

# Simple Knowledge Organization System (SKOS) and Linked Data

**Thomas Baker**

Co-chair, W3C Semantic Web Deployment Working Group  
Kompetenzzentrum Interoperable Metadaten (KIM), Germany

Semantic Days 2009  
Stavanger, 19 May 2009

# State of Semantic Web technologies

- Stable standards since 2004 for RDF and OWL
- Standard query language (SPARQL) since 2008
- Well-established RDF vocabularies
  - Dublin Core for describing resources
  - FOAF for describing people
- Deployed domain ontologies
  - At this conference: POSC Caesar's OWL representation of ISO 15926
- New developments
  - OWL 2, Rule Interchange Format...
- Research problems
  - Security, trust. Provenance.
  - Ontology development, versioning, alignment.
  - Fuzzy logic. Probabilistic statements.

# This talk: “When less is more”

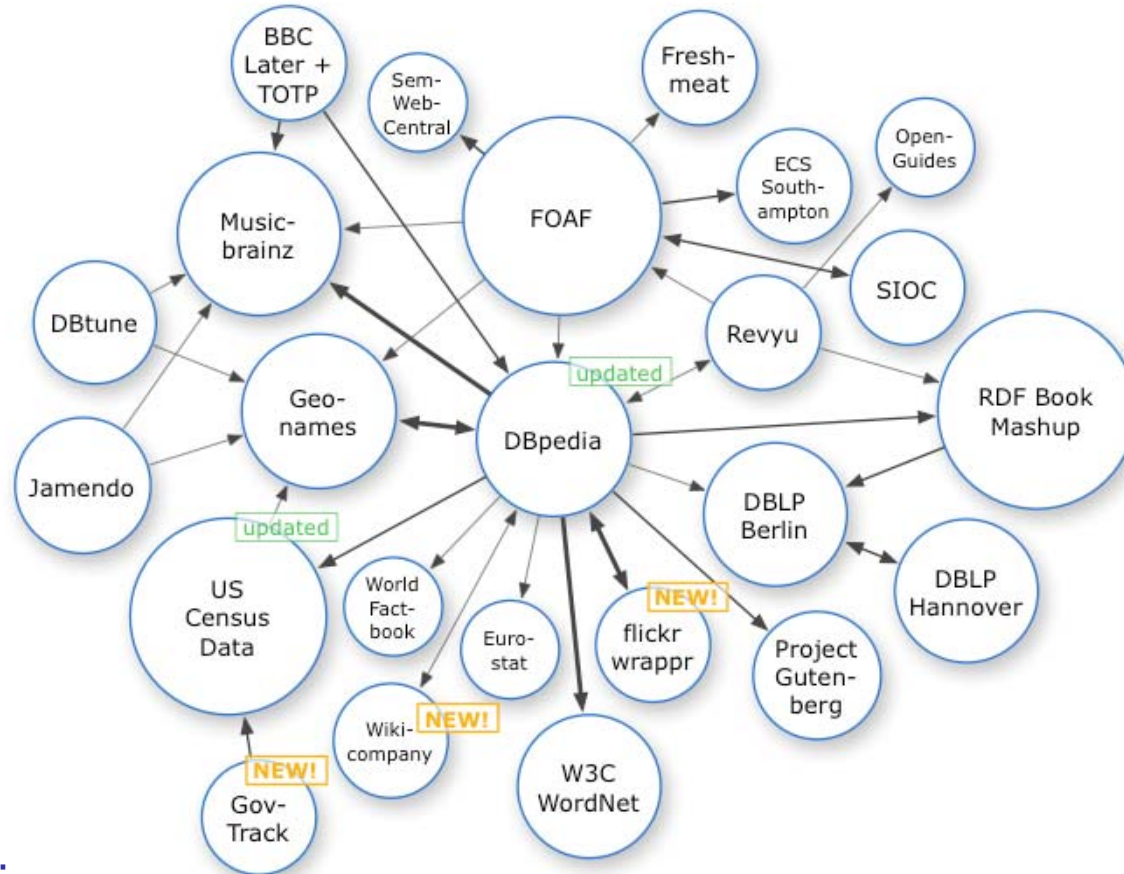
- **Back to basics**
  - URIs provide global identity independently of application context
  - “Network effect” when vocabularies, ontologies, data shared on the Web
  - Using Web infrastructure to assign names (URIs) to... anything
  - Relationships between things asserted and interpreted globally
- **Semantic Web language (RDF)**
  - Language for Web data. URIs are its words.
  - Precision and comprehensiveness cost money.
  - This talk: simple approaches leveraging URIs and RDF
  - Using URIs and RDF to express simple connections
- **Semantic Web Deployment Working Group**
  - RDFa: method for embedding RDF in normal Web pages
  - SKOS: method for describing 'semi-formal' knowledge systems on Web

# Open Linked Data

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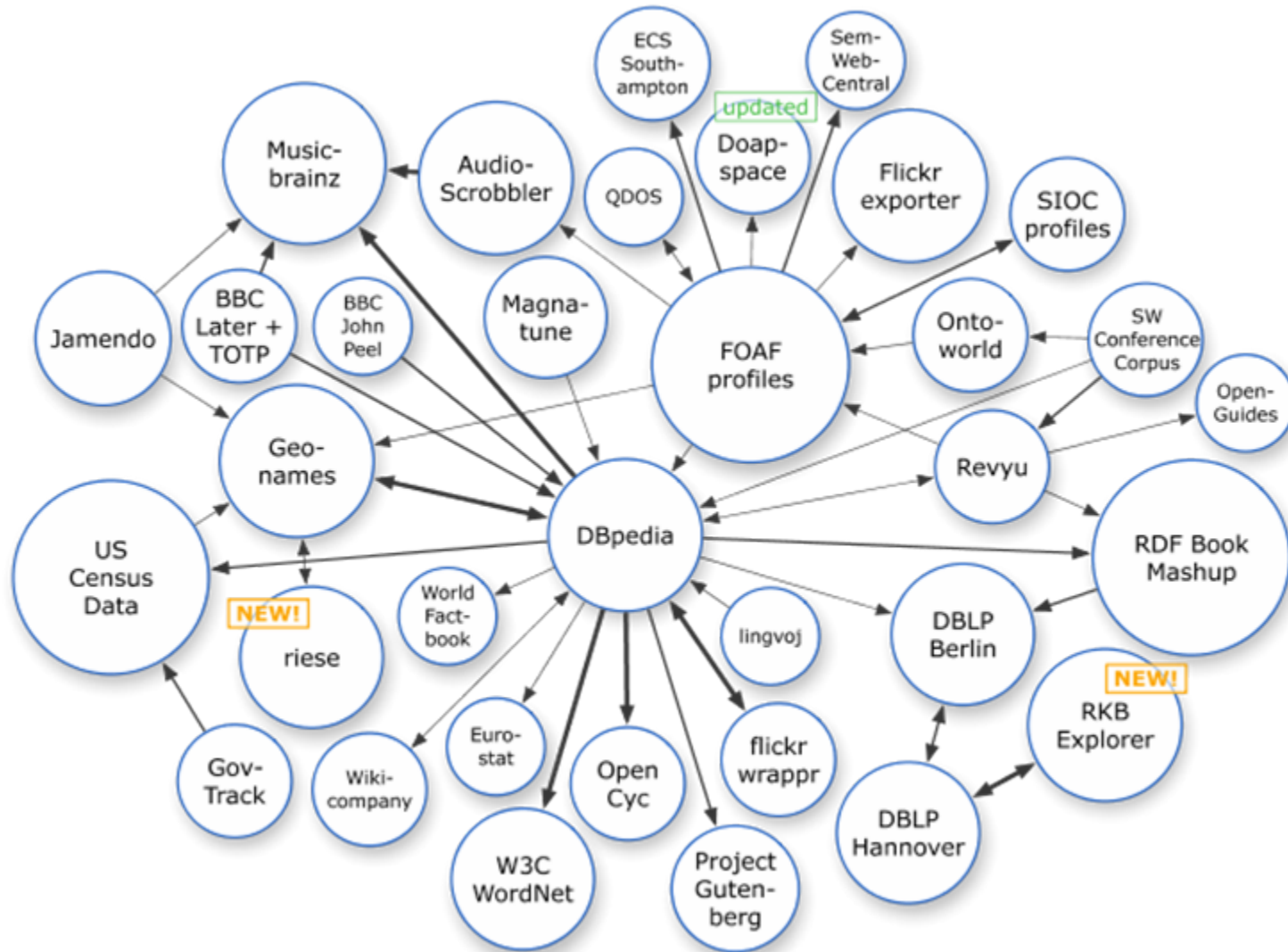
- Value of information as function of what it links to (Tim Berners-Lee)
- Four rules for maximizing “unplanned re-use”
  - 1. Identify things with URIs.
  - 2. Use HTTP URIs.
  - 3. Serve information on the Web against the URIs.
  - 4. Link related material.
- “Give your raw data” (Tim Berners-Lee)
  - [http://www.ted.com/index.php/talks/tim\\_berners\\_lee\\_on\\_the\\_next\\_web.html](http://www.ted.com/index.php/talks/tim_berners_lee_on_the_next_web.html)
- Technologies for doing this:
  - mapping from databases, GRDDL, RDFa, SKOS

# Linked Data Cloud, 2007

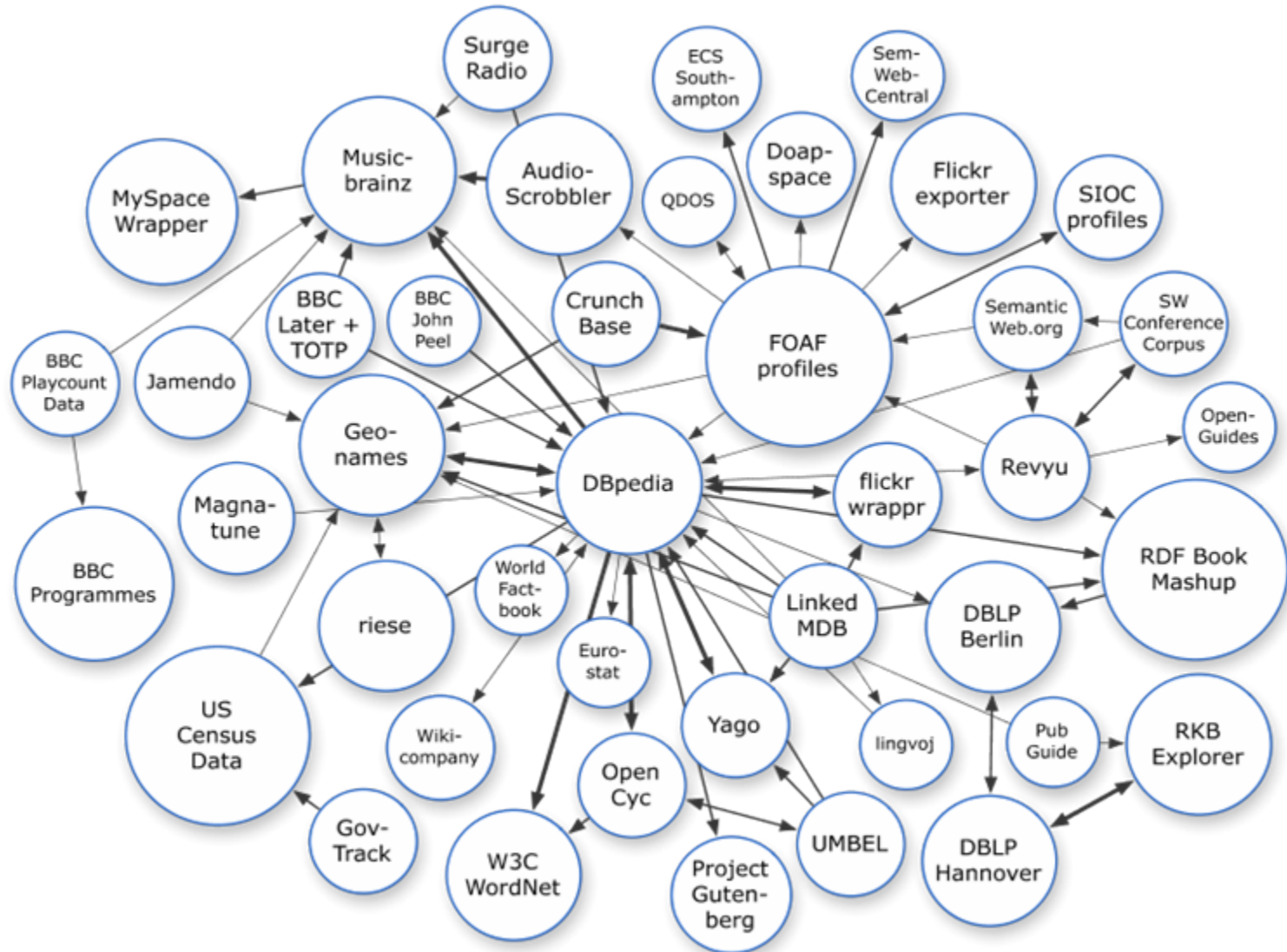


<http://dbpedia.org>

# Linked Data Cloud, March 2008

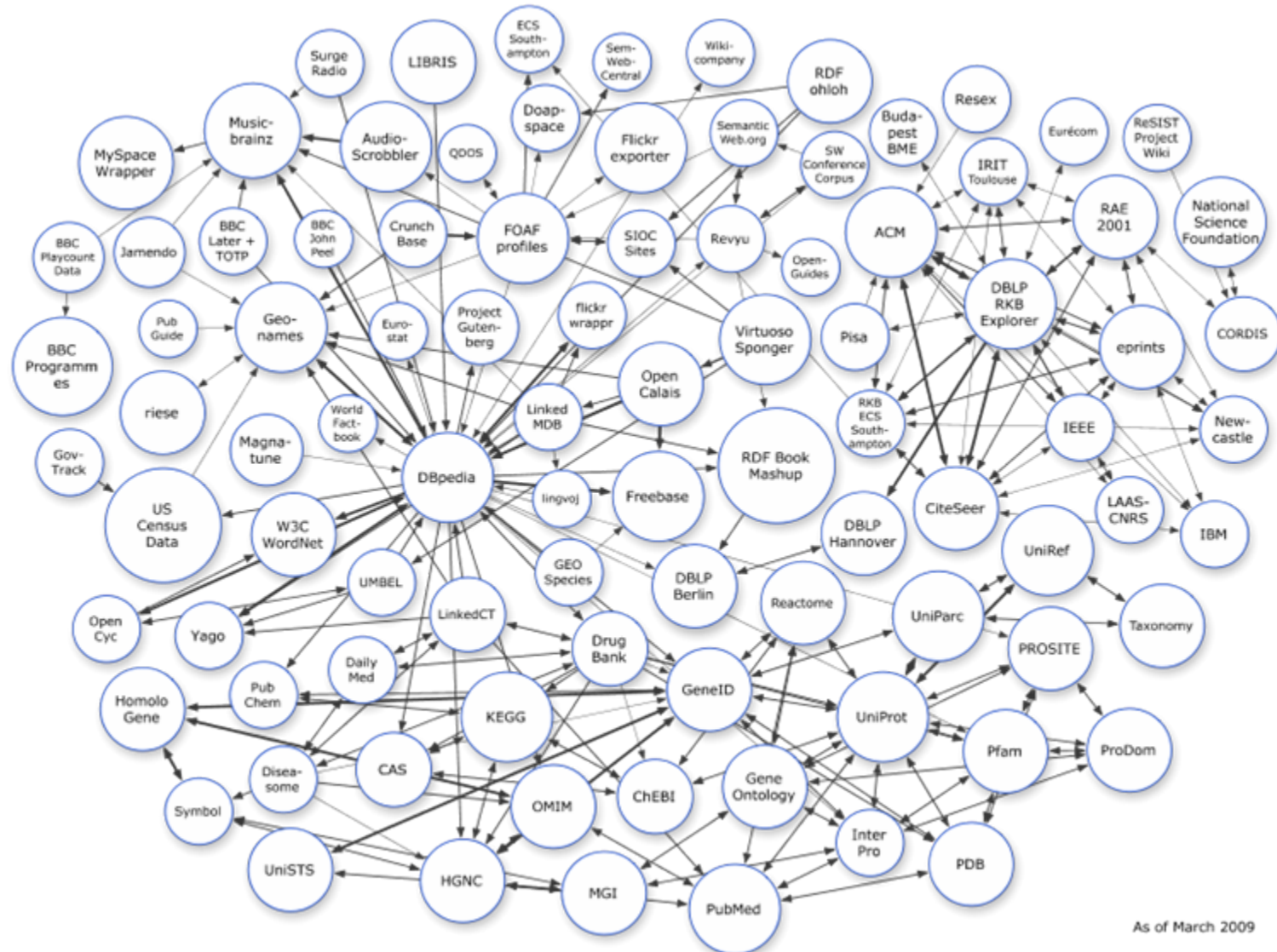


# Linked Data Cloud, September 2008



As of September 2008

# Linked Data Cloud, March 2009



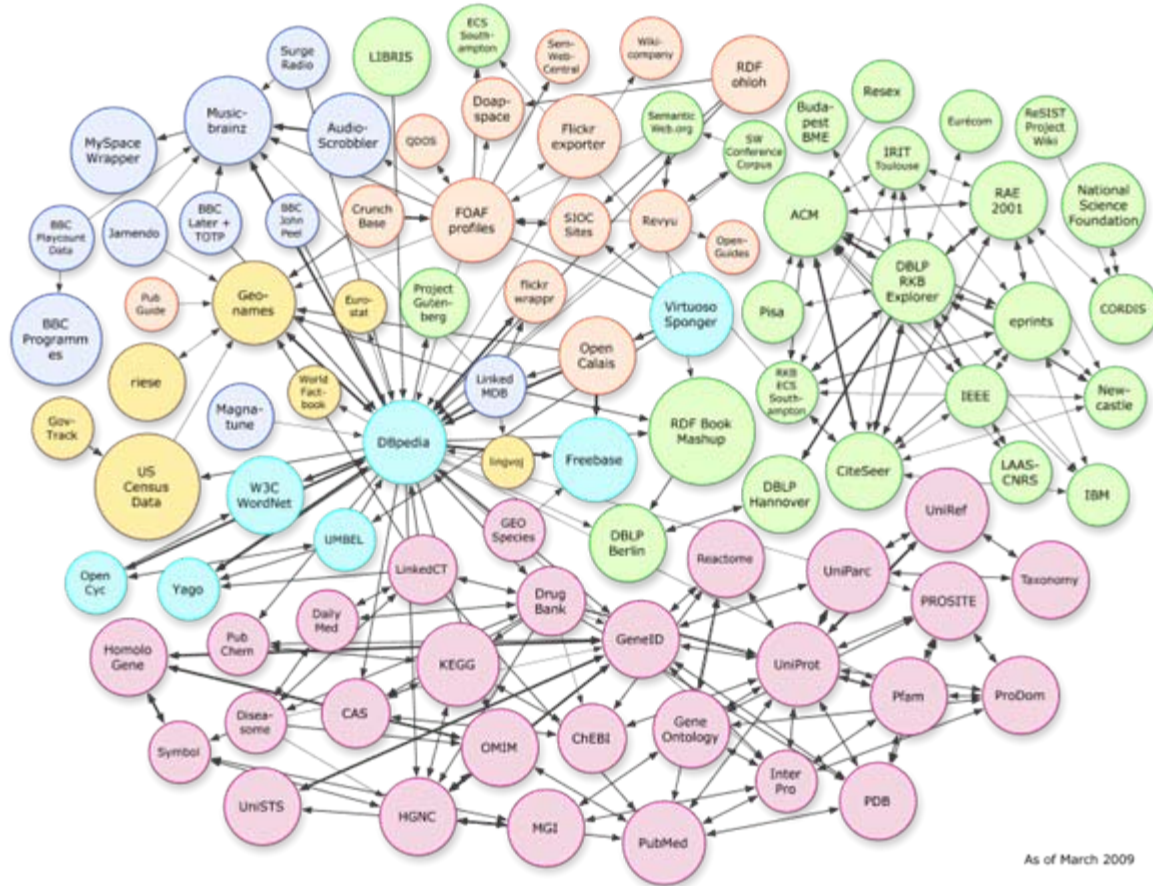
As of March 2009



# Application-specific parts of the cloud

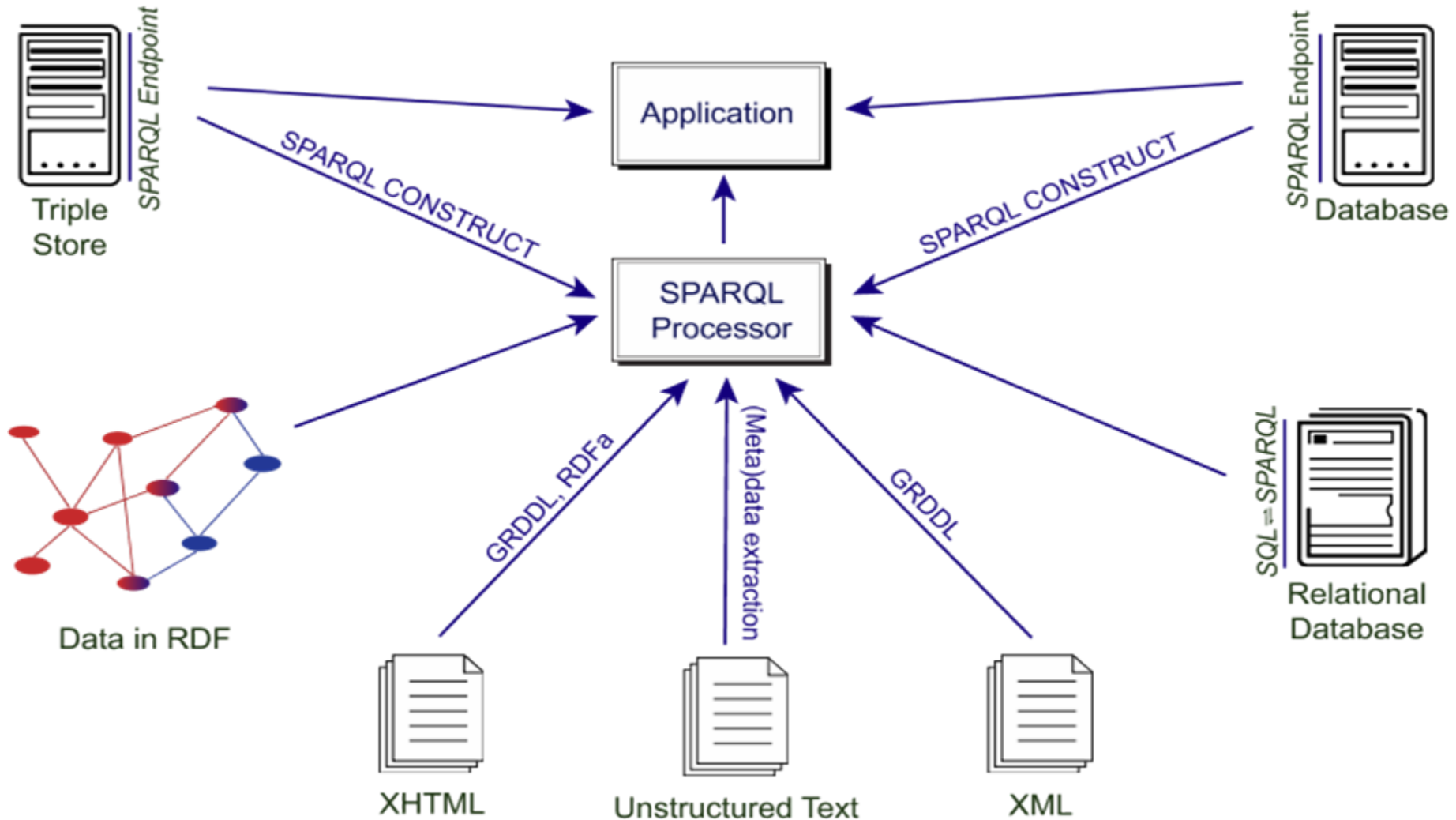
## “Bio”-related datasets

thanks in part to “Linking Open Drug Data” task force of the HCLS at W3C

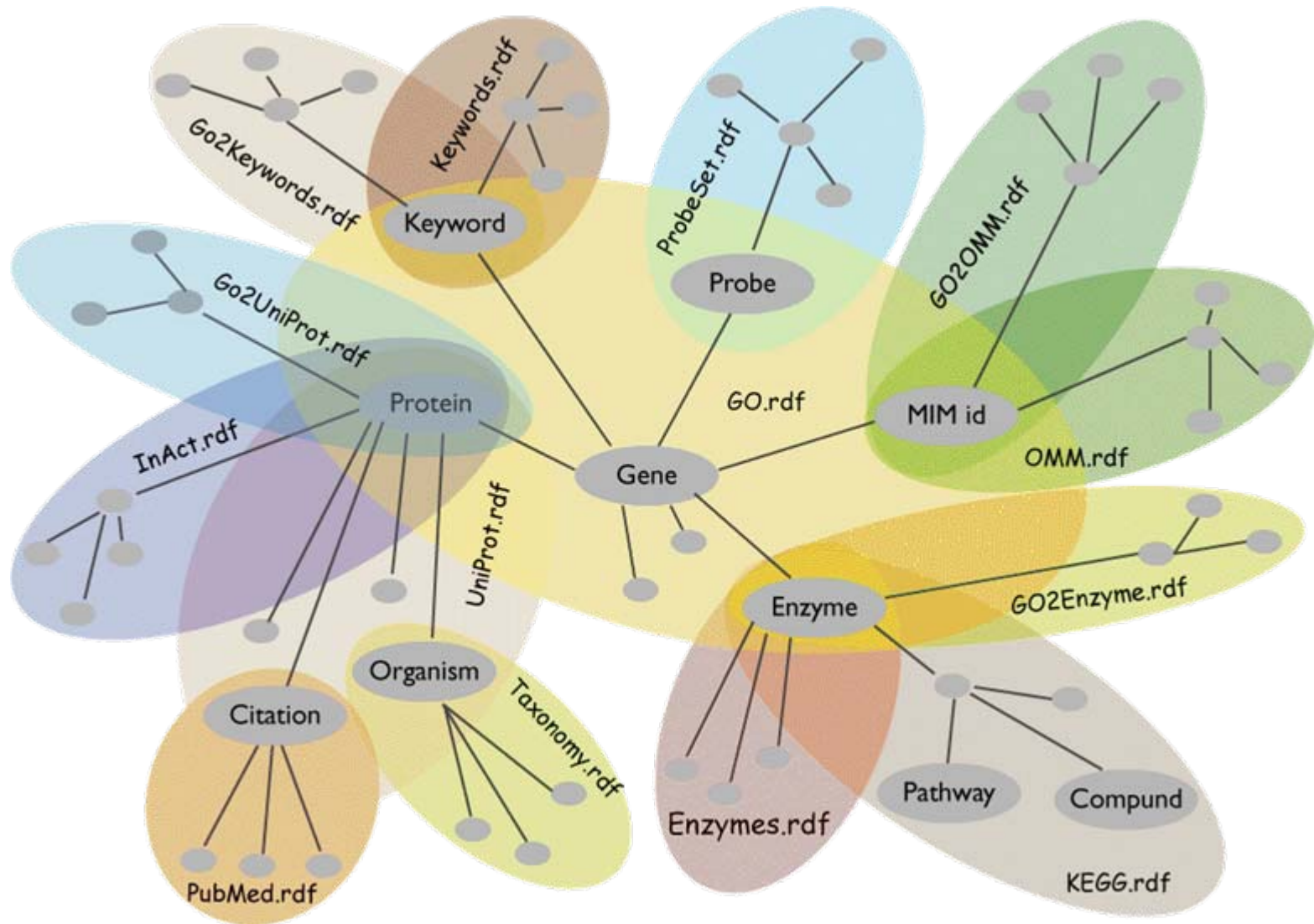


# Merged data queried through “endpoints”

Queries are expressed as RDF triples with unknown variables.



# Finding things related to “genes” across databases



# http://openflydata.org

FlyWeb Research Tools :: Search FlyTED and BDGP Images By Gene - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites

Address http://localhost/flyweb-apps-A/clients/sisterofmashupUI/ Go

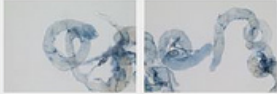
FlyWeb Research Tools

### Search FlyTED and BDGP Images By Gene

Enter a gene name, e.g. "CG10151".

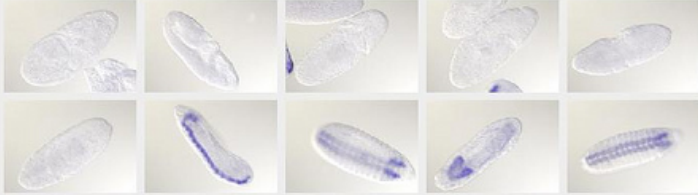
#### Image results from FlyTED ([www.fly-ted.org](http://www.fly-ted.org))

Found 2 results for gene "CG10151".



#### Image results from BDGP ([www.fruitfly.org](http://www.fruitfly.org))

Found 10 results for gene "CG10151".



Logger Console

# Getting data into triples

- Not realistic to create lots of RDF data by hand!
  - Generate automatically when possible, “fill in” by hand when necessary
- Huge amount of data stored in (relational) databases
  - “RDFying” databases is impractical
  - “Bridges” map RDB tables to RDF graphs, possibly on the fly
- GRDDL
  - Gleaning Resource Descriptions from Dialects of Languages
  - Extracting structured data from XML and XHTML, converting into RDF
  - Can be used to extract RDF triples from Microformats
- RDFa (“RDF-in-attributes”)
  - Embeds RDF data into Web pages
  - Processable by generic RDF tools – no need to implement a separate transformation for each vocabulary

# GRDDL transformation scripts...

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+1-617-395-0241 DanC \*

hCard

standards: HTML WG, TAG, GRDDL WG, RDF Calendar, QA, DAWG/SPARQL, Semantic Web IG, OWL, HTML 2, ESW  
research: *breadcrumbs* journal/weblog, cwm, N3, tabulator, PAW, TAMI, microformats open source  
life: family, volleyball, guitar

Dan Connolly is a research scientist at the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL) in the Decentralized Information Group (DIG) and a member of the technical staff of the World Wide Web Consortium (W3C). His research interest is investigating the value of formal descriptions of complex systems like the Web, especially in the consensus-building process.

hCalendar Events

- Nov 5-10: to **Cambridge, MA** for W3C Technical Plenary Meetings
  - TPAC 2007 - URI-Based Extensibility: Benefits, Deviations, Lessons-Learned
  - TPAC 2007 - HTML Working Group had informal jamming session/by Mauro
  - Technology that inspires... for Midwest Web Sense trip stuff including itinerary
- Dec 12 - 13: to **San Jose, CA** for the W3C Video on the Web Workshop
- Feb 10-Feb 14: to **New York, NY** for Tools of Change (TOC)
  - Free Culture: Why buy the Amazon Kindle when you can give and get an OLPC XO-1 for the same price?

## ... behind the scenes ...

```
1 <!DOCTYPE html><!--*- nxml -*-->
2 <html xmlns="http://www.w3.org/1999/xhtml">
3   <head profile="http://www.w3.org/2002/12/cal/cardcaletc
4     http://purl.org/NET/erdf/profile">
5     <title>Dan Connolly, W3C</title>
6     <link rel="transformation"
7       href="http://www.w3.org/2002/12/cal/glean-hcal.xsl"/>
8     <link rel="schema.owl" href="http://www.w3.org/2002/07/owl#" />
9     <link rel="schema.dc" href="http://purl.org/dc/elements/1.1/" />
10    <link rel="schema.dcq" href="http://purl.org/dc/terms/" />
11    <link rel="schema.foaf" href="http://xmlns.com/foaf/0.1/" />
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110   <li class="vevent" id="_6768">
111     <abbr class="dtstart" title="2008-02-10">Feb 10</abbr>--<abbr
112       class="dtend" title="2008-02-14">Feb 14</abbr>: to <b
113       class="location">New York, NY</b><br/> for <a class="summary"
114       href="http://en.oreilly.com/toc2008/public/content/home">Tools of
115       Change (TOC)</a>
116     <ul>
117     </ul>
118   </li><cite><a
```

## ...yielding, through the GRDDL transform

```
<http://www.w3.org/People/Connolly/#_6768>
  a <http://www.w3.org/2002/12/cal/icaltzd#Vevent>;
  <http://www.w3.org/2002/12/cal/icaltzd#organizer>
    <http://www.w3.org/People/Connolly/#me>;
  <http://www.w3.org/2002/12/cal/icaltzd#summary>
    "Tools of Change (TOC)";
  <http://www.w3.org/2002/12/cal/icaltzd#dtstart>
    "2008-02-10"^^<http://www.w3.org/2001/XMLSchema#date>;
  <http://www.w3.org/2002/12/cal/icaltzd#dtend>
    "2008-02-14"^^<http://www.w3.org/2001/XMLSchema#date>;
  <http://www.w3.org/2002/12/cal/icaltzd#url>
    <http://www.w3.org/People/Connolly/#_6768>;
  <http://www.w3.org/2002/12/cal/icaltzd#location>
    "New York, NY" .
```



# RDFa (RDF attributes) embedded in Web pages

Ivan Herman - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.w3.org/People/Ivan/

World Clock Netvibes Twines Search Mobical Validate! RDFa it! Semantic Web W3C Mailing lists Bookmarklets

W3C

## Ivan Herman

[My Work at W3C](#) | [Contact information](#) | [Short CV](#) | [Upcoming trips](#) | [Public presentations](#)

### My Work at W3C

Semantic Web Activity Lead; that is my main work at W3C. I am a member of the W3C (International World Wide Web Conference Committee, the committee coordinating the yearly WWW conference series), serving as a liaison for W3C, and of SWSA (Semantic Web Science Association), the committee responsible for the International Semantic Web Conferences series.

As part of my work, I also participate in lots of outreach activities, and I regularly make presentations, tutorials, etc. You can consult my [list of presentations](#) for further details.

### Contact information

Email: [ivan@w3.org](mailto:ivan@w3.org)  
(sha1sum: 5ac8032d5f6012aa1775ea2f63e1676bafd5e80b)

Postal address:

Done

Z RDFa PIP ivanherman

# ... behind the scenes ...

The screenshot shows a code editor window titled "jEdit - ( Session: default ) C:\Documents and Settings\Ivan Herman\My Documents\W3C\WWW\People\Ivan\Overview.php". The code is as follows:

```
46 <h2><a id="Meh2">My Work at W3C</a></h2>
47
48 <p>I am <a rel="foaf:currentProject"
49 href="http://www.w3.org/2001/sw">Semantic Web</a> Activity
50 Lead;
51 that is my main work at <a rel="foaf:workInfoHomepage"
52 href="http://www.w3.org">W3C</a>.
53 I am member of <a rel="foaf:workInfoHomepage"
54 href="http://www.iw3c2.org">
55 <abbr title="International World Wide Web Conference
56 Committee">IW3C2</abbr>
57 </p>
58 <p><a href="http://www.w3.org/2001/sw">Semantic Web</a>
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136 <p><a href="http://www.w3.org/2001/sw">Semantic Web</a>
137 </p>
138 <p><a href="http://www.w3.org/2001/sw">Semantic Web</a>
139 </p>
140 <p>Leiden</a>, in the Netherlands.
141 I joined the <a rel="foaf:workInfoHomepage"
142 href="http://www.w3.org">W3C</a> Team as Head of
143 <a rel="foaf:pastProject"
144 href="http://www.w3.org/Consortium/Offices"><span
145 property="dc:title">W3C Offices</span></a>
146 in January 2001 while maintaining my position at <abbr
147 title="Centrum voor Wiskunde en Informatica"
148 xml:lang="nl">CWI</abbr>.
```

The code editor also shows a "Project Viewer" on the right side and a "Diff" window at the bottom. The status bar at the bottom indicates "122,102-119 12%" and "(php,none,UTF-8)S - - - U 50/83M".

# ...yielding, by extracting RDF from XHTML

```
<Overview.html#me> a foaf:Person;  
  foaf:currentProject <http://www.w3.org/2001/sw>;  
  foaf:workInfoHomepage  
    <http://www.iw3c2.org>,  
    <http://www.w3.org>;  
  foaf:pastProject  
    <http://www.w3.org/Consortium/Offices>;  
  ...  
  
<http://www.w3.org/Consortium/Offices> dc:title "W3C Offices".
```

# Extracted data can be SPARQL-ed

```
SELECT DISTINCT ?name ?home ?orgRole ?orgName ?orgHome
# Get RDFa from my home page:
FROM <http://www.w3.org/People/Ivan/>
# GRDDL-ing http://www.w3.org/Member/Mail:
FROM <http://www.w3.org/Member/Mail/>
WHERE {
?foafPerson    foaf:mbox ?mail;
                foaf:homepage ?home.
?individual    contact:mailbox ?mail;
                contact:fullName ?name.
?orgUnit ?orgRole ?individual;
                org:name ?orgName;
                contact:homePage ?orgHome.
}
```

# Commercial applications

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[The Slanted Door - Embarcadero - San Francisco, CA](#)  

★★★★☆ 1438 reviews - Price range: \$\$\$

1438 Reviews of The **Slanted Door** "**Slanted Door** is a nice restaurant. It has a wonderful view of the bridge and bay just outside it's back doors.

[www.yelp.com/biz/the-slanted-door-san-francisco](http://www.yelp.com/biz/the-slanted-door-san-francisco) - 189k - [Cached](#) - [Similar pages](#) - 

- Yahoo SearchMonkey and Google Rich Snippets
  - Harvest RDFa and microformat metadata from Web pages
  - Customized “enhanced display” of search results

# Extract data from Wikipedia infoboxes...



## navigation

- [Main page](#)
- [Contents](#)
- [Featured content](#)
- [Current events](#)
- [Random article](#)

## search

## interaction

- [About Wikipedia](#)
- [Community portal](#)
- [Recent changes](#)
- [Contact Wikipedia](#)
- [Donate to Wikipedia](#)
- [Help](#)

## toolbox

- [What links here](#)
- [Related changes](#)
- [Upload file](#)
- [Special pages](#)
- [Printable version](#)
- [Permanent link](#)
- [Cite this page](#)

## languages

- [Afrikaans](#)
- [Alemannisch](#)
- [Anglo-Saxon](#)
- [العربية](#)
- [Aragonés](#)

## Charles Darwin

From Wikipedia, the free encyclopedia

(Redirected from [Charles darwin](#))

*For other people of the same surname, and places and things named after Darwin, see [Darwin](#).*

**Charles Robert Darwin** (February 12, 1809 – April 19, 1882) was an [English naturalist](#),<sup>[1]</sup> who realised and demonstrated that all [species](#) of life have [evolved](#) over time from [common ancestors](#) through the process he called [natural selection](#).<sup>[1]</sup> The [fact that evolution occurs](#) became accepted by the [scientific community](#) and the general public in his lifetime, while his [theory](#) of natural selection came to be widely seen as the primary explanation of the process of evolution in the 1930s,<sup>[1]</sup> and now forms the basis of [modern evolutionary theory](#). In modified form, Darwin's scientific discovery remains the foundation of [biology](#), as it provides a unifying logical explanation for the [diversity of life](#).<sup>[2]</sup>

Darwin developed his interest in natural history while studying [medicine](#) at [Edinburgh University](#), then [theology](#) at [Cambridge](#).<sup>[3]</sup> His [five-year voyage](#) on the *Beagle* established him as an eminent [geologist](#) whose observations and theories supported [Charles Lyell's](#) [uniformitarian](#) ideas, and publication of his [journal of the voyage](#) made him famous as a popular author. Puzzled by the geographical distribution of wildlife and [fossils](#) he collected on the voyage, Darwin investigated the [transmutation of species](#) and conceived his theory of natural selection in 1838.<sup>[4]</sup> Although he discussed his ideas with several naturalists, he needed time for extensive research and his geological work had priority.<sup>[5]</sup> He was writing up his theory in 1858 when [Alfred Russel Wallace](#) sent him an essay which described the same idea, prompting immediate joint publication of [both of their theories](#).<sup>[6]</sup>

His 1859 book *On the Origin of Species* established evolution by [common descent](#) as the dominant scientific explanation of diversification in nature. He examined [human evolution](#) and [sexual selection](#) in *The Descent of Man, and Selection in Relation to Sex*, followed by *The Expression of the Emotions in Man and Animals*. His research on plants was published in a series of books, and in his final book, he examined [earthworms](#) and their effect on soil.<sup>[7]</sup>

In recognition of Darwin's pre-eminence, he was one of only five 19th century UK non-royal personages to be honoured by a state funeral,<sup>[8]</sup> and was buried in [Westminster Abbey](#), close to [John Herschel](#) and [Isaac Newton](#).<sup>[9]</sup>

### Contents [hide]

- 1 Biography
  - 1.1 Early life
  - 1.2 Journey of the Beagle
  - 1.3 Inception of Darwin's evolutionary theory
  - 1.4 Overwork, illness, and marriage
  - 1.5 Preparing the theory of natural selection for publication
  - 1.6 Publication of the theory of natural selection
  - 1.7 Reaction to the publication
  - 1.8 Descent of Man, sexual selection, and botany

### Charles Darwin



Charles Robert Darwin (1809-1882). At the age of 50, Charles Darwin had just published *On the Origin of Species*.

<b>Born</b>	12 February 1809 <a href="#">Mount House, Shrewsbury, Shropshire, England</a>
<b>Died</b>	19 April 1882 (aged 73) <a href="#">Down House, Downe, Kent, Engl</a>
<b>Residence</b>	England
<b>Nationality</b>	<a href="#">British</a>
<b>Fields</b>	<a href="#">Naturalist</a>
<b>Institutions</b>	<a href="#">Royal Geographical Society</a>
<b>Alma mater</b>	<a href="#">University of Edinburgh</a> <a href="#">University of Cambridge</a>
<b>Academic advisors</b>	<a href="#">Adam Sedgwick</a> <a href="#">John Stevens Henslow</a>

# Extract data from Wikipedia infoboxes...

```
@prefix dbpedia <http://dbpedia.org/resource/>.  
@prefix dbterm  <http://dbpedia.org/property/>.
```

```
dbpedia:Amsterdam
```

```
dbterm:officialName "Amsterdam" ;
```

```
dbterm:longd "4" ;
```

```
dbterm:longm "53" ;
```

```
dbterm:longs "32" ;
```

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...
```

```
dbterm:leaderTitle "Mayor" ;
```

```
dbterm:leaderName dbpedia:Job_Cohen ;
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...
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```
dbterm:areaTotalKm "219" ;
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...
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```
dbpedia:ABN_AMRO
```

```
dbterm:location dbpedia:Amsterdam ;
```

```
...
```

# Matching URIS create automatic links among datasets

```
<http://dbpedia.org/resource/Amsterdam>  
  owl:sameAs <http://rdf.freebase.com/ns/...> ;  
  owl:sameAs <http://sws.geonames.org/2759793> ;  
  ...
```

```
<http://sws.geonames.org/2759793>  
  owl:sameAs <http://dbpedia.org/resource/Amsterdam>  
  wgs84_pos:lat "52.3666667" ;  
  wgs84_pos:long "4.8833333" ;  
  geo:inCountry <http://www.geonames.org/countries/#NL> ;  
  ...
```



# Query on merged data in DBPedia

UNIVERSITÄT LEIPZIG **pedia**

## Query Wikipedia

This semantic database contains over 10 million statements extracted from the English Wikipedia.

search for queries | [Most popular](#) | [Upcoming](#)

- [Tennis players from Moscow](#)
- [Sitcoms set in NYC](#)
- [People influenced by Friedrich Nietzsche](#)
- [Soccer player with tricot number 11 from club with stadium with >40000 seats born in a country with more than 10M inhabitants](#)
- [Film music composer born 1965](#)
- [Films longer than 5 hours](#)
- [Space Missions](#)
- [People being 1.80m tall](#)
- [List of Web browser software](#)
- [Battles in Saxony](#)
- [Mayors of US cities higher than 1000m](#)
- [Hip hop CDs from Texas Artists](#)
- [Pictures of American guitarists](#)
- [Scientists and their doctoral advisors](#)
- [Planes and their designers built in the 1st decade of the 20th century](#)

<< 1 >>

**More Information:** at [dbpedia.org](#) and in the paper [What have Innsbruck and Leipzig in common? Extracting Semantic from Wiki Content.](#)





**Contact:** [AKSW Workgroup](#) @ BIS / Universität Leipzig

## Scientists and their doctoral advisors

[Modify this query or create your own!](#)

Click on a column header to sort results on this page.

69 results found in 0.212s

Nr.	?advisee	?image	?advisor	?image_advisor
1	<a href="#">Charles Darwin</a>		<a href="#">Adam Sedgwick</a>	
2	<a href="#">William Hopkins</a>		<a href="#">Adam Sedgwick</a>	

# Library catalog card

---

English literature--Early modern, 1500-1700--  
History and criticism.

PQ  
6277 **O'Connor, John Joseph, 1918 (June 15)-**  
02 Amadis de Gaule and its influence on Elizabethan literature, by John J. O'Connor. New Brunswick, N. J., Rutgers University Press [1970]  
ix, 308 p. facsims. 25 cm. 9.00  
Bibliography : p. 287-293.

1. Amadis de Gaula. 2. English literature—Early modern (to 1700)—History and criticism.

PQ6277.O2 863'.2 76-96031  
SBN 8135-0622-0 MARC

Library of Congress 70 r41

# Library catalog card – subject headings

PQ  
6277  
02

English literature--Early modern, 1500-1700--  
History and criticism.

~~O'Connor, John Joseph, 1918 (June 15)~~  
Amadis de Gaule and its influence on Elizabethan literature, by John J. O'Connor. New Brunswick, N. J., Rutgers University Press [1970]  
ix, 308 p. facsims. 25 cm. 9.00  
Bibliography : p. 287-293.

1. Amadis de Gaula. 2. English literature—Early modern (to 1700)—History and criticism.

PQ6277.O2  
SBN 8135-0622-0

863'.2

76-96031  
MARC

Library of Congress 70 r41

# Converting Library of Congress Subject Headings...

```
01671cz a2200337n 450000100080000000500170000800800410002503500210006603500170
00870350021001040350016001259060018001410100017001590400018001760530034001940530
04200228150001900270450002400289450002500313450005500338450002500393550002500418
55000260044355000130046967002700048267002570075267001200100967001570112967500320
1286953001501318^^4865449^^20011001235750.0^^950125|| anannbavn la ana
^^ ^_a(DLC)sh 95000541^^ ^_a(DLC)5086766^^ ^_a(DLC)sp 95000541^^ ^_a(DL
C)258303^^ ^_t0019^_ute07^_v0^^ ^_ash 95000541 ^^ ^_aDLC^_cDLC^_dDLC^^ 0^_aTK
5105.888^_cTelecommunication^^ 0^_aZA4195^_bZA4235^_cInformation resources^^ ^_
aWorld Wide Web^^ ^_aW3 (World Wide Web)^^ ^_aWeb (World Wide Web)^^ ^_wnne^_
aWorld Wide Web (Information retrieval system)^^ ^_aWWW (World Wide Web)^^ ^_w
g^_aHypertext systems^^ ^_wg^_aMultimedia systems^^ ^_aInternet^^ ^_aWork cat
.: 94067520: December, J. The World Wide Web Unleashed, c1994^_b(WWW, the Web, a
distributed hypermedia system, a collection of interconnected hardware, softwar
e, and networked systems, it is a concept, not a program, system, or protocol, i
t is an interface)^^ ^_a94234135: Brown, S. The Internet via Mosaic and World W
ide Web, c1994^_b(WWW, the Web) p. 35 (Although the WWW is primarily used on a g
lobal scale as a part of the Internet, it is feasible for a two-machine network
to run the WWW client/server software)^^ ^_aInternet publishing handbook, c1995
:^_bp. 15 (World-Wide Web system is known by its various names: WWW, W3, and Web
)^^ ^_aMAGS, Dec. 8, 1995:^_barticle by Robert M. Metcalfe (first generation of
WWW based on Hypertext Transfer Protocol and Hypertext Transfer Markup Language
)^^ ^_aASTI;^_aEngr. index;^_aWeb. 3^^ ^_ajf08^_bta25^^^]
```

# Using existing identifiers as basis for URIs...

01671cz a2200337n 450000100080000000500170000800800410002503500210006603500170  
00870350021001040350016001259060018001410100017001590400018001760530034001940530  
04200228150001900270450002400289450002500313450005500338450002500393550002500418  
55000260044355000130046967002700048267002570075267001200100967001570112967500320  
1286953001501100110011001235750.0^^950125|| anannbabn la ana  
^^ ^\_a(DLC)sh 95000541^^ ^\_a(DLC)5086766^^ ^\_a(DLC)sp 95000541^^ ^\_a(DL  
C)258303^^ +0019^^ ute07^^ \_v0^^ ^\_ash 95000541 ^^ ^\_aDLC^\_cDLC^\_dDLC^^ 0^\_aTK  
5105.888^\_cTelecommunication^^ 0^\_aZA4195^\_bZA4235^\_cInformation resources^^ ^\_  
aWorld Wide Web^^ ^\_aW3 (World Wide Web)^^ ^\_aWeb (World Wide Web)^^ ^\_wnne^\_  
aWorld Wide Web (Information retrieval system)^^ ^\_aWWW (World Wide Web)^^ ^\_w  
g^\_aHypertext systems^^ ^\_wg^\_aMultimedia systems^^ ^\_aInternet^^ ^\_aWork cat  
.: 94067520: December, J. The World Wide Web Unleashed, c1994^\_b(WWW, the Web, a  
distributed hypermedia system, a collection of interconnected hardware, softwar  
e, and networked systems, it is a concept, not a program, system, or protocol, i  
t is an interface)^^ ^\_a94234135: Brown, S. The Internet via Mosaic and World W  
ide Web, c1994^\_b(WWW, the Web) p. 35 (Although the WWW is primarily used on a g  
lobal scale as a part of the Internet, it is feasible for a two-machine network  
to run the WWW client/server software)^^ ^\_aInternet publishing handbook, c1995  
:^\_bp. 15 (World-Wide Web system is known by its various names: WWW, W3, and Web  
)^^ ^\_aMAGS, Dec. 8, 1995:^\_barticle by Robert M. Metcalfe (first generation of  
WWW based on Hypertext Transfer Protocol and Hypertext Transfer Markup Language  
)^^ ^\_aASTI;^\_aEngr. index;^\_aWeb. 3^^ ^\_ajf08^\_bta25^^^]

# ...represented with URIs and RDF

---

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF
  xmlns:dcterms="http://purl.org/dc/terms/"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:skos="http://www.w3.org/2004/02/skos/core#"
>
  <rdf:Description rdf:about="http://lcsb.info/sh95000541#concept">
    <skos:prefLabel xml:lang="en">World Wide Web</skos:prefLabel>
    <skos:narrower rdf:resource="http://lcsb.info/sh2003001415#concept"/>
    <skos:narrower rdf:resource="http://lcsb.info/sh97003254#concept"/>
    <skos:narrower rdf:resource="http://lcsb.info/sh2002000569#concept"/>
    <skos:inScheme rdf:resource="http://lcsb.info/">
    <dcterms:created rdf:datatype="http://www.w3.org/2001/XMLSchema#date">2000-04-28</dcterms:created>
    <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
    <skos:broader rdf:resource="http://lcsb.info/sh88002671#concept"/>
    <skos:broader rdf:resource="http://lcsb.info/sh92002381#concept"/>
    <skos:related rdf:resource="http://lcsb.info/sh92002816#concept"/>
    <skos:editorialNote xml:lang="en">94234135: Brown, S. The Internet via Mosaic and World Wide Web, c1994 (WWW, the
    <skos:editorialNote xml:lang="en">ASTI; Engr. index; Web. 3</skos:editorialNote>
    <skos:editorialNote xml:lang="en">Work cat.: 94067520: December, J. The World Wide Web Unleashed, c1994 (WWW, the
    <skos:editorialNote xml:lang="en">MAGS, Dec. 8, 1995: article by Robert M. Metcalfe (first generation of WWW base
    <skos:editorialNote xml:lang="en">Internet publishing handbook, c1995: p. 15 (World-Wide Web system is known by :
    <dcterms:modified rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">2001-10-01T09:56:06</dcterms:modified>
    <skos:altLabel xml:lang="en">WWW (World Wide Web)</skos:altLabel>
    <skos:altLabel xml:lang="en">W3 (World Wide Web)</skos:altLabel>
    <skos:altLabel xml:lang="en">World Wide Web (Information retrieval system)</skos:altLabel>
    <skos:altLabel xml:lang="en">Web (World Wide Web)</skos:altLabel>
    <dcterms:LCC>TK5105.888</dcterms:LCC>
  </rdf:Description>
</rdf:RDF>
```

...published as open linked data (<http://id.loc.gov>)

The screenshot shows a web browser window displaying the Library of Congress Authorities & Vocabularies search page. The browser's address bar shows the URL <http://id.loc.gov/authorities/search/>. The page header includes the Library of Congress logo and navigation links: [ASK A LIBRARIAN](#), [DIGITAL COLLECTIONS](#), and [LIBRARY CATALOGS](#). A search input field with a **GO** button and an [Options](#) link is also present. Below the header, a breadcrumb trail reads: [The Library of Congress](#) > [Authorities & Vocabularies](#) > Search and Download. The main content area is divided into two columns. The left column, titled **Authorities & Vocabularies**, features a navigation menu with links: [Authorities & Vocabularies](#), [About](#), [Technical Center](#), [Search & Download](#), and [Contact Us](#). The right column, titled **Search & Download**, displays the text: **Search 342,684 subject authority records**. Below this, a paragraph explains that LCSH has been actively maintained since 1898 to catalog materials held at the Library of Congress and is used internationally. A **Search** section includes an input field labeled "Enter search terms..." and a **GO** button. A **Download** section offers a **Download current version (ZIP compressed):** option, with a dropdown menu set to "RDF/XML (April 30 2009; 32.4 MB)" and a **GO** button. A [Terms of Service](#) link is also provided. The footer contains links for [About](#), [Press](#), [Site Map](#), [Contact](#), [Accessibility](#), [Legal](#), and [USA.gov](#).

# See links to broader/narrower terms...

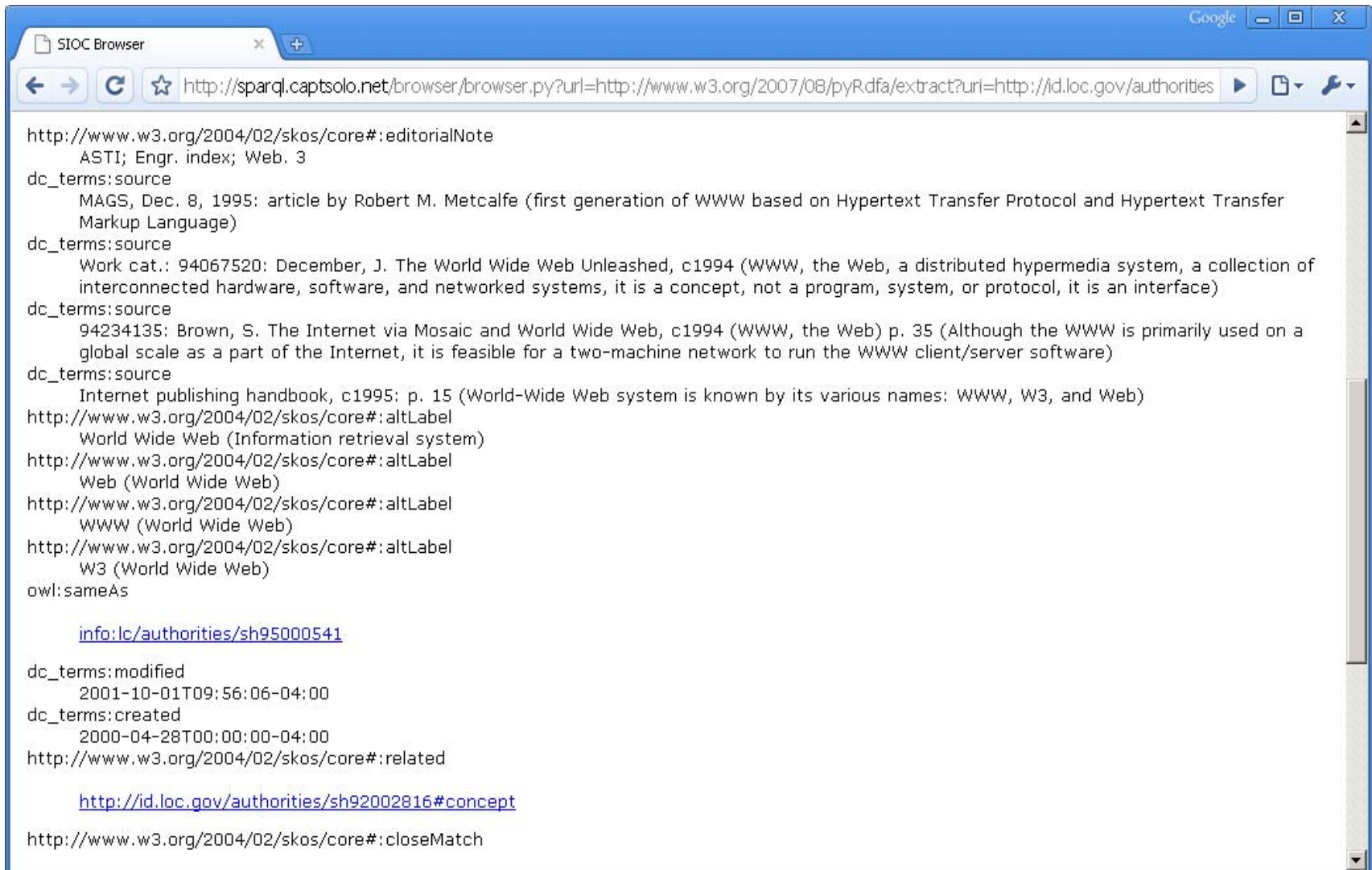
The screenshot shows a web browser window displaying the Library of Congress Authorities & Vocabularies page for the term 'World Wide Web'. The browser's address bar shows the URL <http://id.loc.gov/authorities/sh95000541>. The page header includes the Library of Congress logo and navigation links: 'ASK A LIBRARIAN', 'DIGITAL COLLECTIONS', 'LIBRARY CATALOGS', a search box with a 'GO' button, and an 'Options' link. The breadcrumb trail reads 'The Library of Congress > Authorities & Vocabularies > World Wide Web'. The main content area is titled 'Authorities & Vocabularies' and includes a 'Return' link, a search box with the placeholder 'Enter search terms...' and a 'GO' button, and two tabs: 'Details' (selected) and 'Visualize'. The 'Details' tab shows the following information:

- World Wide Web**
- URI:** <<http://id.loc.gov/authorities/sh95000541#concept>>
- Type:** Topical Term
- Alternate Labels:** W3 (World Wide Web); Web (World Wide Web); World Wide Web (Information retrieval system); WWW (World Wide Web)
- Broader Terms:**
  - [Hypertext systems](#)
  - [Multimedia systems](#)
- Narrower Terms:**
  - [Mashups \(World Wide Web\)](#)
  - [Semantic Web](#)
  - [Web 2.0](#)
  - [WebDAV \(Standard\)](#)

<http://id.loc.gov/authorities>



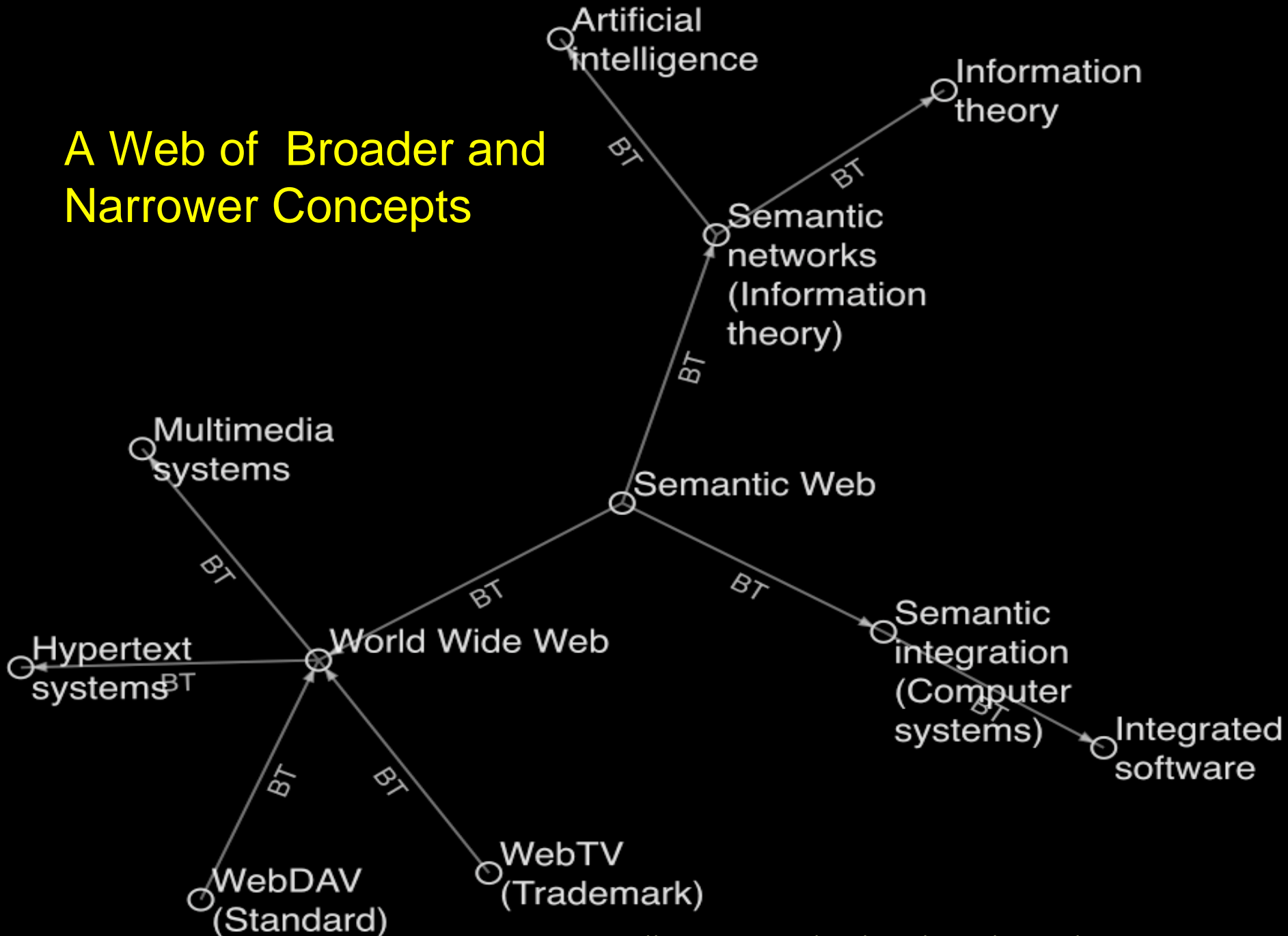
# ...or extract the hidden RDFa



The screenshot shows a browser window titled "SIOC Browser" with the address bar containing a SPARQL query. The main content area displays the results of the query, which are RDFa properties and values extracted from the target page. The properties include editorialNote, source, altLabel, modified, created, related, and closeMatch, with their corresponding values and URIs.

```
http://www.w3.org/2004/02/skos/core#:editorialNote
  ASTI; Engr. index; Web. 3
dc_terms:source
  MAGS, Dec. 8, 1995: article by Robert M. Metcalfe (first generation of WWW based on Hypertext Transfer Protocol and Hypertext Transfer Markup Language)
dc_terms:source
  Work cat.: 94067520: December, J. The World Wide Web Unleashed, c1994 (WWW, the Web, a distributed hypermedia system, a collection of interconnected hardware, software, and networked systems, it is a concept, not a program, system, or protocol, it is an interface)
dc_terms:source
  94234135: Brown, S. The Internet via Mosaic and World Wide Web, c1994 (WWW, the Web) p. 35 (Although the WWW is primarily used on a global scale as a part of the Internet, it is feasible for a two-machine network to run the WWW client/server software)
dc_terms:source
  Internet publishing handbook, c1995: p. 15 (World-Wide Web system is known by its various names: WWW, W3, and Web)
http://www.w3.org/2004/02/skos/core#:altLabel
  World Wide Web (Information retrieval system)
http://www.w3.org/2004/02/skos/core#:altLabel
  Web (World Wide Web)
http://www.w3.org/2004/02/skos/core#:altLabel
  WWW (World Wide Web)
http://www.w3.org/2004/02/skos/core#:altLabel
  W3 (World Wide Web)
owl:sameAs
  info:lc/authorities/sh95000541
dc_terms:modified
  2001-10-01T09:56:06-04:00
dc_terms:created
  2000-04-28T00:00:00-04:00
http://www.w3.org/2004/02/skos/core#:related
  http://id.loc.gov/authorities/sh92002816#concept
http://www.w3.org/2004/02/skos/core#:closeMatch
```

# A Web of Broader and Narrower Concepts

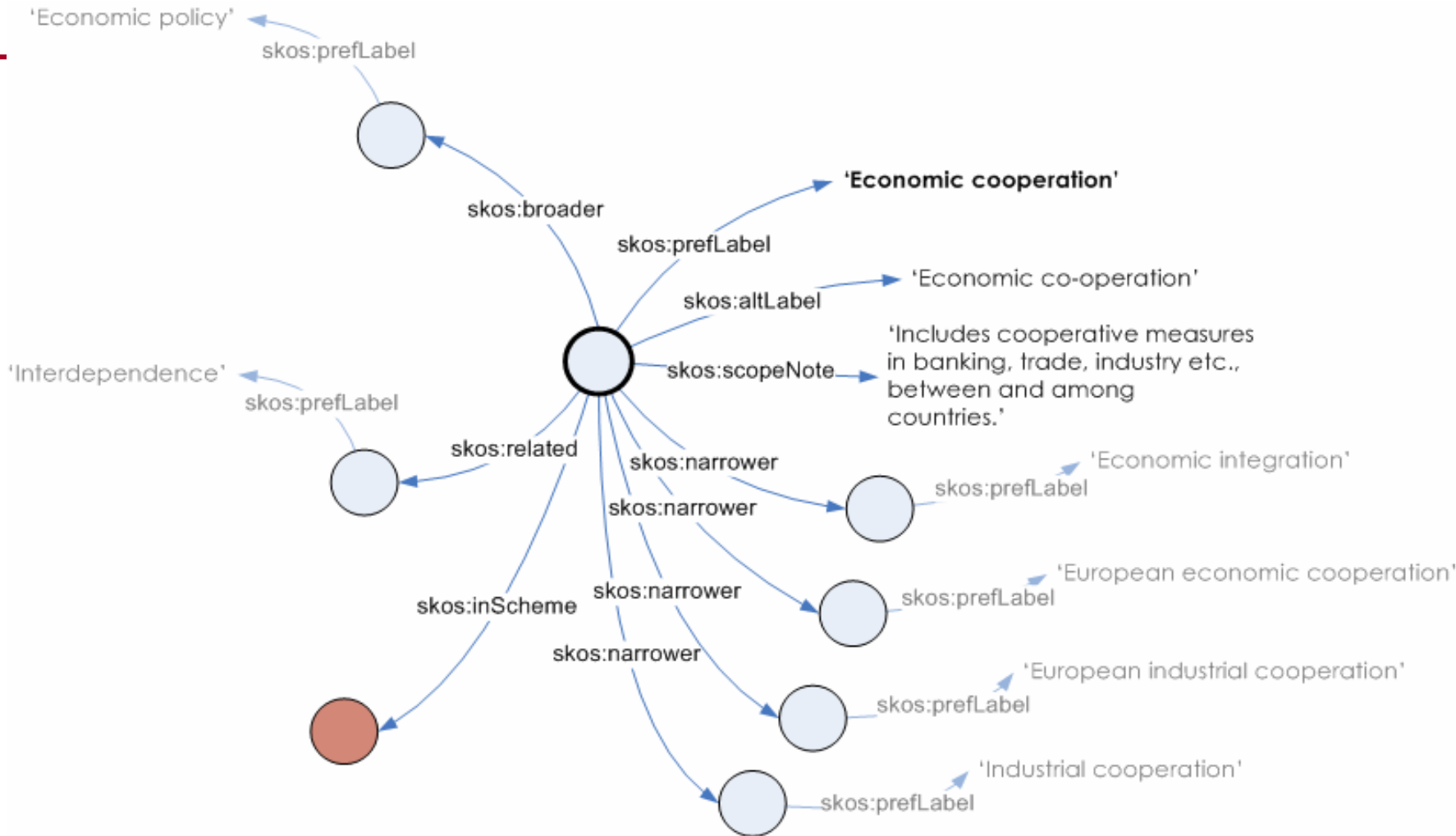


# Simple Knowledge Organization System (SKOS)

- Simple language for expressing classification systems and thesauri as linked data
- RDF properties for links to Broader, Narrower, Related Concepts
- RDF properties and classes for defining a knowledge system
  - Basic description (Concept, Concept Scheme)
  - Labeling (Preferred Label, Alternative Label)
  - Documentation (Definition, History Note)
  - Mapping (Broader Match, etc)
- Currently a W3C Candidate Recommendation
  - <http://www.w3.org/TR/skos-reference>



# Expressing a thesaurus as linked data



prefix skos: <<http://www.w3.org/2004/02/skos/core#>>

# Citing LCSH URIs in metadata...

---

<<http://openlibrary.org/6/0L7983950M>>

a bibo:Book

dc:title 'Weaving the Web';

dc:creator 'Tim Berners-Lee' ;

dc:subject 'World Wide Web' ;

dc:publisher 'Texere Publishing';

dc:identifier '0752820907'.

## ...Linked Metadata

---

<<http://openlibrary.org/6/0L7983950M>>

a bibo:Book

dc:title 'Weaving the Web';

dc:creator 'Tim Berners-Lee' ;

dc:subject <<http://id.loc.gov/authorities/sh95000541#concept>> ;

dc:publisher 'Texere Publishing';

dc:identifier '0752820907'.

# Formal Ontologies versus KOSes

---

- **Formal Ontologies**
  - Provide an interpretation of reality
  - Assert axioms or facts about things in the world
  - Inference using logical entailments
- **Knowledge Organization Systems**
  - Concepts may be linked pragmatically
  - Semi-formal, intuitive “maps” of domains
  - Aid in finding related objects
  - Port to Semantic Web without re-engineering using SKOS

# Simpler OWL?

- “OWL 1” stable since 2004
  - Flavors balance expressibility and implementability: OWL-Lite, OWL-DL, OWL-Full
- “OWL 2” in development
  - Some implementable extensions (disjoint properties, property chains...)
  - OWL “Profiles”: simple sub-sets easier to understand and implement
  - For times even OWL-Lite is too heavy...



# Simple steps

- **Open Linked Data enables “unplanned re-use”**
  - 1. Identify things with URIs.
  - 2. Use HTTP URIs.
  - 3. Serve information on the Web against the URIs.
  - 4. Link related material.
- **Small vocabularies can say alot**
  - Simple description (Dublin Core, FOAF) may suffice.
  - Semi-formal, intuitive knowledge structures in SKOS.

tbaker@tbaker.de

<http://www.w3.org/2006/07/SWD/>

<http://www.kim-forum.org/>

## Acknowledgments

[http://www.w3.org/People/Ivan/CorePresentations/State\\_of\\_SW/](http://www.w3.org/People/Ivan/CorePresentations/State_of_SW/)

<http://inkdroid.org/bzr/lcsh/docs/slides/>