The world must learn to work together,
or finally it will not work at all.......
---- Dwight D. Eisenhower

ESIS Engels Semantic Information Services

Engels Semantic Information Services (ESIS) - Home

W3C's Semantic Web s

W3C Semantic Web

semweb report X10

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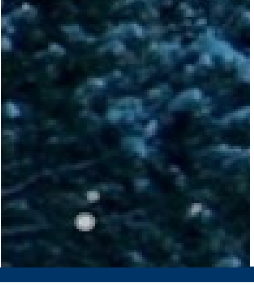
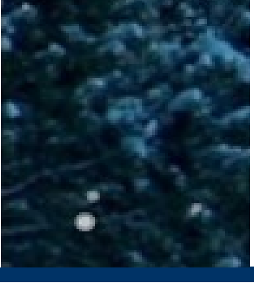


Robert H.P. Engels

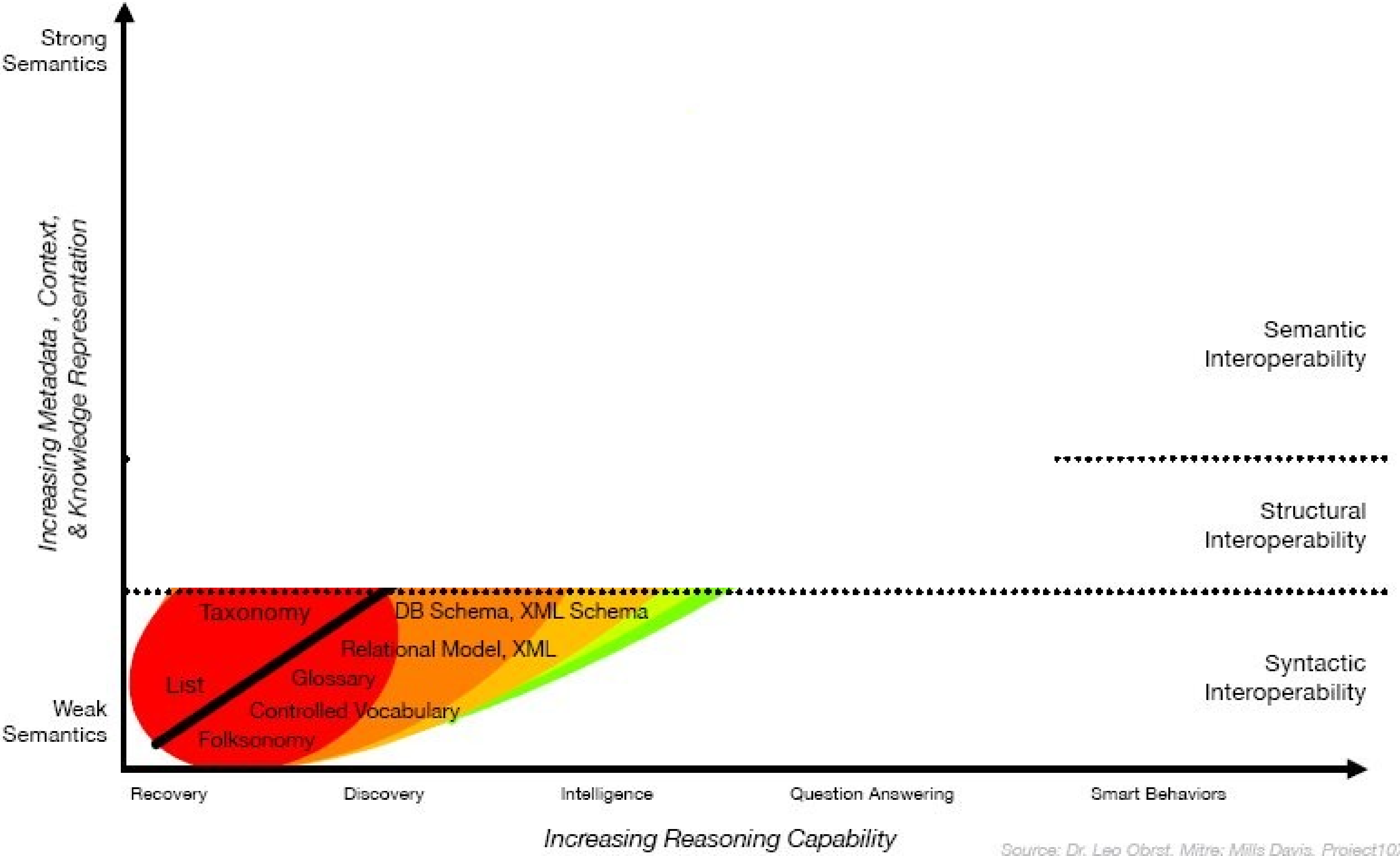
- Born in Amsterdam (1968)
- Studied at University of Amsterdam, Stockholm and Karlsruhe. MSc in Psy, PhD in AI & ML
- ML systems, Econometric Systems, KM systems, Computational Linguistics, Semantic Web
- Company owner, Products, EU expert, courses, consultancy etc.
- Also builds motorcycles ;-)
- robert.engels@esis.no / 99544481



Why are we here today?

- Discuss the (im-)possibilities of ISO15926 and possibilities for its implementation in KRL's with a strong(er) semantics
  - Motivate universities/research institutions in Norway to increase focus on semantics and ontologies
  - Strengthen the relation between universities/research institutions and the oil & gas industry
  - Create an academic network on ontology within research and teaching

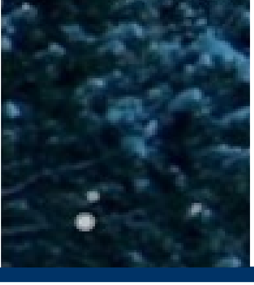
Spectrum of KR and Reasoning



Source: Dr. Leo Obrst, Mitre; Mills Davis, Project10X

“Semantic” standards to choose from...

- Unified Modeling Language (UML)
  - wellknown and often used standard
- UN/CEFACT Core Components
  - context independent: Core Component Technical Specification (CCTS)
  - context specific: Business Information Entities
- ISO Topic Maps
  - weak semantics, drawback in reasoning and wrt interoperability
- ISO 15926
  - extensive metamodel, predefines much of domain specific vocabulary
- W3C RDF/RDFSchema/OWL
  - well defined semantics, several flavours
  - widespread use on internet
  - enabler for data interoperability
  - complexity problems in specific problem domains



Implications of choosing

- Is support for the standard global?
  - » amateur content, professional content, sharing of digital assets
- Does the standard have enough international momentum?
  - » availability of human resources, development, tool support?
  - » pricing/licences – open source tools and standards?
- Does the standard support your needs for digital publication?
  - » can you actually represent what you need and use it in the ways you need?
  - » human readability (do you really facilitate people?)
  - » machine interoperability (can intelligent programs automatically interact with your information? can you automatically import information from other places?)
  - » will it be embedded in your digital formats?
- Does one need to choose at all?
  - » what is the choice actually?
  - » possibility for a heterogenous environment?

ESIS
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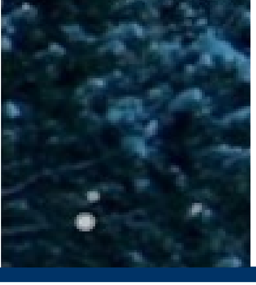
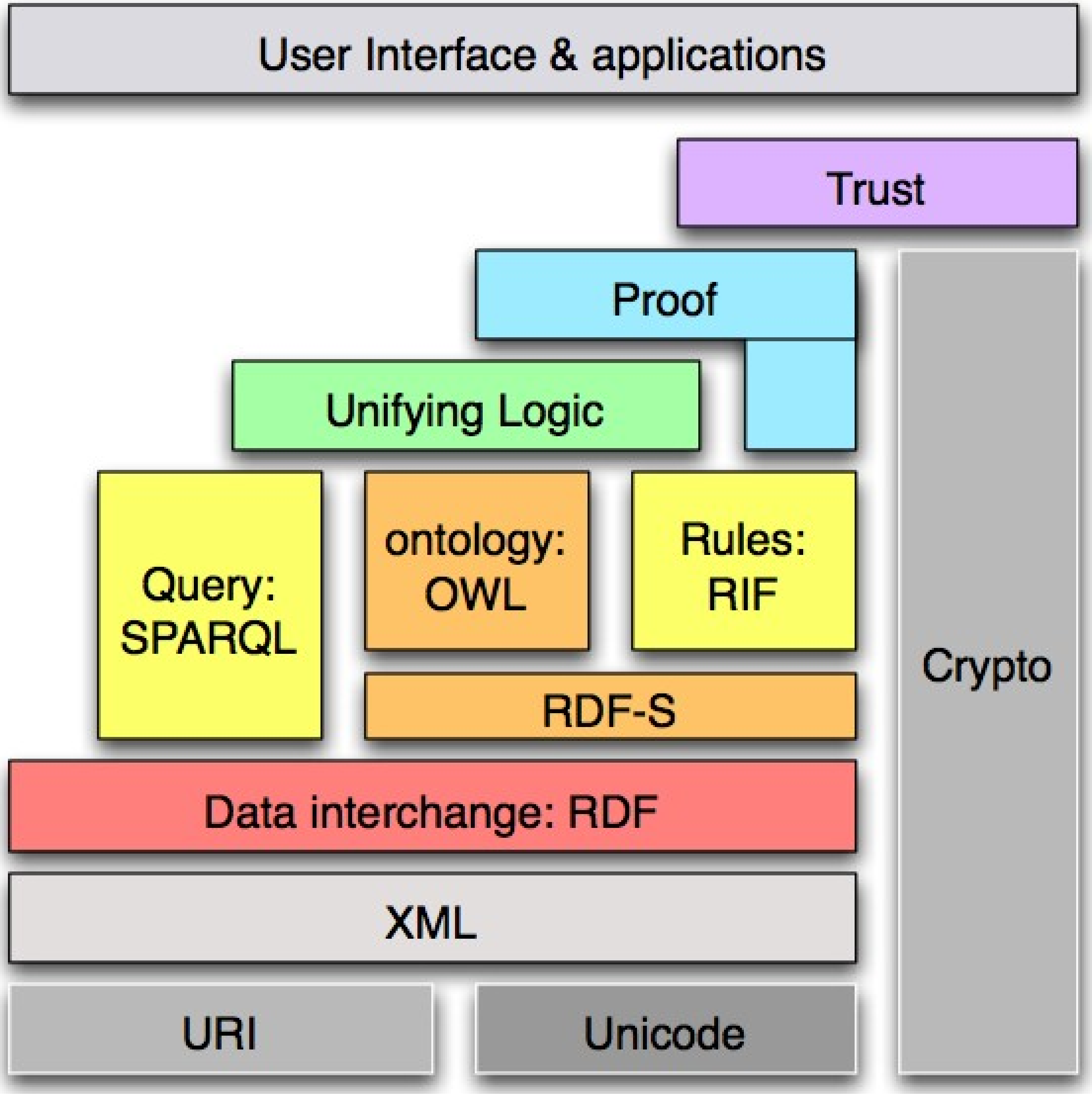
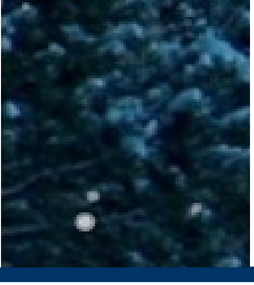
Semantic Web (W3C)

- W3C
  - Founded by Tim Berners Lee (the “initiator” of the Internet) in 1994
  - Creates Web Standards and Guidelines
  - Involved in education, outreach and software development
  - Started the Web (1991) and coined the Semantic Web (1999)
  - Coordinated by MIT (USA), European Research Centre (ERCIM, France) and Keio University (Japan) + World Offices all around the globe
- Semantic Web standard and technology
  - Set of standards for the “next generation in Internet” (1999)
  - Query Language for RDF (SPARQL – W3C recommendation)
  - Web Ontology Language (OWL – W3C recommendation)
  - RDF Schema (ontology definition)
  - Resource Description Framework

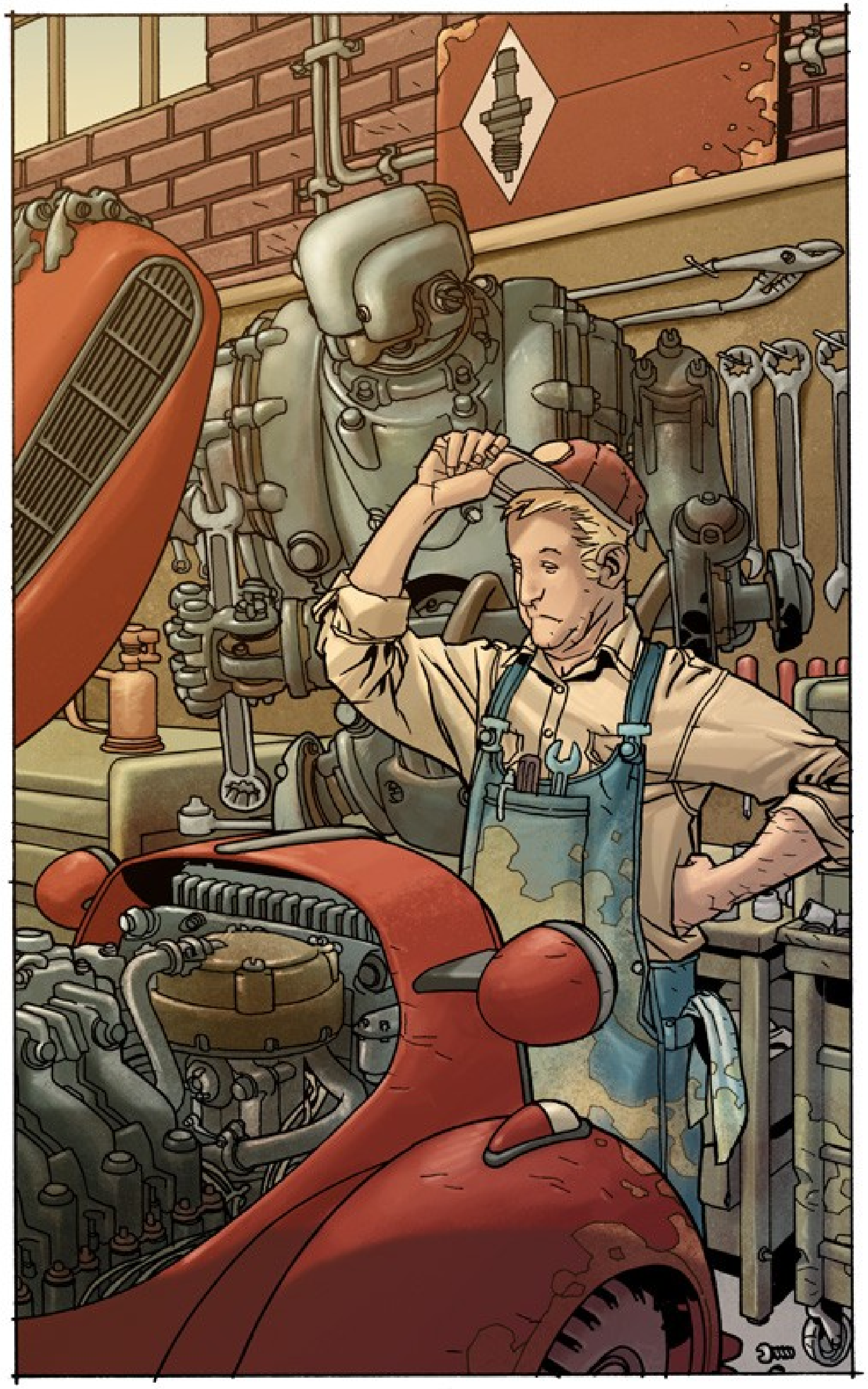


Current Status





Semantic Web Under the hood



a littlehelp from Ivan Herman's intro course to the semantic web

E

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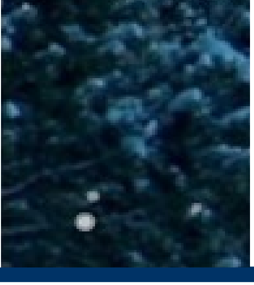

RDF triples (cont.)

- An RDF Triple **`(s,p,o)`** is such that:
  - “**s**”, “**p**” are URI-s, ie, resources on the Web; “**o**” is a URI or a literal
    - “**s**”, “**p**”, and “**o**” stand for “subject”, “property”, and “object”
  - here is the complete triple:

```
(<http://…isbn…6682>, <http://…/original>, <http://…isbn…409X>)
```

- *RDF* is a general model for such triples (with machine readable formats like RDF/XML, Turtle, N3, RXR, …)

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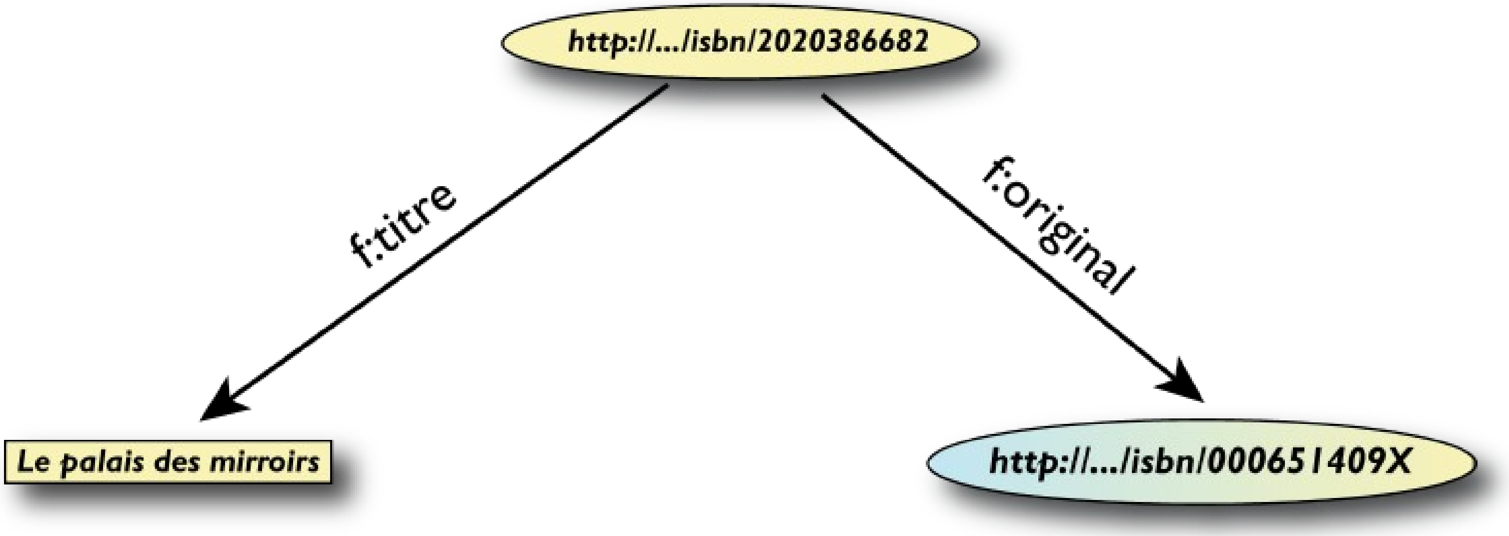
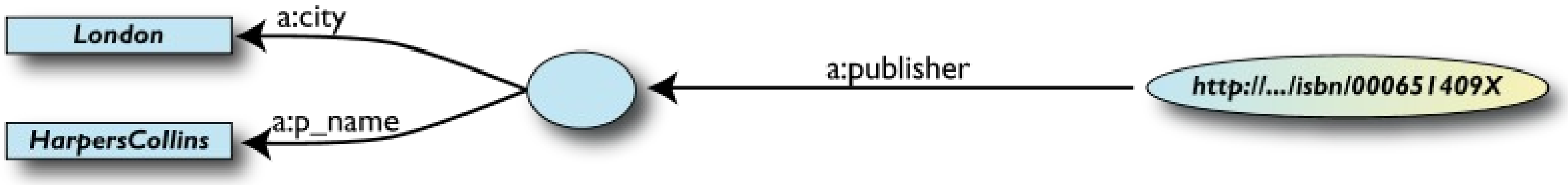
A simple RDF example (in Turtle)



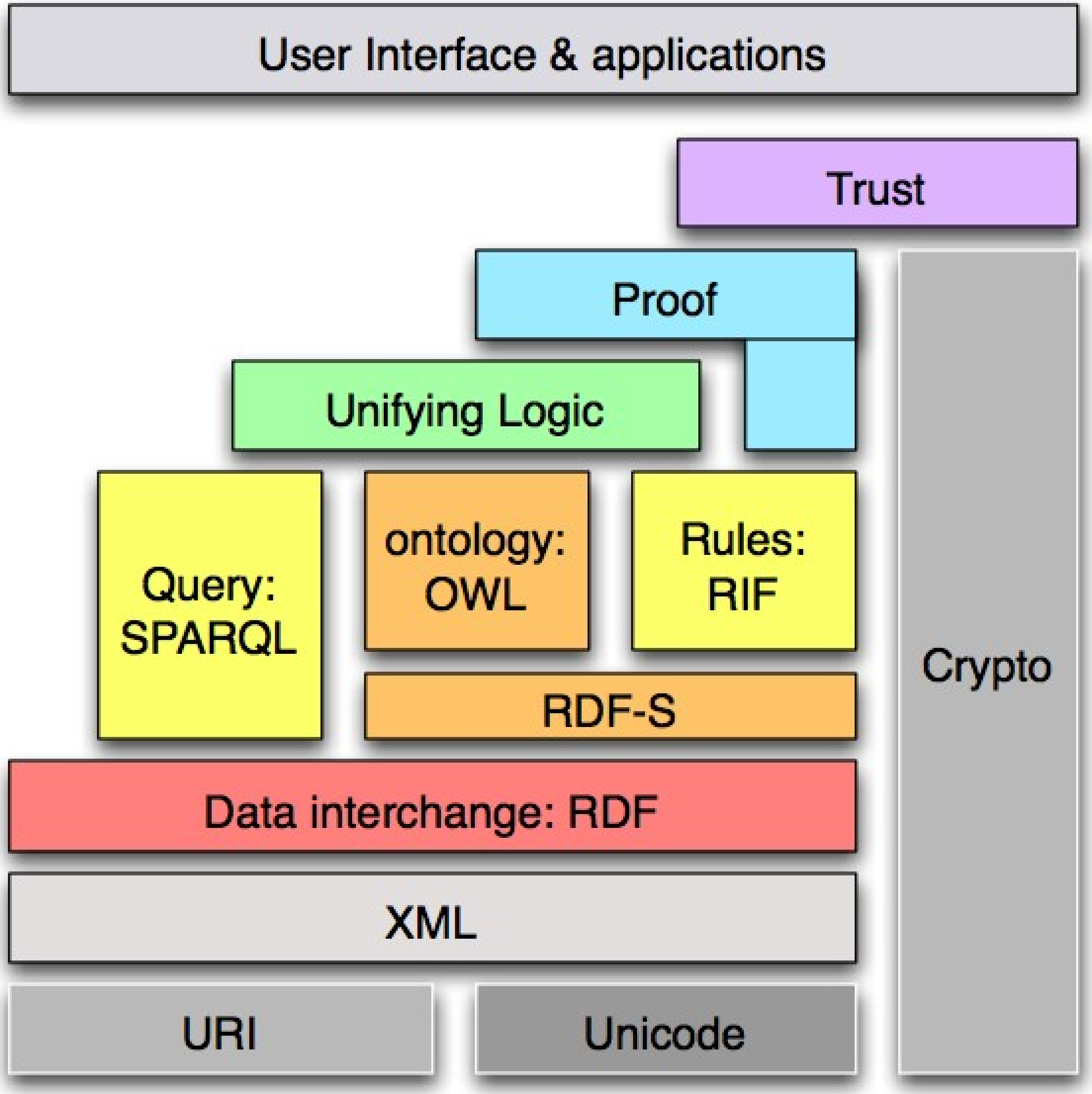
```
<http://…/isbn/2020386682>
    f:titre "Le palais des mirroirs"@fr ;
    f:original <http://…/isbn/000651409X> .
```

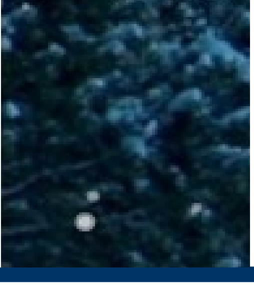
“Internal” nodes

- Consider the following statement:
  - “the publisher is a «thing» that has a name and an address”
- nodes were identified with a URI. But…
- …what is the URI of «thing»?
- Use the concept of blank nodes
      - » but be carefull when merging



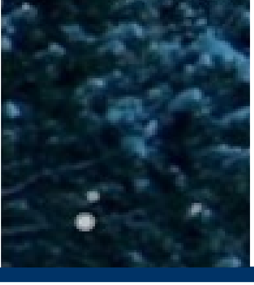
Semantic Web stack





Need for RDF schemas

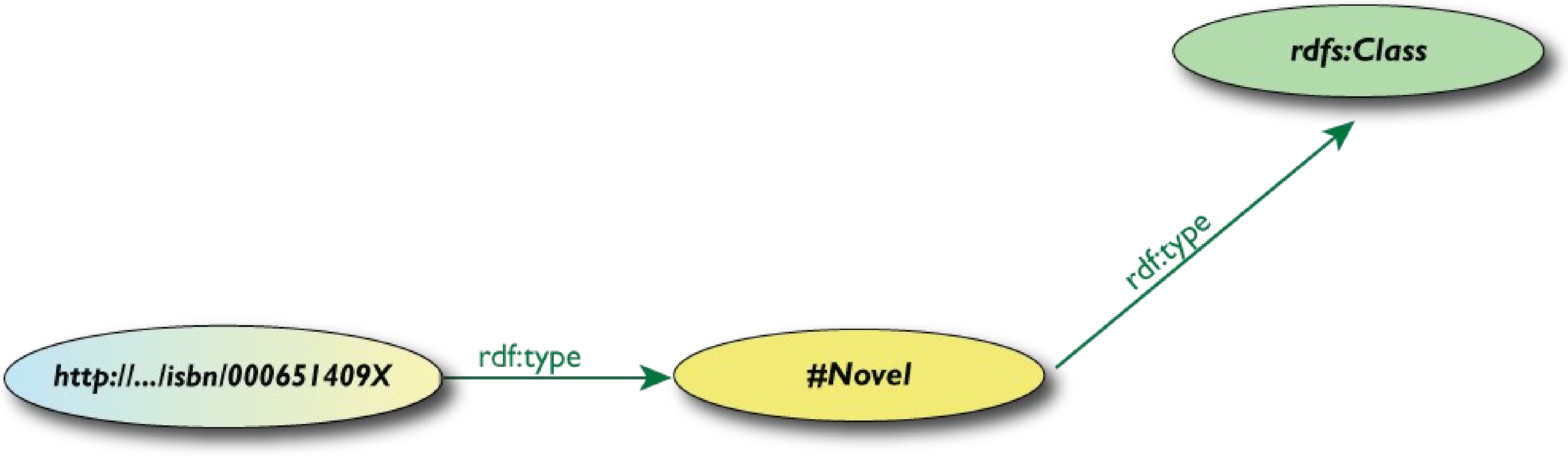
- We need “extra knowledge”, so let's:
  - define the terms we can use
  - what restrictions apply
  - what extra relationships are there?
- This is where RDF Schemas come in
  - officially: “RDF Vocabulary Description Language”; the term “Schema” is retained for historical reasons…



Classes, resources, … (cont.)

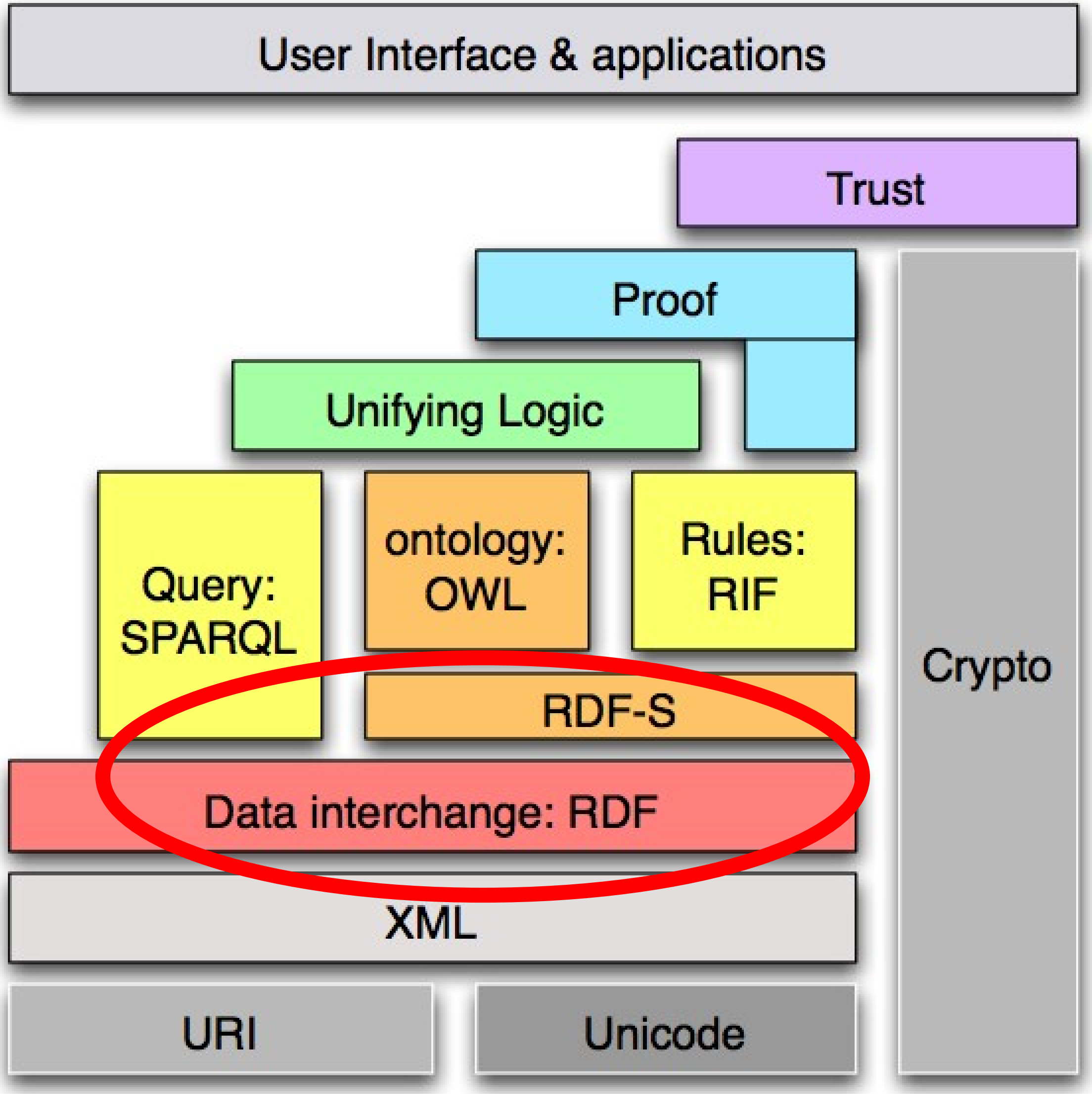
- Relationships are defined among classes/resources:
  - “typing”: an individual belongs to a specific class
    - “«The Glass Palace» is a novel”
    - to be more precise: “«http://.../**`000651409X`**» is a novel”
  - “subclassing”: *all* instances of one are also the instances of the other (“every novel is a fiction”)
- *RDFS formalizes these notions in RDF*

Classes, resources in RDF(S)



- RDFS defines the meaning of these terms
  - (these are all special URI-s, we just use the namespace abbreviation)

Current Status



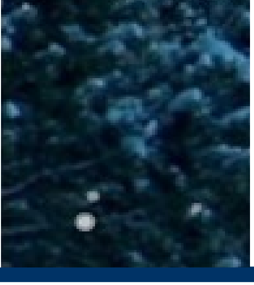
What can we do with RDF/S?

Interoperability

Interchange

Sharing

An example



The rough structure of data integration

1. Map the various data onto an **abstract data representation**
   - make the data independent of its internal representation…
2. **Merge** the resulting representations
3. Start **querying** on the whole!
   - queries not possible on the individual data sets

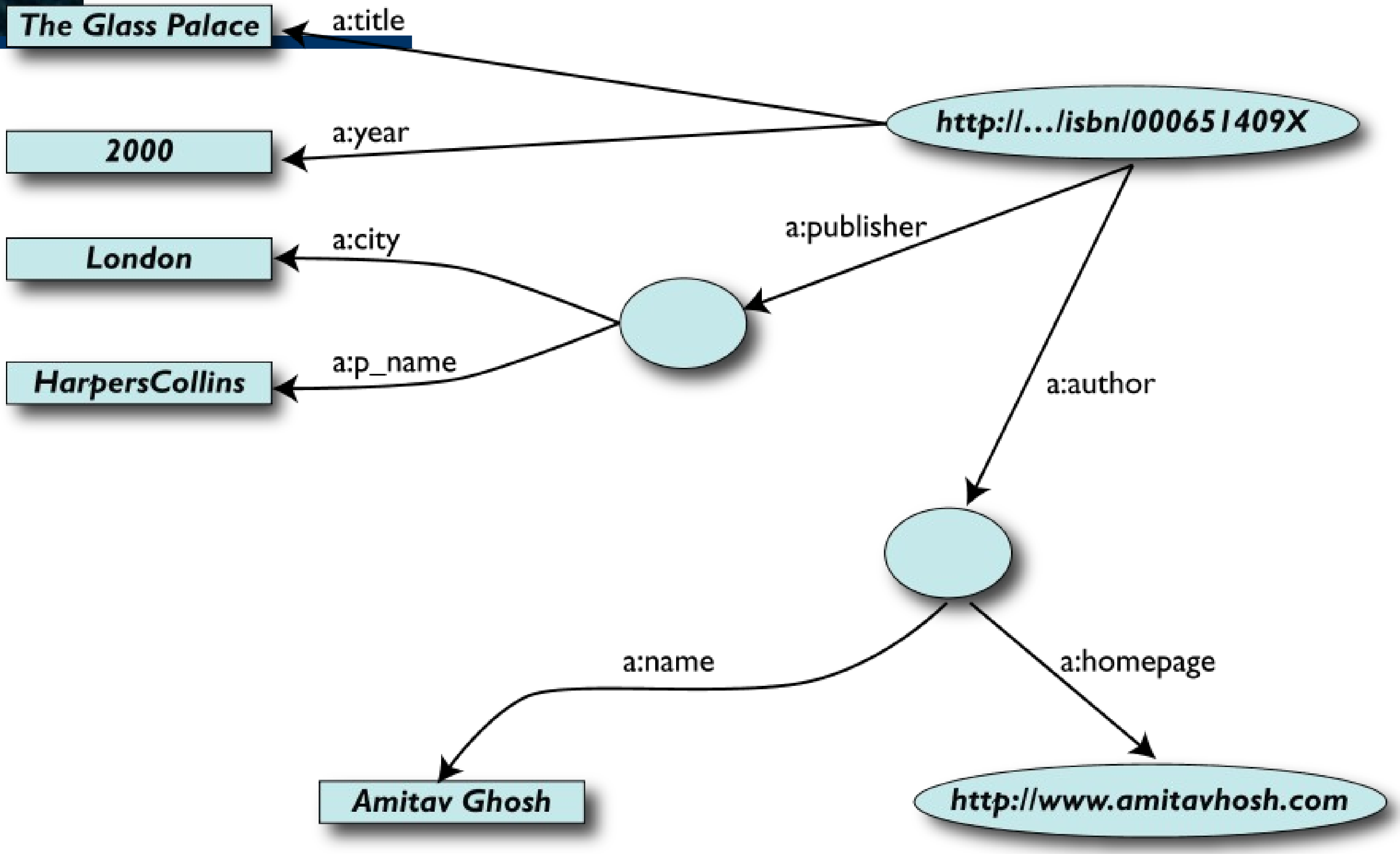
A *simplified* bookstore data (dataset “A”)

KEYFIELD: ID	Author	Title	Publisher	Year
ISBN0-00-651409-X	id_xyz	The Glass Palace	id_qpr	2000

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

ID	Publ. Name	City
id_qpr	Harpers Collins	London

1st: export your data as a set of *relations*



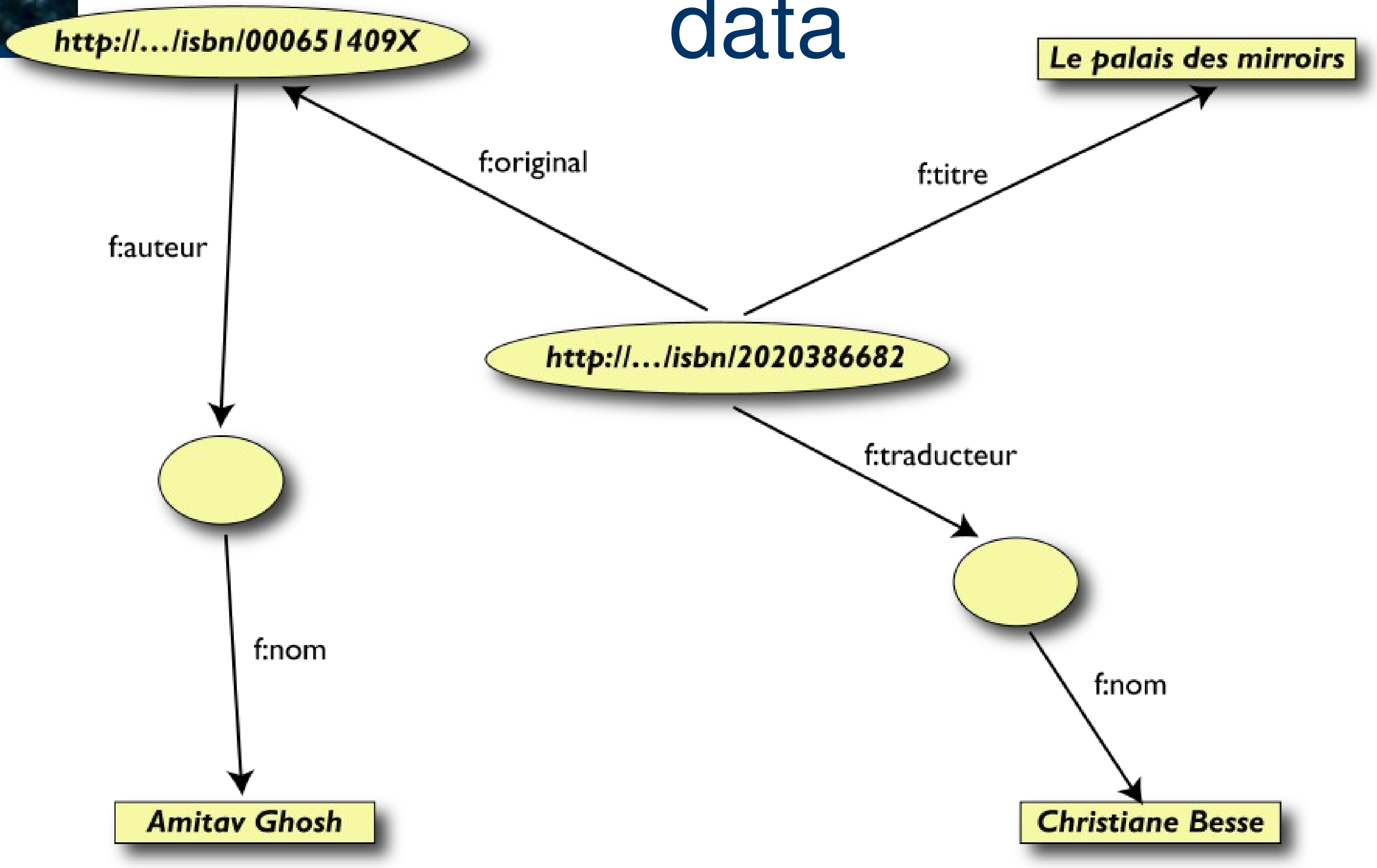
Some notes on the exporting the data

- Data export does *not* necessarily mean physical conversion of the data
  - relations can be generated on-the-fly at query time
    - via SQL “bridges”
    - scraping HTML pages
    - extracting data from Excel sheets
    - etc.
- One can export *part* of the data

Another bookstore data (dataset “F”)

	A	B	C	D	E
1	**ID**	**Titre**	**Auteur**	**Traducteur**	**Original**
2	ISBN0 2020386682	Le Palais des miroirs	A7	A8	ISBN-0-00-651409-X
3					
4					
5					
6	**Nom**				
7	Ghosh, Amitav				
8	Besse, Christianne				

2nd: export your second set of data



http://.../isbn/000651409X

Le palais des mirroirs

f:original

f:titre

f:auteur

http://.../isbn/2020386682

f:traducteur

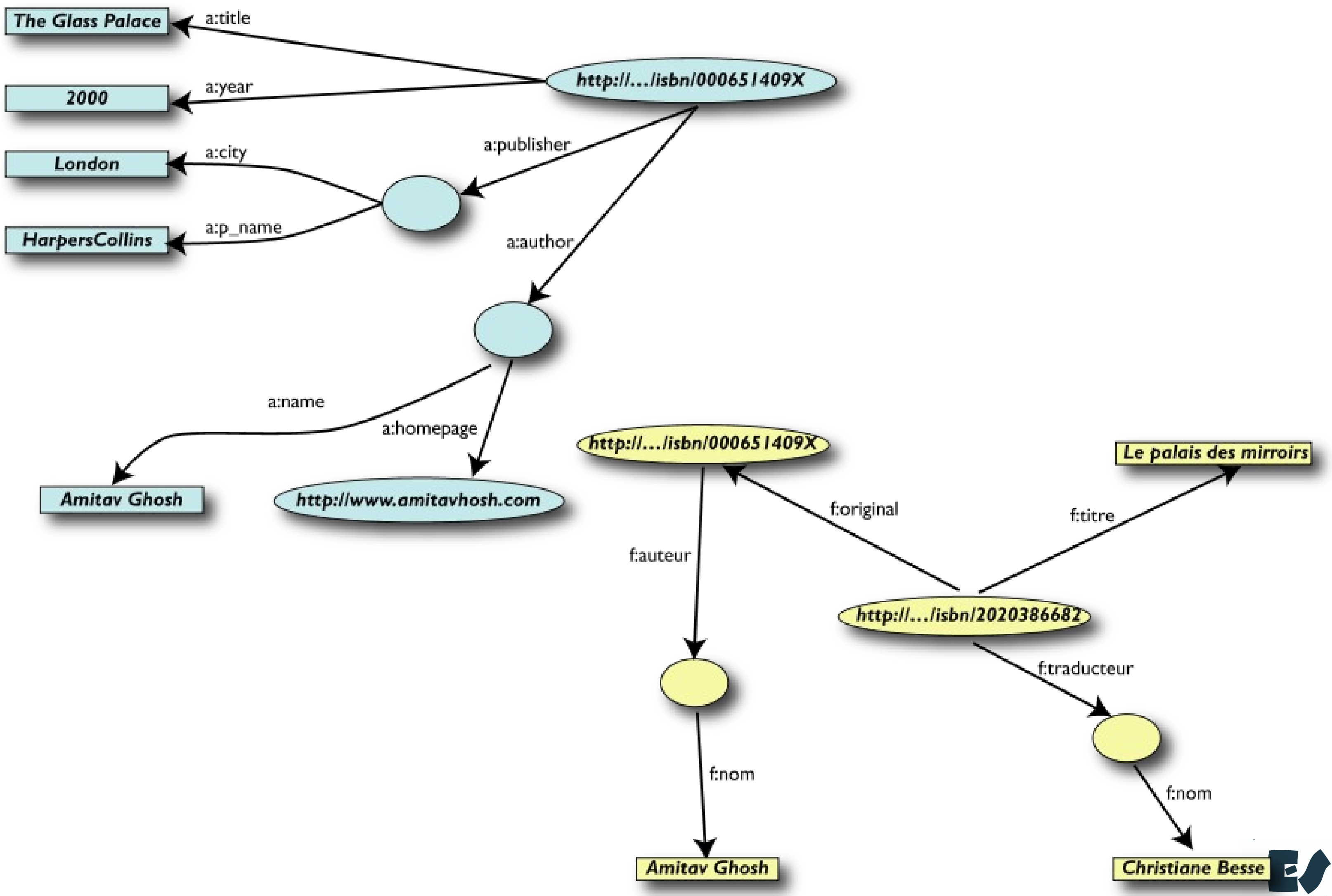
f:nom

f:nom

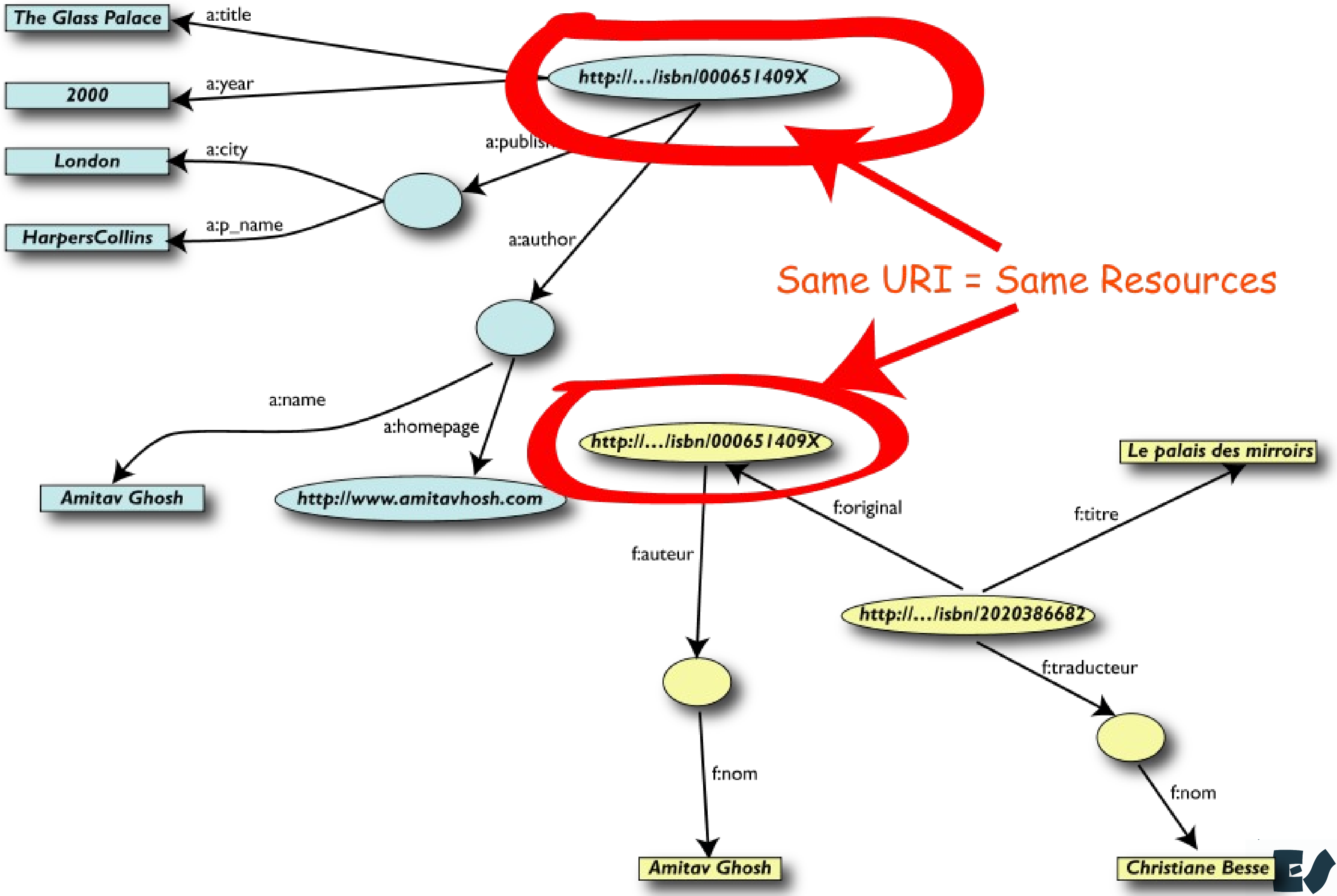
Amitav Ghosh

Christiane Besse

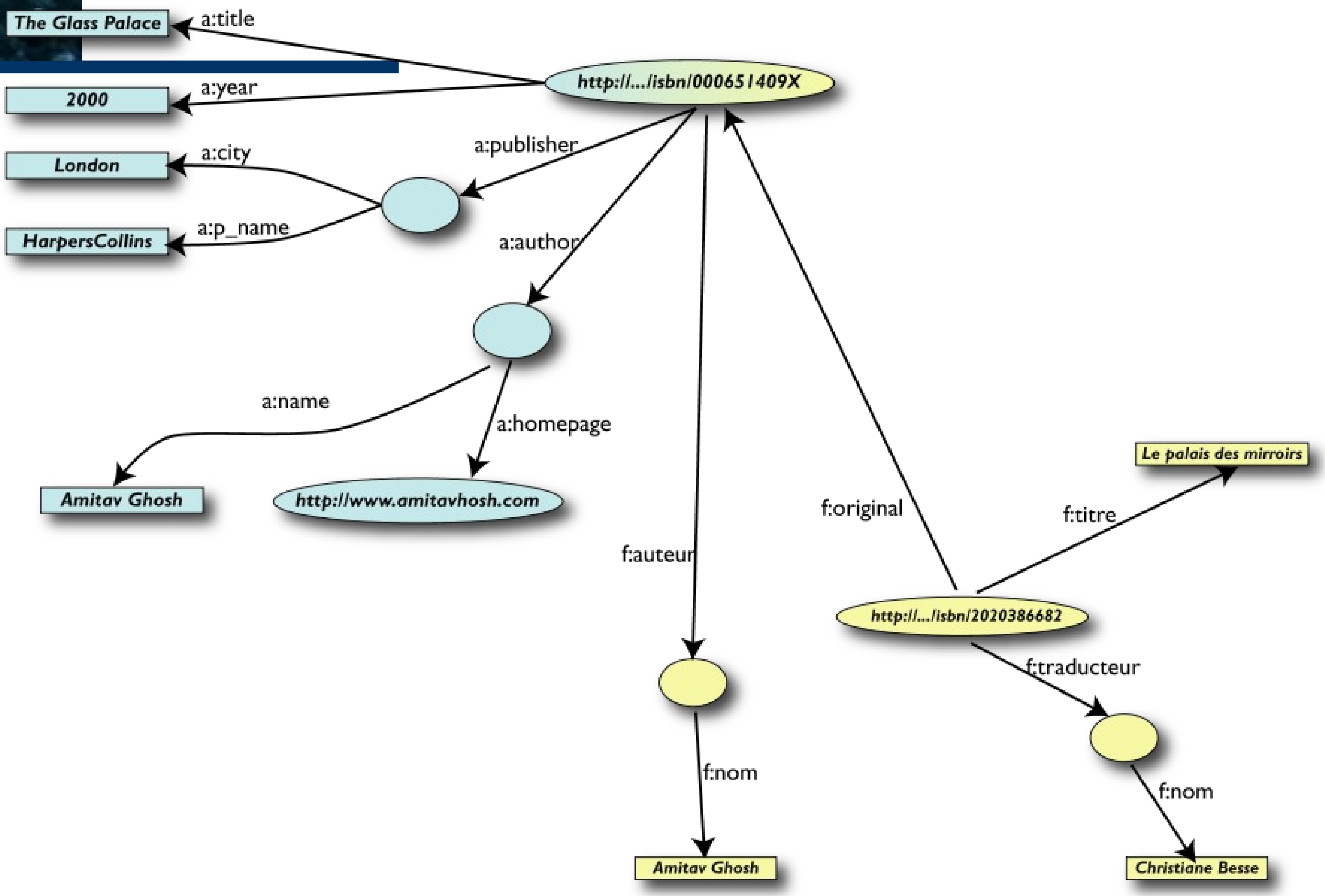
3rd: start merging your data



3rd: start merging your data

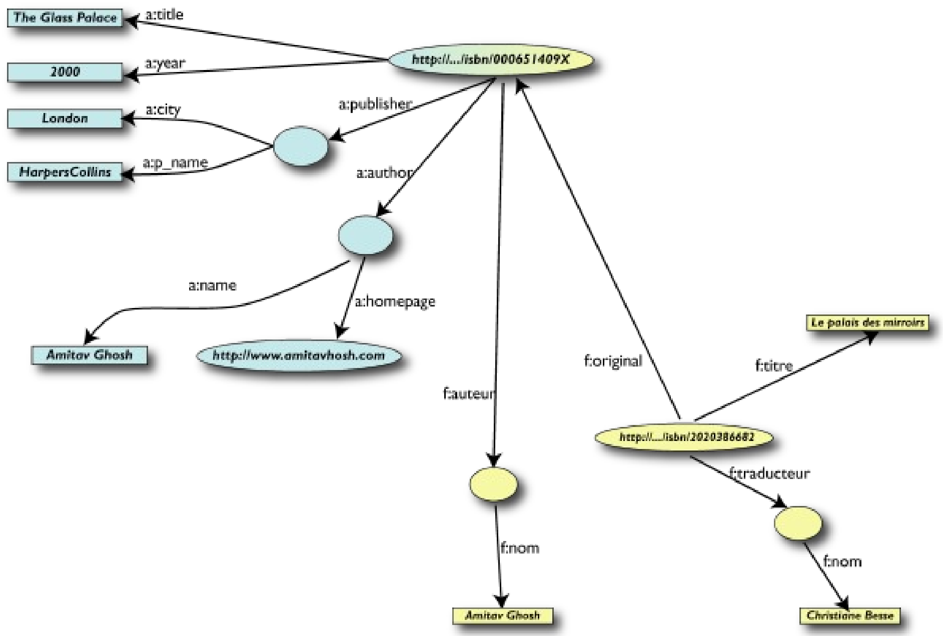


3rd: merge identical resources



Start making queries…

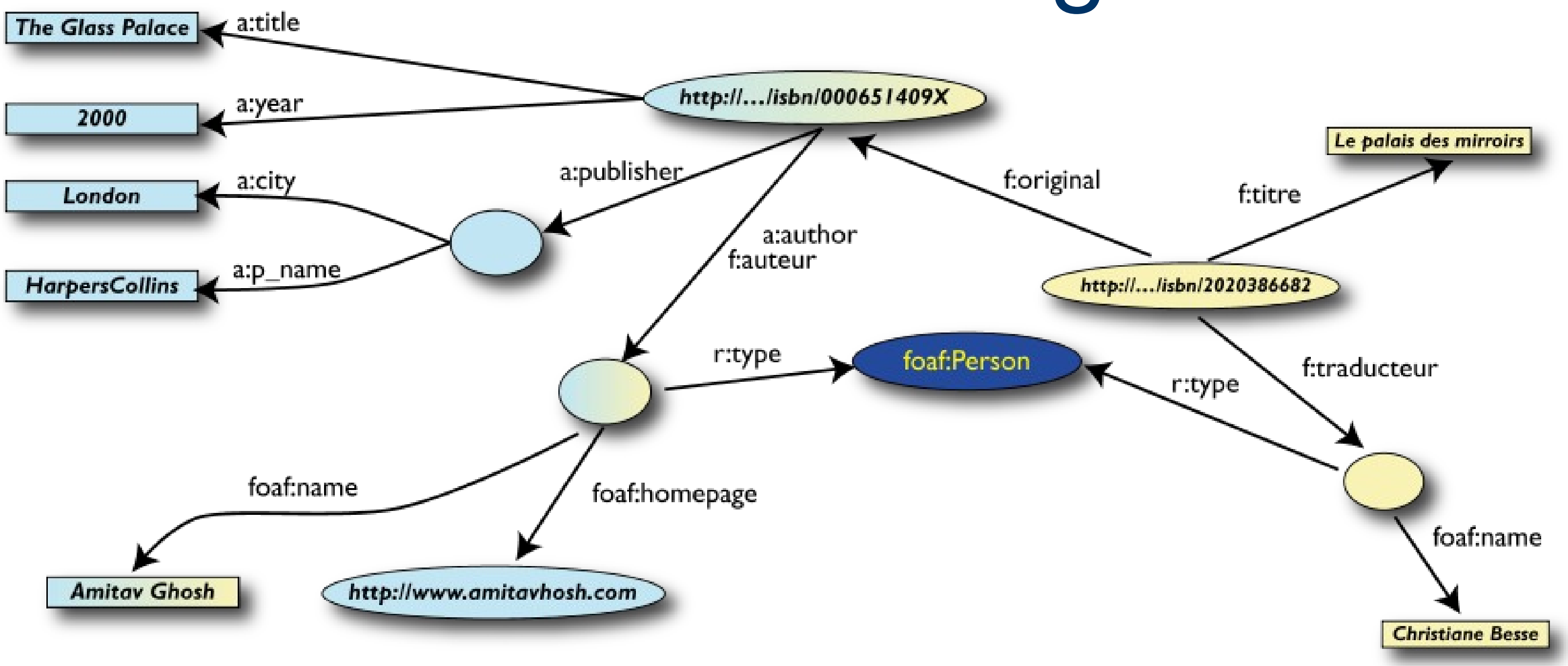
- User of data “F” can now ask queries like:
  - “give me the title of the original”
- This information is not in the dataset “F”…
- …but can be retrieved by merging with dataset “A”!

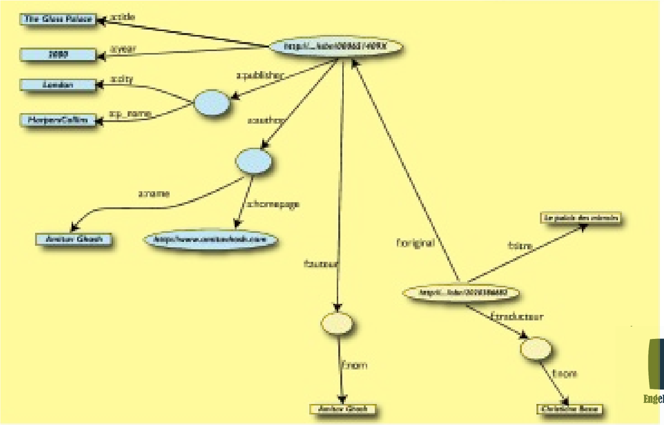


However, more can be achieved…

- We “feel” that ***a:author*** and ***f:auteur*** should be the same
- But an automatic merge does not know that!
- Let us add some extra information to the merged data:
  - ***a:author*** same as **f:auteur**
  - both identify a “Person”
  - a term that a community may have already defined:
    - a “Person” is uniquely identified by his/her name and, say, homepage
    - it can be used as a “category” for certain type of resources

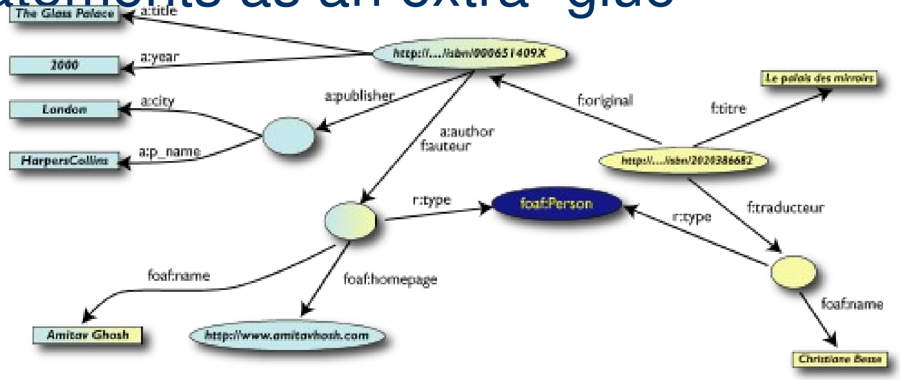
3rd revisited: use the extra knowledge

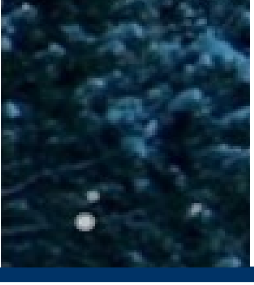




Start making richer queries!

- User of dataset “F” can now query:
  - “give me the home page of the original’s author”
- The information is not in datasets “F” or “A”…
- …but was made available by:
  - merging datasets “A” and datasets “F”
  - adding three simple extra statements as an extra “glue”

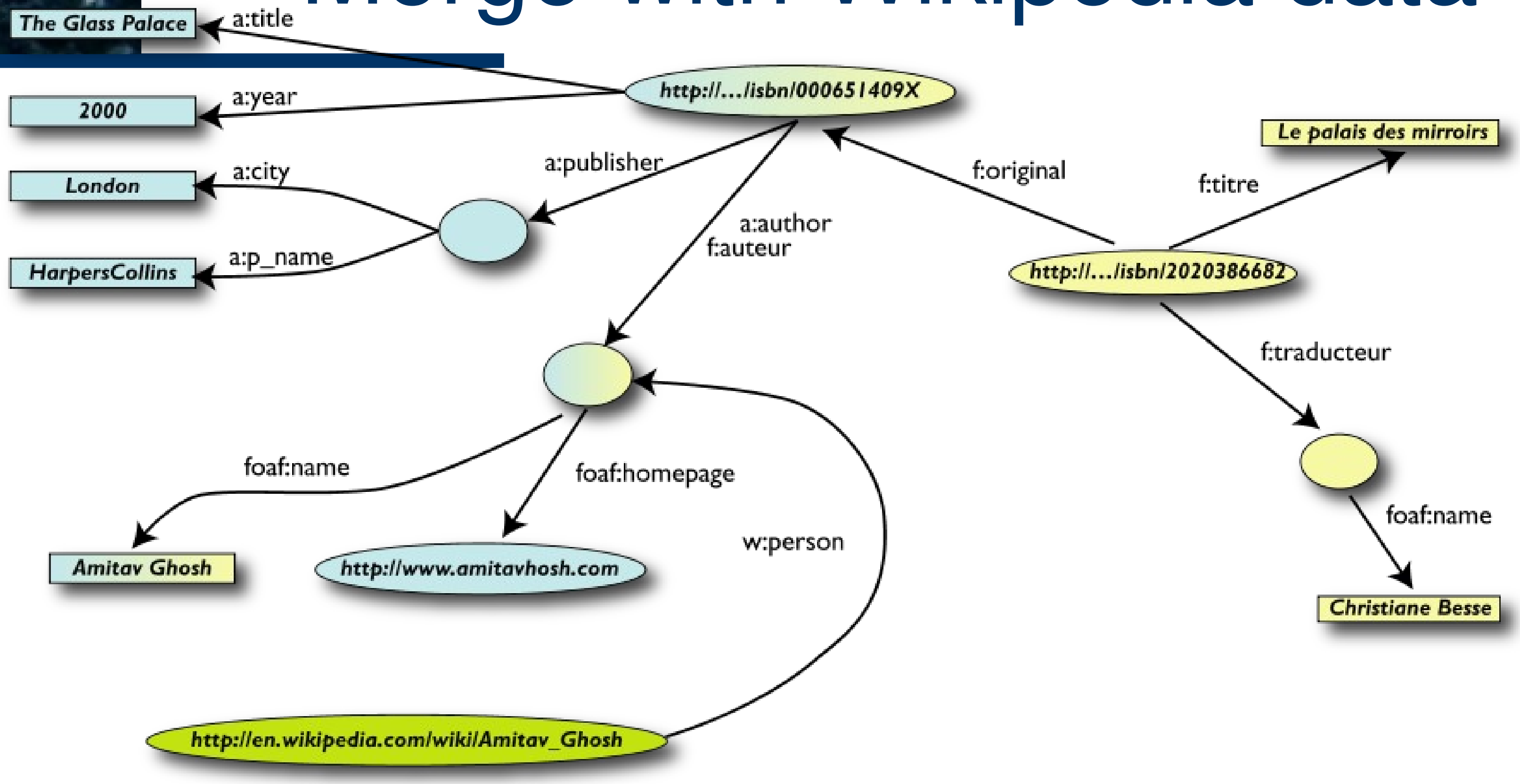




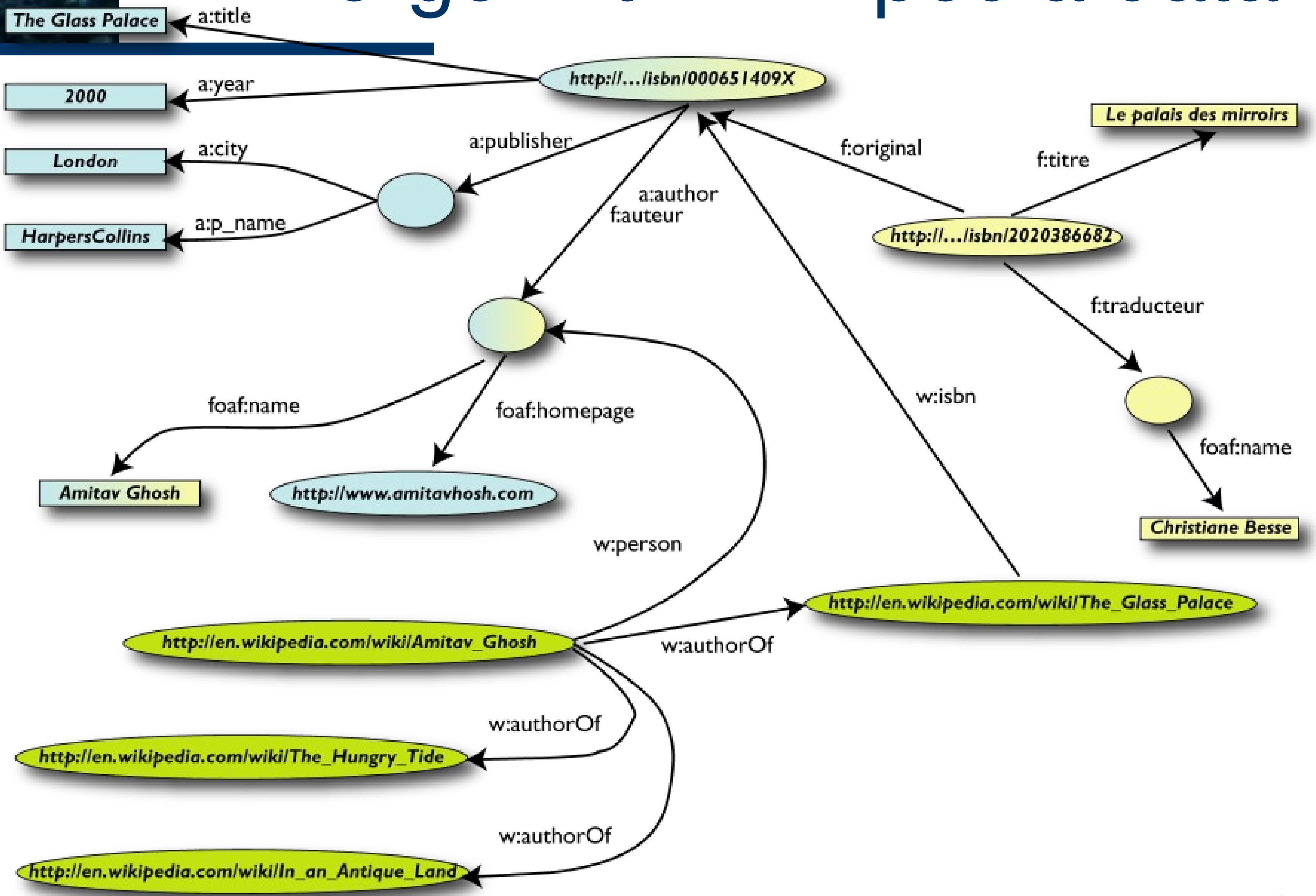
Combine with different datasets

- Via, e.g., the “Person”, the dataset can be combined with other sources
- For example, data in Wikipedia can be extracted using dedicated tools

Merge with Wikipedia data



Merge with Wikipedia data



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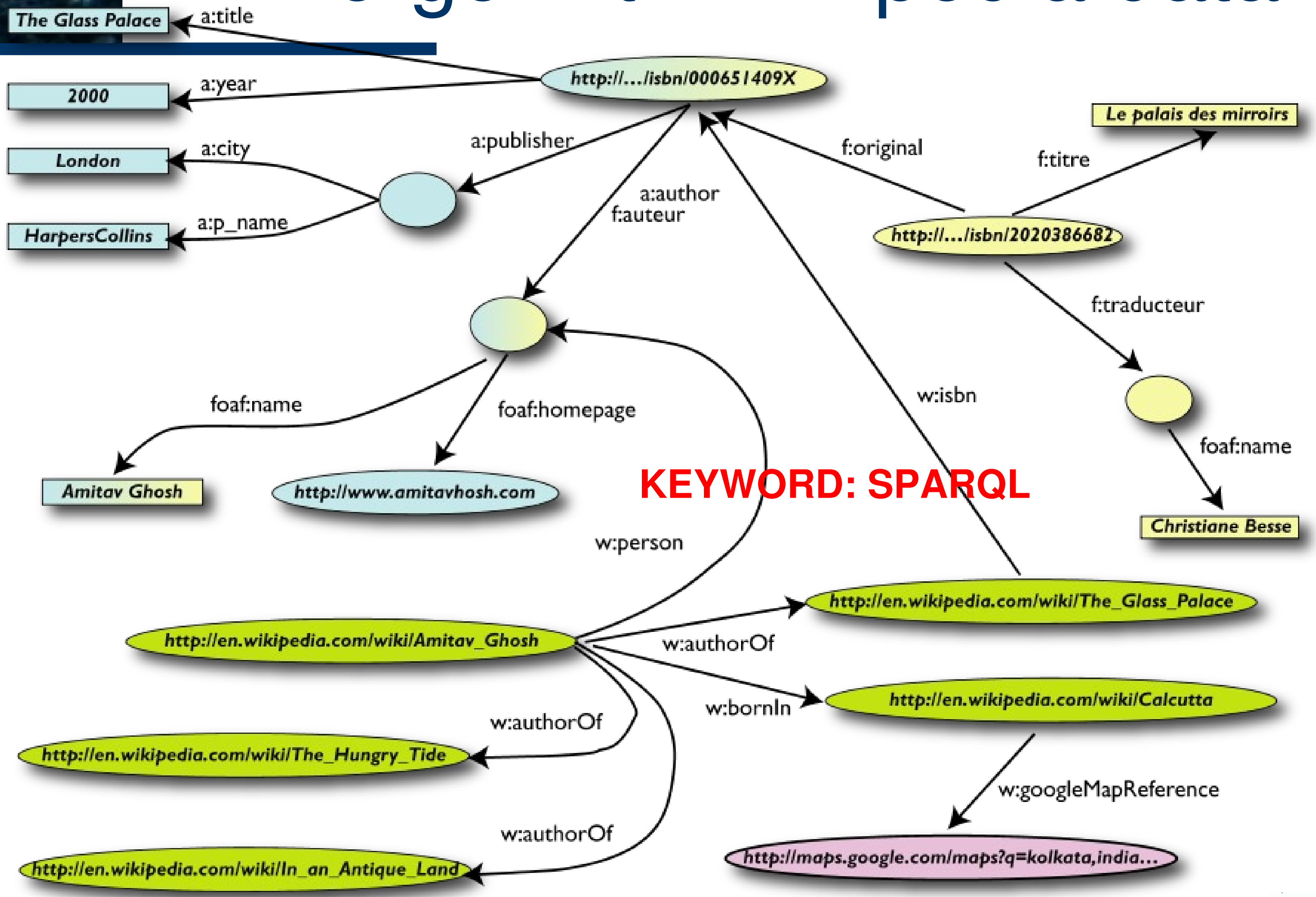
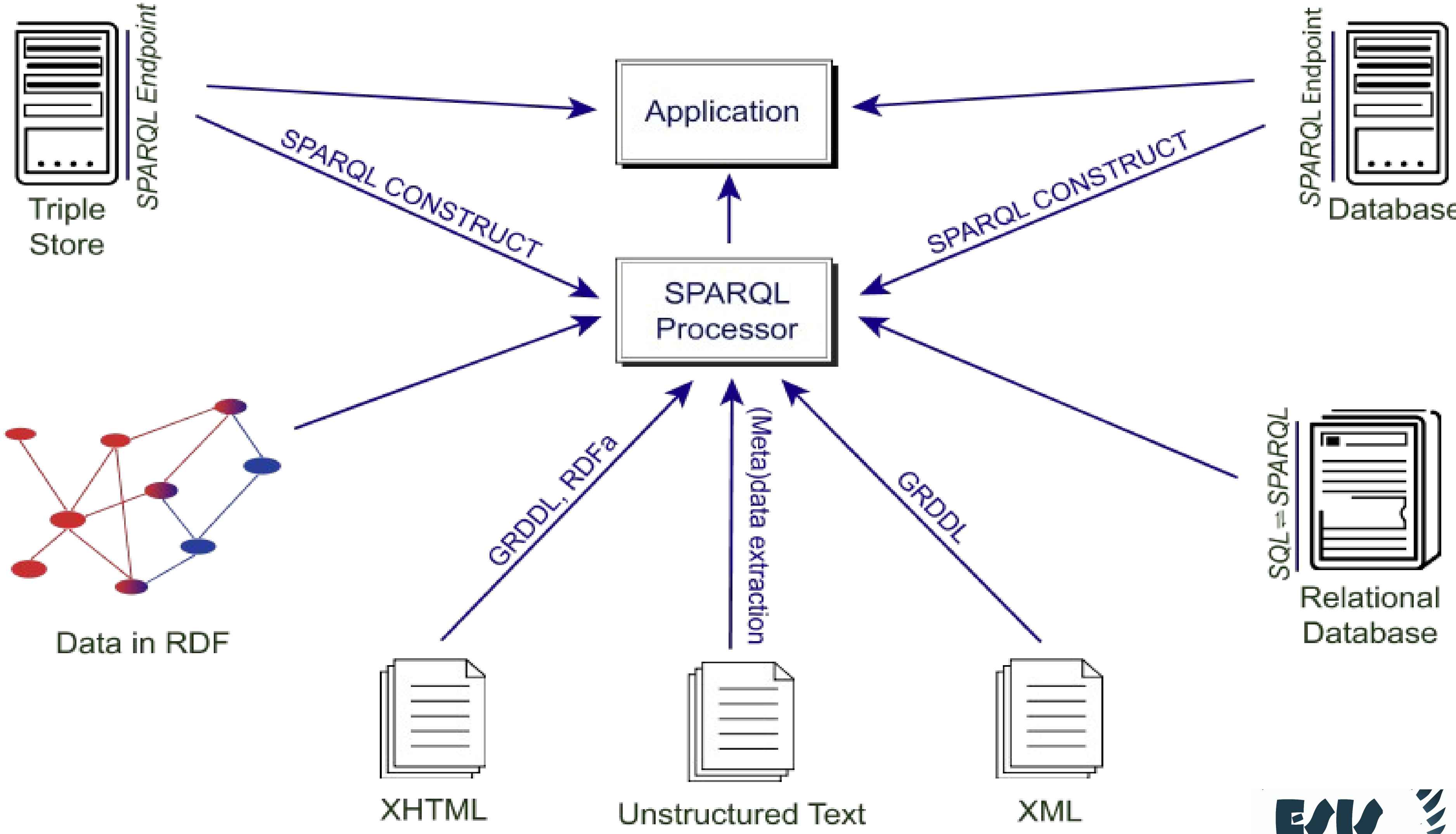
Merge with Wikipedia data



KEYWORD: SPARQL

SPARQL as a unifying point



Triple Store

SPARQL Endpoint

Application

SPARQL CONSTRUCT

SPARQL Processor

SPARQL Endpoint

Database

SPARQL CONSTRUCT

Data in RDF

GRDDL, RDFa

(Meta)data extraction

GRDDL

SQL ⇒ SPARQL

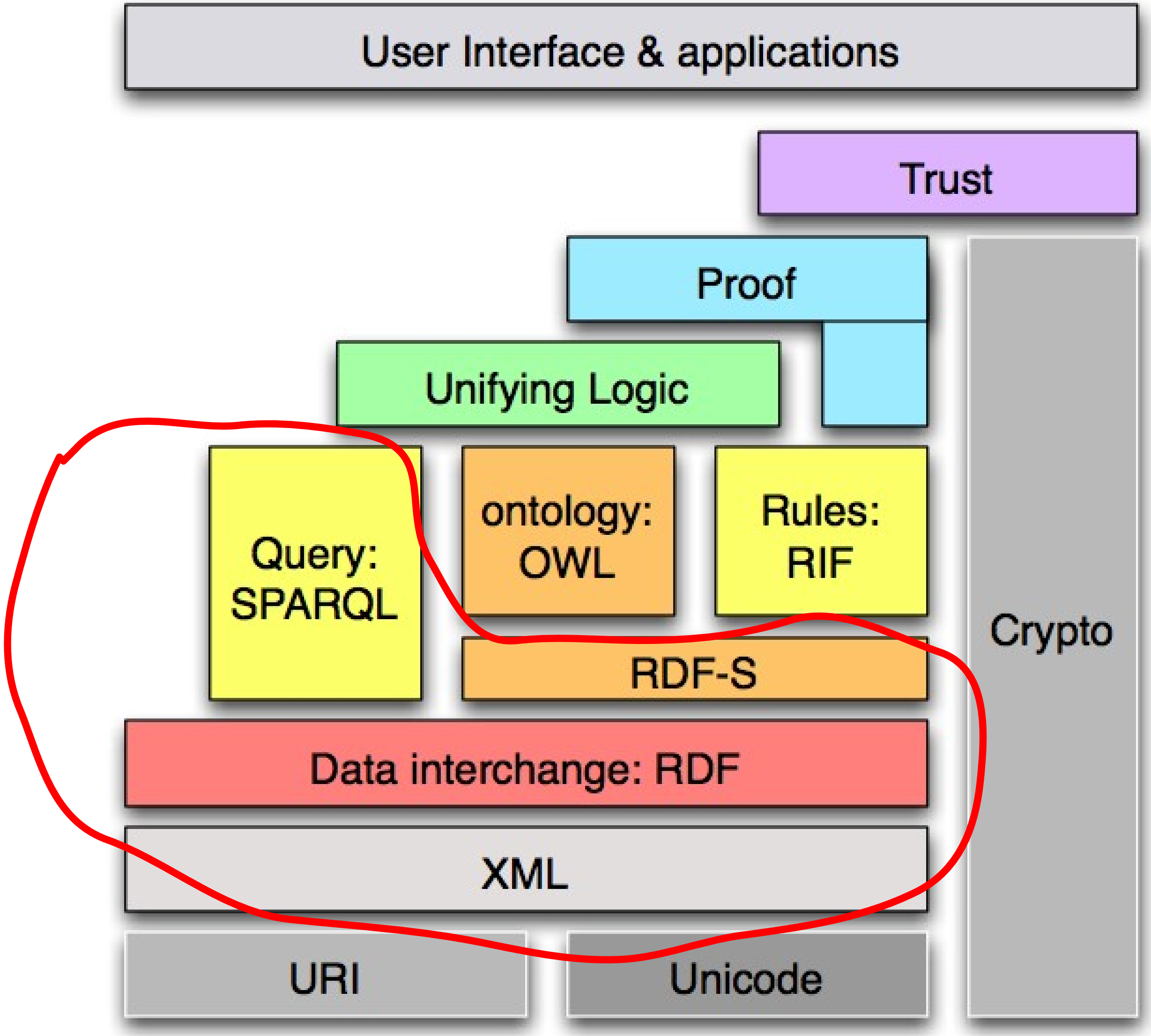
Relational Database

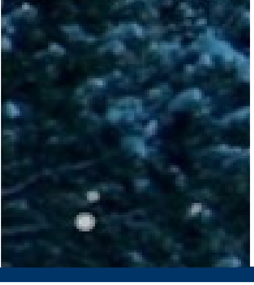
XHTML

Unstructured Text

XML

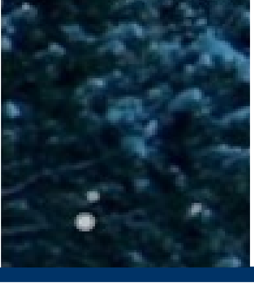
So now we have:





Ontologies

- RDFS is useful, but does not solve all possible requirements
- Complex applications may want more possibilities:
  - characterization of properties
  - identification of objects with different URI-s
  - disjointness or equivalence of classes
  - construct classes, not only name them
  - more complex classification schemes
  - can a program reason about some terms? E.g.:
    - "if «Person» resources «A» and «B» have the same «**`foaf:email`**» property, then «A» and «B» are identical"
  - etc.

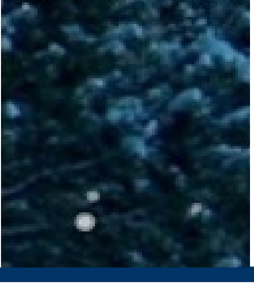


Ontologies (cont.)

- The term *ontologies* is used in this respect:

> “defines the concepts and relationships used to describe and represent an area of knowledge”

- Ie, there is a need for Web Ontology Language(s)
  - RDFS can be considered as a simple ontology language
- Languages should be a compromise between
  - rich semantics for meaningful applications
  - feasibility, implementability



Web Ontology Language = OWL

- OWL is an extra layer, a bit like RDF Schemas
  - own namespace, own terms
  - it relies on RDF Schemas
- It is a separate recommendation
- There is an active W3C Working Group working on *extensions* of the current standards
  - the new version will be called “OWL 2”
  - in what follows, some features will be referred to as “may come in future”, i.e., under consideration by that group

Term equivalence

- For classes:
  - **owl:equivalentClass**: two classes have the same individuals
  - **owl:disjointWith**: no individuals in common
- For properties:
  - **owl:equivalentProperty**
    - remember the **a:author** vs. **f:auteur**?
- For individuals:
  - **owl:sameAs**: two URIs refer to the same concept (“individual”)
  - **owl:differentFrom**: negation of **owl:sameAs**

Typical usage of owl:sameAs

- Linking Kolkata from one data set (DBpedia) to another (Geonames):

```
<http://dbpedia.org/resource/Kolkata>
   owl.sameAs <http://sws.geonames.org/1275004/>;
```

- This is the main mechanism of “Linking” in the Linking Open Data project

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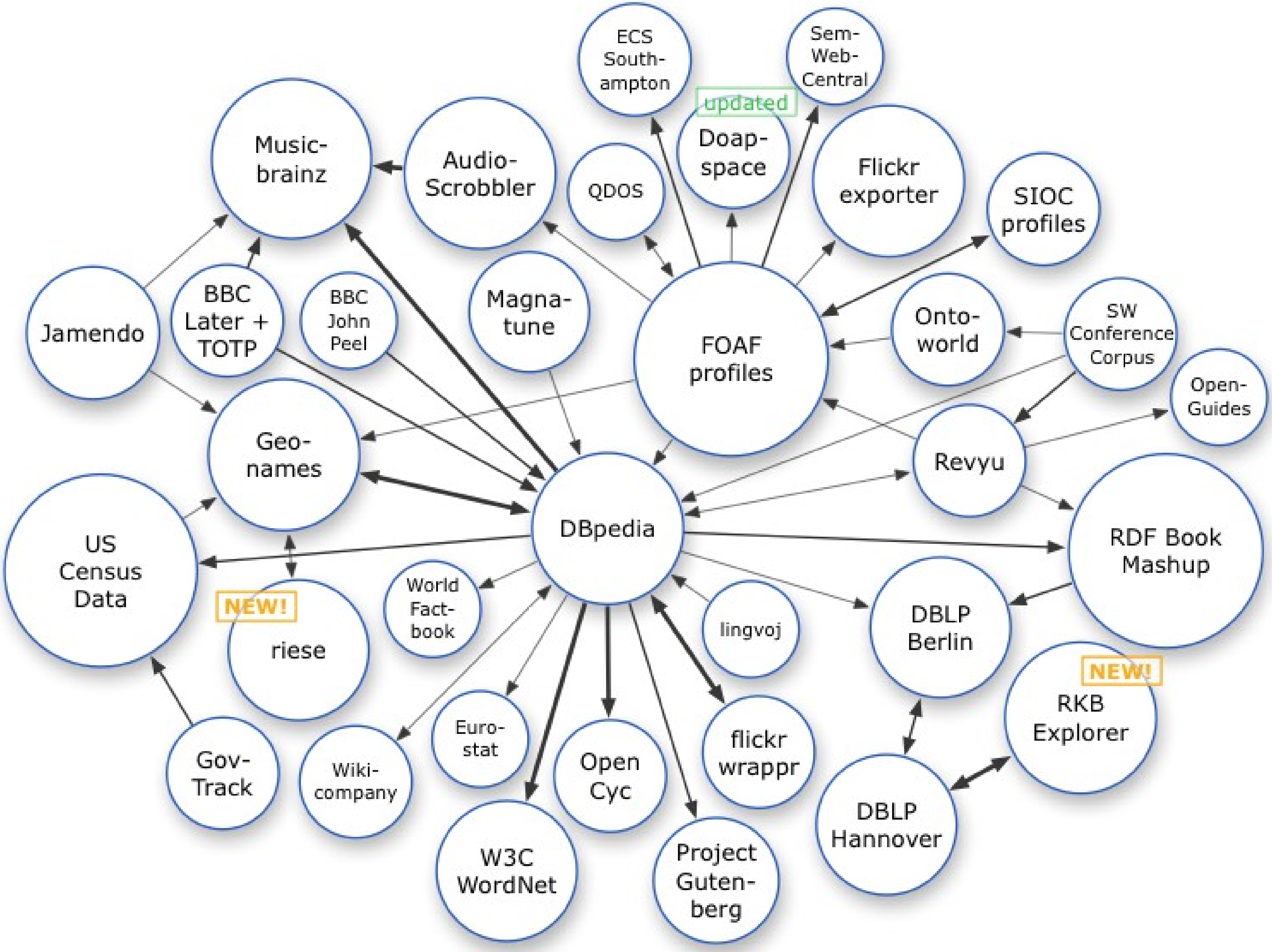
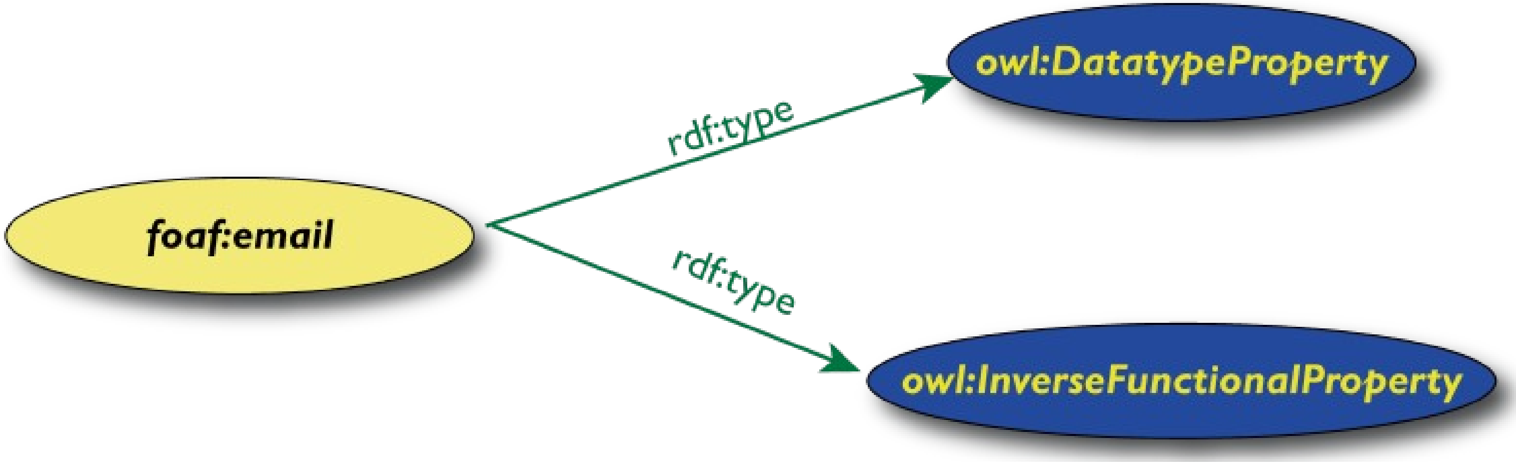

ECS Southampton
Sem-Web-Central
updated
Doap-space
Music-brainz
Audio-Scrobbler
QDOS
Flickr exporter
SIOC profiles
Jamendo
BBC Later + TOTP
BBC John Peel
Magna-tune
FOAF profiles
Onto-world
SW Conference Corpus
Open-Guides
Geo-names
Revyu
US Census Data
DBpedia
RDF Book Mashup
NEW!
riese
World Fact-book
lingvoj
DBLP Berlin
NEW!
RKB Explorer
Gov-Track
Wiki-company
Euro-stat
Open Cyc
flickr wrappr
DBLP Hannover
W3C WordNet
Project Guten-berg

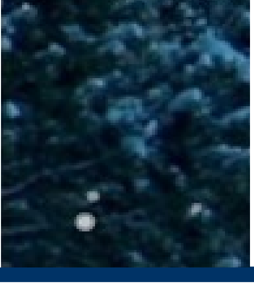
Property characterization

- In OWL, one can characterize the behaviour of properties (symmetric, transitive, functional, inverse functional…)
- OWL also separates *data* and *object* properties
  - “datatype property” means that its range are typed literals

Characterization example

- "`foaf:email`" is inverse functional (i.e., two different subjects cannot have identical objects)





What this means is…

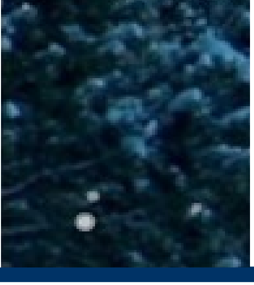
- If the following holds in our triples:

```
:email rdf:type owl:InverseFunctionalProperty.
<A> :email “mailto:a@b.c”.
<B> :email “mailto:a@b.c”.
```

- then the following holds, too:

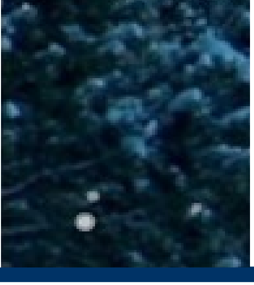
```
<A> owl:sameAs <B>.
```

- I.e., *new relationships* were discovered again (beyond what RDFS could do)



Other property characterizations

- Functional property (“*owl:***FunctionalProperty**”)
- Transitive property (“*owl:***TransitiveProperty**”)
- Symmetric property (“*owl:***SymmetricProperty**”)
- Inverse of another property (“***owl:inverseOf***”)
- May come in future:
  - reflexive and irreflexive object properties
  - specify that properties are “disjoint”

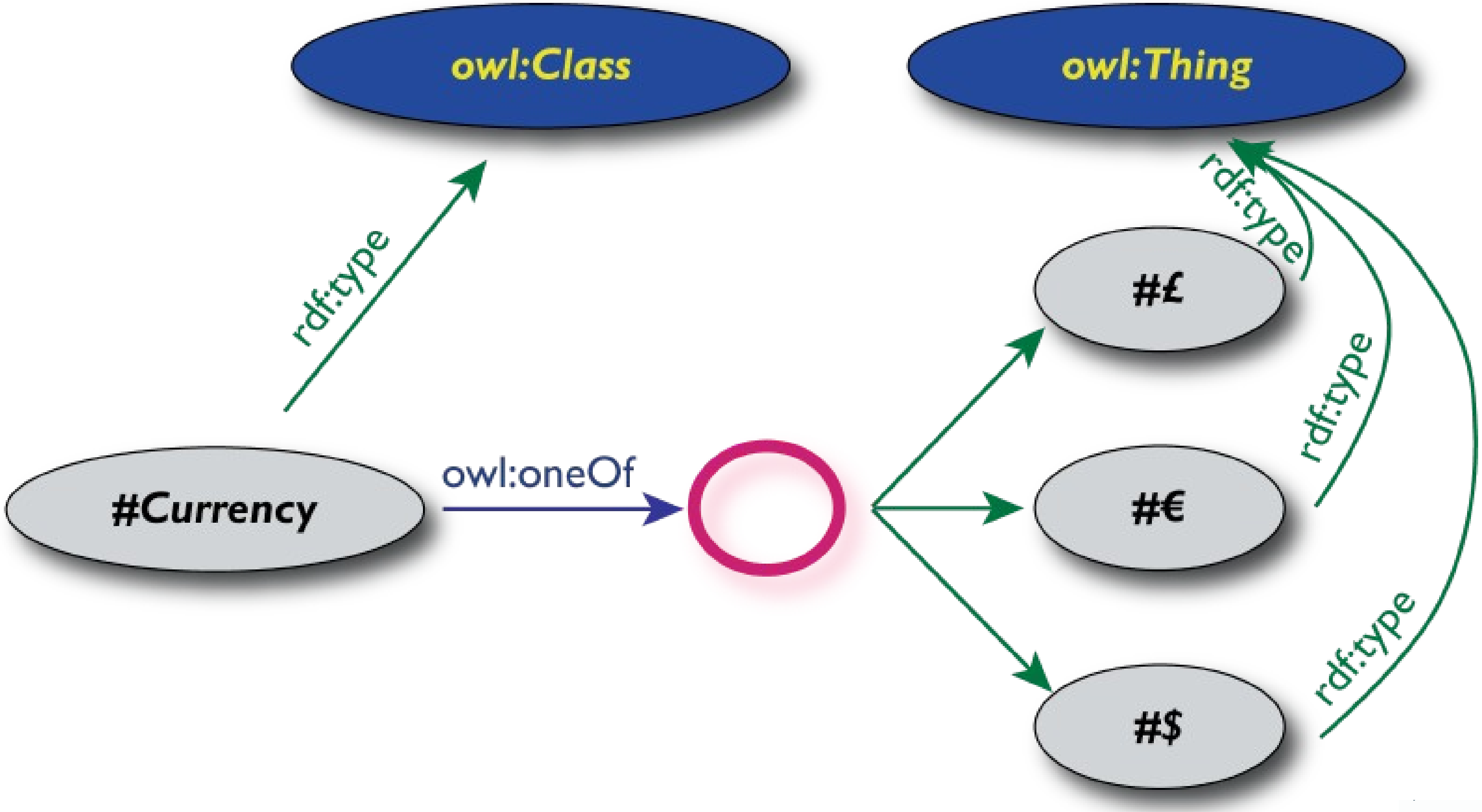


Classes in OWL

- In RDFS, you can subclass existing classes… that’s all
- In OWL, you can *construct* classes from existing ones:
  - enumerate its content
  - through intersection, union, complement
  - etc
- OWL makes a stronger distinction between *classes* and *individuals*
  - referring to its own ***`Class`*** and to “***`Thing`***”, respectively
    - of course, ***`owl:Class`*** is a subclass of ***`rdfs:Class`***, i.e., it is a refinement

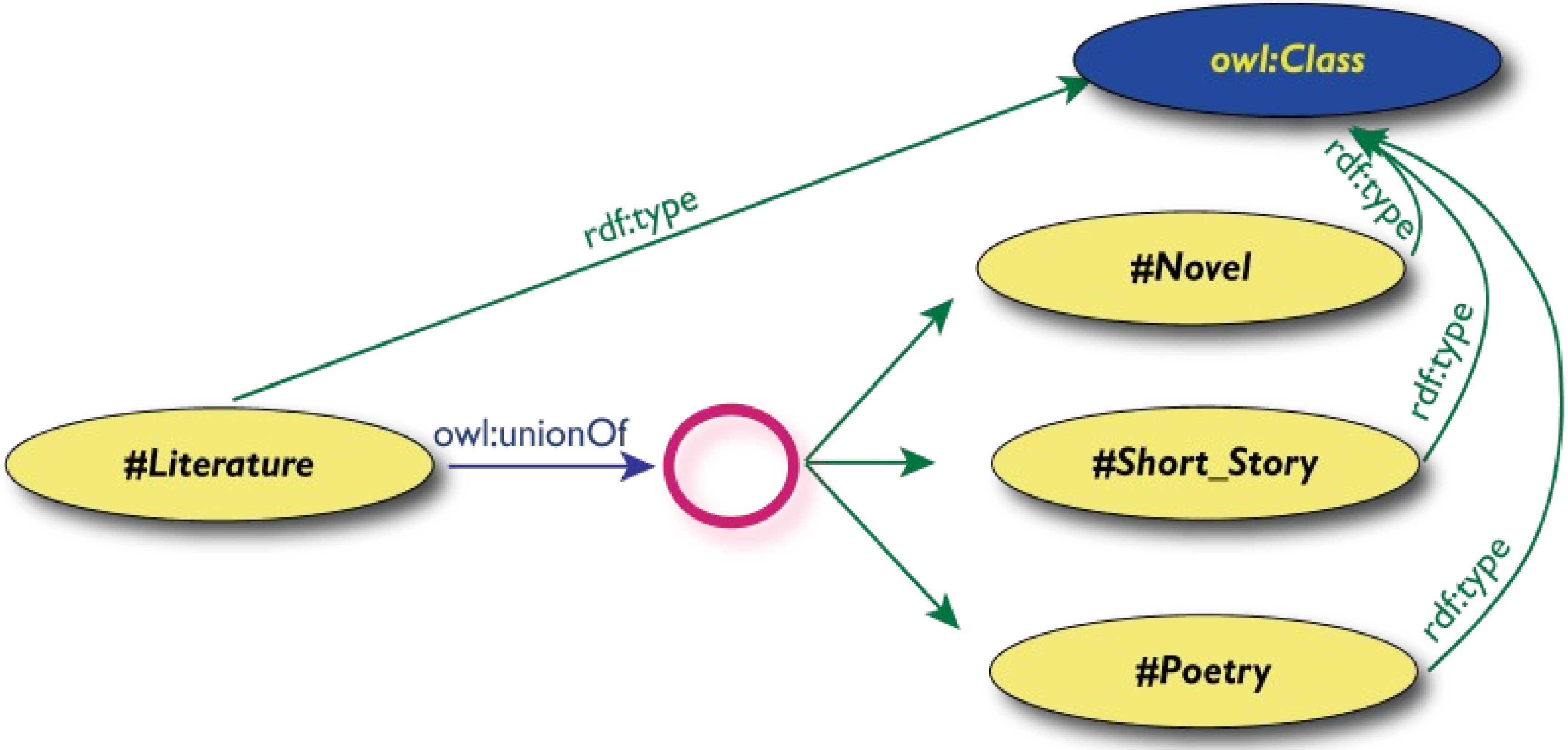
OWL classes can be "enumerated"

- The OWL solution, where possible content is explicitly listed:



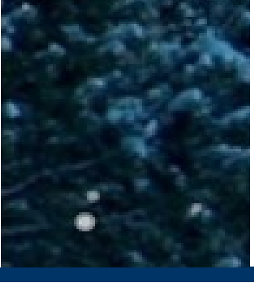
Union of classes

- Essentially, like a set-theoretical union:



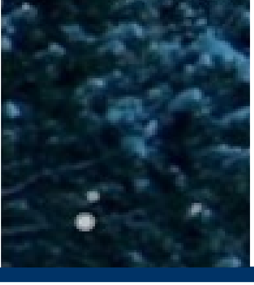
What we have so far…

- The OWL features listed so far are already fairly powerful
- E.g., various databases can be linked via ***`owl:sameAs`***, functional or inverse functional properties, etc.
- It is still possible to find all inferred relationship using a traditional rule engine
  - (more or less… there are some restrictions on details)



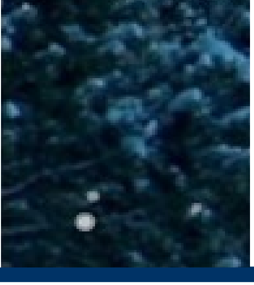
However… that may not be enough

- Very large vocabularies might require even more complex features
  - typical example: definition of all concepts in a health care environment
- One major issue is the way classes (i.e., “concepts”) are defined ☹
- OWL includes those extra features but… the inference engines become (much) more complex



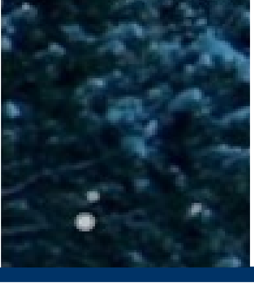
OWL profiles

- The term OWL “profiles” comes to the fore:
  - restricting *which* terms can be used and *under what circumstances (restrictions)*
  - if one abides to those restrictions, then simpler inference engines can be used



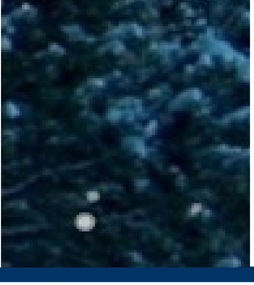
OWL profiles (cont.)

- In the ***current* OWL standard**, three such “profiles” are defined:
  - **OWL Full**: no restrictions whatsoever
  - **OWL DL**
  - (and its “sub profile” **OWL Lite**): major restrictions to ensure implementability
- The **OWL 2** work will add new profiles
  - profiles that are simple enough to be implementable with simple rule engines (like the first few examples we had)
  - profiles that are optimized to a small number of class and property definition but a large amount of data
  - etc.



OWL Full

- No constraints on the various constructs
  - **`owl:Class`** is equivalent to ***`rdfs:Class`***
  - **`owl:Thing`** is equivalent to **`rdfs:Resource`**
  - this means that:
    - Class can also be an individual, a URI can denote a property as well as a Class
      - e.g., it is possible to talk about class of classes, etc.
    - one can make statements on RDFS constructs (e.g., declare **`rdf:type`** to be functional…)
    - etc.
- But: *an OWL Full ontology may be undecidable!*



Note on OWL profiles

- OWL profiles are defined to reflect compromises:
    - *expressibility vs. implementability*
- Some application just need to express and interchange terms (with possible scruffiness): OWL Full is fine
    - *they may build application-specific reasoning instead of using a general one*
- Some applications need rigour, but only a simple set of statements: a rule engine based profile might be o.k.
- Some applications need rigour and complex term classification; then OWL DL/Lite might be the right choice

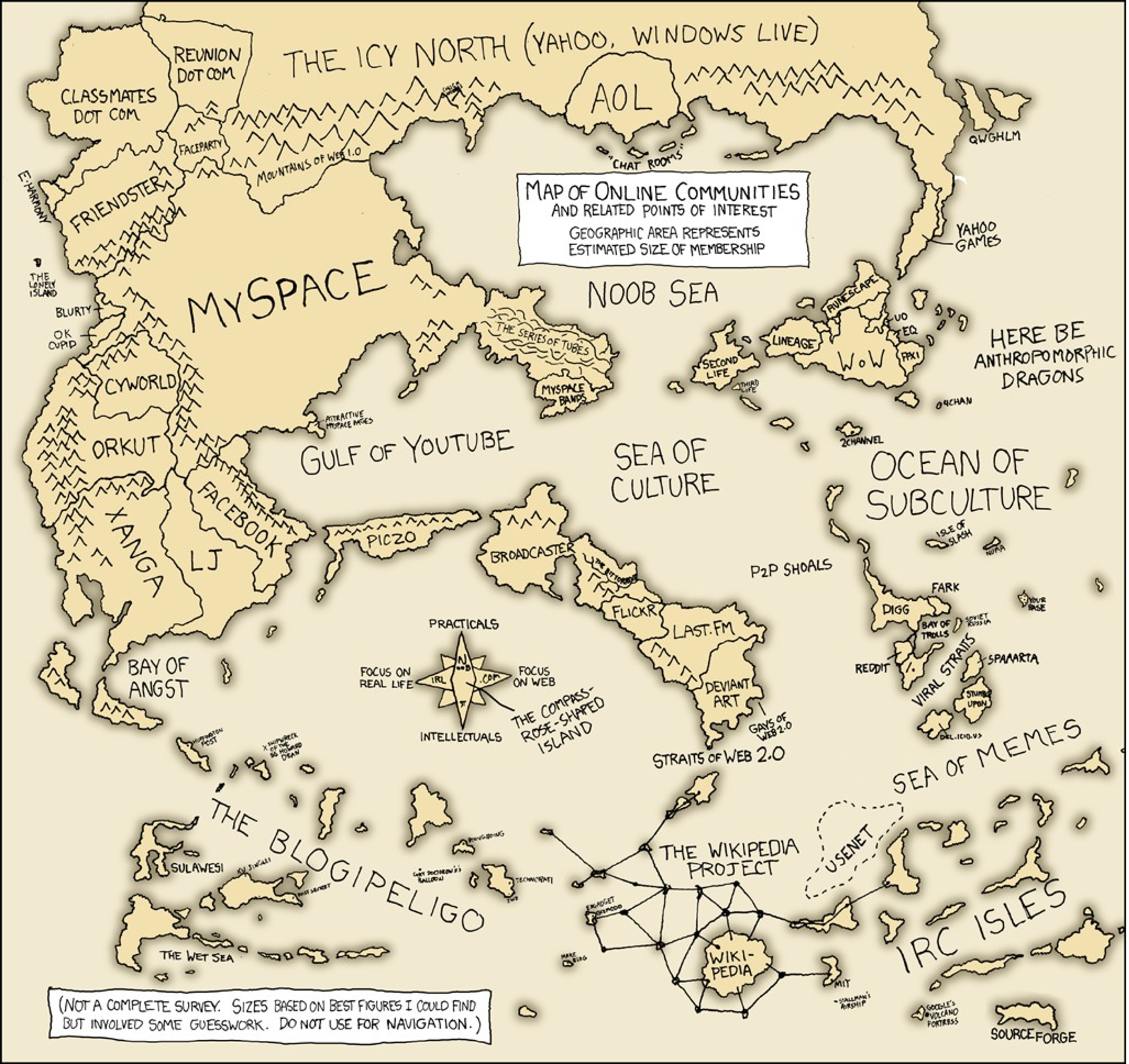
Some of the issues we will not manage to talk about

- GRDDL
- RDFa
- OWL2
- QCR (Qual.Card.Restr.)
- POWDER
- N3/Turtle
- SKOS
- RIF

- Temporal Logic!!
- Trust, Proof
- Linking Open Data Project
- Uncertainty & Probabilistic approaches
- SWBP

Main Message

Publication (Web 1.0), *Participation & Interaction* (Web 2.0) and **Interoperability** (Web 3.0) are key!



A 14 year's old map of
the world

- Sep 2008

Engels Semantic Information Services

So, how are you too choose?

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with many thanks to Ivan Herman (W3C) for letting me use slides from his tutorial