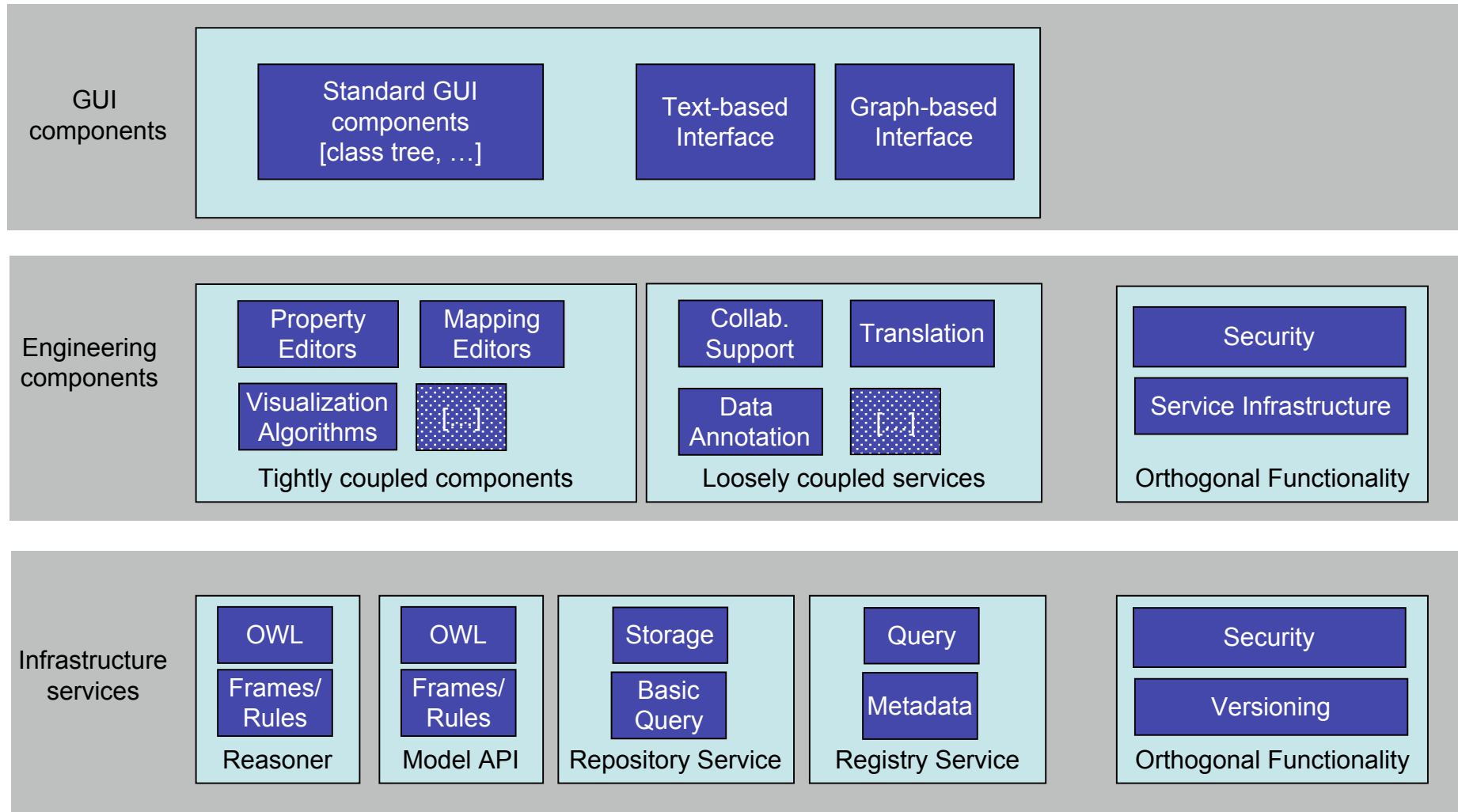
modeling

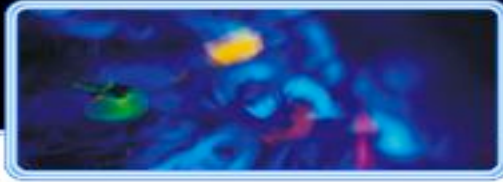
Succeeds

OntoStudio



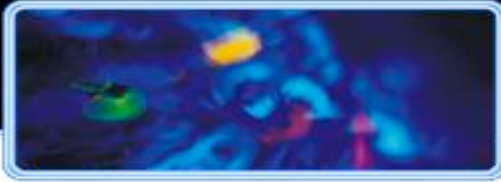
NeOn Architecture to Support the Entire Ontology Lifecycle





Applications

- Content Management / Information Retrieval
 - BT Digital Library
- Expert and Assistance Systems
 - HALO
- Social and collaborative applications
 - Ontoworld
- Web Applications
 - PiggyBank
 - eMerges: Semantic Web Services GIS based Emergency Management



Scenario (BT Digital Library)

Bob works as technology analyst for British Telecom. His daily work includes research on new technological trends, market developments as well as the analysis of competitors.

*Bob's company maintains a **digital library** that gives access to a **repository of internal surveys and analysis documents**. The company also has a **license with an academic research database** which is accessed via a **separate interface**.*

*Depending on his work context, Bob uses the **topic hierarchies**, the **full-text search functionalities** or **metadata search facilities** provided by the two libraries to get access to the relevant data.*

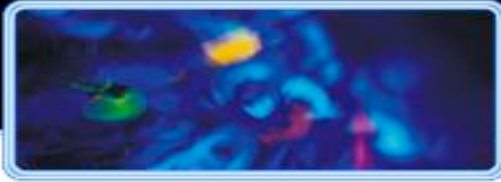
*However, Bob is often annoyed by the **differing topic hierarchies and metadata schemes** used by the two libraries as well as by a **cumbersome syntax for metadata queries**.*

Heterogeneity of content

Heterogeneity of search facilities

Heterogeneity of data models (schemas)

Interface design challenge



Why Ontology-Based Digital Libraries?

Immediate support for unified structured queries against metadata and documents

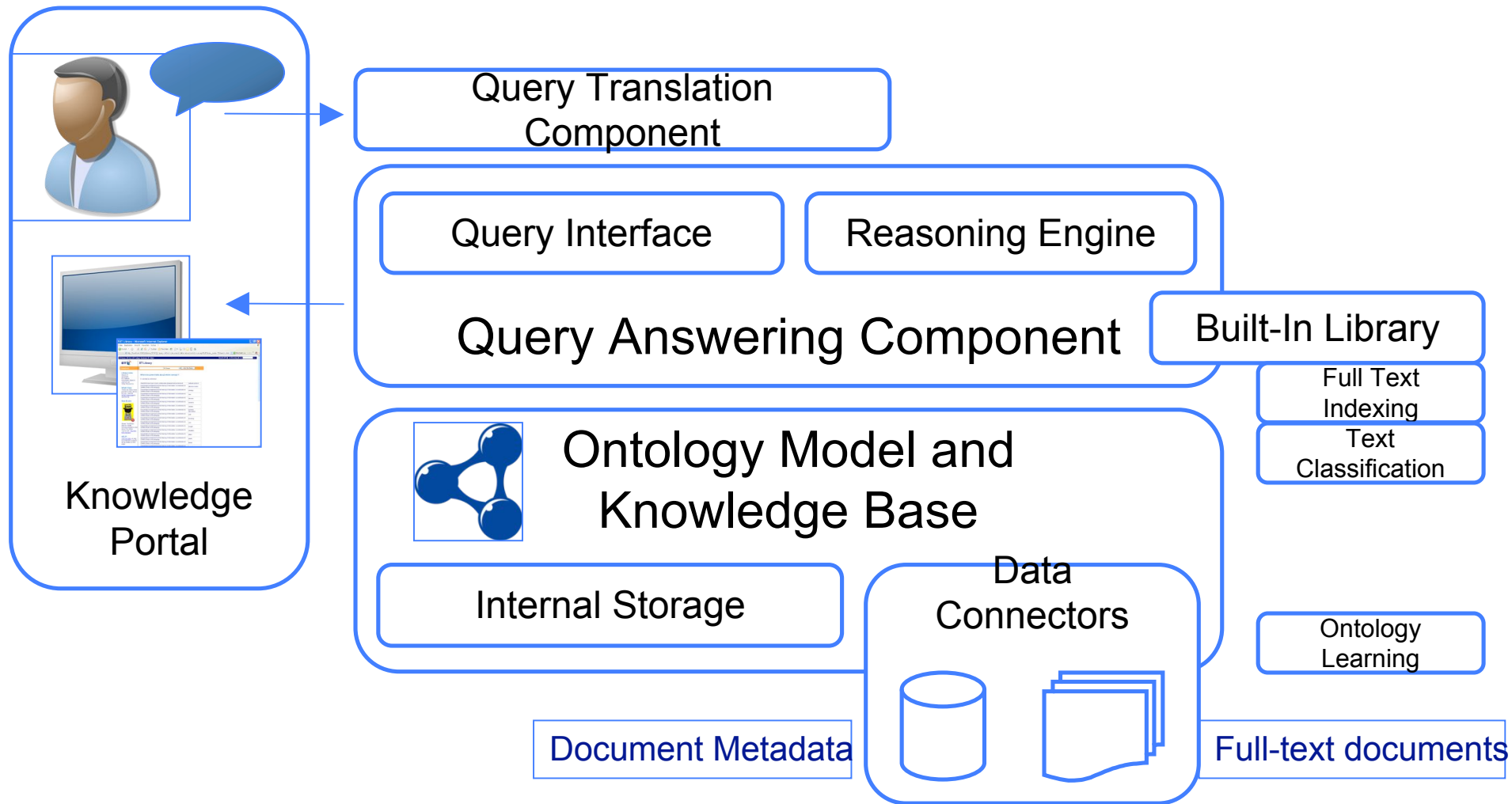
Easy integration of heterogeneous knowledge sources

Easy integration with knowledge elicitation methods from unstructured content

Mapping to natural language queries

Generic, flexible and modular architecture

Conceptual Architecture





Ontology Model and Knowledge Base

■ Ontology

- global conceptual model
- aligned with established schemas (e.g. Dublin Core)

■ Knowledge base of the digital library

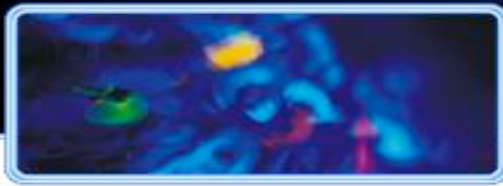
- actual bibliographical metadata, topic hierarchies, and full-text document content
- data aligned with global ontology via mapping axioms

```
swrc:Book      rdfs:subClassOf  protont:Document
expl:document5127  rdf:type          swrc:InProceedings
expl:document5127  protont:title     "Digital Libraries"
```



■ Query answering against knowledge base (SPARQL)

```
SELECT ?x WHERE {
  ?x rdf:type <http://proton.semanticweb.org/2005/04/protonu#Article> .
  ?x <http://proton.semanticweb.org/2005/04/protont#hasSubject> ?y .
  ?y rdfs:label ?z .
  match(?z,"Intellectual Capital")
}
```

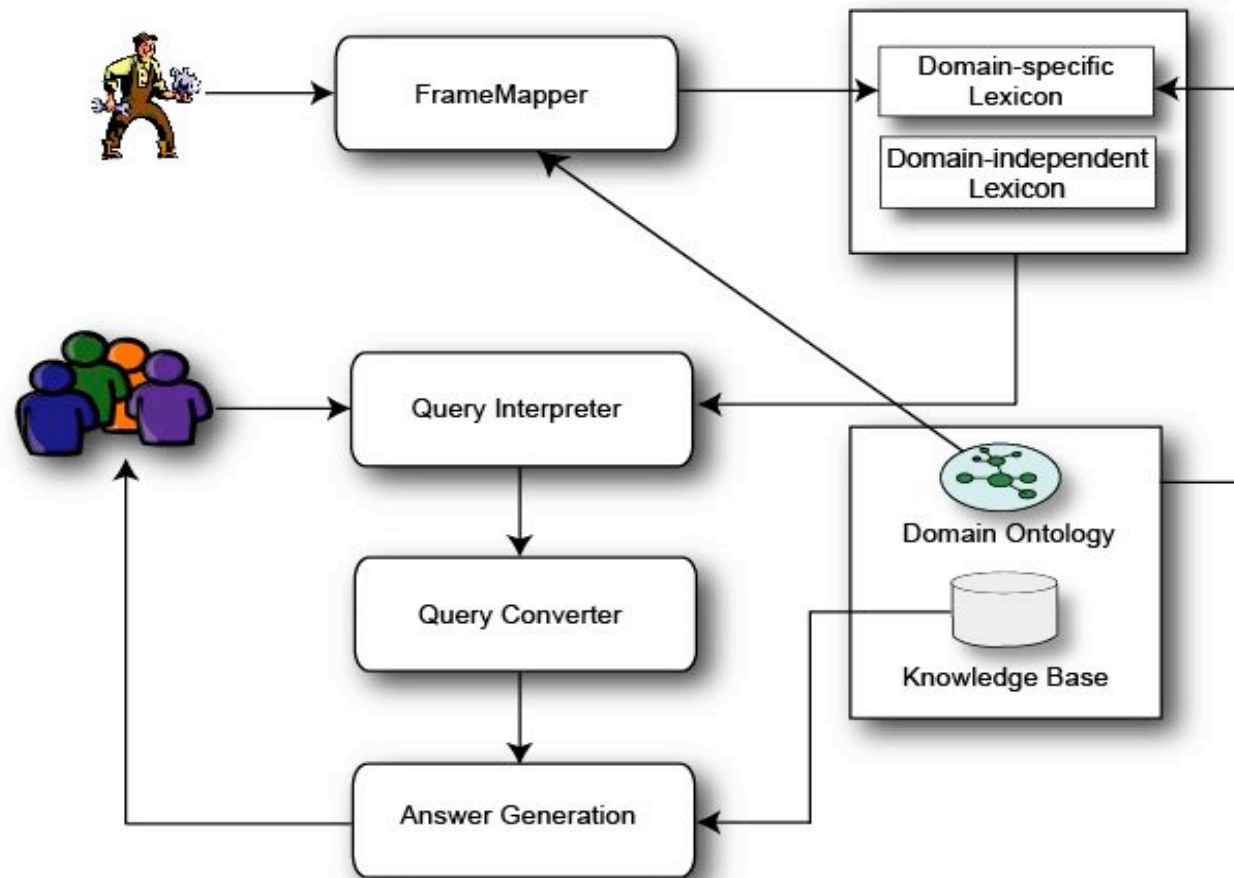



Knowledge Portal

- Presentation layer for underlying content
- Interaction via standard interfaces
 - keyword-search, topic browsers etc.
- Interaction via natural language queries
 - converts natural language queries into SPARQL
- Translation step comprises
 - deep parsing of the questions
 - roughly, linguistic frames become query constraints
 - lexicon describes possible lexical realizations of ontology elements

"Who wrote books on 'digital libraries'?"
"Which journal articles were written by 'Tim Berners-Lee' (and for which journal)?"

Natural Language Interface



Overview of the ORAKEL System



Scenario Revisited



“Which journal articles were written by 'Tim Berners-Lee' for which journal?”



```
PREFIX protonu:<http://proton.semanticweb.org/2005/04/protonu#>  
PREFIX protont:<http://proton.semanticweb.org/2005/04/protont#>
```

```
SELECT ?x ?z WHERE {  
  ?x rdf:type protonu:Article .  
  ?x protont:documentAuthor ?y .  
  ?y rdfs:label ?ys .  
  match(?ys, "Tim Berners Lee") .  
  ?z rdf:type protonu:Journal .  
  ?x protonu:publishedWithin ?z  
}
```



"The Semantic Web"	"The Scientific American"
"WWW: Past, Present, and Future"	"IEEE Computer"
[...]	[...]



The BT Digital Library

The screenshot shows a web browser window displaying the BT Digital Library interface. The browser's address bar contains the URL: `http://localhost:8080/btdemo/SPARQL?query=Which+document+talks+about+which+concept%3F&new_meta=*%26Search=Ask+`. The page header includes navigation links: [BT Home](#), [BT A-Z](#), [BT Today](#), [Services](#), and [BT Help](#). A search bar is present with the text "Search BT or Directory for".

The main content area is titled "BT Library" and features a search input field containing the query "Which document talks about which concept?". A blue arrow points to this query. Below the search bar, it indicates "31 answer(s) retrieved".

The search results are displayed in a table with two columns: the first column contains the document title, and the second column contains the concept. The results are as follows:

WebDAV based open source collaborative development environment	network protocol
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	decision maker
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	strategy
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	role
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	discuss
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	analysis
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	relation
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	problem description
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	skill
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	teaching
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	use
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	insight
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	situation
Knowledge management and the framing of information: a contribution to OR/MS practice and pedagogy	effect
Knowledge management and the framing of information: a contribution to	

Screenshot from BT Digital Library



Project Halo

- “Building a digital Aristotle”
- A system that...
 - Encompasses much of the world’s scientific knowledge
 - Reasons over that knowledge
 - Answers novel scientific questions
 - Explains these answers
 - Is quite ambitious
- Multi-stage effort:
 - Start with a specific science (Chemistry)
 - Challenge with several teams
 - Answer AP-style questions
- Complete information at <http://www.projecthalo.com/>





Formalizing questions

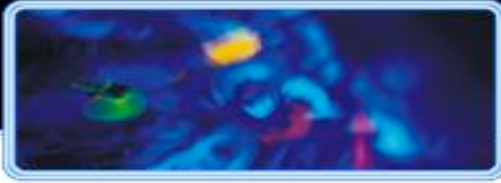
■ Example

Which of the following compounds will produce a gas when HCl is added to the solid compound? HCl is a strong acid producing a yellow-green colored gas above the acid solution.

- Ba(OH)_2 (s)
- CaCO_3 (s)
- CuSO_4 (s)
- Na_3PO_4 (s)
- NaCl (s)



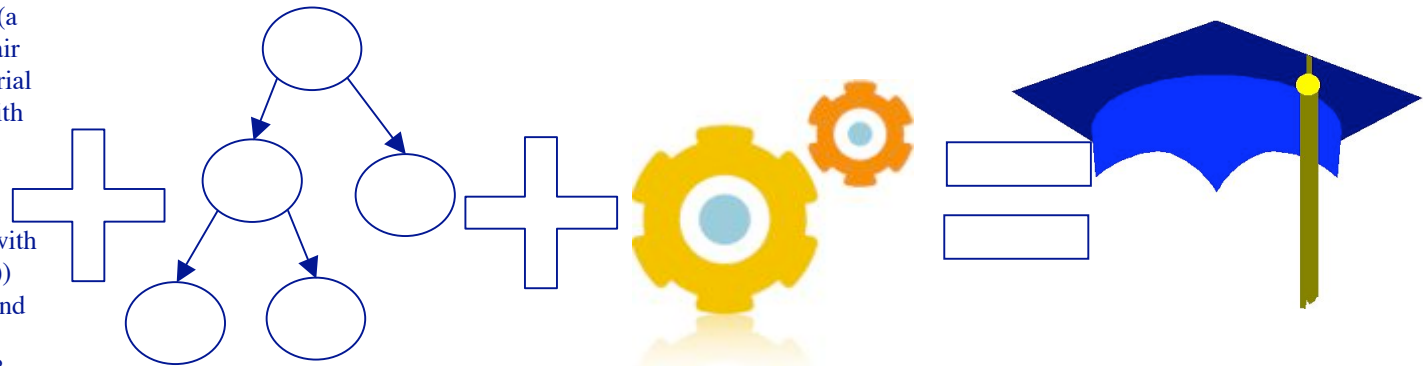
```
(every QF1 has (context ((:pair "(a)
Ba(OH)2(s)" (a Reaction with (raw-material
((a HCl-Substance) (a Ba_OH_2-Substance
with (state ((a State-Value with (value
(*solid)))))))))) (:pair "(b) CaCO3(s)" (a
Reaction with (raw-material ((a HCl-
Substance) (a CaCO3-Substance with (state
((a State-Value with (value (*solid))))))))))
(:pair "(c) CuSO4(s)" (a Reaction with (raw-
material ((a HCl-Substance) (a CuSO4-
Substance with (state ((a State-Value with
(value (*solid)))))))))) (:pair "(d) Na3PO4(s)"
(a Reaction with (raw-material ((a HCl-
Substance) (a Ionic-Compound-Substance
with (state ((a State-Value with (value
(*solid)))) (has-basic-structural-unit ((a
Ionic-Compound with (nested-atomic-
chemical-formula ((a Chemical-Formula with
(term ((:seq (:pair 3 Na) (:pair 1 P) (:pair 4
O)))))))))))))) (:pair "(e) NaCl(s)" (a Reaction
with (raw-material ((a HCl-Substance) (a
NaCl-Substance with (state ((a State-Value
with (value *solid)))))))))) (output ((forall
(the context of Self) where (oneof2 (the result
of (the2 of It)) where ((the value of (the state
of It2)) = *gas)) (the1 of It) (comm [QF1-
output-1] Self))))))
```



Background knowledge

- Formalizing questions is “just” question understanding
- Needs a huge amount of background knowledge = ontology
- And a reasoner to answer the question using the ontology

```
(every QF1 has (context ((:pair "(a)
Ba(OH)2(s)" (a Reaction with (raw-material ((a
HCl-Substance) (a Ba_OH_2-Substance with
(state ((a State-Value with (value
(*solid)))))))))) (:pair "(b) CaCO3(s)" (a
Reaction with (raw-material ((a HCl-
Substance) (a CaO3-Substance with (state ((a
State-Value with (value (*solid)))))))))) (:pair
"(c) CuSO4(s)" (a Reaction with (raw-material
((a HCl-Substance) (a CuSO4-Substance with
(state ((a State-Value with (value
(*solid)))))))))) (:pair "(d) Na3PO4(s)" (a
Reaction with (raw-material ((a HCl-
Substance) (a Ionic-Compound-Substance with
(state ((a State-Value with (value (*solid))))
(has-basic-structural-unit ((a Ionic-Compound
with (nested-atomic-chemical-formula ((a
Chemical-Formula with (term ((:seq (:pair 3
Na) (:pair 1 P) (:pair 4 O)))))))))))))) (:pair "(e)
NaCl(s)" (a Reaction with (raw-material ((a
HCl-Substance) (a NaCl-Substance with (state
((a State-Value with (value *solid))))))))))
(output ((forall (the context of Self) where
(oneof2 (the result of (the2 of It)) where ((the
```





Evaluation

- **Correctness**
 - Was pretty high
- **Justification**
 - Considerably lower than correctness
- **Speed**
 - Was critical, but all systems faired well
- **Results:**
 - Human mean average in this test is AP-2.82
 - Project Halo scored an AP-3 – they would have passed!





Result browser

- <http://www.projecthalo.com/halotempl.asp?cid=2135#>

PROJECT HALO

RESULTS BROWSER

QUESTION CHOOSER

MC1 Which of the following compounds will produce a gas when HCl is added to the solid compound? HCl is a strong acid producing a yellow-green colored gas above the acid solution.

MC2 When lithium metal is reacted with nitrogen gas, under proper conditions, the product is:

MC3 Sodium azide is used in air bags to rapidly produce gas to inflate the bag. The products of the decomposition reaction are:

MC4 When calcium carbonate is heated it decomposes forming:

Calcium carbonate reacts with acids to produce gas

MC5 The most likely products for the reaction of NH₃ with oxygen are:

Oxygen is reactive with many chemical compounds while nitrogen gas is very unreactive.

MC6 Which solution has the highest conductivity?

MC7 Which of the following is a non-electrolyte?

MC8 Which of the following combinations would produce a precipitate?

MC9 A solution of nickel nitrate and

QUESTION

MC 1 Which of the following compounds will produce a gas when HCl is added to the solid compound? HCl is a strong acid producing a yellow-green colored gas above the acid solution.

a. Ba(OH)₂ (s)
b. CaCO₃ (s)
c. CuSO₄ (s)
d. Na₃PO₄(s)
e. NaCl(s)

CORRECT ANSWER

(b) CaCO₃ (s)

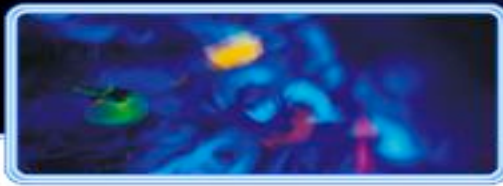
HIDE ANSWER

RESULTS DETAIL

SCORING MATRIX

TEAMS	ENCODING	SME I GRADES			SME II GRADES			SME III GRADES		
		ANSWER	JUST.	VIEW	ANSWER	JUST.	VIEW	ANSWER	JUST.	VIEW
CYCORP		0/1.0	0/1.0		0/1.0	0/1.0		0/1.0	0/1.0	
ONTOPRISE		1/1.0	0/1.0		1/1.0	0/1.0		1/1.0	0/1.0	
SRI		1/1.0	0.5/1.0		1/1.0	1/1.0		1/1.0	0/1.0	

LEGEND: SUBJECT MATTER EXPERTS (SME) QUESTION ENCODING GRADED RESULTS FAILURE DETAIL TIME TO ANSWER



- A semantic wiki for the semantic web community

article | discussion | view source | history

Main Page

Semantics to the people!

Welcome!

This is *ontoworld.org*, the wiki for the Semantic Web community. Our mission is to provide a knowledge repository and platform for advertising events, spreading news, and announcing new developments. It is a wiki: everybody can quickly edit its content, even without logging in. So look around and participate!

If you are new to this wiki you may want to start browsing the contents on the right. Editing pages works as on *Wikipedia*, but we also have a [starters guide](#) within this wiki. Be sure to check out the page about yourself (yes, it might even be there already!).

News

- **Julv 5 2007.** Semantic MediaWiki receives the third prize of

People

The wiki should now contain pages for many community members others. The [semantic features](#) of this wiki also create a [FOAF](#) file. To go to your page, just type your name into the below field and

For an overview of the people in this wiki, go to the [people portal](#)

Events

You can find information about many events and calls for papers annotation, it is possible to [query](#) for particular events.

Upcoming conferences, etc.: [SAAKM2007](#) (Whistler, 28 October 2007 - November 2007), [FEWS](#) (Busan, 12 November 2007), [ISWC2007](#) (Busan, 11 (Busan, 11 November 2007) [full list](#)

Upcoming submission deadlines: [PIM2007](#) (15 October 2007), [WWW2](#)

navigation

- Main Page
- People
- Events
- Help
- browse
- RDF Feeds
- Recent changes

search

toolbox

- What links here
- Related changes
- Upload file
- Special pages
- Printable version



The Semantic Web wiki

- Persons
- Events
- Tools
- Publications

Events

You can find information about many events at papers within this wiki. Using semantic annotations it is possible to [query](#) for particular events.

Upcoming conferences, etc.: [SAAKM2007](#) (Wh 2007), [Ontology Engineering](#) (Baden-Baden, 2 November 2007), [FEWS](#) (Busan, 12 November 2007), [ISWC2007](#) (Busan, 11 November 2007), [ISWC2007+ASWC2007](#) (Busan, 11 November 2007)

Upcoming submission deadlines: [PIM2007](#) (1 November 2007), [WWW2008](#) (1 November 2007), [ESWC2008](#) (14 December 2007)

Organising an event? Advertise it here by creating an article! Just enter the event's abbreviation in the box below to get an edit box with further documentation.

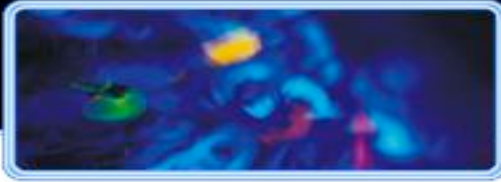
[article](#) [discussion](#) [edit](#) [history](#)

People

This wiki contains annotated articles for a large number of community members. If you should read the [documentation](#) and create a new article. To be listed below, use [Category:Person](#), e.g. by using the [person template](#) on their pages.


The following list is cached for better performance. If it appears to be out of date, click the link at the bottom of this page. You can also directly browse the [current](#)

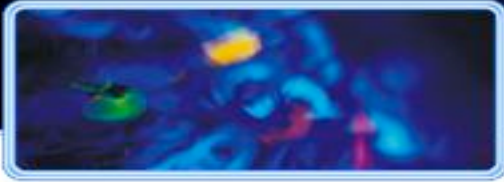
<input type="checkbox"/>	<input type="checkbox"/> Affiliation
A Min Tjoa	TU Wien
Aaron Stanton	QualitySmith
Aaron Swartz	
Abhita Chugh	Stanford University
Abir Qasem	Lehigh University
Abraham Bernstein	IFI
Achille Fokoue	IBM Watson Research
Adam Cheyer	SRI International
Adina Sirbu	DERI Innsbruck
Aditya Kalyanpur	IBM Watson Research
Adrian Mocan	DERI Innsbruck
Afraz Jaffri	University of Southampton
Agnes Koschmider	University of Karlsruhe



Why should the community care?

- High Google rank
- Person articles and event articles ranked high, easy to find
- Collects information
 - Overview over several conferences, dates, etc.
 - But also PC /OC memberships
- Growing steadily
- Easy to add
- Easy to extend

York Sure	
Affiliation:	SAP
Homepage:	my CV 
PC member of: BIS2007, ESWC2007, ISWC2006, KWEPSY2006, KWEPSY2007, SBPM2007, SemWiki2006, VORTE2006	
OC member of: AST2006, EON2006, Ping Karlsruhe 2007	

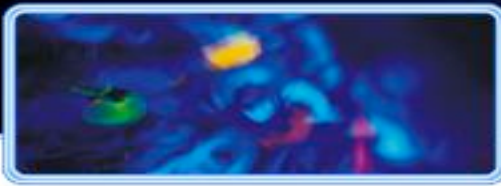


Piggybank

- Firefox extension
- Collects data on the web while browsing
- Has a cute logo
- Collected data can be ...
 - Explored as you like
 - Aggregated from different sources
 - Compared
 - Browsed and viewed
 - Queried
- Mashup whatever *you* want whenever *you* want!
- Try it out - http://simile.mit.edu/wiki/Piggy_Bank



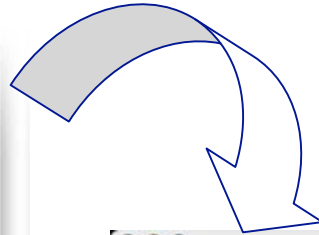

Scrape data



Danforth Court Inquire

2375 Danforth
Toronto, ON

[More Information](#)



Information collected from VacancyGuide.com - Apartments in the GTA

http://127.0.0.1:1978/10da4962bd7?command=browse&-=%40lwq.proje

Getting Started Latest Headlines

[My Flickr Bank] | VacancyGuide.com - Apartments in the GTA - Collected Information

VacancyGuide.com - Apartments in the GTA

Collected Information

1 filter criterion

- type: Property (remove)

Order Commands

List View **Calendar View** Map View Graph View Timeline View

41 items
sorted by unit [A to Z]

2(8) 3(1) 2(5) 3(1) 2(2) 3(11) 2(2) 3(1) 2(10)

< previous 1 2 3 4 5 next >


Wellesley & Jarvis [URI]

address 100 Wellesley St. E., Toronto, ON, Canada

coordinates 43.666223,-79.378614

feature

- A/C
- Balcony/Patio
- Fitness
- Heat
- Hydro
- Local Transit
- Parking
- Pool
- Storage

img 

(focus on these values)

feature [click to expand]

unit [click to expand]

title [click to expand]

address [click to expand]

min-price [click to expand]

coordinates [click to expand]

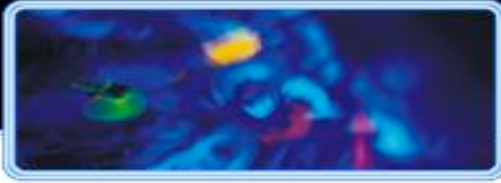
phone [click to expand]

img [click to expand]

Simile

Done

- Loads data from current page
- Either data is available in a standard format
- Or there is a screenscraper for that page



Explore your data

- Data you have just collected viewable in many different ways

- Like HousingMap.com

a Mashup that combines
Craigslist and
Google Maps

- But you did it yourself in your browser!

Information collected from VacancyGuide.com - Apartments in the GTA

Getting Started Latest Headlines

[My Flickr Bank] | VacancyGuide.com - Apartments in the GTA - Collected Information

VacancyGuide.com - Apartments in the GTA

Collected Information

filter criterion

- type: Property (remove)

Order Commands

List View Calendar View Map View Graph View Timeline View

Map Satellite Hybrid

feature (click to expand)

unit (click to expand)

title (click to expand)

address (click to expand)

min-price (click to expand)

coordinates (click to expand)

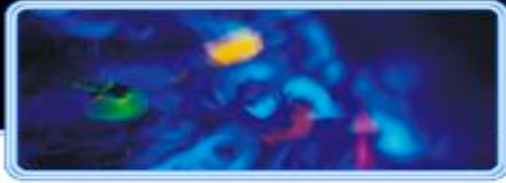
phone (click to expand)

img (click to expand)

Simile

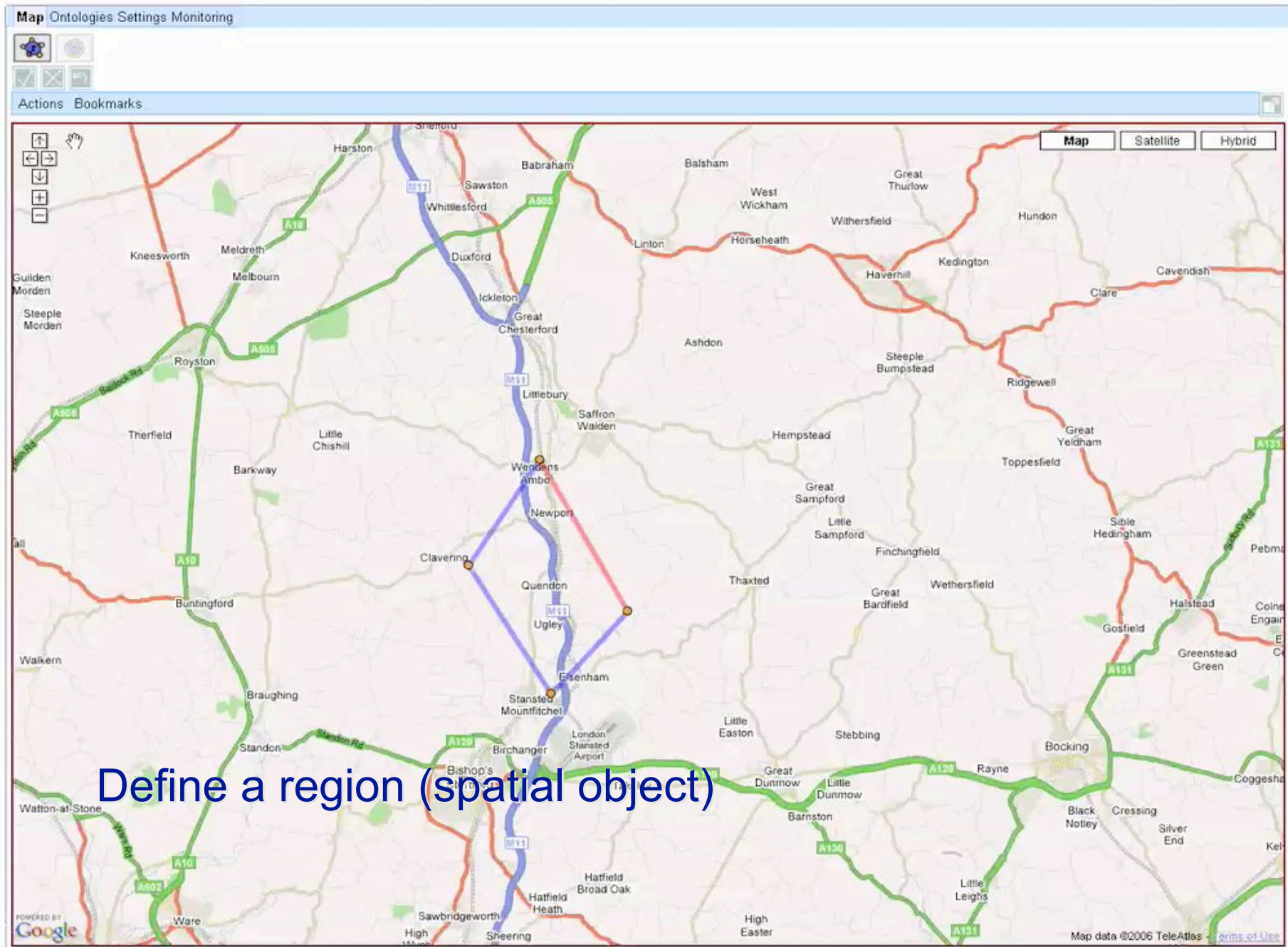
Map data ©2006 TeleAtlas - Terms of Use

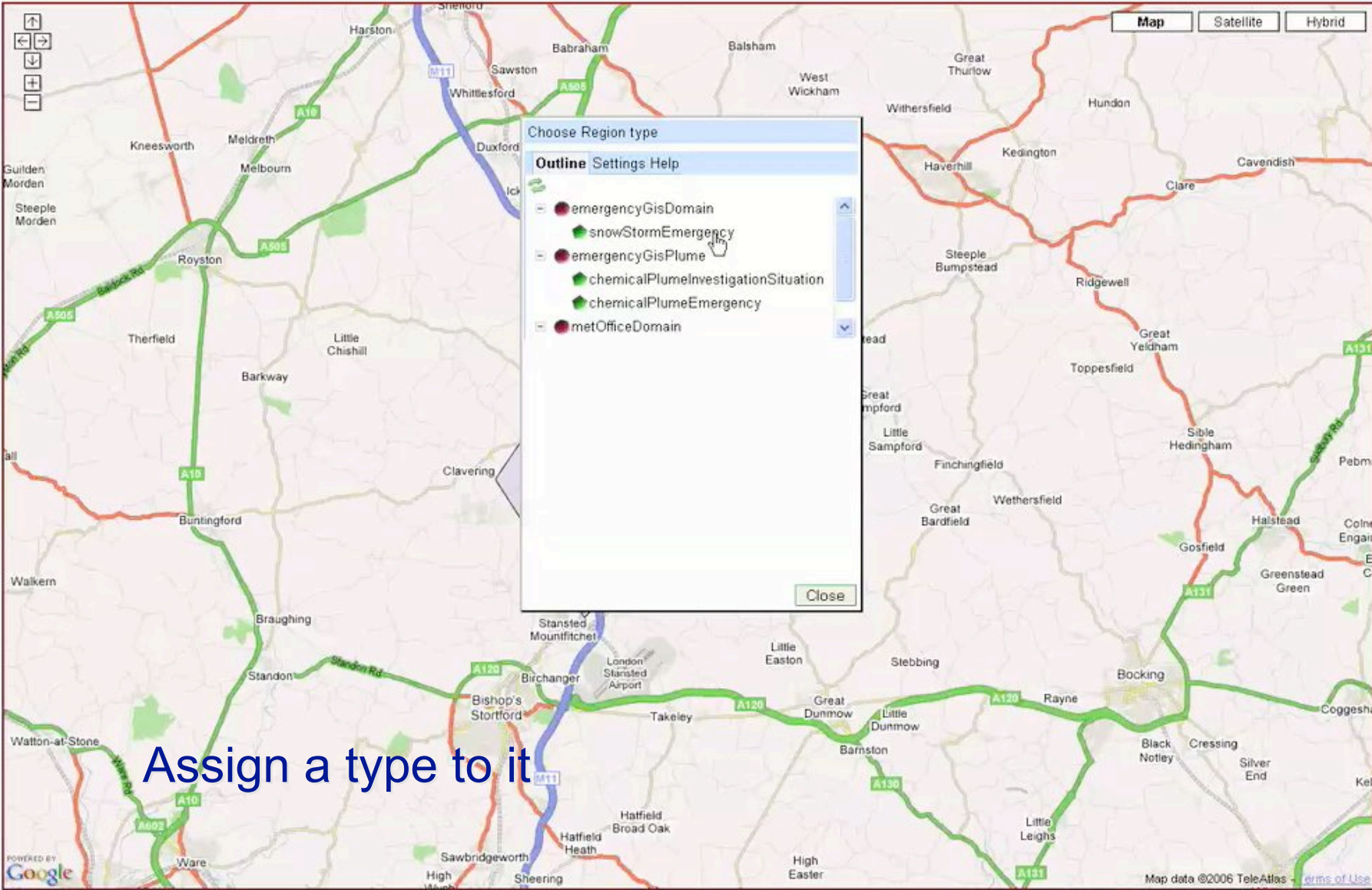
Done



eMerges

- Supporting Emergency Planning for Essex County Council
- Many heterogeneous data sources
- Need a simple integration interface
 - Users are potentially under high stress





Choose Region type

Outline Settings Help

- emergencyGisDomain
- snowStormEmergency
- emergencyGisPlume
- chemicalPlumeInvestigationSituation
- chemicalPlumeEmergency
- metOfficeDomain

Close

Assign a type to it

Map Ontologies Settings Monitoring

Actions Bookmarks

Map Satellite Hybrid

Spatial Object: Snow Storm Emergency

Affordances	Features
<input type="checkbox"/> get-hotels-affordance	has-latitude <input type="text" value="51.95502467935475"/>
<input type="checkbox"/> get-rest-centres-affordance	has-method <input type="text" value="getRestCentresInRadiu"/>
<input type="checkbox"/> get-temp-rest-centres-affordance	has-longitude <input type="text" value="0.21011180122758588"/>
<input type="checkbox"/> get-snow-storm-resources-affordance	has-spatial-object-query <input type="text" value="restcentresquery"/>
<input type="checkbox"/> get-inns-affordance	has-radius <input type="text" value="15"/>
<input type="checkbox"/> get-filtered-rest-centres-affordance	<input type="button" value="Invoke"/>
<input type="checkbox"/> login-affordance	
<input type="checkbox"/> get-supermarkets-affordance	
<input type="checkbox"/> get-hospitals-affordance	

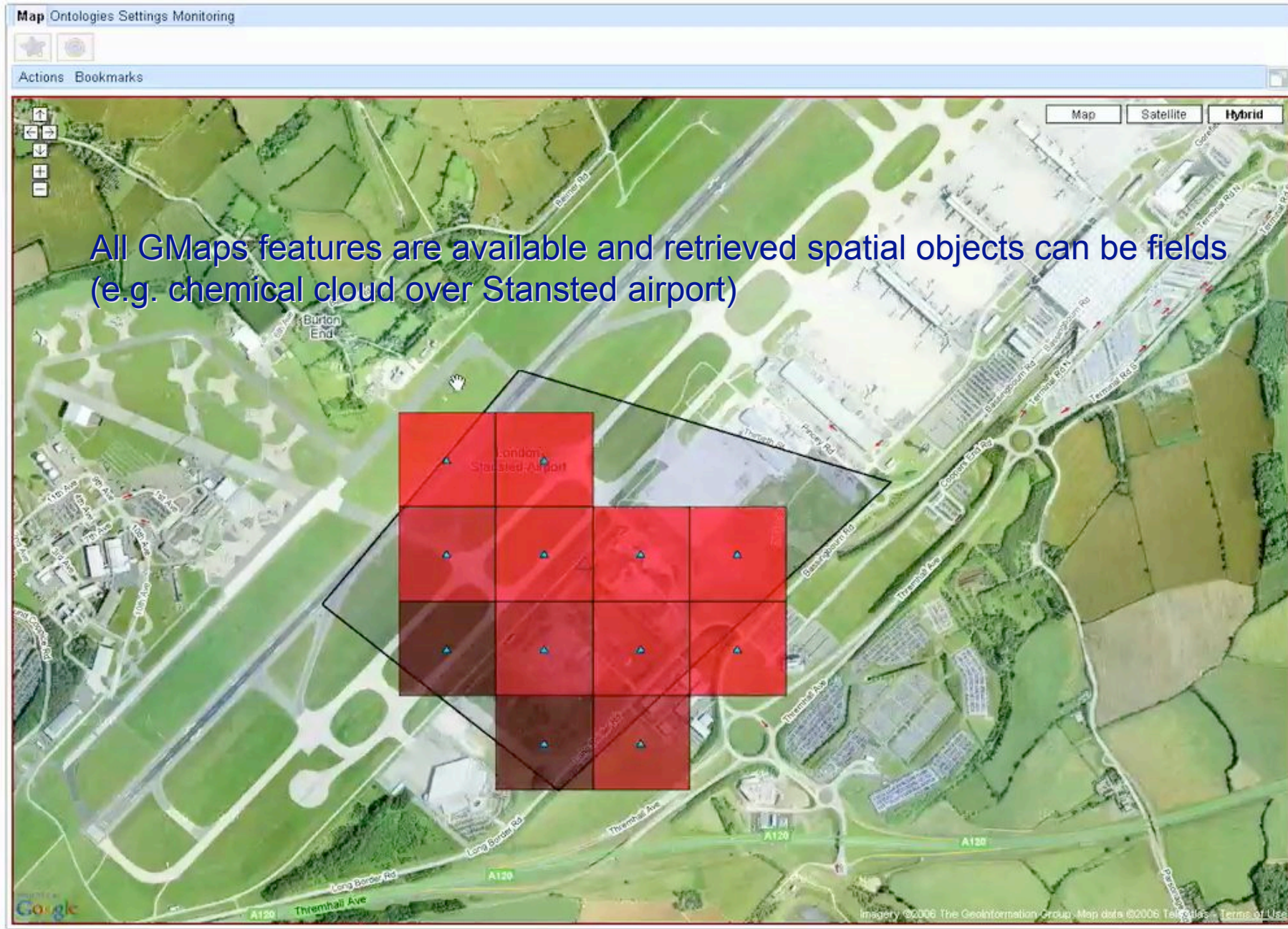
Hide Others Forget Me Forget All Show All Close

Uniform representation: Spatial Object have context-dependent affordances (actions), and features (properties)

Map data ©2006 TeleAtlas



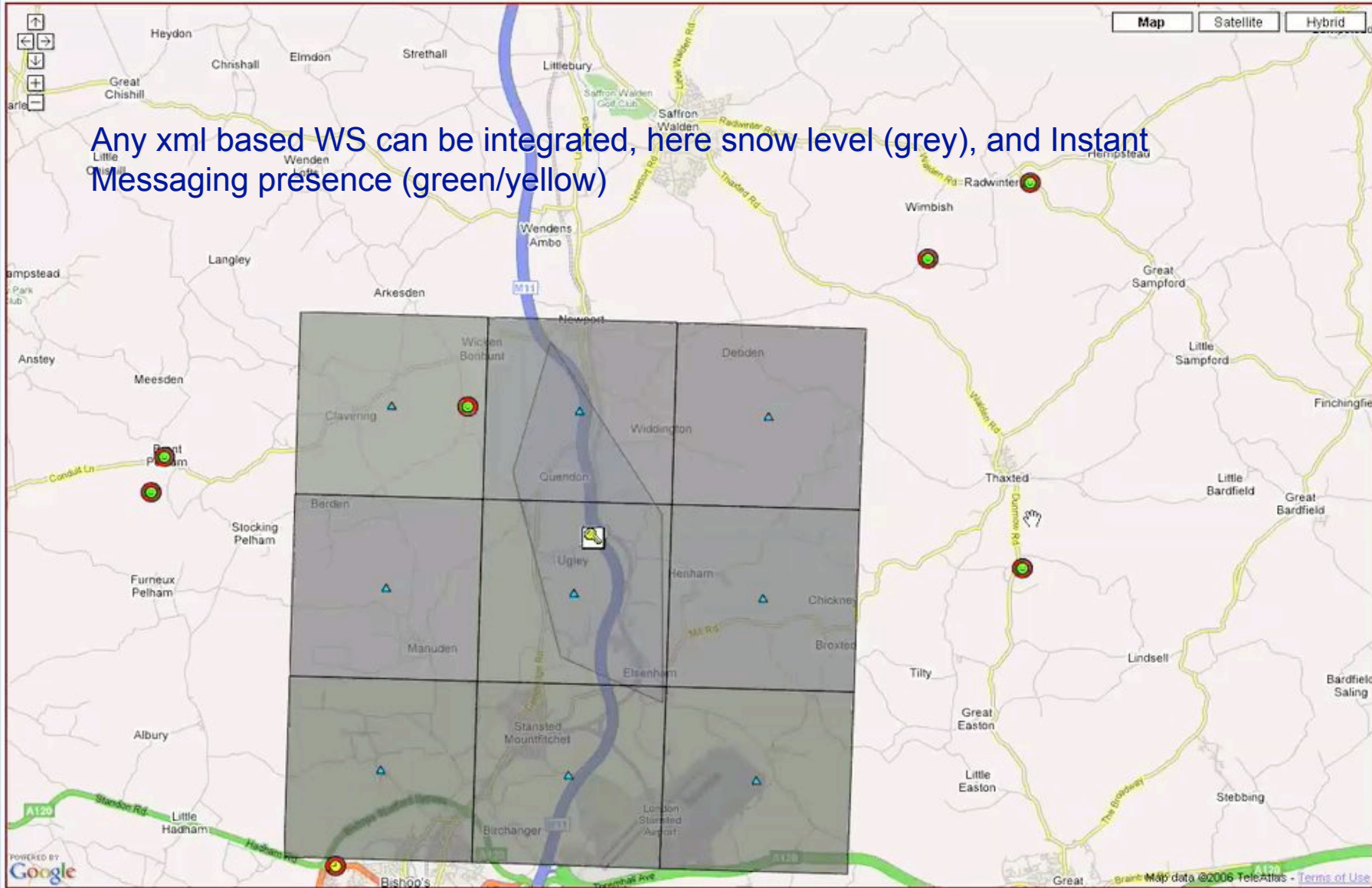
Here retrieves the shelters in an area

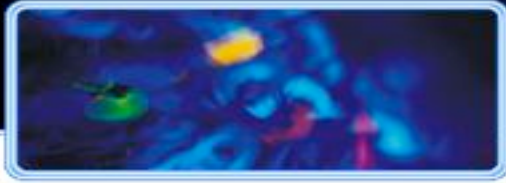


All GMaps features are available and retrieved spatial objects can be fields (e.g. chemical cloud over Stansted airport)



Any xml based WS can be integrated, here snow level (grey), and Instant Messaging presence (green/yellow)

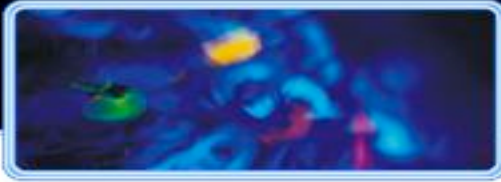




Applications – Conclusion

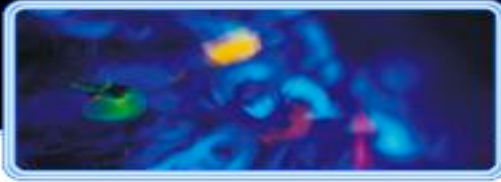
- Any ideas? Try them out in your projects...

- Next: Hands-on Session!



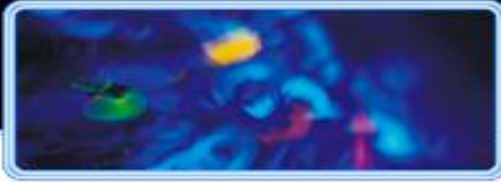
Ontologies and Semantic Technologies

- Steffen Staab, Rudi Studer: **Handbook on Ontologies**. Springer Verlag, Heidelberg. 2004.
- Tim Berners-Lee, James Hendler, Ora Lassila: ***The Semantic Web : a new form of Web content that is meaningful to computers will unleash a revolution of new possibilities.*** In: *Scientific American*, 284 (5), S. 34–43, May 2001
- Tim Berners-Lee, Wendy Hall, Jim Hendler, Kieran O'Hara, Nigel Shadbolt, Daniel Weitzner: ***A Framework for Web Science***, in *Foundations and Trends in Web Science* 1(1) pp. 1-130., 2006



Ontology Engineering

- Asun Gómez-Pérez, Mariano Fernández-López, Oscar Corcho: ***Ontological Engineering***. In: *Advanced Information and Knowledge Processing*, Springer, (2003)
- Duc Thanh Tran, Peter Haase, Holger Lewen, Oscar Munoz-Garcia, Asunción Gómez-Pérez, Rudi Studer : **Lifecycle-Support in Architectures for Ontology-Based Information Systems**, In *Proceedings of the 6th International Semantic Web Conference*. Busan, Korea, November 2007.
- York Sure, Steffen Staab, Rudi Studer: **Methodology for Development and Employment of Ontology Based Knowledge Management Applications** in *SIGMOD Record* 31 (4): 18-23. December 2002.
- Christoph Tempich, H. Sofia Pinto, Steffen Staab. ***Ontology Engineering Revisited: an Iterative Case Study with DILIGENT***. In *Proceedings of the 3rd European Semantic Web Conference*, June 11-14, 2006



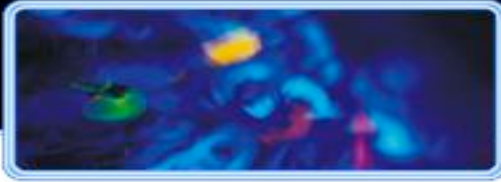
Ontology Learning, Mapping

- Philipp Cimiano, Johanna Völker, Rudi Studer. ***Ontologies on Demand? - A Description of the State-of-the-Art, Applications, Challenges and Trends for Ontology Learning from Text*** Information, Wissenschaft und Praxis 57 (6-7): 315-320. October 2006.
- Marc Ehrig: ***Ontology Alignment: Bridging the Semantic Gap***. Springer 2007



Applications

- Markus Krötzsch, Denny Vrandečić, Max Völkel, Heiko Haller, Rudi Studer: **Semantic Wikipedia**, in *Journal of Web Semantics*. December 2007.
- Stephan Bloehdorn, Philipp Cimiano, Alistair Duke, Peter Haase, Jörg Heizmann, Ian Thurlow, Johanna Völker
Ontology-based Question Answering for Digital Libraries
In *Proceedings of the 11th European Conference on Research and Advanced Technologies for Digital Libraries (ECDL 2007)*, Budapest, Hungary, September 16-21 2007.
- Enrico Motta, Marta Sabou: **Next Generation Semantic Web Applications**. ASWC 2006: 24-29



Application (cont.)

- Noah S. Friedland, Paul G. Allen, *and many more*: **Project Halo – Towards a Digital Aristotle**, in *AI Magazine* 2004
- David Huynh, Stefano Mazzocchi, David Karger: **Piggy Bank: Experience the Semantic Web Inside Your Web Browser** in *International Semantic Web Conference (ISWC) 2005*.
- Vlad Tanasescu, Alessio Gugliotta, John Domingue, Rob Davies, Leticia Gutiérrez-Villarías, Mary Rowlatt, Marc Richardson, Sandra Stincic: **A Semantic Web Services GIS Based Emergency Management Application**. *International Semantic Web Conference 2006*: 959-966