State of the Semantic Web

Bangalore, 23 February, 2007

Ivan Herman, W3C

What will I talk about?

- The history of the Semantic Web goes back to several years now
- It is worth looking at what has been achieved, where we are, and where we might be going…

Let us look at some results first!

The basics: RDF(S)

- We have a solid specification since 2004: well defined (formal) semantics, clear RDF/XML syntax
- *Lots* of tools are available. Are listed on W3C's wiki:
  - *RDF programming environment for 14+ languages, including C, C++, Python, Java, Javascript, Ruby, PHP,… (no Cobol or Ada yet ☹!)*
  - *13+ Triple Stores, ie, database systems to store (sometimes huge!) datasets*
  - *converters to and from RDF*
  - *etc*
- Some of the tools are Open Source, some are not; some are very mature, some are not ☺: *it is the usual picture of software tools*, nothing special any more!
- *Anybody can start developing RDF-based applications today*

The basics: RDF(S) (cont.)

- There are lots of tutorials, overviews, and books around
  - *again, some of them good, some of them bad, just as with any other areas…*
- Active developers' communities
- Large datasets are accumulating. E.g.:
  - *IngentaConnect bibliographic metadata storage: over 200 million triplets*
  - *RDF access to Wikipedia: more than 27 million triplets*
  - *tracking the US Congress: data stored in RDF (around 25 million triplets)*
  - *RDFS/OWL Representation of Wordnet: also downloadable as 150MB of RDF/XML*
  - *"Département/canton/commune" structure of France published by the French Statistical Institute*
  - *Geonames Ontology and associated RDF data: 6 million (and growing) geographical features*
  - *RDF Book Mashup, integrating book data from Amazon, Google, and Yahoo*
- Some mesaures claim that there are over 10^7 Semantic Web documents… (ready to be integrated…)

Ontologies: OWL

- This is also a stable specification since 2004
- Separate layers have beed defined, balancing expressibility vs. implementability (OWL-Lite, OWL-DL, OWL-Full)
- Looking at the tool list on W3C's wiki again:
  - *a number programming environments (in Java, Prolog, …) include OWL reasoners*
  - *there are also stand-alone reasoners (downloadable or on the Web)*
  - *ontology editors come to the fore*
- OWL-DL and OWL-Lite relies on Description Logic, ie, can use a large body of accumulated research knowledge

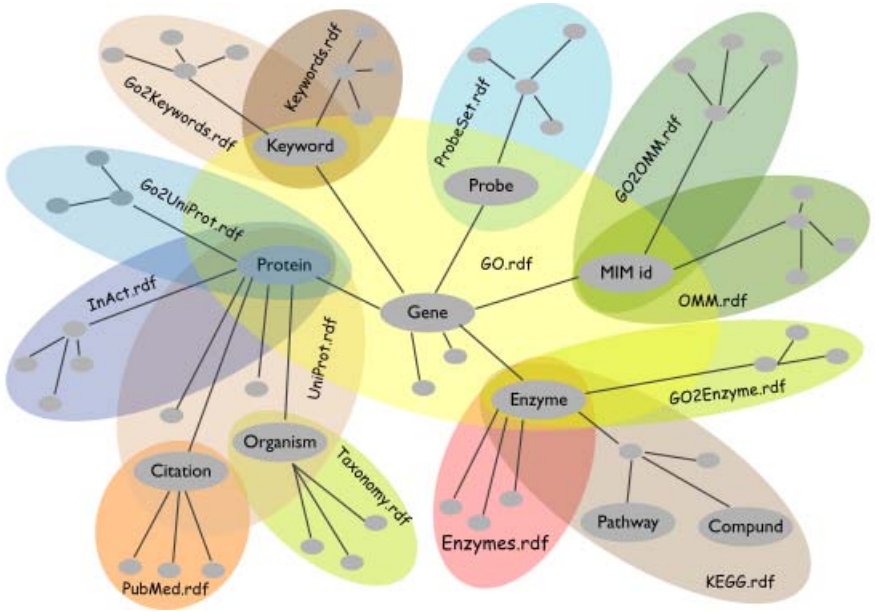
Ontologies

- Large ontologies are being developed (converted from other formats or defined in OWL)
  - *eClassOwl: eBusiness ontology for products and services, 75,000 classes and 5,500 properties*
  - *the Gene Ontology: to describe gene and gene product attributes in any organism*
  - *BioPAX, for biological pathway data*
  - *UniProt: protein sequence and annotation terminology and data*

Vocabularies

- There are also a number “core vocabularies” (not necessarily OWL based)
  - *Dublin Core: about information resources, digital libraries, with extensions for rights, permissions, digital right management*
  - *FOAF: about people and their organizations*
  - *DOAP: on the descriptions of software projects*
  - *MusicBrainz: on the description of CDs, music tracks, …*
  - *SIOC: Semantically-Interlinked Online Communities*
  - *vCard in RDF*
  - *…*
- One should *never* forget: ontologies/vocabularies must be shared and reused!

A mix of vocabularies/ontologies (from life sciences)…



Ontologies, Vocabularies

- Ontology and vocabulary *development* is still a complex task
- The W3C SW Best Practices and Deployment Working Group has developed some documents:
  - *"Best Practice Recipes for Publishing RDF Vocabularies"*
  - *"Defining N-ary relations"*
  - *"Representing Classes As Property Values"*
  - *"Representing "value partitions" and "value sets""*
  - *"XML Schema Datatypes in RDF and OWL"*

  the work is continuing in the (new) SW Deployment Working Group

Querying RDF: SPARQL

- Querying RDF graphs becomes essential
- SPARQL is almost here
  - *query language based on graph patterns*
  - *there is also a protocol layer to use SPARQL over, eg, HTTP*
  - *hopefully a Recommendation end 2007*
- There are a number of implementations already
- There are also SPARQL “endpoints” on the Web:
  - *send a query and a reference to data over HTTP GET, receive the result in XML or JSON*
  - *applications may not need any direct RDF programming any more, just a SPARQL endpoint*

SPARQL as the *only* interface to RDF data?

- **http://www.sparql.org/sparql?query=…**
  with the query:

```
SELECT ?translator ?translationTitle ?originalTitle ?originalDate
FROM <http://…/Translations.rdf>
FROM <http://…/tr.rdf>
…
WHERE {
   ?trans rdf:type trans:Translation;
                  trans:translationFrom ?orig;
                  trans:translator      [ contact:fullName ?translator ];
                  dc:language           "fr";
                  dc:title              ?translationTitle.
   ?orig  rdf:type rec:REC;
                  dc:date               ?originalDate;
                  dc:title              ?originalTitle.
}
ORDER BY ?translator ?originalDate
```

- yields…

A word of warning on SPARQL…

- It is *not* a Recommendation yet
- New issues may pop up at the last moment via reviews
  - *a query language needs very precise semantics and that is not that easy* ☹
- Some features *are* missing
  - *control and/or description on the entailment regimes of the triple store (RDFS? OWL-DL? OWL-Lite?…)*
  - *modify the triple store*
  - *…*

  postponed to a next version…

Of course, not everything is so rosy…

- There are a number of open issues, problems to solve
  - *how to bind to different communities (e.g., the "digital library world")*
  - *how to get RDF data*
  - *missing functionalities: rules, "light" ontologies, fuzzy reasoning, necessity to review RDF and OWL,…*
  - *misconceptions, messaging problems*
  - *need for more applications, deployment, acceptance*
  - *etc*

Simple Knowledge Organization System (SKOS)

- Goal: porting ("Webifying") thesauri: representing and sharing classifications, glossaries, thesauri, etc, as developed in the "Print World". For example:
  - *Dewey Decimal Classification, Art and Architecture Thesaurus, ACM classification of keywords and terms…*
  - *DMOZ categories (a.k.a. Open Directory Project)*
- The system must be simple to allow for a quick port of traditional data
- *This is where SKOS comes in*

Example: Entries in a Glossary (1)

“Assertion”

“(i) Any expression which is claimed to be true. (ii) The act of claiming something to be true.”

“Class”

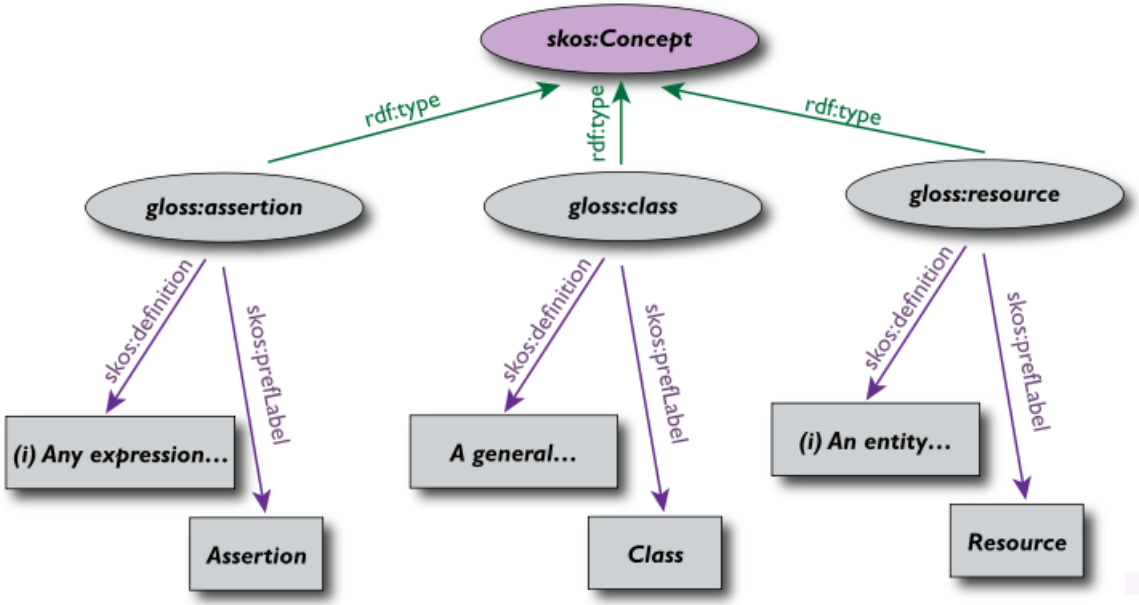
“A general concept, category or classification. Something used primarily to classify or categorize other things.”

“Resource”

“(i) An entity; anything in the universe. (ii) As a class name: the class of everything; the most inclusive category possible.”

(from the RDF Semantics Glossary)

Example: Entries in a Glossary (2)



Example: Taxonomy (1)

Illustrates “broader” and “narrower”

General

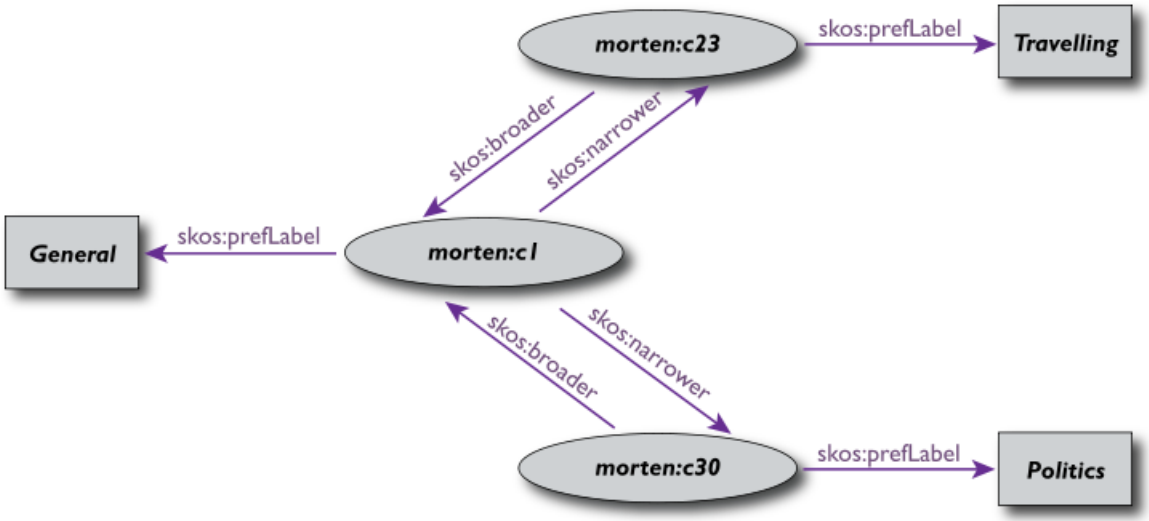
- Travelling
- Politics

SemWeb

- RDF
  - *OWL*

(From MortenF’s weblog categories. Note that the categorization is arbitrary!)

Example: Taxonomy (2)



Example: Thesaurus (1)

Term

Economic cooperation

Used For

Economic co-operation

Broader terms

Economic policy

Narrower terms

Economic integration, European economic cooperation, …

Related terms

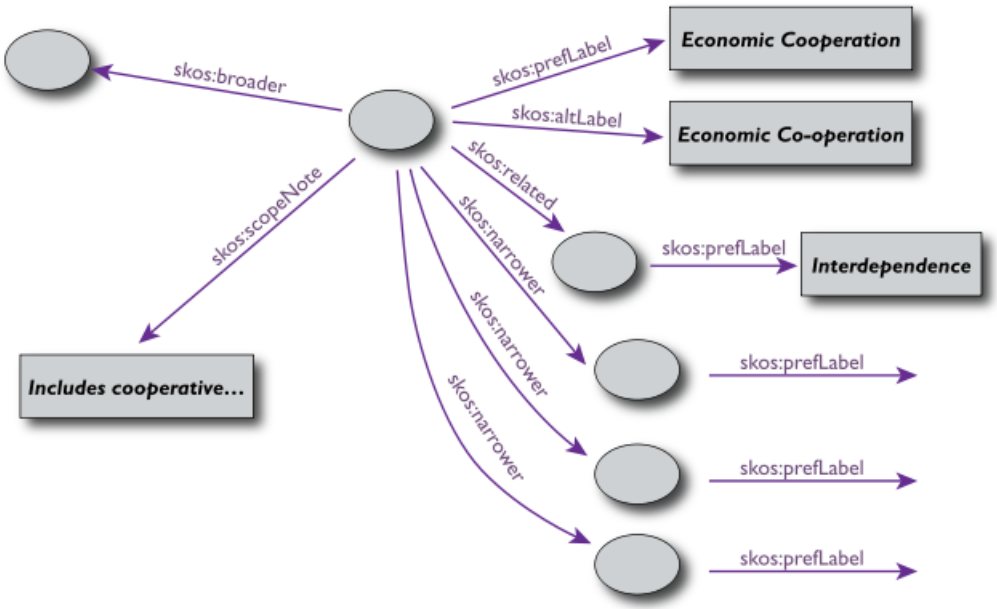
Interdependence

Scope Note

Includes cooperative measures in banking, trade, …

(from UK Archival Thesaurus)

Example: Thesaurus (2)



SKOS Core Overview

- Classes and Predicates:
  - *Basic description (`Concept`, `ConceptScheme`, …)*
  - *Labelling (`prefLabel`, `altLabel`, `prefSymbol`, `altSymbol` …)*
  - *Documentation (`definition`, `scopeNote`, `changeNote`, …)*
  - *Semantic relations (`broader`, `narrower`, `related`)*
  - *Subject indexing (`subject`, `isSubjectOf`, …)*
  - *Grouping (`Collection`, `OrderedCollection`, …)*
  - *Subject Indicator (`subjectIndicator`)*
- Some simple inference rules (a bit like the RDFS inference rules) to define some semantics

Why Having SKOS *and* OWL?

- OWL's precision not always necessary or even appropriate
  - *"OWL a sledge hammer/SKOS a nutcracker", or "OWL a Harley/SKOS a bike"*
  - *complement each other, can be used in combination to optimize cost/benefit*
- Role of SKOS is
  - *to bring the worlds of library classification and Web technology together*
  - *to be simple and undemanding enough in terms of cost and required expertise*
- A typical example: the Glossary of project of W3C stores all terms in SKOS (and extracted from W3C documents)
- But we have heard about other usage at this conference already!

How to get RDF data?

- Of course, one could create RDF data manually…
- … but that is unrealistic on a large scale
- Goal is to generate RDF data automatically when possible and “fill in” by hand only when necessary

Data may be around already…

- Part of the (meta)data information is present in tools … but thrown away at output
  - *e.g., a business chart can be generated by a tool: it "knows" the structure, the classification, etc. of the chart, but, usually, this information is lost*
- storing it in web data would be easy!
- "SW-aware" tools are around (even if you do not know it…), though more would be good:
  - *Photoshop CS stores metadata in RDF in, say, jpg files (using XMP)*
  - *RSS1.0 feeds are generated by (almost) all blogging systems (a huge amount of RDF data!)*
  - *…*
- There are a number of projects "harvesting" and linking data to RDF (e.g., "Linking Open Data on the Semantic Web" community project)

Data may be extracted (a.k.a. “scraped”)

- Different tools, services, etc, come around every day:
  - *get RDF data associated with images, for example:*
    - service to get RDF from flickr images (see example)
    - service to get RDF from XMP (see example)
  - *XSLT scripts to retrieve microformat data from XHTML files*
  - *scripts to convert spreadsheets to RDF*
  - *etc*
- Most of these tools are still individual “hacks”, but show a general tendency
- Hopefully more tools will emerge

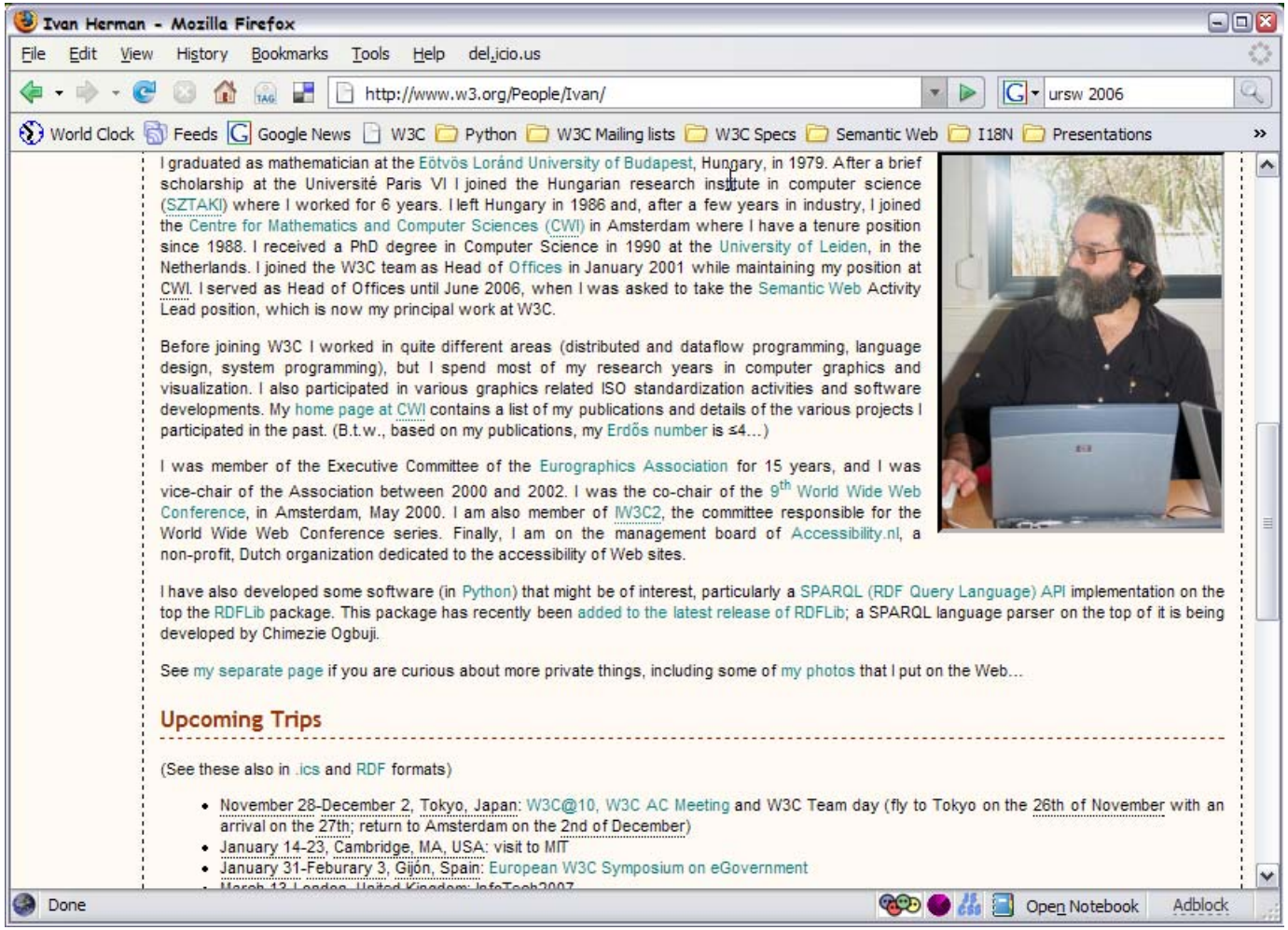
Getting structured data to RDF: GRDDL

- GRDDL is a way to access structured data in XML/XHTML and turn it into RDF:
  - *defines XML attributes to bind a suitable script to transform (part of) the data into RDF*
    - script is usually XSLT but not necessarily
    - has a variant for XHTML
  - *a "GRDDL Processor" runs the script and produces RDF on–the–fly*
- A way to access existing structured data and "bring" it to RDF
  - *a possible link to microformats*

Getting structured data to RDF: RDFa

- RDFa (formerly RDF/A) extends XHTML with a set of attributes to *include* structured data into XHTML
  - *an XHTML 1 module is being defined*
- Makes it easy to “bring” existing RDF vocabularies into XHTML
- Uses namespaces for an easy mix of terminologies
- It *can* be used with GRDDL but RDFa aware systems can manage it directly, too
  - *no need to implement a separate transformation per vocabulary*

GRDDL & RDFa example: Ivan' home page…



…marked up with GRDDL headers…

Source of: http://www.w3.org/People/Ivan/ - Mozilla Firefox

File Edit View Help

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-t
<html xmlns="http://www.w3.org/1999/xhtml" lang="en"
      xmlns:foaf="http://xmlns.com/foaf/0.1/"
      xmlns:con="http://www.w3.org/2000/10/swap/pim/contact#"
      xmlns:wot="http://xmlns.com/wot/0.1/"
      xmlns:vcard="http://www.w3.org/2001/vcard-rdf/3.0#"
      xmlns:cal="http://www.w3.org/2002/12/cal/ical#"
      xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
      xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
      xmlns:owl='http://www.w3.org/2002/07/owl#'
      xmlns:dc="http://purl.org/dc/elements/1.1/"
      xmlns:bio="http://purl.org/vocab/bio/0.1/">
        <head profile="http://www.w3.org/2003/g/data-view">
        <meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
        <title>Ivan Herman</title>
        <link rel="stylesheet" type="text/css" href="StyleSheets/Private.css" />
        <link rel="meta" type="application/rdf+xml" title="FOAF" href="http://www.ivan-herman.net/foaf.r
        <script src='/2004/08/TalkFiles/popup.js' type='text/javascript'><!-- The popup script --></scri
        <link rel="transformation" href="http://www.w3.org/2002/12/cal/glean-hcal.xsl" />
        <link rel="transformation" href="http://www-sop.inria.fr/acacia/soft/RDFa2RDFXML.xsl"/>
        </head>
    <body xml:lang="en" lang="en">
        <div class="left">
                  <a href="/"><img src="http://www.w3.org/Icons/w3c_home.png" alt="W3C Logo" /></a><br
       </div>

        <div class="right" id="me" role="foaf:Person">
           <link rel="owl:sameAs" href="http://www4.wiwiss.fu-berlin.de/dblp/resource/person/103481"/>
           <link rel="owl:sameAs" href="http://ivan-herman.net/Ivan_Herman"/>
           <link rel="owl:sameAs" href="http://ivan-herman.net/foaf.rdf#me"/>
                  <h1 property="foaf:name">Ivan Herman</h1>
                  <img class="me" rel="foaf:depiction" src="http://www.cwi.nl/%7Eivan/AboutMe/Ivan.Herr
```

…and hCard microformat tags…

Source of: http://www.w3.org/People/Ivan/ - Mozilla Firefox

File Edit View Help

```
        on the management board of <a href="http://www.accessibility.nl">Accessibility.nl</a>,
        a non-profit, Dutch organization dedicated to the accessibility of Web sites. </p>

        <p>I have also developed some software (in <a href="http://www.python.org">Python</a>) that migh
        a <a href="http://dev.w3.org/cvsweb/%7Echeckout%7E/2004/PythonLib-IH/Doc/sparqlDesc.html">SPARQL
        on the top the <a href="http://rdflib.net/">RDFLib</a> package.
        This package has recently been <a href="http://www.ivan-herman.net/WebLog/WorkRelated/SemanticWe
        added to the latest release of RDFLib</a>; a SPARQL language parser on the top of it is being de
        Chimezie Ogbuji.
        </p>

See <a rel="foaf:homepage" href="http://www.ivan-herman.net">my separate page</a> if you are curious abou
e private things, including some of <a href="http://www.ivan-herman.net/Photos/">my photos</a> that I put

        <h2><a id="trips" name="trips">Upcoming Trips</a></h2>

        <p>(See these also in <a href="http://feeds.technorati.com/events/http%3A//www.w3.org/People/Iva
                and <a href="http://www.w3.org/2000/06/webdata/xslt?xslfile=http%3A%2F%2Fwww.w3.org%2F20
        <ul>

                <li><span class="vevent" id="ac06"><abbr class="dtstart" title="2006-11-28">November 28<
                <span class="location vcard"><abbr class="geo" title="35.670685;139.770813">Tokyo, Japan
                <span class="summary"><a href="http://www.w3.org/Member/Meeting/2006ac/November/" class=
                W3C AC Meeting</a> and W3C Team day</span></span> (<span class="vevent" id="flyTok06"><s
                <abbr class="dtstart" title="2006-11-26">26th of November</abbr> with an arrival on the<
                 27th</abbr></span>; <span class="vevent" id="flyTokAms06"><span class="summary">return
                 <abbr class="dtstart" title="2006-12-02">2nd of December</abbr></span>)</li>

                <li class="vevent" id="mitjan"><abbr class="dtstart" title="2007-01-14">January 14</abbr
                <span class="location vcard"><abbr class="geo" title="42.365;-71.105">Cambridge, MA, USA
                <span class="summary">visit to MIT</span></li>
```

…yielding; …

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:dataview="http://www.w3.org/2003/g/data-view#"
         xml:base="http://www.w3.org/People/Ivan/">
   <c:Vcalendar xmlns:r="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
                xmlns:c="http://www.w3.org/2002/12/cal/icaltzd#"
                xmlns:h="http://www.w3.org/1999/xhtml">
      <c:prodid>-//connolly.w3.org//palmagent 0.6 (BETA)//EN</c:prodid>
      <c:version>2.0</c:version>
      <c:component>
         <c:Vevent r:about="#ac06">
            <summary xmlns="http://www.w3.org/2002/12/cal/icaltzd#" xml:lang="en">W3C@10,
                                 W3C AC Meeting and W3C Team day</summary>
            <dtstart xmlns="http://www.w3.org/2002/12/cal/icaltzd#"
                     r:datatype="http://www.w3.org/2001/XMLSchema#date">2006-11-28</dtstart
            <dtend xmlns="http://www.w3.org/2002/12/cal/icaltzd#"
                   r:datatype="http://www.w3.org/2001/XMLSchema#date">2006-12-03</dtend>
            <url xmlns="http://www.w3.org/2002/12/cal/icaltzd#"
                 r:resource="http://www.w3.org/Member/Meeting/2006ac/November/"/>
            <location xmlns="http://www.w3.org/2002/12/cal/icaltzd#" xml:lang="en">Tokyo, J
            <geo xmlns="http://www.w3.org/2002/12/cal/icaltzd#" r:parseType="Resource">
               <r:first r:datatype="http://www.w3.org/2001/XMLSchema#double">35.670685</r:f
               <r:rest r:parseType="Resource">
                  <r:first r:datatype="http://www.w3.org/2001/XMLSchema#double">139.770813<
                  <r:rest r:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#nil"/>
               </r:rest>
            </geo>
         </c:Vevent>
      </c:component>
      …
```

(see the full file if interested…)

…marked up with RDFa tags…

Source of: http://www.w3.org/People/Ivan/ - Mozilla Firefox

File Edit View Help

```
                <dt>PGP/GPG:</dt>
                <dd>My <a rel="wot:pubkeyAddress" href="http://www.cwi.nl/%7Eivan/AboutMe/pgpkey.html">G
                available on-line.</dd>
                <dt>FOAF:</dt>
                <dd>You can either extract a short FOAF information from this page using an
                <a href="http://torrez.us/services/rdfa/http://www.w3.org/People/Ivan/">RDFa service</a>
                of consult <a href="http://www.ivan-herman.net/foaf.rdf" rel="rdfs:seeAlso">my more comp
                <dt>Misc:</dt>
                <dd>I am often on the freenode #swig irc channel, usually using the nickname
                <span about="[_:p]" role="foaf:OnlineChatAccount">
                <link rev="foaf:holdsAccount" href="#me"/>
                '<span property="foaf:accountName">IvanHerman</span>' or 'ivan'
                <link href="http://www.freenode.net/irc_servers.shtml" rel="foaf:accountServiceHomepage"
            </span>
            <br/>
                My URI (as a real person): <a href="http://www.ivan-herman.net/Ivan_Herman"><code>http:/
                </dd>
        </dl>

        <h2><a id="bio" name="bio">Short CV</a></h2>
        <img class="me" src="http://www.ivan-herman.net/me2003.png" alt="Another picture at CWI" />

        <p>I graduated as mathematician at the <a rel="foaf:schoolHomepage" href="http://www.elte.hu/">E
        in 1979. After a brief scholarship at the Université Paris VI I joined the Hungarian resear
        science (<a href="http://www.sztaki.hu"><abbr title="Számítástechnikai és Automatizálási Kutatói
        6 years. I left Hungary in 1986 and, after a few years in industry, I joined the <a href="http:/
        Mathematics and Computer Sciences (<abbr title="Centrum voor Wiskunde en Informatica" lang="nl">
        Amsterdam where I have a tenure position since 1988. I received a PhD degree in Computer Science
        the <a href="http://www.leidenuniv.nl/">University of Leiden</a>, in the Netherlands.
        I joined the W3C team as Head of <a href="/Consortium/Offices">Offices</a> in January 2001 while
        maintaining my position at <abbr title="Centrum voor Wiskunde en Informatica" lang="nl">CWI</abb
        I served as Head of Offices until June 2006, when I was asked to take the
        <a href="http://www.w3.org/2001/sw/">Semantic Web</a> Activity Lead position, which is now
```

…yielding; …

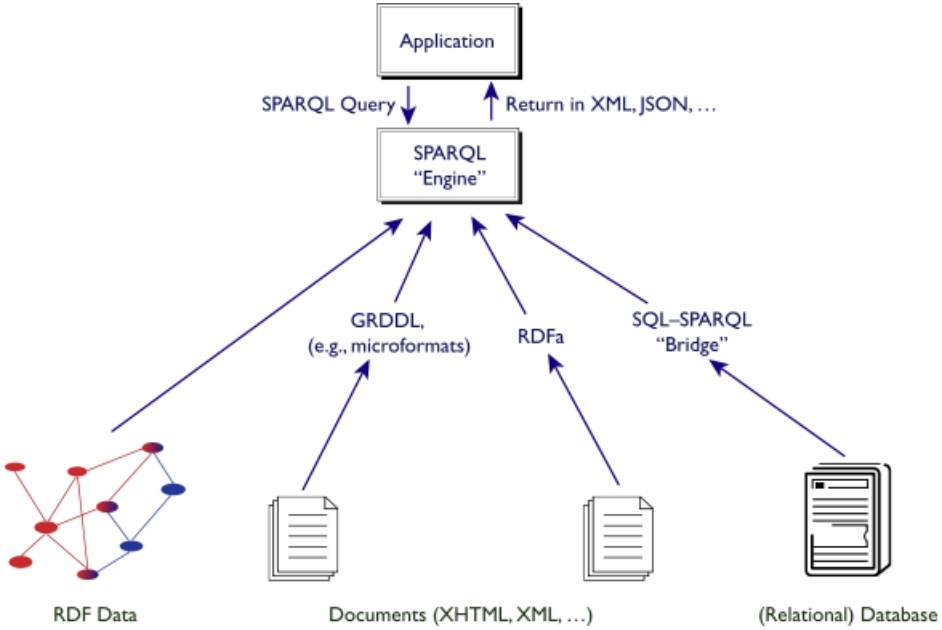
```
<rdf:RDF xmlns:foaf="http://xmlns.com/foaf/0.1/"
         xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
         xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
  <foaf:Person rdf:about="http://www.w3.org/People/Ivan/#me">
    <foaf:mbox rdf:resource="mailto:ivan@w3.org"/>
    <foaf:workInfoHomepage rdf:resource="http://www.w3.org/Consortium/Offices"/>
    <foaf:workInfoHomepage rdf:resource="http://www.iw3c2.org"/>
    <foaf:workInfoHomepage rdf:resource="http://www.w3.org/2001/sw"/>
    <foaf:name>Ivan Herman</foaf:name>
    <foaf:workplaceHomepage rdf:resource="http://www.w3.org"/>
    <foaf:schoolHomepage rdf:resource="http://www.elte.hu/"/>
      …
```

(see the full file if interested…)

Linking to SQL

- A huge amount of data in Relational Databases
- Although tools exist, it is not feasible to *convert* that data into RDF
- Instead: SQL ⇋ RDF "bridges" are being developed:
  - *a query to RDF data is transformed into SQL on-the-fly*
  - *the modalities are governed by small, local ontologies or rules*
- An active area of development, on the radar screen of W3C!
- (remind you again of "Linking Open Data on the Semantic Web" community project)

SPARQL as a unifying point?



Missing features, functionalities…

- Everybody has a favorite item, ie, the list tends to infinite…
- W3C is a *standardization* body, and has to look at where a consensus can be found

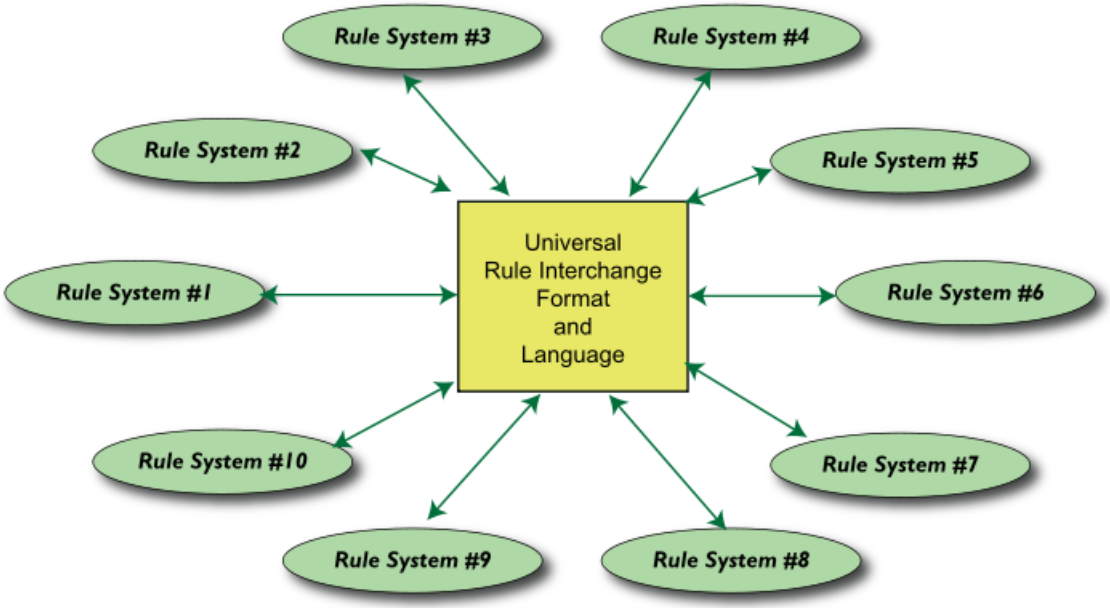
Rules

- OWL-DL and OWL-Lite are based on Description Logic; there are things that DL cannot express
  - *a well known examples is Horn rules (eg, the "uncle" relationship):*
    - $(P_1 \wedge P_2 \wedge \ldots) \rightarrow C$
    - e.g.: for *any* «X», «Y» and «Z»: "if «Y» is a parent of «X», and «Z» is a brother of «Y» then «Z» is the uncle of «X»"
  - *there are a number of attempts to combined these: RuleML, SWRL, cwm, …*
- There is also an increasing number of rule-based system that want to *interchange* rules
  - *a new type of data (potentially) on the Web to be interchanged…*

Some typical use cases

- Negotiate eBusiness contracts across platforms: supply vendor-neutral representation of your business rules so that others may find you
- Describe privacy requirements and policies, and let clients “merge” those (e.g., when paying with a credit card)
- Medical decision support, combining rules on diagnoses, drug prescription conditions, etc,
- Extend RDFS (or OWL) with rule-based statements (e.g., the uncle example)

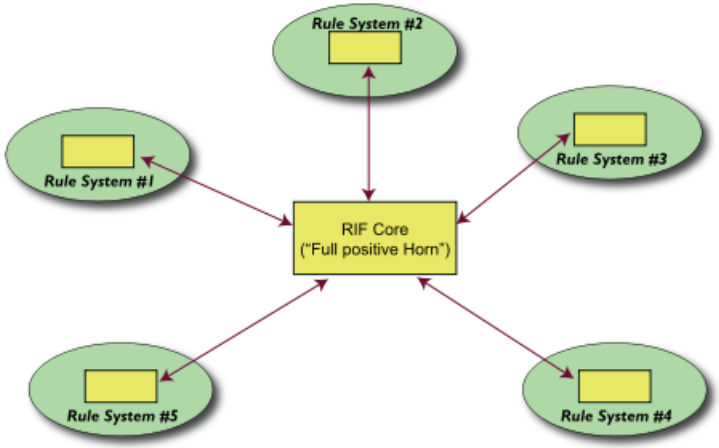
In an ideal World…



In the real World…

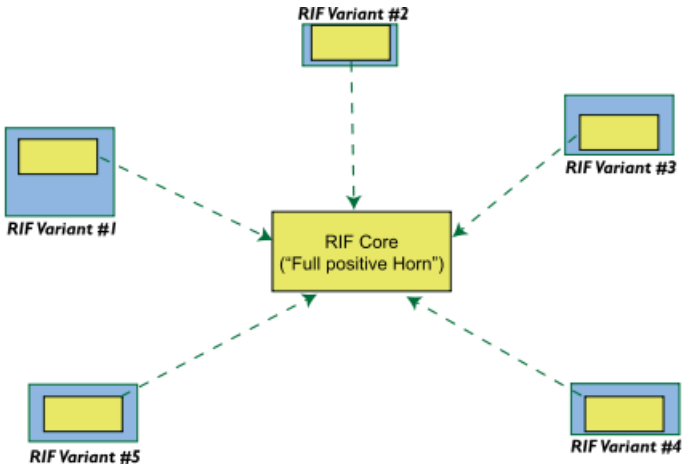
- Rule based systems can be *very* different
  - *different rule semantics (based on various type of model theories, on proof systems, etc)*
  - *production rule systems, with procedural references, state transitions, etc*

RIF “core”: only partial interchange



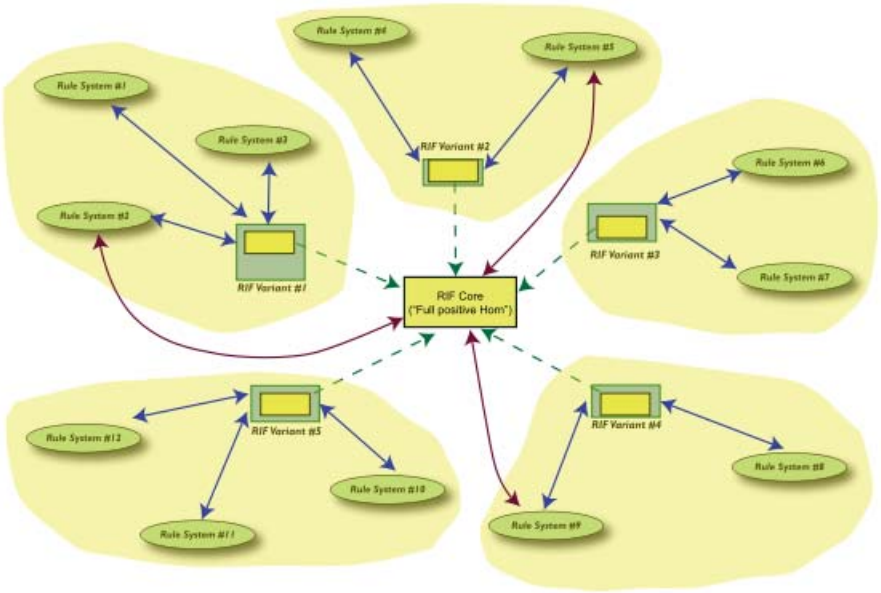
- Specification of the “core” is the first step
- It also forms a logic language to be used, eg, with OWL, RDF, XML data, …

RIF “variants”



Possible variants: F-logic, production rules, fuzzy logic systems, …; none of these have been finalized yet

Role of variants



“Light” ontologies

- For a number of applications RDFS is not enough, but even OWL Lite is too much
- There may be a need for a “light” version of OWL, just a few extra possibilities v.a.v. RDFS
- There are a number of proposals, papers, prototypes around: RDFS++, OWL Feather, pD*,…
  - *pD*, for example, has property characterization (symmetric, transitive, inverse), class and property equivalence, and property restrictions with some or all values*
- This might consolidate in the coming years

Other items…

- Fuzzy logic
  - *look at alternatives of Description Logic based on fuzzy logic*
  - *alternatively, extend RDF(S) with fuzzy notions*
- Probabilistic statements
  - *have an OWL class membership with a specific probability*
  - *combine reasoners with Bayesian networks*
- Security, trust, provenance
  - *combining cryptographic techniques with the RDF model, sign a portion of the graph, etc*
- Ontology merging, alignment, term equivalences, versioning, development, …
- etc

(Need a new PhD topic?☺)

A major problem: messaging

- Some of the messaging on Semantic Web has gone terribly wrong ☹. See these statements:
  - *“the Semantic Web is a reincarnation of Artificial Intelligence on the Web”*
  - *“it relies on giant, centrally controlled ontologies for "meaning" (as opposed to a democratic, bottom–up control of terms)”*
  - *“one has to add metadata to all Web pages, convert all relational databases, and XML data to use the Semantic Web”*
  - *“it is just an ugly application of XML”*
  - *“one has to learn formal logic, knowledge representation techniques, description logic, etc, to use it”*
  - *“it is, essentially, an academic project, of no interest for industry”*
  - *…*
- Some simple messages should come to the fore!

RDF ≠ RDF/XML!

- *RDF is a model*, and RDF/XML is only *one* possible serialization thereof
  - *lots of people prefer, for example, Turtle*
  - *a good percentage of the tools have Turtle parsers, too!*
- The model is, after all, simple: interchange format for Web resources. That is it ☺!

RDF ≠ RDF/XML! (cont.)

- RDF/XML is indeed a very complex serialization format
- Certainly not the nicest possible XML application
  - *good to know that it was created when XML was not yet final…*
- Again: it is only syntactic sugar!
- One has to emphasize: RDF is *not* an XML application!

RDF is not *that* complex…

- Of course, the formal semantics of RDF *is* complex
- But the average user should not care, it is all "under the hood"
  - *how many users of SQL have ever read its formal semantics?*
  - *it is not much simpler than RDF…*
- *People should "think" in terms of graphs*, the rest is syntactic sugar!

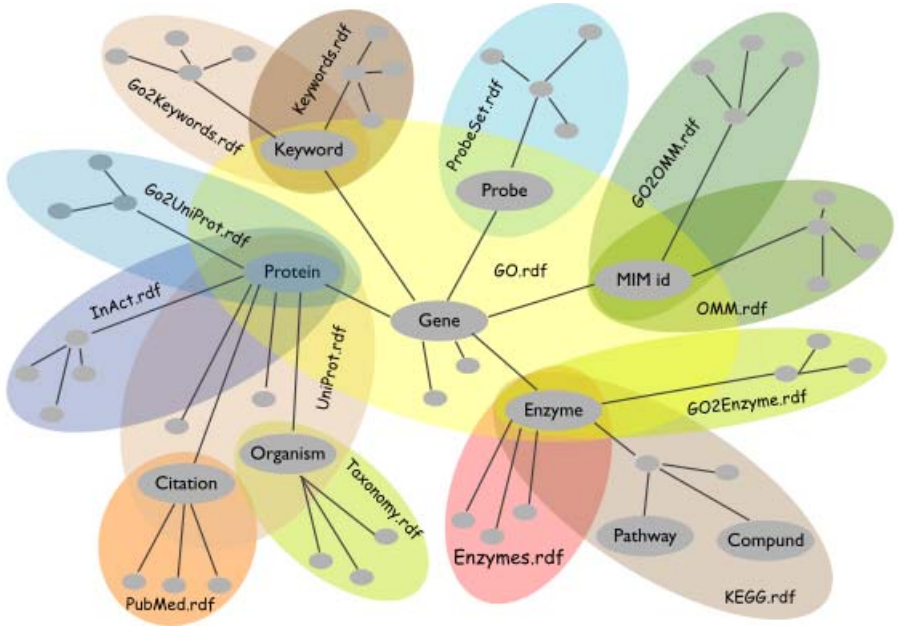
Semantic Web ≠ Ontologies on the Web!

- Formal ontologies (like OWL) are important, but use them *only when necessary*
  - *you can be a perfectly decent citizen of the Semantic Web if you do not use Ontologies, not even RDFS…*
  - *remember the "light ontologies" issue?*

SW Ontologies ≠ some *central*, big ontology!

- The “ethos” of the Semantic Web is on *sharing*, ie, sharing ontologies (small or large)
- A huge, central ontology would be unmanageable
- OWL includes statements for versioning, for equivalence and disjointness of terms
  - *a revision of those may be necessary, but the goal is clear*
- The practice:
  - *SW applications using ontologies always mix large number of ontologies and vocabularies (FOAF, DC, and others)*
  - *the real advantage comes from this mix: that is also how new relationships may be discovered*

Remember?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Semantic Web ≠ an academic research only!

- SW has indeed a strong foundation in research results
- But remember:
  - *(1) the Web was born at CERN…*
  - *(2) …was first picked up by high energy physicists…*
  - *(3) …then by academia at large…*
  - *(4) …then by small businesses and start-ups…*
  - *(5) "big business" came only later!*
- network effect kicked in early…
- Semantic Web is now at #4, and moving to #5!

Some RDF deployment areas

- Some communities that are coming to the fore: defense sector, health care, bioinformatics, eGovernment, energy sector (oil industry), financial services, *digital libraries*…
- Health care and life science sector is now very active
  - *also at W3C, in the form of an Interest Group*

The “corporate” landscape is moving

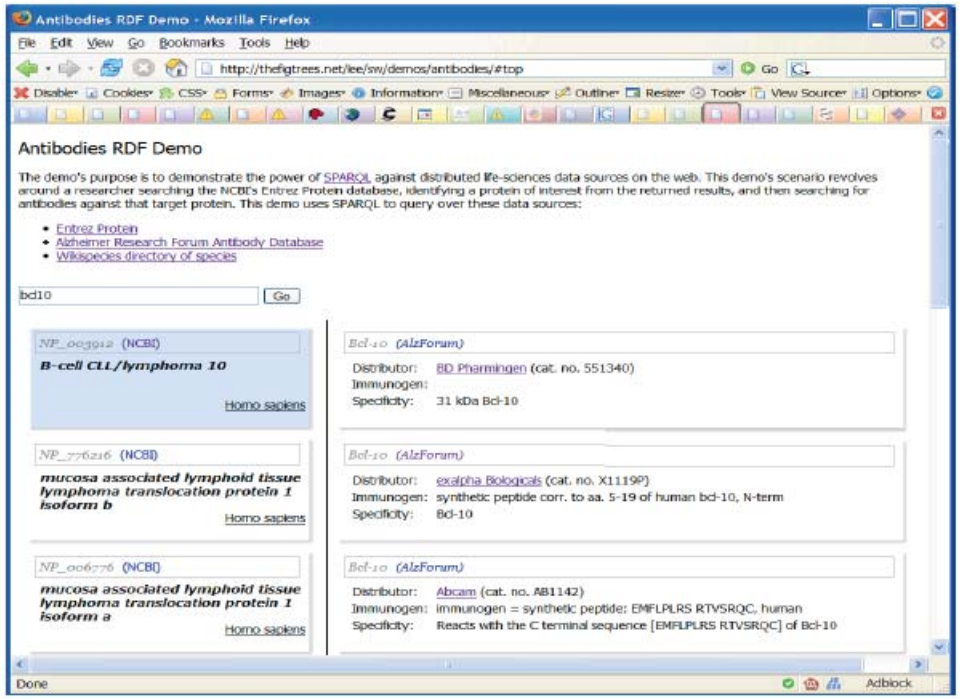
- Major companies offer (or will offer) Semantic Web tools or systems using Semantic Web: Adobe, Oracle, IBM, HP, Software AG, webMethods, Northrop Gruman, Altova,…
- Some of the names of active participants in W3C SW related groups: ILOG, HP, Agfa, SRI International, Fair Isaac Corp., Oracle, Boeing, IBM, Chevron, Siemens, Nokia, Merck, Pfizer, AstraZeneca, Sun, Citigroup,…
- “Corporate Semantic Web” listed as major technology by Gartner in 2006
- The Semantic Technology Conference series also attract lots of participants
  - *speakers in 2006: from IBM, Cisco, BellSouth, GE, Walt Disney, Nokia, Oracle, …*
  - *not all referring to Semantic Web (eg, RDF, OWL,…) but semantics in general*
  - *but they might come around!*

Data integration

- Data integration comes to the fore as one of *the* SW Application areas
- Very important for large application areas (life sciences, energy sector, eGovernment, financial institutions), as well as everyday applications (eg, reconciliation of calendar data)
- Life sciences example:
  - *data in different labs…*
  - *data aimed at scientists, managers, clinical trial participants…*
  - *large scale public ontologies (genes, proteins, antibodies, …)*
  - *different formats (databases, spreadsheets, XML data, XHTML pages)*
  - *etc*
- We already heard yesterday: “libraries realize they are not alone…”: similar issues arise in that area

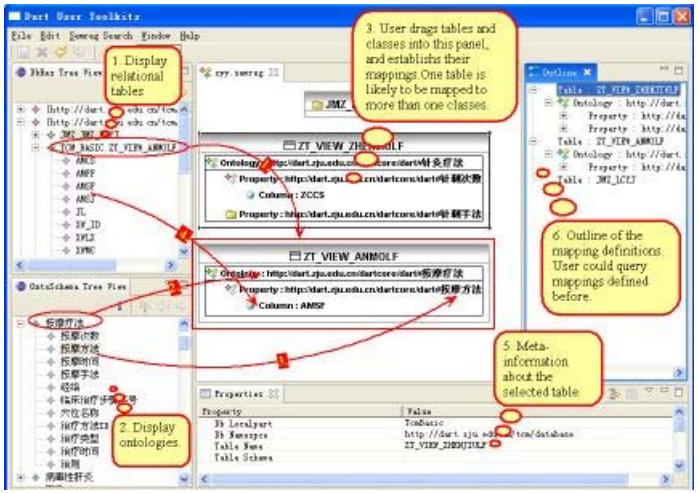
Example: antibodies demo

- Scenario: find the known antibodies for a protein in a specific species
- Combine (“scrape”…) three different data sources
- Use SPARQL as an integration tool (see also demo online)



There has been lots of R&D

- Boeing, MITRE Corp., Elsevier, EU Projects like Sculpteur and Artiste, national projects like MuseoSuomi, DartGrid, …
- Developments are under way at various places in the area
- A general question: can / access your (RDF) data directly?

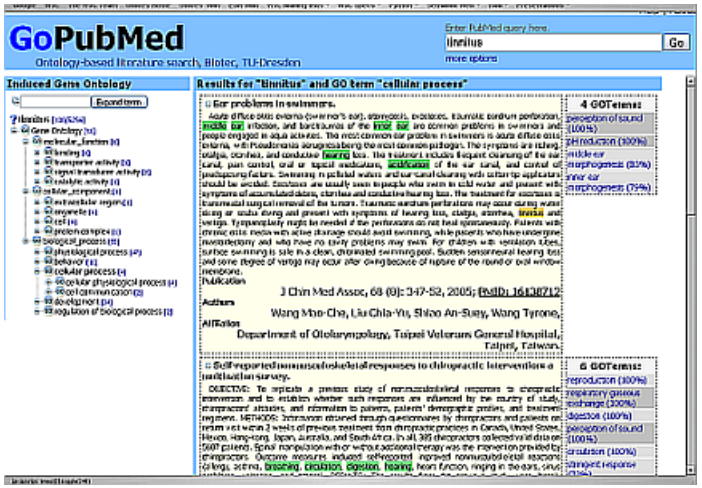


Portals

- Vodafone's Live Mobile Portal
  - *search application (e.g. ringtone, game, picture) using RDF*
    - page views per download decreased 50%
    - ringtone up 20% in 2 months
- A number of other portal examples: Sun's White Paper Collections and System Handbook collections; Nokia's S60 support portal; Harper's Online magazine linking items via an internal ontology; Oracle's virtual press room; Opera's community site, Yahoo! Food…
- A general question again: can I access your (RDF) data directly?

Improved Search via Ontology: GoPubMed

- Improved search on top of pubmed.org
  - *search results are ranked using the specialized ontologies*
  - *extra search terms are generated and terms are highlighted*
- Importance of *domain specific ontologies* for search improvement



Other Application Areas Come to the Fore

- Knowledge management
- Business intelligence
- Linking virtual communities
- Management of multimedia data (e.g., video and image depositories)
- Content adaptation and labeling (e.g., for mobile usage)
- etc

Thank you for your attention!

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http://www.w3.org/2007/Talks/0223-Bangalore_IH/
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in XHTML and PDF formats; the XHTML version has active links that you can follow