

The Semantic Web Vision

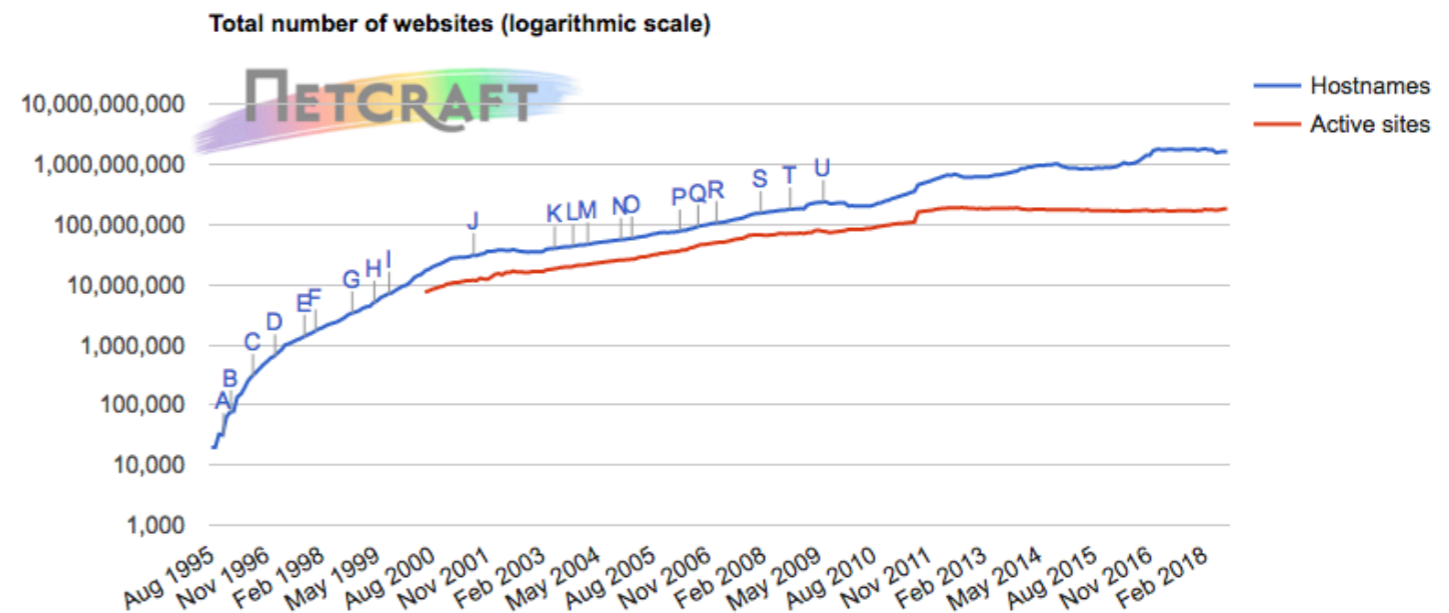
After all, what is the Semantic Web?

The World Wide Web

- The World Wide Web changed the ways knowledge and information are shared
- The technology affected society, with major impact in the organisation of work as well as entertainment.
- From this point of view, the World Wide Web has been a success supported mostly in the existence of amazing search engines.
- The uncontrolled exponential growth of the Web brought new challenges...

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- The uncontrolled exponential growth of the Web brought new challenges...



<http://news.netcraft.com/>

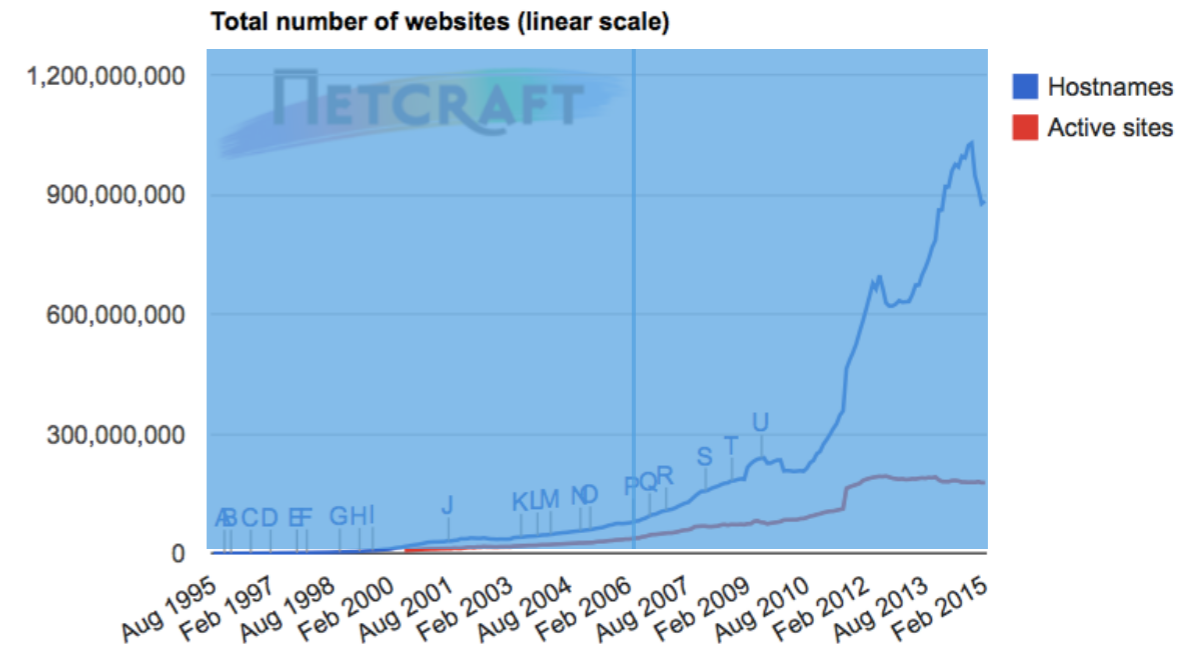
Web 1.0 and 2.0 jargon

- Web 1.0

- A huge portal of documents, in which information can be retrieved
- Directories
- Too static and read-only

- Web 2.0

- The social web
- Document (and information) sharing
- Collaboration
- User-centred



Daily use of the WWW

The image shows a screenshot of the Publico.pt website displayed in a browser window. The browser's address bar shows the URL <http://www.publico.clix.pt/>. The website header includes the Publico logo and navigation links such as "Fórum", "Crónicas de garfo e faca", and "Caderno Cidadão". A main navigation bar lists various news categories: MUNDO, POLÍTICA, ECONOMIA, DESPORTO, SOCIEDADE, EDUCAÇÃO, CIÊNCIAS, ECOSFERA, CULTURA, LOCAL, and M. Below the navigation bar, there are several news articles. The first article is titled "Aumento do preço dos transportes pode atingir entre 3 a 4 por cento" and features a photograph of a yellow bus on a city street. The second article is titled "Sindicato dos Quadros Técnicos pede intervenção de Cavaco sobre impostos" and includes a sub-headline "Foto de...". The third article is titled "Há candidatos que tentam aprisionar os partidos", diz líder do PS/Porto sobre Alegre". The browser window also shows a sidebar on the left with a search bar and a list of items numbered 1 to 6. The overall layout is typical of a news website from the early 2000s.

Na COFIDIS não tem custos de gestão nem de abertura. Simule já!

PSILON | GUIA DO LAZER | CINECARTAZ | INIMIGO PÚBLICO | PESO E MEDIDA |

Siga-nos em: [f](#) | [t](#) | [r](#)

Público 20

Fórum
Quem vai ser o jogador dispensado por Carlos Queiroz?

Crónicas de garfo e faca
A vida dos críticos de gastronomia

Caderno Cidadão
Envie-nos uma pergunta sobre um problema da sua rua, bairro ou cidade

JORNAL DO DIA | PDF | VÍDEOS | MULTIMÉDIA | INFOGRAFIAS | BLOGUES | DOSSIERS | LOJA | ASSINATURAS |

MUNDO POLÍTICA ECONOMIA DESPORTO SOCIEDADE EDUCAÇÃO CIÊNCIAS ECOSFERA CULTURA LOCAL M

Dias Verdes | Biodiversidade | Papa em Portugal | Logos Público | Continue o conto de Gonçalo M. Tavares | 20 anos/20 histórias | Comunidade

Aumento do preço dos transportes pode atingir entre 3 a 4 por cento

Sindicato dos Quadros Técnicos pede intervenção de Cavaco sobre impostos

17:27 Raquel Martins
O Sindicato dos Quadros Técnicos do Estado (STE) enviou hoje uma carta ao Presidente da República a pedir a fiscalização preventiva do aumento das taxas de IRS em 2010.

Comentar | Ler Comentários (4)

"Há candidatos que tentam aprisionar os partidos", diz líder do PS/Porto sobre Alegre

18:45 Lusa
O líder do PS/Porto, Renato Sampaio, afirmou hoje que a candidatura presidencial de Manuel Alegre não o entusiasma e lamentou que os candidatos a presidentes da República procurem agora aprisionar os

16:52 Lusa, PUBLICO
O presidente da Associação Nacional de Transportadores Rodoviários de Passageiros disse

€1

1
2
3
4
5
6

AVIÃO+HO
Os melh
De
Partida:
12/04/201
Adultos
1
Com
mais opçõ

JLDDE DE
ICIAS E TECNOLOGIA
ERSIDADE NOVA DE LISBOA

Web of Documents

- Most of today's Web content is designed and appropriate for human consumption
- Even Web content that is generated automatically is usually then processed and presented without the original structural information (e.g. from databases)
- Typical Web usage of today needs people
 - for seeking and making use of information,
 - searching for and getting in touch with other people,
 - reviewing catalogues of online stores and ordering products by filling out forms, ...
- **A Web in machines, for humans' usage**

Planning a trip

hotel.info | Hotel Tivoli Coimbra in Coimbra (Portugal) simply book for less

http://www.hotel.info/booking.aspx?gclid=CLXz8Pfe9aACFYou3gods0qWvA&h_ hotel tivoli coimbra

Netviagens - Agência de Viagens e Turismo

http://netviagens.sapo.pt/

hotel tivoli coimbra

sapo.pt ACESSO À INTERNET | MAIL | MESSENGER | VÍDEOS | VIAGENS | COMPRAS | IMÓVEIS | CLASSIFICADOS Pesquisa SAPO Ok

AS MINHAS VIAGENS

LOGIN

pesquise aqui

netviagens.com

LIGUE 707 205 205

MOTOR DE PESQUISA

GRANDES VIAGENS | VOOS | HOTEL | VOOS + HOTEL | FÉRIAS | PORTUGAL | ESCAPADELAS FORD

AVIÃO+HOTEL AVIÃO HOTEL FÉRIAS ESCAPADELAS

PRÉ VENDA VERÃO 2010 | CIRCUITOS PELO MUNDO | EUROPA 5 ESTRELAS

Os melhores preços

De Para
Partida: 12/04/2010 Horas: todas Chegada: 22/04/2010 Horas: todas

Adultos 1 Crianças 0 Bebés 0 Só voos directos

Com Low Costs

* SUPERVERÃO * 5-19 ABRIL *
* PRAIAS & CAMPO *
CAMPANHA DE PRÉ-VENDA
DE VERÃO EM PORTUGAL

Férias em Cabo Verde:

Sal + São Vicente - 09/04 - 859€ | Boavista - 10/04 - 555€ | Sal - 30/04 - 536€

AS MELHORES OFERTAS

BILHETES DE AVIÃO - Preço Total

Barcelona	Voos TAP Portugal	97€
Londres	Voos British Airways	122€
Budapeste	Voos Lufthansa	180€
Cairo	Voos Egyptair	395€
Miami	Voos US Airways	497€



Carvoeiro - Férias 7...



Alvor - Férias 7...

€15 valem €20 em filmes
do MEO VideoClube



tripadvisor

THE BEST HOTELS

Home Hotels

City, hotel name, etc

Coimbra

Coimbra Tourism

Coimbra Hotels

Vacation Rentals

Flights to Coimbra

Coimbra Deals

More

Refine search

12 of 26

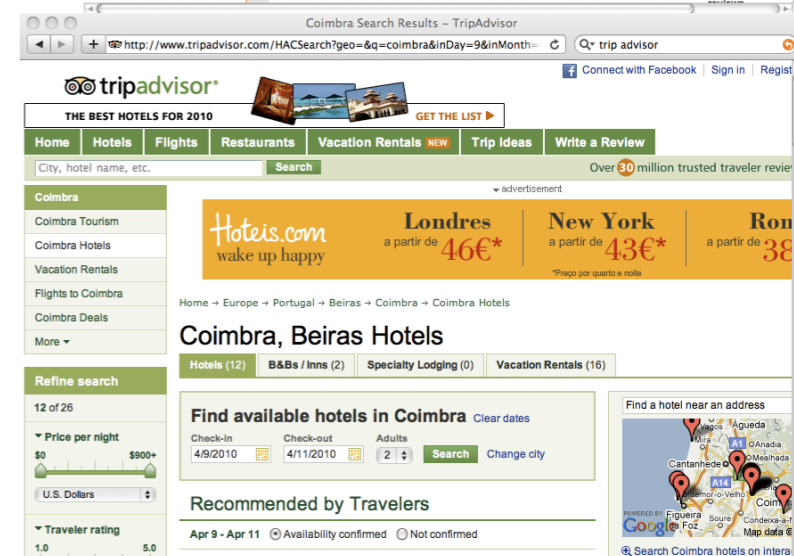
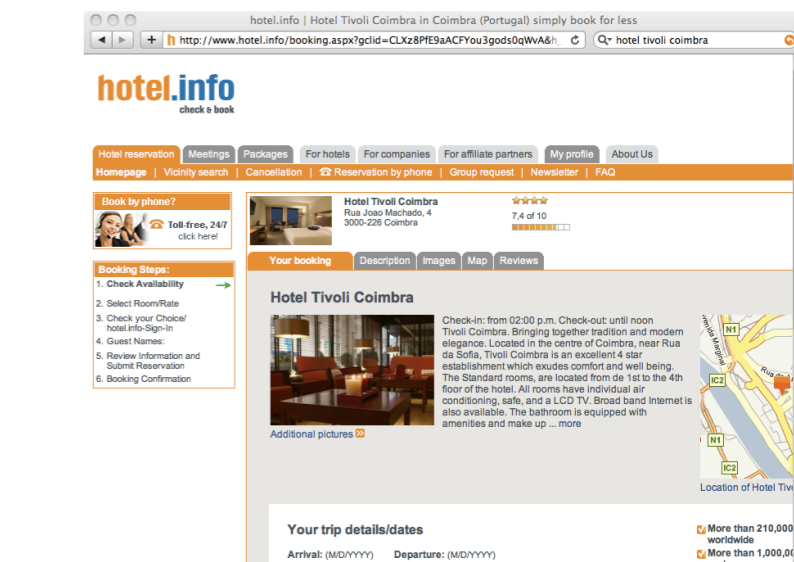
Price per night

\$0 \$90

U.S. Dollars

Planning a trip

- One has to consult several sites, with different styles, purposes, languages, ...
- Mentally integrate the data and understand it
- Apply personal preferences
- How could we do a program to perform such a task?
- Note that those pages most likely are already based in structured data, but one can't access it (easily)



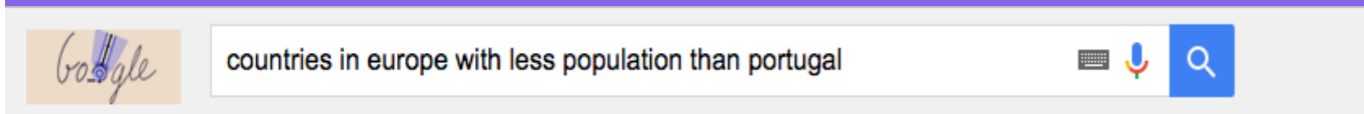
Querying the Web

The image shows a screenshot of a web browser displaying Google search results. The search query is "countries in europe with less population than portugal". The results are sorted by relevance, showing three main entries:

- Portugal - OECD Better Life Index**
www.oecdbetterlifeindex.org/countries/portugal/
People in **Portugal** work 1 691 hours a year, slightly **less than** the OECD average of 1 ... A well-educated and well-trained **population** is essential for a **country's** social ... areas, much more **than** the 12 % average of OECD **European countries**.
- Muslim populations by country - The Guardian**
www.theguardian.com > World > Islam
Jan 28, 2011 - Muslim **populations** by **country**: how big will each Muslim **population** be by 2030? ... In the US the **population** projections show the number of Muslims more **than** doubling over the next ... In **Europe**, the Muslim share of the **population** is expected to grow by nearly 172, **Portugal**, 65,000, 0.6, 65,000, 0.6, 0.
- European diaspora - Wikipedia, the free encyclopedia**
en.wikipedia.org/wiki/European_diaspora
Country, Percentage of the local **population**, **Population** in 0.1% of the **population** is mostly **Portuguese**, with 0.2% of mixed **Portuguese** and This figure excludes the

2011

Querying the Web



2016

Tudo Notícias Imagens Mapas Vídeos Mais Ferramentas de pesquisa

Cerca de 38 700 000 resultados (0,40 segundos)

Area and population of European countries - Wikipedia, the free ...

https://en.wikipedia.org/.../Area_and_population_of_European_c... Traduzir esta página
This is a list of countries and territories in Europe by population density. ... The data for Portugal includes the Madeira Islands. ... inland water bodies (lakes, reservoirs, rivers) and therefore the population densities stated here may be lower.

Portugal - Wikipedia, the free encyclopedia

<https://en.wikipedia.org/wiki/Portugal> Traduzir esta página
Location of Portugal (dark green). – in Europe (green & dark grey) – in the European Union ... It is the westernmost country of mainland Europe. of Celts invaded Portugal from Central Europe and inter-married with the local populations, a century later in 1031 into no less than 23 small kingdoms, called Taifa kingdoms.

European Union statistics - Wikipedia, the free encyclopedia

https://en.wikipedia.org/wiki/European_Union_statistics Traduzir esta página
Statistics in the European Union are collected by Eurostat (European statistics body). ... The least densely populated country is Finland. Population figures in the table below are from 2006 or 2007 estimates. The highest and lowest figures in each ...

Demographics of the European Union - Wikipedia, the free encyclopedia

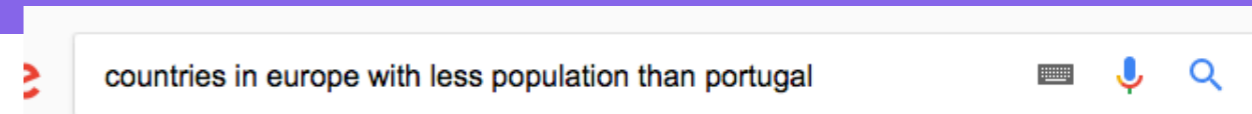
https://en.wikipedia.org/.../Demographics_of_the_European_Uni... Traduzir esta página
The demographics of the European Union show a highly populated, culturally diverse union of ... Germany has the lowest birth rate in Europe with 8.221 births per thousand people per year. Spectacular growth in Spain's immigrant population came as the country's economy created more than half of all the new jobs in the ...

Spain and Portugal in the European Union: The First Fifteen Years

<https://books.google.pt/books?isbn=1135757844> Traduzir esta página
Paul Christopher Manuel, Sebastian Royo - 2004 - Political Science
They may be a liability for state-nations who have powerful neighbours and lack ... Portuguese population is 2.5 times smaller than EU-15 member states and ...

Portugal Facts on Largest Cities, Populations, Symbols - Worldatlas.com

www.worldatlas.com/.../countrys/europe/portugal/ptfacts.htm Traduzir esta página
29/09/2015 - Portugal's capital city, currency, ethnicity, gdp, largest cities, languages, ... number less than 100,000; since 1990 East Europeans have entered ...



2018

Tudo Imagens Mapas Notícias Vídeos Mais Definições Ferramentas

Cerca de 39 400 000 resultados (0,56 segundos)

Area and population of European countries - Wikipedia

https://en.wikipedia.org/.../Area_and_population_of_European_c... Traduzir esta página
This is a list of countries and territories in Europe by population density. ... the African continent. The data for Portugal includes the Azores and Madeira Islands.

List of European countries by population - Wikipedia

https://en.wikipedia.org/.../List_of_European_countries_by_popu... Traduzir esta página
List of European countries by population present the list of 50 countries, territories and ... European population by country (top 10). Russia ... 16, Portugal, Steady ...

Population of Countries in Europe 2018 - World Population Review

worldpopulationreview.com/countries/countries-in-europe Traduzir esta página
Population of Countries in Europe 2018 ... However, the majority of European countries have fewer than ten million residents – these ... Portugal, 10,291,196.

The 10 Least Populated Countries Of Europe - WorldAtlas.com

<https://www.worldatlas.com/articles/the-10-least-populated-countr...> Traduzir esta página
20/10/2017 - Vatican City is Europe's least populated country, with a population of under 1,000. ... More than 90% of the nation's population has a Slavic origin. The life ... The biggest ethnic minority here is the Portuguese-origin people. Roman ... It is thus one of the least densely populated nations in the world. 93% of ...

Portugal has second lowest birth rate in Europe, after Italy - The ...

www.theportugalnews.com News Traduzir esta página
13/07/2017 - In a nutshell, more people are leaving the country than coming into it, and ... Eurostat noted there was an increase in the EU population from ...

Is Portugal a poor country? - Quora

<https://www.quora.com/Is-Portugal-a-poor-country> Traduzir esta página
17/01/2018 - In Europe, even in the countries of the former Soviet Bloc, population ... relaxed and less organized than in the Central and Northern European countries, there is ...

Why is Portugal poorer than Spain? 2/06/2017

Why does brazil has much larger population than portugal despite ... 6/03/2016

Mais resultados de www.quora.com

Querying the Web

- Search engines are great!
 - for keyword search
 - improving its “understanding” capabilities for more complex “natural language” queries
- What if we want to make more elaborate queries?
 - Similar to what you may do in databases.
- What about very specialised queries?
 - E.g. in specific domains (e.g. protein structures)
 - Again similar to those to databases.

A Web of Data

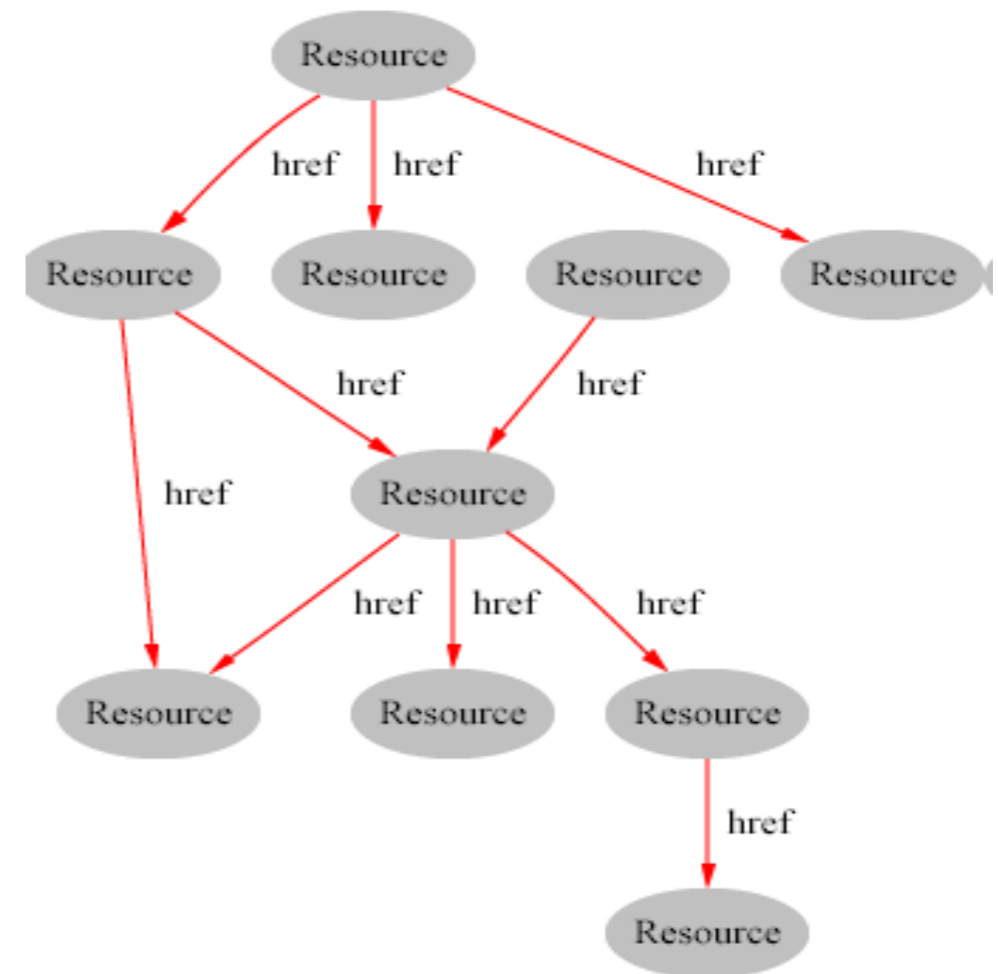
- What we need is a Web of (raw) Data
- Use the linked data in the same way we do with linked documents
 - be able to link data independently of presentation
 - use the data to query it, present it, mine it
 - have data in a machine processable format

A Semantic Web of Data

- In the Web, such data must be accompanied by its meaning.
- The meaning of Web pages is not readily machine-accessible: lack of semantics
- It is difficult to distinguish the meaning between these two sentences:
 - I am a professor of computer science.
 - I am a professor of computer science, you may think.
Well, . . .
- Natural language processing cannot be the answer in such a huge scale

The Syntactic Web

- The Web is a set of resources and links (relationships)
- Resources are identified by URLs
- There is little information for automated processing (keywords, plain text)
- The meaning of the links is contextual (it depends on the included Web Page)



The Semantic Web Vision

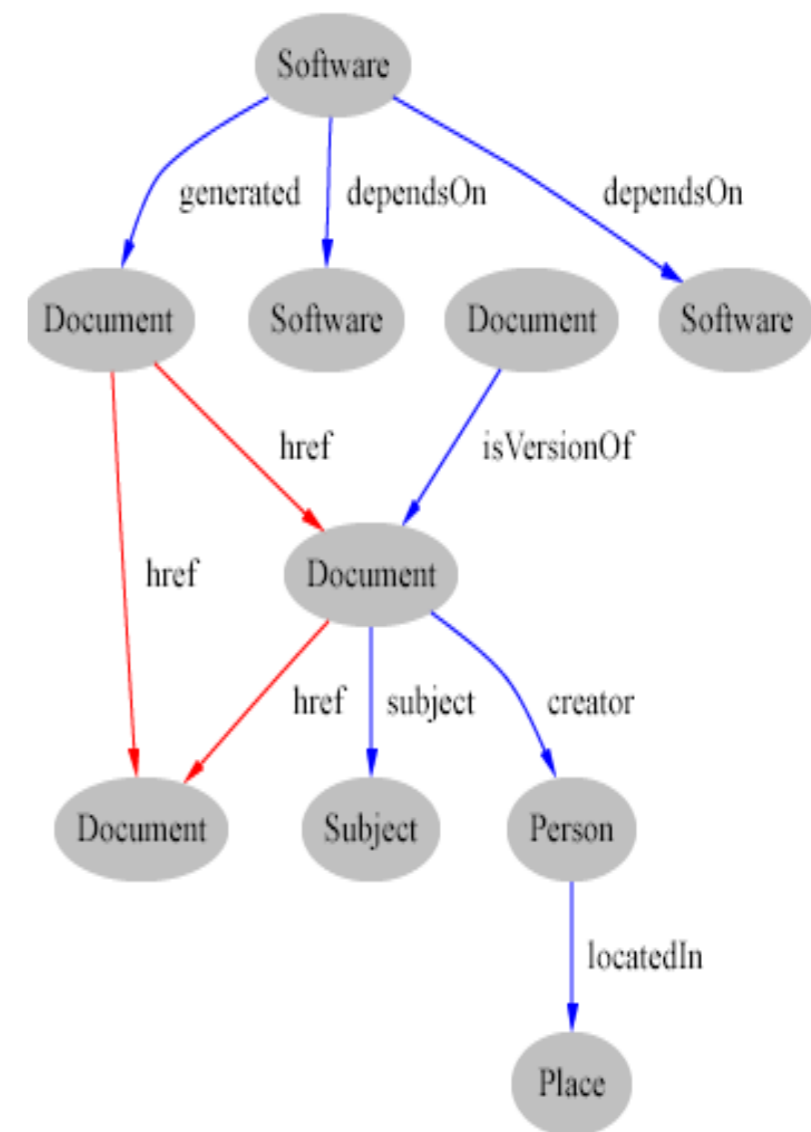
“I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web – the content, links, and transactions between people and computers. A ‘Semantic Web’, which should make this possible, has yet to emerge, but when it does, the day-to-day mechanisms of trade, bureaucracy and our daily lives will be handled by machines talking to machines. The ‘intelligent agents’ people have touted for ages will finally materialize.”

Tim Berners-Lee, 1999



The Semantic Web

- The Web is still a set of resources and links (relationships)
- Resources and relationships are identified by URIs
- Resources are strongly typed
- Transparent to the user
- Machine understandable
- Ontologies defining the meaning



The Semantic Web Approach

- Represent Web content in a form that is more easily machine-processable.
- Use intelligent techniques to take advantage of these representations.
- The Semantic Web will gradually evolve out of the existing Web
 - It is not a competition to the current WWW (like Web 2.0 was not a competitor to Web 1.0)
- **A Web in machines, for humans and machines usage**
- **Evolving into a Web of Data**

Semantic Web definitions

- *"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."* - Tim Berners-Lee, James Hendler, Ora Lassila, [The Semantic Web](#), Scientific American, May 2001
- *"Now, miraculously, we have the Web. For the documents in our lives, everything is simple and smooth. But for data, we are still pre-Web."* - Tim Berners-Lee, Business Model for the Semantic Web

Semantic Web definitions

- *The Semantic Web provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries. It is a collaborative effort led by W3C with participation from a large number of researchers and industrial partners. It is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML for syntax and URIs for naming. - In w3c.org*

An example of integration

- Consider the following data(base) on a bookstore, to be published in a Web page

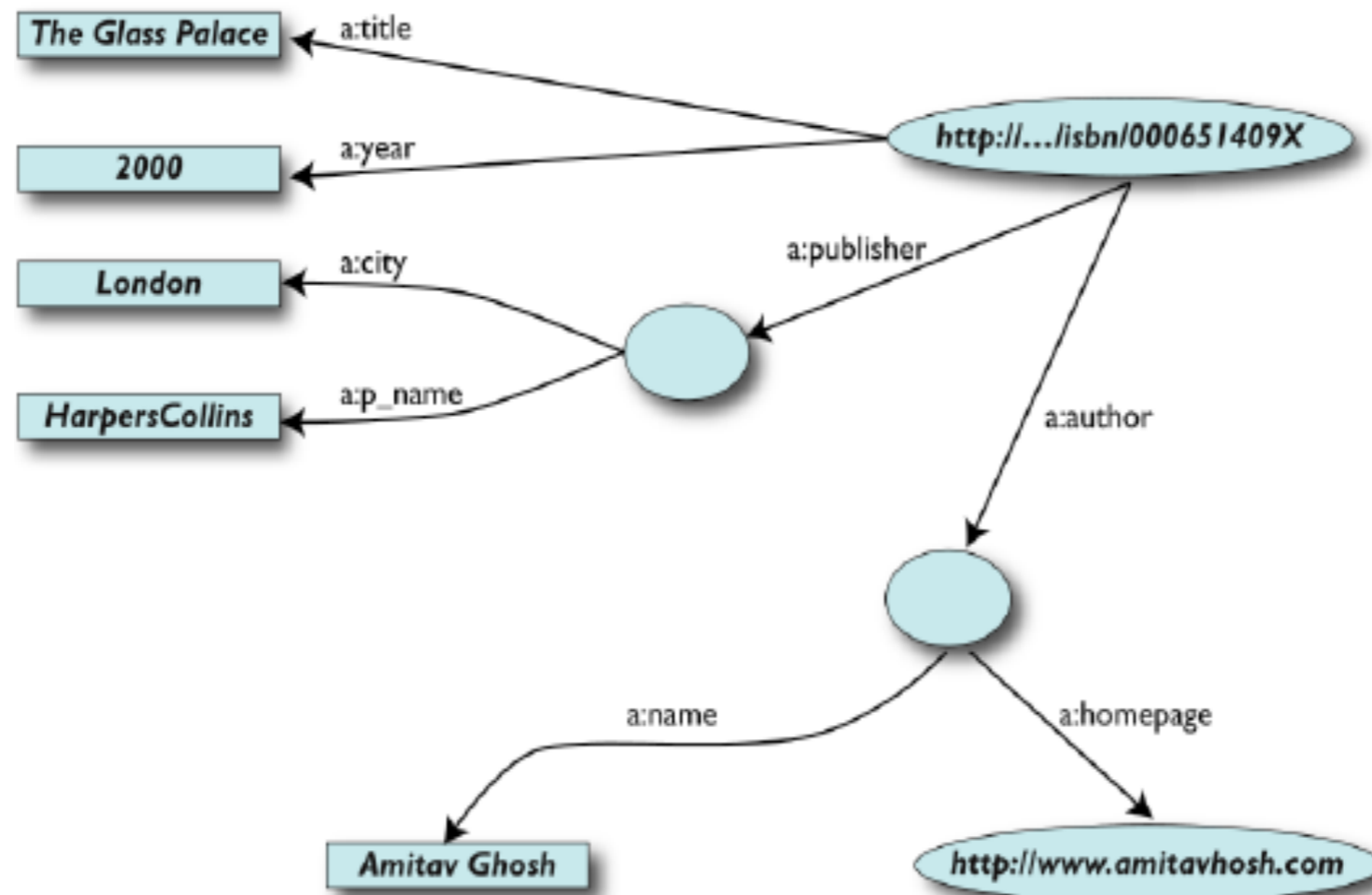
ID	Author	Title	Publisher	Year
ISBN 0-00-651409-X	id_xyz	The Glass Palace	id_qpr	2000

ID	Name	Home page
id_xyz	Amitav Ghosh	http://www.amitavghosh.com/

ID	Publisher Name	City
id_qpr	Harper Collins	London

Data Integration Example

- Besides publishing the data on a nice Web page, also export data as relations
 - Relations form a graph, where nodes refer to either data or identifiers (URI)

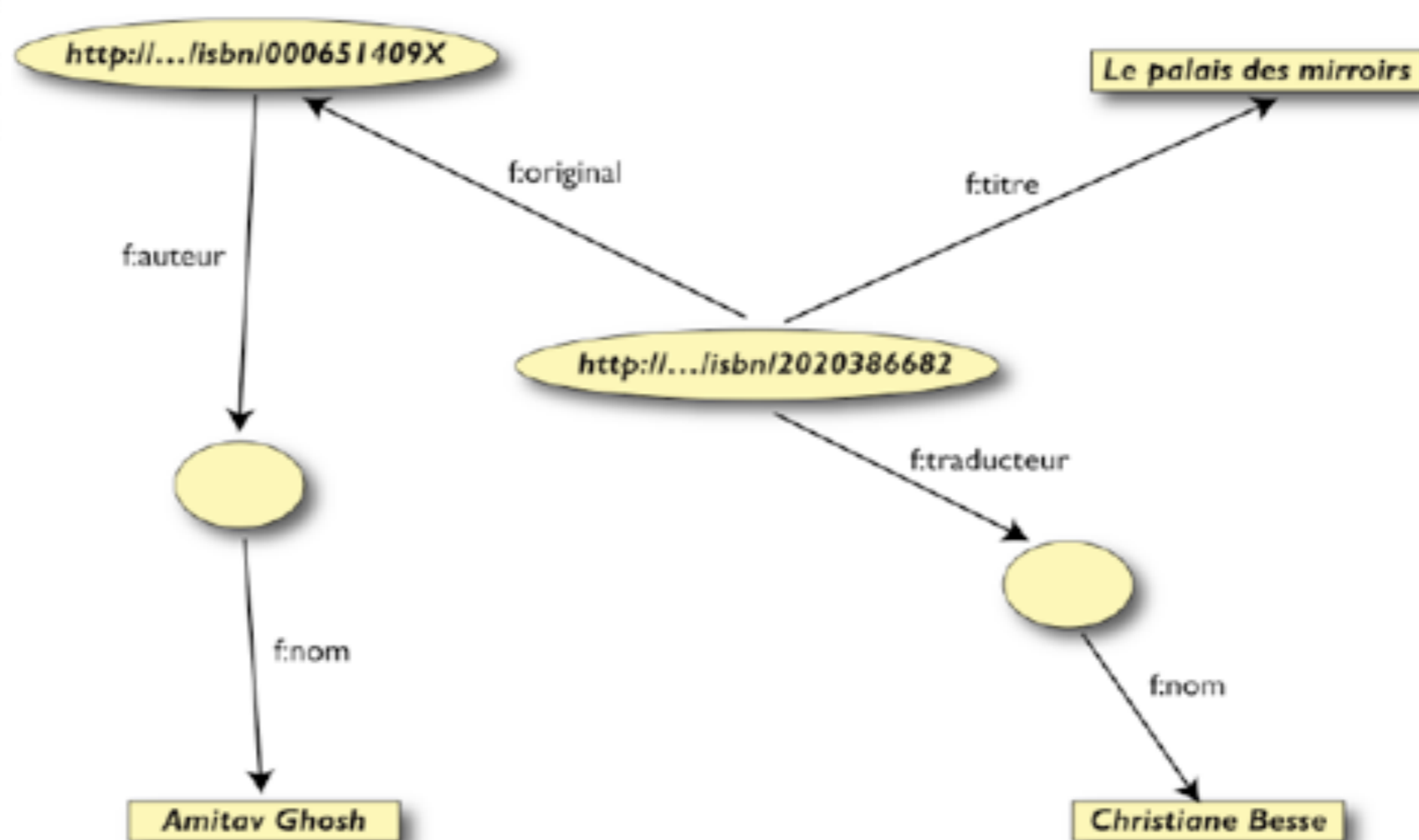


Data Integration Example

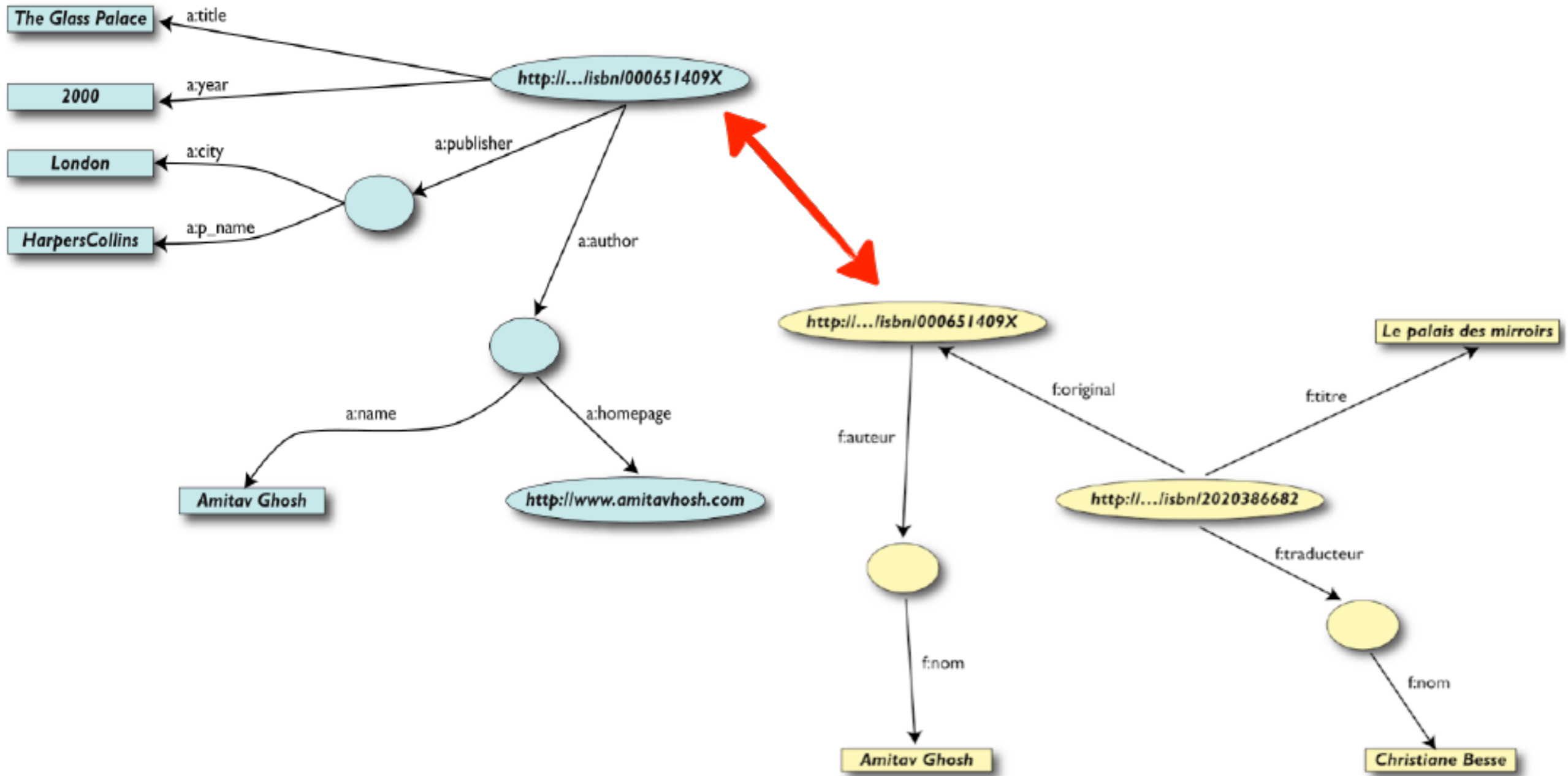
- Data in another bookstore:

ID	Titre	Auteur	Traducteur	Original
ISBN 2020386682	Le Palais des miroirs	i_abc	i_qrs	ISBN 0-00-651409-X

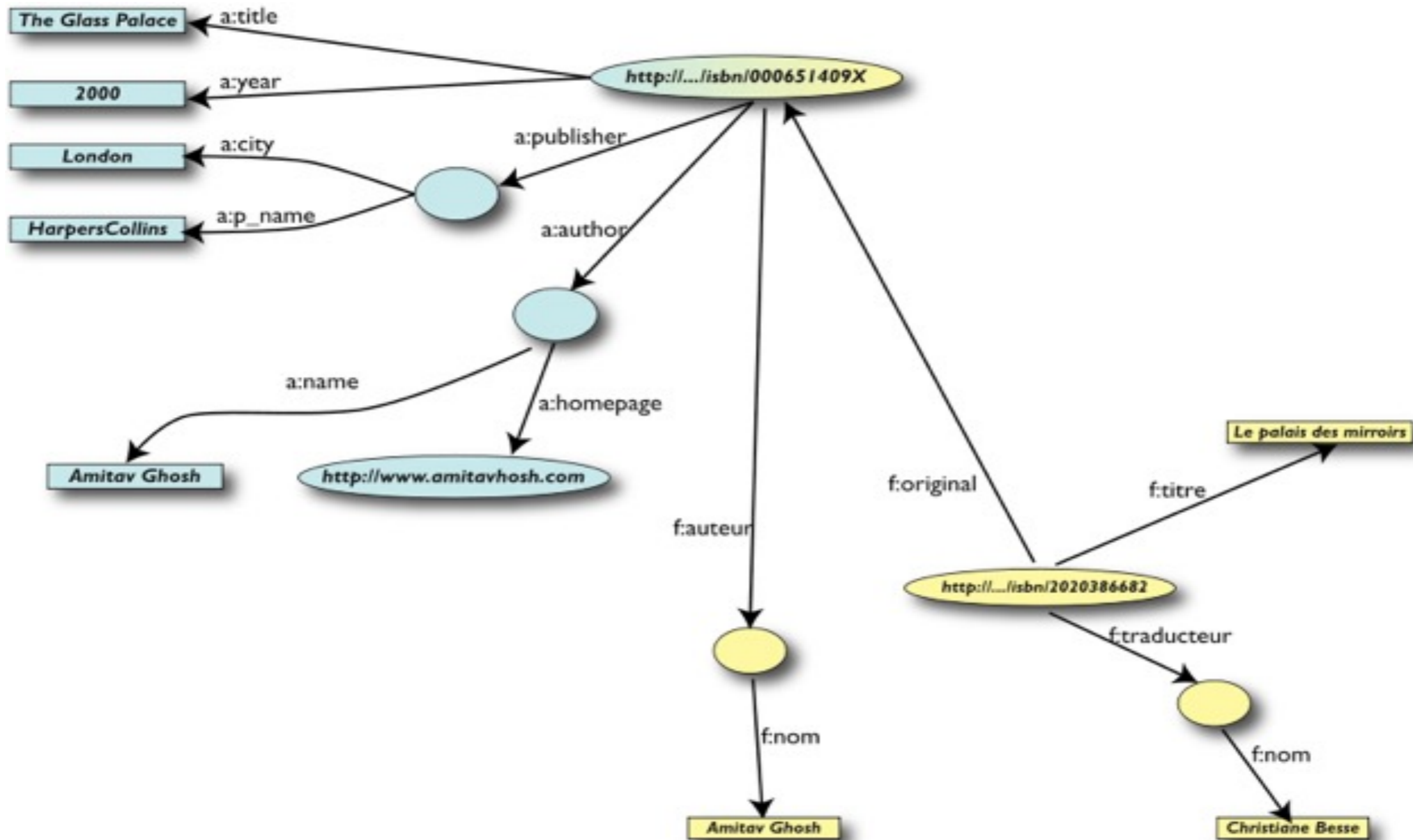
ID	Nom
i_abc	Amitav Ghosh
i_qrs	Christiane Besse



Data Integration Example



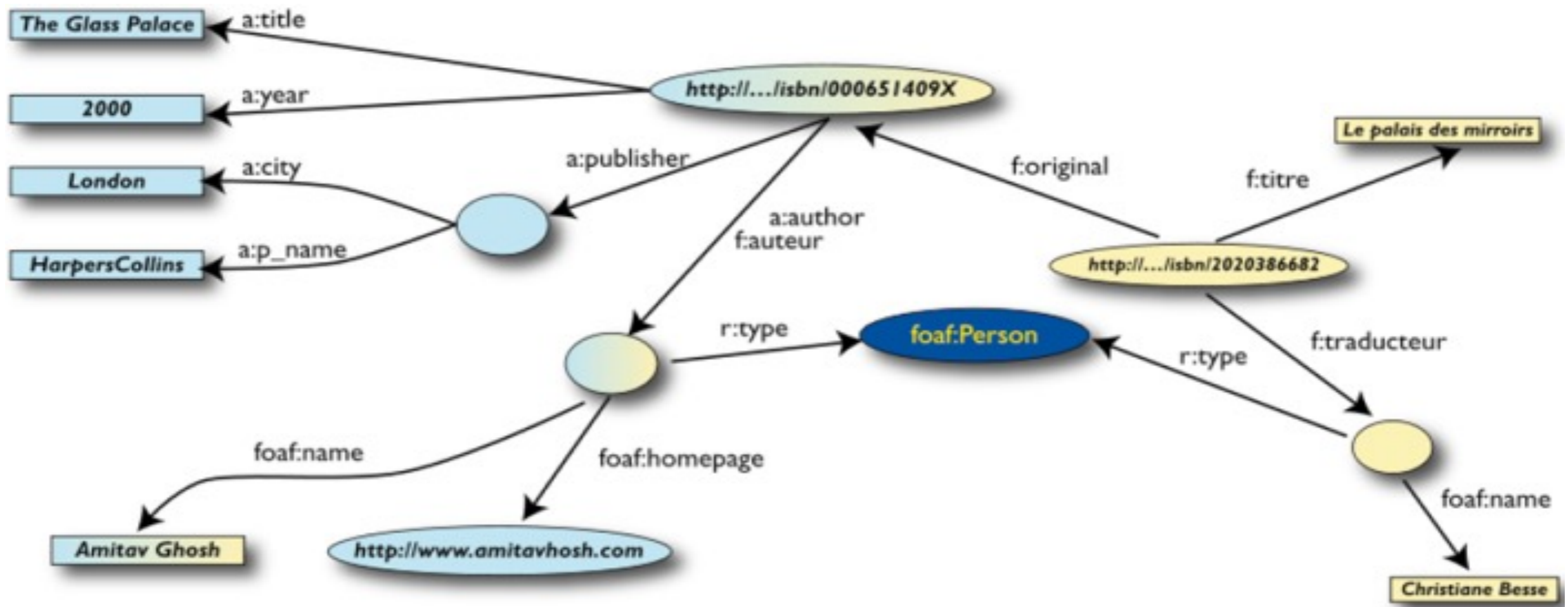
Data Integration Example



Data Integration Example

- What if we had additional knowledge?
- E.g.
 - we could know that a:author is the same as f:auteur
 - We could know that in both cases they represent persons
- In other words, we could have
 - ontologies describing the concepts and relations
 - mappings of our relations into the ontologies

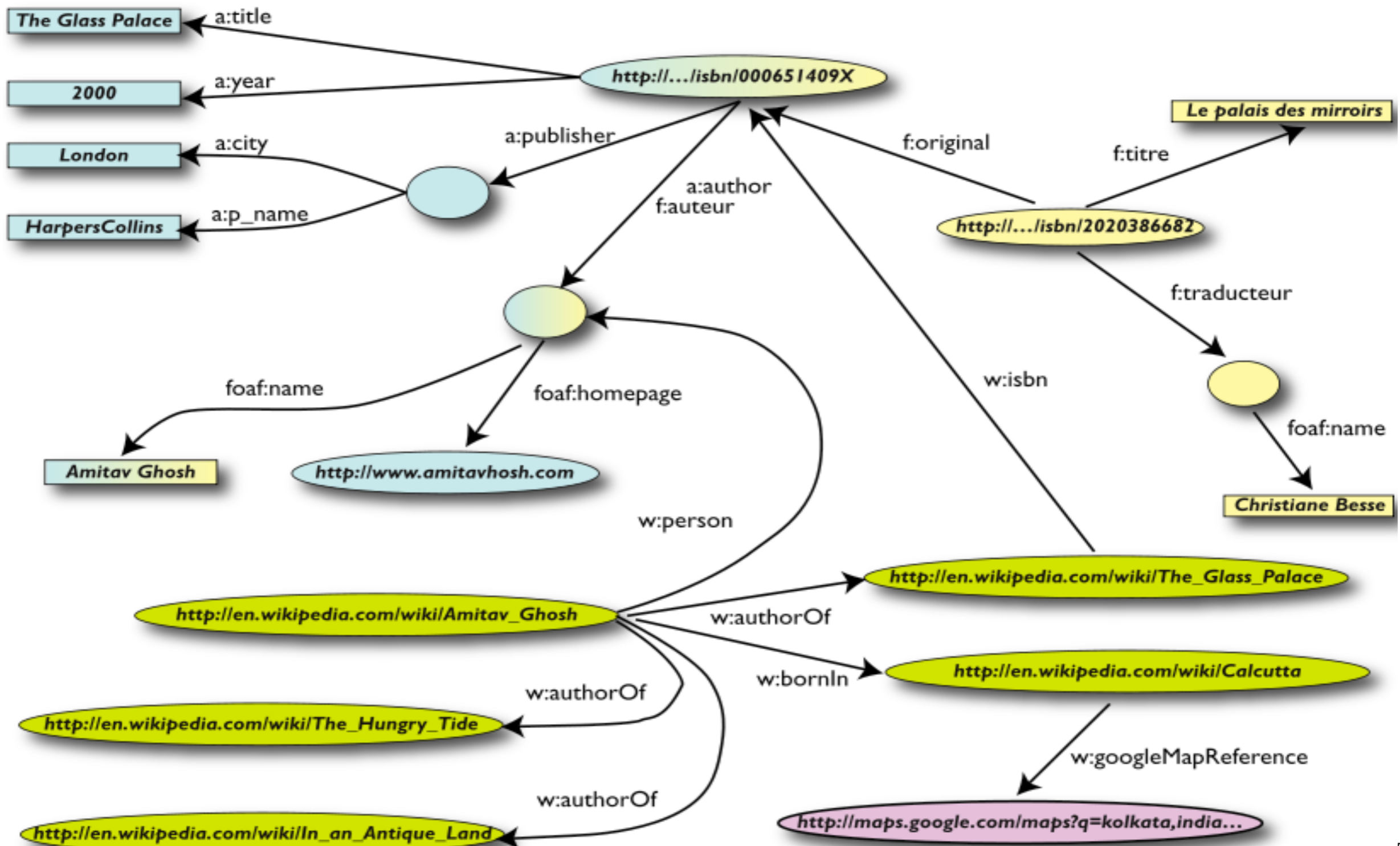
Data Integration Example



Data Integration Example

- With this merged information, richer queries are possible:
 - The second bookstore can query what is the web page of the author of the book
 - Possibly can ask about other information on the author, or translator via foaf
 - The first bookstore can query information about the translator
 - ...

A Web of Data Example



Automatic data integration

- This process of merging knowledge is done easily by users in the Web
- For doing it automatically, some more rigour was needed
 - Have data structured in the web
 - Name relations in a standard manner
 - Have ontologies for describing general concepts
 - Refer to the ontologies when exporting relations
- The Semantic Web provides technologies to make all this possible
 - For structuring data; defining relations; defining ontologies; querying data; reasoning over data; ...

Semantic Web Principles

- Everything which is identifiable is in the Semantic Web
 - All resources are identifiable
 - Real world's people, places and objects will have a “representation” in the Web identified by Uniform Resource Identifiers (URIs)
 - URIs ease integration, participation, and contextualisation in the Semantic Web

Semantic Web Principles

- Information in the Semantic Web is partial
 - The (Semantic) Web is unlimited.
 - Everyone can say anything about something
 - There will always exist something new to be discovered / indexed
 - Unlike in databases, here the lack of some piece of information does not mean that the information is false (no Closed World Assumption)

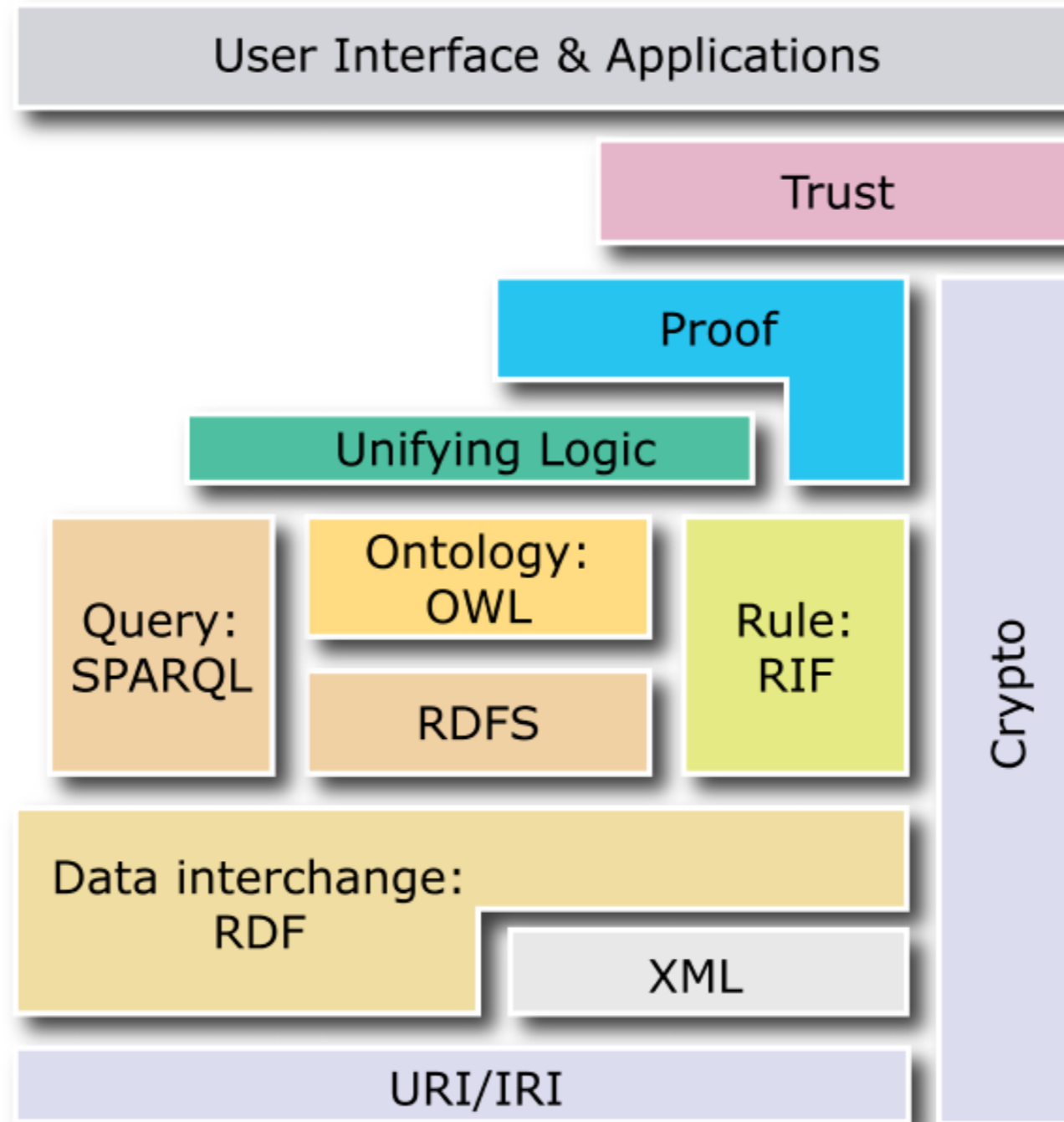
Semantic Web Principles

- There should be support for evolution
 - The Semantic Web should allow information and knowledge of independent communities to be effectively combined.
 - Allow the addition of new information without the need for updating old information.
 - Provide mechanisms to solve ambiguities and solve inconsistencies.
 - The Semantic Web should be based on descriptive conventions that grow while human knowledge increases.
 - The semantics of vocabularies should be defined by the communities resorting to W3C technology.

Semantic Web Principles

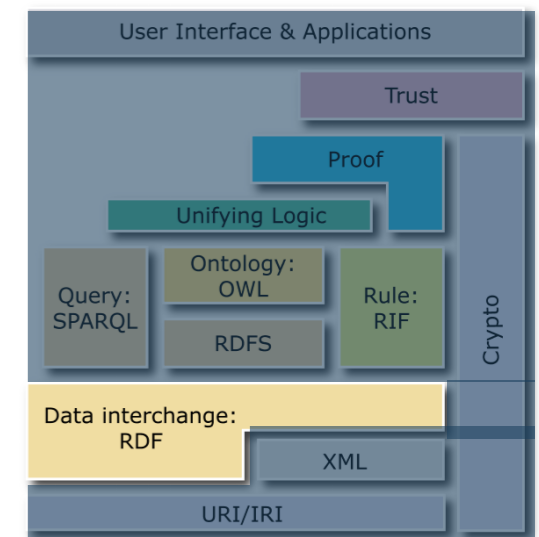
- The design should be minimalist
 - Do not make simple things difficult
 - But, at the same time, allow representation of complex information.
 - Standardise what is essential; not more!
 - More than the sum of parts
- The architecture should be based on existing technology
 - Common syntax in XML and JSON
 - Use ontologies to give meaning to data
 - Logic to derive and validate knowledge
 - Software agents

The Semantic Web Cake



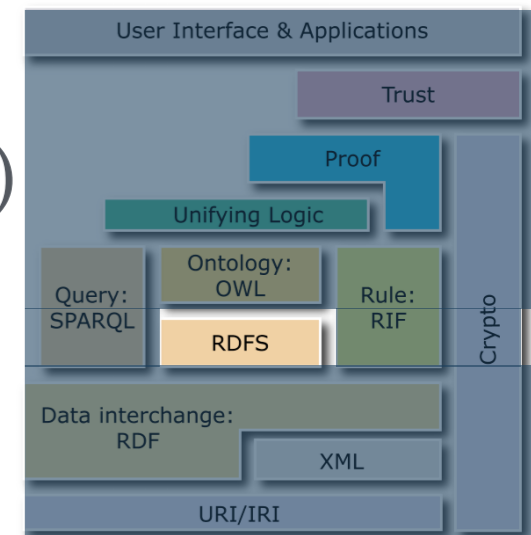
RDF (Resource Description Framework)

- **RDF** is a data model for objects and relations between them
 - much like the graphs of the integration example
- Set of triples (*subject, property, object*)
 - *subject* and *property* are URIs
 - *object* is either a value or a URI
- Plus some standard machine readable formats (e.g. RDF / XML)
 - and some more details... of course



RDFS (RDF Schema)

- **RDFS** is a vocabulary description language
 - Describes properties and classes of RDF resources (defines the terms that can be used)
 - Allows for “typing” objects and properties
 - Provides semantics for generalisation hierarchies of properties and classes
- RDFS already allows for some inference
 - e.g class / subclass relations
- Represented in RDF, and available in the Web



Beyond RDFS

- In general RDFS is not enough to completely characterise the objects and properties
- Users would like to state e.g.
 - that two concepts are equivalent, or disjoint, or complementary (e.g. author and auter are the same concept)
 - that some logical relations exist between object (e.g. a country must have a capital)
 - Value and cardinality restriction (e.g. min and max value, etc)
- A richer **ontology language** is needed

Ontologies

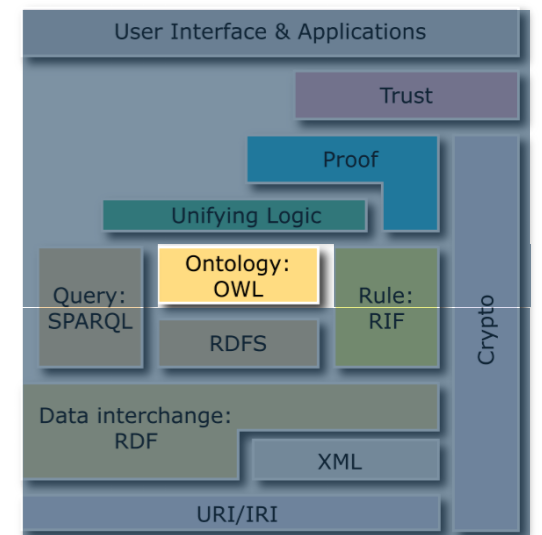
- The term *ontology* originates from philosophy
 - *The study of the nature of existence*
- Different meaning in computer science
 - *An ontology is an explicit and formal specification of a conceptualisation*
- Ontologies provide a shared understanding of a domain: semantic interoperability
 - overcome differences in terminology
 - mappings between ontologies

More on ontologies for the SW

- Ontologies are also useful for improving accuracy of Web searches
 - search engines can look for pages that refer to a precise concept in an ontology
- Web searches can exploit generalisation/specialisation information
 - If a query fails to find a relevant document, the search engine may suggest to the user a more general query.
 - If too many answers are retrieved, the search engine may suggest to the user some specialisation.

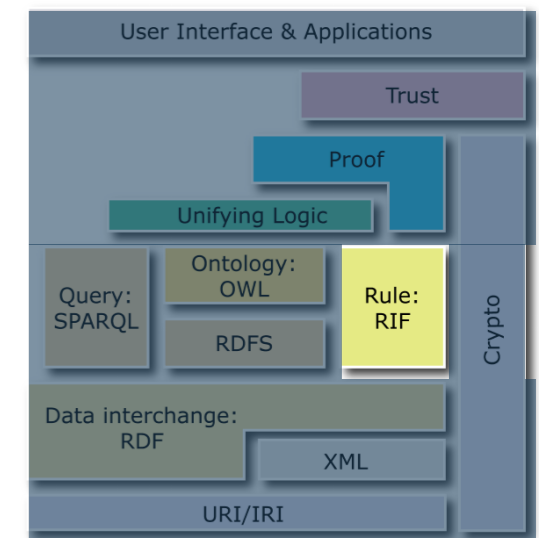
OWL (Web Ontology Language)

- A richer ontology language, including
 - relations between classes (e.g., disjointness)
 - cardinality (e.g. “exactly one”)
 - richer typing of properties
 - characteristics of properties (e.g., symmetry)
 - (and much more)
- It is in fact a Web-like language for a *Description Logic Language* (a fragment of 1st Order Logic)



Rules

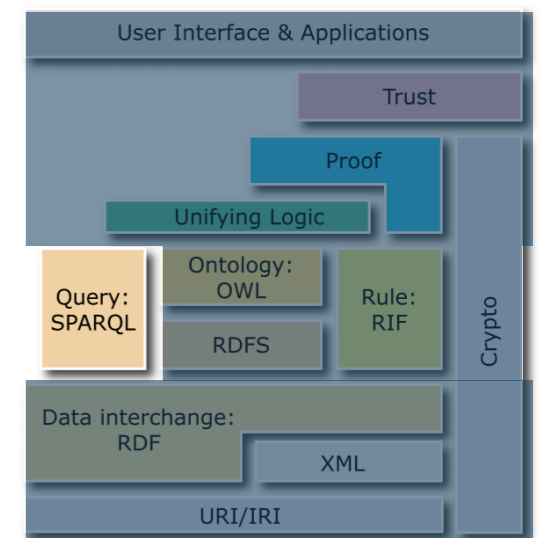
- Richer statements about data can also be expressed
 - Declarative rules (like database views)
 - Production (Reactive) rules (like triggers)
- RIF - Rule Interchange Format



SPARQL (Sparql Protocol And Rdf Query Language)

- A standard language for querying Semantic Web data
 - Much like SQL is for relational databases

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX ns: <http://example.org/ns#>
SELECT ?title ?price WHERE {
  ?x ns:price ?price .
  FILTER (?price < 30) .
  ?x dc:title ?title . }
```

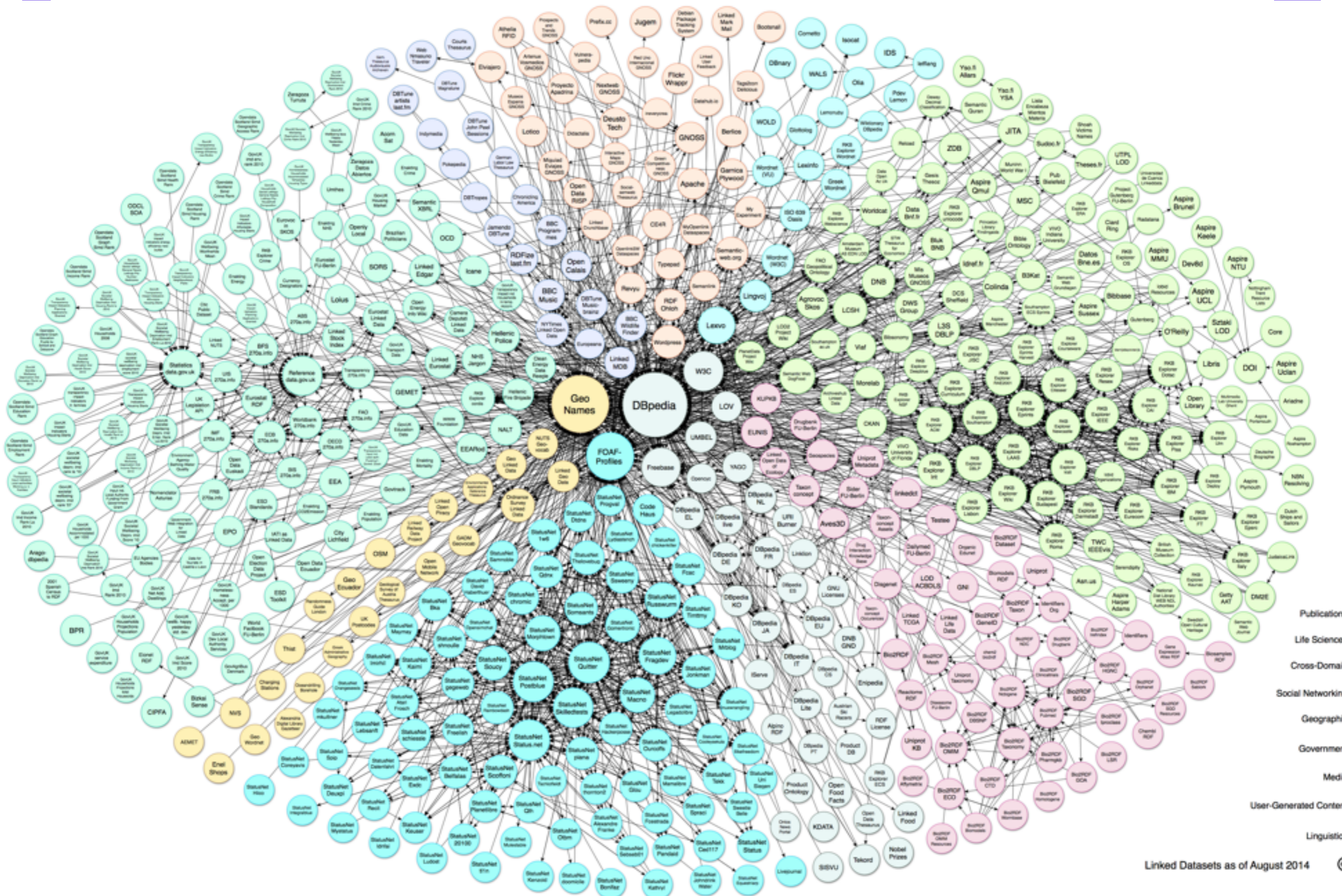


The Semantic Web at work

- Until recently, the Semantic Web was mainly a vision for a future, better, web
- Today it is becoming a reality!
- The Semantic Web can only work if there is enough linked web data out there, and enough ontologies to go with it
- But the same could have been said about the Web, in its beginning
 - It could (and did!) only work with enough web documents out there

Linked Open Data Project

- An open initiative project
- “Exposing, sharing, and connecting pieces of data, information, and knowledge on the Semantic Web using URIs and RDF.”
- Large number of datasets with connections between them
- Billions of triples, millions of links!
- See at <http://linkeddata.org/>



Linked Datasets as of August 2014

DBpedia

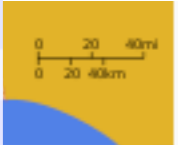


- It is one of the nodes in that Linked Data graph
- Includes (up-to-date) raw data extracted from wikipedia (infobox)
- Interlinks with other datasets on the linked open data

DBpedia



property	hasValue
rdf:type	owl:Thing
rdf:type	dbpedia:ontology/Place
rdf:type	dbpedia:ontology/Area
rdf:type	<http://sw.opencyc.org/2008/06/10/concept/Mx4rvVjnqJwpEbGdrcN5Y29ycA>
rdf:type	dbpedia:class/yago/MunicipalitiesOfPortugal
rdf:type	dbpedia:ontology/PopulatedPlace
rdf:type	dbpedia:class/yago/UniversityTowns
rdf:type	dbpedia:class/yago/CitiesInPortugal
foaf:homepage	<http://www.cm-coimbra.pt/>
dbpedia:ontology/populationTotal	137212
dbpedia:ontology/PopulatedPlace/populationDensity	"429.6000"^^ dbpedia:ontology/inhabitantsPerSquareKilometre
dbpedia:ontology/PopulatedPlace/leaderName	: Carlos_Encarna%C3%A7%C3%A3o
dbpedia:ontology/leaderTitle	"Mayor"
dbpedia:ontology/type	: Municipalities_of_Portugal
owl:sameAs	<http://sw.opencyc.org/2008/06/10/concept/Mx4rwSroZpwpEbGdrcN5Y29ycA>
owl:sameAs	<http://sws.geonames.org/2740637/>
owl:sameAs	<http://rdf.freebase.com/ns/guid.9202a8c04000641f8000000000209e59>
owl:sameAs	<http://umbel.org/umbel/ne/wikipedia/Coimbra>
foaf:name	"Coimbra"
foaf:page	<http://en.wikipedia.org/wiki/Coimbra>
dbpedia:ontology/PopulatedPlace/populationTotal	137212
dbpedia:ontology/PopulatedPlace/leaderTitle	"Mayor"
dbpedia:ontology/Place/areaTotal	"319.4000"^^ dbpedia:ontology/squareKilometre
dbpedia2:reference	<http://web.archive.org/web/20071011035847/http://www.cm-coimbra.pt/>
dbpedia2:reference	<http://www.flickr.com/photos/vitor107/sets/1419567/>
dbpedia2:reference	<http://www.turismo-centro.pt/>
dbpedia2:reference	<http://wikitravel.org/en/Coimbra>
dbpedia2:reference	<http://www.verdesanos.com/home.htm>
dbpedia2:reference	<http://www.forumcoimbra.com/>
<http://www.georss.org/georss/point>	"40.2 -8.4166666666667"
<http://www.georss.org/georss/point>	"40.20000000 -8.416666667"



Revisiting Queries

- With this kind of information we can make database-like queries to data in the web
- We can query, e.g. inside a program, the Web of Data
- Let's try it (in a SPARQL query web interface)

```
SELECT ?Pais ?Populacao ?PopulacaoPT
WHERE {
  ?Pais rdf:type <http://dbpedia.org/ontology/Country>.
  ?Pais dbpedia2:populationEstimate ?Populacao.
  <http://dbpedia.org/resource/Portugal> dbpedia2:populationEstimate ?PopulacaoPT .
  FILTER (?Populacao < ?PopulacaoPT) .
}
```


SPARQL Explorer for http://dbpedia.org/sparql

http://dbpedia.org/snorql/?query=SELECT+%3FPais+?Populacao+?PopulacaoPT

Google

SPARQL:

```

PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX : <http://dbpedia.org/resource/>
PREFIX dbpedia2: <http://dbpedia.org/property/>
PREFIX dbpedia: <http://dbpedia.org/>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>

SELECT ?Pais ?Populacao ?PopulacaoPT
WHERE {
  ?Pais rdf:type <http://dbpedia.org/ontology/Country>.
  ?Pais dbpedia2:populationEstimate ?Populacao.
  <http://dbpedia.org/resource/Portugal> dbpedia2:populationEstimate ?PopulacaoPT .
  FILTER (?Populacao < ?PopulacaoPT) .
}

```

Results:

-
-
-

```

SELECT ?Pais
WHERE {
  ?Pais rdf:ty
  ?Pais dbpe
  <http://dk
  FILTER (?Pc
}

```

SPARQL results:

Pais	Populacao	PopulacaoPT
:Clipperton_Island	0	10707924
:South_Georgia_and_the_South_Sandwich_Islands	30	10707924
:Pitcairn_Islands	50	10707924
:British_Antarctic_Territory	250	10707924
:Cocos_%28Keeling%29_Islands	596	10707924
:Sark	600	10707924
:Vatican_City	826	10707924
:Niue	1398	10707924
:Christmas_Island	1402	10707924
:Tokelau	1416	10707924
:Norfolk_Island	2141	10707924
:Alderney	2400	10707924
:Svalbard	2572	10707924
:Montserrat	4655	10707924
:Easter_Island	4781	10707924
:Nisga%27a	6000	10707924

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e ?PopulacaoPT .

Revisiting Queries

- Or restricting to countries in Europe, as wanted before
 - I.e. What are the countries in Europe with less population than Portugal.

```
SELECT ?Pais ?Populacao
WHERE {
  ?Pais rdf:type <http://dbpedia.org/ontology/Country>.
  ?Pais dbpedia2:populationEstimate ?Populacao.
  ?Pais <http://purl.org/dc/terms/subject> <http://dbpedia.org/resource/
Category:Countries_in_Europe>.
  <http://dbpedia.org/resource/Portugal> dbpedia2:populationEstimate ?PopulacaoPT .
  FILTER (?Populacao < ?PopulacaoPT) .
}
```

- Or re
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```
SELECT ?Pais ?P
WHERE {
  ?Pais rdf:type
  ?Pais dbpedia:
  ?Pais <http://
Category:Count
<http://dbpe
FILTER (?Popu
}
```

SPARQL results:

Pais	Populacao
:Georgia_(country) ↗	4942157
:Vatican_City ↗	839
:Albania ↗	3011405
:Andorra ↗	85082
:Azerbaijan ↗	9494600
:Belarus ↗	9468154
:Cyprus ↗	1117000
:Finland ↗	5457429
:Hungary ↗	9879000
:Latvia ↗	2003000
:Liechtenstein ↗	36281
:Lithuania ↗	2944459
:Luxembourg ↗	537853
:Moldova ↗	3559500
:Monaco ↗	36371
:San_Marino ↗	32576
:Slovakia ↗	5415949
:Slovenia ↗	2059114
:Switzerland ↗	8014000
:Denmark ↗	5627235
:Republic_of_Macedonia ↗	2058539
:Estonia ↗	1311870

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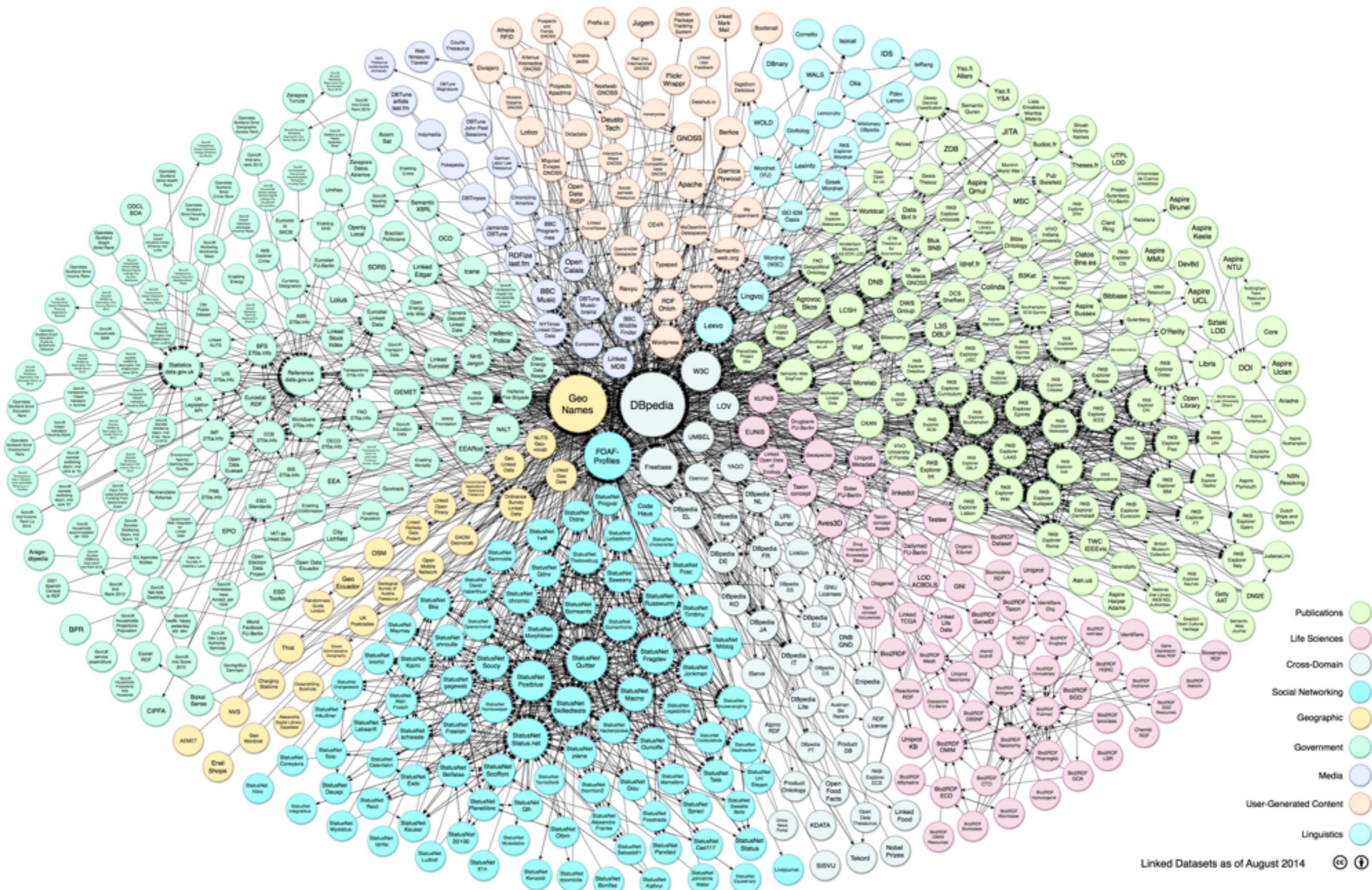
ess

resource/

mate ?PopulacaoPT .

Some More Datasets

- PubMed
- GeneOntology
- BBC
- Music Brainz
- US Census Data
- Data.Gov.UK
- US Congress
- ...



- Publications
- Life Sciences
- Cross-Domain
- Social Networking
- Geographic
- Government
- Media
- User-Generated Content
- Linguistics

Linked Datasets as of August 2014

Applications are popping up

Unlocking innovation | data.gov.uk

Most Recent Apps

[View all apps](#) +



Geopostcode

An API for retrieving geographic information (grid reference, latitude and longitude) relating to postcodes. Data is available as XML or JSON. A PHP class is also provided...

By Chris Hastie
21/05/2010 - 22:38



Find BRB (Residuary) Ltd. property

This tool allows users to search by postcode for nearby property owned by BRB (Residuary) Ltd. Under the 1993 Railways Act, the old British Rail was split up and sold off....

By Adam Brookes
20/05/2010 - 13:33



UK Climate Projections (UKCP09)

The UK climate projections (UKCP09) provide information on how the UK's climate could change in the 21st century, as it responds to rising levels of greenhouse gases in the...

By Kathryn Humphrey
14/05/2010 - 13:20

Most Recent Ideas

[View all ideas](#) +



Map of UK housing associations

It would be great if there was an app showing the exact location of all UK housing...

By John R.



Road Safety

hello i have contacted Tomtom and Garmin to make an addition to their software which...

By Mark Wilkinson
16/05/2010

Do you have a great idea?



be up soon <-
excellent

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- ▶ [Digital Britain](#) ↗
- ▶ [Jeni Tennison](#) ↗

Applications are popping up

- Development and querying application
 - Yagoo
 - iSparql
 - OpenLink data Explorer; ...
- Application making use of data
 - Relation Finder
 - DBpedia mobile
 - GoPubMed
 - TrialX; ...
- A lot of prototypes at:
 - <http://challenge.semanticweb.org/>

Things not called Semantic Web

- Others give different names to things that are similar to the Semantic Web
 - Facebook's OpenGraph and OpenGraph Protocol
 - Google's Knowledge Graph
 - Oracle's Spatial and Graph
 - Besides Oracle's Semantic Technologies
 - Schema.org
 - ...

The Semantic Web today

- The Semantic Web is about creating a Web of Data
- This World Wide Web of Data is rapidly becoming a reality
- It poses many new challenges for Computer Science
 - Management of SW Data (languages, tools, scalable processing, ...)
 - Populating the Web of Data (reading the web)
 - Dealing with, and building Ontologies
 - Reasoning over the Semantic Web
 - Reactivity over the Semantic Web
 - ...
- It opens lots of opportunities for applications

W3C Data Activity

The [W3C Data Activity](#) is the follower of the Semantic Web and eGovernment activities

- designed to support the needs of the public and private sector organizations working to publish and integrate data across the Web
- the primary value of Linked Data, of RDF and related technologies, is that these technologies have the Web at their “core,” providing a unique means of integrating data at Web scale
- not all applications need the power of Semantic Web technologies to achieve data integration
- The Data Activity will contribute to the larger data ecosystem to ensure interoperability and ease of application development.

W3C Data Activity

Other Interesting sites to visit

- [Data Exchange Group](#)
- [*The RDF Data Cube Vocabulary*](#)
- [Spatial Data on the Web Working Group](#) (includes also time!)
- [Data on the Web Best Practices Recommendation](#)
- [Web of Things - Linked Data as the basis for countering fragmentation of the IoT](#)
- [Big Data Europe](#)
- [Big Data for Industry \(Boost 4.0\)](#)
- [Linked Data for data privacy management \(SPECIAL\)](#)

Syllabus (revisited)

- What is the Semantic Web?
- Data Language:
 - RDF's language, model and encodings
 - RDFS's language, semantics and entailment
- Query Language
 - SPARQL: syntax, semantics and translations in relational algebra
- Modelling language:
 - Ontologies, OWL's language and reasoning
 - Rules, and their integration with ontologies