Semantic Web
Methods, Tools and Applications

November 05, 2007

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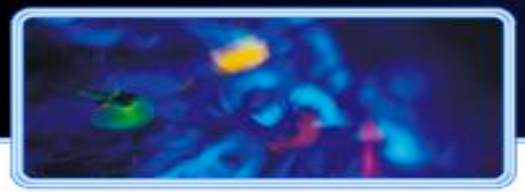
Asian Autumn School for the Semantic Web
AASSW2007

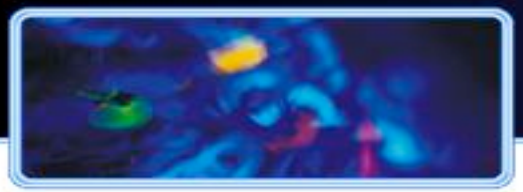
Busan, Korea



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

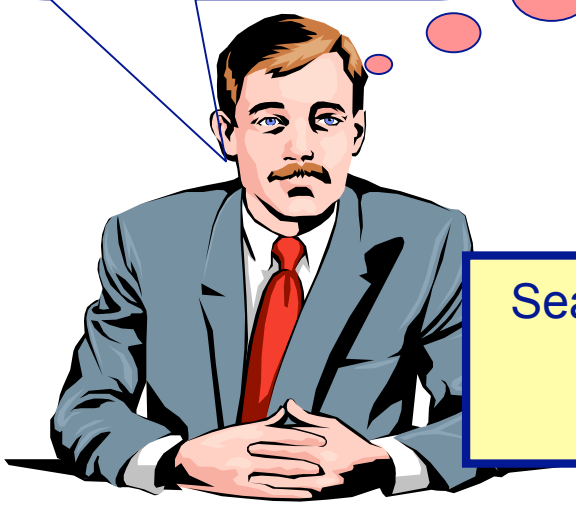
- Motivation
  - Semantic Technologies and Ontologies
  - Ontology Lifecycle
- Methods and Tools
  - Ontology Development
  - Ontology Learning
  - Ontology Mapping
  - Ontology Evaluation and Evolution
  - Ontology Management: Repositories and Reasoners
- Applications
  - Content Management / Information Search and Retrieval
  - Expert and Assistance Systems
  - Social and collaborative applications
  - Web Applications

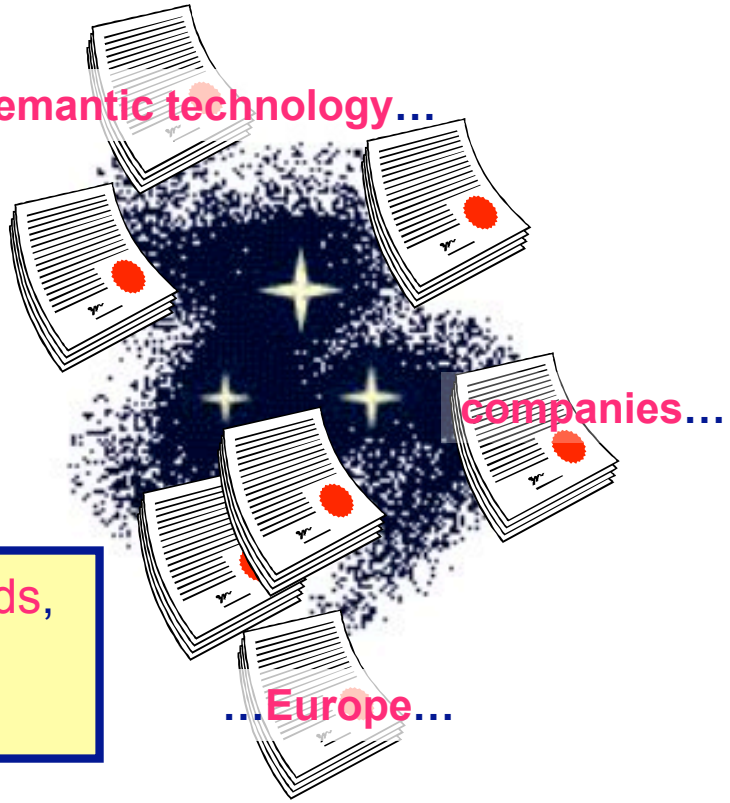
Information Search Example

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?

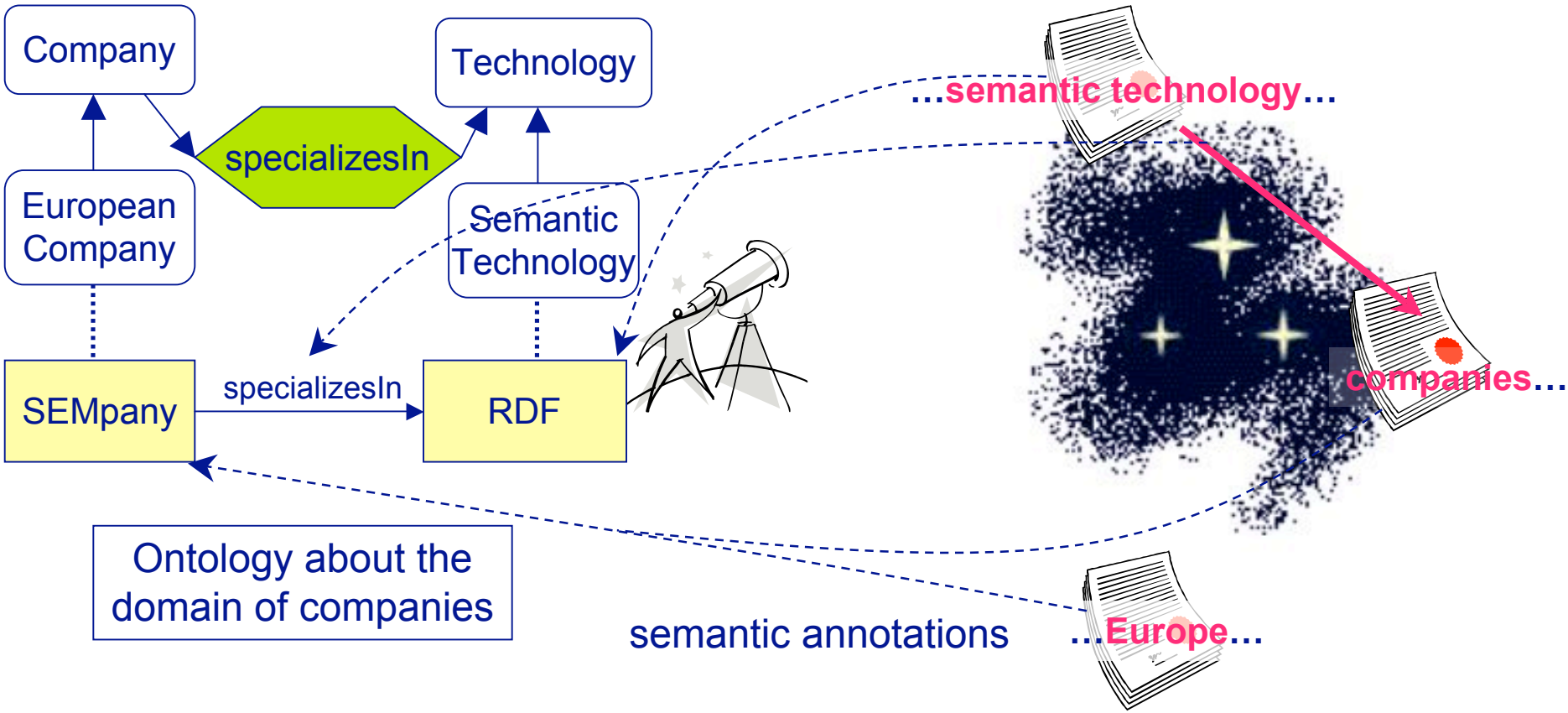




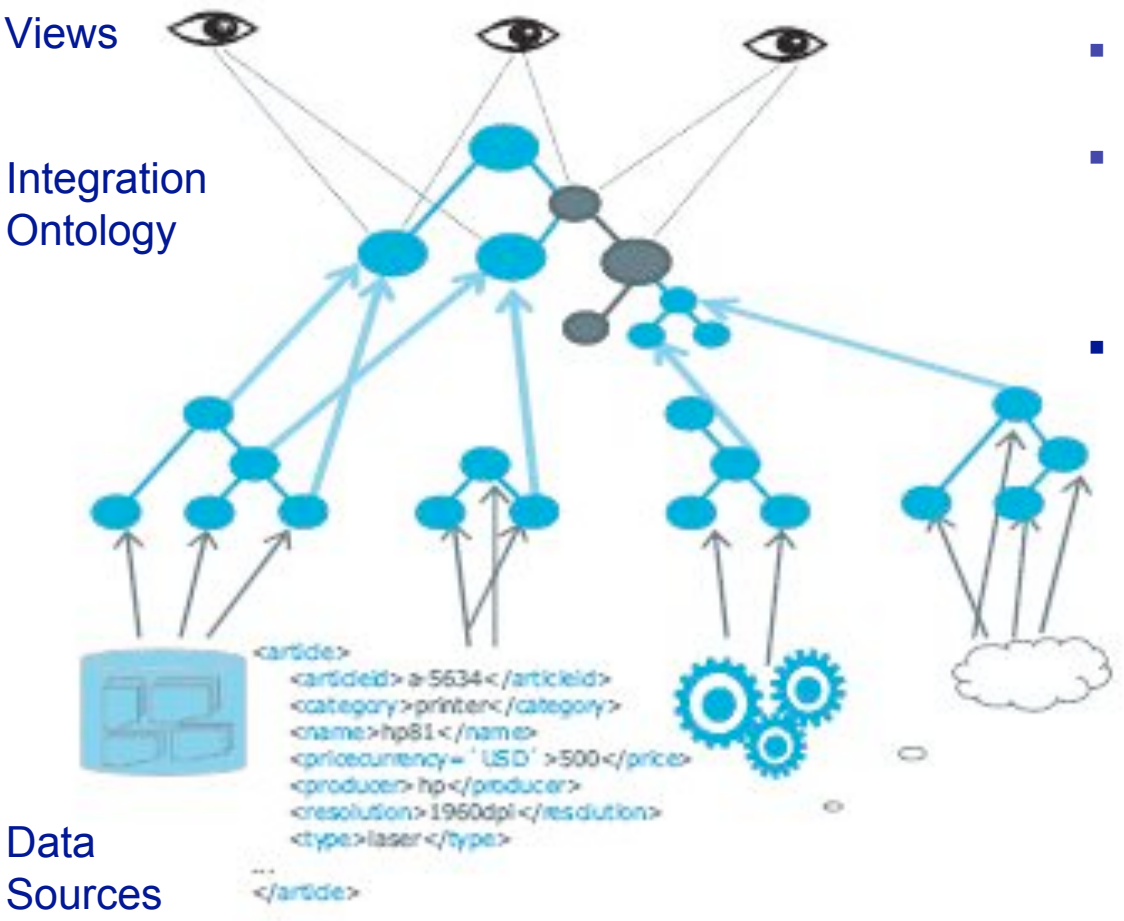
Search is based on keywords, and not on the actual meaning/semantics.

Information Search Example

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



Semantic Technologies Provide Dynamic Integration Solutions to EII

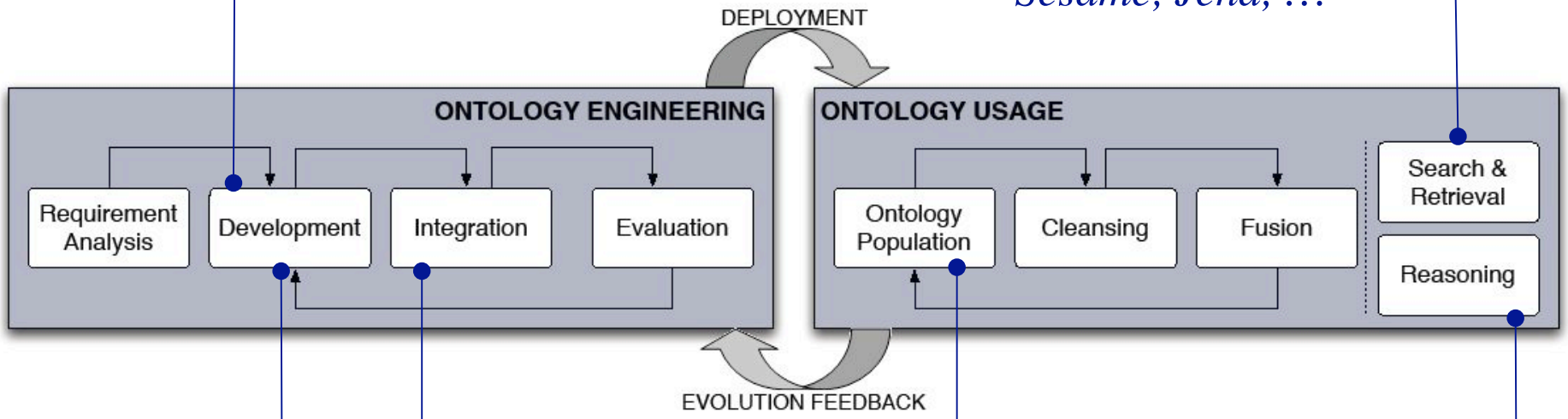


- Data Integration **most costly** and challenging task for enterprises
- E.g. up to 80% of migration costs due to data integration
- Semantic technologies enable dynamic integration solution which federate queries and merge data from heterogeneous data sources
- **Benefits** of ontologies
  - **Shared 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, …

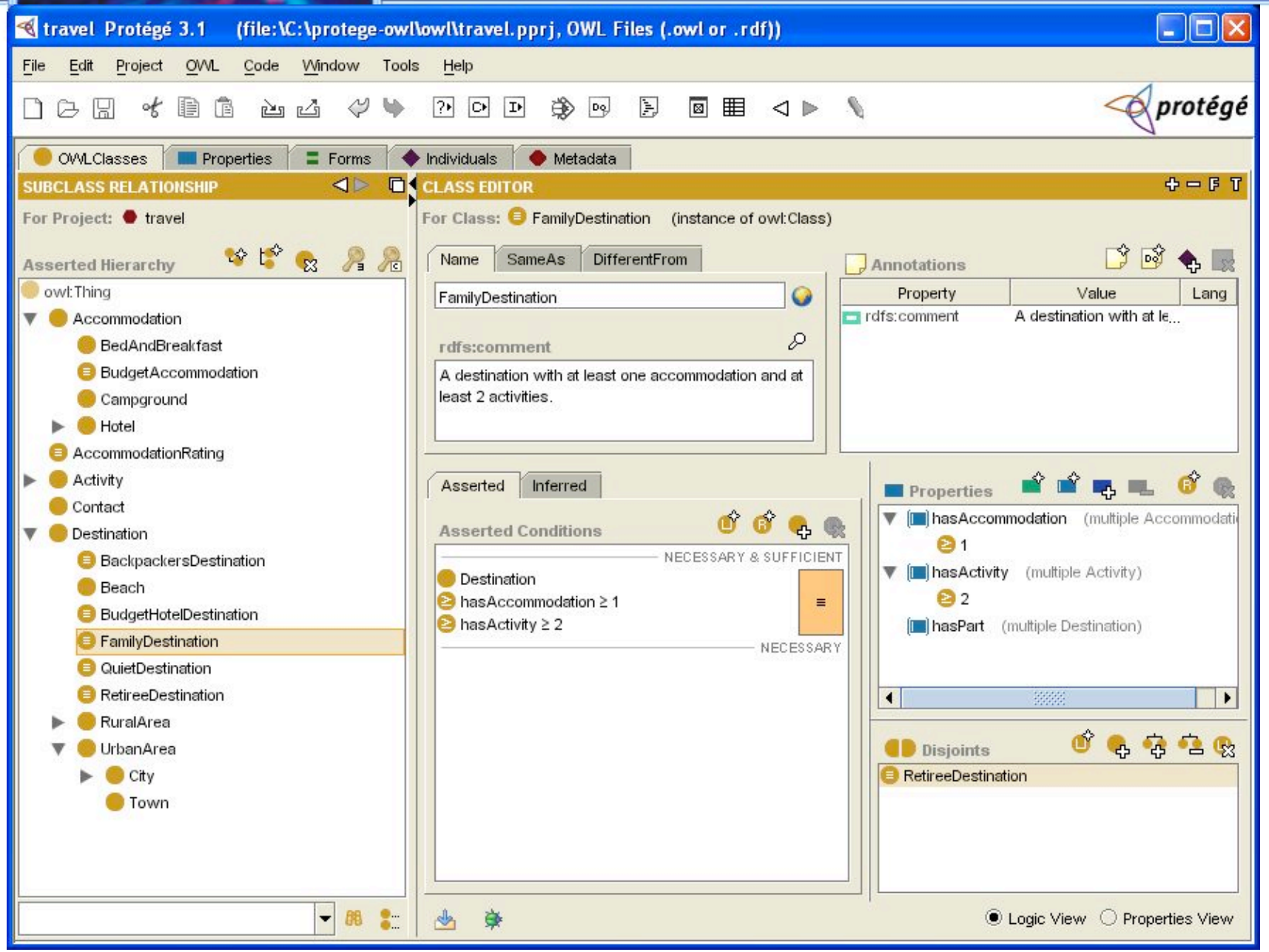


Ontology Mapping Tools
Prompt, OntoMap…

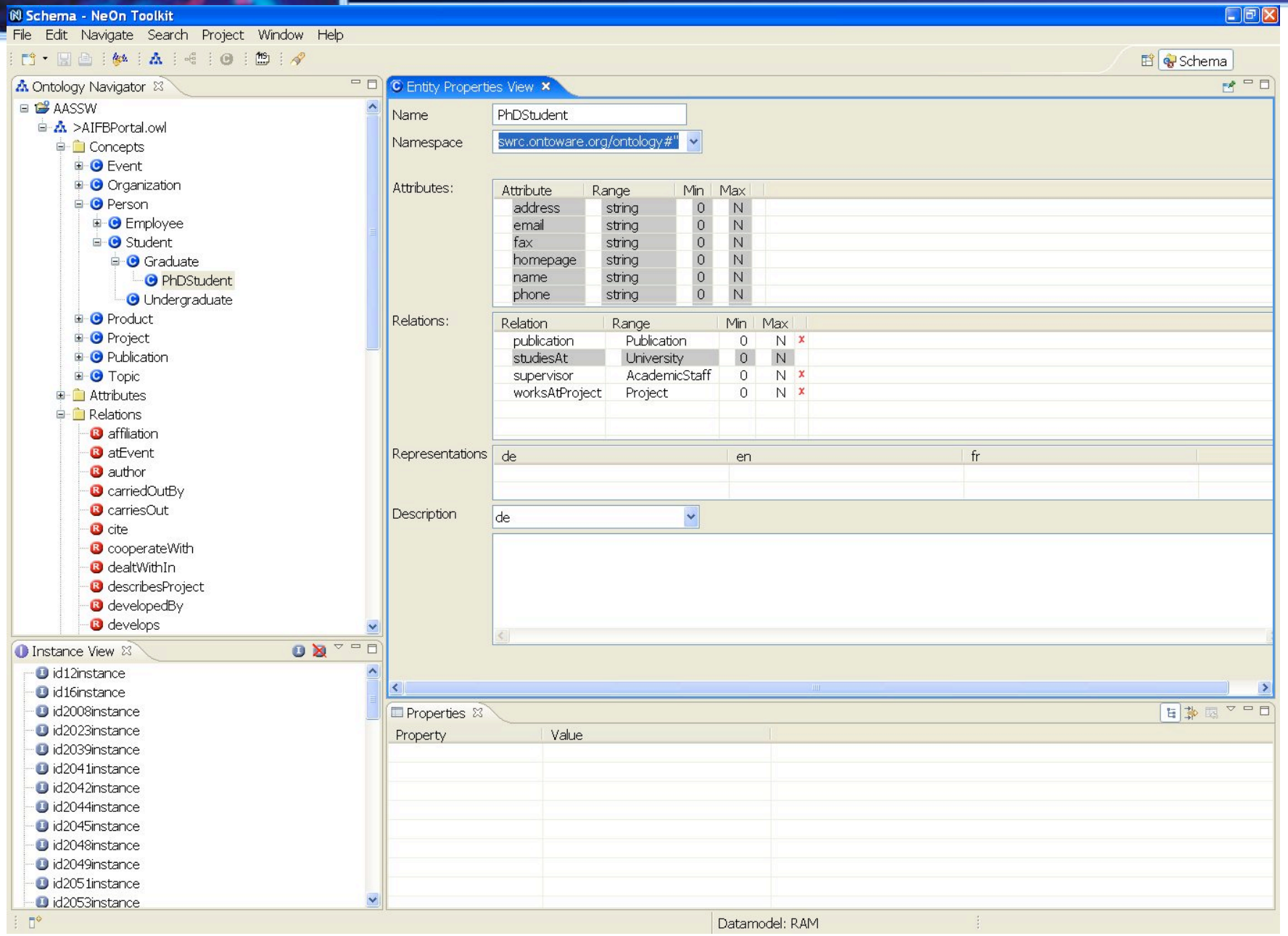
Ontology Learning Tools
Text2Onto, OntoLT, …

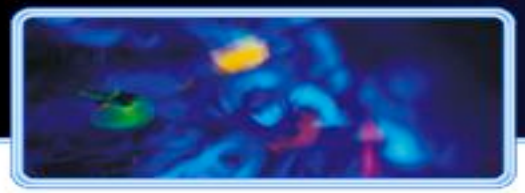
Ontology Reasoners
Pellet, KAON2, Racer,…

Ontology Development with Protege OWL



Ontology Development with the NeOn Toolkit



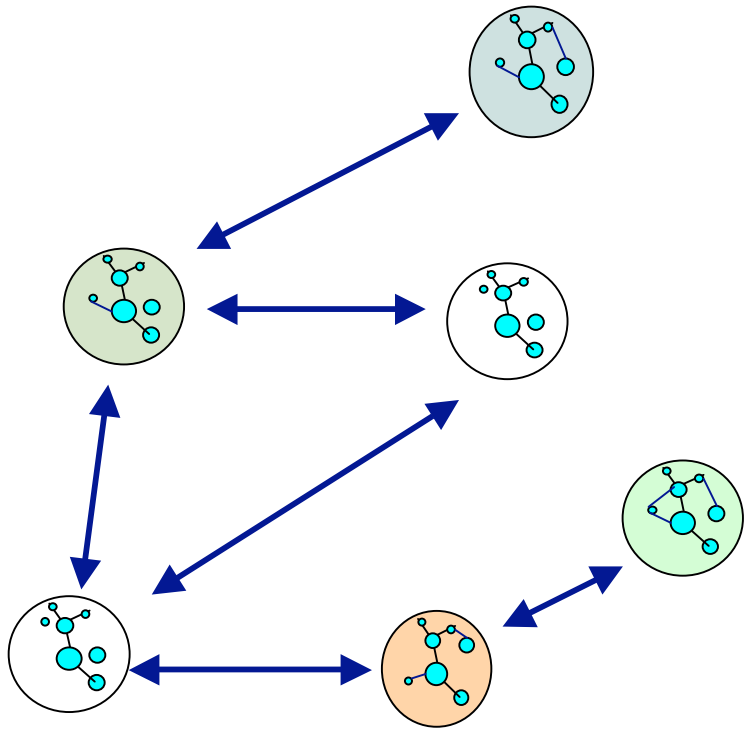


Ontology Development Tools

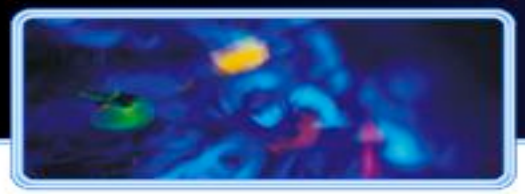
	Protégé OWL	*Semantic Works*	*TopBraid Composer*	*IODT*	*SWOOP*	*OntoStudio (NeOn Toolkit)*
Developer	Stanford	Altova	TopQuadrant	IBM	Univ. of Maryland	Ontoprise (NeOn Found.)
Primary Ontology Language	OWL	OWL	OWL	OWL	OWL	F-Logic (+OWL)
View	Form Text	Form Text Graph	Form Text (UML-like) Graph	(UML-like) 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



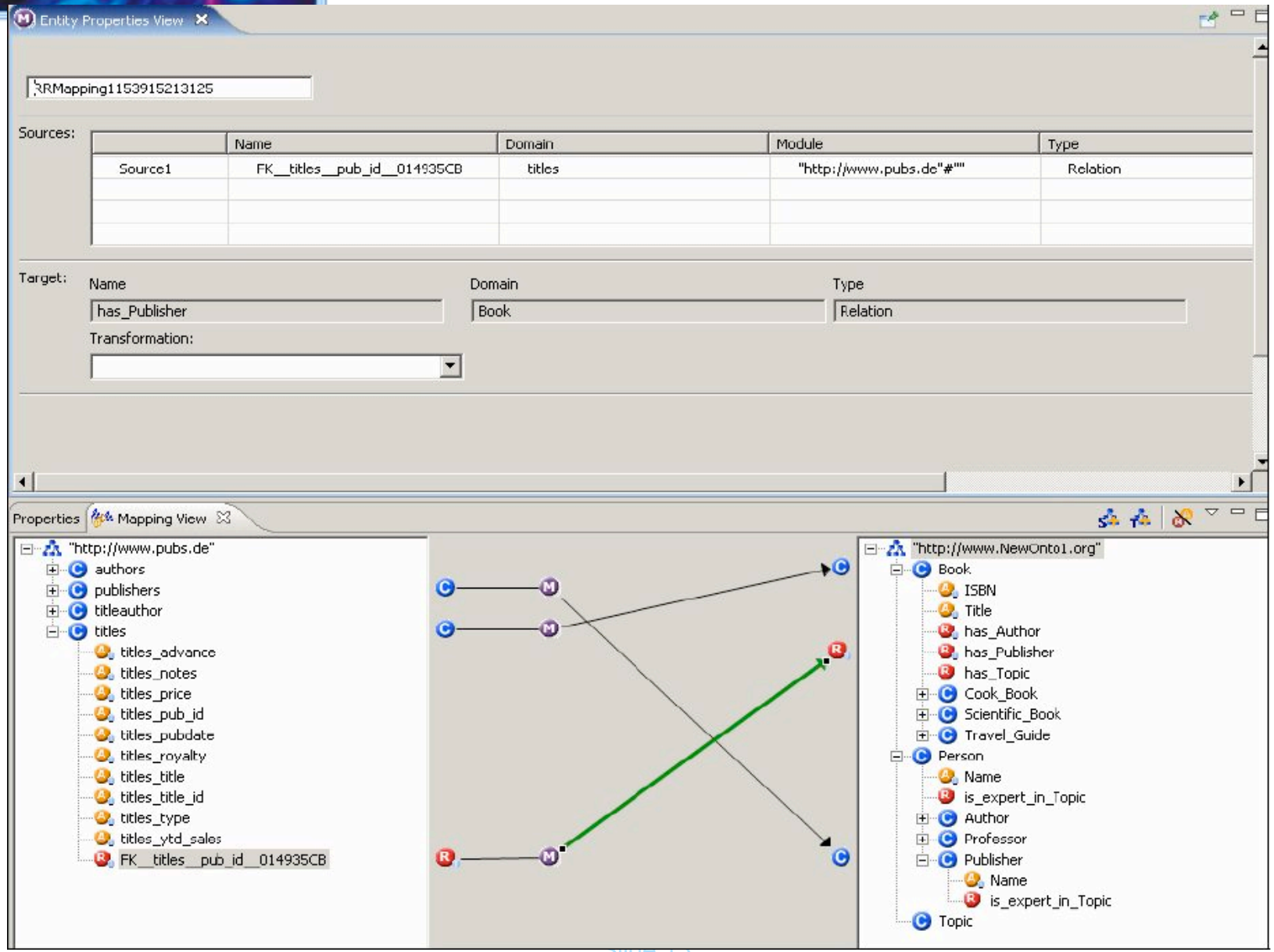
Ontology Mapping – Techniques and Tools

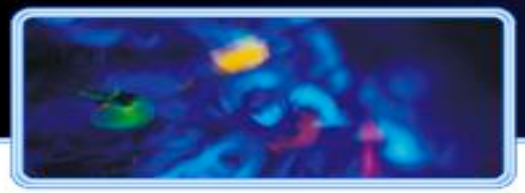
- Great number of Techniques
  - Syntactic, Semantic, External
  - Element-Level, Structure-Level
  - Schema or Instance Level mapping

- 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





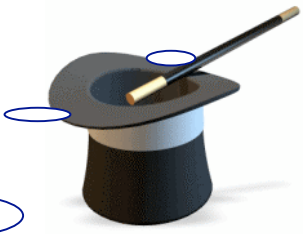
Ontology Learning

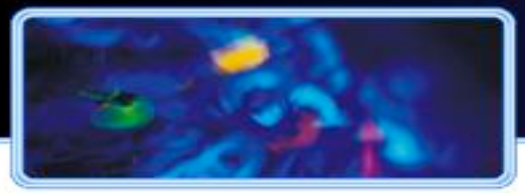
Challenge: Ontology development is a bottleneck!

- **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



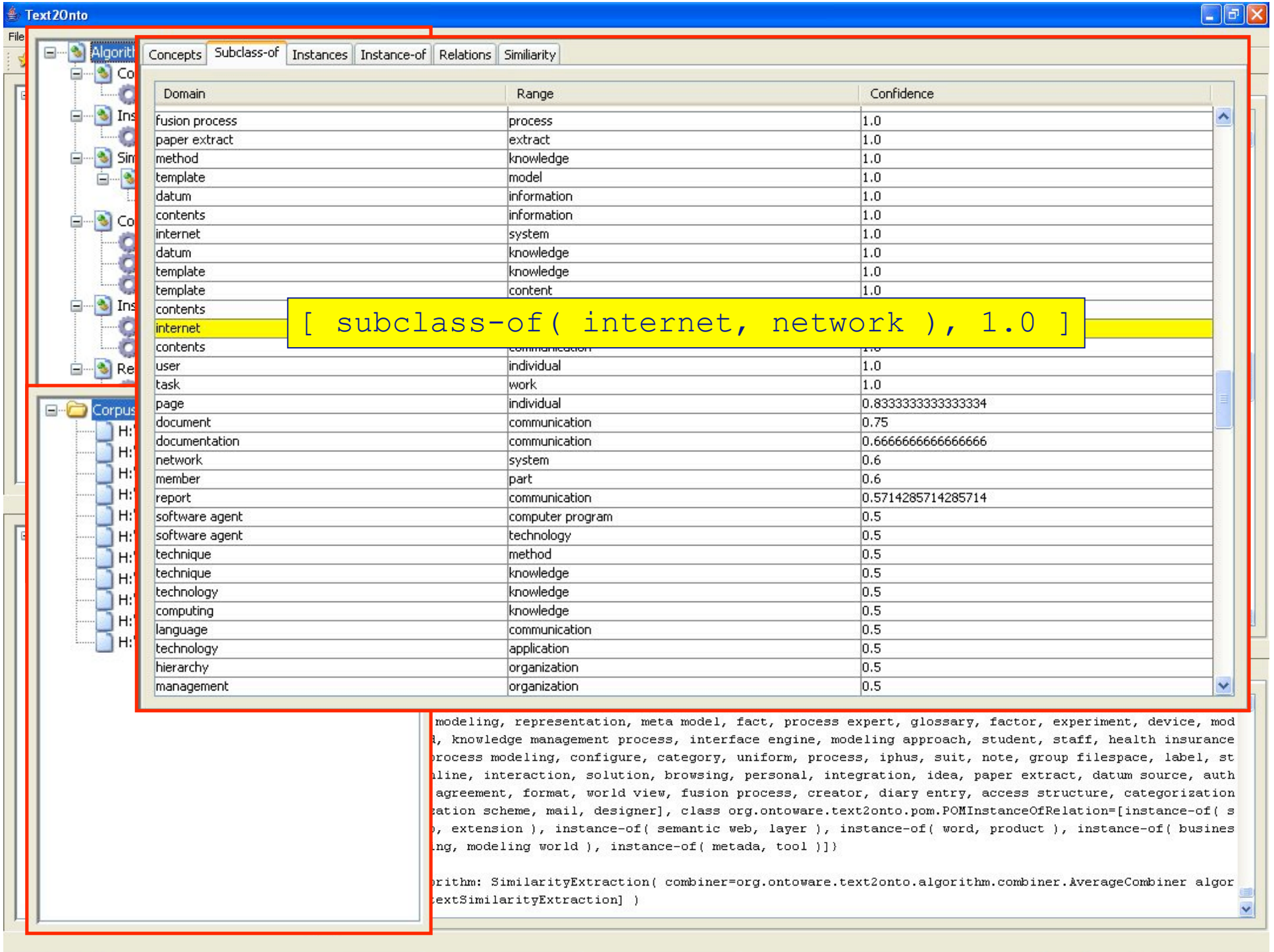


Text2Onto

- 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


Text2Onto
File
Concepts
Subclass-of
Instances
Instance-of
Relations
Similiarity
Domain
Range
Confidence
fusion process
process
1.0
paper extract
extract
1.0
method
knowledge
1.0
template
model
1.0
datum
information
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contents
information
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page
individual
0.8333333333333334
document
communication
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documentation
communication
0.6666666666666666
network
system
0.6
member
part
0.6
report
communication
0.5714285714285714
software agent
computer program
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communication
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technology
application
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hierarchy
organization
0.5
management
organization
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modeling, representation, meta model, fact, process expert, glossary, factor, experiment, device, mod
, knowledge management process, interface engine, modeling approach, student, staff, health insurance
process modeling, configure, category, uniform, process, iphus, suit, note, group filespace, label, st
line, interaction, solution, browsing, personal, integration, idea, paper extract, datum source, auth
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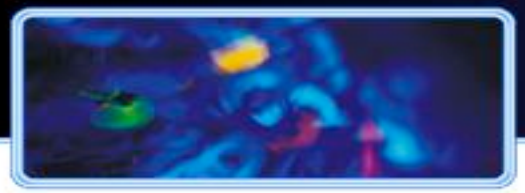
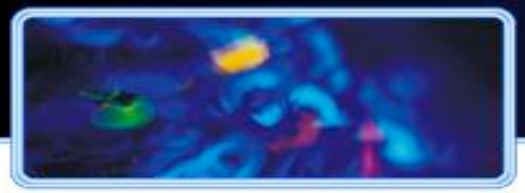


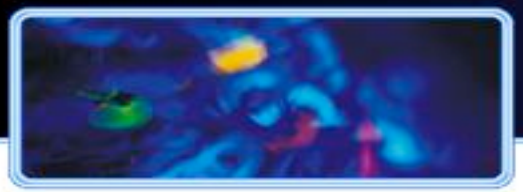
Ontology Learning Tools

Organization	*System*	*Ontology Learning Subtasks*					
		Terms	*Synonyms*	*Concepts*	*Concept Hierarchy*	*Relations*	*Other Axioms*
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	**ATRACT**	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

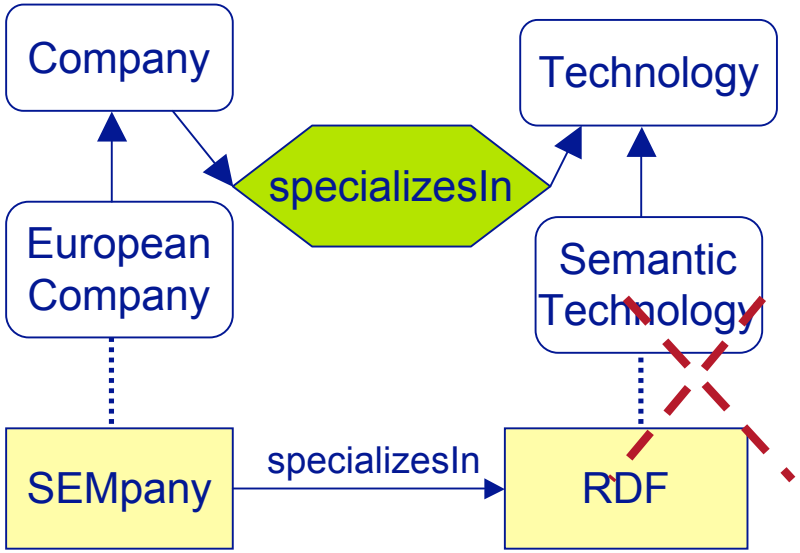
- What is a ‘good’ ontology?

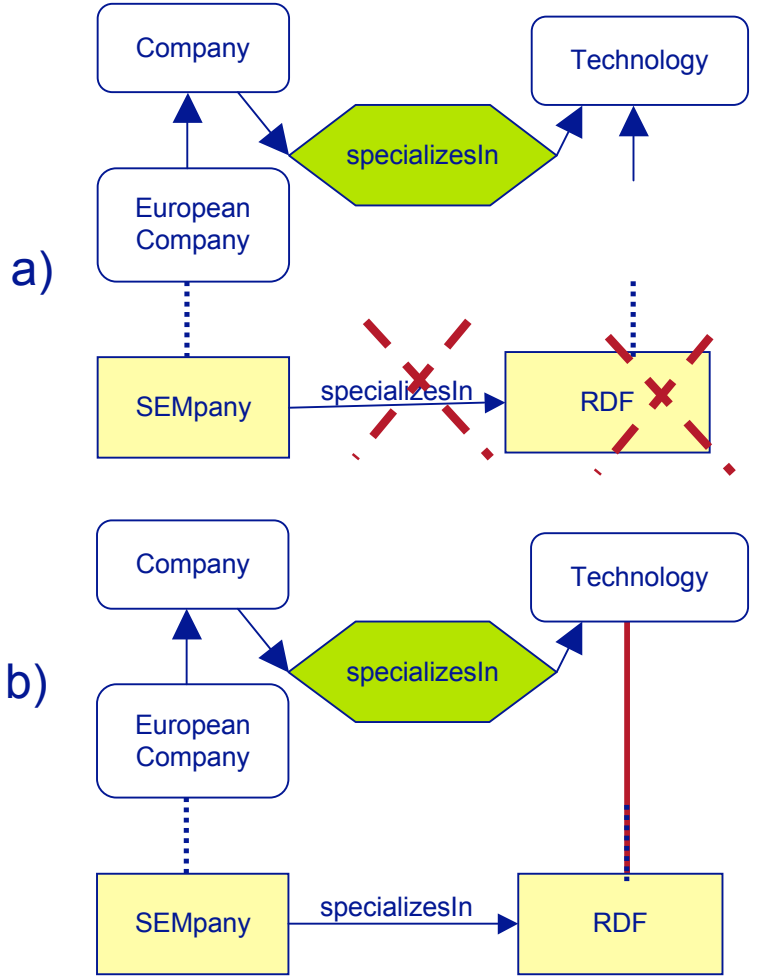
  - Usage, application performance, data coverage, corpus fit, reasoning adequacy ?
  - Well-known: OntoClean (formal evaluation of taxonomic relationships), developed by Guarino and Welty
  - System of conceptual tags (Rigidity, Unity, Identity, Independence) + constraints on possible subsumption relations (e.g. ~R can‘t subsume +R)
  - OntoClean is based on philosphical principles and is even hard to understand for experts
  - AEON approach tries to (automatically) approximate the tagging with OntoClean

Ontology Evolution

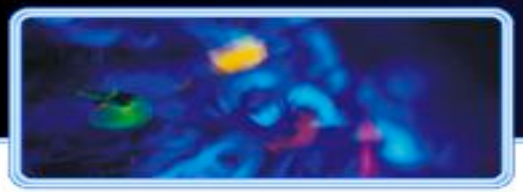
Challenge: Domain ontologies are ever changing!

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

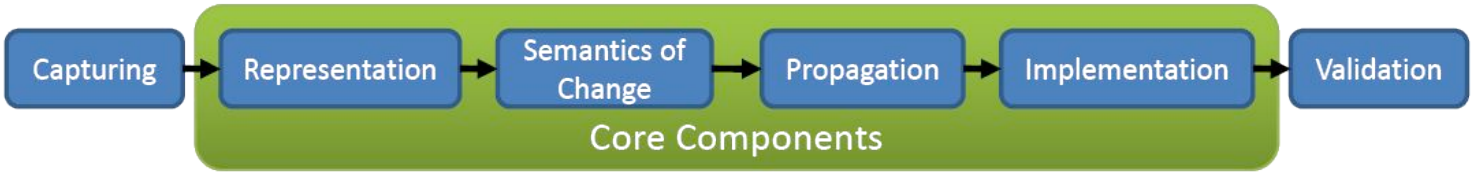




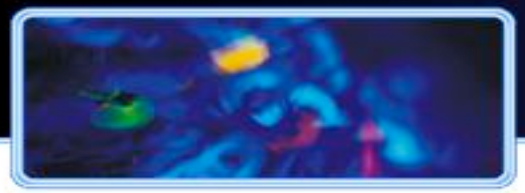
- Traceability (of changes)
  - which change to the ontology was performed by whom and when, possibly why?
  - if the change has been generated as a byproduct of updating the corpus, keep a reference to the segment in a corpus which triggered the change



Ontology Evolution (Process)

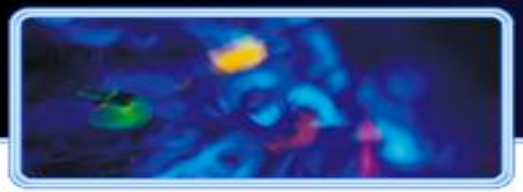


- Capturing
  - Explicit changes – intended by Ontology Engineer
  - Implicit changes: *usage-driven, data-driven, structure-driven*
- Representation
  - Fine grained (simple) change operation
  - Coarse grained (complex/composite) change operations
- Semantics of change
  - Consistency: *structural 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

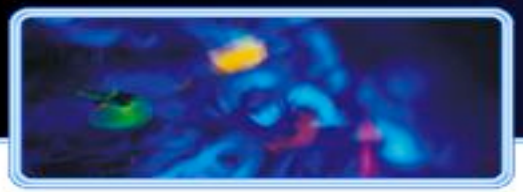


Ontology Repositories

- 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

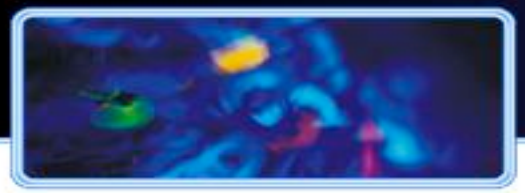
- Others: YARS, Kowari, OWLIM



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 v D
  - i.e. whether instances of C are always instances of D
  - subsumption checking
  - equivalent to query containment

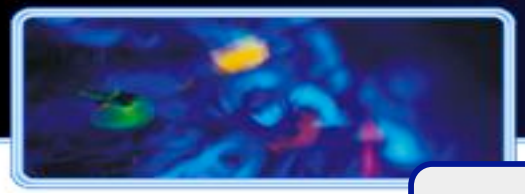
- Selecting the right reasoner depends on many aspects
  - Reasoning task
  - Complexity of ontology (underlying logical language)
  - Size of ontology (ABox vs. TBox)



Overview of Reasoners

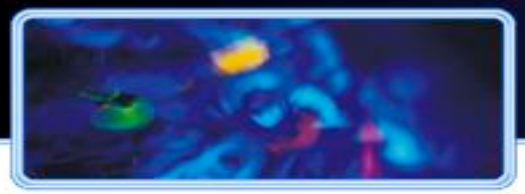
	Cerebra *(Web Methods)*	***FACT++*** *(U of Manchester)*	***KAON2*** *(ontoprise)*	***Pellet*** *(U of Maryland)*	***Racer*** *(Racer Systems)*	***Ontobroker*** *(ontoprise)*	***OWLIM*** *(ontotext)*
Interfaces	OWL API	DIG	KAON2 API	DIG, OWL API, Jena API	DIG, OWL API	KAON2 API DIG	Sesame API
Reasoning 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

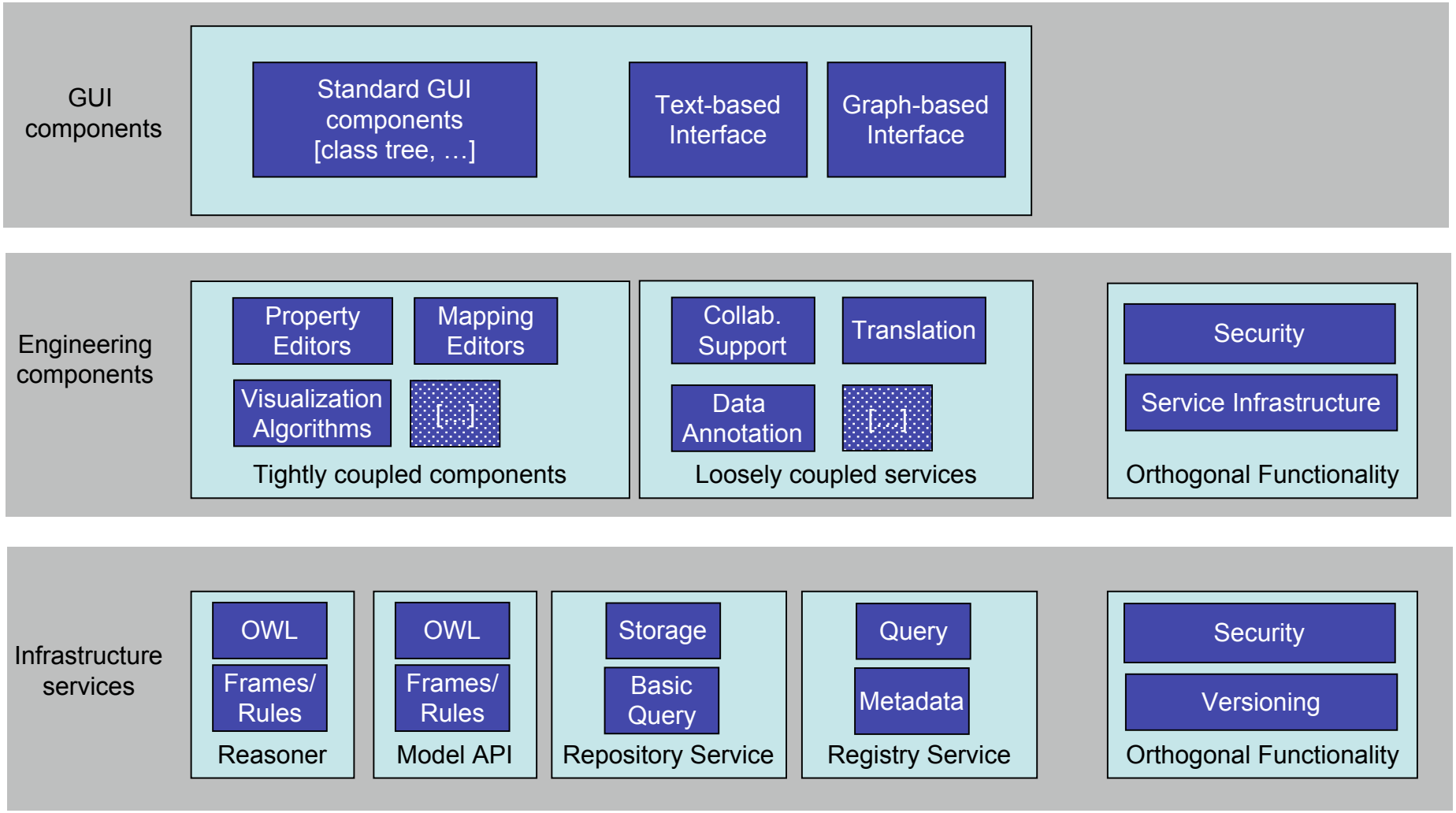
What is the NeOn Toolkit?

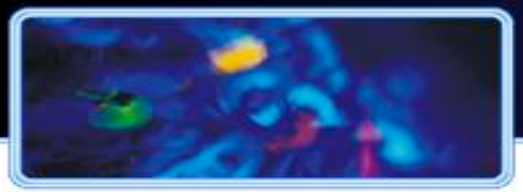


	Ontology	Engineering	Environment			
	Supports the lifecycle of networked ontologies					
	Modeling		Collaboration	Modularization	Documentation	
		Integration	Verification	Testing	Deployment	
	Dual language	approach	Modular	Extensible	Platform	
	F-Logic rules Frame-like	modeling		Based on	Eclipse	
	OWL-DL	modeling		Succeeds	OntoStudio	

NeOn Architecture to Support the Entire Ontology Lifecycle

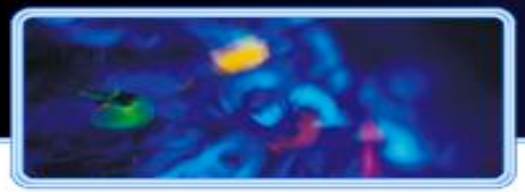






Applications

- 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)

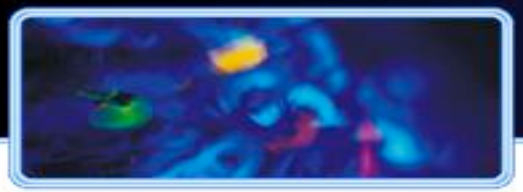
Bob works as technology analyst for British Telecom. His daily work includes research on new technological trends, market developments as well as the analysis of competitors.

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.

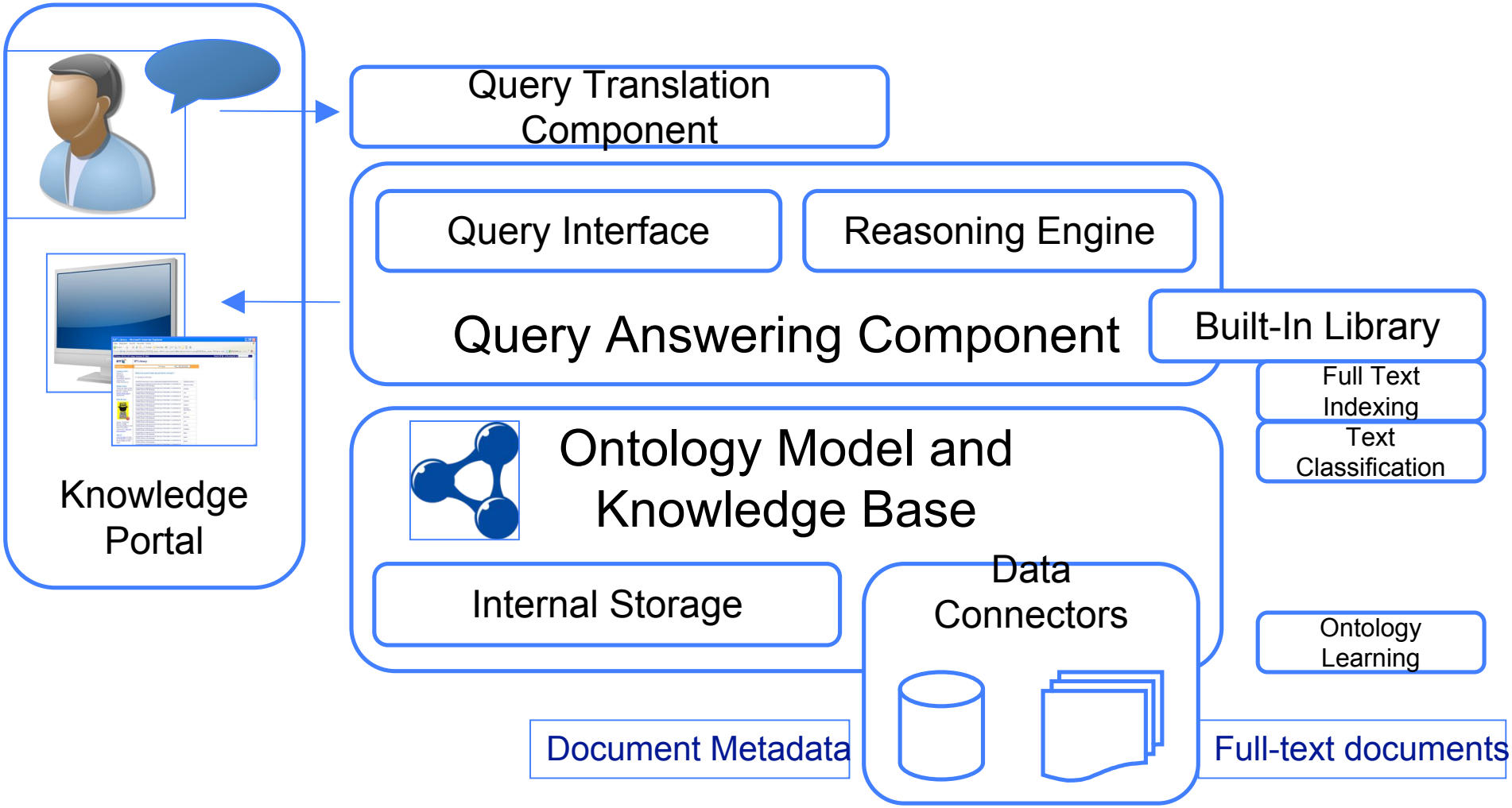
- Heterogeneity of content
- Heterogeneity of search facilities
- Heterogeneity of data models (schemas)
- Interface design challenge

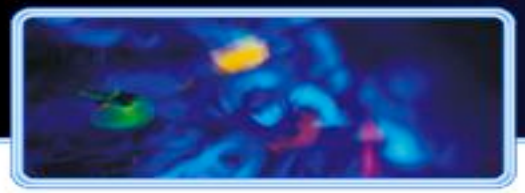


Why Ontology-Based Digital Libraries?

- 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





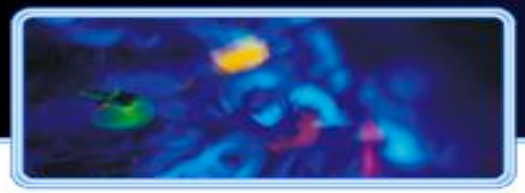
Ontology Model and Knowledge Base

- 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")
}
```

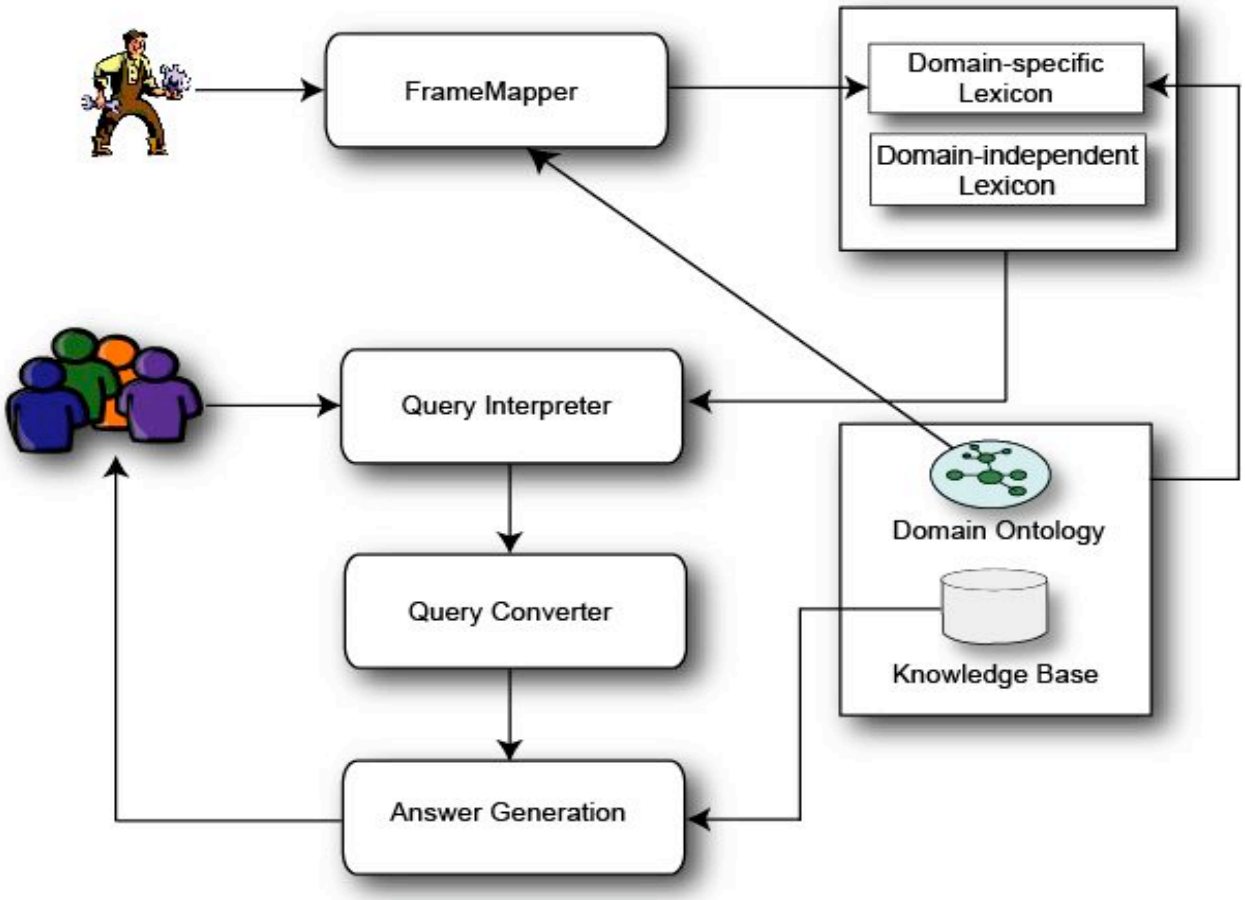


Knowledge Portal

- 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

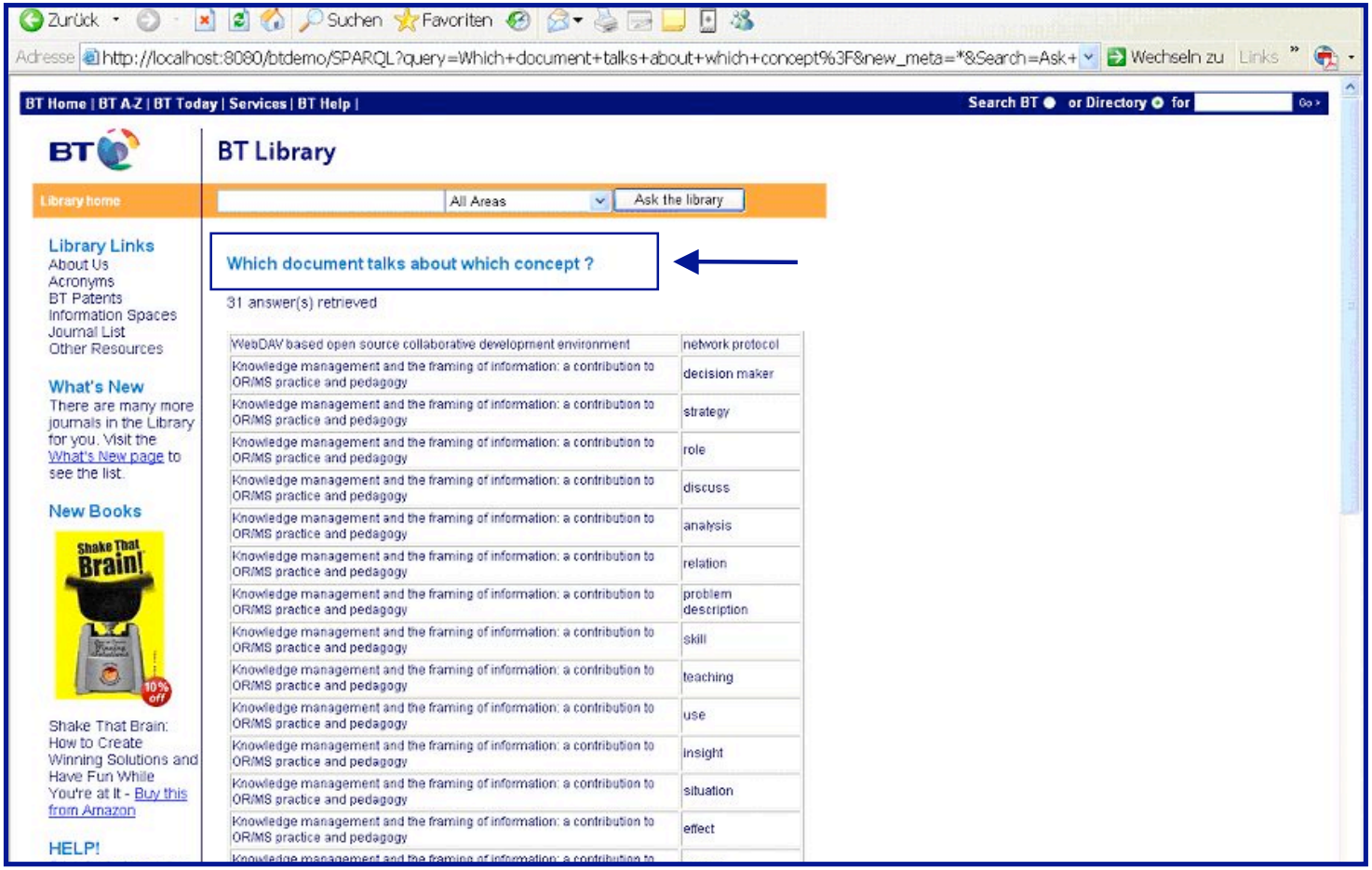
Scenario Revisited

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

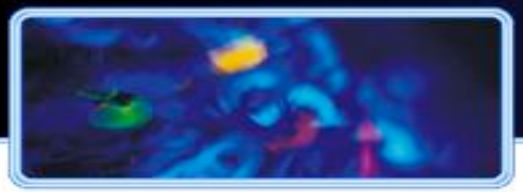
```
PREFIX protonu:<http://proton.semanticweb.org/2005/04/protonu#>
PREFIX protont:<http://proton.semanticweb.org/2005/04/protont#>

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

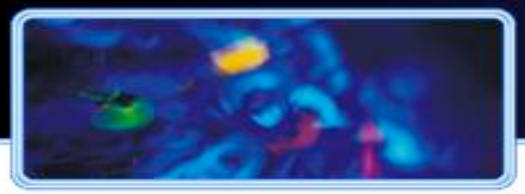


Screenshot from BT Digital Library



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 ambitous
- 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)

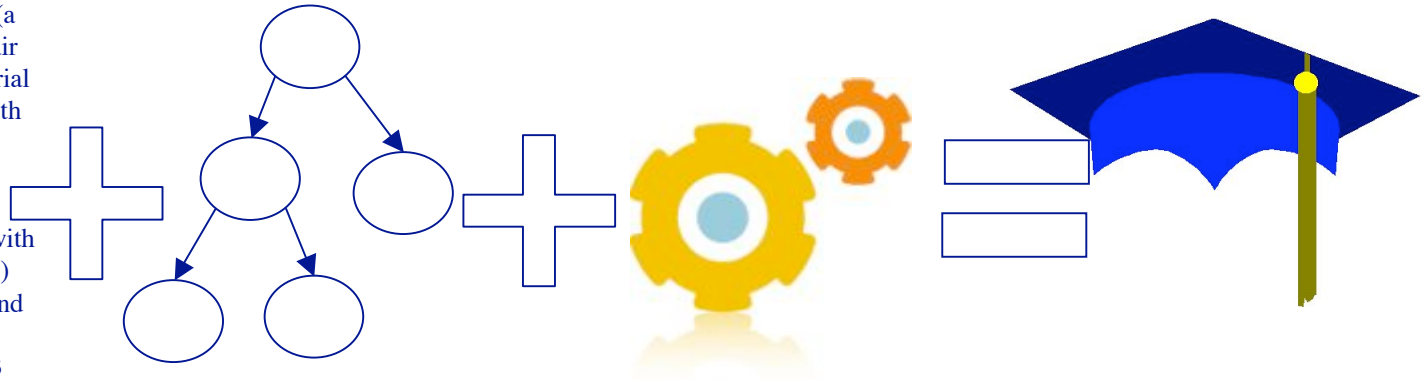
Formalized

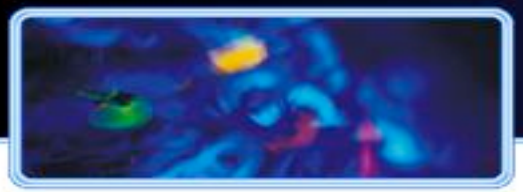
(every QF1 has (context ((:pair "(a) Ba(OH)2(s)" (a Reaction with (raw-material ((a HCl-Substance) (a Ba_OH_2-Substance with (state ((a State-Value with (value (*solid)))))))))) (:pair "(b) CaCO3(s)" (a Reaction with (raw-material ((a HCl-Substance) (a CaCO3-Substance with (state ((a State-Value with (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





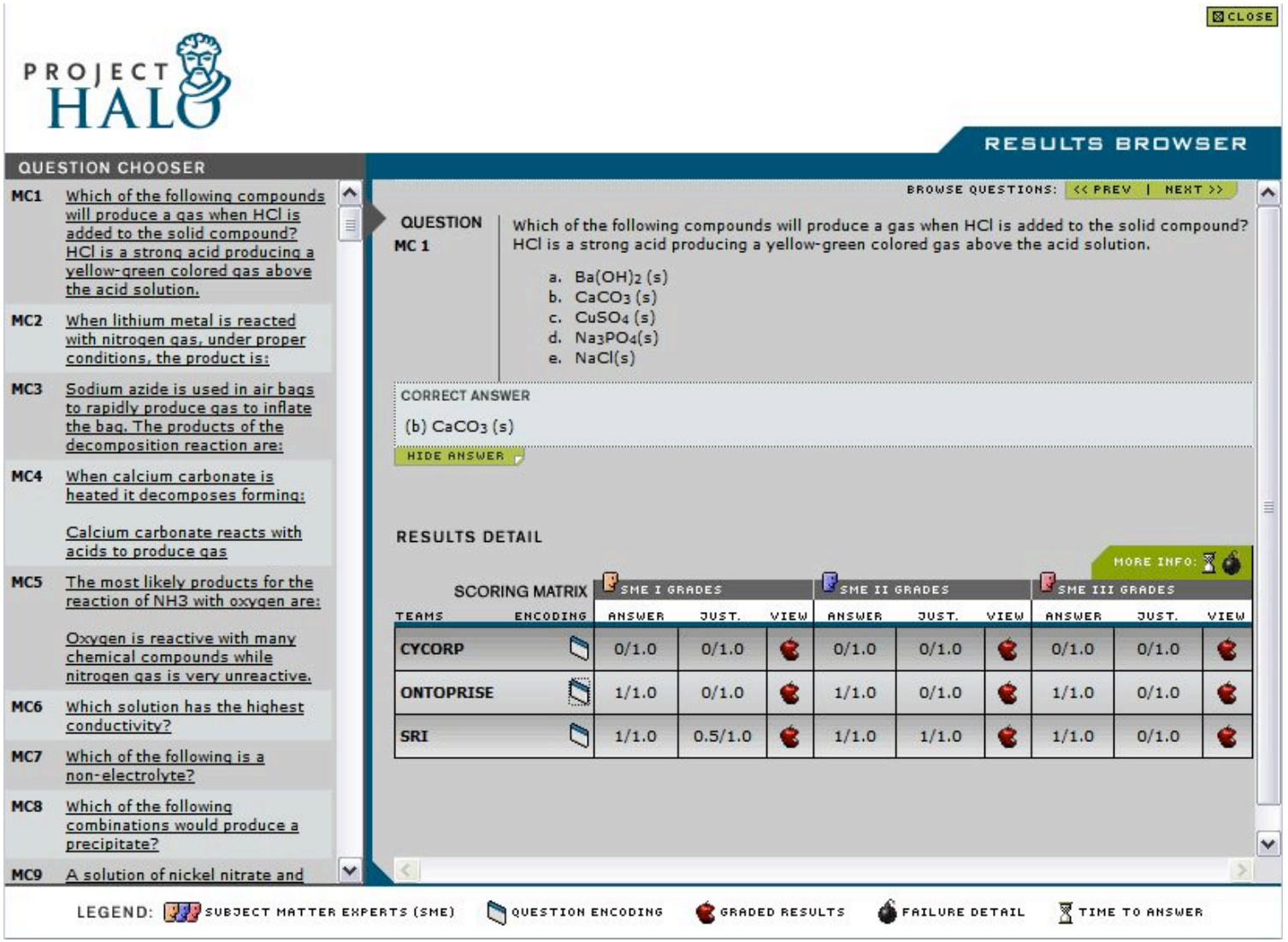
Evaluation

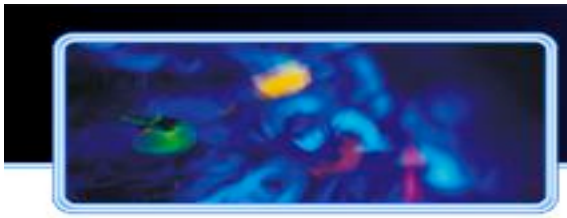
- Correctness
  - Was pretty high
- Justification
  - Considerably lower than correctness
- Speed
  - Was critical, but all systems faired well

- Results:
  - Human mean average in this test is AP-2.82
  - Project Halo scored an AP-3 – they would have passed!

Result browser

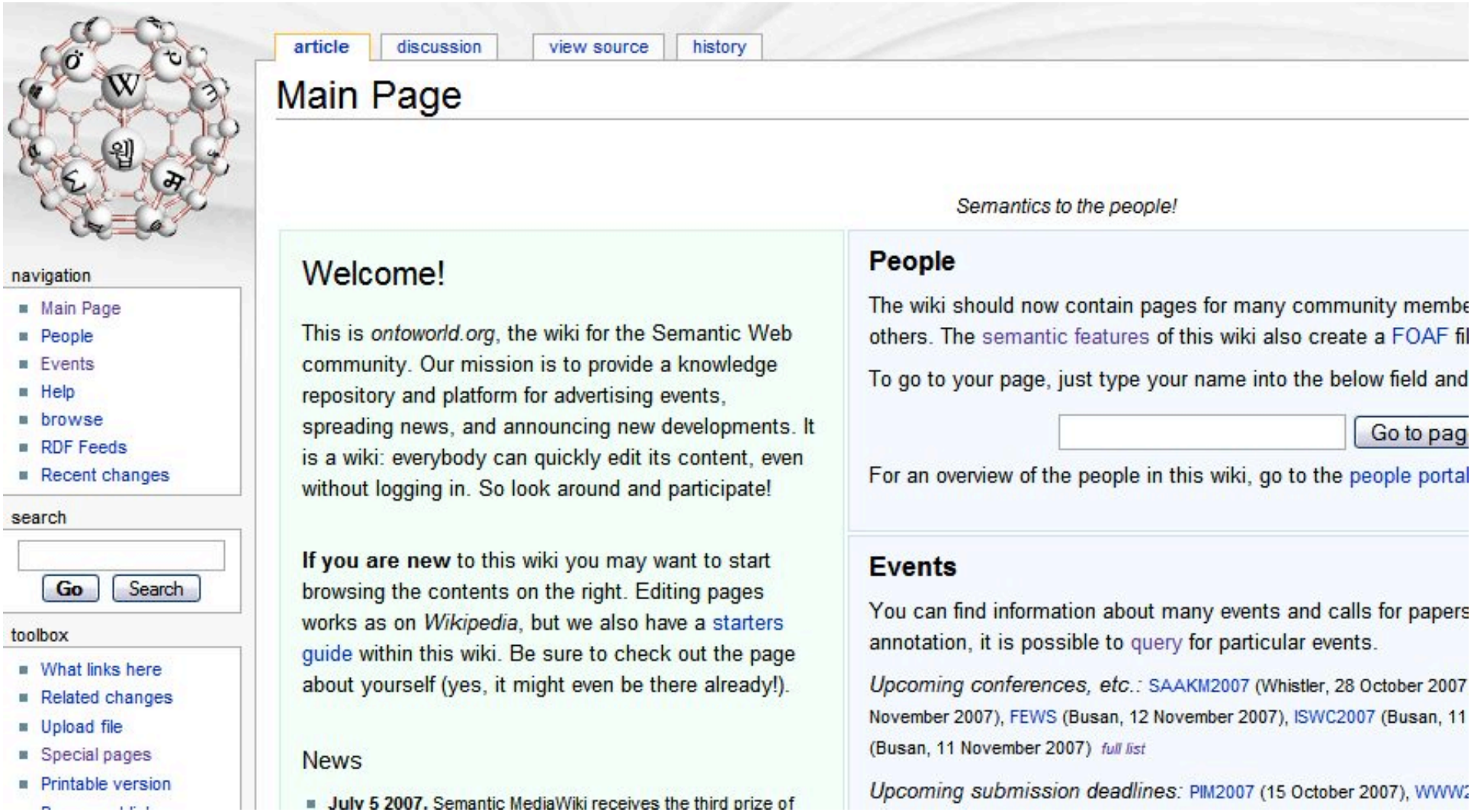
- http://www.projecthalo.com/halotempl.asp?cid=2135#

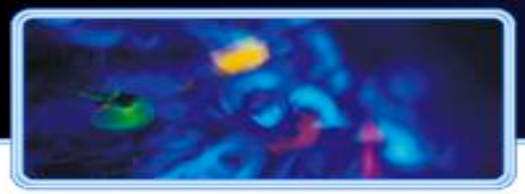




ontoworld.org

- A semantic wiki for the semantic web community





The Semantic Web wiki

- Persons
- Events
- Tools
- Publications

Events

You can find information about many events a
papers within this wiki. Using semantic annotat
possible to query for particular events.

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

Upcoming submission deadlines: PIM2007 (1
WWW2008 (1 November 2007), ESWC2008 (14 De

list

Organising an event? Advertise it here by q
an article! Just enter the event's abbreviation i
below to get an edit box with further document

Add

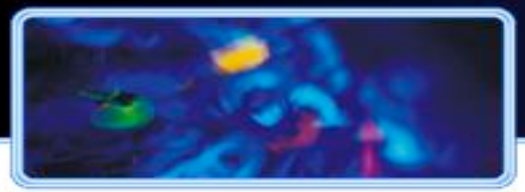
article | discussion | edit | history

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, us
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,
clicking the link at the bottom of this page. You can also directly browse the current

	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



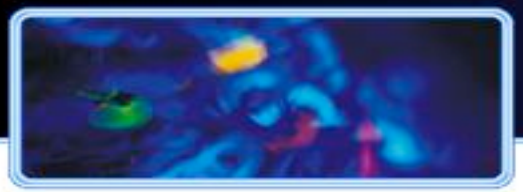
Why should the community care?

- 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

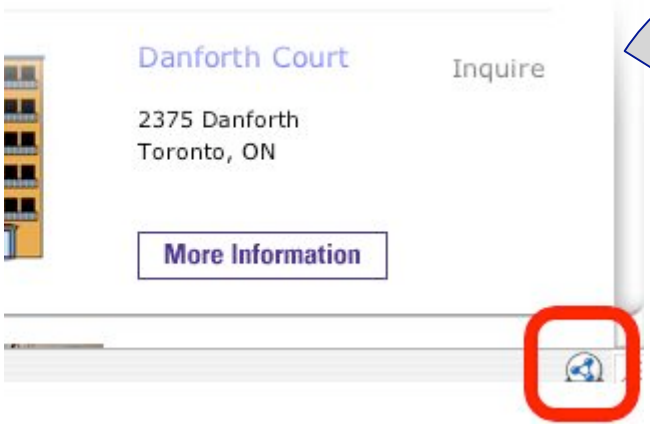


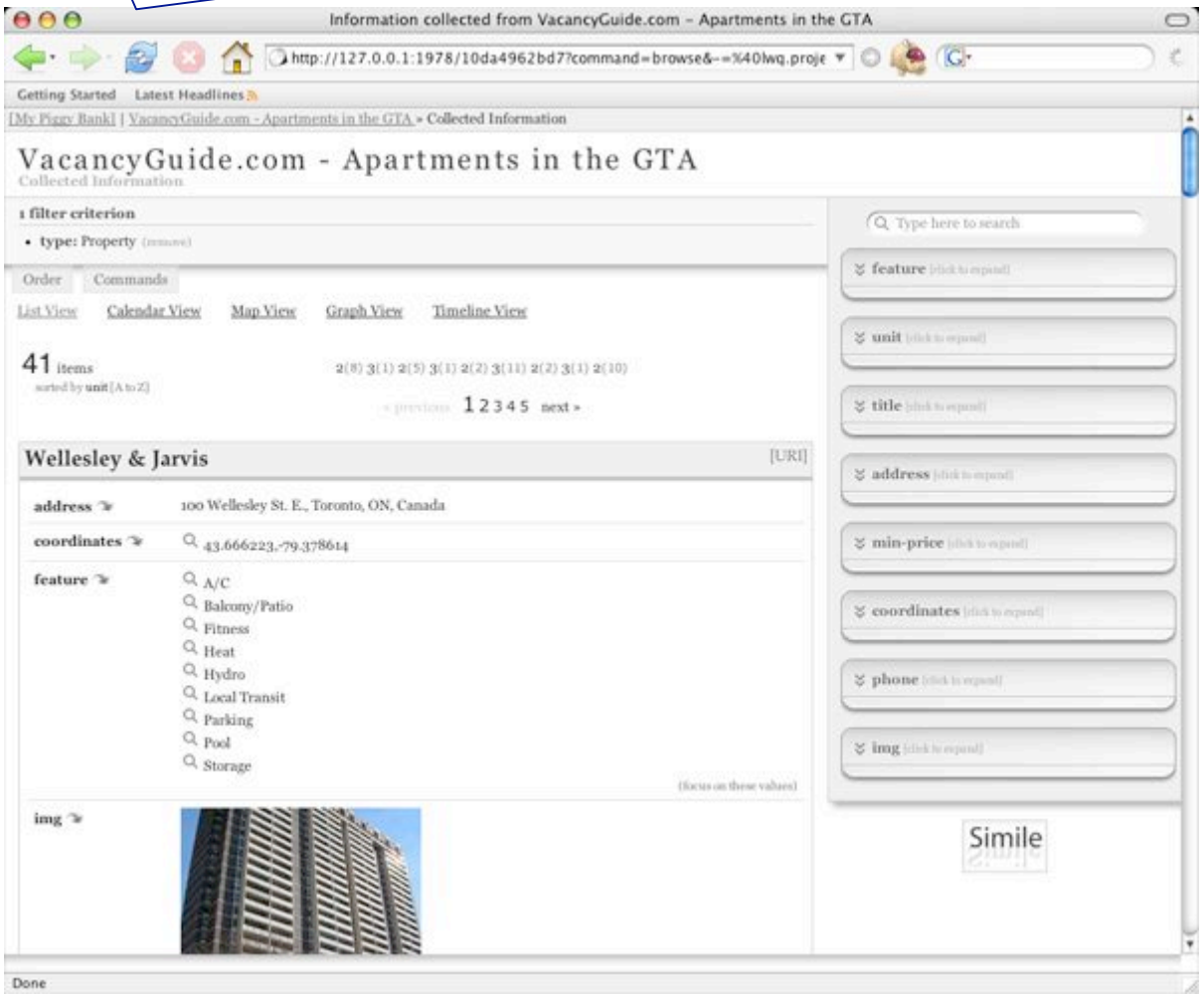
Piggybank

- 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

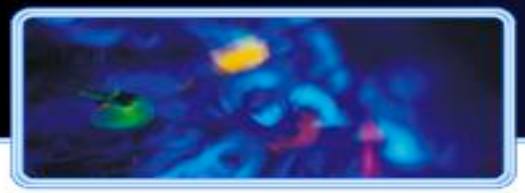
- Mashup whatever *you* want whenever *you* want!
- Try it out - http://simile.mit.edu/wiki/Piggy_Bank

Scrape data





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



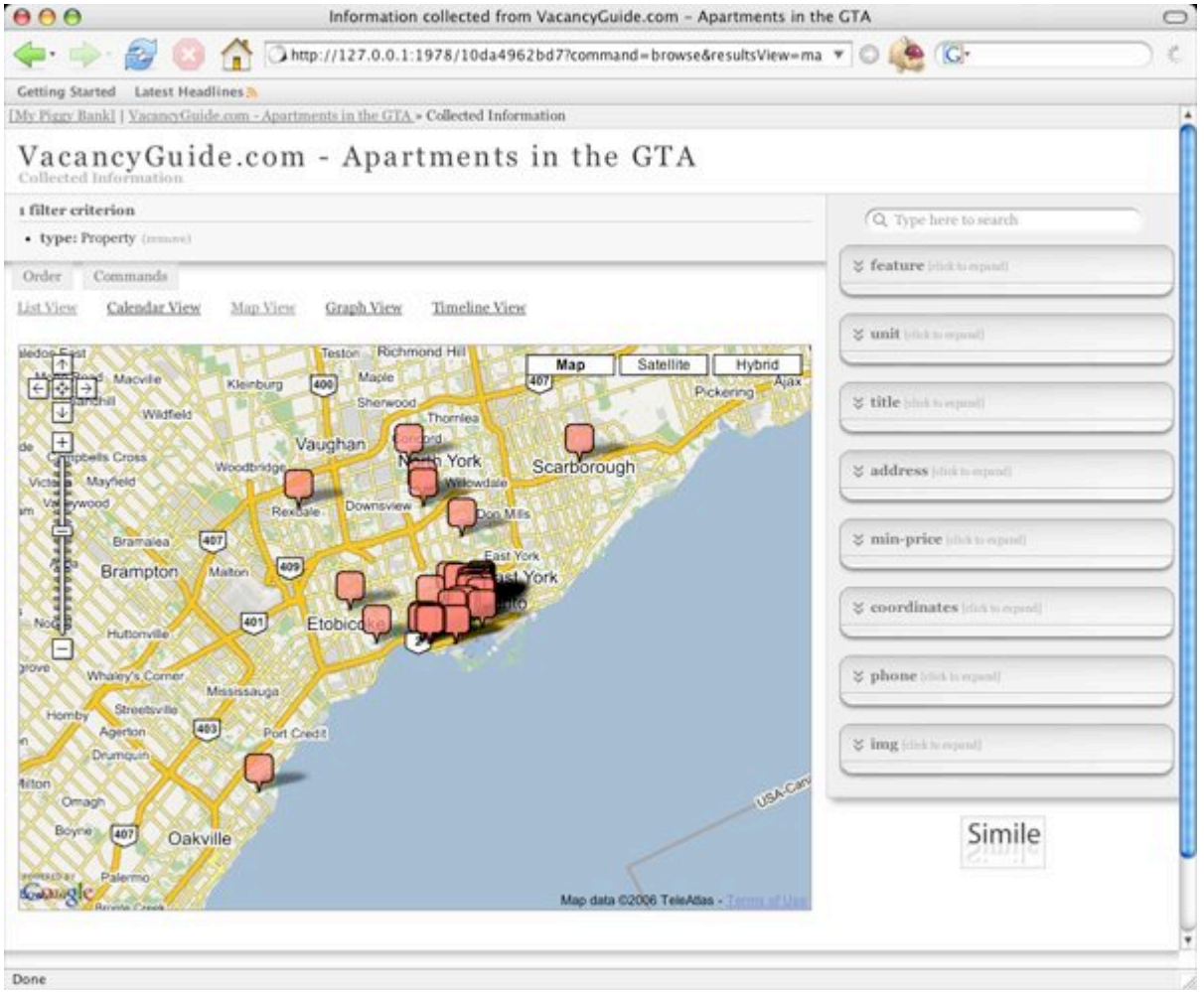
Explore your data

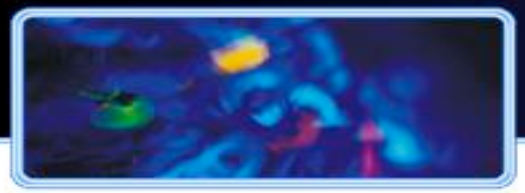
- Data you have just collected viewable in many different ways

- Like HousingMap.com

  a Mashup that combines CraigsList and Google Maps

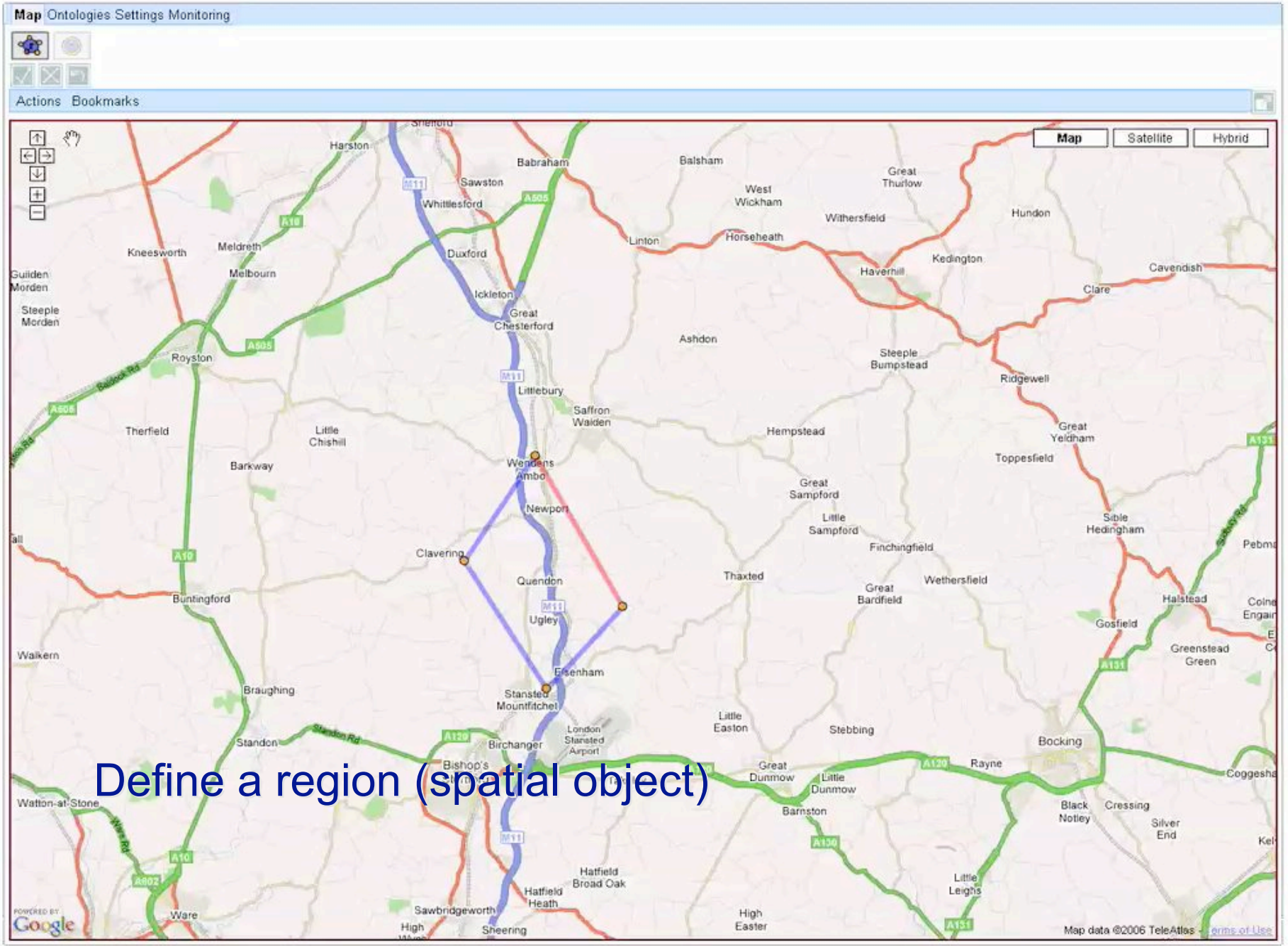
- But you did it yourself in your browser!

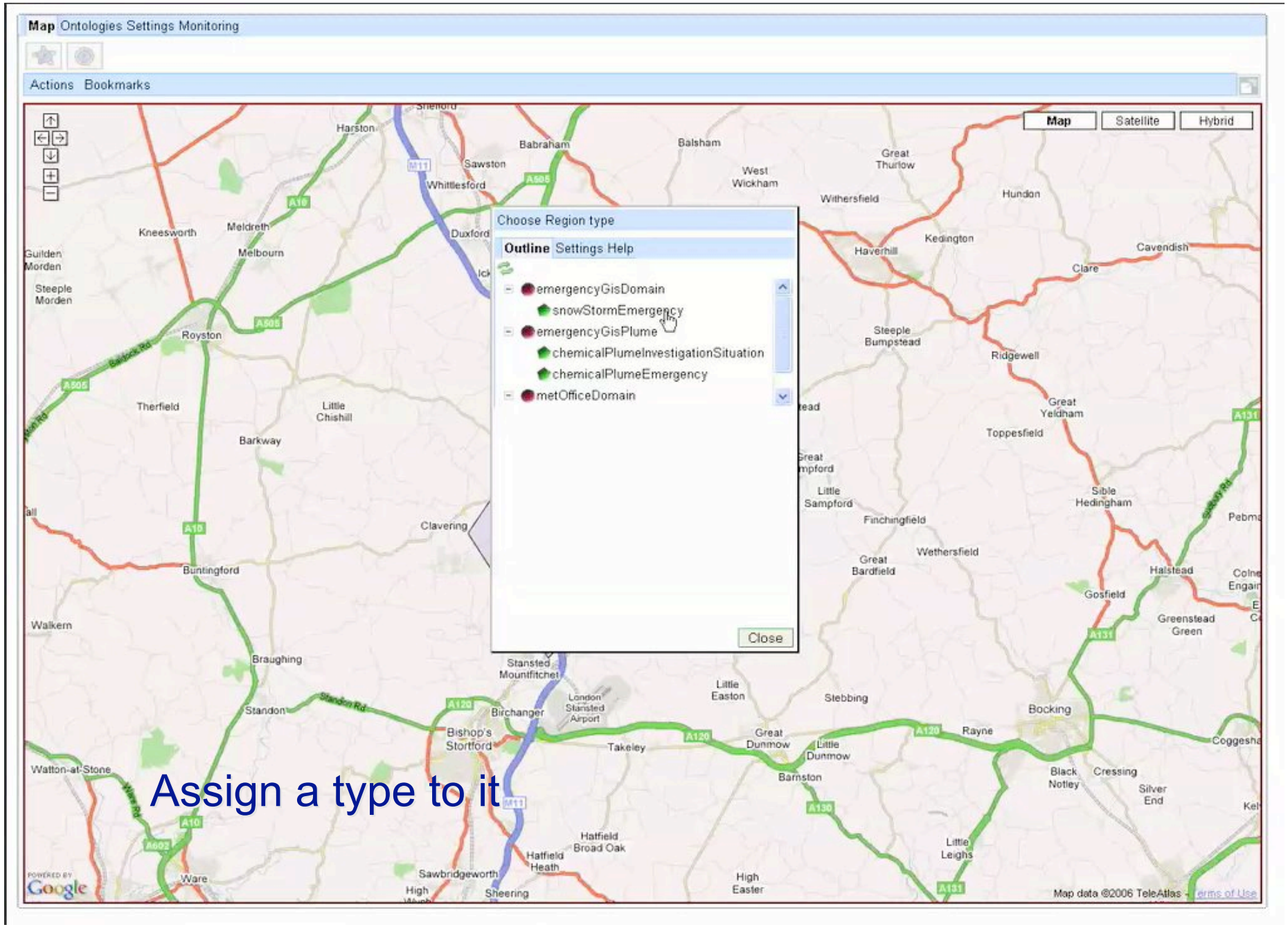


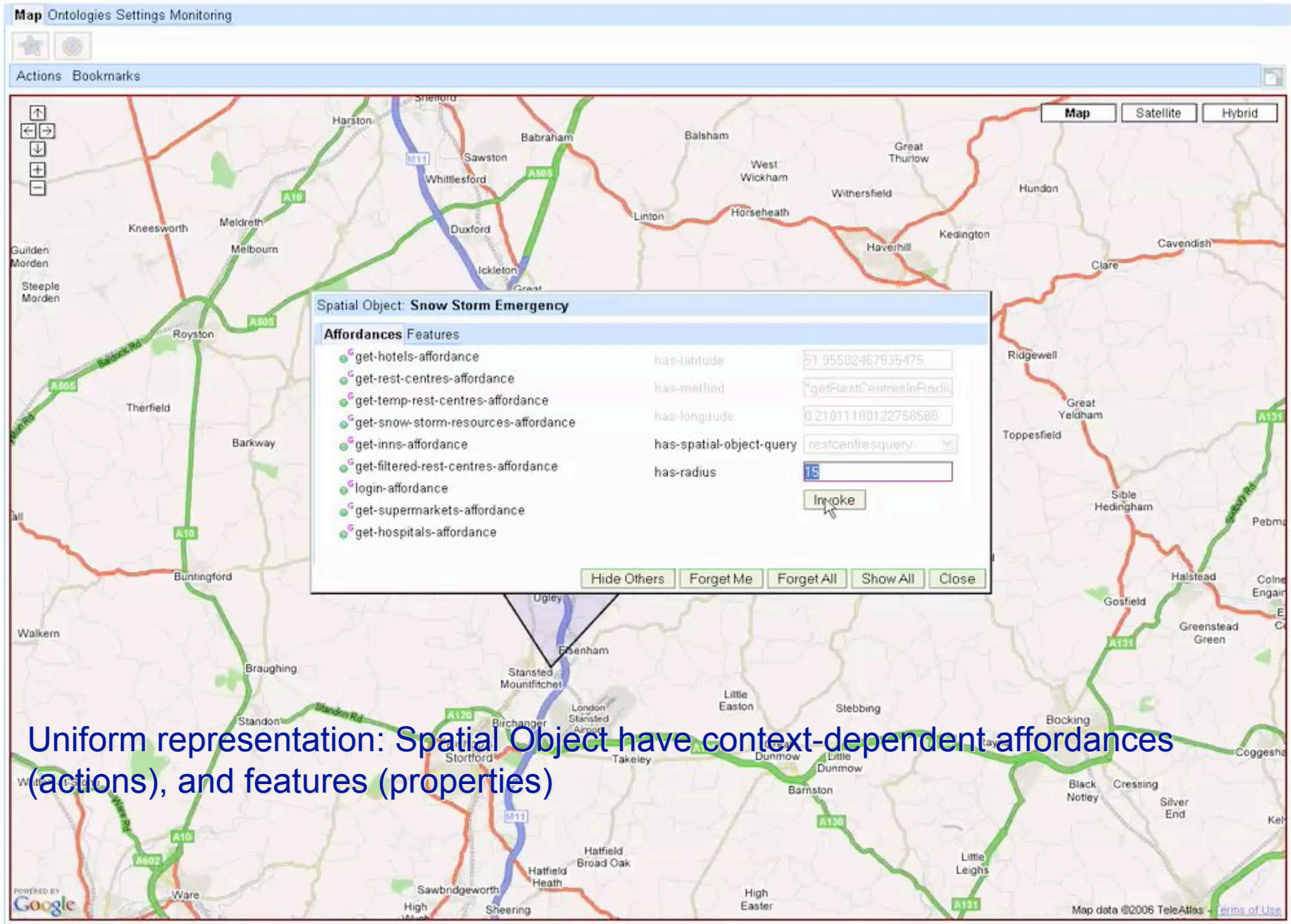


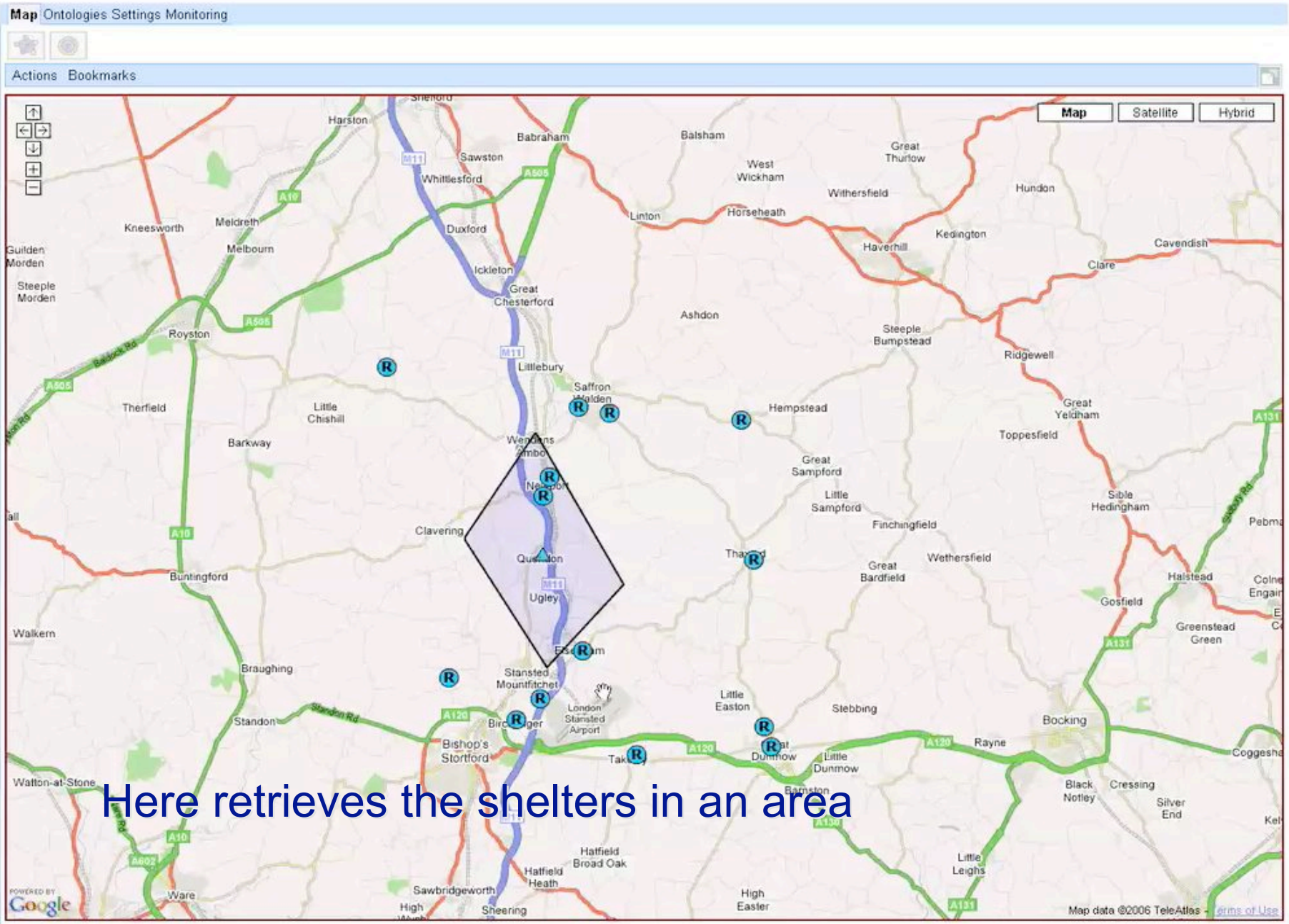
eMerges

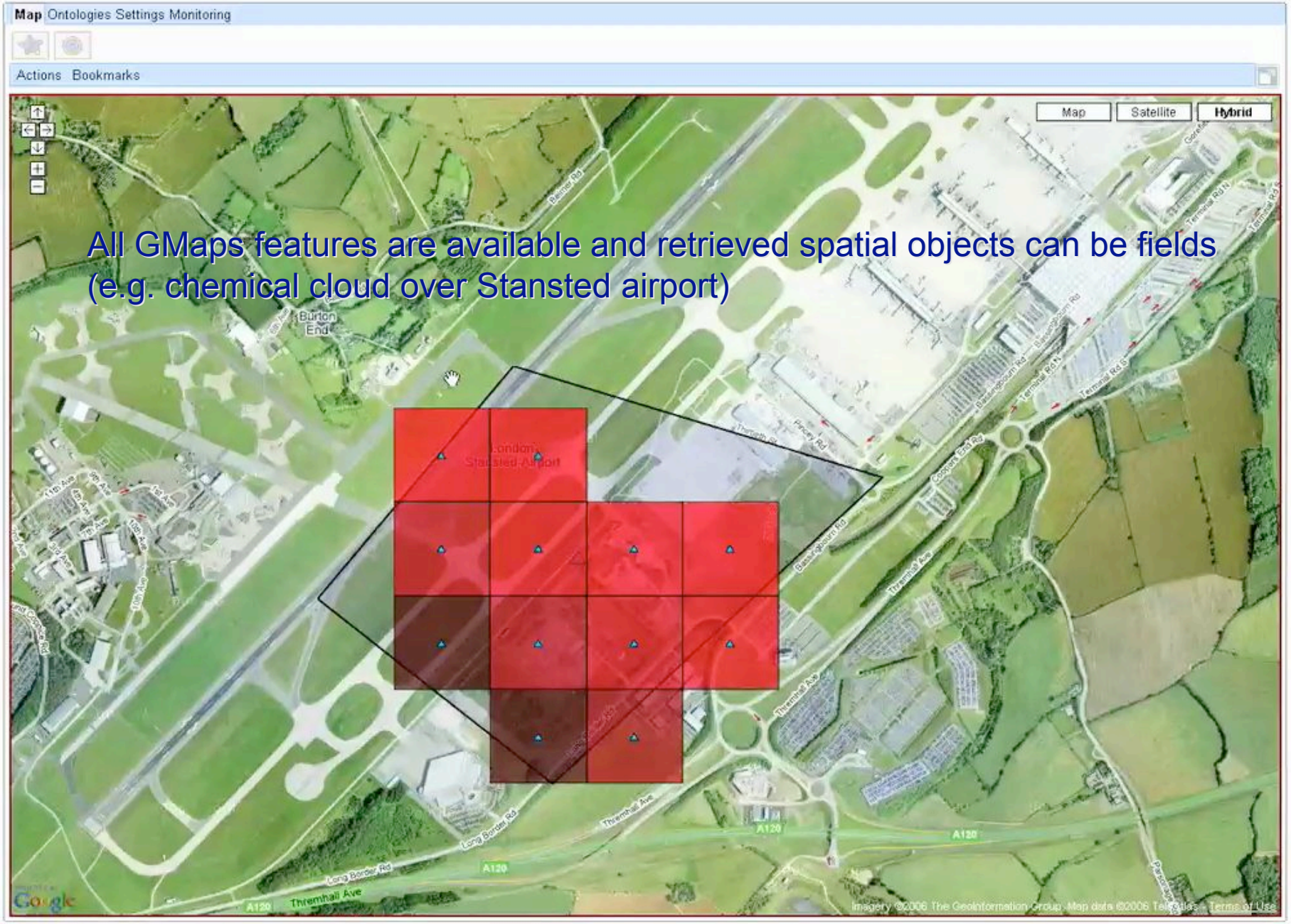
- Supporting Emergency Planning for Essex County Council
- Many heterogeneous data sources
- Need a simple integration interface
  - Users are potentially under high stress

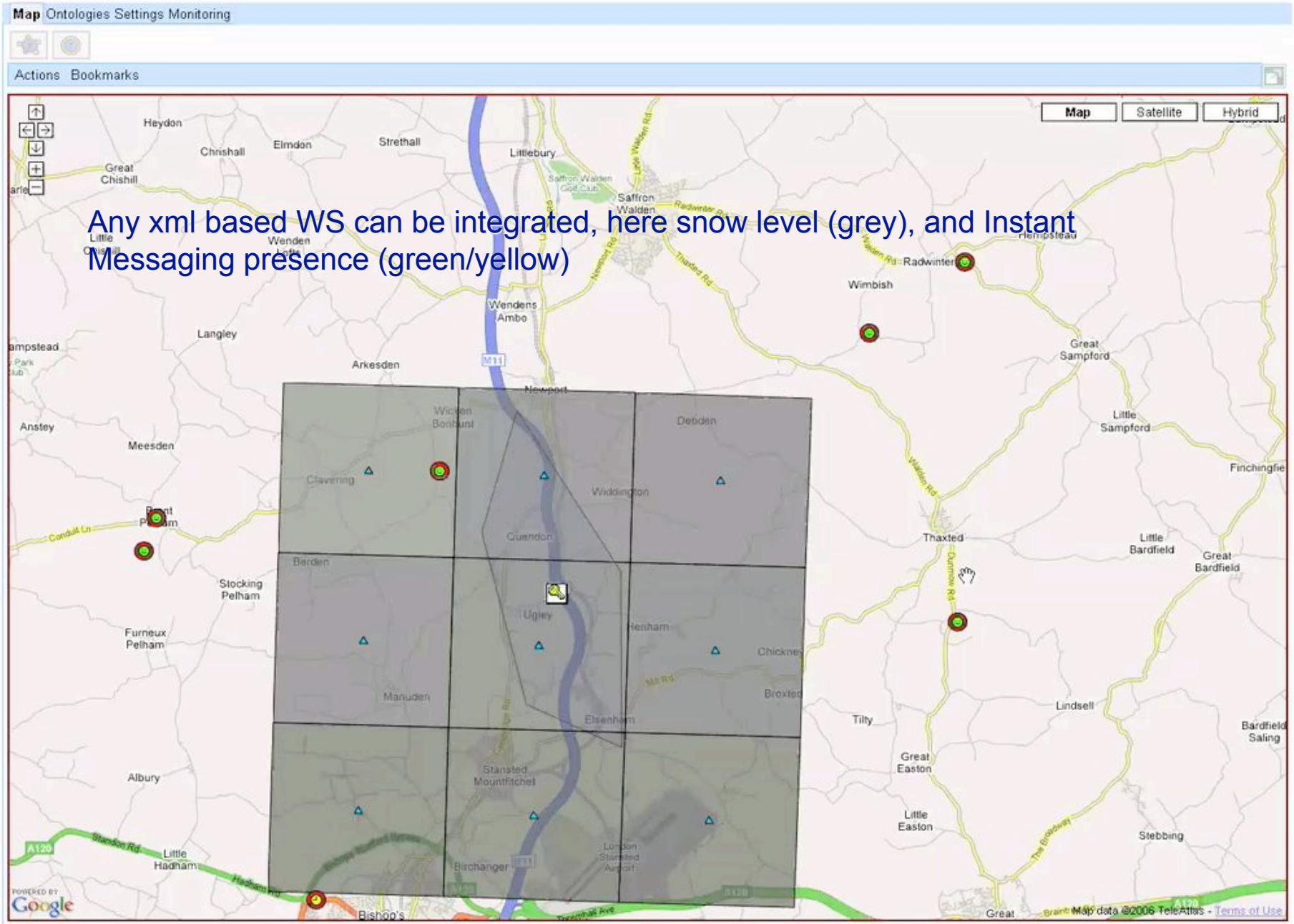

Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
Define a region (spatial object)
Map data ©2006 TeleAtlas

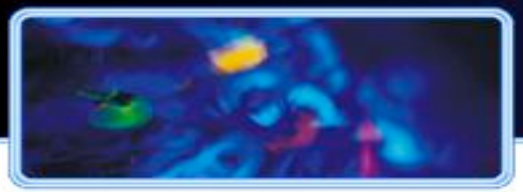

Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
Choose Region type
Outline Settings Help
emergencyGisDomain
snowStormEmergency
emergencyGisPlume
chemicalPlumeInvestigationSituation
chemicalPlumeEmergency
metOfficeDomain
Close
Assign a type to it
Harston
Babraham
Balsham
Great Thurlow
West Wickham
Withersfield
Hundon
Kedington
Haverhill
Cavendish
Clare
Steeple Bumpstead
Ridgewell
Great Yeldham
Toppesfield
Kneesworth
Meldreth
Melbourn
Duxford
Guilden Morden
Steeple Morden
Royston
Therfield
Little Chishill
Barkway
Clavering
Buntingford
Walkern
Braughing
Standon
Stansted Mountfitchet
Birchanger
London Stansted Airport
Bishop's Stortford
Takeley
Little Easton
Stebbing
Great Dunmow
Little Dunmow
Barnston
Rayne
Bocking
Coggeshall
Black Notley
Cressing
Silver End
Watton-at-Stone
Ware
Hatfield Broad Oak
Hatfield Heath
Sawbridgeworth
Sheering
High Easter
Little Leighs
Little Sampford
Finchingfield
Great Bardfield
Wethersfield
Sible Hedingham
Halstead
Gosfield
Greenstead Green
Whittlesford
Sawston
Great Chesterford
Little Walden
Saffron Walden
Elmdon
Duddenhoe End
Wendens Ambo
Littlebury
Newport
Quendon
Rickling
Rickling Green
Arkesden
Clavering
Langley
Wicken Bonhunt
Chrishall
Heydon
Elmdon
Chrishall
Powered by Google
Map data ©2006 TeleAtlas - Terms of Use


Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
Spatial Object: Snow Storm Emergency
Affordances Features
get-hotels-affordance
get-rest-centres-affordance
get-temp-rest-centres-affordance
get-snow-storm-resources-affordance
get-inns-affordance
get-filtered-rest-centres-affordance
login-affordance
get-supermarkets-affordance
get-hospitals-affordance
has-latitude
has-method
has-longitude
has-spatial-object-query
has-radius
Invoke
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


Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
Harston
Babraham
Balsham
Great Thurlow
West Wickham
Withersfield
Hundon
Sawston
Whittlesford
Linton
Horseheath
Kedington
Haverhill
Cavendish
Clare
Kneesworth
Meldreth
Melbourn
Duxford
Guilden Morden
Steeple Morden
Ickleton
Great Chesterford
Ashdon
Steeple Bumpstead
Ridgewell
Royston
Littlebury
Saffron Walden
Hempstead
Great Yeldham
Toppesfield
Therfield
Little Chishill
Barkway
Great Sampford
Little Sampford
Sible Hedingham
Finchingfield
Clavering
Thaxted
Great Bardfield
Wethersfield
Bunting ford
Ugley
Halstead
Gosfield
Greenstead Green
Walkern
Braughing
Stansted Mountfitchet
Little Easton
Stebbing
Standon
London Stansted Airport
Bishop's Stortford
Rayne
Bocking
Little Dunmow
Watton-at-Stone
Black Notley
Cressing
Silver End
Hatfield Broad Oak
Hatfield Heath
Little Leighs
Sawbridgeworth
Ware
High Easter
Sheering
Here retrieves the shelters in an area
Google
Map data ©2006 TeleAtlas


Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
All GMaps features are available and retrieved spatial objects can be fields
(e.g. chemical cloud over Stansted airport)
Burton End
A120
Thremhall Ave
Long Border Rd
Google

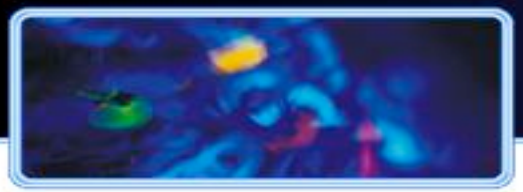

Map Ontologies Settings Monitoring
Actions Bookmarks
Map
Satellite
Hybrid
Any xml based WS can be integrated, here snow level (grey), and Instant Messaging presence (green/yellow)
Heydon
Chrishall
Elmdon
Strethall
Littlebury
Great Chishill
Saffron Walden
Wenden Ambo
Langley
Arkesden
Newport
Radwinter
Wimbish
Great Sampford
Little Sampford
Finchingfie
Debden
Clavering
Widdington
Quendon
Anstey
Meesden
Thaxted
Little Bardfield
Great Bardfield
Berden
Stocking Pelham
Furneux Pelham
Ugley
Henham
Chickney
Manuden
Broxted
Elsenham
Lindsell
Tilty
Great Easton
Little Easton
Bardfield Saling
Stebbing
Albury
Stansted Mountfitchet
Little Hadham
Bishop's
Map data ©2006 TeleAtlas - Terms of Use



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.

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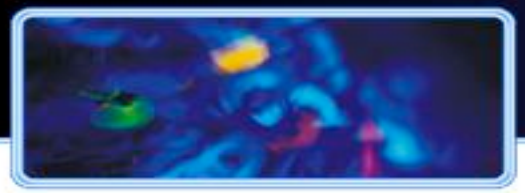

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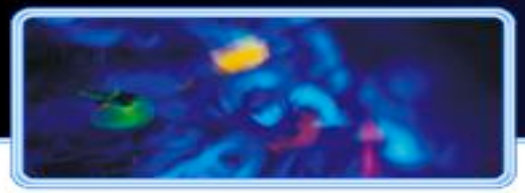

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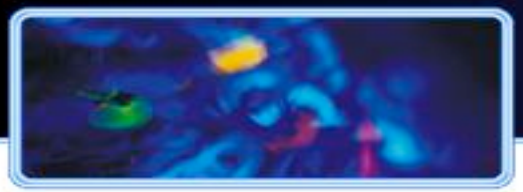

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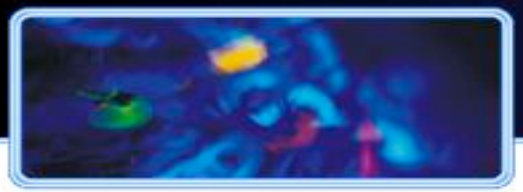

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