Semantic Web and Linked Data Graphs

or how to link data and schemas on the web

Fabien Gandon, http://fabien.info, @fabien_gandon

CERN DD/

Information

This proposal c
CERN. It discu
solution based o

Keywords: Hyp
control

CERN DD/

Information

This proposal c
CERN. It discu
solution based o

Keywords: Hyp
control

semantic web

mentioned by Tim BL

in **1994** at WWW

[Tim Berners-Lee 1994, http://www.w3.org/Talks/WWW94Tim/]

IDENTIFYING EVERYTHING ON THE WEB

SEMANTIC WEB STACK

W3C®

User Interface & Applications
Trust
Proof
Unifying Logic
SPARQL
Ontology:
OWL
RDF-S
Rule:
RIF
Crypto
RDF
XML
identify
URI/IRI

W3C®

User Interface & Applications
Trust
Proof
Unifying Logic
A WEB OF LINKED DATA
SPARQL
Ontology: OWL
RDF-S
Rule: RIF
Crypto
RDF
XML
URI/IRI
W3C®

User Interface & Applications
Trust
Proof
Unifying Logic
Ontology:
OWL
RDF-S
SPARQL
Rule:
RIF
Crypto
RDF
XML
URI/IRI
PUBLISHED
SEMANTICS
OF SCHEMAS

W3C®

What are the three keystones of the Web architecture?

HTTP
URL
HTML
address
communication
identification
WEB

HTTP
address
URI/IRI
WEB
communication
identification
representations

propose your own languages (XML)

- structure data
- using tags
- in a textual format
- open standard family languages
- composable languages
- open non-proprietary

XML 101

```
<root>...</root>
<x>...</x> or <x/>
<a><b></a></b> 🚫
<x> ≠ <X>
<1an> <xmla> <bla bla> 🚫
<a b='c'></a> or <a b='c'/>
```

example of a name card

```
<card>
 <name>gandon</name>
 <tel type="office">+33492965170</tel>
 <page url="fabien.info"/>
</card>
```

root

```
<card>
 <name>gandon</name>
 <tel type="office">+33492965170</tel>
 <page url="fabien.info"/>
</card>
```

opening and closing tags

```
<card>
 <name>gandon</name>
 <tel type="office">+33492965170</tel>
 <page url="fabien.info"/>
</card>
```

attributes

```
<card>
 <name>gandon</name>
 <tel type="office">+33492965170</tel>
 <page url="fabien.info"/>
</card>
```

self-closing tag

```
<card>
 <name>gandon</name>
 <tel type="office">+33492965170</tel>
 <page url="fabien.info"/>
</card>
```

Practice XML

```
<book>
 <AAAA>Architecture Now</title>
 <author>Jodidio, Philip<BBBB>
 <ID isbn10="3822840912" CCCC>
<DDDD>
```

multiplication of supporting tools and standards

- Parsers (DOM, SAX) to access the content
- DTD / XML Schema to validate the structure
- XPath to select a part
- XPointer & XLink to link
- XQuery to query
- XSL to transform
- XProc to orchestrate

linked data principles

- Use **RDF** as data format
- Use **HTTP URI**s as names for things so that people can look up those names
- When someone looks up a URI, provide useful information (RDF, HTML, etc.) using **content negotiation**
- Include **links to other URIs** so that related things can be discovered

URL

identify what
exists on the web.

http://my-site.fr

URL → URI

identify what
exists on the web.

identify,
on the web,
what exists.

http://my-site.fr →

http://animals.org/zebra#this

URL → URI → IRI

identify what
exists on the web.

identify,
on the web,
what exists.

identify,
on the web,
in any language,
what exists.

http://my-site.fr

http://animals.org/zebra#this

http://الحيوانات.tn/斑馬#this

URL → URI → IRI

RESOURCE

Definition: a resource is anything that can be identified by a URI.

http://fabien.info/objects#mycar

e.g. a page, a person, a car, a dog, an idea, a country, a product, a service...

ratatouille.fr

datatouille.fr

linked open data(sets) cloud on the Web

Linking Open Data cloud diagram, http://lod-cloud.net/

go there !!!!

http://lod-cloud.net/

just the small part of LOD

http://lod-cloud.net/

thematic content

Domains	Number of datasets	Number of Triples	%	Out links	%
Media	25	1 841 852 061	5,82 %	50 440 705	10,01 %
Geography	31	6145 532 484	19,43 %	35 812 328	7,11 %
Government	49	13 315 009 400	42,09 %	19 343 519	3,84 %
Publications	87	2 950 720 693	9,33 %	139 925 218	27,76 %
Inter-domain	41	4 184 635 715	13,23 %	63 183 065	12,54 %
Life Sciences	41	3 036 336 004	9,60 %	191 844 090	38,06 %
Users' content	20	134 127 413	0,42 %	3 449 143	0,68 %
	295	***31 634 213 770***		***503 998 829***	

surf on the Web of data

Practice with BBC

Great White Shark

http://www.bbc.co.uk/nature/life/Great_white_shark

http://www.bbc.co.uk/nature/life/Great_white_shark.rdf

Reference: "Current and future uses of Semantic Web technologies at the BBC"
http://raimond.me.uk/slides/isemantics-2013/

a Web approach to data publication

« http://fr.dbpedia.org/resource/Paris »

URI ???...

a Web approach to data publication

« **http://**fr.dbpedia.org/resource/Paris »

a Web approach to data publication

a Web approach to data publication

a Web approach to data publication

a Web approach to data publication

a Web approach to data publication

linked data

Fichier Édition Affichage Historique Marque-pages Outils ?

http://fr.dbpedi.../data/Paris.rdf

fr.dbpedia.org/data/Paris.rdf


```
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource
  /Liste_de_périphrases_désignant_des_pays">
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Stéphane_Mallarmé">
    <dbpedia-owl:birthPlace rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource
  /Système_international_d'unités">
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Sharon_Stone">
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Seine">
    <prop-fr:villes rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
    <dbpedia-owl:city rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Seconde_Guerre_mondiale">
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Stanley_Kubrick">
    <dbpedia-owl:wikiPageWikiLink rdf:resource="http://fr.dbpedia.org/resource/Paris"/>
  </rdf:Description>
– <rdf:Description rdf:about="http://fr.dbpedia.org/resource/Sigmund_Freud">
```


Fichier Édition Affichage Historique Marque-pages Outils ?

About: Paris

fr.dbpedia.org/page/Paris

prop-fr:worldcatid	▪ lccn-n79-058874
dcterms:subject	▪ dbpedia-fr:Catégorie:Ville_décorée_de_la_Légion_d'honneu ▪ dbpedia-fr:Catégorie:Ancien_chef-lieu_de_district ▪ dbpedia-fr:Catégorie:Paris_Métropole ▪ dbpedia-fr:Catégorie:Commune_Compagnon_de_la_Libéra ▪ dbpedia-fr:Catégorie:Ville_décorée_de_la_Croix_de_guerre ▪ dbpedia-fr:Catégorie:Via_Turonensis ▪ dbpedia-fr:Catégorie:Paris ▪ dbpedia-fr:Catégorie:Wikipédia:Outil_de_retour_des_lecteu
georss:point	▪ 48.856578 2.351828
rdf:type	▪ owl:Thing ▪ http://www.opengis.net/gml/_Feature ▪ dbpedia-owl:PopulatedPlace ▪ dbpedia-owl:Place ▪ http://schema.org/Place ▪ dbpedia-owl:Settlement ▪ skos:Concept
rdfs:comment	▪ Paris, ville la plus peuplée et capitale de la France, chef-li centre du Bassin parisien, sur une boucle de la Seine, ent s'appellent les Parisiens. La ville est divisée en 20 arrondi janvier 2009 plus de 2,2 millions d'habitants. ▪ Paris is the capital and largest city of France. It is situate Paris Region, French: Région parisienne). As of January 2 has an estimated population of 2,211,297 and a metropolit Europe. ▪ Parigi è la capitale e la città più popolosa della Francia, c tempo dipartimento. È inoltre dopo Londra, Berlino, Madri la Torre Eiffel. ▪ Пари́ж — столица Франции, важнейший экономический Франции, в регионе Иль-де-Франс на берегах реки Сен находятся штаб-квартиры ЮНЕСКО, ОЭСР и Междуна ▪ París, és la capital de França i de la regió de l'Illa de Fran aglomeracions urbanes més grans d'Europa, amb una pob seva renda per capita és la ciutat més rica d'Europa.

content negotiation

- mechanism defined in the HTTP protocol specification
- serve different representation of a resource at the same URI
- user agents inform the servers of media types preferences (format, language, etc.)

```
Accept-Language: fr; q=1.0, en; q=0.5
Accept: text/html; q=1.0, text/*; q=0.8, image/gif; q=0.7,
image/jpeg; q=0.6, image/*; q=0.5, */*; q=0.1
```

- servers select the most suited representation

a Web approach to data publication

a Web approach to data publication

a Web approach to data publication

DBpedia demo

Practical Session

1. Find “London” on DBpedia.org

   e.g. Google: "london site:dbpedia.org“

   make sure you are on the English chapter (dbpedia.org) as there are many others (fr.dbpedia.org, de.dbpedia.org)

2. Find `dbp:populationDemonym` and give its value
3. Find `rdf:type`
4. Click on value `yago:WikicatCapitalsInEurope`
5. Find “Vienna” and get its URI

   (careful: with content negotiation and redirection, the URL of the page you are currently viewing may be different from the URI of the resource it describes)

6. Native name of Vienna ?

use CURL to get data

Command Prompt

```
C:\Users\gandon\Documents\mooc>
```

Practical Session

Do you have CURL? (windows=no, mac= yes, linux=?)

CURL : http://curl.haxx.se/

Installation wizard: http://curl.haxx.se/dlwiz/?type=bin

curl -o Paris.html -L http://dbpedia.org/resource/Paris

curl -o Paris-rdf-xml.txt -L -H "Accept: application/rdf+xml" http://dbpedia.org/resource/Paris

Practical Session ++

Do you have CURL? (windows=no, mac= yes, linux=?)

CURL : http://curl.haxx.se/

Installation wizard: http://curl.haxx.se/dlwiz/?type=bin

1. HTML and RDF for PARIS:

```
curl -o Paris.html -L -H "Accept: text/html"
http://dbpedia.org/resource/Paris

curl -o Paris-rdf-xml.txt -L -H "Accept: application/rdf+xml"
http://dbpedia.org/resource/Paris
```

2. HTML and RDF : `http://ns.inria.fr/fabien.gandon#me`
3. HTML and RDF for 'Vienna' on Dbpedia
4. HTML and RDF for great white shark at BBC
   `http://www.bbc.co.uk/nature/life/Great_white_shark`
5. HTML and RDF for a protein
   `http://purl.uniprot.org/uniprot/P43121`
6. What is the topic and format of data obtained with
   `curl -o json.txt -L -H "Accept: application/json"`
   `https://www.wikidata.org/wiki/Special:EntityData/Q551861`
7. What is the topic and format of data obtained with
   `curl -o turtle.txt -L -H "Accept: text/turtle"`
   `http://dx.doi.org/10.1007/3-540-45741-0_18`

LINKED OPEN DATA
On the web
Machine-readable data
Non-proprietary format
RDF standards
Linked RDF
IS YOUR DATA 5 ?

linked data streams
web of sensors, things, …
linked enterprise data
VISIBILITY
enterprise data
big data streams
VELOCITY
personal data
data streams
big linked data
linked healthcare data
closed data
data mining
open data
data bases
big data
VOLUME
data structures
linked open data
data type
data
linked data
data models
VICINITY
VARIETY
linked data schemas
web of data
data schemas
semantic web of data
VVeb data

dir.w3.org

Login Lookup...

W3C

Community Directory

- About
- View by Directory
- View by Category
- View Statistics

Main page

Contents

All pages

Recent changes

Administration

- User groups
- Manifest
- Concept schemes
- Ontologies
- Named queries
- SPARQL query

Toolbox

- What links here
- Related changes

DIRECTORY OF LINKED DATA SUPPLIERS AND DEPLOYMENTS

Enter the Directory

This is a **beta** Web application and is intended as an open directory listing of vendors, government authorities and Open Government deployments worldwide. The goal of this directory is to better connect suppliers and consumers of Linked Data. This application was developed by the W3C Government Linked Data Working Group per our charter.

Regardless of W3C affiliation, we invite independent consultants, SMEs, multi-national corporations and academic research groups to enter their details. At this time a username & password is required to enter your details. Please email support at 3roundstones dot com with subject "Directory". Thanks.

Anyone can browse the details contained in this directory of Linked Data vendors, researchers and deployments.

Step #1: To get started add your organization to the directory.

Step #2: Click on the "Edit" tab (found on the top of your Organization's page) to add a product, service, or project. You may enter as many products, services and projects as you wish.

Step #3: Click on the "View" tab (found on the top of your Organization's page) and click on the 'Add deployment' link located on the right.

If you have any feedback or questions, please email team-gld-chairs at w3 dot org.

We used Callimachus, an open source framework for creating Linked Data applications. All data in this Directory is available as RDF. Download the bulk RDF.

License

This resource was last modified at 12:35 am, 10 Nov 2011

Powered By Callimachus

Sindice - The semantic web index - Mozilla Firefox

Fichier Édition Affichage Historique Delicious Marque-pages ScrapBook Outils ?

http://sindice.com/

Sindice - The semantic web index

Home About Search Submit Forum Dev

sindice
THE SEMANTIC WEB INDEX

Sindice - Data Web Services

Over 10 billion pieces of reusable information can already be found across 100 million web pages which embed RDF and Microformats. Start consuming this data today with Sindice Data Web services.

LEARN MORE →

Term | Property | Advanced

Search the Semantic Web

harr

harry potter

SEARCH

Searching on about 37.71 million documents.

Latest News

Meet us at:

XTech: May 6-9, Dublin, Ireland

SINDICE BLOG

Feed

Sindice Beta 1 index JUN 20, 2008

The Sindice Beta 1 index is now onlineApart from the exciting geek wizardries (e.g. (More →)

An Exciting Hard Hat area MAY 30, 2008

As you might have noticed by the look of the site we're now in a very exciting transition phase. Here is a short summary of the ma... (More →)

Sindice in use FEB 20, 2008

Sindice is really meant to be used by your project, and for us it could't

Terminé

DBpedia Spotlight - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages Outils ?

wiki.dbpedia.org : spotlight | DBpedia Spotlight | Muse (band) - Wikipedia, the free enc...

spotlight.dbpedia.org/demo/

ontology alignment initiative

Confidence: 0.0

Contextual score: 0.0

Prominence (support): 0

No 'common words'

Default disambiguation

Show best candidate

SELECT TYPES... ANNOTATE

You should know:

#WatchDogs #WeAreData @ubisoft

Free book !!!

Linked Data: Evolving the Web into a Global Data Space,

Tom Heath and Christian Bizer, Synthesis Lectures on the Semantic Web: Theory and Technology, 1:1, 1-136. Morgan & Claypool (2011)

http://linkeddatabook.com/

A WEB OF LINKED DATA

User Interface & Applications
Trust
Proof
Unifying Logic
A WEB OF LINKED DATA
SPARQL
Ontology: OWL
RDF-S
Rule: RIF
Crypto
RDF
XML
URI/IRI
W3C®

RDF: data model

RDF stands for

Resource: *pages, dogs, ideas... everything that can have a URI*

Description: *attributes, features, and relations of the resources*

Framework: *model, languages and syntaxes for these descriptions*

RDF is a triple model *i.e.* every piece of knowledge is broken down into

(subject , predicate , object)

doc.html has for author Fabien and has for theme Music

doc.html has for author Fabien
doc.html has for theme Music

(doc.html , author , Fabien)
(doc.html , theme , Music)

(subject , predicate , object)

a triple

the RDF atom

Break this statement into triples?

“Fabien is a man and is French. He was born in Orléans in 1975”

?

RDF is also a graph model
to link the descriptions of resources

RDF triples can be seen as arcs of a graph (vertex,edge,vertex)

(doc.html , author , Fabien)
(doc.html , theme , Music)

Fabien
author
doc.html
theme
Music

RDF is a model for **directed** labeled multigraphs

edges have a direction:
starting/head node (subject)
arrival/tail node(object)

RDF is a model for directed **labeled** multigraphs

edges and nodes have labels

RDF is a model for directed labeled **multigraphs**

several edges/arcs between nodes/vertices

several points of views on a graph

What is the mathematical structure built by the RDF triples?

(give the type of structure and its definition/explanation)

?

URL → IRI

identify what exists on the web

identify, on the web, what exists

http://my-site.fr →

http://animals.org/this-zebra →

http://ns.inria.fr/fabien.gandon#me
http://inria.fr/schema#author
http://inria.fr/rr/doc.html
http://inria.fr/schema#theme
Music

open and link data in a

global giant graph

in RDF values of properties can also be literals i.e. strings of characters

(doc.html , author , Fabien)
(doc.html , theme , "Music")

http://ns.inria.fr/fabien.gandon#me
http://inria.fr/schema#author
http://inria.fr/rr/doc.html
http://inria.fr/schema#theme
"Music"

http://ns.inria.fr/fabien.gandon#me
http://inria.fr/schema#author
http://inria.fr/rr/doc.html
http://inria.fr/rr/doc.html
http://inria.fr/schema#theme
Music

Fill the blanks

"Margot is a journalist woman, 32 years old, married to Arthur who is a man with whom she had two children: Marie who is a woman and Simon who is a man". For each person we also also explicitly specify the name.

:Arthur, :Simon, voc:name, voc:hasChild, voc:age, voc:hasSpouse, rdf:type, voc:Woman, voc:Man, "Margot", "Arthur", "Marie", "Simon"

see the graph

namespace (XML)

- prevent name collision
- prefixes associate a tag to a URI e.g.

```
<ugb:score xmlns:ugb='http://www.ugb.sn/'>18</ugb:score>
<bla:score xmlns:bla='http://www.ugb.sn/'>18</bla:score>
```

- definitions are inherited in XML tree
- default namespace xmlns = "..."

namespace

Definition: abstract space gathering names in a same set

http://inria.fr/sujets#compilation

http://mit.edu/org/Lab

e.g. a dictionary, a library index, a glossary, a standard, a thesaurus,...

NAMESPACES

- A collection of names identified by a URI
- Names belonging to a same namespace start with the same URI.

PREFIXES

- local shortcut to declare an namespace in a file, document, etc.
- localy use prefix instead of repeating namespace
- representation languages provide prefix declaration means

QUALIFIED NAMES

- prefix + ":" + local name
- e.g. dc:title instead of <http://purl.org/dc/elements/1.1/title>

Namespaces, Prefixes, Qualified Names (in general)

http://ns.inria.fr/fabien.gandon#me
voc:author
http://inria.fr/rr/doc.html
http://inria.fr/rr/doc.html
voc:theme
Music

The web site prefix.cc is a useful service to find the namespaces usually associated to a prefix.
Use it to find the RDF namespace.

?

< RDF /> has an XML syntax

<RDF/> : graphs serialized in XML trees

```
<a>
 <b>
  <c/>
 </b>
</a>
```

<RDF/> : graphs serialized in XML trees

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
 rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
  <inria:theme>Music</inria:theme>
</rdf:Description>

</rdf:RDF>
```

<RDF/> : one root

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
 rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
  <inria:theme>Music</inria:theme>
</rdf:Description>

</rdf:RDF>
```

<RDF/> : resource **descriptions**

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
 rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
  <inria:theme>Music</inria:theme>
</rdf:Description>

</rdf:RDF>
```

<RDF/> : links between ressources

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
 rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
  <inria:theme>Music</inria:theme>
</rdf:Description>

</rdf:RDF>
```

<RDF/> : literal values

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
 rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
  <inria:theme>Music</inria:theme>
</rdf:Description>

</rdf:RDF>
```

RDF/XML : many syntactic variations

```
<rdf:RDF (…) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
   "http://ns.inria.fr/fabien.gandon#me"/>
</rdf:Description>
</rdf:RDF>
```

```
<rdf:RDF (…) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:theme>Music</inria:theme>
</rdf:Description>
</rdf:RDF>
```

RDF/XML : many syntactic variations

```
<rdf:RDF (…) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:theme>Music</inria:theme>
  <inria:author>
    <rdf:Description
      rdf:about="http://ns.inria.fr/fabien.gandon#me"/>
  </inria:author>
</rdf:Description>
</rdf:RDF>
```

RDF/XML : many syntactic variations

```
<rdf:RDF (…) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:theme>Music</inria:theme>
  <inria:author>
    <rdf:Description
      rdf:about="http://ns.inria.fr/fabien.gandon#me">
      <inria:firstName>Fabien</firstName>
    </rdf:Description>
  </inria:author>
</rdf:Description>
</rdf:RDF>
```

Fill the blanks

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE rdf:RDF [   <!ENTITY vocabulaire "http://www.unice.fr/voc">
<!ENTITY xsd "http://www.w3.org/2001/XMLSchema#"> ]>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:voc="&vocabulaire;#" xml:base="http://www.unice.fr/data">
 <AAA rdf:about="#Margot">
    <voc:name>Margot</voc:name>
    <voc:age
rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">32</voc:age>
    <BBB rdf:resource="#Arthur"></BBB>
    <voc:hasChild rdf:resource="#Simon"></voc:hasChild>
    <voc:hasChild>
      <rdf:Description rdf:about="#Marie">
        <voc:name>Marie</voc:name>
        <rdf:type CCC="&vocabulaire;#Woman"></rdf:type>
      </rdf:Description>
    </voc:hasChild>
    <DDD rdf:resource="&vocabulaire;#Journalist"></DDD>
 </AAA>  (…)
```

Fill the blanks

```
(…)
 <EEE rdf:about="#Arthur">
    <voc:name>Arthur</voc:name>
    <voc:hasChild rdf:resource="#Simon"></voc:hasChild>
    <voc:hasChild rdf:resource="#Marie"></voc:hasChild>
  </EEE>
  <voc:Man rdf:about="#Simon">
    <voc:name>Simon</voc:name>
  </voc:Man>
</rdf:RDF>
```

RDF has other syntaxes

(Turtle, TriG, N-Triples, N-Quads, JSON, RDFa)

RDF has a minimalist syntax (N-Triples)

W3C ©

```
<http://inria.fr/rr/doc.html>
 <http://inria.fr/schema#author>
   <http://ns.inria.fr/fabien.gandon#me> .

<http://inria.fr/rr/doc.html>
 <http://inria.fr/schema#theme> "Music" .
```

just a list of triples: simple to load / parse

- URI between angle brackets <...>
- literal values between double quotes "..."
- triplets separated by a point .

(but verbose)

N-Triples

RDF popular and concise syntax (Turtle/N3)

W3C ©

RDF very concise syntax (Turtle/N3)

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

<http://inria.fr/rr/doc.html>
 inria:author <http://ns.inria.fr/fabien.gandon#me> ;
 inria:theme "Music" .
```

RDF prefix declaration

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

<http://inria.fr/rr/doc.html>
 inria:author <http://ns.inria.fr/fabien.gandon#me> ;
 inria:theme "Music" .
```

RDF URI between angle brackets or qualified names

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

<http://inria.fr/rr/doc.html>
 inria:author <http://ns.inria.fr/fabien.gandon#me> ;
 inria:theme "Music" .
```

RDF one (.) or many properties (;) or values (,)

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

<http://inria.fr/rr/doc.html>
 inria:author <http://ns.inria.fr/fabien.gandon#me> ;
 inria:theme "Music", "Piano" .
```

Fill the blanks

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix voc: <http://www.unice.fr/voc#> .
@prefix xml: <http://www.w3.org/XML/1998/namespace> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
<http://www.unice.fr/data#Margot> a voc:Journalist AAA BBB ;
    voc:age "32"^^xsd:string ;
    voc:hasChild <http://www.unice.fr/data#Marie>, <CCC>;
    voc:hasSpouse <http://www.unice.fr/data#Arthur> ;
    voc:name "Margot" .
<http://www.unice.fr/data#Arthur> DDD voc:Man ;
    voc:hasChild <http://www.unice.fr/data#Marie>,
        <http://www.unice.fr/data#Simon> ;
    voc:name "Arthur" .
<http://www.unice.fr/data#Marie> a voc:Woman ;
    voc:name "Marie" .
<EEE> a FFF ;
     GGG HHH .
```

What is the historical syntax of RDF ?

validate & transform

Firefox Fichier Édition Affichage Historique Marque-pages Outils Fenêtre Aide

Tim Berners-Lee | RDF Translator | W3C RDF Validation Service

www.w3.org/People/Berners-Lee/

Contents

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

See also

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

Tim Berners-Lee

Note that the battle for the net display I put onto this page in a personal capacity, and with apologies that it is rather Americanist -- assumes the reader is from the USA. But the message, and the battle is important and global, in my personal opinion.

Biography

A graduate of Oxford University, Tim Berners-Lee invented the World Wide Web, an internet-based hypermedia initiative for global information sharing while at CERN, the European Particle Physics Laboratory, in 1989. He wrote the first web client and server in 1990. His specifications of URIs, HTTP and HTML were refined as Web technology spread.

He is the 3Com Founders Professor of Engineering in the School of Engineering with a joint appointment in the Department of Electrical Engineering and Computer Science at the Laboratory for Computer Science and Artificial Intelligence (CSAIL) at the Massachusetts Institute of Technology (MIT) where he also heads the Decentralized Information Group (DIG). He is also a Professor in the Electronics and Computer Science Department at the University of Southampton, UK.

He is the Director of the World Wide Web Consortium (W3C), a Web standards organization founded in 1994 which develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. He was a Director of the Web Science Trust (WST) launched in 2009 to promote research and education in Web Science, the multidisciplinary study of humanity connected by technology.

Tim is a Director of the World Wide Web Foundation, launched in 2009 to coordinate efforts to further the potential of the Web to benefit humanity.

He has promoted open government data globally, is a member of the UK's Transparency Board, and president of London's Open Data Institute.

In 2001 he became a Fellow of the Royal Society. He has been the recipient of several international awards including the Japan Prize, the Prince of Asturias Foundation Prize, the Millennium Technology Prize and Germany's Die Quadriga award. In 2004 he was knighted by H.M. Queen Elizabeth and in 2007 he was awarded the Order of Merit. In 2009 he was elected a foreign associate of the National Academy of Sciences. He is the author of "Weaving the Web".

On March 18 2013, Tim, along with Vinton Cerf, Robert Kahn, Louis Pouzin and Marc Andreesen, was awarded the Queen Elizabeth Prize for Engineering for "ground-breaking innovation in engineering that has been of global benefit to humanity."

(Longer biography)

Firefox envoie automatiquement certaines informations à Mozilla afin que nous puissions améliorer votre navigation. Choisir ce que j'envoie

Practice

1. Get the RDF data from: http://ns.inria.fr/fabien.gandon#me
2. What is the syntax used?
3. Validate it and see the graph: http://www.w3.org/RDF/Validator/
4. Translate into Turtle/N3: http://rdf-translator.appspot.com/
5. Visualize it also with: https://graves.cl/visualRDF/
6. Adapt to your data and do it again

writing rules for RDF triples

- the subject is always a resource (never a *literal*)
- properties are binary relations and their types are identified by IRIs
- the value is a resource or a literal

XML schema datatypes & literals

standard literals are xsd:string

type literals with datatypes from XML Schema

```
<rdf:Description rdf:about="#Fabien">
 <teaching rdf:datatype="http://www.w3.org/2001/XMLSchema#boolean">
  true</teaching>
 <birth rdf:datatype="http://www.w3.org/2001/XMLSchema#date">
  1975-07-31</birth>
</rdf:Description/>
```

```
#Fabien teaching "true"^^xsd:boolean ;
        birth "1975-07-31"^^xsd:date .
```

W3C - http://www.w3.org/TR/xmlschema-2/

XML Schema datatypes

blank nodes (bnodes)

handy anonymous nodes (existential quantification)

there exist a resource such that… { ∃ r ; …}

```
<rdf:Description rdf:about="http://bu.ch/123.html ">
 <author>
  <rdf:Description>
   <surname>Doe</surname>
   <firstname>John</firstname>
  </rdf:Description>
 </author>
 <title>My Life</title>
</rdf:Description>
```

```
<http://bu.ch/123.html>
 author
  [surname "Doe" ;
   firstname "John" . ] ;
 title "My Life" .
```

```
<rdf:Description rdf:about="#car91">
 <ex:weight rdf:parseType="Resource">
  <rdf:value
  rdf:datatype="http://www.w3.org/2001/XMLSchema#decimal">1.5</rdf:value>
  <ex:unit rdf:resource="http://unit.org/ton"/>
 </ex:weight>
</rdf:Description>
```

```
<#car91> ex:weight [ ex:unit <http://unit.org/ton> ;
            rdf:value 1.5 ] .
```

complex values

```
<Book>
 <title xml:lang='fr'>Seigneur des anneaux</title>
 <title xml:lang='en'>Lord of the rings</title>
</Book>
```

```
<Book> title "Seigneur des anneaux"@fr ;
       title "Lord of the rings"@en .
```

literals with languages and without are disjoint

"Fabien" ≠ "Fabien"@en ≠ "Fabien"@fr

language

typing resources

using URIs to identify the types

```
<urn://~fgandon> rdf:type <http://www.inria.fr/schema#Person>
```

a resource can have several types

```
<urn://~fgandon> rdf:type <http://www.inria.fr/schema#Person>
<urn://~fgandon> rdf:type <http://www.inria.fr/schema#Researcher>
<urn://~fgandon> rdf:type <http://www.mit.edu/schema#Lecturer>
```

```
<rdf:Description rdf:about="urn://~fgandon">
 <rdf:type rdf:resource="http://www.inria.fr/schema#Person" />
 <name>Fabien</name>
</rdf:Description>

<in:Person rdf:about="urn://~fgandon">
  <name>Fabien</name>
</in:Person>
```

```
<urn://~fgandon>
 a in:Person ;
 name "Fabien" .
```

question:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:exs="http://example.org/schema#">
 <rdf:Description rdf:about="http://example.org/doc.html">
  <rdf:type rdf:resource="http://example.org/schema#Report"/>
  <exs:theme rdf:resource="http://example.org#Music"/>
  <exs:theme rdf:resource="http://example.org#History"/>
  <exs:nbPages rdf:datatype="http://www.w3.org/2001/XMLSchema#int">23</exs:nbPages>
 </rdf:Description>
</rdf:RDF>
```

means…?

question:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:exs="http://example.org/schema#">
 <rdf:Description rdf:about="http://example.org/doc.html">
  <rdf:type rdf:resource="http://example.org/schema#Report"/>
  <exs:theme rdf:resource="http://example.org#Music"/>
  <exs:theme rdf:resource="http://example.org#History"/>
  <exs:nbPages rdf:datatype="http://www.w3.org/2001/XMLSchema#int">23</exs:nbPages>
 </rdf:Description>
</rdf:RDF>
```

Visit Victor Hugo

1. See HTML data from: http://id.loc.gov/authorities/names/n79091479.html
2. Get RDF data from: http://id.loc.gov/authorities/names/n79091479.rdf
3. What is the syntax?
4. Translate into Turtle/N3: http://rdf-translator.appspot.com/
5. Any remark?

bags = unordered groups

```
<rdf:Description rdf:about="#">
 <author>
   <rdf:Bag>
     <rdf:li>Ivan Herman</rdf:li>
     <rdf:li>Fabien Gandon</rdf:li>
  </rdf:Bag>
 </author>
</rdf:Description>
```

```
<#> author [
 a rdf:Bag ;
 rdf:li "Ivan Herman" ;
 rdf:li "Fabien Gandon" . ] .
```

```
<#> author _:a
_:a rdf:_1 “Ivan Herman”
_:a rdf:_2 “Fabien Gandon”
```

sequence

ordered group of resources or literals

```
<rdf:Description rdf:about="#partition">
  <contains>
   <rdf:Seq>
    <rdf:li rdf:about="#C"/>
    <rdf:li rdf:about="#C"/>
    <rdf:li rdf:about="#C"/>
    <rdf:li rdf:about="#D"/>
    <rdf:li rdf:about="#E"/>
   </rdf:Seq>
 </contains>
</rdf:Description>
```

```
<partition>
 contains [
  a rdf:Seq ;
  rdf:li "C" ;
  rdf:li "C" ;
  rdf:li "C" ;
  rdf:li "D" ;
  rdf:li "E" .
] .
```

alternatives

e.g. title of a book in different languages

```
<rdf:Description rdf:about="#book">
  <title>
   <rdf:Alt>
    <rdf:li xml:lang="fr">l'homme qui prenait sa femme
                          pour un chapeau</rdf:li>
    <rdf:li xml:lang="en">the man who mistook his wife
                          for a hat</rdf:li>
   </rdf:Alt>
 </title>
</rdf:Description>
```

```
<#book>
 title [
  a rdf:Alt ;
  rdf:li "l'homme…"@fr ;
  rdf:li "the man…"@en .
] .
```

collection

exhaustive and ordered list

```
<rdf:Description rdf:about="#week">
 <dividedIn rdf:parseType="Collection">
  <rdf:Description rdf:about="#monday"/>
  <rdf:Description rdf:about="#tuesday"/>
  <rdf:Description rdf:about="#wednesday"/>
  <rdf:Description rdf:about="#thursday"/>
  <rdf:Description rdf:about="#friday"/>
  <rdf:Description rdf:about="#saturday"/>
  <rdf:Description rdf:about="#sunday"/>
 </devidedIn>
</rdf:Description>
```

```
<#week> dividedIn
  ( <#monday> <#tuesday> <#wednesday>
    <#thursday> <#friday> <#saturday> <#sunday>
   ) .
```

The 3 winners of a race

To represent the fact a race had excatly three winners of a race sorted according to the arrival order, you preferably use:

1. alternatives (rdf:Alt)
2. a sequence (rdf:Seq)
3. a collection (rdf:List)
4. a group/set (rdf:Bag)

reification of a statement (~deprecated)

- a triple is reified by a statement
- the statement turns the triple into a ressource
- the statement ressource can be described

```
<rdf:Statement rdf:nodeID="decFab">
 <rdf:subject rdf:resource="http://inria.fr/doc.html" />
 <rdf:predicate rdf:resource="&dc;creator"/>
 <rdf:object rdf:resource="urn://~fgandon" />
</rdf:Statement>

<rdf:Description rdf:nodeID="decFab">
  <dc:creator rdf:resource="http://inria.fr/"/>
</rdf:Description>
```

RDF (named) graphs

group triples in graphs named by IRIs

http://ns.inria.fr/fabien.gandon#me
http://inria.fr/schema#author
http://inria.fr/rr/doc.html
http://inria.fr/people
http://inria.fr/rr/doc.html
http://inria.fr/schema#theme
Music
http://inria.fr/topics

RDF 1.1 extends Turtle and N-Triples for named graphs

W3C ©

```
@prefix rdf:
  <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

GRAPH <http://inria.fr/people>
{ <http://inria.fr/rr/doc.html>
   inria:author
    <http://ns.inria.fr/fabien.gandon#me> .
}

GRAPH <http://inria.fr/topics>
{ <http://inria.fr/rr/doc.html>
 inria:theme "Music" .
}
```

TriG

```
<http://inria.fr/rr/doc.html>
 <http://inria.fr/schema#author>
   <http://ns.inria.fr/fabien.gandon#me>
    <http://inria.fr/people> .

<http://inria.fr/rr/doc.html>
 <http://inria.fr/schema#theme> "Music"
  <http://inria.fr/topics> .
```

N-Quads

Named graph

What is the syntax of the following RDF statement?
What does mean?

```
@prefix dcterms: <http://purl.org/dc/terms/>.
GRAPH  <http://inria.fr/topics/algebre>
{
  <http://inria.fr/rr/doc.html>
    dcterms:subject
      <http://data.bnf.fr/ark:/12148/cb121105993> .
}
```

Visit Leukocyte surface antigen CD53

1. See HTML data from: http://www.uniprot.org/uniprot/Q61451
2. Get RDF data from: http://www.uniprot.org/uniprot/Q61451.rdf
3. What is the syntax?
4. Translate into Turtle/N3: http://rdf-translator.appspot.com/
5. Any remark?

RDF in JSON (latter in the course)

W3C ©

RDF Semantics: subset of First Order Logic (FOL)

- Binary predicates
- Existential Quantificatio
- Conjunctions

BUT:

- no n-ary predicates
- no disjunction
- no negation
- no universal quantification

SO: RDF is monotonous

what is true and what can be inferred remains true as we add new statements

RDF formal semantics - theory models http://www.w3.org/TR/rdf-mt/

dc:creator

rdf:label

ex:weight

ex:ingredients

rdf:about

rdf:type

http://my_domain.org/my_path/my_type

openmodel

- extensible vocabulary based on URIs
- anyone can say anything about anything

link
to the world

ACCESSING DATA ON THE WEB

Query RDF data

SPARQL

Protocol and
RDF
Query
Language

SPARQL in 3 parts

part 1: query language

part 2: result format

part 3: access protocol

SPARQL query

```
SELECT ...
FROM ...
WHERE { ... }
```

query syntax based on Turtle

URI:	<http://ns.Inria.fr/fabien.gandon#me>
QName:	rdf:type foaf:name
Variable:	?x ?name $test
Blank Node:	_:b1 _:b2
Literal:	"Victor Hugo"@fr
	3.14
	true
	"12"^^xsd:integer

query syntax based on Turtle

e.g. persons at least 18-year old

```
PREFIX ex: <http://inria.fr/schema#>
SELECT ?person ?name
WHERE {
  ?person rdf:type ex:Person .
  ?person ex:name ?name .
  ?person ex:age ?age .
  FILTER (?age > 17)
}
```

left(x,y) right(z,v)

left(y,z) right(z,u)

right(u,v)

$\models$

left(x,?p) left(?p,z)

$\Leftrightarrow$

graph mapping / projection

classical three clauses:

- Select: clause to select the values to be returned
- Where: triple/graph pattern to match
- Filter: constraints expressed using test functions (XPath 2.0 or external)

SPARQL triples

- triples and question marks for variables:

```
?x  rdf:type   ex:Person
```

- graph patterns to match:

```
SELECT ?subject ?proprerty ?value
WHERE {?subject ?proprerty ?value}
```

- a pattern is, by default, a conjunction of triples

```
SELECT ?x WHERE
{ ?x     rdf:type        ex:Person .
  ?x     ex:name         ?name . }
```

question:

- Query:

```
SELECT ?name WHERE {
 ?x name ?name .
 ?x email ?email .
}
```

- Base:

```
_:a name "Fabien"   x2
_:b name "Thomas"
_:c name "Lincoln"
_:d name "Aline"
_:b email <mailto:thom@chaka.sn>
_:a email <mailto:Fabien.Gandon@inria.fr>
_:d email <mailto:avalandre@pachinko.jp>
_:a email <mailto:bafien@fabien.info>
```

- Results ?

prefixes

to use namespaces:

```
PREFIX mit: <http://www.mit.edu#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?student
WHERE {
 ?student mit:registeredAt ?x .
 ?x foaf:homepage <http://www.mit.edu> .
}
```

Base namespace : `BASE <…>`

compare...

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select * where {
  ?x foaf:name ?n
}

select * where {
  ?x <http://xmlns.com/foaf/0.1/name> ?n
}
```

Test online

- Connect to:

  https://corese.inria.fr/srv/template

- Query:

```
prefix v: <http://www.inria.fr/2015/humans#>
select * where
{
 ?x a v:Person .
}
```

to respect an attribute e.g. `@fr` , `^^xsd:integer`

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?x ?f WHERE {
 ?x foaf:name "Fabien"@fr ; foaf:knows ?f
.
}
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?x WHERE {
 ?x foaf:name "Fabien"@fr ;
    foaf:age "21"^^xsd:integer .
}
```

specify the language and the type of literals

same shortcuts as Turtle

triples with a common subject:

```
SELECT ?name ?fname
WHERE {
 ?x a Person;
    name ?name ;
    firstname ?fname ;
    author ?y . }
```

⟷

```
SELECT ?name ?fname
WHERE {
 ?x rdf:type Person .
 ?x name ?name .
 ?x firstname ?fname .
 ?x author ?y .
}
```

list of values

```
?x firstname "Fabien", "Lucien" .
```

blank node

```
[firstname "Fabien"] or [] firstname "Fabien"
```

Query DBpedia

Test on DBpedia

- Connect to:

  http://dbpedia.org/snorql/ or
  http://fr.dbpedia.org/sparql or …

  http://wiki.dbpedia.org/Internationalization/Chapters

- Query:

```
SELECT * WHERE {
   ?x rdfs:label "Paris"@fr .
   ?x ?p ?v .
}
LIMIT 10
```

American presidents on Wikidata

https://query.wikidata.org/

```
SELECT ?president  ?name WHERE

{       wd:Q30 p:P6/ps:P6 ?president .
        ?president p:P734 ?pLabel .
        ?pLabel ?x ?v .
        ?v rdfs:label ?name .
        FILTER (lang(?name)="en")
}
```

dataset

```
PREFIX mit: <http://www.mit.edu#>
SELECT ?student
FROM NAMED <http//www.mit.edu/data1.rdf>
FROM NAMED <http//www.mit.edu/data2.rdf>
WHERE {
 GRAPH ?g {
  ?student mit:registeredAt ?x .
 }
}
```

union

alternative graph patterns

```
PREFIX mit: <http://www.mit.edu#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?student ?name
WHERE {
 ?student mit:registeredAt ?x .
 {
  {
   ?x foaf:homepage <http://www.mit.edu> .
  }
  UNION
  {
   ?x foaf:homepage <www.stanford.edu/> .
  }
 }
}
```

optional part

```
PREFIX mit: <http://www.mit.edu#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?student ?name
WHERE {
 ?student mit:registeredAt ?x .
 ?x foaf:homepage <http://www.mit.edu> .
 OPTIONAL {?student foaf:name ?name . }
}
```

possibly unbound

question:

```
SELECT * WHERE {
 ?x :hasCreated ?doc .
 OPTIONAL {
  ?x :age ?age .
  ?x :isMemberOf ?org
 }
}
```

```
:John :hasCreated :d1
:John :hasCreated :d2
:Jack :hasCreated :d3
:Jack :isMemberOf :club
:Jim :hasCreated :d4
:Jim :isMemberOf :assoc
:Jim :age 45
```

Results

(1) x = :John ; doc = :d1 ; org = unbound ; age = unbound

(2) x = :John ; doc = :d2 ; org = unbound ; age = unbound

(3) x = :Jack ; doc = :d3 ; org = unbound ; age = unbound

(4) x = :Jim ; doc = :d4 ; org = :assoc ; age = 45

sort, filter and limit answers

```
PREFIX mit: <http://www.mit.edu#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?student ?name
WHERE {
 ?student mit:registeredAt ?x .
 ?x foaf:homepage <http://www.mit.edu> .
 ?student foaf:name ?name .
 ? student foaf:age ?age .
 FILTER (?age > 22)
}
ORDER BY ?name
LIMIT 20
OFFSET 20
```

students older than 22 years sorted by name
results from number #21 to #40

Result Modifiers

SELECT * WHERE

SELECT DISTINCT ?x ?y WHERE

ORDER BY ?x DESC(?y)

LIMIT 10

OFFSET 10

question:

```
select distinct ?x ?z
where {
 ?x :friend ?y .
 ?y :friend ?z
}
```

```
:Jules :friend :Jim
:Jim   :friend :Jack
:Jules :friend :James
:James :friend :Jack
```

Result with distinct

(1) x = :Jules ; z = :Jack

Result without distinct

(1) x = :Jules ; z = :Jack

(1) x = :Jules ; z = :Jack

question:

```
select ?doc ?date
where {
 ?pers :author ?doc
 ?doc :date ?date
}
order by ?date
desc(?doc)
```

```
:Jim :author :d2
:Jack :author :d1
:Jack :author :d3
:d2 :date 2008-01-01
:d1 :date 2007-12-31
:d3 :date 2007-12-31
```

Result

(1) doc = :d3 ; date = 2007-12-31

(2) doc = :d1 ; date = 2007-12-31

(3) doc = :d2 ; date = 2008-01-01

operators

- Inside the FILTER:
  - Comparators: **`<, >, =, <=, >=, !=`**
  - Tests on variables : **`isURI(?x), isBlank(?x), isLiteral(?x), bound(?x)`**
  - Regular expression **`regex(?x, "A.*")`**
  - Attributes and values: **`lang(), datatype(), str()`**
  - Casting: **`xsd:integer(?x)`**
  - External functions and extensions
  - Boolean combinations: **`&&, ||`**
- In the where WHERE: **`@fr , ^^xsd:integer`**
- In the SELECT: **`distinct`**

meaning?

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select ?x where {
  ?x foaf:knows ?y ;
       foaf:knows ?z .
  filter (?y != ?z)
}
```

results?

```
select * where {
  ?x ex:age ?a
  filter (?a <= 30)
}
```

```
ex:John ex:age "18" .
ex:Jim  ex:age "20" .
ex:Jack ex:age "22" .
ex:Jude ex:age "35" .
```

other functions (v 1.1)

`isNumeric(Val)` test it is a numeric value

`coalesce(val,…, val)` first valid value

`IRI(Str)/URI(Str)` to build an iri/uri from a string

`BNODE(ID)` to build a blank node

`RAND()` random value between 0 and 1

`ABS(Val)` absolute value

`CEIL(Val), FLOOR(Val), ROUND(Val)`

`NOW()` today's date

`DAY(Date), HOURS(Date), MINUTES(Date), MONTH(Date), SECONDS(Date), TIMEZONE(Date), TZ(Date), YEAR(Date)`
to access different parts of a date

`MD5(Val), SHA1(Val), SHA256(Val), SHA384(Val), SHA512(Val)` hash functions

string / literal functions (v1.1)

`STRDT(value, type)` build a typed literal

`STRLANG(value, lang)` build a literal with a language

`CONCAT(lit1,…,litn)` concatenate a list of literal

`CONTAINS(lit1,lit2)`, `STRSTARTS(lit1,lit2)`, `STRENDS(lit1,lit2)`

to test string inclusion

`SUBSTR(lit, start [,length])` extract a sub string

`ENCODE_FOR_URI (Str)` encodes a string as URI

`UCASE (Str)`, `LCASE (Str)` uppercase and lowercase

`STRLEN (Str)` length of the string

e.g. DBpedia

SPARQL Explorer for http://dbpedia.org/sparql
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#>
Results: Browse
Go!
Reset
Powered by OpenLink Virtuoso and dbpedia

question:

```
PREFIX ex: <http://www.exemple.abc#>
SELECT ?person
WHERE {
   ?person rdf:type ?type .
   FILTER(! ( ?type = ex:Man ))
}
```

minus

substract a pattern: remove from the results of PAT1 the results of PAT2 PAT1 minus {PAT2}

```
PREFIX ex: <http://www.exemple.abc#>
SELECT ?x
WHERE {
 { ?x rdf:type ex:Person }
  minus {?x rdf:type ex:Man}
}
```

Remove results that are compatible: same variables have same values and at least one common variable

Quizz:

Could this query return `ex:a c:memberOf ex:b` ?

```
select * where {
  ?x c:memberOf ?org .
  minus { ex:a c:memberOf ex:b }
}
```

not exists

check the absence of a pattern in the graph

PAT1 . filter(! exists {PAT2})

```
PREFIX ex: <http://www.exemple.abc#>
SELECT ?x
WHERE {
 ?x ex:memberOf ?org .
 filter (not exists
   {?y ex:memberOf <Hell>})
}
```

not exist vs. minus

Same results:

```
?x c:memberOf ?org . filter(! exists {?x c:author ?doc })
?x c:memberOf ?org . minus {?x c:author ?doc }
```

Different results:

```
?x c:memberOf ?org . filter(! exists {?y c:author ?doc })
?x c:memberOf ?org . minus {?y c:author ?doc }
```

Example: integrity constraint, coherence constraint, etc.

if… then… else

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select * where {
 ?x foaf:name ?name ; foaf:age ?age .
 filter (
  if (langMatches( lang(?name), "FR"),
     ?age>=18, ?age>=21) )
}
```

test a value is `in` / `not in` a list

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select * where {
    ?x foaf:name ?n .
    filter (?n in ("fabien", "olivier",
                   "catherine") )
}
```

values

pre-defined bindings

```
select ?person where {
 ?person name ?name .
 VALUES (?name)
   { "Peter" "Pedro" "Pierre" }
}
```

bind

allows a value to be assigned to a variable

```
PREFIX  dc:  <http://purl.org/dc/elements/1.1/>
PREFIX  ns:  <http://example.org/ns#>

SELECT  ?title ?price
{  { ?x ns:price ?p .
     ?x ns:discount ?discount
     BIND (?p*(1-?discount) AS ?price)
   }
   {?x dc:title ?title . }
   FILTER(?price < 20)
}
```

aggregates

Aggregation functions:
`group by` + **`count`**, **`sum`**, **`min`**, **`max`**, **`avg`**, **`group_concat`** or **`sample`**

Additional filter after aggregate: **`having()`**

aggregates

- Return one result when there is no group by

```
select (min(?price) as ?min) where { ?x ex:price ?price }
```

- Return a result for each « group by » key

```
select ?class (min(?price) as ?min)
where { ?x a ?class ; ex:price ?price} group by ?class
```

- Count the number of results

```
select (count(*) as ?count) where { ?x ex:price ?price }
```

- Count the number of distinct results

```
select (count(distinct *) as ?count)
where { [ a ?class ; ex:price ?price ] }
```

aggregates

ex. average scores, grouped by the subject, but only where the mean is greater than 10

```
SELECT (AVG(?score) AS ?average)
WHERE { ?student score ?score . }
GROUP BY ?student
HAVING(AVG(?score) > 10)
```

aggregates

ex. members of organizations and number of other members they are linked to through them

```
select ?x (count(distinct ?y) as ?count) where
{
 ?x c:memberOf ?o .
 ?y c:memberOf ?o
}
group by ?x
```

group_concat

concatenate grouped values

```
select ?x (group_concat(?p) as ?prices)
where { ?x c:price ?p } group by ?x
```

?x = <book1> ; ?prices = “12 8 10"

?x = <pen8> ; ?prices = “5 6"

```
select ?x (group_concat(?p ; separator='; ') as
?prices) where { ?x c:price ?p } group by ?x
```

?x = <book1> ; ?prices = “12; 8; 10"

?x = <pen8> ; ?prices = “5; 6"

meaning?

```
prefix ex: <http://example.org/>
select ?x (count(?doc) as ?c)
where {  ?x ex:author ?doc  }
group by ?x
order by desc(count(?doc))
```

meaning?

```
select distinct ?x ?c where {
  ?x a foaf:Person
  optional { ?x foaf:name  ?n }
  optional { ?x foaf:mbox  ?m }
  optional { ?x foaf:knows ?y }
  bind (
    if (bound(?n), 1, 0) + if (bound(?m), 1, 0) + if (bound(?y), 1, 0)
   as ?c)
}
order by desc(?c)
```

FLINT editor

paths

/ : sequence
| : alternative
+ : one or several
*** : zero or several**
? : optional
^ : reverse
! : negation
{min,max} : length

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select ?f_of_f where {
 ?x foaf:name "Fabien Gandon" ;
    foaf:knows/foaf:knows ?f_of_f .
}
```

paths

/ : sequence
| : alternative
+ : one or several
*** : zero or several**
? : optional
^ : reverse
! : negation
{min,max} : length

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select ?network_fab where {
 ?x foaf:name "Fabien Gandon" ;
    foaf:knows+ ?network_fab .
}
```

paths

- / : sequence
- | : alternative
- + : one or several
- * : zero or several
- ? : optional
- ^ : reverse
- ! : negation
- {min,max} : length

```
prefix ex: <http://example.org/voc#>
select * where {
  ?x ^ex:hasParent ?y }
```

paths

/ : sequence
| : alternative
+ : one or several
*** : zero or several**
? : optional
^ : reverse
! : negation
{min,max} : length

```
prefix ex: <http://example.org/voc#>
select * where {
  ?x !ex:hasParent ?y }
```

paths

/	: sequence
|	: alternative
+	: one or several
*	: zero or several
?	: optional
^	: reverse
!	: negation
{min,max}	: length

```
prefix ex: <http://example.org/voc#>
prefix rdf: <…>
prefix rdfs: <…>
select * where {
  ?x rdf:type/rdfs:subClassOf* ex:Person}
```

paths

/	: sequence
|	: alternative
+	: one or several
*	: zero or several
?	: optional
^	: reverse
!	: negation
{min,max}	: length

```
prefix rdf: <…>
select ?val where {
 ?list rdf:rest*/rdf:first ?val
}
```

quizz

What expression should we use to find the ?x related to ?y by paths composed of any composition of properties foaf:knows or/or rdfs: seeAlso?

- ?x (foaf:knows | rdfs:seeAlso)+ ?y
- ?x foaf:knows+ | rdfs:seeAlso+ ?y
- ?x (foaf:knows / rdfs:seeAlso)+ ?y

select expression

```
select ?x (year(?date) as ?year)
where {
 ?x birthdate ?date .
}
```

meaning?

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select ?x (if (bound(?n), ?n, "JohnDoe") as ?m)
where {
  ?x foaf:knows ?y
  optional { ?y foaf:name ?n }
}
```

meaning?

```
prefix ex:  <http://example.org/>
select ?x (avg(?a) as ?b)
where {
  ?x ex:knows ?y .
  ?y ex:age ?a
}
group by ?x
```

subquery / nested query

```
select ?name where {
 {select (max(?age) as ?max)
  where { ?person age ?age }
 }
 ?senior age ?max
 ?senior name ?name
}
```

Service Clause

remote access to a SPARQL endpoint

```
prefix r: <http://fr.dbpedia.org/resource/>
prefix p: <http://fr.dbpedia.org/property/>
prefix o: <http://dbpedia.org/ontology/>
select * where {
  service <http://fr.dbpedia.org/sparql> { r:Auguste p:succ ?s ;  o:wife ?w  }
}
```

```
prefix geo: <http://rdf.insee.fr/def/geo#>
select * where {
 service <http://rdf.insee.fr/sparql> {
  ?region rdf:type geo:Region ; geo:nom "Bourgogne" ;   ?p ?v
 }
}
```

SPARQL result

failure/ success

values found

result formats

- a binding i.e. list of all the selected values (SELECT) for each answer found;
  (stable XML format ; e.g. for XSLT transformations)
- RDF sub-graphs for each answer found
  (RDF/XML format ; e.g. for application integration)
- JSON (eg. ajax web applications)
- CSV/TSV (eg. export)

example of binding

results for previous query in XML

```
<?xml version="1.0"?>
<sparql xmlns="http://www.w3.org/2005/sparql-results#">
 <head>
  <variable name="student"/>
 </head>
 <results ordered="false" distinct="false">
  <result>
   <binding name="student">
<uri>http//www.mit.edu/data.rdf#ndieng</uri></binding>
  </result>
  <result>
   <binding name="student">
<uri>http//www.mit.edu/data.rdf#jdoe</uri></binding>
  </result>
</sparql>
```

example of JSON result

for Internet Media Type `application/sparql-results+json`


```
{
 "head": { "vars": [ "book" , "title" ]
 } ,
 "results": {
   "bindings": [
     {
       "book": { "type": "uri" , "value": "http://example.org/book/book6" } ,
       "title": { "type": "literal" , "value": "Harry Potter and the Half-Blood
Prince" }
     } ,
     {
       "book": { "type": "uri" , "value": "http://example.org/book/book7" } ,
       "title": { "type": "literal" , "value": "Harry Potter and the Deathly
Hallows" }
     } ,
     {
       "book": { "type": "uri" , "value": "http://example.org/book/book1" } ,
       "title": { "type": "literal" , "value": "Harry Potter and the Philosopher's
Stone" }
     }
   ]
 }
}
```

example of CSV result

for Internet Media Type `text/csv`

```
uri,name
http://fabien.info,Gandon
http://inria.fr,Inria
```

PS: same principle for TSV

Check the existence of at least one answer/result

does not list all the results but just checks if there exists at least one (true/false)

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
ASK { ?person foaf:age 111 . }
```

free description

```
PREFIX mit: <http://www.mit.edu#>
DESCRIBE ?student
{ ?student rdf:type mit:Student . }

or

DESCRIBE <…URI…>
```

construct RDF as result

```
PREFIX mit: <http://www.mit.edu#>
PREFIX corp: <http://mycorp.com/schema#>
CONSTRUCT
{ ?student rdf:type corp:FuturExecutive . }
WHERE
{ ?student rdf:type mit:Student . }
```

Gephi 0.8.1 beta - my graph.gephi

File Workspace View Tools Window Plugins Help

Overview | Data Laboratory | Preview

Partition | Ranking

Nodes | Edges

Group | Show Pie | Apply

Layout

---Choose a layout

Run

<No Properties>

Presets... Reset

Semantic Web Import | Graph

Driver | Request | Log | Configurations

SPARQL Request

```
prefix dbpedia-owl: <http://dbpedia.org/ontology/>
prefix dbpedia-pro: <http://dbpedia.org/property/>
prefix geo: <http://www.w3.org/2003/01/geo/wgs84_pos#>
prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
prefix geonames: <http://sws.geonames.org/>
prefix wgs84_pos: <http://www.w3.org/2003/01/geo/wgs84_pos#>
prefix gephi:<http://gephi.org/>
prefix owl: <http://www.w3.org/2002/07/owl#>

construct {
        ?city1 owl:sameLanguage ?city2 .
        ?city1 gephi:label ?city_name1 ;
                gephi:longitude ?long1 ;
                gephi:latitude ?lat1 ;
                gephi:image ?im1 ;
                gephi:language ?language ;
                gephiopulationTotal ?population1 .

      ?city2 gephi:label ?city_name2 ;
                gephi:longitude ?long2 ;
                gephi:latitude ?lat2 ;
                gephi:image ?im2 ;
                gephi:language ?language ;
                gephiopulationTotal ?population2 .
}
where {
        {
        service <http://live.dbpedia.org/sparql/> {
```

Run

Context

Nodes: 765

Edges: 2184

Directed Graph

St... | Filters | Mul...

Settings

Network Overview

Average Degree

Avg. Weighted Degree

Network Diameter

Graph Density

HITS

Modularity

PageRank

Erdös Number

Connected Components

Node Overview

Avg. Clustering Coefficient

SW Type Statistics

Clustering Coefficient

Eigenvector Centrality

Edge Overview

Avg. Path Length

Neighborhood Overlap, Embeddedness

RDF Request Graph

RDF Datasets

- Query an RDF base with several graphs
- Named graphs with URIs
- Default graph
- Identify, characterize, etc. the graphs that are queried

http://ns.inria.fr/fabien.gandon#me
http://inria.fr/schema#author
http://inria.fr/rr/doc.html
http://inria.fr/people
http://inria.fr/rr/doc.html
http://inria.fr/schema#theme
Music
http://inria.fr/topics

```
select ?g where
 { graph ?g { ?p inria:author ?doc } }
```

```
select ?g from named <http://g1> where
 {graph ?g { ?p inria:author ?doc } }
```

```
select ?g from <http://g1> where
 { ?p inria:author ?doc }
```

```
select * where { graph <http://g1>
   { ?p inria:author ?doc } }
```

```
select ?g where { ?g inria:date 2016 .
  graph ?g { ?p inria:author ?doc } }
```

Quizz

On which graph(s) is calculated ?x ?p ?y

On which graph(s) is calculated graph ?g { ?y ?q ?z }

```
prefix ex:  <http://example.org/>
select *
from ex:g1
from named ex:g2
where {
  ?x ?p ?y .
  graph ?g { ?y ?q ?z}  }
```

SPARQL Update

Update language for RDF graphs

CRUD: Create Read Update Delete

SPARQL Update

Add or remove triples or graphs

```
LOAD <http://example.org/dataset>
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX ex:   <http://example.org/>

INSERT DATA {
   ex:Fab foaf:name "Fabien" ;
      foaf:knows ex:Cathy, ex:Olivier .
}
```

SPARQL Update

Add and remove triples

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX ex:   <http://example.org/>

INSERT DATA {
   ex:Fab foaf:name "Fabien" ;
      foaf:knows ex:Cathy, ex:Olivier .
}

;

DELETE DATA {
   ex:Fab foaf:knows ex:Bill .
}
```

SPARQL Update

Search and add triples

```
PREFIX ex: <http://example.org/>
INSERT {
   ?x a ex:Artist
}
WHERE {
   ?x a ex:Musician
}
```

SPARQL Update

Search and remove triples

```
PREFIX ex: <http://example.org/>
DELETE {
    ?x a ex:Musician
}
WHERE {
    ?x a ex:Musician
}
```

SPARQL Update

Search, remove and add triples

```
PREFIX ex: <http://example.org/>
DELETE {
   ?x a ex:Musician
}
INSERT {
   ?x a ex:Artist
}
WHERE {
   ?x a ex:Musician
}
```

SPARQL Update

Search, remove and add triples

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX ex: <http://example.org/>
DELETE { ?person foaf:firstName 'Fred' }
INSERT { ?person foaf:firstName 'Frederique' }
WHERE
{ ?person a ex:Woman .
  ?person foaf:firstName 'Fred'
}
```

SPARQL Update

USING like FROM : source graph

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
DELETE { ?person foaf:firstName 'Fred' }
USING <g1>
WHERE { ?person foaf:firstName 'Fred' }
```

SPARQL Update

WITH target graph

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
WITH <g1>
INSERT { ?person foaf:firstName 'Frederique' }
WHERE { ?person foaf:firstName 'Fred' }
```

SPARQL Update on graphs

```
LOAD <documentURI> [ INTO GRAPH <uri> ]
CLEAR [ SILENT ] (GRAPH <uri> | DEFAULT | NAMED | ALL )
DROP [ SILENT ] (GRAPH <uri> | DEFAULT | NAMED | ALL )
CREATE [ SILENT ] GRAPH <uri>
```

meaning?

```
prefix ex: <http://example.org/>
insert { ?y ex:hasParent ?x }
where  { ?x ex:hasChild  ?y }
```

meaning?

```
prefix ex: <http://example.org/>
delete { ?x ex:age ?a }
insert { ?x ex:age ?i }
where  {
  select ?x (xsd:integer(?a) as ?i)
  where {
    ?x ex:age ?a
    filter(datatype(?a) = xsd:string)
  }
}
```

SPARQL protocol

exchange queries and their results through the web

HTTP SPARQL

Linked Data Platform

HTTP access to LD resources & containers

get, post, put, delete resources from LD servers.

```
GET /people/fab HTTP/1.1
Host: data.inria.fr
```

```
PUT http://data.inria.fr/people/fab  HTTP/1.1
Host: data.inria.fr
Content-Type: text/turtle

<fab> a foaf:Person ;
      rdfs:label "Fabien" ;
      foaf:mbox  <fabien.gandon@inria.fr> .
```

Corese KGram

File Edit Engine Debug Query Template Explain ?

System +

Loaded files:

/Users/ereal_5/Desktop/demoquery/history.ttl

Logs:

```
reset...

done.
Loading ttl File from path : /Users/ereal_5/Desktop/demoquery/history.ttl
```

SEMANTIC WEB

do not read
the following sign

you
loose

we identify and interpret information,

machines don’t.

180°C+ = ?

publish the data schemas

know the meaning of data

to find out what can be done with it.

+

								Foyers fiscaux en 2009	Revenu net déclaré foyers fiscaux en 2009 (€)	Impôt total foyers fiscaux en 2009 (€)	Foyers fiscaux imposables en 2009	Rev net déclaré by foyers fiscaux imposables en 2009 (€)	Foyers fiscaux non imposables en 2009
CODGEO	REG	DEP	ARR	CV	ZE2010	EPCI	LIBGEO	NBFF09	RNETTF09	IMPTOTTF09	NBFF09	RNETTF09	NBFFN09
01001	82	01	012	0110	8213	241010644	L'Abergement-Clemenciat	404	10621027	459741	264	8879689	140
01002	82	01	011	0101	8201	241100883	L'Abergement-de-Varey	127	3163192	119686	79	2649523	48
01004	82	01	011	0101	8201	241100883	Ambérieu-en-Bugey	7627	163316020	6769425	4054	127815327	3573
01005	82	01	012	0130	8213	241010735	Ambérieux-en-Dombes	824	21115054	892477	519	17944057	305
01006	82	01	011	0104	8216	241100354	Ambléon	64	1515404	79359	35	1180658	29
01007	82	01	011	0101	8201	241100883	Ambronay	1261	29091328	925955	741	23582147	520
01008	82	01	011	0117	8201	241100883	Ambutrix	375	9580352	355871	261	8200681	114
01009	82	01	011	0104	8216	241100354	Andert-et-Condon	170	5042106	276829	102	4237545	68
01010	82	01	011	0131	8219	247400823	Anglefort	525	11767033	321265	286	8762809	239
01011	82	01	014	0122	8203	241100909	Apremont	187	4441860	106861	114	3621251	73
01012	82	01	011	0115	8203	241100578	Arano	197	4267862	177702	110	3419086	87
01013	82	01	011	0128	8201	241100396	Arandas	79	1515076	37886	40	1133052	39
01014	82	01	014	0123	8203	241100172	Arbent	1755	43933313	2253068	967	34739649	788
01015	82	01	011	0104	8216	241100354	Arbignieu	274	6354673	224353	164	5170255	110
01016	82	01	012	0126	0053	241100885	Arbigny	208	4565586	130885	109	3438553	99
01017	82	01	011	0128	8201	241100396	Argis	265	4729197	129253	124	3321918	141
01019	82	01	011	0136	8203	241100743	Armix						
01021	82	01	012	0142	8213	241010735	Ars-sur-Formans	646	16789107	797404	380	14006622	266
01022	82	01	011	0109	8216	241100370	Artemare	667	13069468	332456	340	9748215	327
01023	82	01	012	0102	0053	241100818	Ars-sur-Formans-Saone	45	788202	8419	21	528296	24
01024	82	01	012	0121	8202	241100156	Attignat	1507	37579086	1382931	972	31245219	535
01025	82	01	012	0102	0053	241100818	Bage-la-Ville	1472	36185741	1211234	868	29519068	604
01026	82	01	012	0102	0053	241100818	Bage-le-Chatel	467	9713907	387278	240	7458898	227
01027	82	01	012	0120	8214	241100610	Balan	741	19481804	752380	506	16846338	235
01028	82	01	012	0130	8213	241100644	Baneins	296	7035714	214786	190	5769873	106
01029	82	01	012	0111	8202	241100851	Beaupont	358	5954984	56617	153	4210296	205
01030	82	01	012	0134	8213	241010735	Beauregard	476	11210478	472630	262	9002107	214
01031	82	01	014	0141	8203	241100172	Bellignat	1975	41912804	1679468	1053	32925596	922
01032	82	01	012	0120	8214	241100610	Belleneuve	1762	40245076	1380167	1204	33567849	558
01033	82	01	014	0103	8219	241100891	Bellegarde-sur-Valserine	6197	125605495	3081739	2941	88859401	3256
01034	82	01	011	0104	8216	241100354	Belley	5147	106205221	4342466	2512	80527548	2635
01035	82	01	014	0123	8203	241100172	Belleydoux	183	3962017	113745	103	3053825	80
01036	82	01	011	0109	8216	241100370	Belmont-Luthezieu	300	6861866	227556	180	5648816	120
01037	82	01	011	0118	8201	241100412	Berencoux	159	3298480	118266	77	2519009	82
01038	82	01	012	0111	8202	241100851	Berny	367	9061682	340392	218	7281839	149
01039	82	01	011	0109	8216	241100438	Beon	220	4783182	169459	115	3590158	105
01040	82	01	012	0121	8202	241100156	Bereziat	235	4542566	58890	117	3294318	118
01041	82	01	011	0101	8201	241100883	Bettant	438	10643331	575048	268	8941011	170
01042	82	01	012	0127	0053	241100826	Bey	109	3927868	185011	86	3271887	23
01043	82	01	012	0140	8214	241100800	Beynost	2327	72699937	4356332	1606	64460531	721
01044	82	01	014	0103	8219	241100861	Billiat	244	6713802	91929	154	5564879	90
01045	82	01	012	0135	8214	241100875	Birieux	120	3257358	127941	76	2691053	44
01046	82	01	012	0110	0053	241100669	Bisiat	413	9632681	353032	230	7512447	183
01047	82	01	011	0117	8201	241100883	Blyes	431	12453953	436134	298	10625490	133
01049	82	01	012	0120	8214	241100610	La Boisse	1458	41474096	2026702	1005	36344784	453
01050	82	01	012	0126	0053	241100885	Boissey	147	2818268	13011	71	2039920	76
01051	82	01	014	0116	8203	241100701	Bolozon	58	1093157	29615	35	856604	23
01052	82	01	012	0135	8214	241100875	Boulignieu	157	4854963	285846	109	4301187	48
01053	82	01	012	0199	8202	241100628	Bourg-en-Bresse	23688	480557607	22269721	12149	372480510	11539
01054	82	01	012	0119	8201	241100883	Bourg-Saint-Christophe	584	16406383	719269	390	14290198	194
01056	82	01	014	0124	8201	200029999	Boyeux-Saint-Jerome	192	3853870	84725	106	3088834	86
01057	82	01	012	0126	0053	241100885	Boz	252	5338111	199053	144	4145493	108
01058	82	01	011	0104	8209	241100347	Bregnier-Cordon	387	8144868	232099	205	6113260	182
01059	82	01	011	0109	8216	241100370	Brénaz	58	1037775	15038	26	710970	32
01060	82	01	014	0106	8203	241100867	Brenod	270	6662480	270607	163	5469956	107
01061	82	01	011	0104	8216	241100354	Brens	523	14418128	452949	344	12441768	179
01062	82	01	012	0120	8214	241100610	Bressolles	368	11291204	557686	259	10208418	109
01063	82	01	014	0122	8203	241100909	Brion	267	7910648	419674	188	7001544	79
01064	82	01	011	0118	8201	241100412	Briord	502	9833339	204916	277	7490605	225
01065	82	01	012	0143	8202	241100628	Buellas	836	25899579	1366612	602	23188243	234
01066	82	01	011	0136	8201	241100743	La Burbanche	57	968466	16312	20	635445	37
01067	82	01	014	0116	8203	241100701	Cerdon	149	3340373	116097	87	2875099	62
01068	82	01	014	0124	8201	200029999	Cerdon	450	8176991	210730	213	5977680	237
01069	82	01	012	0125	8202	241100842	Certines	725	20250800	844404	483	17383516	242
01071	82	01	013	0114	8219	241100750	Ceser	1781	70515404	3235114	1117	58952291	664
01072	82	01	012	0107	8202	241100893	Ceyzeriat	1533	41883682	1918484	962	35704267	571
01073	82	01	011	0136	8216	241100438	Ceyzeriieu	582	13396617	554933	333	11049953	229
01074	82	01	012	0108	8214	241100677	Chalamont	1274	27931969	937359	671	21507865	603
01075	82	01	012	0130	8213	ZZZZZZZZ	Chaleins	576	16113361	656774	369	13760306	207
01076	82	01	011	0128	8201	241100396	Chaley	84	1440881	23803	45	1074636	39

=

what is the last

document

you read?

documents

{ }

your answer relies on a

shared ontology

you infer from it

we all understood

kind of

kind
of
"document"
#12
"book"
"livre"
#21
#47
#48
"novel"
"roman"
"short story"
"nouvelle"

formalized ontological knowledge

languages

to formalize

ontologies

PUBLISH SEMANTICS OF SCHEMAS

W3C®

stack of standards

RDFS means RDF Schema

RDFS provides primitives to *W*rite lightweight ontologies

RDFS to define classes of resources and organize their hierarchy

RDFS to define relations between resources, their signature and organize their hierarchy

car(x)⇒vehicle(x)

$$F \wedge O \rightarrow R \Leftrightarrow G_F \leq G_R$$

mapping modulo an ontology

an old schema of RDFS

W3C http://www.w3.org/TR/2000/CR-rdf-schema-20000327/

RDFS means « RDF Schema »

- standard Vocabulary to write lightweight ontologies
- written in RDF
- query RDFS (schemas) in SPARQL

associate a namespace with a vocabulary

complete URI of classes, properties, etc. or shortcuts:

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
(…)
</rdf:RDF>
```

associate a namespace with a vocabulary

complete URI of classes, properties, etc. or shortcuts:

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
(…)
</rdf:RDF>
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
(…)
```

RDFS: meta-ontology / meta-vocabulary

Standard RDF classes and properties to define our own classes and properties.

A schema to describe schemas.

Query a schema in SPARQL

RDFS Classes

meta-classes and some of their links

→ sub-type / subsumption

-------→ typing/ instance

RDFS Classes

meta-classes and some of their links

sub-type / subsumption

typing/ instance

RDFS Classes

meta-classes and some of their links

RDFS properties

meta-properties and some of their links

sub-type / subsumption

typing/ instance

RDFS properties

meta-properties and some of their links

→ sub-type / subsumption

-------→ typing/ instance

RDFS properties

meta-properties and some of their links

→ sub-type / subsumption

-------→ typing/ instance

RDFS properties

meta-properties and some of their links

→ sub-type / subsumption

-------→ typing/ instance

RDFS properties

meta-properties and some of their links

sub-type / subsumption

typing/ instance

RDFS properties

meta-properties and some of their links

quizz

RDFS contains primitives to... (several answers possible)

- ❑ describe classes of resources
- ❑ describe formulas of calculation for values of properties
- ❑ describe types of properties of resources
- ❑ document definitions in natural language
- ❑ sign and authenticate the authors of the definitions of classes and properties

semantics

everything is a resources

IF `x p y` THEN
`x rdf:type rdfs:Resource`

IF `x p y` THEN
`y rdf:type rdfs:Resource`

Define classes of resources

- declare and name classes
- organize their hierarchy
- multiple inheritance hierarchy

instances of rdfs:Class

the class of classes is in RDFS namespace.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:ID="Man">
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:subClassOf rdf:resource="#Male"/>
 </rdfs:Class>
</rdf:RDF>
```

instances of rdfs:Class

the class of classes is in RDFS namespace.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:ID="Man">
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:subClassOf rdf:resource="#Male"/>
 </rdfs:Class>
</rdf:RDF>
```

instances of rdfs:Class

the class of classes is in RDFS namespace.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:ID="Man">
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:subClassOf rdf:resource="#Male"/>
 </rdfs:Class>
</rdf:RDF>
```

instances of rdfs:Class

the class of classes is in RDFS namespace.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:ID="Man">
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:subClassOf rdf:resource="#Male"/>
 </rdfs:Class>
</rdf:RDF>
```

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<Man> a rdfs:Class ;
      rdfs:subClassOf <Person>, <Male> .
```

semantics

1. Every class is a subclass of rdfs:Resource
   IF `c rdf:type rdfs:Class` THEN
   `c rdfs:subClassOf rdfs:Resource`

2. Type propagation
   IF `c2 rdfs:subClassOf c1` AND `x rdf:type c2`
   THEN `x rdf:type c1`

3. Reflexivity of subsumption
   IF `c rdf:type rdfs:Class`
   THEN `c rdfs:subClassOf c`

4. Transitivity of subsumption
   IF `c2 rdfs:subClassOf c1` AND `c3 rdfs:subClassOf c2`
   THEN `c3 rdfs:subClassOf c1`

quizz

What is defined and derived from these definitions?

```
@prefix rdfs:  <http://www.w3.org/2000/01/rdf-schema#>
@base  <http://inria.fr/2005/humans.rdfs>
 <B> rdfs:subClassOf  <A> .
 <C> rdfs:subClassOf  <A> .
 <D> rdfs:subClassOf  <B> .
 <D> rdfs:subClassOf  <C> .
```

types of relations (properties) between resources

- declare and name the types of relationships/arcs/properties
- organize their hierarchy
- multiple inheritance hierarchy

instances of rdf:Property

the class of properties was placed in the RDF namespace because triples are a construction of RDF.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
 </rdf:Property>
</rdf:RDF>
```

instances of rdf:Property

the class of properties was placed in the RDF namespace because triples are a construction of RDF.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
 </rdf:Property>
</rdf:RDF>
```

instances of rdf:Property

the class of properties was placed in the RDF namespace because triples are a construction of RDF.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
 </rdf:Property>
</rdf:RDF>
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> .
```

instances of rdf:Property

the class of properties was placed in the RDF namespace because triples are a construction of RDF.

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
 </rdf:Property>
</rdf:RDF>
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> .
```

semantics

1. Type propagation
   IF `p2 rdfs:subPropertyOf p1` AND `x p2 y`
   THEN `x p1 y`
2. Reflexivity of subsumption
   IF `p rdf:type rdf:Property`
   THEN `p rdfs:subPropertyOf p`
3. Transitivity of subsumption
   IF `p2 rdfs:subPropertyOf p1` AND `p3 rdfs:subPropertyOf p2`
   THEN `p3 rdfs:subPropertyOf p1`

quizz

What can be said about the properties defined below?

```
@prefix rdfs:  < http://www.w3.org/2000/01/rdf-schema# >
@base < http://inria.fr/2005/humans.rdfs >
<P2> rdfs:subPropertyOf  <P1> .
<P3> rdfs:subPropertyOf  <P1>.
<P4> rdfs:subPropertyOf  <P2>,  <P3>.
```

signature: classes to which a property applies

Differences with object-oriented languages :

- RDFS <u>does not define a class in terms of properties</u> possessed by its instances.
- RDFS <u>defines a property in terms of classes</u> of resources to which it applies.

signature of a binary relation

- class of departure of the relation (domain)
- class of the arrival of the relation (range / co-domain)

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
  <rdfs:domain rdf:resource="#Human"/>
  <rdfs:range  rdf:resource="#Woman"/>
 </rdf:Property>
</rdf:RDF>
```

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
  <rdfs:domain rdf:resource="#Human"/>
  <rdfs:range  rdf:resource="#Woman"/>
 </rdf:Property>
</rdf:RDF>
```

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
  <rdfs:domain rdf:resource="#Human"/>
  <rdfs:range  rdf:resource="#Woman"/>
 </rdf:Property>
</rdf:RDF>
```

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> ;
  rdfs:domain <Human> ;
  rdfs:range  <Woman> .
```

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> ;
  rdfs:domain <Human> ;
  rdfs:range  <Woman> .
```

domain and range

Class of departure or domain: rdfs:domain
Class of arrival, co-domain or range: rdfs:range

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> ;
  rdfs:domain <Human> ;
  rdfs:range  <Woman> .
```

multiple domains and ranges

- conjunction of domains and ranges.
- the effective domain is the intersection of declared and inherited domains.
- the effective range is the intersection of declared and inherited ranges.

semantics

1. Type inference (domain)
   IF `p rdfs:domain d` AND `x p y`
   THEN `x rdf:type d`

2. Type inference (range)
   IF `p rdfs:range r` AND `x p y`
   THEN `y rdf:type r`

question

If I use the property author on a car what happens?

quizz

What can be said about the properties defined below?

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<P1>  rdfs:subPropertyOf  <P2> .
<P2>  rdfs:domain  <B> ;  rdfs:range  <C> .
<P1>  rdfs:domain  <A> .
```

rdfs:label

a resource may have one or more labels in one or more natural language

```
<rdf:Property rdf:ID='name'>
 <rdfs:domain rdf:resource='Person'/>
 <rdfs:range rdf:resource='&rdfs;Literal'/>
 <rdfs:label xml:lang='fr'>nom</rdfs:label>
 <rdfs:label xml:lang='fr'>nom de famille</rdfs:label>
 <rdfs:label xml:lang='en'>name</rdfs:label>
</rdf:Property>
```

```
<name> a rdf:Property ;
  range rdfs:Literal ; domain <Person> ;
  label "nom"@fr, "nom de famille"@fr, "name"@en .
```

textual labels attached to resources

any resource may have one or more labels in one or more languages

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID='name'>
  <rdfs:label xml:lang='fr'>nom</rdfs:label>
  <rdfs:label xml:lang='fr'>nom de famille</rdfs:label>
  <rdfs:label xml:lang='en'>name</rdfs:label>
 </rdf:Property>
</rdf:RDF>
```

textual labels attached to resources

any resource may have one or more labels in one or more languages

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdf:Property rdf:ID='name'>
  <rdfs:label xml:lang='fr'>nom</rdfs:label>
  <rdfs:label xml:lang='fr'>nom de famille</rdfs:label>
  <rdfs:label xml:lang='en'>name</rdfs:label>
 </rdf:Property>
</rdf:RDF>
```

textual labels attached to resources

any resource may have one or more labels in one or more languages

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<name> a rdf:Property ;
            rdfs:label "nom"@fr, "nom de famille"@fr, "name"@en .
```

textual labels attached to resources

any resource may have one or more labels in one or more languages

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<name> a rdf:Property ;
            rdfs:label "nom"@fr, "nom de famille"@fr, "name"@en .
```

rdfs:comment & rdfs:seeAlso

comments provide definitions and explanations in natural language

```
<rdfs:Class rdf:about='#Woman'>
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:comment xml:lang='fr'>une personne adulte du
                              sexe féminin</rdfs:comment>
  <rdfs:comment xml:lang='en'>a female adult person
  </rdfs:comment>
</rdfs:Class>
```

```
<Woman> a rdfs:Class ; rdfs:subClassOf <Person> ;
  rdfs:comment "adult femal person"@en ;
  rdfs:comment "une adulte de sexe féminin"@fr .
```

see also…

```
<rdfs:Class rdf:about='#Man'>
    <rdfs:seeAlso rdf:resource='#Woman'/>
</rdfs:Class>
```

```
<Man> a rdfs:Class ; rdfs:seeAlso <Woman> .
```

textual comments attached to resources

comments provide definitions and explanations in natural language

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:about='#Woman'>
  <rdfs:comment xml:lang='fr'>personne adulte de
                              sexe féminin</rdfs:comment>
  <rdfs:comment xml:lang='en'>female adult person</rdfs:comment>
  </rdfs:Class>
</rdf:RDF>
```

textual comments attached to resources

comments provide definitions and explanations in natural language

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<Woman> a rdfs:Class ;
  rdfs:comment "adult femal person"@en ;
  rdfs:comment "une adulte de sexe féminin"@fr .
```

references between resources

invitation to check another resource

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:about='#Man'>
  <rdfs:seeAlso rdf:resource='#Woman'/>
 </rdfs:Class>
</rdf:RDF>
```

references between resources

invitation to check another resource

```
<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
 <rdfs:Class rdf:about='#Man'>
  <rdfs:seeAlso rdf:resource='#Woman'/>
 </rdfs:Class>
</rdf:RDF>
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@base <http://inria.fr/2005/humans.rdfs> .
<Man> a rdfs:Class ; rdfs:seeAlso <Woman> .
```

quizz

What could we add to this schema (several answers)?

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

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>

@base <http://inria.fr/2005/humans.rdfs>

<p1> a rdf:Property ; rdfs:label "age"@fr .

<c1> a rdfs:Class; rdfs:comment "un être humain"@fr .

- ❑ <p1> rdfs:label "prénom"@fr .
- ❑ <c1> rdfs:comment "a human being"@fr .
- ❑ <c1> rdfs:label "personne"@fr .
- ❑ <p1> rdfs:label "age"@en .
- ❑ <c1> rdfs:label "woman"@en .
- ❑ <c1> rdfs:label "persona"@es .

example of RDFS classes

```
<rdf:RDF xml:base  ="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns     ="http://www.w3.org/2000/01/rdf-schema#>
 <Class rdf:ID="Man">
  <subClassOf rdf:resource="#Person"/>
  <subClassOf rdf:resource="#Male"/>
  <label xml:lang="en">man</label>
  <comment xml:lang="en">an adult male person</comment>
 </Class>
```

```
<Man> a Class ; subClassOf <Person>, <Male> .
```

example of RDFS properties

```
<rdf:RDF xml:base  ="http://inria.fr/2005/humans.rdfs"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns     ="http://www.w3.org/2000/01/rdf-schema#>
 <rdf:Property rdf:ID="hasMother">
   <subPropertyOf rdf:resource="#hasParent"/>
   <range rdf:resource="#Female"/>
   <domain rdf:resource="#Human"/>
   <label xml:lang="en">has for mother</label>
   <comment xml:lang="en">to have for parent a female.
                                                  </comment>
 </rdf:Property>
```

```
<hasMother> a rdf:Property ;
  subPropertyOf <hasParent> ;
  range <Female> ; domain <Human> .
```

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-
  syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns="http://inria.fr/2005/humans.rdfs#"
  xml:base=" http://inria.fr/2005/humans.rdfs-instances" >

  <rdf:Description rdf:ID="Lucas">
     <rdf:type
  rdf:resource="http://inria.fr/2005/humans.rdfs#Man"/>
     <hasMother rdf:resource="#Laura"/>
  </rdf:Description>

  <Man rdf:ID="Lucas">
     <hasMother rdf:resource="#Laura"/>
  </Man>
```

```
<Luca> a Man; hasMother <Laura> .
```

example of RDF using this schema

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base="http://inria.fr/2005/humans.rdfs-instances" >
 <rdf:Description rdf:ID="Lucas">
   <rdf:type rdf:resource="http://inria.fr/2005/humans.rdfs#Man"/>
   <h:hasMother rdf:resource="#Laura"/>
 </rdf:Description>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base="http://inria.fr/2005/humans.rdfs-instances" >
 <rdf:Description rdf:ID="Lucas">
   <rdf:type rdf:resource="http://inria.fr/2005/humans.rdfs#Man"/>
   <h:hasMother rdf:resource="#Laura"/>
 </rdf:Description>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base="http://inria.fr/2005/humans.rdfs-instances" >
 <rdf:Description rdf:ID="Lucas">
   <rdf:type rdf:resource="http://inria.fr/2005/humans.rdfs#Man"/>
   <h:hasMother rdf:resource="#Laura"/>
 </rdf:Description>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base="http://inria.fr/2005/humans.rdfs-instances" >
 <rdf:Description rdf:ID="Lucas">
   <rdf:type rdf:resource="http://inria.fr/2005/humans.rdfs#Man"/>
   <h:hasMother rdf:resource="#Laura"/>
 </rdf:Description>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <h:Man rdf:ID="Lucas">
   <h:hasMother rdf:resource="#Laura"/>
 </h:Man>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <h:Man rdf:ID="Lucas">
   <h:hasMother rdf:resource="#Laura"/>
 </h:Man>
</rdf:RDF>
```

RDF/XML

Turtle

```
@prefix h: <http://inria.fr/2005/humans.rdfs#> .
@base <http://inria.fr/2005/humans.rdfs-instances> .
<Lucas> a h:Man; h:hasMother <Laura> .
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <h:Man rdf:ID="Lucas">
   <h:hasMother rdf:resource="#Laura"/>
 </h:Man>
</rdf:RDF>
```

RDF/XML

Turtle

```
@prefix h: <http://inria.fr/2005/humans.rdfs#> .
@base <http://inria.fr/2005/humans.rdfs-instances> .
<Lucas> a h:Man; h:hasMother <Laura> .
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:h="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <h:Man rdf:ID="Lucas">
   <h:hasMother rdf:resource="#Laura"/>
 </h:Man>
</rdf:RDF>
```

RDF/XML

Turtle

```
@prefix h: <http://inria.fr/2005/humans.rdfs#> .
@base <http://inria.fr/2005/humans.rdfs-instances> .
<Lucas> a h:Man; h:hasMother <Laura> .
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <Man rdf:ID="Lucas">
   <hasMother rdf:resource="#Laura"/>
 </Man>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <Man rdf:ID="Lucas">
   <hasMother rdf:resource="#Laura"/>
 </Man>
</rdf:RDF>
```

usage and references to schemas

in a resource description

```
<rdf:RDF xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns="http://inria.fr/2005/humans.rdfs#"
 xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
 <Man rdf:ID="Lucas">
   <hasMother rdf:resource="#Laura"/>
 </Man>
</rdf:RDF>
```

RDF/XML

Turtle

```
@prefix : <http://inria.fr/2005/humans.rdfs#> .
@base <http://inria.fr/2005/humans.rdfs-instances> .
<Lucas> a :Man; :hasMother <Laura> .
```

SEMANTIC WEB

OWL provides additional primitives for heavyweight ontologies

Web Ontology Language (OWL)

- a W3C recommendation
- additional primitives for more complex ontologies.
- richer definitions of classes and properties.
- perform more inferences, draw more conclusions.

namespace and prefix for OWL

http://www.w3.org/2002/07/owl#

- namespace of the OWL primitives
- same principle as RDFS
- `owl:` prefix in the rest of the slides

OWL in one…

algebraic properties

disjoint properties

qualified cardinality

individual prop. neg

chained prop.

union

disjunction

intersection

complement

restriction

cardinality

equivalence

enumeration

value restrict.

disjoint union

keys

…

enumerated class {a,b,c,d,e}

define a class by providing all its members

```
<owl:Class rdf:id="EyeColor">
    <owl:oneOf rdf:parseType="Collection">
      <owl:Thing rdf:ID="Blue"/>
      <owl:Thing rdf:ID="Green"/>
      <owl:Thing rdf:ID="Brown"/>
      <owl:Thing rdf:ID="Black"/>
    </owl:oneOf>
</owl:Class>
```

```
<EyeColor> rdf:type owl:Class ;
  owl:oneOf
      ( <Blue> <Green> <Brown> <Black> )  .
```

classes defined by union

of other classes

```
<owl:Class rdf:id="LegalAgent">
   <owl:unionOf rdf:parseType="Collection">
       <owl:Class rdf:about="#Person"/>
       <owl:Class rdf:about="#Group"/>
   </owl:unionOf>
</owl:Class>


<LegalAgent> rdf:type owl:Class ;
  owl:unionOf ( <Person> <Group> )  .
```

classes defined by intersection

of other classes

```
<owl:Class rdf:id="Man">
   <owl:intersectionOf
rdf:parseType="Collection">
        <owl:Class rdf:about="#Person"/>
        <owl:Class rdf:about="#Male"/>
   </owl:unionOf>
</owl:Class>
```

```
<Man> rdf:type owl:Class ;
  owl:intersectionOf ( <Person> <Male> ) .
```

No comma

complement

of a class

```
<owl:Class rdf:ID="Inedible">
    <owl:complementOf rdf:resource="#Edible"/>
</owl:Class>
```

```
<Inedible> rdf:type owl:Class ;
 owl:complementOf <Edible> .
```

class

class

S + P + O

disjunction
of classes

```
<owl:Class rdf:ID="Square">
  <owl:disjointWith rdf:resource="#Circle"/>
</owl:Class>
```

```
<Square> rdf:type owl:Class ;
  owl:disjointWith <Circle> .
```

disjunction

of several classes

```
<owl:AllDisjointClasses>
   <owl:members rdf:parseType="Collection">
     <owl:Class rdf:about="#Square"/>
     <owl:Class rdf:about="#Circle"/>
     <owl:Class rdf:about="#Triangle"/>
   </owl:members>
 </owl:AllDisjointClasses>

[] rdf:type owl:AllDisjointClasses ;
   owl:members
    ( <Square> <Circle> <Triangle> ) .
```

Blank Node

disjoint union

of several classes

```
<owl:Class rdf:about="Passenger">
  <owl:disjointUnionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#Adult"/>
    <owl:Class rdf:about="#Child"/>
    <owl:Class rdf:about="#Pet"/>
  </owl:disjointUnionOf>
</owl:Class>
```

```
<Passenger> rdf:type owl:Class ;
  owl:disjointUnionOf
  ( <Adult> <Child> <Pet> ) .
```

quizz

What can we deduce?

```
ex:Man owl:intersectionOf (ex:Male ex:Human) .
ex:Woman owl:intersectionOf (ex:Female ex:Human) .
ex:Human owl:unionOf (ex:Man ex:Woman) .
ex:Jane a ex:Human .
ex:John a ex:Man .
ex:James a ex:Male .
ex:Jane a ex:Female .
```

quizz

What are we defining?

```
ex:p a rdf:Property ;
  rdfs:domain [
    a owl:Class ;
    owl:unionOf (ex:Human ex:Software)
  ] .
```

quizz

What are we defining and inferring?

```
@prefix ex: <http://example.org/>

ex:GrandFather rdfs:subClassOf [
   a owl:Class ;
   owl:intersectionOf ( ex:Parent ex:Man )
] .


ex:Jim a ex:Man, ex:Parent .
ex:Jack a ex:GrandFather .
```

types of properties

- `owl:ObjectProperty` are relations between resources only e.g. hasParent(#thomas,#stephan)
- `owl:DatatypeProperty` have a literal value possibly typed ex:hasAge(#thomas,16^^xsd:int)
- `owl:AnnotationProperty` are ignored in inferences and used for documentation and extensions

symmetric property

a relation that, as soon as it exists, exists in both directions (e.g. to be maried)

$x\ R\ y \Rightarrow y\ R\ x$

```
<owl:SymmetricProperty rdf:ID="hasSpouse" />
```

RDF/XML

```
<hasSpouse> a owl:SymmetricProperty .
```

Turtle

asymmetric property

a relation that, as soon as it exists, exists in only one direction (e.g. parent)

$x\,R\,y \Rightarrow \neg\, y\,R\,x$

```
<owl:AsymmetricProperty rdf:ID="hasChild" />
```

```
<hasChild> a owl:AsymmetricProperty .
```

inverse property

two relations that exist simultaneously and inversly (ex. parent_of / child_of)

$x\ R_1\ y \Leftrightarrow y\ R_2\ x$

```
<rdf:Property rdf:ID="hasChild">
  <owl:inverseOf rdf:resource="#hasParent" />
</rdf:Property>
```

```
<hasChild> owl:inverseOf <hasParent> .
```

transitive property

a property propagated from peers to peers (e.g ancestors)

x R y & y R z ⇒ x R z

```
<owl:TransitiveProperty rdf:ID="hasAncestor" />
```

```
<hasAncestor> a owl:TransitiveProperty .
```

disjoint properties

relations that cannot exist together on the same subject and the same object

```
<owl:ObjectProperty rdf:about="hasSon">
  <owl:propertyDisjointWith rdf:resource="hasDaughter"/>
</owl:ObjectProperty>
```

```
<hasSon> owl:propertyDisjointWith <hasDaughter> .
```

reflexive property

a relation that links all individuals to themselves

```
<owl:ReflexiveProperty rdf:about="hasRelative"/>
```

```
<hasRelative> a owl:ReflexiveProperty .
```

irreflexives proprieties

relations never link resources to themselves

```
<owl:IrreflexiveProperty rdf:about="hasParent"/>
```

```
<hasParent> a  owl:IrreflexiveProperty .
```

property chain

relations which combine as a path/chain imply another relation
(e.g. parent + brother = uncle)

x P y & y Q z ⇒ x R z

```
<owl:ObjectProperty rdf:ID="uncle">
  <owl:propertyChainAxiom rdf:parseType="Collection">
    <owl:ObjectProperty rdf:about="#parent"/>
    <owl:ObjectProperty rdf:about="#brother"/>
  </owl:propertyChainAxiom>
</owl:ObjectProperty>
```

```
<uncle> rdf:type owl:ObjectProperty ;
  owl:propertyChainAxiom
  ( <parent> <brother> ) .
```

functional property

a relation for which a resource can have only one value (e.g. birth date)

$x\ R\ y\ \&\ x\ R\ z \Rightarrow y = z$

```
<owl:FunctionalProperty rdf:ID="birthDate" />
```

```
<birthDate> a owl:FunctionalProperty .
```

inverse functional property

a relation for which identical values imply the same subject (e.g. SSN)

$x\ R\ y\ \&\ z\ R\ y \Rightarrow x = z$

```
<owl:InverseFunctionalProperty
   rdf:ID="socialSecurityNumber" />
```

```
socialSecurityNumber a owl:InverseFunctionalProperty .
```

identification by keys

two resources with the same key values are the same

$x\ c_1\ v_1\ ;\ c_2\ v_2\ \&\ y\ c_1\ v_1\ ;\ c_2\ v_2 \Rightarrow x = y$

```
<owl:Class rdf:ID="Person">
  <owl:hasKey rdf:parseType="Collection">
    <owl:ObjectProperty rdf:about="#name"/>
    <owl:ObjectProperty rdf:about="#firstname"/>
    <owl:ObjectProperty rdf:about="#birthdate"/>
    <owl:ObjectProperty rdf:about="#birthplace"/>
  </owl:hasKey>
</owl:Class>
```

```
<Person> owl:hasKey ( <name> <firstname> <birthdate>
<birthplace> ) .
```

quizz

What can we deduce?

```
ex:hasSpouse a owl:SymmetricProperty .
ex:hasChild  owl:inverseOf ex:hasParent .
ex:hasParent rdfs:subPropertyOf ex:hasAncestor .
ex:hasAncestor a owl:TransitiveProperty .
ex:Jim  ex:hasChild  ex:Jane .
ex:Jane ex:hasSpouse ex:John .
ex:Jim  ex:hasParent ex:James .
```

equivalent classes

two classes containing exactly the same resources.

```
ex:Human owl:equivalentClass foaf:Person .
```

```
mit:Student owl:equivalentClass keio:Gakusei .
```

equivalent properties

two properties representing exactly the same relation.

```
ex:name owl:equivalentProperty my:label
```

identical resources

two URIs identifying exactly the same thing.

```
ex:Bill owl:sameAs ex:William
```

transitivity and symmetry of equivalences

ex:Bill owl:sameAs ex:William

ex:Bill owl:sameAs ex:Willy

ex:Willy owl:sameAs ex:Will

$\Rightarrow$????

mit:Student owl:equivalentClass keio:Gakusei

univ:Etudiant owl:equivalentClass keio:Gakusei

$\Rightarrow$????

different resources

two URI for which we know they represent different things.

```
ex:Good owl:differentFrom ex:Evil
```

quizz

What can we deduce?

```
ex:Human owl:equivalentClass foaf:Person .
foaf:name owl:equivalentProperty ex:name .
ex:JimmyPage a ex:Human ;
             owl:sameAs ex:JamesPatrickPage .
ex:JimmyHendrix owl:differentFrom ex:JimmyPage .
```

quizz

What are we defining?

```
ex:UnluckyPerson owl:equivalentClass [
  a owl:Class ;
  owl:intersectionOf (
    ex:Person
    [ a owl:Class ; owl:complementOf ex:Lucky ]
  )
] .
```

restriction on all values

```
<owl:Class rdf:ID="Herbivore">
  <subClassOf rdf:resource="#Animal"/>
  <subClassOf>
   <owl:Restriction>
    <owl:onProperty rdf:resource="#eats" />
    <owl:allValuesFrom rdf:resource="#Plant" />
   </owl:Restriction>
  </subClassOf>
</owl:Class>
```

class

restriction on some values

```
<owl:Class rdf:ID="Sportive">
 <owl:equivalentClass>
  <owl:Restriction>
   <owl:onProperty rdf:resource="#hobby" />
   <owl:someValuesFrom rdf:resource="#Sport" />
  </owl:Restriction>
 </owl:equivalentClass>
</owl:Class>
```

restriction to an exact value

```
<owl:Class rdf:ID="Bike">
 <subClassOf>
  <owl:Restriction>
   <owl:onProperty rdf:resource="#nbWheels" />
   <owl:hasValue>2</owl:hasValue>
  </owl:Restriction>
 </subClassOf>
</owl:Class>
```

self restriction

classes where instances have themselves as value of a property

```
ex:NarcisticPerson rdfs:subClassOf

[ a owl:Restriction ;
   owl:onProperty ex:love ;
   owl:hasSelf true ]
```

restriction on cardinality

how many times a property is used for a same subject but with different values

- Constraints: minimum, maximum, exact number
- Exemple

```
<owl:Class rdf:ID="Person">
 <subClassOf>
  <owl:Restriction>
   <owl:onProperty rdf:resource="#name" />
   <owl:maxCardinality>1</owl:maxCardinality>
  </owl:Restriction>
 </subClassOf>
</owl:Class>
```

qualified cardinality restriction

constraint on the number of time a property may be used with values of a given type with the same subject: minimum, maximum, nombre exact

```
<owl:Class rdf:ID="Human">
 <rdfs:subClassOf>
  <owl:Restriction>
   <owl:onProperty rdf:resource="#hasParent" />
   <owl:onClass rdf:resource="#Male" />
   <owl:qualifiedCardinality>1</owl:qualifiedCardinality>
  </owl:Restriction>
 </rdfs:subClassOf>
</owl:Class>
```

quizz

What can we deduce?

```
ex:Human rdfs:subClassOf
  [ a owl:Restriction ;
    owl:onProperty ex:hasParent ;
    owl:allValuesFrom ex:Human ] .
ex:John a ex:Human .
ex:John ex:hasParent ex:James, ex:Jane .
```

quizz

What are we defining and inferring?

```
@prefix ex: <http://example.org/>
ex:PersonList rdfs:subClassOf
  [
    a owl:Restriction ;
    owl:onProperty rdf:first ;
    owl:allValuesFrom ex:Person
  ] ,  [
    a owl:Restriction ;
    owl:onProperty rdf:rest ;
    owl:allValuesFrom ex:PersonList
  ] .

ex:value rdfs:range ex:PersonList .
ex:abc ex:value (ex:a ex:b ex:c) .
```

quizz

What are we defining and inferring?

```
@prefix ex: <http://example.org/>
ex:Human rdfs:subClassOf [
  owl:intersectionOf (
    [
      a owl:Restriction ;
        owl:onProperty ex:hasFather ;
        owl:maxCardinality 1
    ] , [
      a owl:Restriction ;
        owl:onProperty ex:hasMother ;
        owl:maxCardinality 1
    ] )
] .
ex:John a ex:Human ;  ex:hasFather ex:James , ex:Jimmy .
```

quizz

What are we defining and inferring?

```
@prefix ex: <http://example.org/>
ex:Wealthy a owl:Class ;
     owl:equivalentClass  [
       a owl:Class ; owl:intersectionOf  (
         [ a owl:Restriction ;
           owl:onProperty ex:hasChild ;
           owl:allValuesFrom ex:Wealthy
         ] ,
         [ a owl:Restriction ;
           owl:onProperty ex:hasChild ;
           owl:someValuesFrom ex:Wealthy
         ]
     )] .
ex:John a ex:Wealthy ; ex:hasChild ex:Jim .
```

document the schemas

- an ontology is a Resource
- an ontology has a URI
- OWL provides primitives to describe that ontology resource

description of the ontology

`owl:Ontology, owl:imports, owl:versionInfo, owl:priorVersion, owl:backwardCompatibleWith, owl:incompatibleWith`

versions of classes and properties

`owl:DeprecatedClass, owl:DeprecatedProperty`

describe an ontology

one class(`owl:Ontology`) and several properties (`owl:imports`, `owl:versionInfo`, `owl:priorVersion`, `owl:backwardCompatibleWith`, `owl:incompatibleWith`)

```
<rdf:RDF xml:base="http://inria.fr/2005/humans/"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
 xmlns:owl ="http://www.w3.org/2002/07/owl#">

<owl:Ontology rdf:about="http://inria.fr/2005/humans/">
 <rdfs:comment>An example OWL ontology</rdfs:comment>
 <owl:priorVersion rdf:resource="http://inria.fr/2004/humans/"/>
 <owl:imports rdf:resource="http://cnrs.fr/animals/"/>
 <rdfs:label>Bio Ontology</rdfs:label>
</owl:Ontology>
</rdf:RDF>
```

changes in classes or properties

indicate a class or property is obsolete

```
<rdf:RDF xml:base="http://inria.fr/2005/humans/"
 xmlns:rdf ="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:owl="http://www.w3.org/2002/07/owl#">

 <owl:DeprecatedClass rdf:ID="mammals"/>
 <owl:DeprecatedProperty rdf:ID="age"/>

</rdf:RDF>
```

OWL profiles

- Each profile is a sub-set of the OWL primitives.
- Choosing a profile is choosing a level of expressivity.
- The higher the expressivity the more complex the inferences.
- The more complex the expressivity, the longer it takes to compute the results.

OWL 1 profiles

Lite : essentially for lightweight hierarchies.

DL : more complex ontologies but complete reasoning.

Full : maximum expressivity but incomplete reasoning.

OWL 2 profiles

EL: large numbers of properties and/or classes and polynomial time.

QL: large volumes of instance data, and conjunctive query answering using conventional relational database in LOGSPACE

RL: scalable reasoning without sacrificing too much expressive power using rule-based reasoning in polynomial time

DL: the most expressive with complete reasoning

Protégé

OntologyID(Anonymous-2)
Active Ontology
Entities
Classes
Object Properties
Data Properties
Annotation Properties
Individuals
OWLViz
DL Query
OntoGraf
Ontology Differences
SPARQL Query
Class hierarchy
Class hierarchy (inferred)
Class hierarchy: Thing
Thing
Adult ≡ Grownup
Dead
Female
Grownup ≡ Adult
HappyPerson
Human ≡ Person
JohnsChildren
MyBirthdayGuests
NarcisticPerson
Orphan
Parent
Person ≡ Human
SocialRole
Teenager
YoungChild
Annotations
Usage
Annotations: Thing
Annotations
Description: Thing
Equivalent To
SubClass Of
SubClass Of (Anonymous Ancestor)
Members
Target for Key
Disjoint With
Disjoint Union Of

Web Protégé

Fichier Édition Affichage Historique Marque-pages Outils ?
Nouvel onglet
Saisir un terme à rechercher ou une adresse
Google

FAMOUS SCHEMAS

- Dublin core
- Creative Commons
- FOAF

...

SKOS knowledge

thesauri,
classifications,
subjects,
taxonomies,
folksonomies,
... controlled vocabulary

SKOS schema : 4 classes and 28 properties in OWL

	skos:Concept
URI:	`http://www.w3.org/2004/02/skos/core#Concept`
Definition:	Section 3. The skos:Concept Class
Label:	*Concept*
Disjoint classes:	skos:Collection skos:ConceptScheme
	skos:ConceptScheme
URI:	`http://www.w3.org/2004/02/skos/core#ConceptScheme`
Definition:	Section 4. Concept Schemes
Label:	*Concept Scheme*
Disjoint classes:	skos:Collection skos:Concept

http://www.w3.org/2004/02/skos/core

natural language expressions to refer to concepts

```
inria:CorporateSemanticWeb
  skos:prefLabel "corporate semantic web"@en;
  skos:prefLabel "web sémantique d'entreprise"@fr;
  skos:altLabel "corporate SW"@en;
  skos:altLabel "CSW"@en;
  skos:hiddenLabel "web semantique d'entreprise"@fr.
```

relations

between concepts

```
inria:CorporateSemanticWeb
   skos:broader w3c:SemanticWeb;
   skos:narrower inria:CorporateSemanticWiki;
   skos:related inria:KnowledgeManagement.
```

```
inria:CorporateSemanticWeb
 skos:scopeNote "only within KM community";
 skos:definition "a semantic web on an intranet";
 skos:example "Nokia's internal use of RDF gateway";
 skos:historyNote "semantic intranet until 2006";
 skos:editorialNote "keep wikipedia def. uptodate";
 skos:changeNote "acronym added by fabien".
```

CC (*Creative Commons*)

a very popular schema to describe rights associated to a resource

6+12 classes and 11 properties to :

- describe the rights associated with a resources
- describe a license and associated to a resource
- state the rights, conditions and prohibitions to use a resource

```
@prefic cc: <http://creativecommons.org/ns#>
```

CC REL : Creative Commons Rights Expression Language

http://creativecommons.org/ns

FOAF : *Friend of a Friend*

a very popular schema to describe persons and social networks

13 classes and 62 properties to describe:

- user profiles (your RDF homepage)
- social networks (persons you know)
- social activities (accounts, actions)

```
@prefix foaf: <http://xmlns.com/foaf/0.1/>
```

FOAF = Core + Social Web + Linked Data Utilities

http://xmlns.com/foaf/spec/

VoID: describing RDF datasets/linksets

- void:class
- void:subset
  - void:propertyPartition
  - void:classPartition
- void:classes
- void:dataDump
- void:distinctObjects
- void:distinctSubjects
- void:documents
- void:entities
- void:exampleResource
- void:feature
- dct:isPartOf
  - void:inDataset
- void:linkPredicate
- void:target
  - void:subjectsTarget
  - void:objectsTarget
- void:openSearchDescription
- void:properties
- void:property
- void:rootResource
- void:sparqlEndpoint
- void:triples
- void:uriLookupEndpoint
- void:uriRegexPattern
- void:uriSpace
- void:vocabulary

DCAT: describe any dataset (not just RDF)

Data Cube: publish multi-dimensional data (statistics)

Country of Origin
Method of Production
0 = Organic
1 = Free Range
2 = Barn
3 = Cage
?UK54321
Unique Farm ID
PROVENANCE

User Interface & Applications
Trust
Proof
Unifying Logic
SPARQL
Ontology: OWL
RDF-S
Rule: RIF
Crypto
RDF
XML
URI/IRI

W3C®

Provenance: PROV-DM & PROV-O

describe entities and activities

involved in providing a resource

e.g. a chart produced from two sources of data

```
ex:illustrate prov:used ex:composition .
ex:chart1 prov:wasGeneratedBy ex:illustrate
```

© W3C

e.g. a chart produced from two sources of data

```
ex:compose prov:used ex:dataSet1 ;
           prov:used ex:regionList .
ex:composition prov:wasGeneratedBy ex:compose .
ex:illustrate prov:used ex:composition .
ex:chart1 prov:wasGeneratedBy ex:illustrate
```

© W3C

PROV primer full example: more data

Fichier Édition Affichage Historique Marque-pages Outils ?
Nouvel onglet
Saisir un terme à rechercher ou une adresse
imdb the rock

LOV LOV LOV…

semantic waste separation

the web is a garbage can,

the semantic web will be a semantic garbage can.

EXTENDING TO OTHER SOURCES

Views: desktop mobile print

STANDARDS PARTICIPATE MEMBERSHIP ABOUT W3C

toward all forms of data on the web

W3C » Data Activity

ACTIVE GROUPS

- RDF Working Group
- Linked Data Platform Working Group
- Data on the Web Best Practices Working Group
- CSV on the Web Working Group
- Government Linked Data Working Group
- Semantic Web Interest Group
- Semantic Web Health Care and Life Sciences Interest Group
- Data Activity Coordination Group

NEARBY

- Data Activity Blog
- Activity Statement
- The Digital Publishing Activity
- The XML Activity

ASSOCIATED PROJECTS

- Crosscloud
- Smart Open Data
- Share-PSI 2.0

W3C DATA ACTIVITY *Building the Web of Data*

More and more Web applications provide a means of accessing data. From simple visualizations to sophisticated interactive tools, there is a growing reliance on the availability of data which can be "big" or "small", of diverse origin, and in different formats; it is usually published without prior coordination with other publishers — let alone with precise modeling or common vocabularies. The Data Activity recognizes and works to overcome this diversity to facilitate potentially Web-scale data integration and processing. It does this by providing standard data exchange formats, models, tools, and guidance.

The overall vision of the Data Activity is that people and organizations should be able to share data as far as possible using their existing tools and working practices but in a way that enables others to derive and add value, and to utilize it in ways that suit them. Achieving that requires a focus not just on the interoperability of data but of communities.

Questions? Contact Phil Archer <phila@w3.org>, W3C Data Activity Lead.

Context & Vision

The Data Activity merges and builds upon the eGovernment and Semantic Web Activities. The eGovernment Activity comprised an interest group that offered members a series of interesting talks from well placed speakers in governments around the world, including from countries that are often under-represented at W3C such as Jordan and Uganda. Primary topics have been the use of social media for citizen engagement and open data. The Semantic Web Activity was launched in 2001 to lead the use of the Web as an exchange medium for data as well as documents. That overall aim, along with a series of associated activities by W3C and others, has been highly successful — although not necessarily in the way originally envisioned. For example, the vision was that organizations and individuals would publish data in vocabularies, which the user community sees as critical companions to Web standards such as XML, RDF and HTML.

The use of the Web as a platform for delivering data has been driven by policy as much as by technology. The G8 Open Data Charter being a prime example. Other examples include President Obama's Executive Order and the European Union's revised PSI Directive. These policies apply equally to the areas of government information, scientific research, and cultural heritage and that creates a further source of diversity of workflows, people and the technologies they use.

The W3C Data Activity will support technologists tasked with responding to this political pressure. It will do so in a way that works for those individuals and at the same time delivers maximum return on the political and financial

R2RML

a standard transformation of a relationnal database in RDF

two types of transformations

- Default transformation
  [A Direct Mapping of Relational Data to RDF]

- Customized transformation
  [R2RML: RDB to RDF Mapping Language]

many data

buried and dormant in web pages

The Man Who Mistook His Wife for a Hat (Picador) (Paperback)

by Oliver Sacks (Author)

(19 customer reviews)

RRP: ~~£8.99~~

Price: **£6.99** & eligible for **Free UK delivery** on orders over £15 with Super Saver Delivery. See details and conditions

You Save: £2.00 (22%)

Availability: In stock.
Note: this item will be delivered in time for Christmas in the UK. For orders from our third-party sellers, please refer to the seller's page for delivery information. For destinations outside the UK, please see last-order dates. Dispatched from and sold by Amazon.co.uk.

Product details

Paperback: 256 pages

Publisher: Picador; New Ed edition (7 Nov 1986)

Language English

ISBN-10: 0330294911

ISBN-13: 978-0330294911

Product Dimensions: 19.7 x 13.1 x 1.9 cm

Average Customer Review: (19 customer reviews)

Amazon.co.uk Sales Rank: 1,107 in Books (See Bestsellers in Books)

Popular in these categories:

#1 in Books > Health, Family & Lifestyle > Psychology & Psychiatry > **Psychiatry**
#1 in Books > Science & Nature > Medicine > Medical Sciences A-Z > **Psychiatry**
#1 in Books > Health, Family & Lifestyle > Psychology & Psychiatry > **Neuropsychology**

(Publishers and authors: Improve Your Sales)

Other Editions: Hardcover | Paperback (Large Print e.) | All Editions

RDFa means RDF in HTML attributes

```
<body vocab="http://purl.org/dc/terms/>

 <div resource="http://lib.com/books/0684853949">

 <h2 property="title">The Man Who Mistook His
                                Wife For a Hat</h2>
 <h3 property="creator">Oliver Sacks</h3>
 ...
```

HTML+RDFa content

```
(…)
<body vocab="http://purl.org/dc/terms/">
 <div resource="/books/web_semantique">
  <h2 property="title">Le Web Sémantique</h2>
  <p>Date:
  <span property="created">2012-05-01</span></p>
  <h3 property="creator" resource="#fg">Fabien</h3>
 </div>
 <div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>,
    phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
    mail: <a property="mbox" href="mailto:fgandon@inria.fr">fgandon@inria.fr</a></p>
 </div>

   ...
```

HTML+RDFa content (in browser)

```
(...)
<body vocab="http://purl.org/dc/terms/">
 <div resource="/books/web_semantique">
  <h2 property="title">Le Web Sémantique</h2>
  <p>Date:
  <span property="created">2012-05-01</span></p>
  <h3 property=
 </div>
 <div vocab="ht                                  eof="Person">
  <p> <span pro
    phone: <a p                                  )2965170</a>
    mail: <a pr                                  >fgandon@inria.fr</a></p>
 </div>

   ...
```

HTML+RDFa content (read by RDFa parser)

```
(…)
<body vocab="http://purl.org/dc/terms/">
 <div resource="/books/web_semantique">
  <h2 property="title">Le Web Sémantique</h2>
  <p>Date:
  <span property="created">2012-05-01</span></p>
  <h3 property="creator" resource="#fg">Fabien</h3>
 </div>
 <div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
    phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
    mail: <a property="mbox" href="mailto:fgandon@inria.fr">fgandon@inria.fr</a></p>
 </div>

   ...
```

```
@prefix ns1: <http://purl.org/dc/terms/> .
@prefix ns2: <http://xmlns.com/foaf/0.1/> .
</books/web_semantique> ns1:title "Le Web Sémantique" ;
    ns1:created "2012-05-01" ;
    ns1:creator <#fg>.

<#fg> a ns2:Person;
    ns2:mbox <mailto:fgandon@inria.fr>;
    ns2:name "Fabien Gandon" ;
    ns2:phone <tel:+33492965170> .
```

Do it…

- Look at the Web Page
  http://schema.openspring.net/person/dries-buytaert
- Call the translator on this Web page to get Turtle:
  http://rdf-translator.appspot.com/
- What are the types of the main resource extracted?
- Do the same with:
  http://schema.openspring.net/event/2014-winter-olympics
  http://schema.openspring.net/recipe/apple-pie
  http://schema.openspring.net/events/drupalcamps

Do it…

Use the online tool to play with RDFa adding for instance a "creator" property

https://rdfa.info/play/

```
<div about="" typeof="cc:Work"
     xmlns:cc="http://creativecommons.org/ns#"
     xmlns:dc="http://purl.org/dc/elements/1.1/" align="center">
 <img alt="Creative Commons License"
  src="http://i.creativecommons.org/l/by/3.0/us/88x31.png" /> <br />
 <span property="dc:title">The Lessig Blog</span>, a
 <span rel="dc:type" href="http://purl.org/dc/dcmitype/Text">
  collection of texts </span> by
 <a property="cc:attributionName" rel="cc:attributionURL"
    href="http://lessig.org/"> Lawrence Lessig </a>,<br />
  is licensed under a <a rel="license"
    href="http://creativecommons.org/licenses/by/3.0/"> Creative
         Commons Attribution License </a>.<br />
  There are <a rel="cc:morePermissions"
   href="http://lessig.org/blog/other-license"> alternative
   licensing options </a>. </div>
```

CC REL in RDFa

W3C XHTML + RDFa

BY NC SA

schema.org = bing + Google + YAHOO! + Яндекс Yandex

schemas to improve index, search and display e.g:

- **Creative works**, Book, Movie, MusicRecording, Recipe, TVSeries ...
- **Embedded non-text objects**, AudioObject, ImageObject, VideoObject
- **Event**
- **Organization**
- **Person**
- **Place**, LocalBusiness, Restaurant ...
- **Product**, Offer, AggregateOffer
- **Review**, AggregateRating

OGP code

```
<html xmlns="http://www.w3.org/1999/xhtml" dir="ltr" lang="en-US"
     xmlns:fb="https://www.facebook.com/2008/fbml">
 <head prefix="og: http://ogp.me/ns# fb: http://ogp.me/ns# YOUR_NAMESPACE:
            http://ogp.me/ns/apps/YOUR_NAMESPACE#">
    <meta property="fb:app_id" content="YOUR_APP_ID" />
    <meta property="og:type" content="YOUR_NAMESPACE:recipe" />
    <meta property="og:title" content="Stuffed Cookies" />
    <meta property="og:image" content="http://example.com/cookie.jpg" />
    <meta property="og:description" content="The Turducken of Cookies" />
    <meta property="og:url" content="http://example.com/cookie.html">
    <script type="text/javascript">
    function postCook()
    {   FB.api('/me/YOUR_NAMESPACE:cook' + '?recipe=http://example.com/cookie.html','post',  (…)       });    }
    </script>
</head>
 <body>
(…)
   <form>
     <input type="button" value="Cook" onclick="postCook()" />
   </form>
 </body>
</html>
```

These data are accessible to everyone !

If you apply a parser to these pages, you will get their data...

Test online

- IMDB uses RDFa – OGP for the I like button
- Choose a movie on IMDB http://www.imdb.com
- Copy the URL of the page of the movie
- Go to the RDFa 1.0 RDFa Distiller and Parser: https://www.w3.org/2007/08/pyRdfa/
- Open the URI option, past the URL of the movie page and configure and perform the extraction to get Turtle
- Try also the transformation on the translator: http://rdf-translator.appspot.com/

Call the translator on…

- A product on eBay
- A movie in Dailymotion
- An article on LeMonde.fr
- A recipe on Marmiton.org
- A hotel on Booking.com

…

pages || data

page && data

Tantek's Thoughts - Mozilla Firefox

Fichier Édition Affichage Historique Marque-pages ScrapBook Outils ?

http://tantek.com/ using microformats

Homepage inria my bookmarklets nice bookmarklets Google Pages jaunes Michelin Dico CNRS Le Grand Robert & C...

Addresses (4) Contacts (36) Events (5) Locations Tagspaces (76) Bookmarks Resources Options

Tantek's Thoughts

Tantek's Thoughts

CSS examples favelets blog archives site map

Identity facets XFN FRIENDLY

more thoughts
wiki
twitter / faves
pownce
technorati / faves

events
upcoming (+subscribe)
pownce events (+subscribe)

media - photos & videos
flickr / photos
revver (videos)
bliptv - videos

OpenIDs
myopenid, lj

Projects
microformats to-do changes
hCard
hCalendar
hReview
XOXO
GMPG
XFN 1.1
XMDP
Technorati

Open as possible means public domain plus a strong community

1/1 7:46 PM

tags: open microsoft ie msie iemac publicdomain standards licenses freedom

My journey implementing and/or iterating/improving/creating "open" standards began almost 10 years at Microsoft when I was assigned the area of CSS support in Internet Explorer for Macintosh. Along the way I've learned a lot about the longterm value of open standards, open source, and open content, and as a result the plethora of "open" licenses out there. Having seen real difficulties that different "open" projects have had working together due to license (or even philosophical definition of "freedom") incompatibilities, limitations, friction, barriers to developing derivative materials to help "open" projects, and even FUD used inside many corporations to limit use of "open" resources, it led me inexorably to one conclusion.

» Blogs that link here

2,464 blog reactions

318 TECHNORATI

Technorati

Technorati

Technorati search

this blog

all blogs Search

Top Tags on Tantek's Thoughts

austin flickr personal sxsw sanfrancisco tx travel video hcard microformats navlopomo sxsw2007 sxswm sxswm2007 sxswmusic sxswmusic2007 upcoming:event=95527 videobloggingweek2007 vlog vlogpost

Terminé

Linked Data in JSON

- JSON (JavaScript Object Notation)
  - hierarchy of name-value pairs
- JSON-LD (JSON for Linked Data)
  - designed around the notion of "context" to provide additional mappings from JSON to an RDF model.
  - a context can be embedded directly in a JSON-LD document or put into a separate file and referenced.
  - specific reserved names prefixed by @
    e.g. @context , @type

```
{
  "firstName": "Fabien",
  "headline": "Research Director at Inria",
  "id": "Fg-fjekzI",
  "lastName": "Gandon",
  "siteStandardProfileRequest": {
    "url": "https://www.linkedin.com/profile/view?id=AAAAAA"
  }
}
```


e.g. LinkedIn JSON

```
{
  "@context": {
    "@vocab": "http://schema.org/",
    "@base" : "http://data.org/",
    "id" : "@id",
    "firstName": "givenName",
    "lastName": "familyName",
    "headline": { "@id": "jobTitle", "@language": "en" },
    "siteStandardProfileRequest" : null },

  "firstName": "Fabien",
  "headline": "Research Director at Inria",
  "id": "Fg-fjekzI",
  "lastName": "Gandon",
  "siteStandardProfileRequest": {
    "url": "https://www.linkedin.com/profile/view?id=AAAAAA"
  }
}
```

Mapping with @vocab e.g. LinkedIn JSON

```
{
  "@context": {
    "@vocab": "http://schema.org/",
    "@base" : "http://data.org/",
    "id" : "@id",
    "firstName": "givenName",
    "lastName": "familyName",
    "headline": { "@id": "jobTitle", "@language": "en" },
    "siteStandardProfileRequest" : null },

  "firstName": "Fabien",
  "headline": "Research Director at Inria",
  "id": "Fg-fjekzI",
  "lastName": "Gandon",
  "siteStandardProfileRequest": {
    "url": "https://www.linkedin.com/profile/view?id=AAAAAA"
  }
}
```

```
@prefix : <http://schema.org/> .

<http://data.org/Fg-fjekzI> :familyName "Gandon" ;
    :givenName "Fabien" ;
    :jobTitle "Research Director at Inria"@en .
```

Mapping with @vocab e.g. LinkedIn JSON

Test online

- Transform your FOAF profile in JSON-LD with the translator: http://rdf-translator.appspot.com/
- Use the following online tool to generate different variations of JSON-LD of your profile (expanded, collapsed, flattened, etc.) http://json-ld.org/playground/

CSV-LD & Linked CSV

- contexts to interpret and generate CSV
- conventions for CSV to be linked in RDF

country	country group	name (en)	name (fr)	name (de)	latitude	longitude
at	eu	Austria	Autriche	Österreich	47.6965545	13.34598005
be	eu	Belgium	Belgique	Belgien	50.501045	4.47667405
bg	eu	Bulgaria	Bulgarie	Bulgarien	42.72567375	25.4823218

```
"country","country group","name (en)","name (fr)","name (de)","latitude","longitude"
"at","eu","Austria","Autriche","Österreich","47.6965545","13.34598005"
"be","eu","Belgium","Belgique","Belgien","50.501045","4.47667405"
"bg","eu","Bulgaria","Bulgarie","Bulgarien","42.72567375","25.4823218"
```

Spreadsheet to CSV

```csv
"country","country group","name (en)","name (fr)","name (de)","latitude","longitude"
"at","eu","Austria","Autriche","Österreich","47.6965545","13.34598005"
"be","eu","Belgium","Belgique","Belgien","50.501045","4.47667405"
"bg","eu","Bulgaria","Bulgarie","Bulgarien","42.72567375","25.4823218"
```

```json
{
  "@context": "http://www.w3.org/ns/csvw",
  "url": "countries.csv",
  "tableSchema": {
    "aboutUrl":
"http://example.org/country/{code}",
    "columns": [{
      "titles": "country",
      "name": "code",
      "suppressOutput": true
    },{
      "titles": "country group",
      "suppressOutput": true
    },{
      "titles": "name (en)",
      "lang": "en",
      "propertyUrl": "schema:name"
    },{
      "titles": "name (fr)",
      "lang": "fr",
      "propertyUrl": "schema:name"
    },{
      "titles": "name (de)",
      "lang": "de",
      "propertyUrl": "schema:name"
    },{
      "titles": "latitude",
      "datatype": "number",
      "aboutUrl":
"http://example.org/country/{code}#geo",
      "propertyUrl": "schema:latitude"
    },{
      "titles": "longitude",
      "datatype": "number",
      "aboutUrl":
"http://example.org/country/{code}#geo",
      "propertyUrl": "schema:longitude"
    },{
      "virtual": true,
      "propertyUrl": "rdf:type",
      "valueUrl": "schema:Country"
    },{
      "virtual": true,
      "propertyUrl": "schema:geo",
      "valueUrl":
"http://example.org/country/{code}#geo"
    },{
      "virtual": true,
      "aboutUrl":
"http://example.org/country/{code}#geo",
      "propertyUrl": "rdf:type",
      "valueUrl": "schema:GeoCoordinates"
    }]
  }
}
```

Based on JSON contexts

```
"country","country group","name (en)","name (fr)","name (de)","latitude","longitude"
"at","eu","Austria","Autriche","Österreich","47.6965545","13.34598005"
"be","eu","Belgium","Belgique","Belgien","50.501045","4.47667405"
"bg","eu","Bulgaria","Bulgarie","Bulgarien","42.72567375","25.4823218"
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix schema: <http://schema.org/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

<http://example.org/country/at> a schema:Country;
   schema:geo <http://example.org/country/at#geo>;
   schema:name "Austria"@en, "Autriche"@fr, "Österreich"@de .

<http://example.org/country/be> a schema:Country;
   schema:geo <http://example.org/country/be#geo>;
   schema:name "Belgium"@en, "Belgique"@fr, "Belgien"@de .

<http://example.org/country/bg> a schema:Country;
   schema:geo <http://example.org/country/bg#geo>;
   schema:name "Bulgaria"@en, "Bulgarie"@fr, "Bulgarien"@de .

<http://example.org/country/at#geo> a schema:GeoCoordinates;
   schema:latitude 4.76965545e1;
   schema:longitude 1.334598005e1 .

<http://example.org/country/be#geo> a schema:GeoCoordinates;
   schema:latitude 5.0501045e1;
   schema:longitude 4.47667405e0 .

<http://example.org/country/bg#geo> a schema:GeoCoordinates;
   schema:latitude 4.272567375e1;
   schema:longitude 2.54823218e1 .
```

RDF Result

doggy-bag

impossible

to predict every usage

avoid building

black boxes

make conceptualizations
explicit

open your data

to those who could use them

66 FOAF primitives

3 475 908 348 references (2)

“a small tree ruling a big graph”(1)

(1) Franck Van Harmelen, ISWC 2011
(2) Libby Miller, 2009

[C. Welty, ISWC 2007]

"semantic **web**"

and not

"**semantic** web"

[J. Hendler, ISWC 2007]

"a lightweight ontology allows us to do lightweight reasoning"

identify	URI
describe & link	RDF
query	HTTP, SPARQL, LDP
reasoning	RDFS & OWL
trace	PROV-O

GOALS AND MEANS

identify	http://fabien.fr#me
describe & link	#me type man
query	select * {?r type ?t}
reasoning	man subClassOf male
trace	wasAttributedTo #me

GOALS AND MEANS

linked data streams
web of sensors, things, …
linked enterprise data
VISIBILITY
enterprise data
big data streams
VELOCITY
personal data
data streams
big linked data
linked healthcare data
closed data
data mining
open data
data bases
big data
VOLUME
data structures
linked open data
data type
data
linked data
data models
VICINITY
VARIETY
linked data schemas
web of data
data schemas
semantic web of data
VVeb data

web 1, 2

amazon.com

Click to LOOK INSIDE!

The Quark and the Jaguar: Adventures in the Simple and the Complex [Paperback]

Murray Gell-Mann (Author)

(30 customer reviews)

Price: $13.59

In Stock.

Ships from and sold by **Amazon.com**.

Formats	Amazon Price	New from	Used from
Hardcover	--	$13.67	$0.55
Paperback	$13.59	$10.01	$7.84

Show 4 more formats

Product Details

Paperback: 392 pages

Publisher: St. Martin's Griffin (September 15, 1995)

Language: English

ISBN-10: 0805072535

ISBN-13: 978-0805072532

Product Dimensions: 9.1 x 6.1 x 1.2 inches

Shipping Weight: 1.2 pounds (View shipping rates and policies)

web 1, 2, 3

amazon.com

Click to LOOK INSIDE!

The Quark and the Jaguar: Adventures in the Simple and the Complex [Paperback]

Murray Gell-Mann (Author)

(30 customer reviews)

Price: $13.59

In Stock.

Ships from and sold by **Amazon.com**.

Formats	Amazon Price	New from	Used from
Hardcover	--	$13.67	$0.55
Paperback	$13.59	$10.01	$7.84

Show 4 more formats

Product Details

Paperback: 392 pages

Publisher: St. Martin's Griffin (September 15, 1995)

Language: English

ISBN-10: 0805072535

ISBN-13: 978-0805072532

Product Dimensions: 9.1 x 6.1 x 1.2 inches

Shipping Weight: 1.2 pounds (View shipping rates and policies)

Average Customer Review: (30 customer reviews)

Amazon Bestsellers Rank: #373,365 in Books

Customer Reviews

30 Reviews

5 star:	(9)
4 star:	(8)
3 star:	(7)
2 star:	(4)
1 star:	(2)

Average Customer Review

(30 customer reviews)

one web…

person
document
informal
formal
program
data
metadata
usage
representation

he who controls metadata, controls the web

and through the *world-wide* web many things in our world.

fabien, gandon, @fabien_gandon, http://fabien.info