

Analyse von „Wiki-Daten“: Wikipedia, DBpedia und Wikidata 2

OSD 1

Bettina Berendt

12.1.2024

Wo sind wir, und wo wollen wir hin?

- ✓ Wikipedia kann als Graph betrachtet werden.
- ✓ Wikipedia kann auch als Datenbank betrachtet werden.
- ✓ Ein wichtiger Teil dieser Datenbank ist Dbpedia.
- ✓ Wofür (1)? Ein Anwendungsbeispiel: Diversität in den Medien
- ✓ Dbpedia und Wikidata (Teil 1)
- Format: RDF, RDFS und z.T. OWL; Linked Open Data
 - Das kann auch als relationale Datenbank dargestellt werden (bzw. es können Auszüge generiert werden).
- Anfragesprache: SPARQL; mehr Wikidata
- **Hausarbeit:** Wofür (2)? Selber recherchieren und neue Information hinzufügen.



Grundlagen Digitaler Vernetzung – Linked Data und Semantic Web

Manfred Hauswirth | Open Distributed Systems | Grundlagen Digitaler Vernetzung | SoSe 2022

Überblick

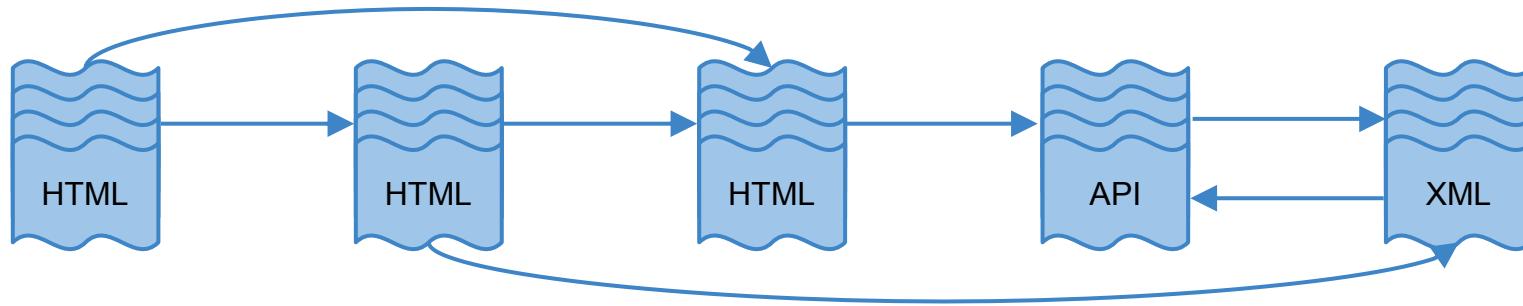
- Semantic Web und Linked Data
 - From the Web of documents to the Web of Data
 - Real-life Examples
 - The Principles
 - Linked Data vs. Big Data
 - Linked Data and Semantic Web
- Technologien
 - URI
 - RDF
 - RDFS
 - Web of Data



Informationsquellen



Web of Documents



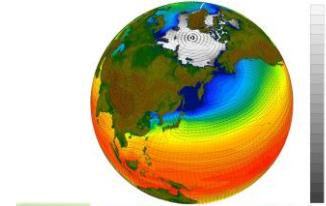
- links between documents
- no structure, no semantics
- for human consumption
- cannot be processed by computers

The background image shows a series of large, cylindrical white storage tanks or silos standing in a row. They are set against a bright blue sky with scattered white clouds. The tanks have dark vertical stripes and ladders attached to their sides. In the foreground, there are some metal railings and pipes.

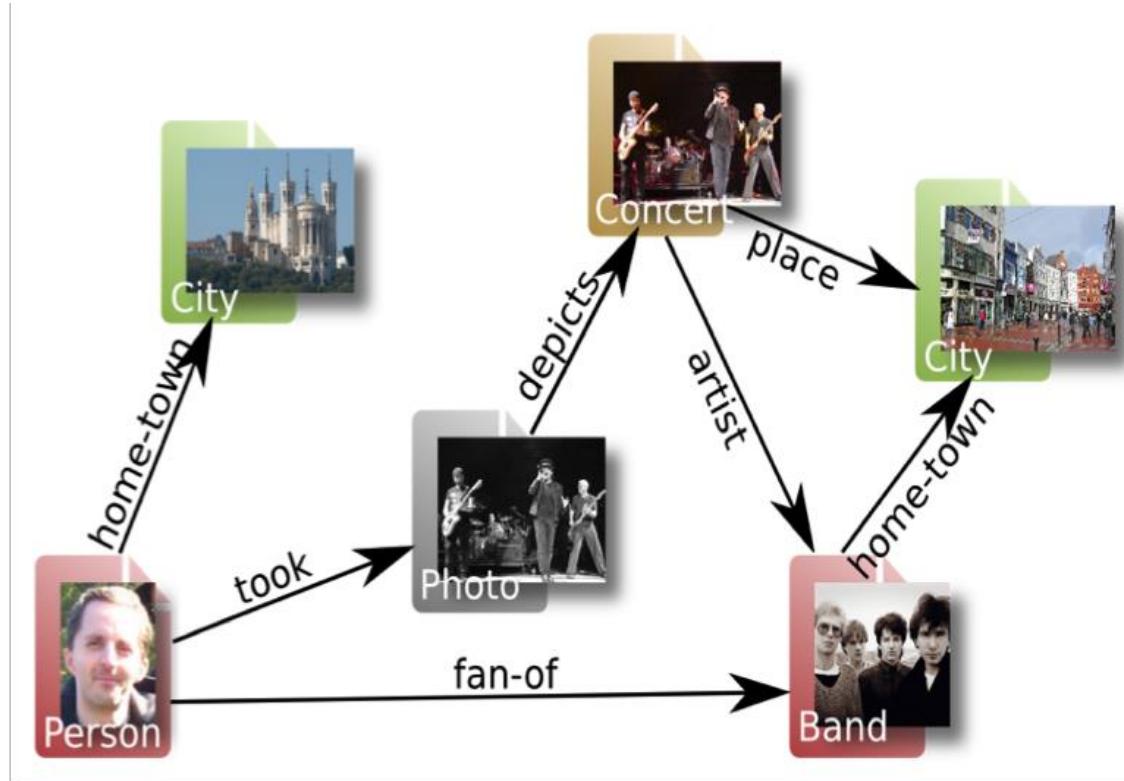
Informationssilos

What's the Problem?

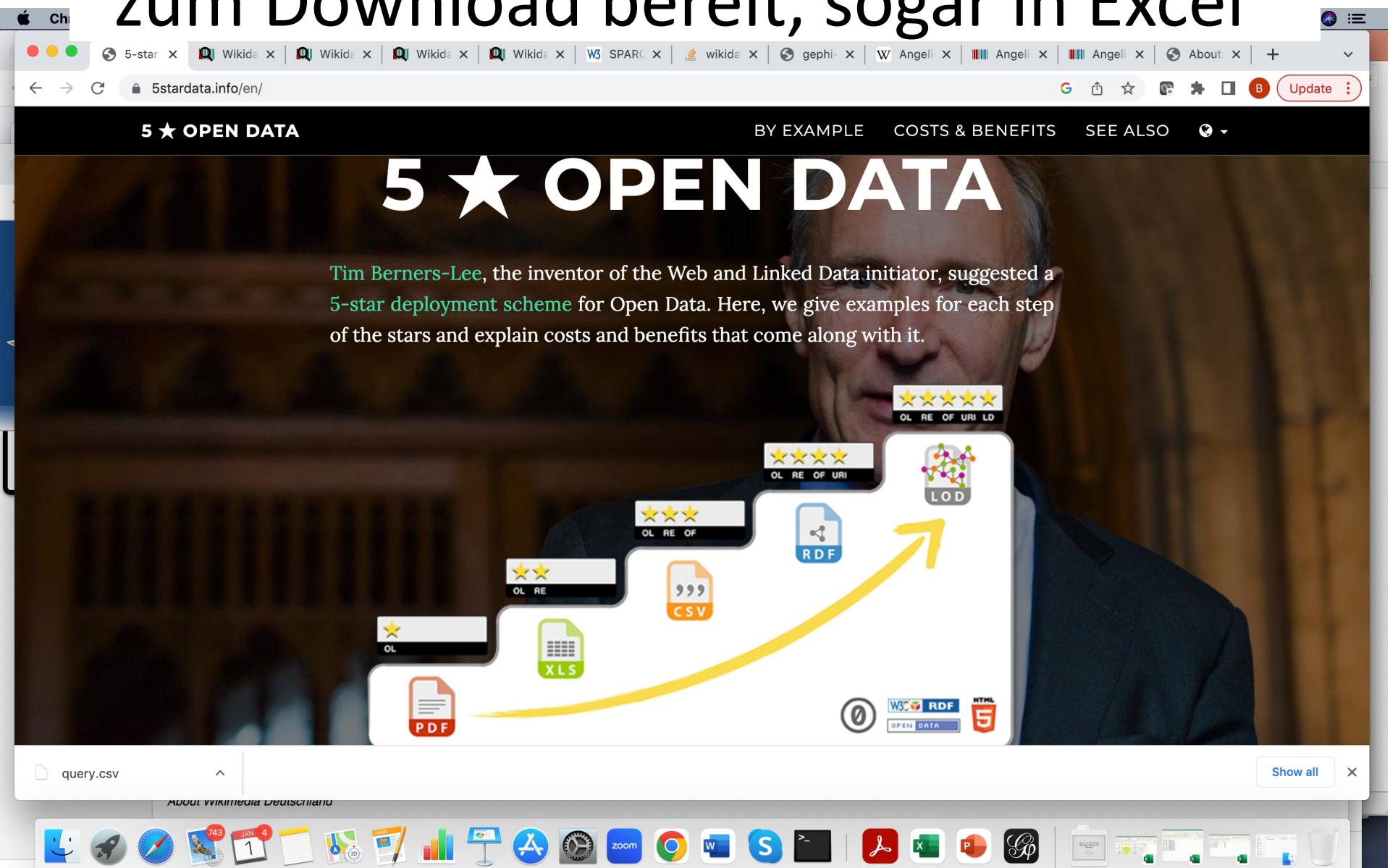
LinkedIn



Web of Data



“Aber wir stellen unsere Daten doch zum Download bereit, sogar in Excel”



“Open” kann halt mehr oder minder nützlich sein

Chrome File Edit View History Bookmarks Profiles Tab Window Help zoom ⚡ 100 % Sun 20:57 5stardata.info/en/ Update

5 ★ OPEN DATA BY EXAMPLE COSTS & BENEFITS SEE ALSO

BY EXAMPLE ...

Below, we provide examples for each level of Tim’s 5-star Open Data plan. The example data used throughout is ‘*the temperature forecast for Galway, Ireland for the next 3 days*’:

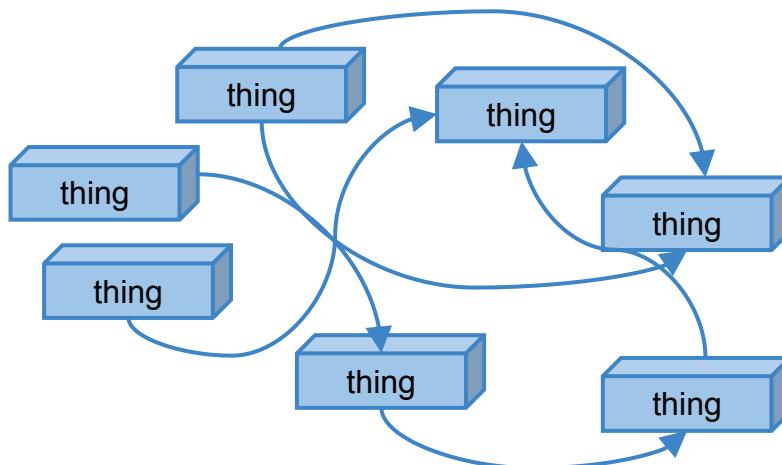
- ★ make your stuff available on the Web (whatever format) under an open license¹ [example ...](#)
- ★★ make it available as structured data (e.g., Excel instead of image scan of a table)² [example ...](#)
- ★★★ make it available in a non-proprietary open format (e.g., CSV instead of Excel)³ [example ...](#)
- ★★★★ use URIs to denote things, so that people can point at your stuff⁴ [example ...](#)
- ★★★★★ link your data to other data to provide context⁵ [example ...](#)

query.csv Show all About Wikimedia Deutschland



Web of Linked Data

links define **relationships** between **things**



- a global database
- design for machines
- links between things
- explicit semantics

How does it change our life?

- a company is moving to another city
 - aggregated information on taxes, prices, salaries, unemployment, climate
- I'm moving to another country
 - mobile phone providers, bank accounts
- you're buying a house
 - crime statistics, weather, house prices, neighbourhood, traffic information
- media annotation
 - video annotated with Linked Data + always up-to-date bio of the speaker

Linked Geo Data

Edit Lukaskirche

Name	Lukaskirche
Description	
Image	
Source_ref	
amenity	place_of_worship
religion	christian
denomination	lutheran
created_by	xybot
[+]	

Search: [Login >>](#) **Instances**

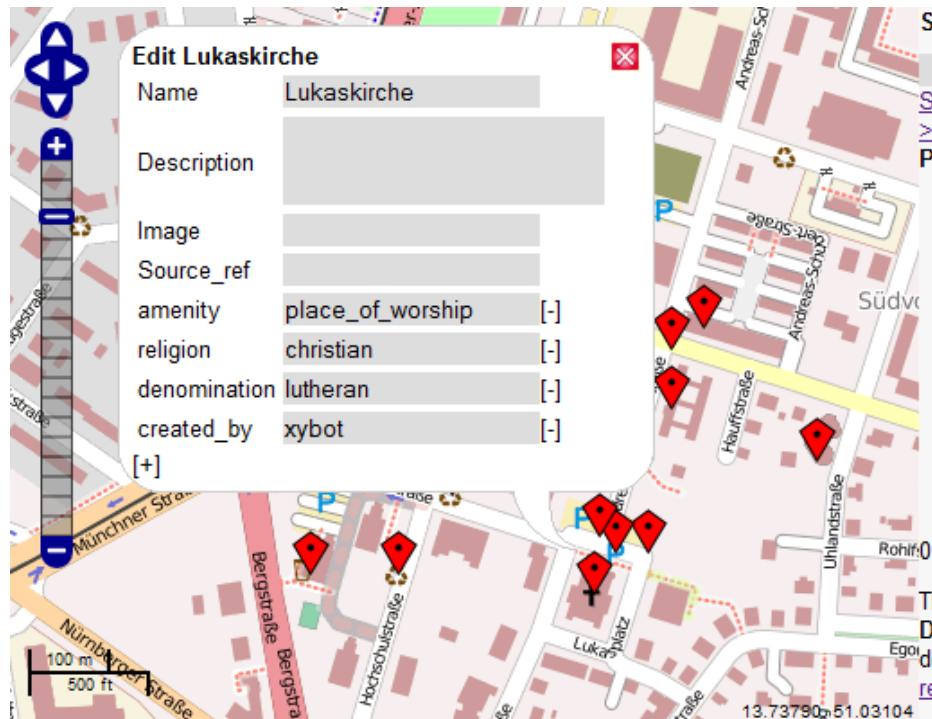
[Show updates in this area](#)

[Properties](#)

- [+] [highway](#) (15)
- [+] [religion](#) (3)
- [+] [amenity](#) (31)
- [+] [denomination](#) (3)
- [+] [historic](#) (1)
- [+] [railway](#) (2)
- [+] [leisure](#) (5)
- [+] [man_made](#) (1)
- [+] [shop](#) (4)
- [+] [sport](#) (1)
- [+] [cuisine](#) (1)

RohR: 0.0658550262451

This faceted Linked Geo Data browser was developed by [AKSW research group](#).



1. Lukaskirche
amenity:
place_of_worship
religion: christian
denomination:
lutheran

2. Club 11
amenity: nightclub

3. amenity: recycling

4. amenity: parking

5. amenity: parking

6. amenity: parking

7. amenity: recycling

8. Lukas-Apotheke
amenity: pharmacy

9. amenity: school

10. amenity: parking

11. Johanneskirche
denomination:
christian_community
religion: christian
amenity:

Clean Air Status and Trends - Ozone

DATA GOV

Castnet Ozone Map



Ozone Stations

Land Use

- 27 Agric
- 1 Coastal/Marsh
- 3 Desert
- 40 Forest
- 1 Forest/Arid
- 2 Forest/Marsh

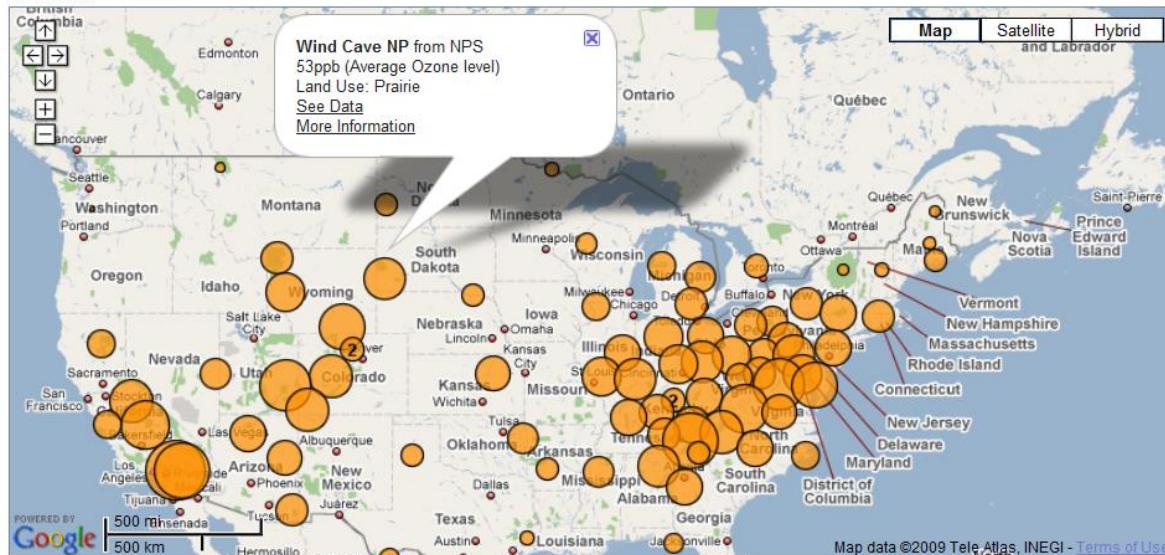
Terrain

- 37 Rolling
- 4 Mountaintop
- 1 Flat/Water
- 14 Flat
- 27 Complex
- 1 Coastal

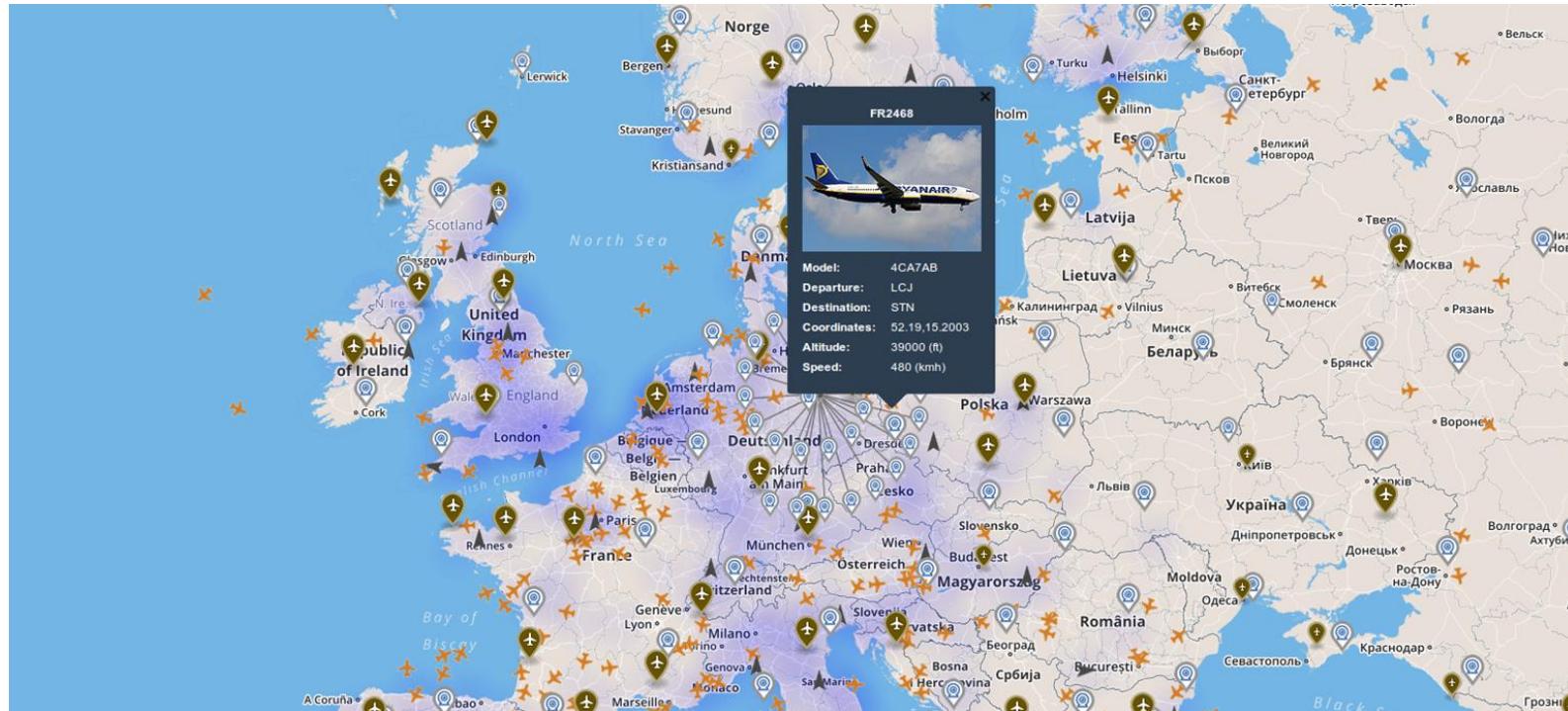
Agency

- 59 EPA
- 25 NPS

84 Items



Graph of Things: Live Linked Data



**Keith Vaz** Labour, from Leicester East

Speaker's URI: <http://reference.data.gov.uk/id/mp/leicester-east/keith-vaz>

Will the right hon. Lady join me in commanding the work of Jan Berry, who was appointed by the previous Government but completed her report under the present Government, and her recommendations to reduce police bureaucracy? Will the right hon. Lady give the House an undertaking that that work will continue, and that Jan Berry or someone like her will continue to monitor the reduction in the bureaucracy that is hampering the police in doing their job?

Hide Media Fragment URI

<http://www.twofourdigital.net/UKParliament/Archive/0000014318.wmv.aspx?t=12590,12615>

play this fragment

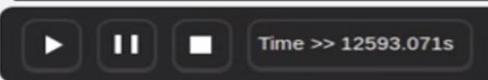
[More...](#)

**Theresa May** Conservative, from Maidenhead

Speaker's URI: <http://reference.data.gov.uk/id/mp/maidenhead/theresa-may>

I am happy to take up the point made by the right hon. Gentleman. Jan Berry did a very good job in looking at police bureaucracy. Obviously, she had considerable experience which enabled her to do that. I can reassure the right hon. Gentleman that the work will continue. We are already taking forward further work in a number of ways to examine the bureaucracy surrounding policing so that we can take further steps to reduce the amount of bureaucracy that the police have to deal with.

With a strong democratic mandate from the ballot box, police and crime commissioners



[Speaker](#) [Annotations](#) [DBpedia](#)

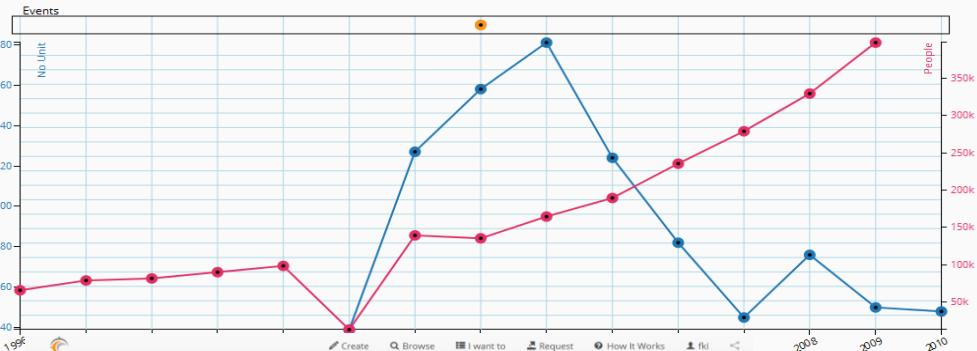
Speaker Information from data.gov.uk

Subject:

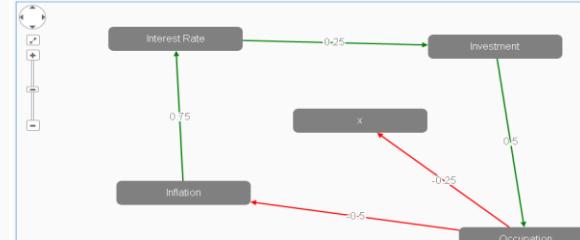
<http://reference.data.gov.uk/id/mp/leicester-east/keith-vaz>

predicate	object
http://www.w3.org/2000/01/rdf-schema#seeAlso	http://www.london-gazette.co.uk/issues/59418/notices/1118281
http://xmlns.com/foaf/0.1/name	Keith Vaz
http://xmlns.com/foaf/0.1/firstName	Keith
http://reference.data.gov.uk/	http://reference.data.gov.uk/

Drug Policy in Spain

[Create Causal Model](#) [Share](#) [Edit](#)

[Browse the Policy Compass Data](#)
[Content type](#) [Datasets \(140\)](#)
[Search content](#) [Go!](#)
[on in Spain](#)
[Sort By](#)
[Relevance](#)
[Show](#)
[10](#)
[Show as %](#)

Interest Rate

[Edit](#) [Delete](#) [Run Simulation](#)


Stic Expenditure on R&D

[Jment Map](#) [Share](#)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Netherlands	45.1	47.2	45.6	48.4	48.7	46.1	47.1	45.1	46.2	45.5	48.7	46.6
Norway												
Poland	45.4	44	37.2	30.4	26.9	23.3	34.8	32.3	37.4	34.4	31	32.9
Portugal	52.2	58.5	54.8	59.3	58.3	62.8	58	58.4	61.2	62.2	63.8	68.4
Romania	45.1	38.3	36.6	35	35.6	34.7	35.1	35.1	33.9	37.7	40.2	32.2
Serbia	30.8	31.4	30	28.8	29.4	28.7	26.6	25.5	27.7	27.2	28.2	27.1
Albania	36.2	37.9	43.3	46	48.4	47.3	41	45.1	45.8	46.8	48.9	
Slovakia	65.1		63.9									
Slovenia												
Spain	70	69.3	66.9	66.6	68.2	70.3	68.1	66.1	67	63.1	60.8	53.5
Belgium	50.8	50.7	51.9	52.3	52.3	50.8	52.3	53.5	55	55.3	55	
Sweden	60.3	60.2	59.7	61	61.4	61	58.7	57.6	60.2	57	56.9	
Switzerland	43.9		48	49.3	50.4	50.4	47.8		49.8		39.2	
Turkey	63.3	62.6	63.3	64.3	64.9	63.5	60.9	57.2	58.6	59.1		
United Kingdom												
United States	74.6	74.8	76.1	77.1	77.7	78.2	75.3	75.9	76.5	76.1	75.5	
Angola	74.3	28.2	27.8	30.6	34.2	30.6	30.2	16.7	16.9	20.8	19.5	
Former Yugoslav Republic of Macedonia, the												
Russia	60.1	65.7	67	69.1	70.4	71.7	71.7	73.9	74	74.6		8.2
China (except Hong Kong)	74	75	75	75.4	73.7	72.9	71.1	71.8	73.7	74.7	75.7	

FAQ | Search | Contact | Cookies | Legal notice English (en)

 EUROPEAN DATA PORTAL

European Data Portal > Data

What we do Providing Data Using Data Library Data

 / Datasets

Filter by location Clear
Search Location...


Atom Feed
Search datasets...
Language: English Order by: Relevance

5,478 datasets found
Catalogs: data.gov.uk Formats: CSV

London Air Quality Network Camden
This dataset contains data captured by sensors operated by London Air. This is downloaded via their API (Application Programming Interface) and filtered to only include sensors...
[CSV](#) [HTML](#) [JSON](#) [XML](#) [RSS](#)

Catalogs: data.gov.uk (5478)
Categories: There are no Categories that match this search
Tags: marine (855), mnrc (853), marine-recorder (853)



EUROPEAN DATA PORTAL

ata.gov.uk / London Air Quality Network ...

Dataset Categories Activity Stream Feedback

London Air Quality Network Camden

This dataset contains data captured by sensors operated by London Air. This is downloaded via their API (Application Programming Interface) and filtered to only include sensors within the London Borough of Camden.

Distributions

[Download \(CSV\)](#) [Download \(RDF\)](#)

Dashboard Profile edp-fraun Log out en-us



data.gov.uk to EDP Harvester

Was this useful?  

CKAN Open Data Portal United Kingdom  

http://data.gov.uk 

CKAN CKAN

EDP The European Data Portal  

http://www.europeandataportal.eu 

Transformation Script  

Runs Daily    

Next: Apr 26, 2016 1:30:00 AM

Run ID	Status
213/213	finished
216/216	finished
384/384	finished
1465/1465	finished
895/895	finished
346/346	finished
710/710	finished
355/355	finished

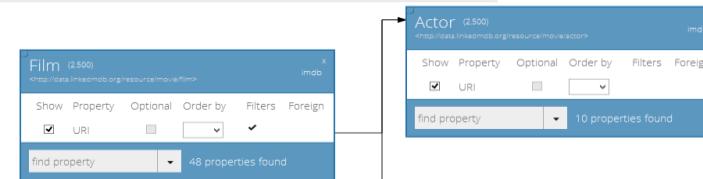
Select Visualization

- AREA CHART**
- BAR CHART**
- LINE CHART**

Configure Visualization

Selected Data	Visualization Options
Columns » Gov_effect	Horizontal Axis
Columns » gdp_per_capita	Drag any data here
X	Gov_effect X
Vertical Axis	Vertical Axis
Drag any data here	gdp_per_capita
X	X
Series	Series
Drag any data here	gdp_per_capita
X	X

Select Data Run Save Download Analyze Visualize
IMDB Search terms Film Agent Actor



DATA VIEW

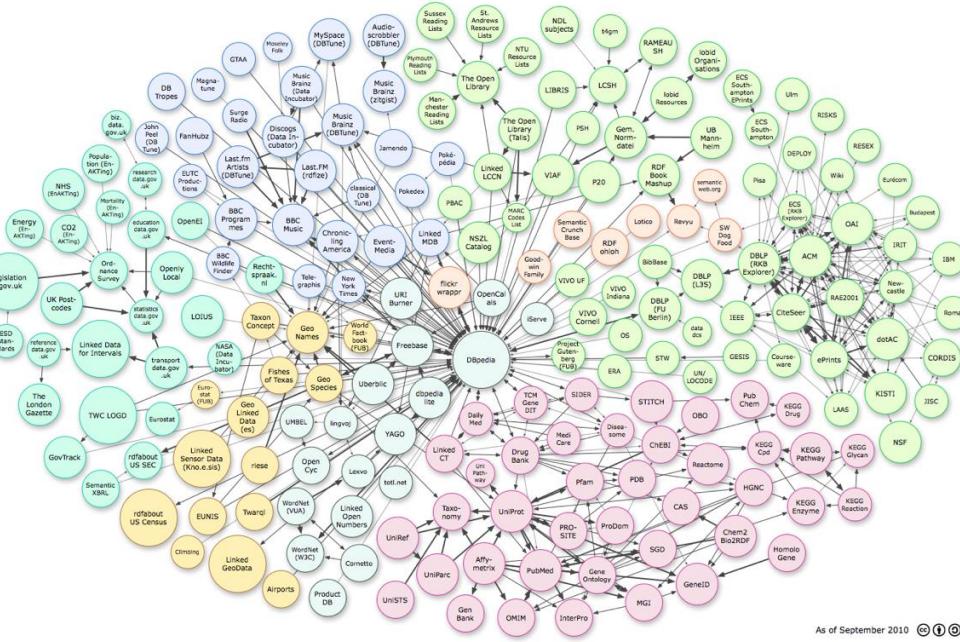
File: Uuser.csv (10 rows example)

Label	# Samples	Average	Min	Max	Std. Dev.	Error %	Throughput	KB/sec	Avg. Bytes
INIT /transformation/	5	163	129	190	19.85	0.00%	25.9	43.01	1700.0
STEP /transformation/csv/step/1	10	109233	82	230755	109374.10	0.00%	.0	0.77	18095.0
STEP /transformation/csv/step/2	5	4717	2747	8958	2213.44	0.00%	.2	4.23	26118.0
STEP /transformation/csv/step/3	5	3007	248	5269	2154.34	0.00%	.2	7.69	33793.0
POST /transformation/csv/step/4	5	3674	446	8617	3039.67	0.00%	.3	9.77	36302.0
STEP /transformation/csv/step/4	5	3674	446	8617	3039.67	0.00%	.3	9.77	36302.0
STEP /transformation/csv/step/5	5	2255	770	3871	1312.42	0.00%	.5	258.21	569330.0
STEP /transformation/csv/step/6	5	743	395	1162	252.66	0.00%	.6	16.88	26644.0
POST /transformation/csv/step/7	5	509	280	978	246.15	0.00%	.7	15.90	24506.0
DOWNLOAD /transformation/csv/step/7	5	158477	148833	167839	7027.91	0.00%	.0	2066.30	71581362.0

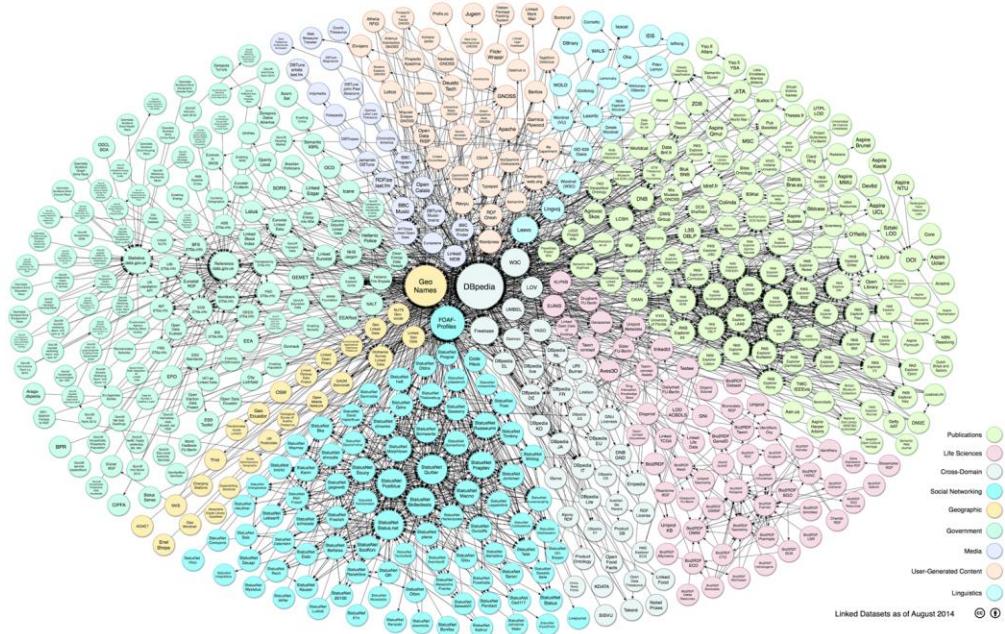
RDF VIEW (10 rows example)

```
<?subject?> <?predicate?> "INIT /transformation/" .  
<?subject?> <?predicate?> "5" .  
<?subject?> <?predicate?> "163" .
```

Linked Open Data

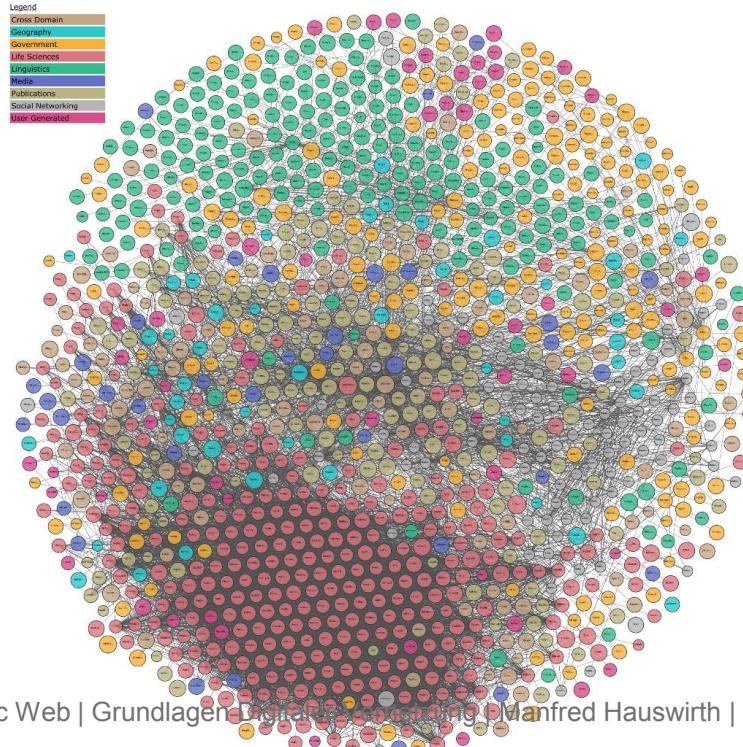


Linked Open Data



Linked Open Data

1,255 Datasets mit 16,174 Links (21.4.2021) – <https://lod-cloud.net>



Linked Data

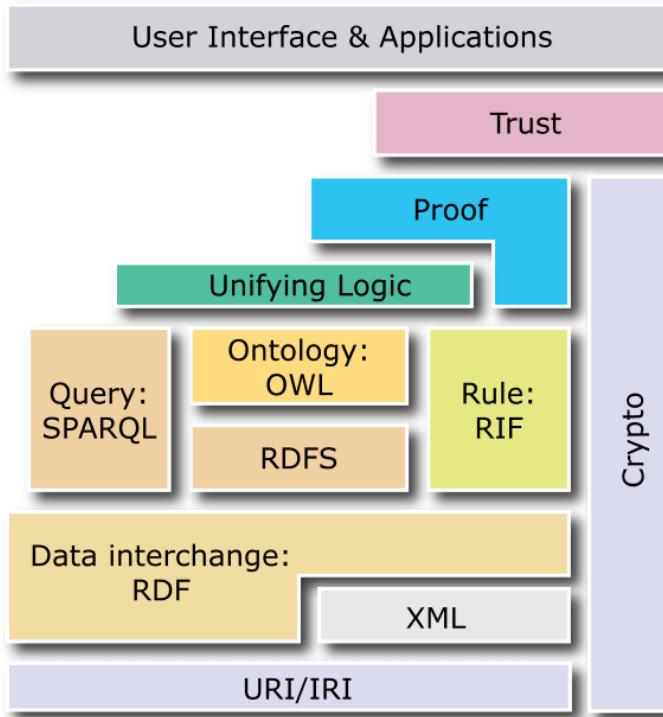
- describes a method of publishing semi-structured data in the Web
- data can be interlinked
- builds upon standard Web technologies such as HTTP, RDF, and URIs
- extends the standards to share information in a way that it can be read automatically by computers

Big data is **high-volume**, **high-velocity** and **high-variety** information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making.

Linked Data is Big Data

- Volume: data size growing exponentially
- Velocity: streams of data from the Internet of Things Cloud
- Variety
 - semi-structured data
 - heterogenous linked collections of data

Linked Data vs. Semantic Web



Semantic Web

Linked Data

Two Key Components

- RDF – Resource Description Framework
 - Graph based Data – nodes and arcs
 - Identifies objects (URIs)
 - Interlink information (Relationships)
- Vocabularies (Ontologies)
 - provide shared understanding of a domain
 - organize knowledge in a machine-comprehensible way
 - give an exploitable meaning to the data



RDF



RDF in General

- Resource Description Framework (RDF)
- A resource is basically everything
 - E.g., persons, places, Web documents, abstract concepts
- Descriptions of resources
 - Attributes and features
 - Relations
- The framework contains:
 - A data model, and
 - Languages and syntaxes

RDF Data Model

➤ Atoms of knowledge are triples (subject, predicate, object)

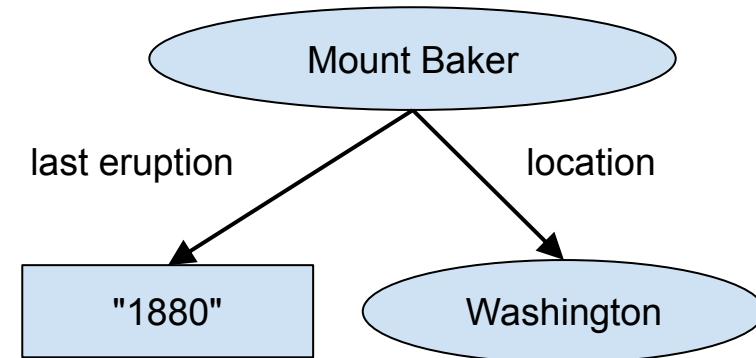
- Subject: resources
- Predicate: properties
- Object: resources or literals

➤ Examples:

- (Mount Baker , last eruption , "1880")
- (Mount Baker , location , Washington)

RDF Data Model

- RDF is also a graph model
 - Triples as directed edges
 - Subjects and objects as vertices
 - Edges labeled by predicate
- Example:
 - (Mount Baker , last eruption , "1880")
 - (Mount Baker , location , Washington)



Uniform Resource Identifier (URI)

- Globally unique identifier for resources
- Syntax:
 - URI schema (e.g. http, mailto, urn)
 - Colon character (“：“)
 - Scheme-specific part (often hierarchical)



- Examples:
 - http://dbpedia.org/resource/Mount_Baker
 - <http://www.informatik.hu-berlin.de/~hartig/foaf.rdf#olaf>
 - urn:isbn:0-486-27557-4

Uniform Resource Identifier (URI)

- URIs extend the concept of URLs
 - URL of a Web document usually used as its URI
 - Attention: URIs identify not only Web documents

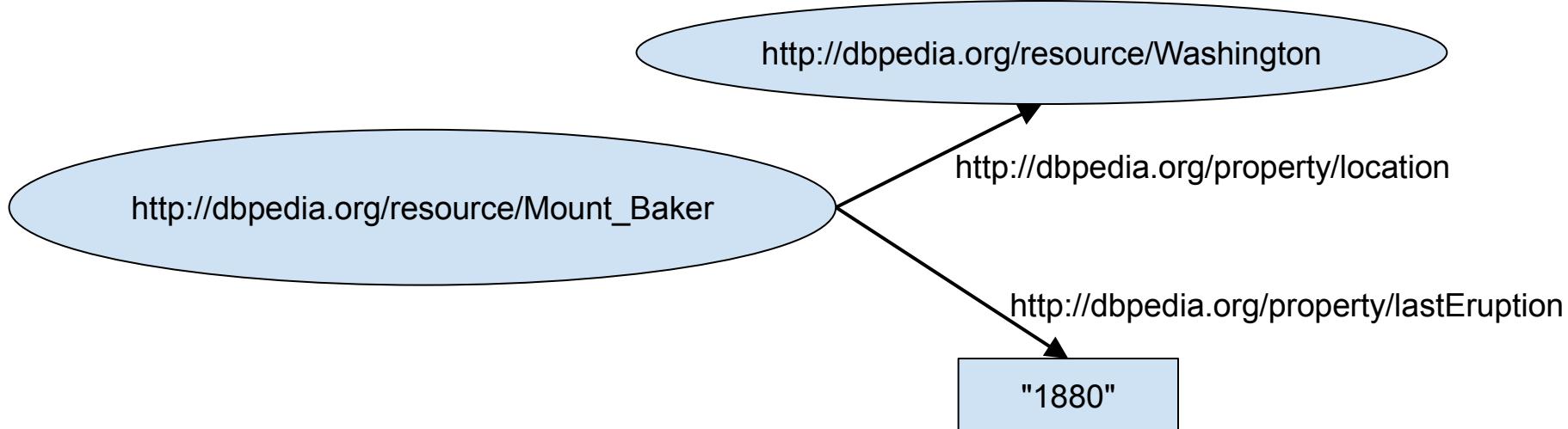
- Example:
 - Olaf: <http://www.informatik.hu-berlin.de/~hartig/foaf.rdf#olaf>
 - RDF document about Olaf: <http://www.informatik.hu-berlin.de/~hartig/foaf.rdf>
 - HTML document about Olaf: <http://www.informatik.hu-berlin.de/~hartig/index.html>



Example (revisited)

(http://dbpedia.org/resource/Mount_Baker,
<http://dbpedia.org/property/lastEruption>,
"1880")

(http://dbpedia.org/resource/Mount_Baker,
<http://dbpedia.org/property/location>,
<http://dbpedia.org/resource/Washington>)



Compact URIs (CURIE)

- Abbreviated Notation for URIs
- Syntax:
 - Prefix name (references the prefix of the URI)
 - Colon character (“.”)
 - Reference part
- URI by concatenating the prefix and the reference part
- Examples:
 - dbpedia:Mount_Baker for
 - http://dbpedia.org/resource/Mount_Baker
 - myfoaf:olaf for
 - <http://www.informatik.hu-berlin.de/~hartig/foaf.rdf#olaf>

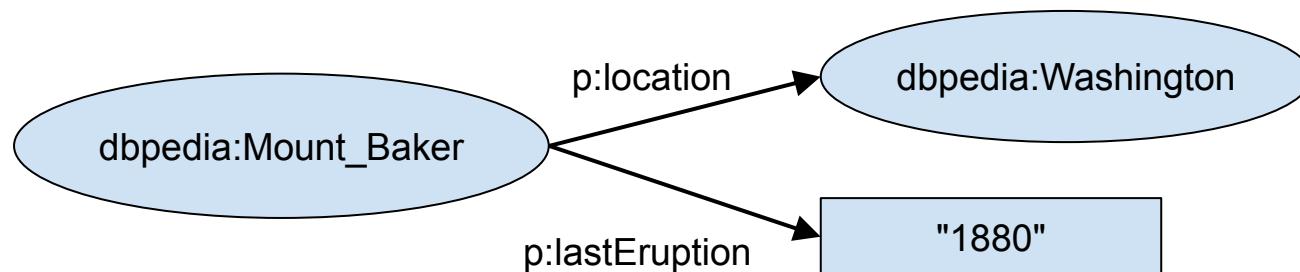
Example with CURIEs

➤ Using

- dbpedia for prefix `http://dbpedia.org/resource/`
- p for prefix `http://dbpedia.org/property/`

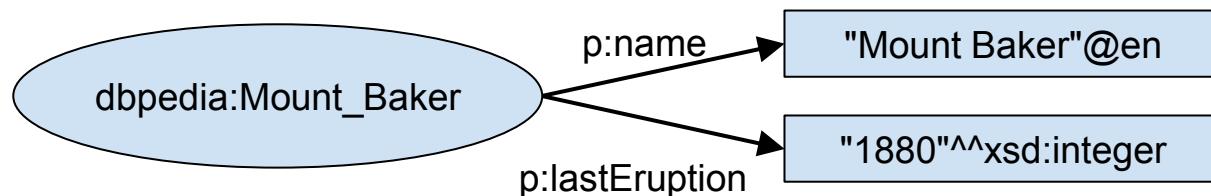
➤ we have

- (`dbpedia:Mount_Baker`, `p:lastEruption`, "1880")
- (`dbpedia:Mount_Baker`, `p:location`, `dbpedia:Washington`)



Literals

- Literals may occur in the object position of triples
- Represented by strings
- Literal strings interpreted by datatypes
 - Datatype identified by a URI
 - Common to use the XML Schema datatypes
 - No datatype: interpreted as xsd:string
- Untyped literals may have language tags (e.g. @de)



RDF Syntax

Simple notation to list RDF triples:

- Triples separated by a period (“.”) character
- Example:

```
<http://dbpedia.org/resource/Mount_Baker>
  <http://dbpedia.org/property/lastEruption>
    "1880"^^xsd:integer .

<http://dbpedia.org/resource/Mount_Baker>
  <http://dbpedia.org/property/location>
    <http://dbpedia.org/resource/Washington> .
```

RDF Syntax

Allows the use of CURIEs:

- @prefix directive binds a prefix to a namespace URI

```
@prefix dbpedia : <http://dbpedia.org/resource/> .  
@prefix p : <http://dbpedia.org/property/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
```

```
dbpedia:Mount_Baker p:lastEruption "1880"^^xsd:integer .  
dbpedia:Mount_Baker p:location dbpedia:Washington .
```

```
dbpedia:Washington p:borderingstates dbpedia:Oregon .  
dbpedia:Washington p:borderingstates dbpedia:Idaho .
```

RDF Syntax

Provides some syntactic sugar:

- Predicate lists separated by a semicolon (“;”) character
- Object lists separated by a comma (“,”) character

```
@prefix dbpedia : <http://dbpedia.org/resource/> .  
@prefix p : <http://dbpedia.org/property/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
  
dbpedia:Mount_Baker p:lastEruption "1880"^^xsd:integer ;  
                      p:location      dbpedia:Washington .  
  
dbpedia:Washington p:borderingstates dbpedia:Oregon ,  
                      dbpedia:Idaho .
```

RDF Syntax

More syntactic sugar:

Shortcuts for number literals

```
dbpedia:Mount_Baker p:lastEruption "1880"^^xsd:integer ;  
    geo:lat "48.777222"^^xsd:float ;  
    geo:long "-121.813332"^^xsd:float .
```

Equivalent:

```
dbpedia:Mount_Baker p:lastEruption 1880 ;  
    geo:lat 48.777222 ;  
    geo:long -121.813332 .
```

RDF/XML – An XML syntax for RDF

```
@prefix dbpedia : <http://dbpedia.org/resource/> .  
@prefix p : <http://dbpedia.org/property/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
```

```
dbpedia:Mount_Baker p:lastEruption "1880"^^xsd:integer .  
dbpedia:Mount_Baker p:location dbpedia:Washington .
```

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"  
         xmlns:p="http://dbpedia.org/property/">  
<rdf:Description rdf:about="http://dbpedia.org/resource/Mount_Baker">  
  <p:lastEruption rdf:datatype="http://www.w3.org/2001/XMLSchema#integer">  
    1880</p:lastEruption>  
  <p:location rdf:resource="http://dbpedia.org/resource/Washington"/>  
</rdf:Description>  
</rdf:RDF>
```

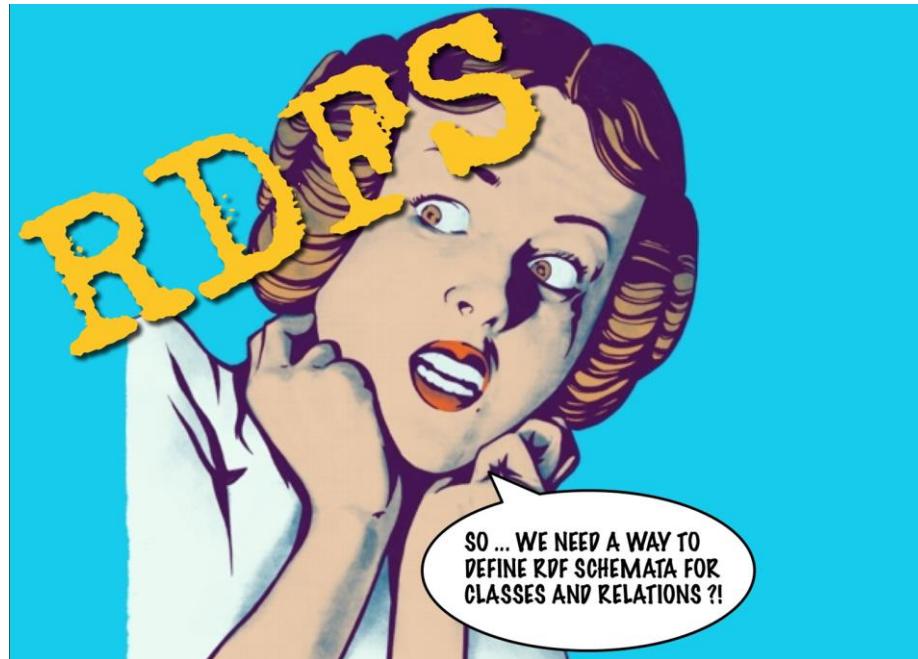
RDF/XML

Further Reading

W3C RDF Specifications – <http://www.w3.org/RDF/>

- RDF Primer
- RDF: Concepts and Abstract Syntax
- RDF Vocabulary Description Language 1.0: RDF Schema
- RDF Semantics
- RDF/XML Syntax Specification (Revised)
- RDF Test Cases

RDFS



Classification

The predefined property rdf:type enables classifications

- Object resource represents a category / class of things
- Subject resource is an instance of that class

```
@prefix dbpedia: <http://dbpedia.org/resource/> .  
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns>.  
@prefix umbel-sc: <http://umbel.org/umbel/sc/> .  
@prefix yago: <http://dbpedia.org/class/yago/>.  
@prefix skos: <http://www.w3.org/2004/02/skos/core#>.  
dbpedia:Oregon rdf:type yago:StatesOfTheUnitedStates .  
dbpedia:Mount_Baker rdf:type umbel-sc:Mountain .  
umbel-sc:Mountain skos:definition "Each instance of Mountain is a topographical feature of ▶  
significantly higher elevation ..."@en
```

UMBEL-SC: *Upper Mapping and Binding Exchange Layer (UMBEL) – Subject Concept SC*

SKOS: *Simple Knowledge Organisation System*

Classification

Class membership is not exclusive,

i.e., instances may have multiple types

```
dbpedia:Mount_Baker rdf:type umbel-sc:Mountain,  
                      umbel-sc:Volcano .
```

Classes may be instances of other classes!

```
dbpedia:Mount_Baker rdf:type umbel-sc:Mountain .  
umbel-sc:Mountain rdf:type umbel-ac:ExistingObjectType .
```

Syntactical distinction between classes and instances a priori impossible

RDF Schema in General

- RDF Schema enables specification of schema knowledge
 - Definition of the vocabulary used in triples
 - Class hierarchies, property hierarchies
- RDF Schema semantics enable elementary inferences

Predefined Classes

RDF Schema defines the following classes

- rdfs:Resource – class of all resources
- rdfs:Literal – class of all literals
- rdfs:Class – class of all classes
 - it holds: (rdfs:Class rdf:type rdfs:Class)
- rdfs:Datatype – class of all datatypes
- rdf:Property – class of all properties

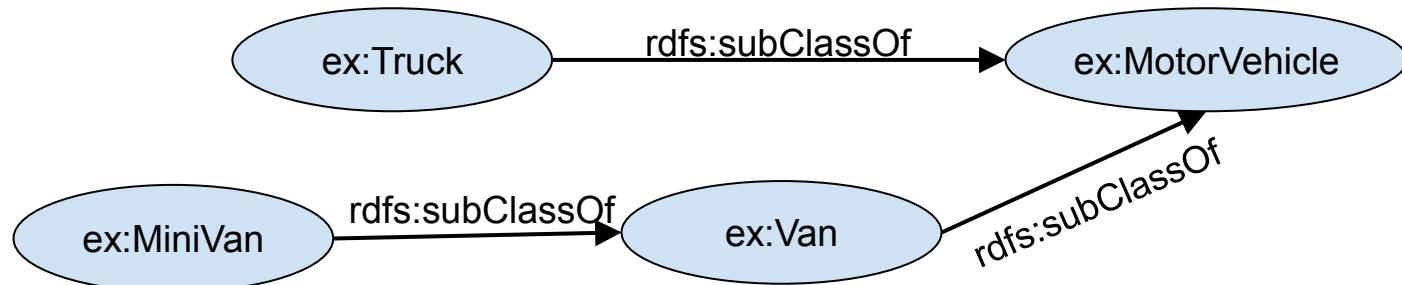
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns>.  
@prefix rdfs : <http://www.w3.org/2000/01/rdf-schema#> .  
@prefix umbel-sc : <http://umbel.org/umbel/sc/> .  
  
umbel-sc:Mountain rdf:type rdfs:Class .
```

Class Hierarchies

rdfs:subClassOf enables the definition of class hierarchies

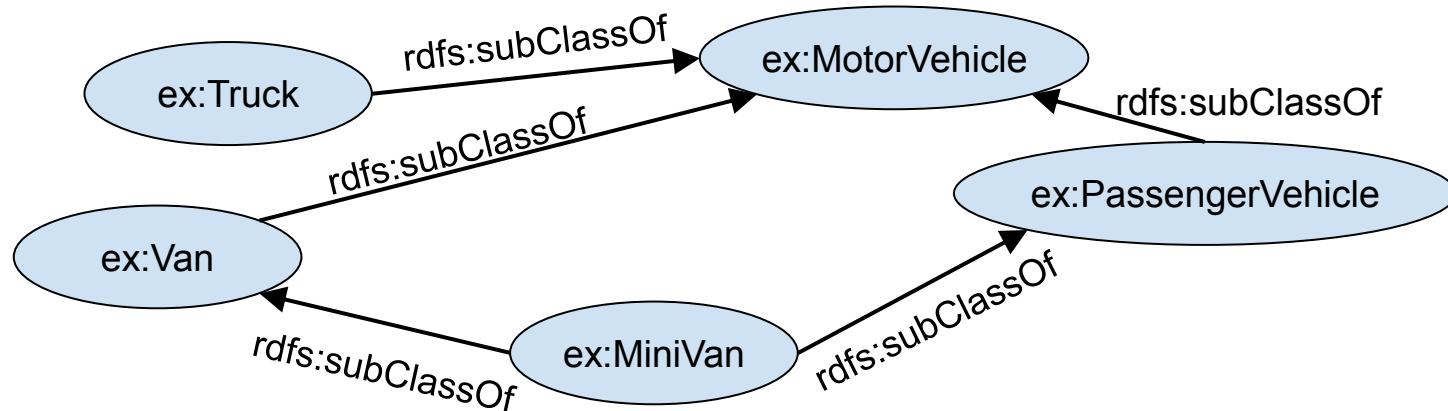
```
@prefix rdfs : <http://www.w3.org/2000/01/rdf-schema#> .  
@prefix ex : <http://example.org/> .
```

```
ex:Truck rdfs:subClassOf ex:MotorVehicle .  
ex:Van rdfs:subClassOf ex:MotorVehicle .  
ex:MiniVan rdfs:subClassOf ex:Van .
```



Class Hierarchies

Multiple inheritance allowed



`rdfs:subClassOf` is reflexive – e.g., it holds:

`ex:Truck rdfs:subClassOf ex:Truck .`

Class Hierarchies

rdfs:subClassOf is transitive,

e.g., given

```
ex:Van rdfs:subClassOf ex:MotorVehicle .  
ex:MiniVan rdfs:subClassOf ex:Van .
```

we can infer

```
ex:MiniVan rdfs:subClassOf ex:MotorVehicle .
```

Entailment rule (defines the information that should be derived based on existing knowledge):

$$\frac{(\text{A , rdfs:subClassOf , B}) \quad \text{IF } \textbf{A} \text{ is subClassOf } \textbf{B} \\ (\text{B , rdfs:subClassOf , C}) \quad \text{AND } \textbf{B} \text{ is subClassOf } \textbf{C}}{(\text{A , rdfs:subClassOf , C}) \quad \text{THEN } \textbf{A} \text{ is subClassOf } \textbf{C}}$$

Class Hierarchies

Another entailment rule:

$$\frac{(\text{a , rdf:type , A}) \quad (\text{A , rdfs:subClassOf , B })}{(\text{a , rdf:type , B })}$$

IF **a** is type **A**
AND **A** is subClassOf **B**
THEN **a** is type **B**

e.g., from

```
ex:Van rdfs:subClassOf ex:MotorVehicle .  
ex:MiniVan rdfs:subClassOf ex:Van .  
ex:MyRedVWT3 rdf:type ex:MiniVan .
```

we may infer

```
ex:MyRedVWT3 rdf:type ex:Van .
```

and (exploiting transitivity)

```
ex:MyRedVWT3 rdf:type ex:MotorVehicle .
```

Property Restrictions

rdfs:domain and rdfs:range specify permitted subjects and objects, respectively

```
@prefix rdfs : <http://www.w3.org/2000/01/rdf-schema#> .  
@prefix xsd : <http://www.w3.org/2001/XMLSchema#> .  
@prefix p : <http://dbpedia.org/property/> .  
@prefix ex : <http://example.org/> .  
@prefix foaf : <http://xmlns.com/foaf/0.1/> .
```

```
ex:authoredBy rdfs:domain ex:Publication .  
ex:createdBy rdfs:range foaf:Person .  
p:lastEruption rdfs:range xsd:integer .
```

Further RDF Schema Properties

- rdfs:label – alternative name of a resources
- rdfs:comment – comment associated to a resource
- rdfs:seeAlso – reference to a resource with more information about the subject
- rdfs:definedBy – reference to a resource with a definition of the subject

```
@prefix rdfs : <http://www.w3.org/2000/01/rdf-schema#> .  
@prefix foaf : <http://xmlns.com/foaf/0.1/> .  
  
foaf:Person rdfs:label "Person"@en , "Person"@de ;  
    rdfs:comment "Class for persons."@en ;  
    rdfs:definedBy <http://xmlns.com/foaf/spec/>.
```

RDF Schema Summary

- RDF Schema (RDFS) provides elementary means to define
 - vocabularies and
 - a machine-processable meaning of RDF data
- RDF data that uses vocabulary described with RDFS can generically be processed by every RDFS-enabled software.

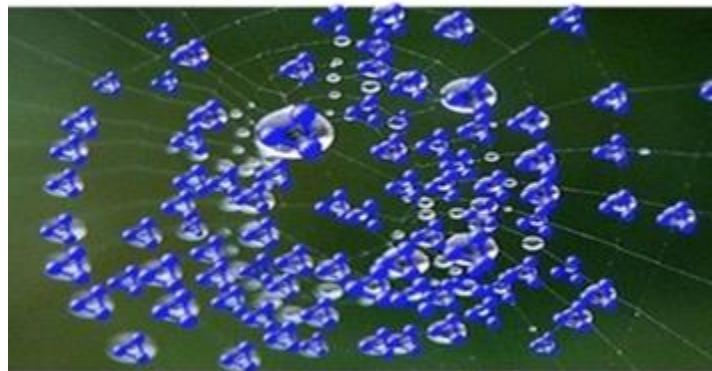
Common Vocabularies

- FOAF (Friend of a Friend)
 - Persons and their main properties (e.g. name, email)
 - foaf:knows relation (enables specification of a network)
 - Namespace URI: <http://xmlns.com/foaf/0.1/>
- DC (Public Core)
 - Enables description of created or published resources
 - Namespace URI: <http://purl.org/dc/elements/1.1/>
- SKOS (Simple Knowledge Organisation System)
 - Thesauri, classification schemes, taxonomies, ...
 - Namespace URI: <http://www.w3.org/2008/05/skos#>

Common Vocabularies

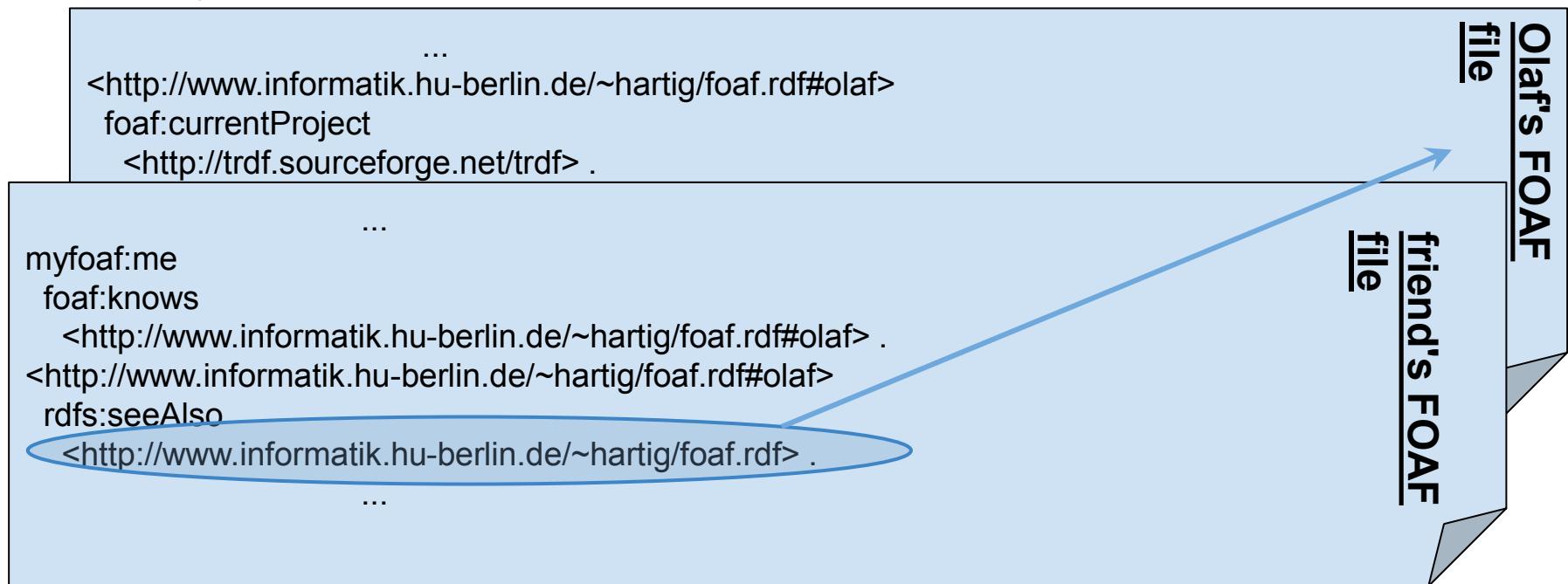
- SIOC (Semantically-Interlinked Online Communities)
 - Content and structure of online community sites
 - Weblogs, mailing lists, newsgroups,
 - Connections between channels and posts
 - Namespace URI: <http://rdfs.org/sioc/ns#>
- DOAP (Description of a Project)
 - (Software) projects
 - Maintainer, programming language, source repository, ...
 - Namespace URI: <http://usefulinc.com/ns/doap#>

Web of Data



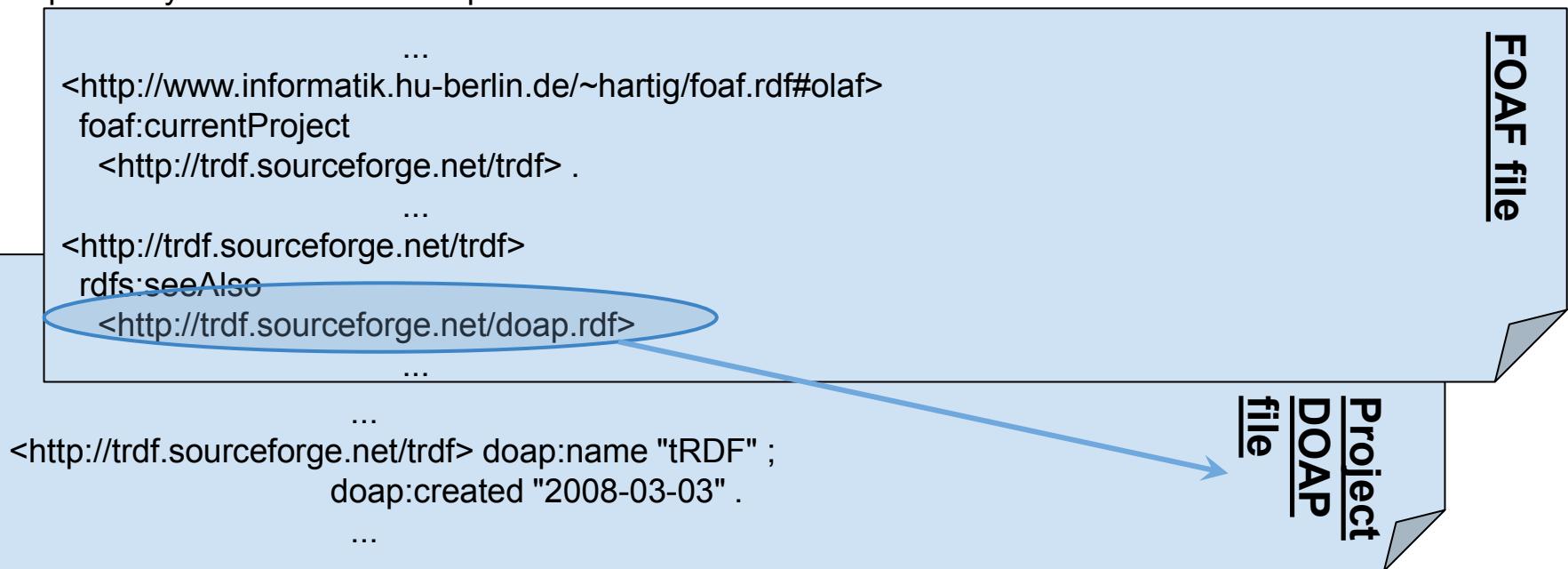
Web of Data

Triples may link different data spaces



Web of Data

Triples may link different data spaces



Web of Data

➤ Linked Data principles (set of best practices for publishing and deploying data on the Web,

<http://www.w3.org/DesignIssues/LinkedData.html>):

- Use URIs as names for things.
- Use HTTP URIs so that people can look up those names.
- When someone looks up a URI, provide useful RDF data.
- Include RDF statements that link to other URIs, so that they can discover related things.



➤ These principles allow a true Web of Data

➤ RDF links have a machine-processable semantic

(in contrast to links between Web documents)

Rückblick

- Semantic Web und Linked Data and
 - From the Web of documents to the Web of Data
 - Real-life Examples
 - The Principles
 - Linked Data vs. Big Data
 - Linked Data and Semantic Web
- Technologien
 - URI
 - RDF
 - RDFS
 - Web of Data

Wo sind wir, und wo wollen wir hin?

- ✓ Wikipedia kann als Graph betrachtet werden.
- ✓ Wikipedia kann auch als Datenbank betrachtet werden.
- ✓ Ein wichtiger Teil dieser Datenbank ist Dbpedia.
- ✓ Wofür (1)? Ein Anwendungsbeispiel: Diversität in den Medien
- ✓ Dbpedia und Wikidata (Teil 1)
 - Format: RDF, RDFS und z.T. OWL; Linked Open Data
 - Das kann auch als relationale Datenbank dargestellt werden (bzw. es können Auszüge generiert werden).
 - Anfragesprache: SPARQL; mehr Wikidata
 - **Hausarbeit:** Wofür (2)? Selber recherchieren und neue Information hinzufügen.