DERI

Using/Extending RIF and SPARQL to navigate Linked Open Data

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Ollscoil na hÉireann, Gaillimh

sfi
science foundation ireland
fondúireacht eolaíochta éireann

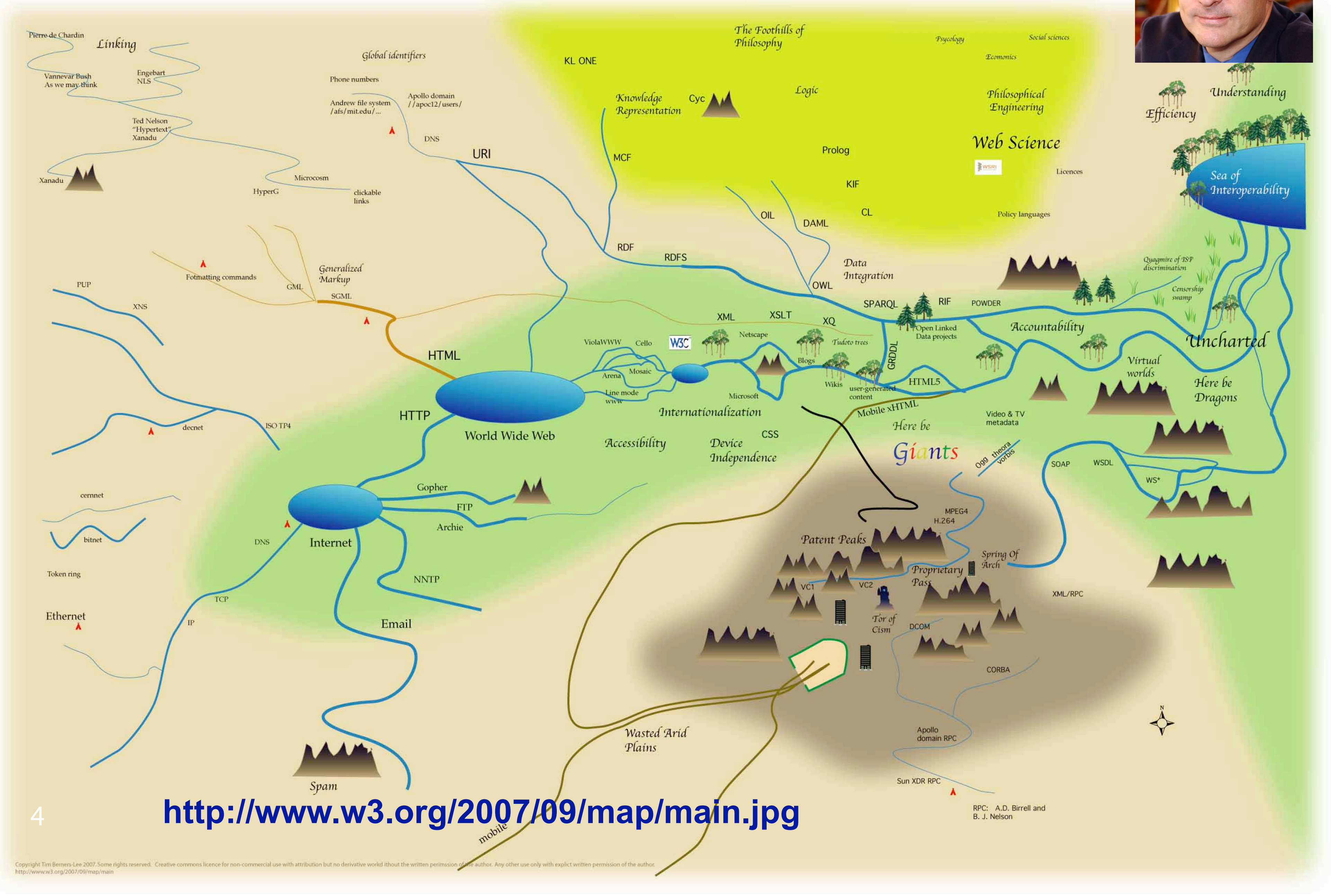
“Keynote Checklist”

- □ *Funny*
- □ *Educating*
- □ *Controversial*
- □ *Inspiring*
- □ *Credits to the hosts*
- □ *Advertising*
- □ *Steal from famous people*

2008

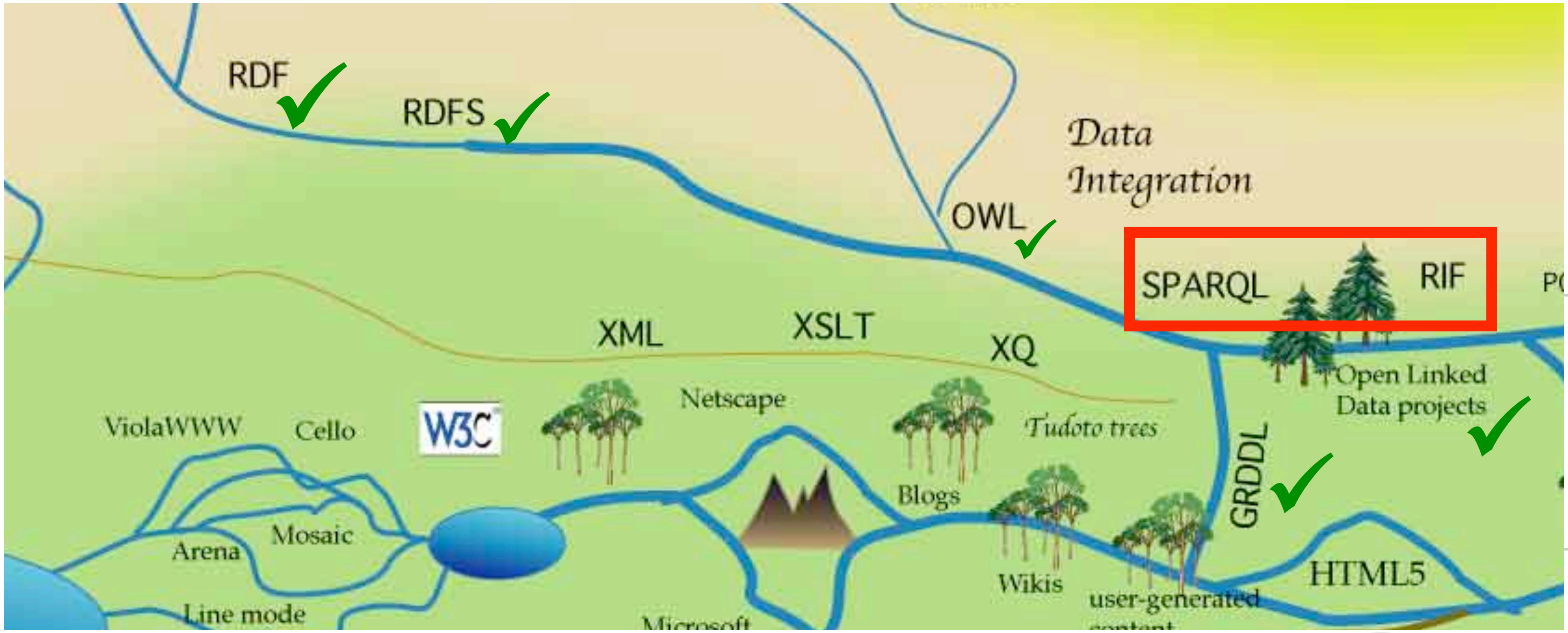
Where is the Semantic Web?

The Web map 2008 © Tim Berners-Lee



http://www.w3.org/2007/09/map/main.jpg

The Web map 2008 © Tim Berners-Lee



- more and more RDF available on the Web…
- …thanks to GRDDL, Linked Open Data, etc.
- … vocabularies (RDFS+OWL) becoming established
- … Now: What can we do with it?

Example: Finding experts/reviewers?

***Tim Berners-Lee**, Dan Connolly, Lalana Kagal, Yosi Scharf, Jim Hendler: **N3Logic: A logical framework for the World Wide Web**. Theory and Practice of Logic Programming (TPLP), Volume 8, p249-269*

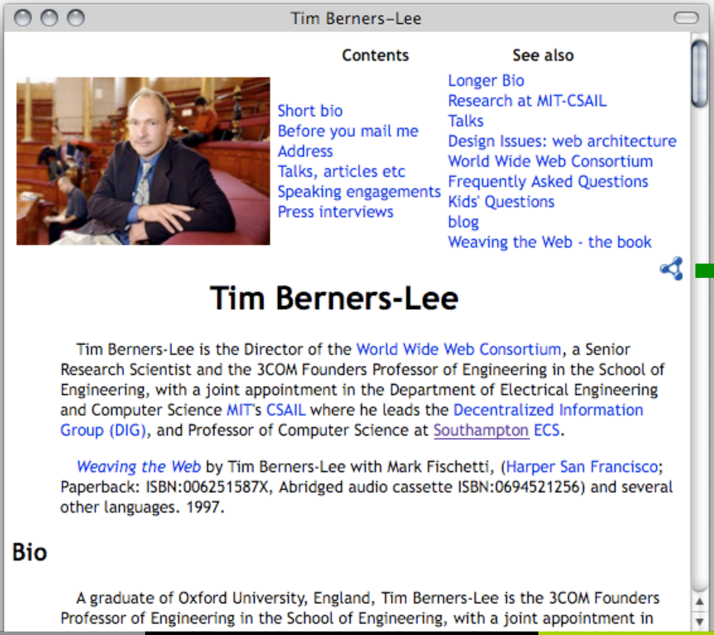
- Who are the right reviewers? Who has the right expertise?
- Which reviewers are in conflict?
- Observation: Most of the necessary data already on the Web!

- More and more of it follows the Linked Data principles, i.e.:
  1. Use URIs as names for things
  2. Use HTTP dereferenceable URIs so that people can look up those names.
  3. When someone looks up a URI, provide useful information.
  4. Include links to other URIs so that they can discover more things.

RDF on the Web

- **(i) directly by the publishers**
- (ii) by GRDDL transformations, or
- (iii) by 3rd-party wrapper

FOAF/RDF linked from a home page: personal data (foaf:name, foaf:phone, etc.), relationships foaf:knows, rdfs:seeAlso)



Contents

Short bio
Before you mail me
Address
Talks, articles etc
Speaking engagements
Press interviews

See also

Longer Bio
Research at MIT-CSAIL
Talks
Design Issues: web architecture
World Wide Web Consortium
Frequently Asked Questions
Kids' Questions
blog
Weaving the Web - the book

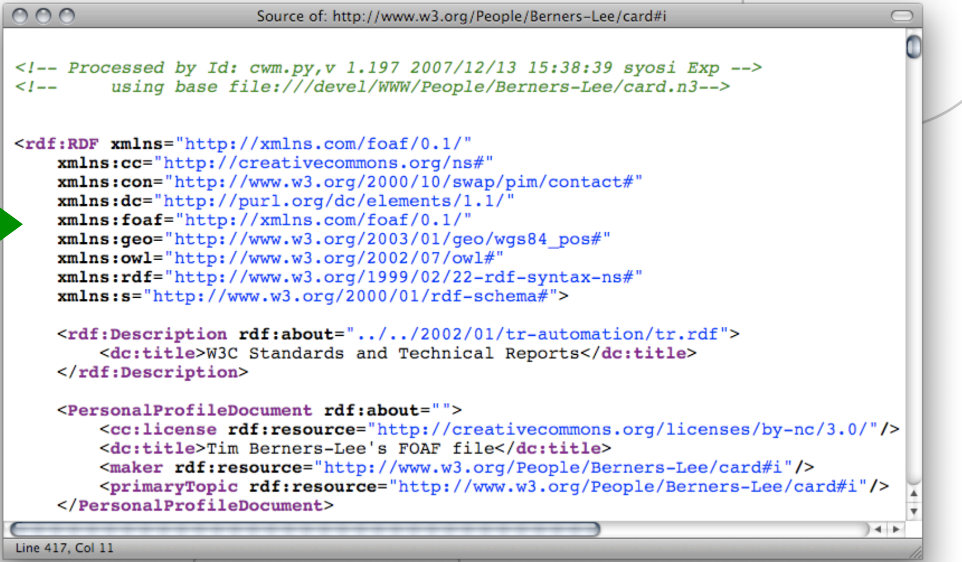
Tim Berners-Lee

Tim Berners-Lee is the Director of the World Wide Web Consortium, a Senior Research Scientist and the 3COM Founders Professor of Engineering in the School of Engineering, with a joint appointment in the Department of Electrical Engineering and Computer Science MIT's CSAIL where he leads the Decentralized Information Group (DIG), and Professor of Computer Science at Southampton ECS.

Weaving the Web by Tim Berners-Lee with Mark Fischetti, (Harper San Francisco; Paperback: ISBN:006251587X, Abridged audio cassette ISBN:0694521256) and several other languages. 1997.

Bio

A graduate of Oxford University, England, Tim Berners-Lee is the 3COM Founders Professor of Engineering in the School of Engineering, with a joint appointment in



```
<!-- Processed by Id: cwm.py,v 1.197 2007/12/13 15:38:39 syosi Exp -->
<!--     using base file:///devel/WWW/People/Berners-Lee/card.n3-->


<rdf:RDF xmlns="http://xmlns.com/foaf/0.1/"
    xmlns:cc="http://creativecommons.org/ns#"
    xmlns:con="http://www.w3.org/2000/10/swap/pim/contact#"
    xmlns:dc="http://purl.org/dc/elements/1.1/"
    xmlns:foaf="http://xmlns.com/foaf/0.1/"
    xmlns:geo="http://www.w3.org/2003/01/geo/wgs84_pos#"
    xmlns:owl="http://www.w3.org/2002/07/owl#"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:s="http://www.w3.org/2000/01/rdf-schema#">

    <rdf:Description rdf:about="../../2002/01/tr-automation/tr.rdf">
        <dc:title>W3C Standards and Technical Reports</dc:title>
    </rdf:Description>

    <PersonalProfileDocument rdf:about="">
        <cc:license rdf:resource="http://creativecommons.org/licenses/by-nc/3.0/"/>
        <dc:title>Tim Berners-Lee's FOAF file</dc:title>
        <maker rdf:resource="http://www.w3.org/People/Berners-Lee/card#i"/>
        <primaryTopic rdf:resource="http://www.w3.org/People/Berners-Lee/card#i"/>
    </PersonalProfileDocument>
```

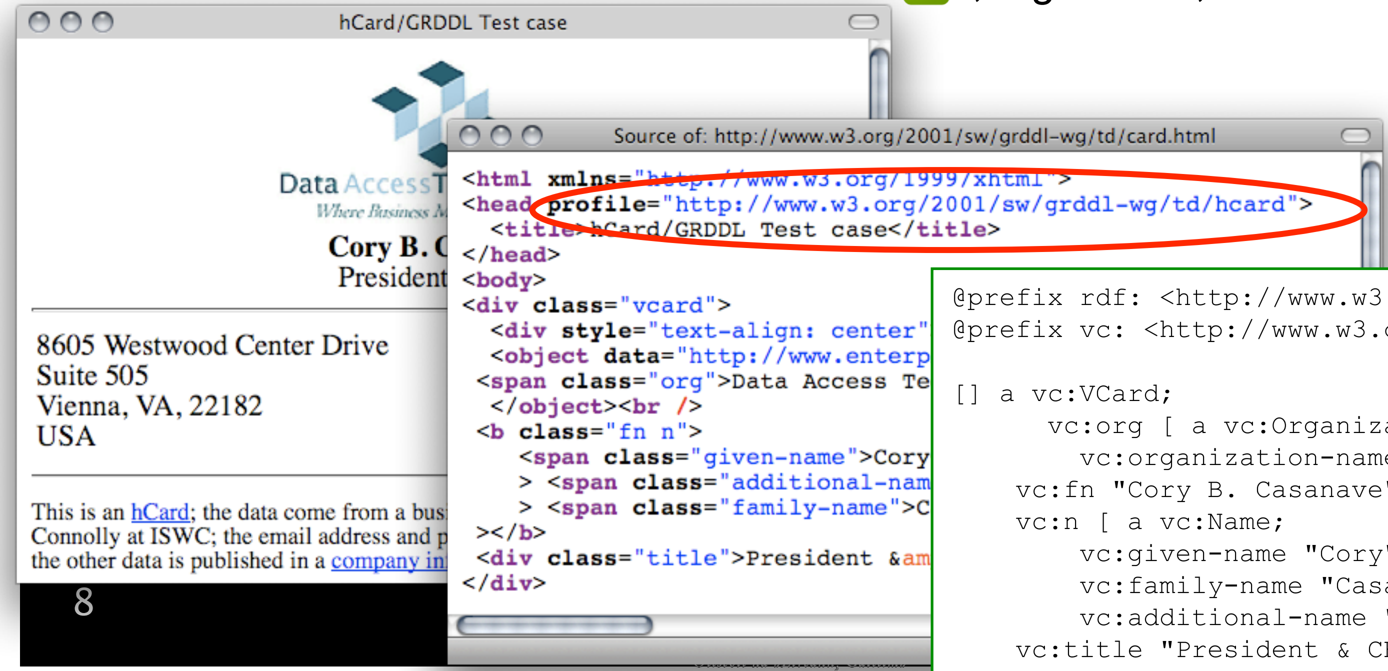
RDF on the Web

- (i) directly by the publishers
- **(ii) by GRDDL transformations**, or
- (iii) by 3rd-party wrapper

GRDDL (**G**leaning **R**esource **D**escriptions from **D**ialects of **L**anguages.),W3C Rec. 2007

Simple principle:

- □ extract RDF directly from HTML or XML files
- □ typically using XSLT transformations (other languages: XQuery, XSPARQL, etc.)
- □ useful for common Microformats, e.g. hCard, hCal:



hCard/GRDDL Test case

Cory B. C
President

8605 Westwood Center Drive
Suite 505
Vienna, VA, 22182
USA

This is an hCard; the data come from a bus
Connolly at ISWC; the email address and p
the other data is published in a company in

Source of: http://www.w3.org/2001/sw/grddl-wg/td/card.html

```
<html xmlns="http://www.w3.org/1999/xhtml">
<head profile="http://www.w3.org/2001/sw/grddl-wg/td/hcard">
  <title>hCard/GRDDL Test case</title>
</head>
<body>
<div class="vcard">
  <div style="text-align: center"
  <object data="http://www.enterp
 <span class="org">Data Access Te
  </object><br />
 <b class="fn n">
    <span class="given-name">Cory
    > <span class="additional-nam
    > <span class="family-name">C
 ></b>
 <div class="title">President &am
</div>
```

profile points to XSLT…

… to extract vCard/RDF

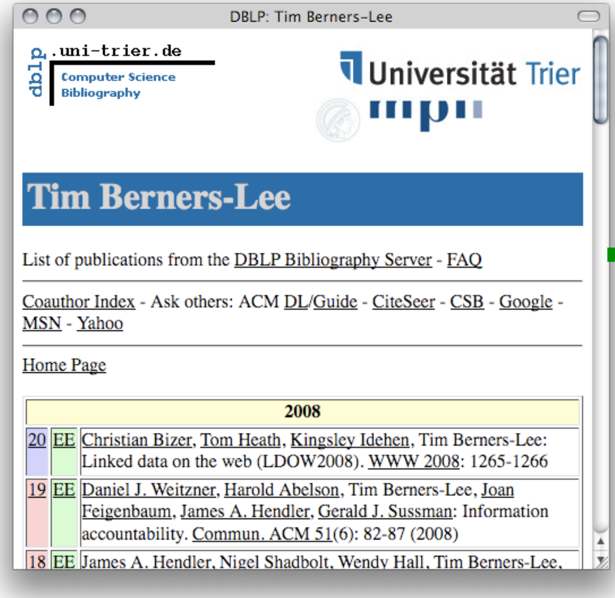
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix vc: <http://www.w3.org/2006/vcard/ns#> .

[] a vc:VCard;
      vc:org [ a vc:Organization;
        vc:organization-name "Data Access Technologies" ];
    vc:fn "Cory B. Casanave";
    vc:n [ a vc:Name;
        vc:given-name "Cory";
        vc:family-name "Casanave";
        vc:additional-name "B." ];
    vc:title "President & CEO";
    vc:adr [ a vc:Address;
        vc:extended-address "Suite 505";
```

RDF on the Web

- (i) directly by the publishers
- (ii) by GRDDL transformations, or
- **(iii) by 3rd-party wrapper**

e.g. L3S’ RDF export of the DBLP citation index, using FUB’s D2R (http://dblp.l3s.de/d2r/)



DBLP: Tim Berners-Lee

dblp.uni-trier.de Computer Science Bibliography

Universität Trier

mpii

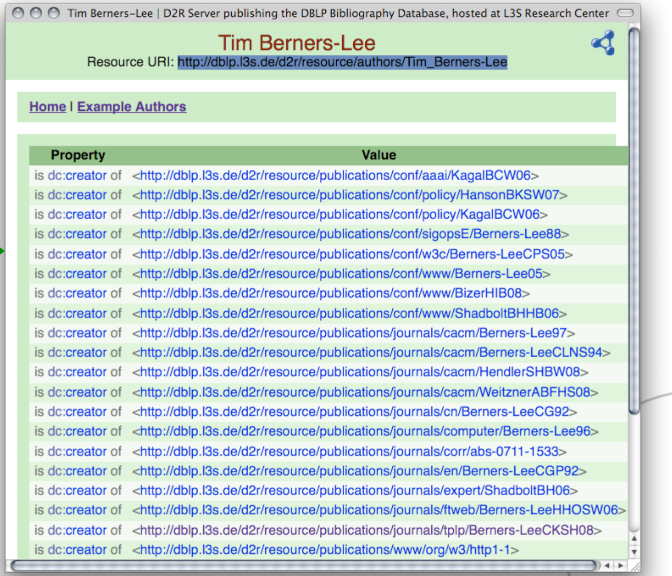
Tim Berners-Lee

List of publications from the DBLP Bibliography Server - FAQ

Coauthor Index - Ask others: ACM DL/Guide - CiteSeer - CSB - Google - MSN - Yahoo

Home Page

		2008
20	EE	Christian Bizer, Tom Heath, Kingsley Idehen, Tim Berners-Lee: Linked data on the web (LDOW2008). WWW 2008: 1265-1266
19	EE	Daniel J. Weitzner, Harold Abelson, Tim Berners-Lee, Joan Feigenbaum, James A. Hendler, Gerald J. Sussman: Information accountability. Commun. ACM 51(6): 82-87 (2008)
18	EE	James A. Hendler, Nigel Shadbolt, Wendy Hall, Tim Berners-Lee,



Tim Berners-Lee | D2R Server publishing the DBLP Bibliography Database, hosted at L3S Research Center

Tim Berners-Lee

Resource URI: http://dblp.l3s.de/d2r/resource/authors/Tim_Berners-Lee

Home | Example Authors

Property	Value
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/aaai/KagalBCW06>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/policy/HansonBKSW07>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/policy/KagalBCW06>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/sigopsE/Berners-Lee88>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/w3c/Berners-LeeCPS05>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/www/Berners-Lee05>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/www/BizerHIB08>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/conf/www/ShadboltBHHB06>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/cacm/Berners-Lee97>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/cacm/Berners-LeeCLNS94>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/cacm/HendlerSHBW08>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/cacm/WeitznerABFHS08>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/cn/Berners-LeeCG92>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/computer/Berners-Lee96>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/corr/abs-0711-1533>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/en/Berners-LeeCGP92>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/expert/ShadboltBH06>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/ftweb/Berners-LeeHHOSW06>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/journals/tplp/Berners-LeeCKSH08>
is dc:creator of	<http://dblp.l3s.de/d2r/resource/publications/www/org/w3/http1-1>

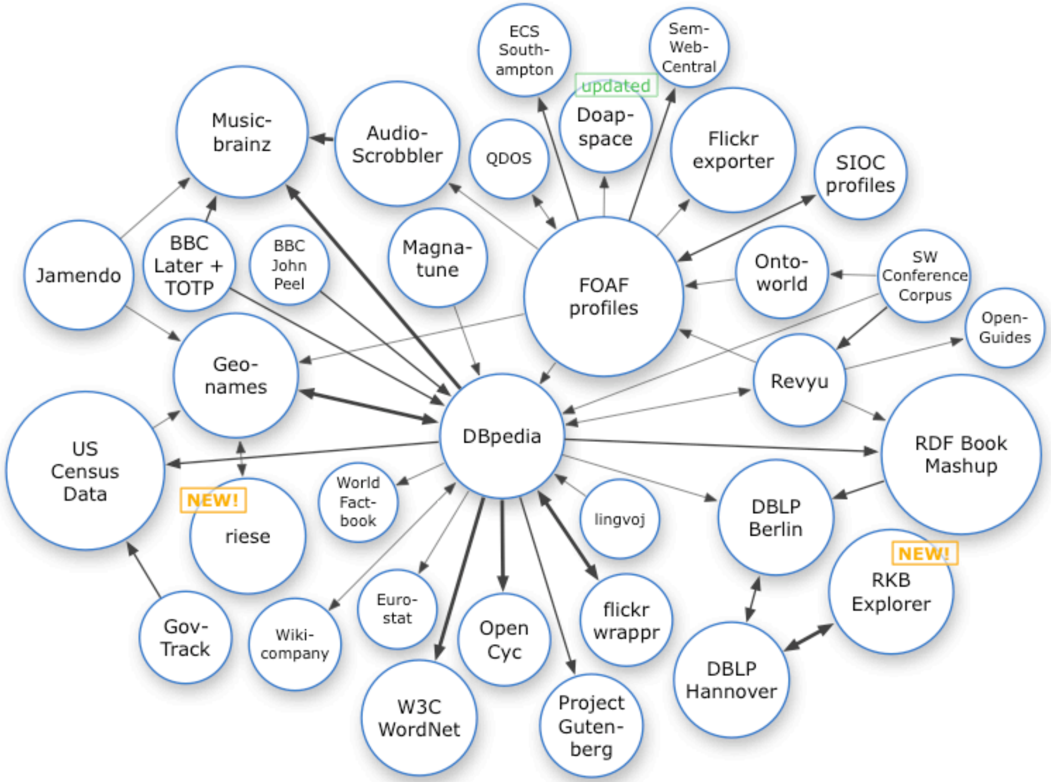
Gives unique URIs to authors, documents, etc. on DBLP! E.g.,

http://dblp.l3s.de/d2r/resource/authors/Tim_Berners-Lee,

http://dblp.l3s.de/d2r/resource/publications/journals/tplp/Berners-LeeCKSH08

Provides RDF version of all DBLP data + query interface!

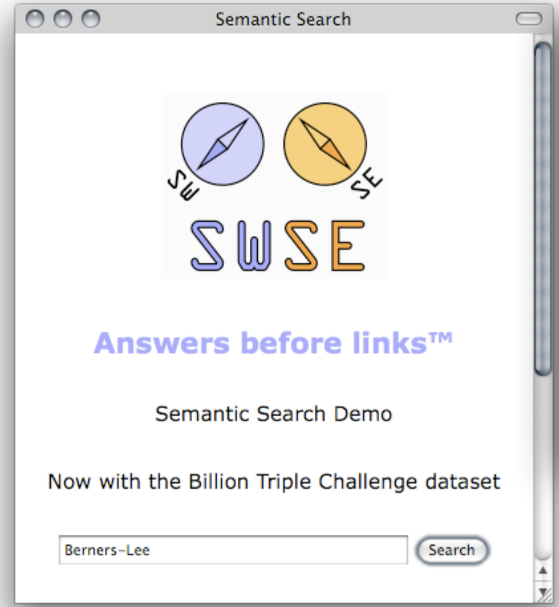
Linked Open Data



- Excellent tutorial here: http://www4.wiwiss.fu- berlin.de/bizer/pub/LinkedDataTutorial/

How can I find RDF Data?

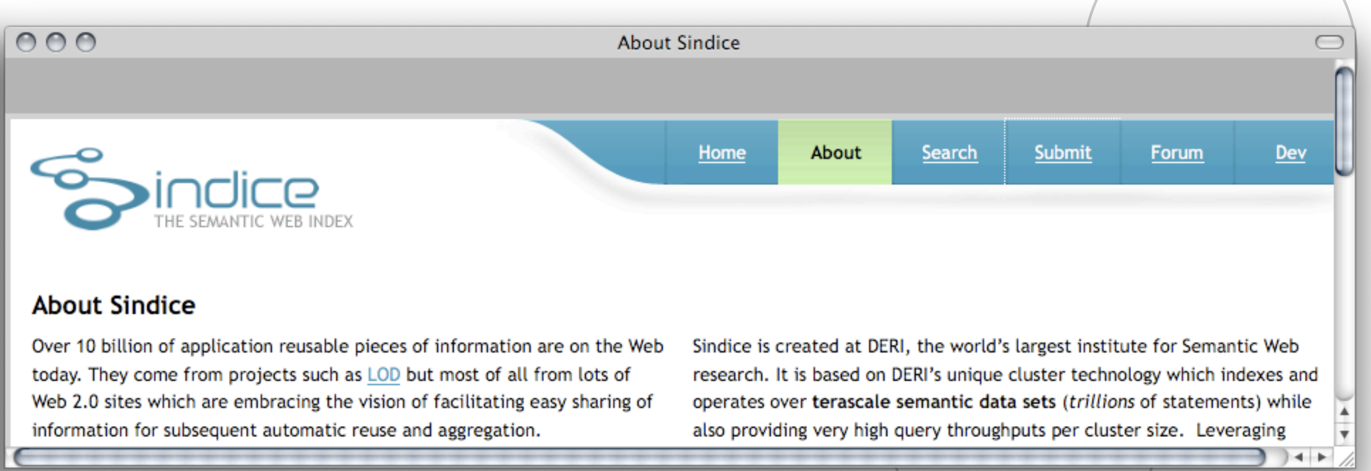
- Datawarehouse approach, e.g. SWSE
  - □ crawling, harvesting, SPARQL interface, RDFS+resricted OWL reasoning
- Search/Lookup indeces for the Semantic Web, e.g. Sindice
  - □ Indexing RDF sources on the Web, go there and query yourself



Answers before links™

Semantic Search Demo

Now with the Billion Triple Challenge dataset



About Sindice

Over 10 billion of application reusable pieces of information are on the Web today. They come from projects such as LOD but most of all from lots of Web 2.0 sites which are embracing the vision of facilitating easy sharing of information for subsequent automatic reuse and aggregation.

Sindice is created at DERI, the world's largest institute for Semantic Web research. It is based on DERI's unique cluster technology which indexes and operates over **terascale semantic data sets** (*trillions* of statements) while also providing very high query throughputs per cluster size. Leveraging

http://swse.deri.org
http://sindice.com

How can I query that data? SPARQL

- SPARQL – W3C approved standardized query language for RDF:
  - □ look-and-feel of "SQL for the Web"
  - □ allows to ask queries like
    - "All documents by Tim Berners-Lee"
    - "All documents published in TPLP that have 'Web' in the title"
    - "Names of all persons who co-authored with authors of http://dblp.l3s.de/d2r/…/Berners-LeeCKSH08 or known by co-authors"
    - "All people who have published in TPLP but have **not** co-authored with any of the authors of http://dblp.l3s.de/d2r/…/Berners-LeeCKSH08"

Example:

```
SELECT ?D
FROM <http://dblp.l3s.de/…/authors/Tim_Berners-Lee>
WHERE {?D dc:creator <http://dblp.l3s.de/…/authors/Tim_Berners-Lee>}
```

What can/can't be done with SPARQL?

- Can:
  - FILTERs
  - UNION
  - traversing GRAPHs
  - OPTIONAL, set difference
  - CONSTRUCT new graphs from existing ones
- Can't:
  - Full support of RDFS+OWL
  - recursive "views", dynamic datasets
  - Aggregates, built-ins
  - Generate XML, HTML

SPARQL “recipes”: FILTERs

- *“All documents published in TPLP **that have ‘Web’ in the title**”*

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX swrc: <http://swrc.ontoware.org/ontology#>

SELECT ?T WHERE
{ ?D swrc:journal <http://dblp.l3s.de/d2r/resource/journals/tplp>.
  ?D dc:title ?T.
  FILTER ( RegEx(?T, "Web"))
}
```

SPARQL “recipes”: UNIONs

- “**Names *of all persons who co-authored with authors of http://dblp.l3s.de/d2r/…/Berners-LeeCKSH08*** *or known by co-authors*”

```
SELECT ?Name WHERE
   { <http://dblp.l3s.de/d2r/resource/publication/journals/tplp/Berners-LeeCKSH08>
        dc:creator ?Author.
     ?D dc:creator ?Author.
     ?D dc:creator ?CoAuthor.
     ?CoAuthor foaf:name ?Name
   }
```

SPARQL “recipes”: UNIONs

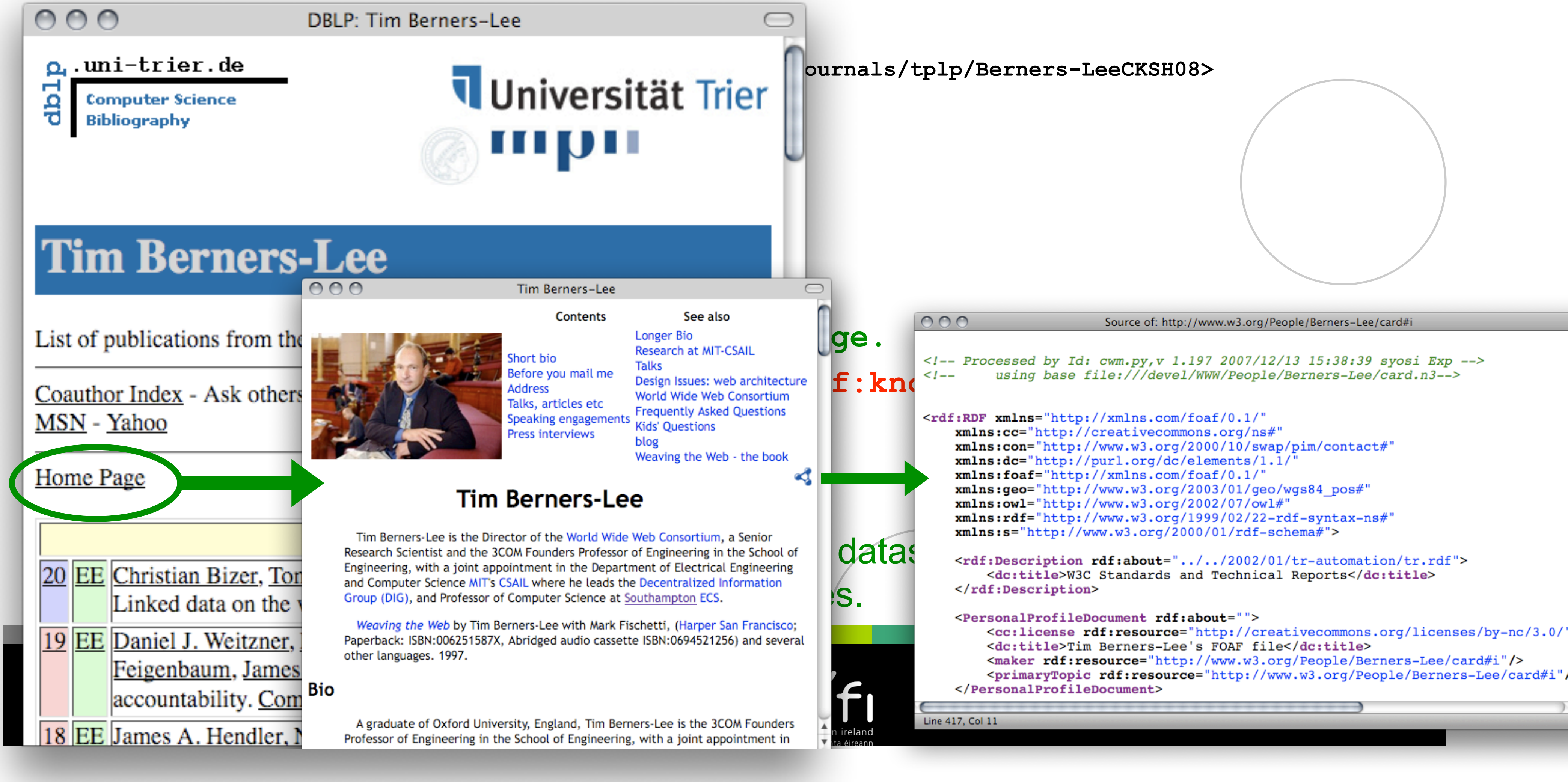
- “Names *of all persons who* ***co-authored*** *with authors of http://dblp.l3s.de /d2r/…/Berners-LeeCKSH08* ***or known by co-authors***”

```
SELECT ?Name WHERE
    { <http://dblp.l3s.de/d2r/resource/publications/journals/tplp/Berners-LeeCKSH08>
         dc:creator ?Author.
     ?D dc:creator ?Author.
     ?D dc:creator ?CoAuthor.
     {  ?CoAuthor foaf:name ?Name . }
    UNION
    {  ?CoAuthor foaf:knows ?Person.
        ?Person foaf:name ?Name }
    }
```

- Doesn’t work… no foaf:knows relations in DBLP ☹

SPARQL “recipes”: UNIONs + traversing GRAPH

- “Names *of all persons who* ***co-authored*** *with authors of* ***http://dblp.l3s.de/d2r/…/Berners-LeeCKSH08 or known by co-authors, according to FOAF information found on their homepages***”



DBLP: Tim Berners-Lee

dblp.uni-trier.de
Computer Science Bibliography

Universität Trier

Tim Berners-Lee

List of publications from the

Coauthor Index - Ask others
MSN - Yahoo

Home Page

20	EE	Christian Bizer, Tor Linked data on the
19	EE	Daniel J. Weitzner, Feigenbaum, James accountability. Com
18	EE	James A. Hendler,

Tim Berners-Lee

Contents

Short bio
Before you mail me
Address
Talks, articles etc
Speaking engagements
Press interviews

See also

Longer Bio
Research at MIT-CSAIL
Talks
Design Issues: web architecture
World Wide Web Consortium
Frequently Asked Questions
Kids' Questions
blog
Weaving the Web - the book

Tim Berners-Lee

Tim Berners-Lee is the Director of the World Wide Web Consortium, a Senior Research Scientist and the 3COM Founders Professor of Engineering in the School of Engineering, with a joint appointment in the Department of Electrical Engineering and Computer Science MIT's CSAIL where he leads the Decentralized Information Group (DIG), and Professor of Computer Science at Southampton ECS.

Weaving the Web by Tim Berners-Lee with Mark Fischetti, (Harper San Francisco; Paperback: ISBN:006251587X, Abridged audio cassette ISBN:0694521256) and several other languages. 1997.

Bio

A graduate of Oxford University, England, Tim Berners-Lee is the 3COM Founders Professor of Engineering in the School of Engineering, with a joint appointment in

ournals/tplp/Berners-LeeCKSH08>

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datas

s.

Source of: http://www.w3.org/People/Berners-Lee/card#i

```
<!-- Processed by Id: cwm.py,v 1.197 2007/12/13 15:38:39 syosi Exp -->
<!--     using base file:///devel/WWW/People/Berners-Lee/card.n3-->


<rdf:RDF xmlns="http://xmlns.com/foaf/0.1/"
    xmlns:cc="http://creativecommons.org/ns#"
    xmlns:con="http://www.w3.org/2000/10/swap/pim/contact#"
    xmlns:dc="http://purl.org/dc/elements/1.1/"
    xmlns:foaf="http://xmlns.com/foaf/0.1/"
    xmlns:geo="http://www.w3.org/2003/01/geo/wgs84_pos#"
    xmlns:owl="http://www.w3.org/2002/07/owl#"
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:s="http://www.w3.org/2000/01/rdf-schema#">

    <rdf:Description rdf:about="../../2002/01/tr-automation/tr.rdf">
        <dc:title>W3C Standards and Technical Reports</dc:title>
    </rdf:Description>

    <PersonalProfileDocument rdf:about="">
        <cc:license rdf:resource="http://creativecommons.org/licenses/by-nc/3.0/'
        <dc:title>Tim Berners-Lee's FOAF file</dc:title>
        <maker rdf:resource="http://www.w3.org/People/Berners-Lee/card#i"/>
        <primaryTopic rdf:resource="http://www.w3.org/People/Berners-Lee/card#i"/
    </PersonalProfileDocument>
```

Line 417, Col 11

SPARQL “recipes”: OPTIONALs

- *“Select names of people who co-authored with authors of* ***http://dblp.l3s.de/d2r/... /Berners-LeeCKSH08*** *and OPTIONALLY their home page” (not all people in DBLP have a homepage)*

```
SELECT ?Name ?Homepage WHERE
    { <http://dblp.l3s.de/d2r/resource/publication/journals/tplp/Berners-LeeCKSH08>
         dc:creator ?Author.
      ?D dc:creator ?Author.
      ?D dc:creator ?CoAuthor.
      ?CoAuthor foaf:name ?Name
      OPTIONAL {?CoAuthor foaf:homepage ?Homepage}

   }
```

- Oops, that is non-monotonic! Closed world! Handle with care on the Web!

SPARQL “recipes”: OPTIONALs, set difference

- *“Select names of people who co-authored with authors of* ***http://dblp.l3s.de/d2r/… /Berners-LeeCKSH08*** *and WHO DON’T HAVE a home page” (not all people in DBLP have a homepage)*

```
SELECT ?Name ?Homepage WHERE
    { <http://dblp.l3s.de/d2r/resource/publication/journals/tplp/Berners-LeeCKSH08>
        dc:creator ?Author.
      ?D dc:creator ?Author.
      ?D dc:creator ?CoAuthor.
      ?CoAuthor foaf:name ?Name
      OPTIONAL {?CoAuthor foaf:homepage ?Homepage}
      FILTER ( ! Bound (?Homepage ) )
   }
```

- This emulates “NOT EXISTS” from SQL.
- BTW: This can be done even WITHOUT using FILTERS!!! Next slide!

SPARQL "recipes": OPTIONALs, set difference

- *"Select names of people who co-authored with authors of* ***http://dblp.l3s.de/d2r/…/Berners-LeeCKSH08*** *and WHO DON'T HAVE a home page" (not all people in DBLP have a homepage)*

```
SELECT ?Name ?Homepage WHERE
   { <http://dblp.l3s.de/d2r/resource/publication/journals/tplp/Berners-LeeCKSH08>
        dc:creator ?Author.
     ?D dc:creator ?Author.
     ?D dc:creator ?CoAuthor.
     ?CoAuthor foaf:name ?Name
     OPTIONAL {?CoAuthor foaf:homepage ?Homepage}
     GRAPH <boundchecker.ttl> { ?Homepage ex:is ex:unbound } .
  }
```

Alternative encoding of set difference:

- *boundchecker.ttl contains the single triple _:b ex:is ex:unboud.*
- *_:b is a blank node - a node without a name (URI) that can only be referenced within the graph in which it is declared.*

SPARQL “recipes”: CONSTRUCTING new graphs

- “I know all people who are my coauthors according to DBLP”

```
CONSTRUCT
   { <http://www.polleres.net/foaf.rdf#me> foaf:knows ?CoAuthor}
WHERE
   { GRAPH <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
     ?D dc:creator
            <http://www.polleres.net/foaf.rdf#me>.
      ?D dc:creator ?CoAuthor.
   }
```

- Doesn’t work…DBLP uses a different identifier for me…

SPARQL “recipes”: CONSTRUCTING new graphs

- “I know all people who are my coauthors according to DBLP”

```
CONSTRUCT
    { <http://www.polleres.net/foaf.rdf#me> foaf:knows ?CoAuthor}
WHERE
    { GRAPH <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
      ?D dc:creator
             <http://www.polleres.net/foaf.rdf#me>.
       ?D dc:creator ?CoAuthor.
    }
```

- A FOAF and OWL aware SPARQL engine should be able to do this…
- DBLP has:

```
<http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
        foaf:homepage <http://www.polleres.net>.
```

- My FOAF file has:

```
<http://www.polleres.net/foaf.rdf#me>
        foaf:homepage <http://www.polleres.net>.
```

- The FOAF ontology has:

```
foaf:homepage rdf:type owl:InverseFunctionalProperty.
```

THUS:

```
<http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
        owl:sameAs <http://www.polleres.net/foaf.rdf#me>
```

SPARQL “recipes”: CONSTRUCTING new graphs

- “I know all people who are my coauthors according to DBLP”

```
CONSTRUCT
   { <http://www.polleres.net/foaf.rdf#me> foaf:knows ?CoAuthor}
WHERE
   { GRAPH <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
     ?D dc:creator
          <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>.
      ?D dc:creator ?CoAuthor.
   }
```

- … Ok, better, but… how do I integrate this in my FOAF file?

Not possible in current RDF/SPARQL: “Views” or “extended RDF Graphs”

- I would actually want to write in my FOAF file:

```
:me a foaf:Person.
:me foaf:name "Axel Polleres".
:me foaf:homepage <http://www.polleres.net>.
CONSTRUCT
   { <http://www.polleres.net/foaf.rdf#me> foaf:knows ?CoAuthor}
WHERE
   { GRAPH <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
     ?D dc:creator
          <http://www.polleres.net/foaf.rdf#me>.
      ?D dc:creator ?CoAuthor.
   }
:me foaf:knows <http://dblp.l3s.de/d2r/resource/authors/Robert_Tolksdorf>.
:me foaf:knows <http://dblp.l3s.de/d2r/resource/authors/Adrian_Paschke>.
```

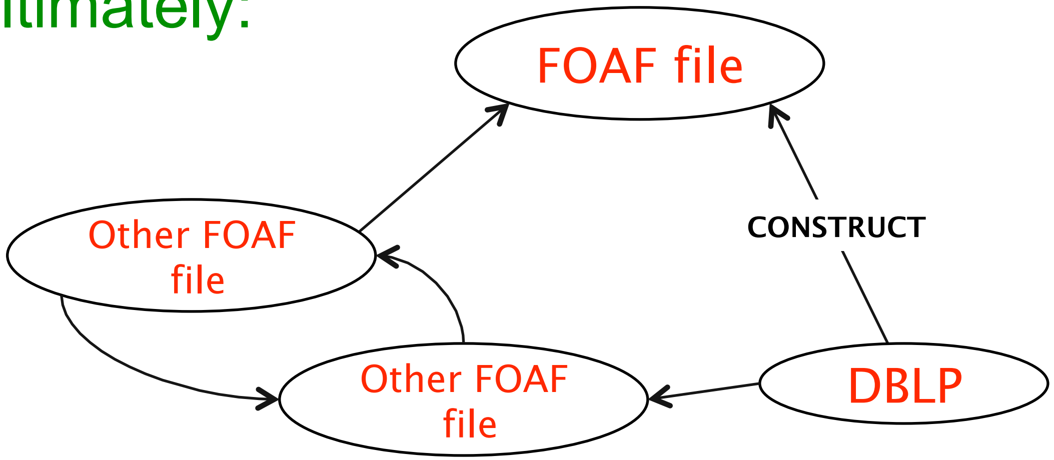
Arbitrary mix of SPARQL and RDF not (yet) standard, but

- □ **Proposals out there: [Schenk+Staab, 2008], [Polleres, et al. 2007]**
- □ **should become possible with Rules (RIF)!**

Credits to the hosts ✓

Open Linked data with extended RDF Graphs:

- Ultimately:



- Publish extended graphs “linked” via CONSTRUCTs

Semantic Web = RDF + CONSTRUCT

- Linked data on steroids!

What can/can't be done with SPARQL?

- Can:
  - FILTERs
  - UNION
  - traversing GRAPHs
  - OPTIONAL, set difference
  - CONSTRUCT new graphs from existing ones
- Can't:
  - Full support of RDFS+OWL
  - recursive "views", dynamic datasets
  - Aggregates, built-ins
  - Generate XML, HTML

RIF: The new kid on the block

COOL
Where's the standardization zoo?
Are they gonna play with me?

- RIF – The Rule Interchange Format

  http://www.w3.org/2005/rules/wg

  - □ W3C working group, established December 2005
  - □ like all W3C WGs: industrial and academic participants
  - □ not only rules for RDF, but also production rules, business rules, policies, etc.
  - □ recent “last call working drafts”, 30 July 2008:
    - RIF Basic Logic Dialect (BLD) [Kifer, Boley (eds.), 2008]
    - RIF RDF and OWL Compatibility [de Bruijn (ed.), 2008]
  - □ We only use RIF's presentation syntax here, more details on RIF, cf. [Boley et al., 2007] as well as the latest RIF drafts.

What can RIF do for you?

- Import RDF similar to “Extended Graphs”
- Custom rules on top of RDF,
  e.g. RDFS and OWL entailment rules
- More flexible use of built-ins supported than in SPARQL,
  e.g. for ontology mappings

Import RDF: “Extended Graphs” use case in RIF

```
:me a foaf:Person.
:me foaf:name "Axel Polleres".
:me foaf:homepage <http://www.polleres.net>.
CONSTRUCT
   { <http://www.polleres.net/foaf.rdf#me> foaf:knows ?CoAuthor}
WHERE
   { GRAPH <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres>
     ?D dc:creator
          <http://www.polleres.net/foaf.rdf#me>.
      ?D dc:creator ?CoAuthor.
   }
:me foaf:knows <http://dblp.l3s.de/d2r/resource/authors/Robert_Tolksdorf>.
:me foaf:knows <http://dblp.l3s.de/d2r/resource/authors/Adrian_Paschke>.
```

Import RDF: “Extended Graphs” use case in RIF

```
Import( <http://dblp.l3s.de/d2r/resource/authors/Axel_Polleres> )

:me#foaf:Person.
:me [ foaf:name ->"Axel Polleres"] .
:me [ foaf:homepage -> <http://www.polleres.net/> ] .

Forall ?D ?CoAuthor (
<http://www.polleres.net/foaf.rdf#me> [foaf:knows -> ?CoAuthor]  :-
    And (
     ?D [ dc:creator -> <http://www.polleres.net/foaf.rdf#me> ]
     ?D [ dc:creator -> ?CoAuthor ] )
)

:me [ foaf:knows -> <http://dblp.l3s.de/d2r/resource/authors/Robert_Tolksdorf> ] .
:me [ foaf:knows -> <http://dblp.l3s.de/d2r/resource/authors/Adrian_Paschke> ] .
```

- Rules Syntax inspired by F-Logic, RDF Triples displayed as FRAMES
- Note: RIF is not meant as an alternative RDF syntax!

RDFS+OWL entailment rules in RIF

- E.g. inverseFunctionalProperty:

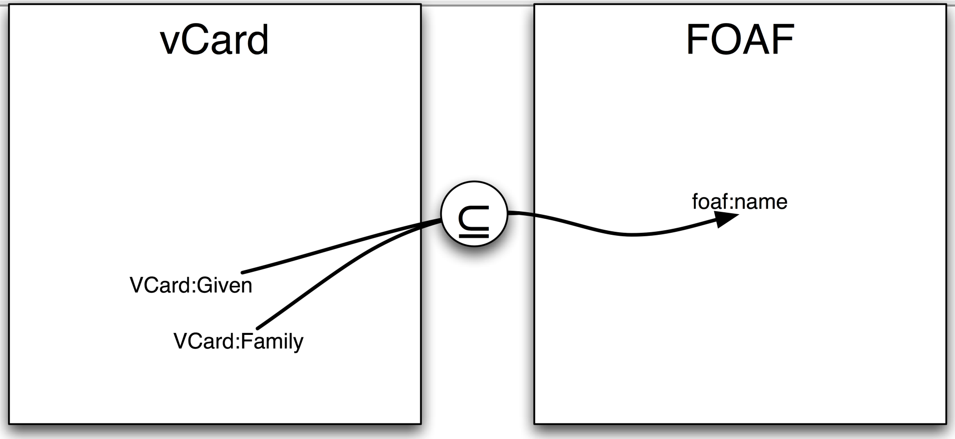
```
Forall ?S1 ?S2 ?P ?O (
?S1 [ owl:SameAs -> ?S2] :-
   And (  ?S1 [ ?P -> ?O]
          ?S2 [ ?P -> ?O]
          ?P [ rdf:type owl:InverseFunctionalProperty ] ) )

Forall ?X ?Y ?P ?O (
?Y [ ?P -> ?O ]  :-   And ( ?X [ owl:SameAs -> ?Y]   ?X [ ?P -> ?O]   ) )

Forall ?X ?Y ?S ?O (
?S [ ?Y -> ?O]  :-    And ( ?X [ owl:SameAs -> ?Y]   ?S [ ?X -> ?O]   ) )

Forall ?X ?Y ?S ?P (
?S [ ?P -> ?Y]  :-    And ( ?X [ owl:SameAs -> ?Y]   ?S [ ?P -> ?X]   ) )
```

Ontology mapping



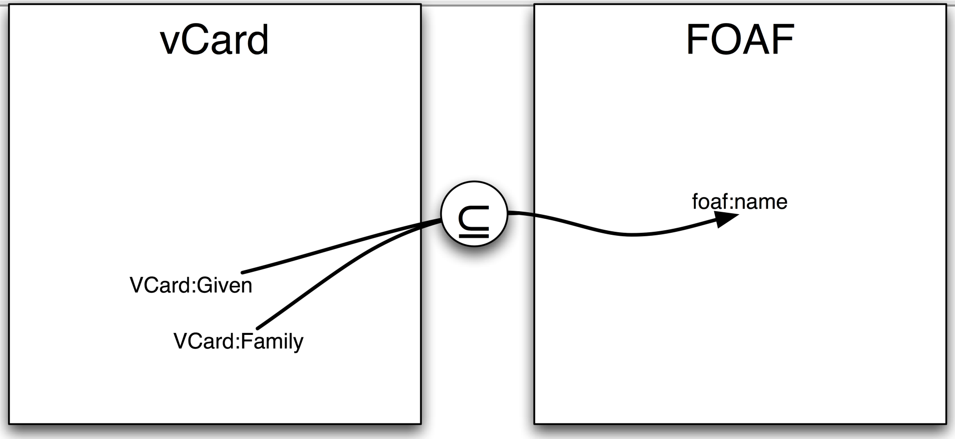
- Mapping names from vCard to FOAF, needs concatenation…
- not expressible in SPARQL…

```
CONSTRUCT{?X foaf:name ?FN}
WHERE {?X VCard:Given ?N. ?X VCard:Family ?F.
       FILTER(?FN = fn:concat(?N," ",?F))   }
```

Doesn't work…

- □ FILTERs only bind variables,can't create newbindings
- □ Not all XPath/Xquery functions available.

Ontology mapping



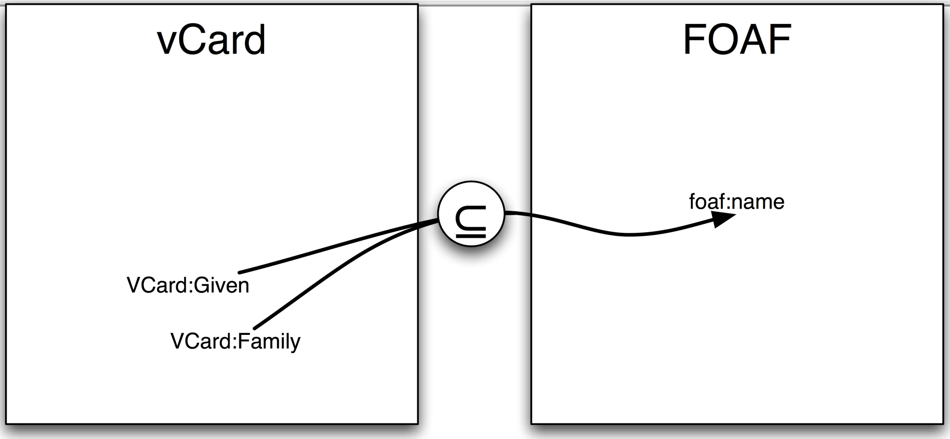
- Mapping names from vCard to FOAF, needs concatenation…
- not expressible in SPARQL…

```
CONSTRUCT{?X foaf:name fn:concat(?N," ",?F) }
WHERE {?X VCard:Given ?N. ?X VCard:Family ?F.
      }
```

Some non-standard extensions of SPARQL support that…

- □ E..g. XSPARQL, see later on.

Ontology mapping



- Mapping names from vCard to FOAF, needs concatenation…
- No problem in RIF:

```
FORALL ?X ?F ?N (
   ?X [ foaf:name -> External( func:concat( ?N " " ?F) ) :-
         And ( ?X [ VCard:Given -> ?N]  ?X [ VCard:Family -> ?F] )
 )
```

Externally defined functions, e.g. Xpath/Xquery built-ins, are allowed!

How do rules (RIF) and SPARQL interplay?

- SPARQL is translateable to Rules! [Polleres, 2007]

  + custom RIF Rules

  + OWL/RDFS entailment Rules in RIF

= Semantic Web toolbox implementable in standard Rules engines!

STARTING POINTS for Advanced SW TOOLS:

- DLVHEX: SPARQL+Rules engine
- Semantic Web Pipes
- XSPARQL

Prototype SPARQL++ engine available:

- dlvhex-semweb: http://sourceforge.net/projects/dlvhex-semweb/
- Based on dlvhex Logic Programming engine, translates SPARQL to Rules in a fully spec compliant way

dlvhex SPARQL

- Supports:
  - □ Extended Graphs
  - □ Adds Built-ins, aggregates to SPARQL
  - □ Persistent storage (database backend)
  - □ RIF support being worked on
- Easy integration with other languages, flexible plugin-system:
  - □ Web service, various output formats, …
- Joint work with TU Vienna, Univ. Calabria

Translating SPARQL to Rules in dlvhex:

Example: “Author names and optionally their Homepages.”

```
SELECT ?Name ?Homepage WHERE
FROM <http://dblp.l3s.de/d2r/data/publications/journals/tplp/Berners-LeeCKSH08>
{ <http://dblp.l3s.de/d2r/resource/publications/journals/tplp/Berners-LeeCKSH08>
        dc:creator ?Author.
        ?Author foaf:name ?Name.
    OPTIONAL {?Author foaf:homepage ?Homepage}
  }
```

Translating SPARQL to Rules in dlvhex:

Example: “Author names and optionally their Homepages.

```
#namespace("foaf","http://xmlns.com/foaf/0.1/")
#namespace("dc","http://purl.org/dc/elements/1.1/")
#namespace("swrc","http://swrc.ontoware.org/ontology#")
answerVars("","Homepage","Name").
"triple"(S,P,O,default) :- &rdf["file:xyz.ttl"](S,P,O).
answer_1(X_Author,default) :-
           "triple"("<http://dblp.l3s.de/d2r/resource/publications/journals/tplp/Berners-LeeCKSH08>",
                    "dc:creator",X_Author,default).
answer_2(X_Author,X_Name,default) :- "triple"(X_Author,"foaf:name",X_Name,default).
answer_3(X_Author,X_Homepage,default) :- "triple"(X_Author,"foaf:homepage",X_Homepage,default).
answer_bjoin_1(X_Author,0,X_Name,default) :-
      answer_1(X_Author,default),answer_2(X_Author,X_Name,default),
      not answer_3_prime(X_Author,X_Name,default).
answer_3_prime(X_Author,X_Name,default) :-
      answer_1(X_Author,default),answer_2(X_Author,X_Name,default),answer_3(X_Author,X_Homepage,default).
answer_bjoin_1(X_Author,X_Homepage,X_Name,default) :-
      answer_1(X_Author,default),answer_2(X_Author,X_Name,default),answer_3(X_Author,X_Homepage,default).
answer(X_Author,X_Homepage,X_Name) :- answer_bjoin_1(X_Author,X_Homepage,X_Name,default).
```

Don’t read the code, important issues are:

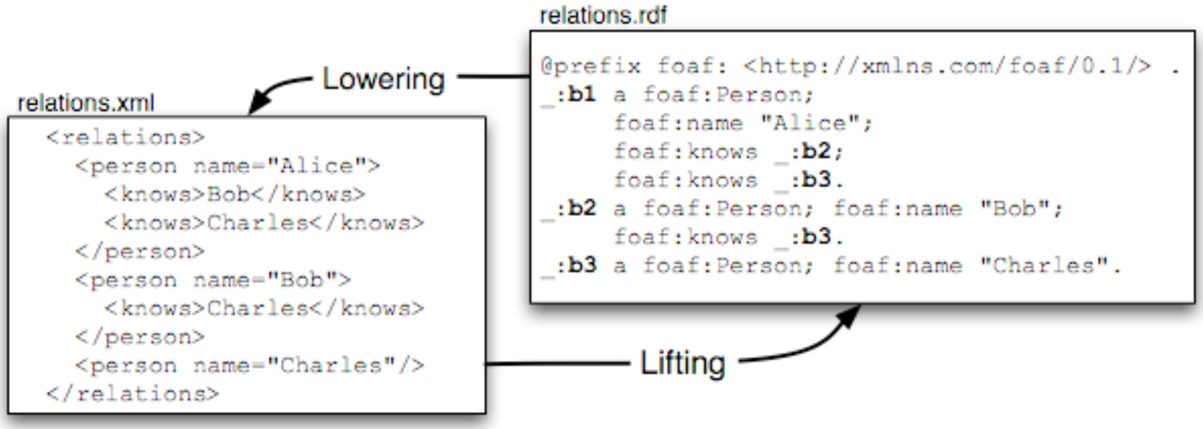
- Each subpattern of the query yields a PROLOG-like rule
- Some trickery necessary to “emulate” SPARQL semantics: multisets, OPTIONALS, UNIONs
- E.g. use of negation as failure (not) for expressing OPTIONAL

- You are welcome to try/extend/help:

http://sourceforge.net/projects/dlvhex-semweb/

dlvhex
SPARQL

XSPARQL: Linking XQuery and SPARQL



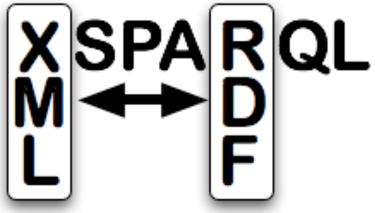
```
<relations>
  <person name="Alice">
    <knows>Bob</knows>
    <knows>Charles</knows>
  </person>
  <person name="Bob">
    <knows>Charles</knows>
  </person>
  <person name="Charles"/>
</relations>
```

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
_:b1 a foaf:Person;
     foaf:name "Alice";
     foaf:knows _:b2;
     foaf:knows _:b3.
_:b2 a foaf:Person; foaf:name "Bob";
     foaf:knows _:b3.
_:b3 a foaf:Person; foaf:name "Charles".
```

- Transformations between XML/HTML and RDF cumbersome: Until recently, XSL the only standard means

- *Combining* SPARQL and XQuery (standardized beginning of 2007) offer new possiblities

- Their combination: http://xsparql.deri.org



- Joint work with Thomas Krennwallner, Waseem Akhtar, Jacek Kopecky, Nuno Lopes

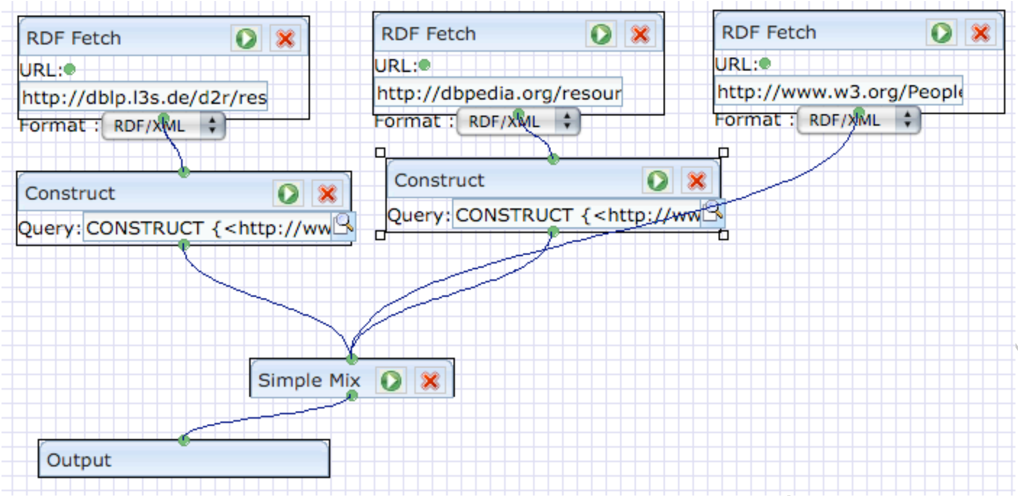
Live data processing with Semantic Web Pipes

- Live, reusable, composable transformation of Semantic Web Sources
- Piping: connecting processing components
- Web Piping: connecting components using web technologies
  - □ Data has URLs
  - □ Components have URLs
- Data mashups, reuse of components
- http://pipes.deri.org/

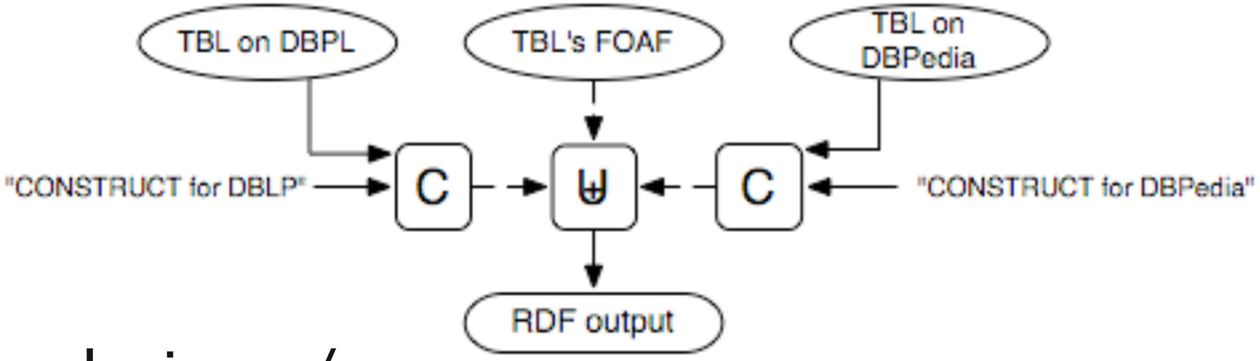
- Joint work with Danh Le Phuoc, Giovanni Tummarello, Christian Morbidoni.

Semantic Web Pipes

- Allow users to build mashups from a set of base operators
- Can be stored and republished under a persistent URI and executed dynamically

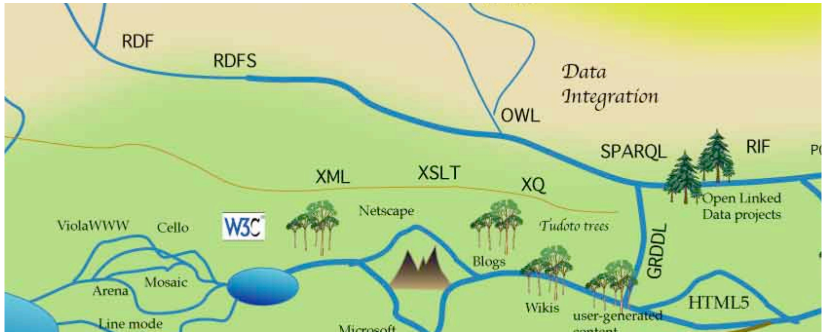


Example:



http://pipes.deri.org/

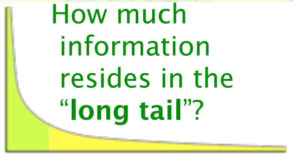
Challenges/What's missing? The small picture:

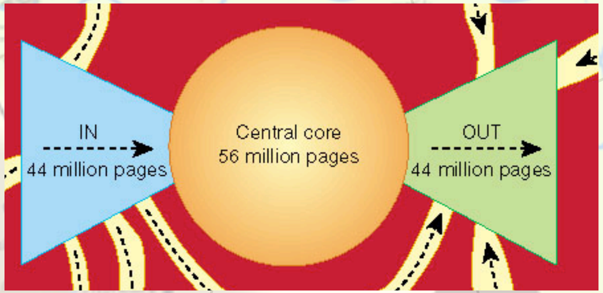


- Theoretical challenges:
  - □ Aggregates in SPARQL: What do they mean?
  - □ SPARQL + OWL, RIF+ OWL: What does it mean?
- Technical challenges:
  - □ semantic data endpoint description
  - □ Scalability, Query distribution (e.g. DARQ good starting point)
  - □ Good tools, easy enough to use for your grandparents
- Integration with other paradigms:
  - □ RDB2RDF (D2R good starting point), RDF2XML (XSPARQL good starting point)

Challenges/What’s missing? The BIG picture:

- Our use case: Finding Experts/reviewers:
  - □ **What are the right metrics for expertise?**
  - □ **Trust? Change?**
- Needs:
  - □ **Temporal, Provenance, Policy extensions to SPARQL, RDF, OWL**
  - □ **Dealing with contradictions, uncertainty, incompleteness**
  - □ **Understanding the Web’s structure**
  - □ **Understanding social networks**
  - □ **Understanding the Web’s economics**


How much information resides in the “**long tail**”?



vs. € ?

A lot of challenges waiting ahead!

Can you take them?

- Thanks to:
  - □ Renaud Delbru, Andreas Harth, Aidan Hogan, Thomas Krennwallner, Nuno Lopes, Alessandra Martello, Danh Le Phuoc, Giovanni Tummarello, Roman Schindlauer, etc., members of the RIF working group, members of the SPARQL working group (esp. Andy Seaborne, Eric Prud'hommeaux, Lee Feigenbaum), etc.