

LINKED DATA

Potenzial und Nutzen

Dr. Steffen Lohmann

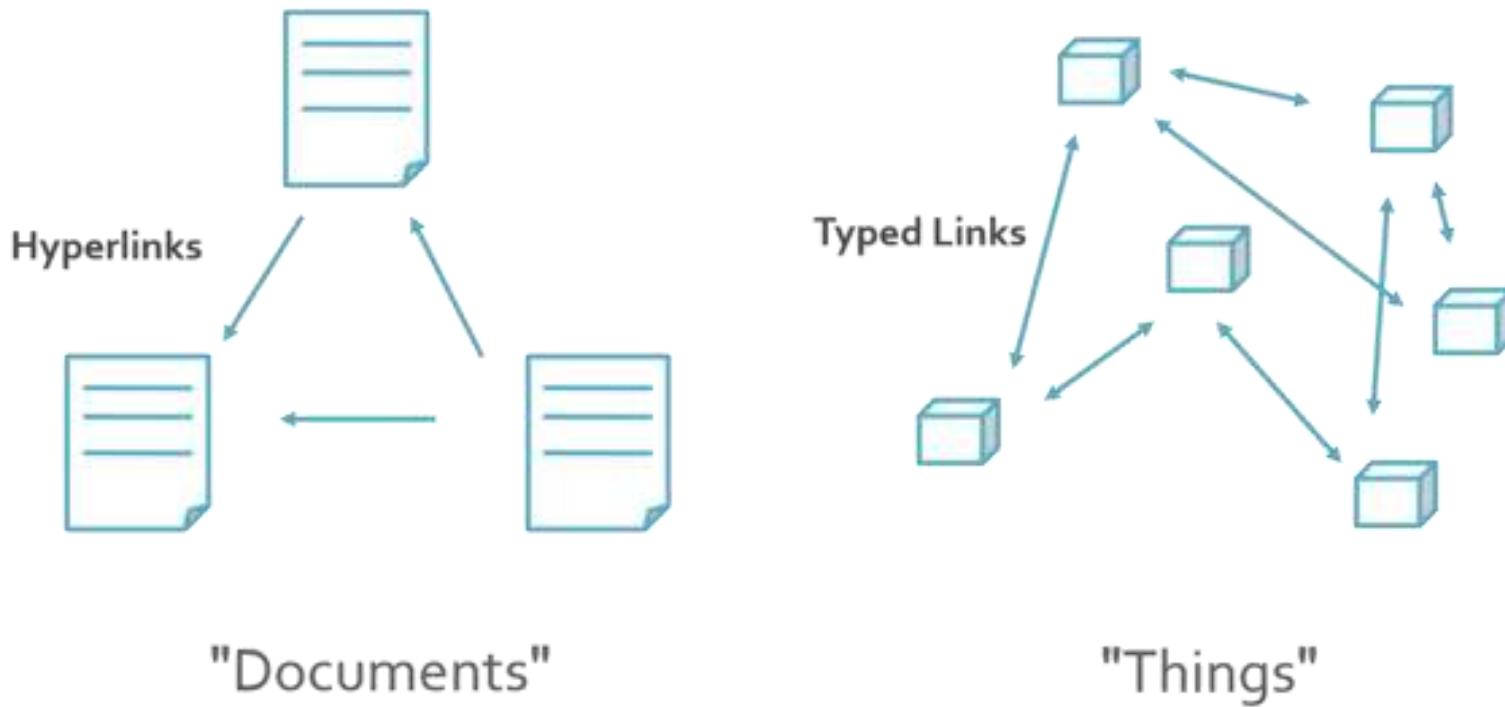
11. November 2016
Stuttgart

Evolution of the Web

Web of Documents



Web of Data



Web of Documents



Nicht angemeldet Diskussionsseite Beiträge Benutzerkonto erstellen Anmelden

Artikel Diskussion Lesen Bearbeiten Quelltext bearbeiten Versionsgeschichte Wikipedia durchsuchen Koordinaten: 48° 47' N, 9° 11' O |

Stuttgart

Der Titel dieses Artikels ist mehrdeutig. Weitere Bedeutungen sind unter Stuttgart (Begriffsklärung) aufgeführt.

Stuttgart^{2/1} ist die Hauptstadt des deutschen Bundeslandes Baden-Württemberg und mit über 600.000 Einwohnern^[2] dessen größte Stadt. Die sechstgrößte Stadt Deutschlands bildet das Zentrum der rund 2,7 Millionen Einwohner zählenden Region Stuttgart, einem der größten Ballungsräume Deutschlands. Zudem ist sie Kernstadt der europäischen Metropolregion Stuttgart (etwa 5,3 Millionen Einwohner), der fünftgrößten in Deutschland. Stuttgart hat den Status eines Stadtkreises und ist in 23 Bezirke gegliedert.

Als Sitz der baden-württembergischen Landesregierung und des Landtags sowie zahlreicher Landesbehörden ist Stuttgart das politische Zentrum des Landes (siehe auch *Liste der Behörden und Einrichtungen in Stuttgart*). Es ist Sitz des Regierungspräsidiums Stuttgart, das den gleichnamigen Regierungsbezirk verwaltet. In Stuttgart tagt das Regionalparlament der Region Stuttgart, einer der drei Regionen im Regierungsbezirk Stuttgart. Darüber hinaus ist Stuttgart Sitz des evangelischen Landesbischofs von Württemberg und Teil der katholischen Diözese Rottenburg-Stuttgart. Die Stadt ist

Wappen

Deutschlandkarte

Basisdaten

Bundesland:	Baden-Württemberg
Regierungsbezirk:	Stuttgart
Höhe:	247 m ü. NHN
Fläche:	207,35 km ²
Einwohner:	623.738 (31. Dez. 2015) ^[1]
Bevölkerungsdichte:	3.008 Einwohner je km ²

<https://de.wikipedia.org/wiki/Stuttgart>

Web of Data



DBpedia Browse using Formats Faceted Browser Sparql Endpoint

About: Stuttgart

An Entity of Type : Siedlung, from Named Graph : <http://dbpedia.org>, within Data Space : dbpedia.org

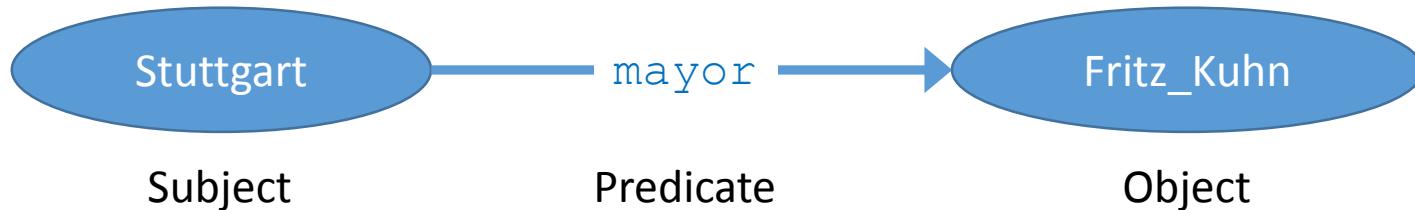
Stuttgart (/ʃtʊtga:rт/; German pronunciation: [ʃtʊtga:ɐ̯t], Swabian: Schduagert, pronounced [χd̥uɑ̯gɛɐ̯t]) is the capital and largest city of the state of Baden-Württemberg in southwest Germany. The eighth largest city in Germany, Stuttgart has a population of 600,068 (October 2014) while the greater Stuttgart Metropolitan Region has a population of 5.3 million (2008), being the fourth-biggest in Germany after the Rhine-Ruhr area, Berlin/Brandenburg and Frankfurt/Rhine-Main.

Property	Value
dbo:PopulatedPlace/areaTotal	▪ 207.36
dbo:abstract	▪ Stuttgart (/ʃtʊtga:rт/; German pronunciation: [ʃtʊtga:ɐ̯t], Swabian: Schduagert, pro largest city of the state of Baden-Württemberg in southwest Germany. The eighth population of 600,068 (October 2014) while the greater Stuttgart Metropolitan Reg (2008), being the fourth-biggest in Germany after the Rhine-Ruhr area, Berlin/Brar city lies at the centre of a densely populated area, surrounded by a ring of smaller has a population of 2.7 million. Stuttgart is spread across a variety of hills (many of unusual for a German city and often a source of surprise to visitors who primarily a reputation as the 'cradle of the automobile'. Stuttgart has the status of Stadtkreis, county. It is also the seat of the State Parliament and State Government of Baden Church in Württemberg as well as one of the two co-seats of the Roman Catholic

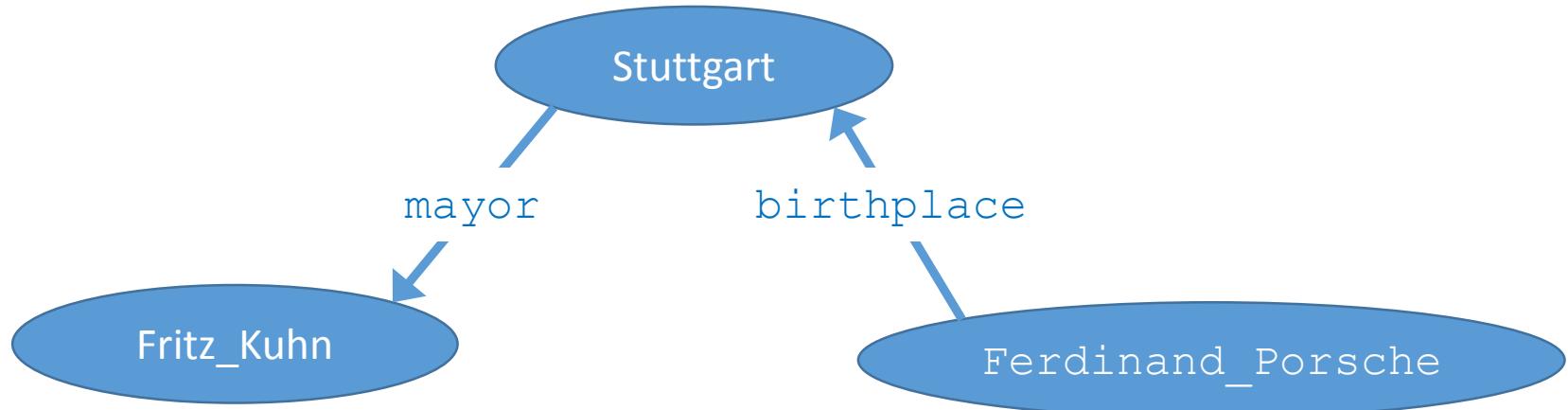
dbo:leaderName	▪ dbr:Fritz_Kuhn
dbo:leaderTitle	▪ Oberbürgermeister (en)
dbo:populationTotal	▪ 604297 (xsd:integer)
dbo:postalCode	▪ 70173–70619
is dbo:birthPlace of	▪ dbr:Eberhard_Weber ▪ dbr:Ferdinand_Alexander_ ▪ dbr:Klaus_Schedl ▪ dbr:Bernard_Tomic ▪ dbr:Fritz_Leonhardt ▪ dbr:Hans_Wilhelm_König ▪ dbr:Alexander_Tuschinski ▪ dbr:Frederick_Leypoldt ▪ dbr:Gottlob_Christian_Sto ▪ dbr:Gustav_Friedrich_Hets ▪ dbr:Hermann_Plocher ▪ dbr:Nadine_Hildebrand ▪ dbr:Patrick_Auracher

<http://dbpedia.org/page/Stuttgart>

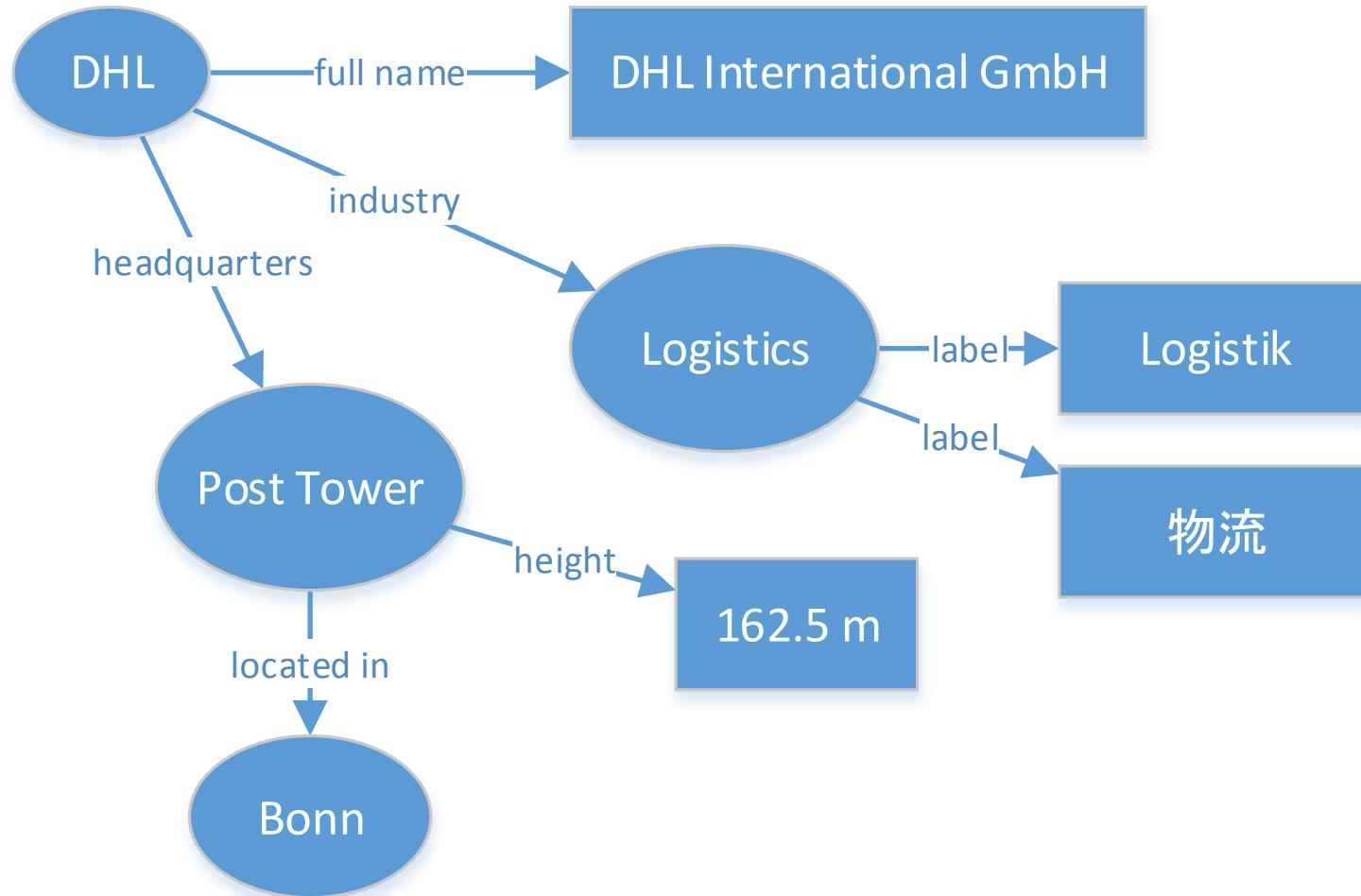
Based on RDF Statements



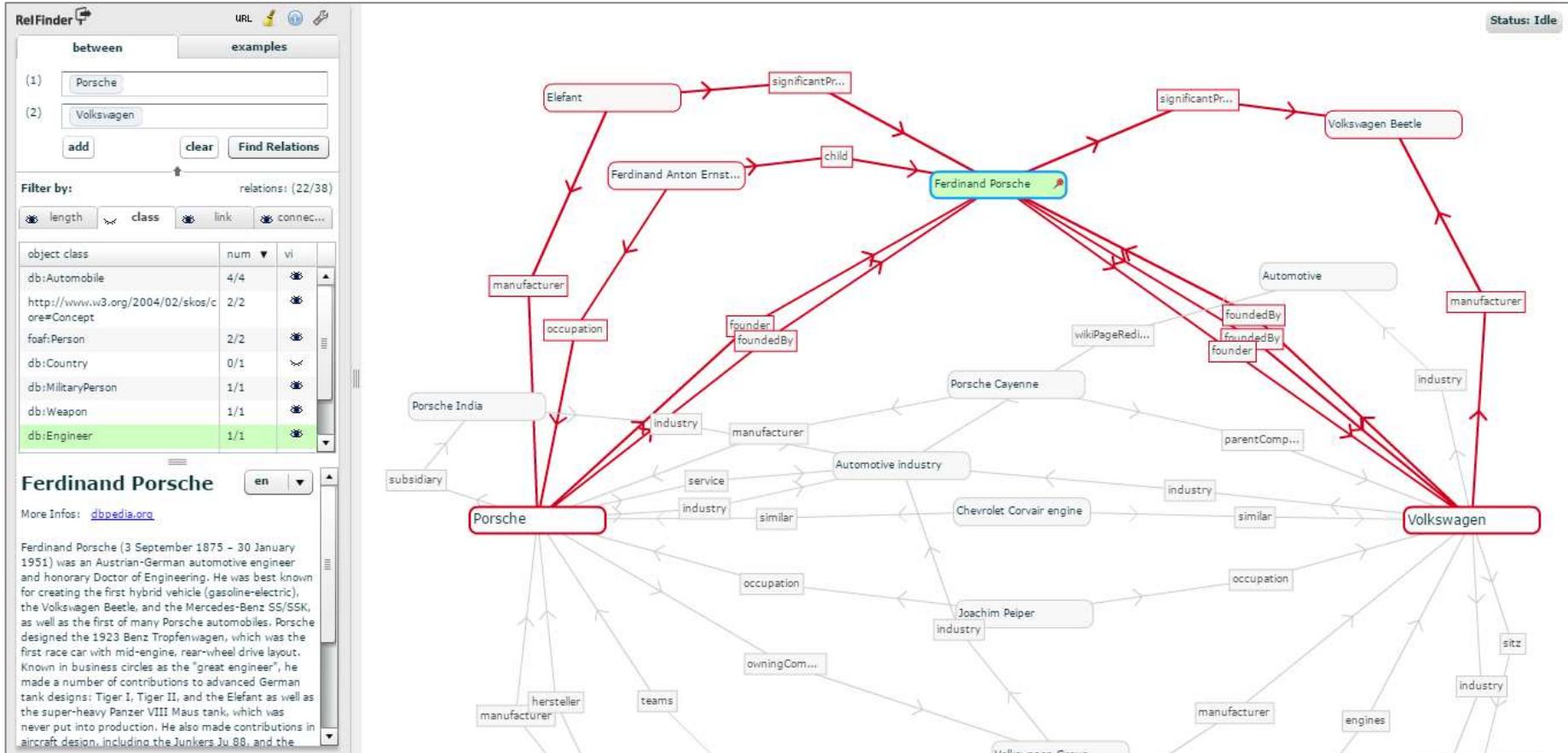
Stuttgart	mayor	Fritz_Kuhn ;
Ferdinand_Porsche	birthplace	Stuttgart ;



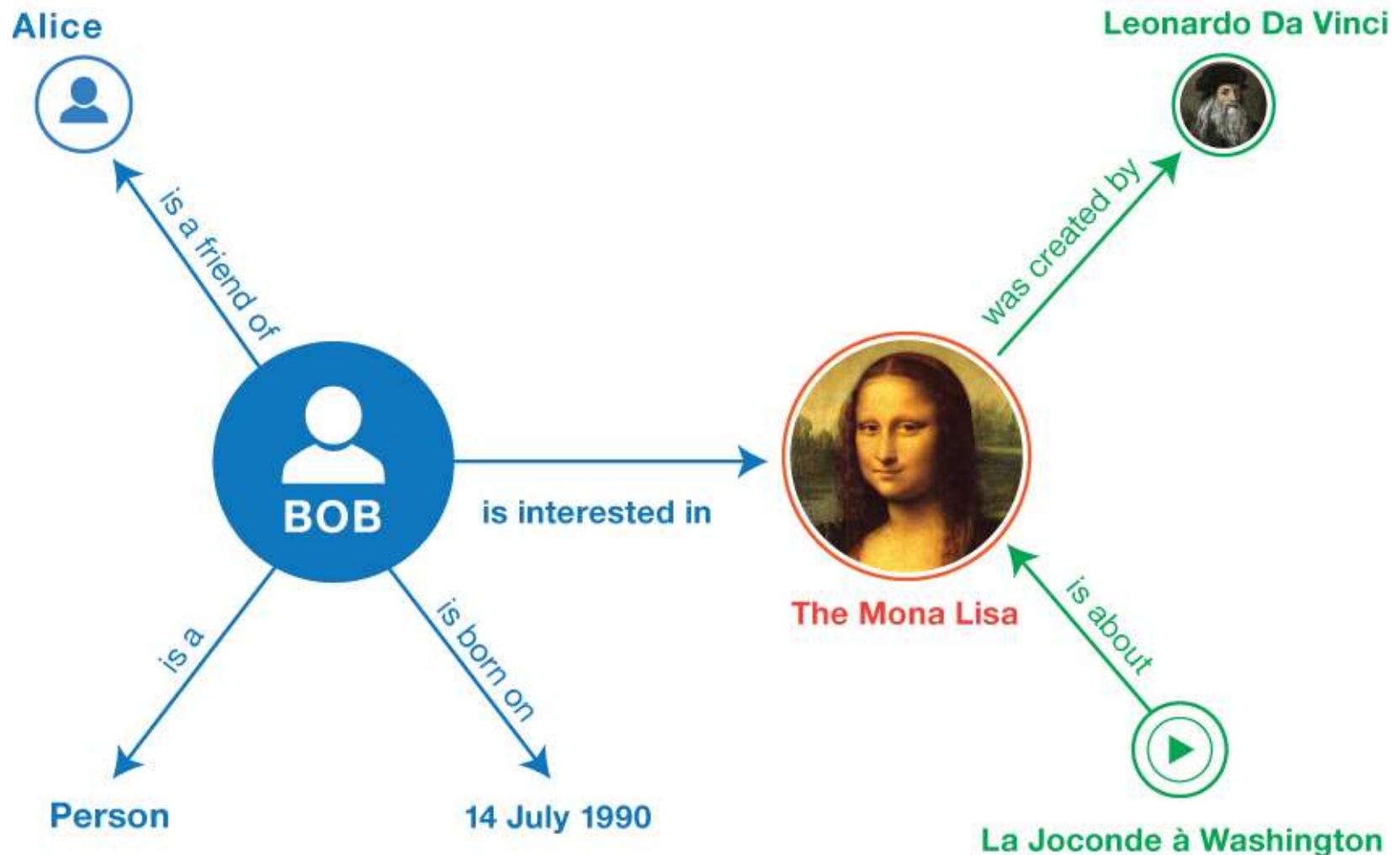
RDF Statements form Graph



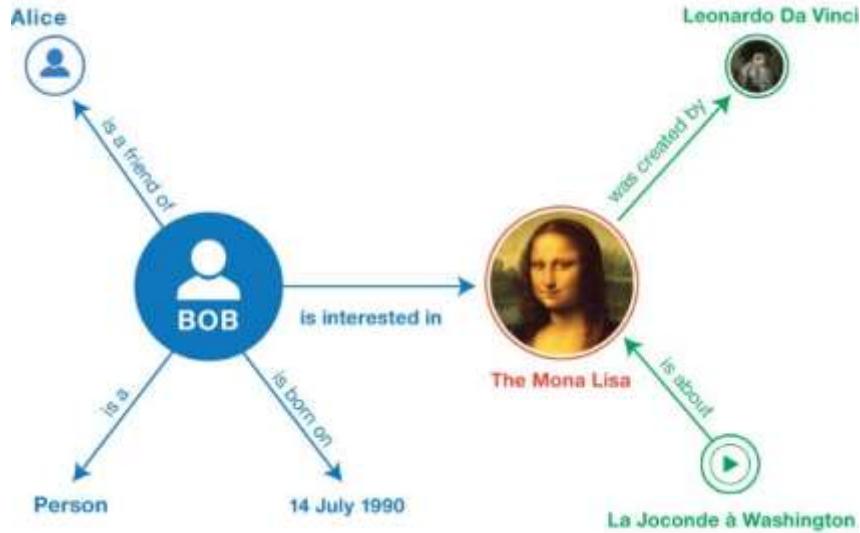
Potential: Relationship Discovery



Knowledge Representation with RDF

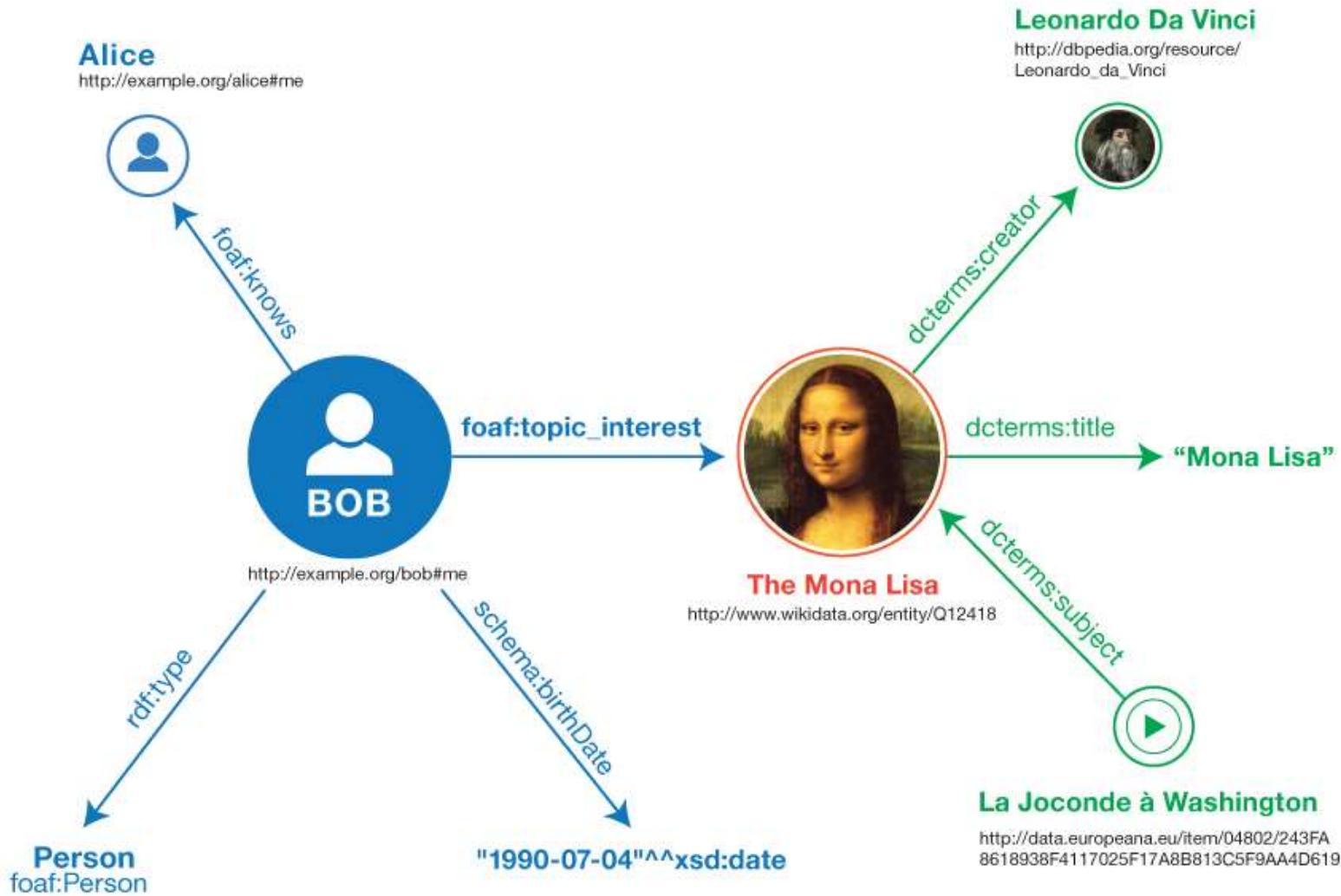


Knowledge Representation with RDF



```
<Bob> <is a> <person>.  
<Bob> <is a friend of> <Alice>.  
<Bob> <is born on> <the 4th of July 1990>.  
<Bob> <is interested in> <the Mona Lisa>.  
<the Mona Lisa> <was created by> <Leonardo da Vinci>.  
<the video 'La Joconde à Washington'> <is about> <the Mona Lisa>
```

Knowledge Representation with RDF



Knowledge Representation with RDF

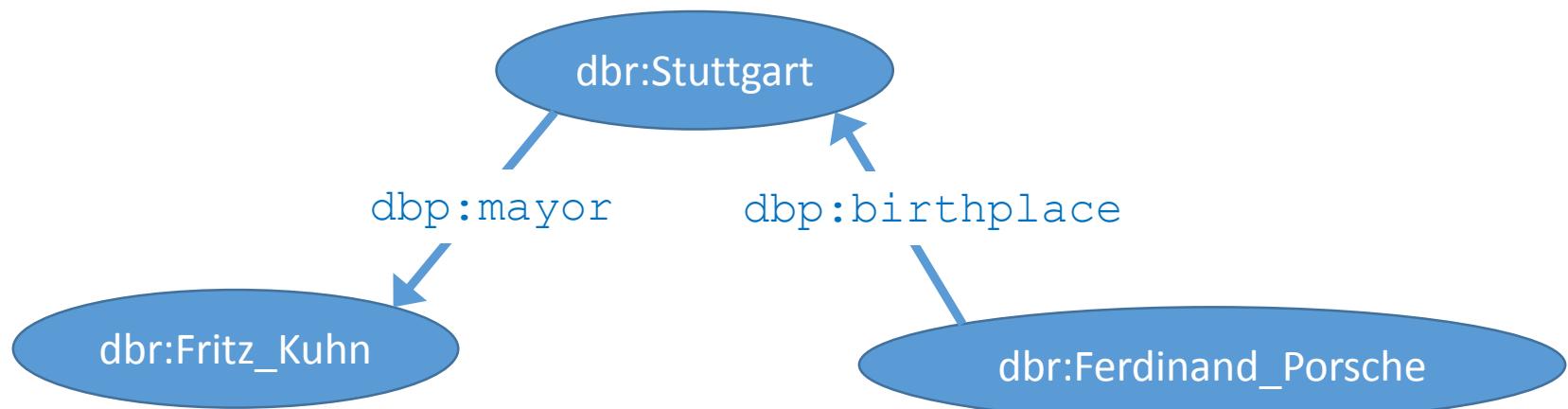
```
BASE  <http://example.org/>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX schema: <http://schema.org/>
PREFIX dcterms: <http://purl.org/dc/terms/>
PREFIX wd: <http://www.wikidata.org/entity/>

<bob#me>
  a foaf:Person ;
  foaf:knows <alice#me> ;
  schema:birthDate "1990-07-04"^^xsd:date ;
  foaf:topic_interest wd:Q12418 .

wd:Q12418
  dcterms:title "Mona Lisa" ;
  dcterms:creator <http://dbpedia.org/resource/Leonardo_da_Vinci> .
```

XML Serialization of RDF

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix dbp: <http://dbpedia.org/property/> .  
@prefix dbr: <http://dbpedia.org/resource/> .  
  
dbr:Stuttgart  
dbr:Ferdinand_Porsche dbp:mayor  
dbr:Fritz_Kuhn dbp:birthPlace dbr:Stuttgart .
```



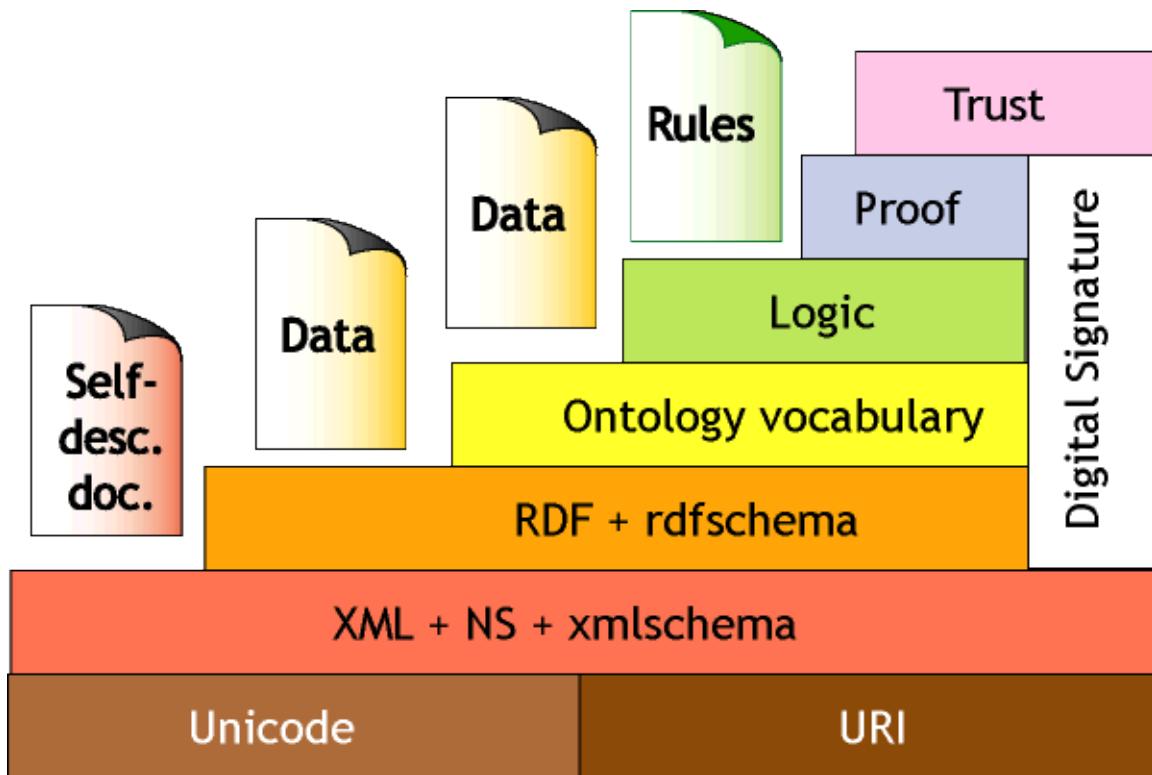
XML Serialization of RDF

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix dbp: <http://dbpedia.org/property/> .  
@prefix dbr: <http://dbpedia.org/resource/> .
```

```
dbr:Stuttgart dbp:mayor dbr:Fritz_Kuhn .  
dbr:Ferdinand_Porsche dbp:birthPlace dbr:Stuttgart .
```

```
<rdf:RDF  
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"  
    xmlns:dbp="http://dbpedia.org/property/">  
<rdf:Description rdf:about="http://dbpedia.org/resource/Stuttgart">  
    <dbp:mayor rdf:resource="http://dbpedia.org/resource/Fritz_Kuhn" />  
</rdf:Description>  
<rdf:Description rdf:about="http://dbpedia.org/resource/Ferdinand_Porsche">  
    <dbp:birthPlace rdf:resource="http://dbpedia.org/resource/Stuttgart" />  
</rdf:Description>  
</rdf:RDF>
```

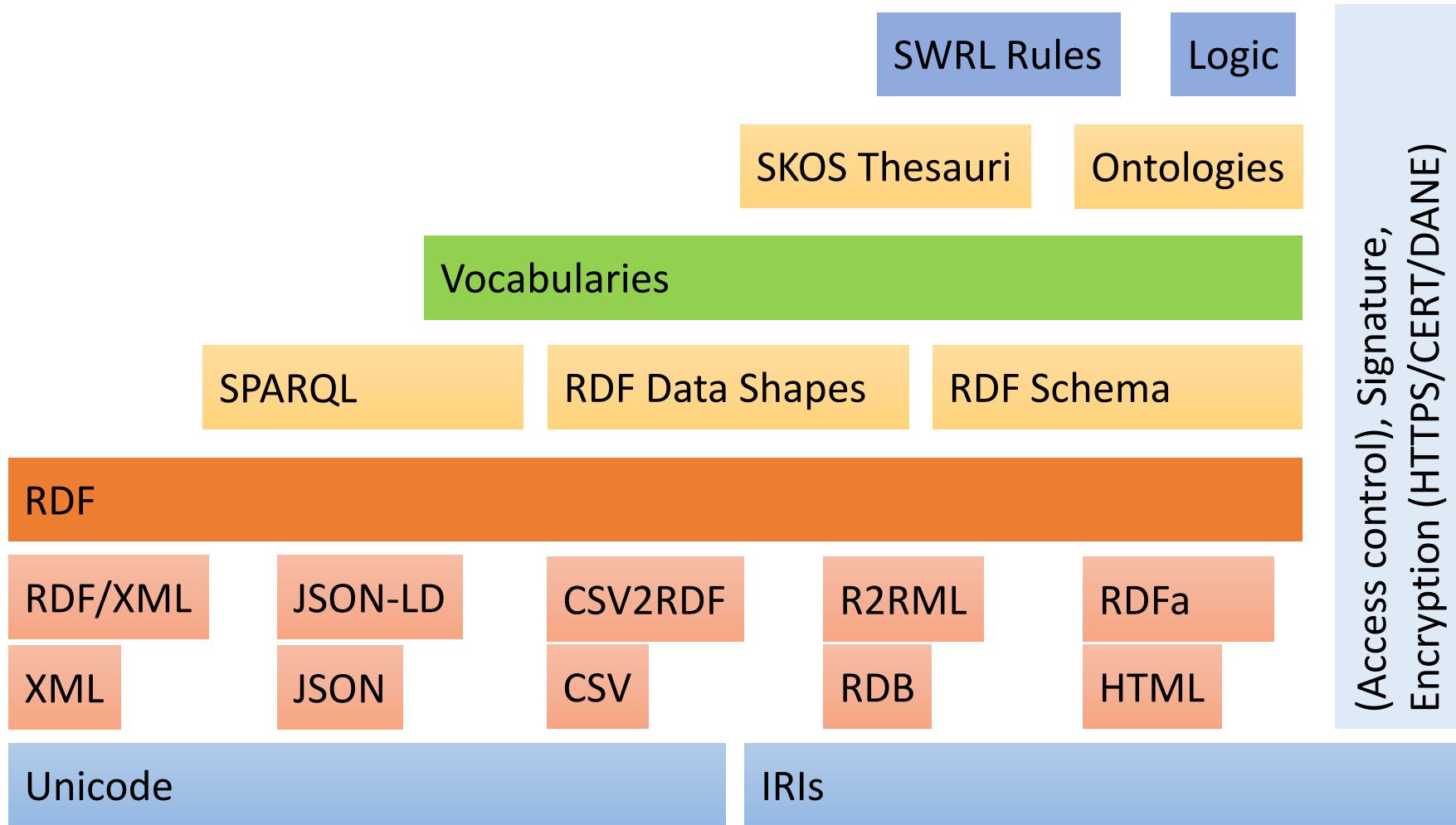
Semantic Web “Layer Cake” 2000



<https://www.w3.org/2000/Talks/1206-xml2k-tbl/slide10-0.html>



Semantic Web “Layer Cake” 2015



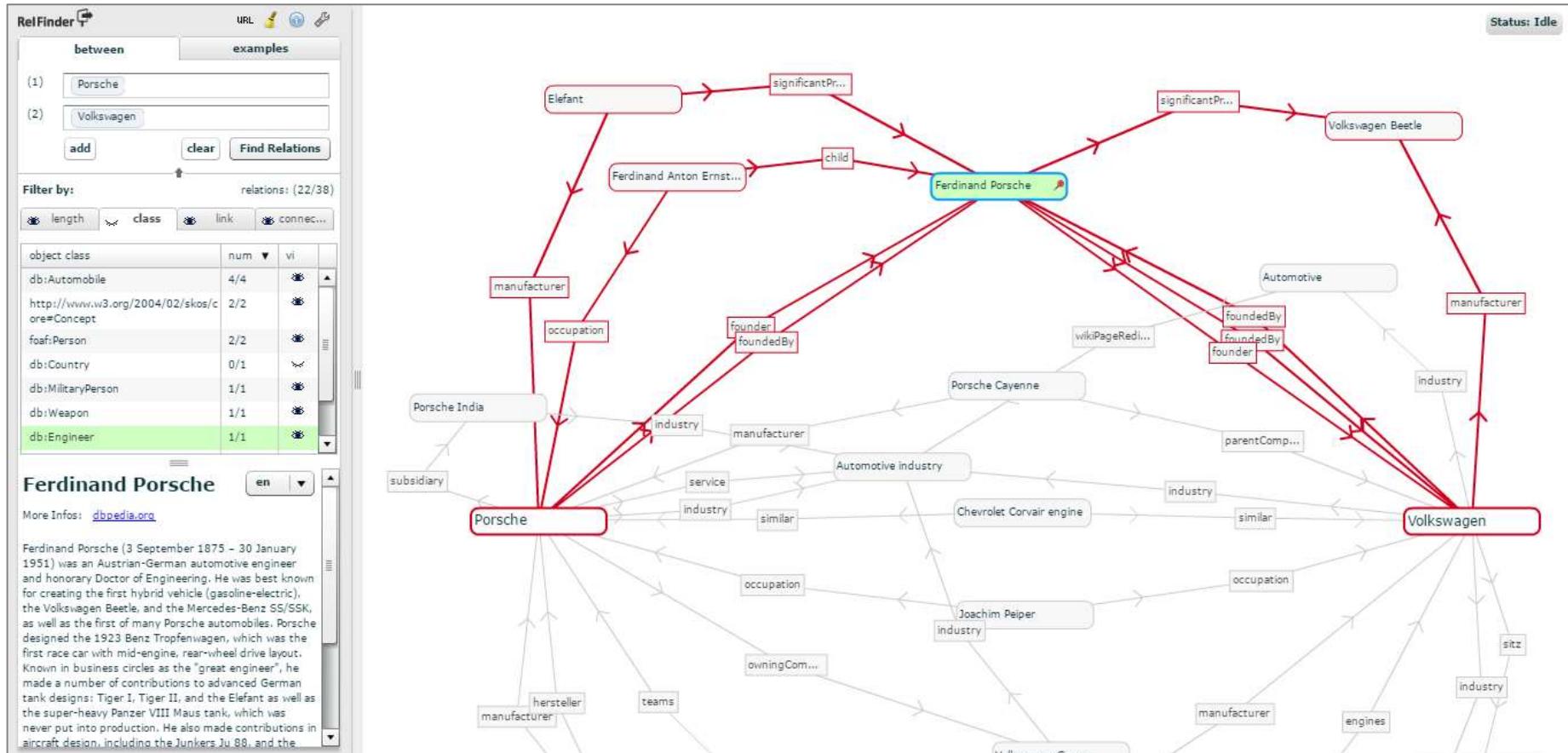
Vocabularies (Ontologies)

```
BASE  <http://example.org/>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX schema: <http://schema.org/>
PREFIX dcterms: <http://purl.org/dc/terms/>
PREFIX wd: <http://www.wikidata.org/entity/>

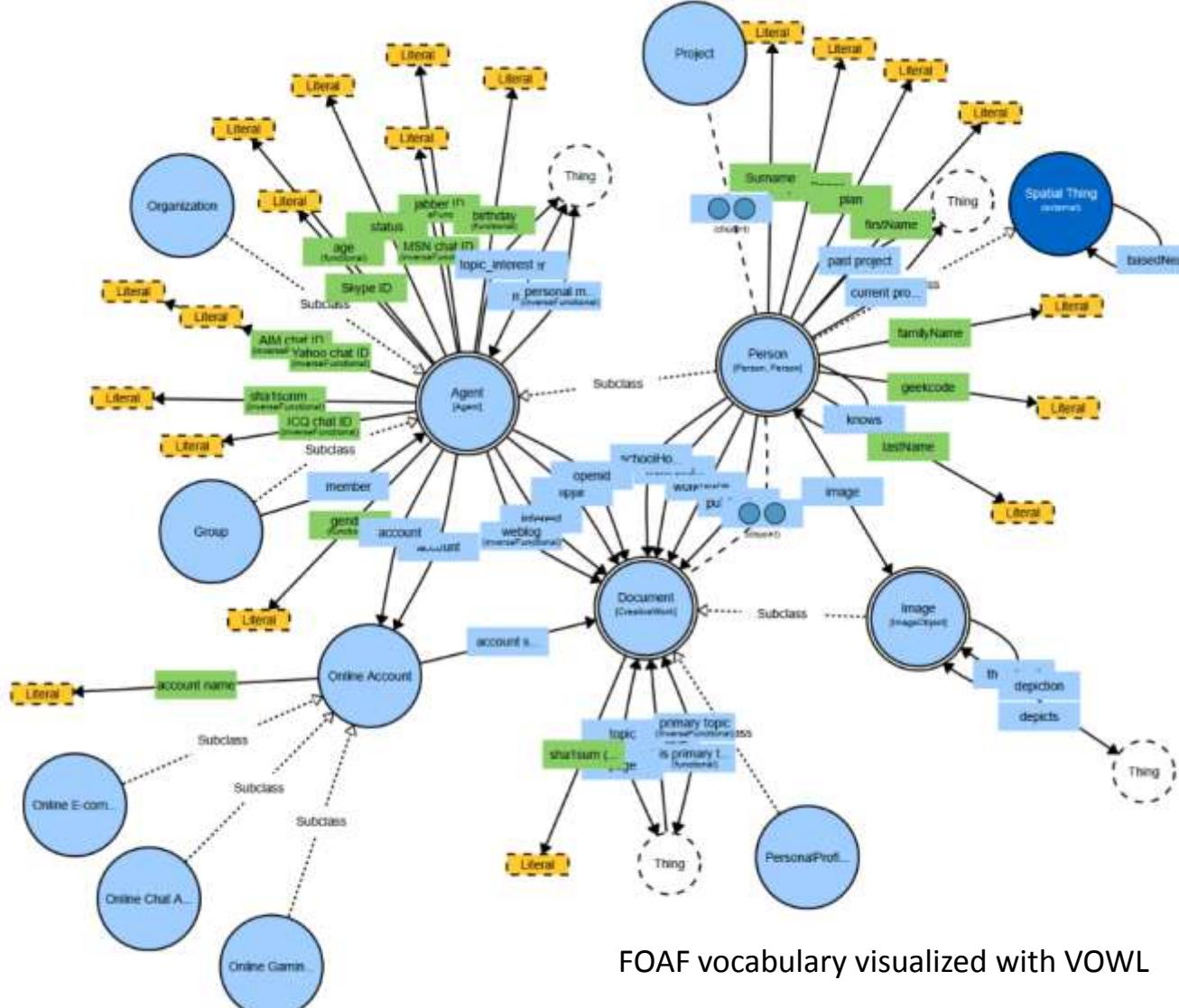
<bob#me>
  a foaf:Person ;
  foaf:knows <alice#me> ;
  schema:birthDate "1990-07-04"^^xsd:date ;
  foaf:topic_interest wd:Q12418 .

wd:Q12418
  dcterms:title "Mona Lisa" ;
  dcterms:creator <http://dbpedia.org/resource/Leonardo_da_Vinci> .
```

Vocabularies: RelFinder

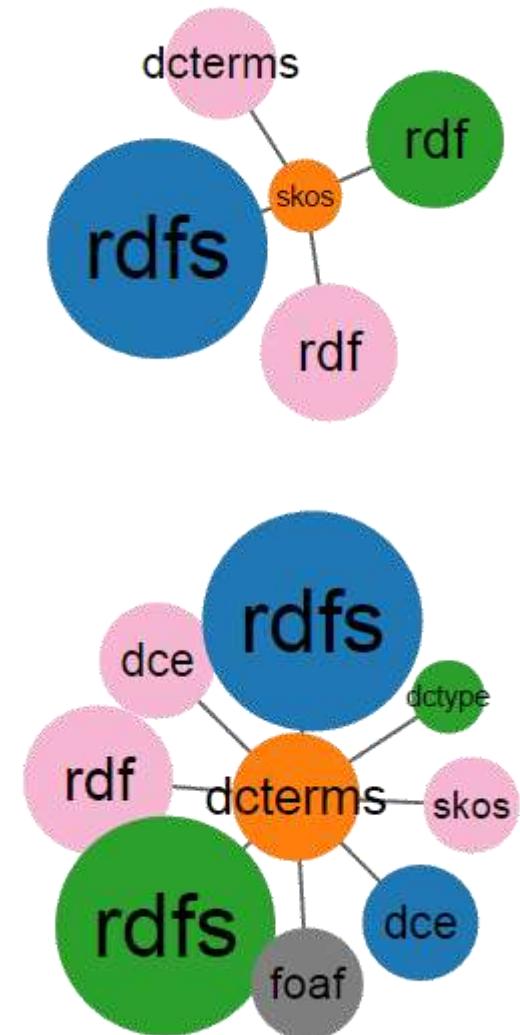
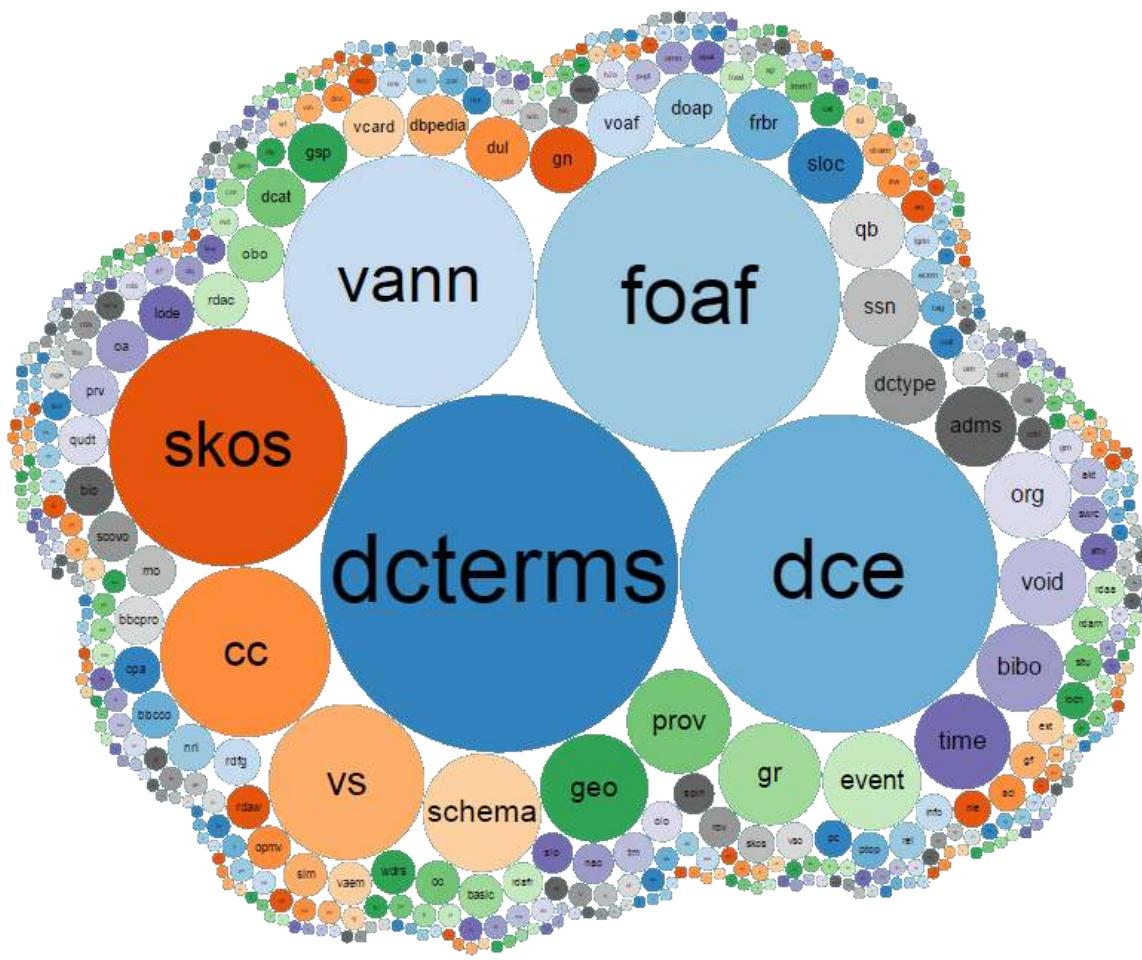


Vocabularies (Ontologies)



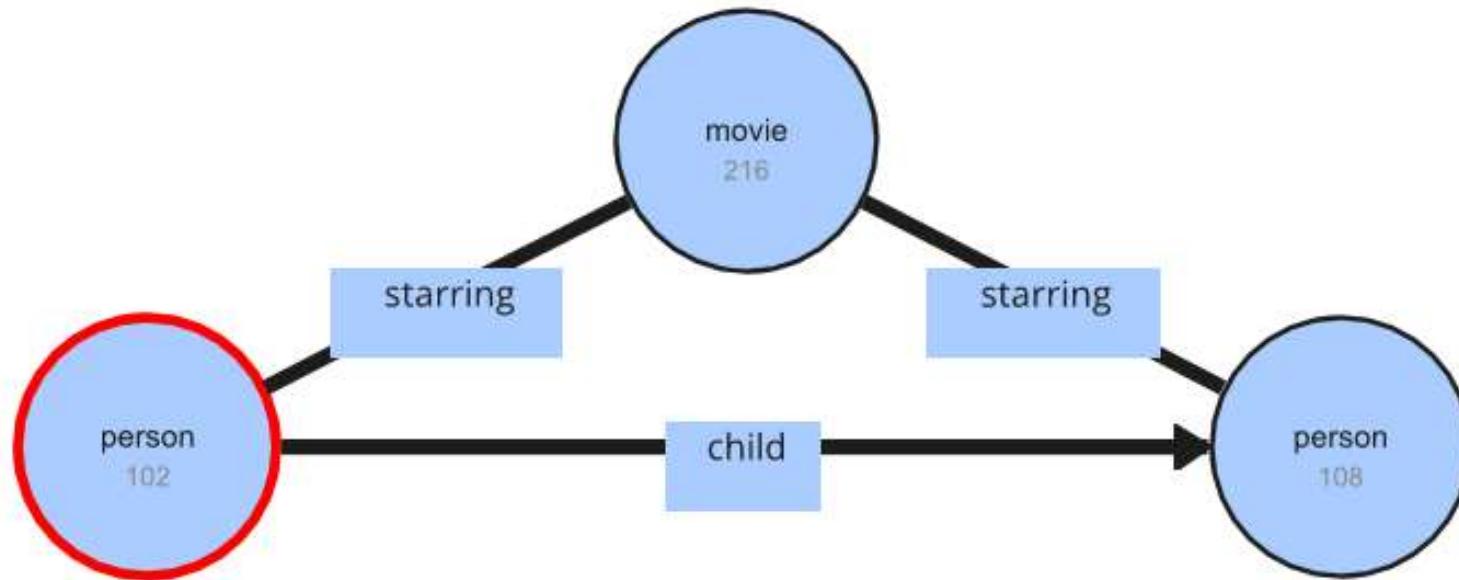
FOAF vocabulary visualized with VOWL

Linked Open Vocabularies (LOV)

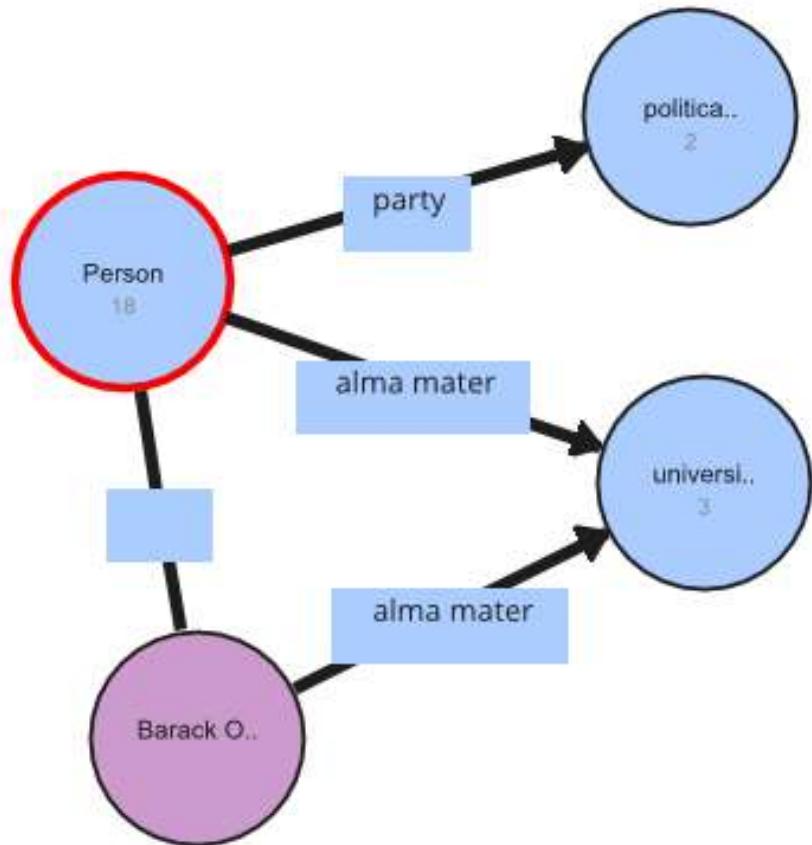


<https://lov.okfn.org/dataset/lov/>

Querying Linked Data



SPARQL Queries



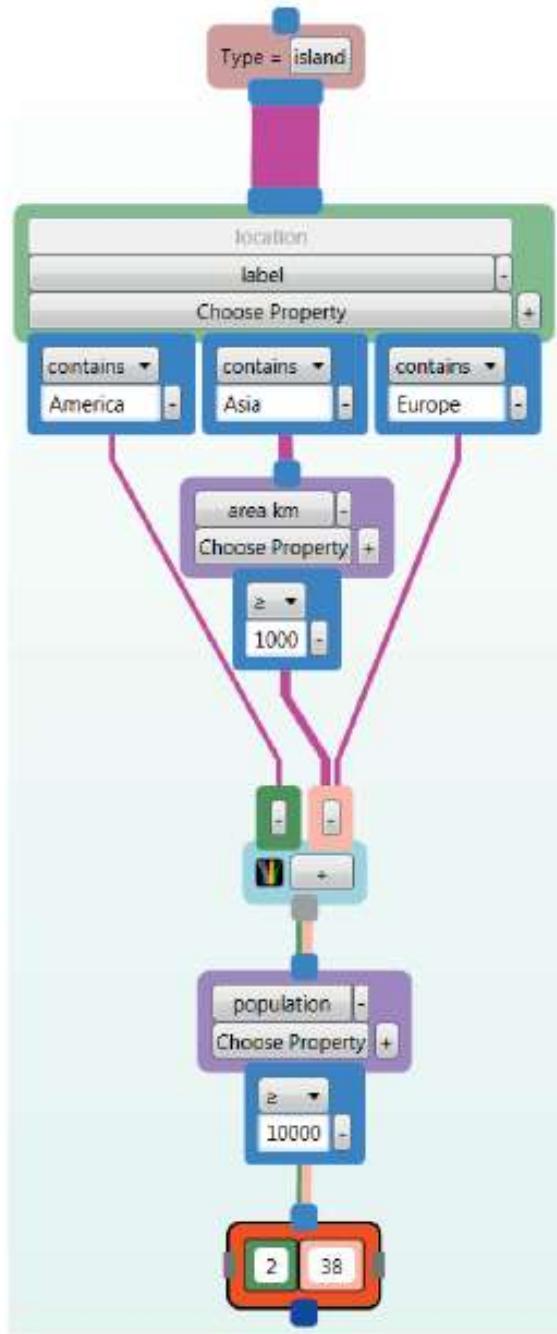
```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX dbpp: <http://dbpedia.org/property/>
PREFIX dbpr: <http://dbpedia.org/resource/>
PREFIX dbpo: <http://dbpedia.org/ontology/>
```

```
SELECT ?Node1
WHERE {
?Node1 a foaf:Person .
?Node1 dbpp:almaMater ?Node2 .
dbpr:Barack_Obama dbpo:almaMater ?Node2 .
?Node2 a dbpo:University .
{ ?Node1 ?Link5 dbpr:Barack_Obama . }
UNION { dbpr:Barack_Obama ?Link5 ?Node1 . }
?Node1 dbpp:party ?Node3 .
?Node3 a dbpo:PoliticalParty .
}
```

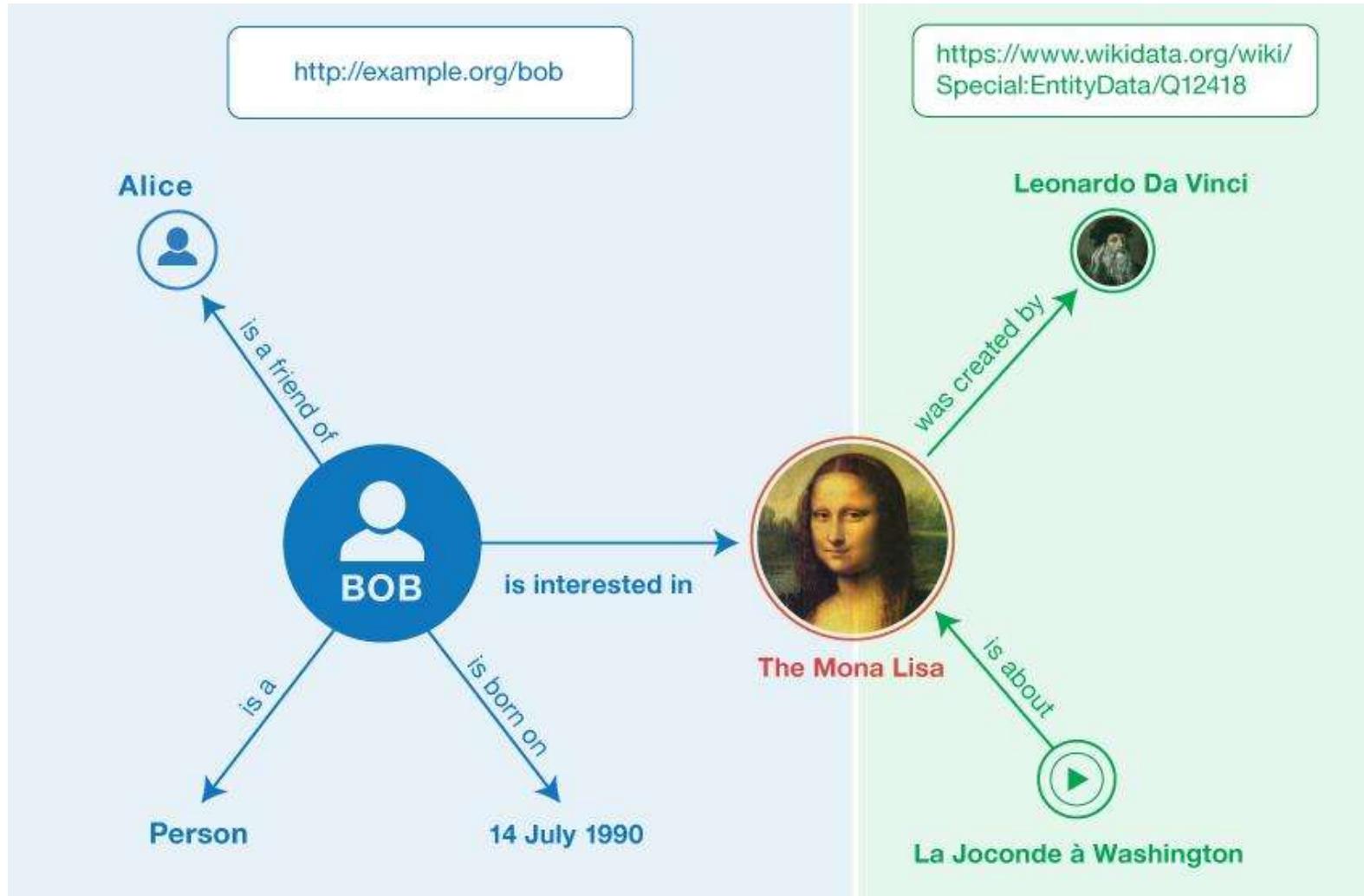
SPARQL Queries

```
PREFIX dbpedia-owl: <http://dbpedia.org/ontology/>
PREFIX dbpprop: <http://dbpedia.org/property/>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>

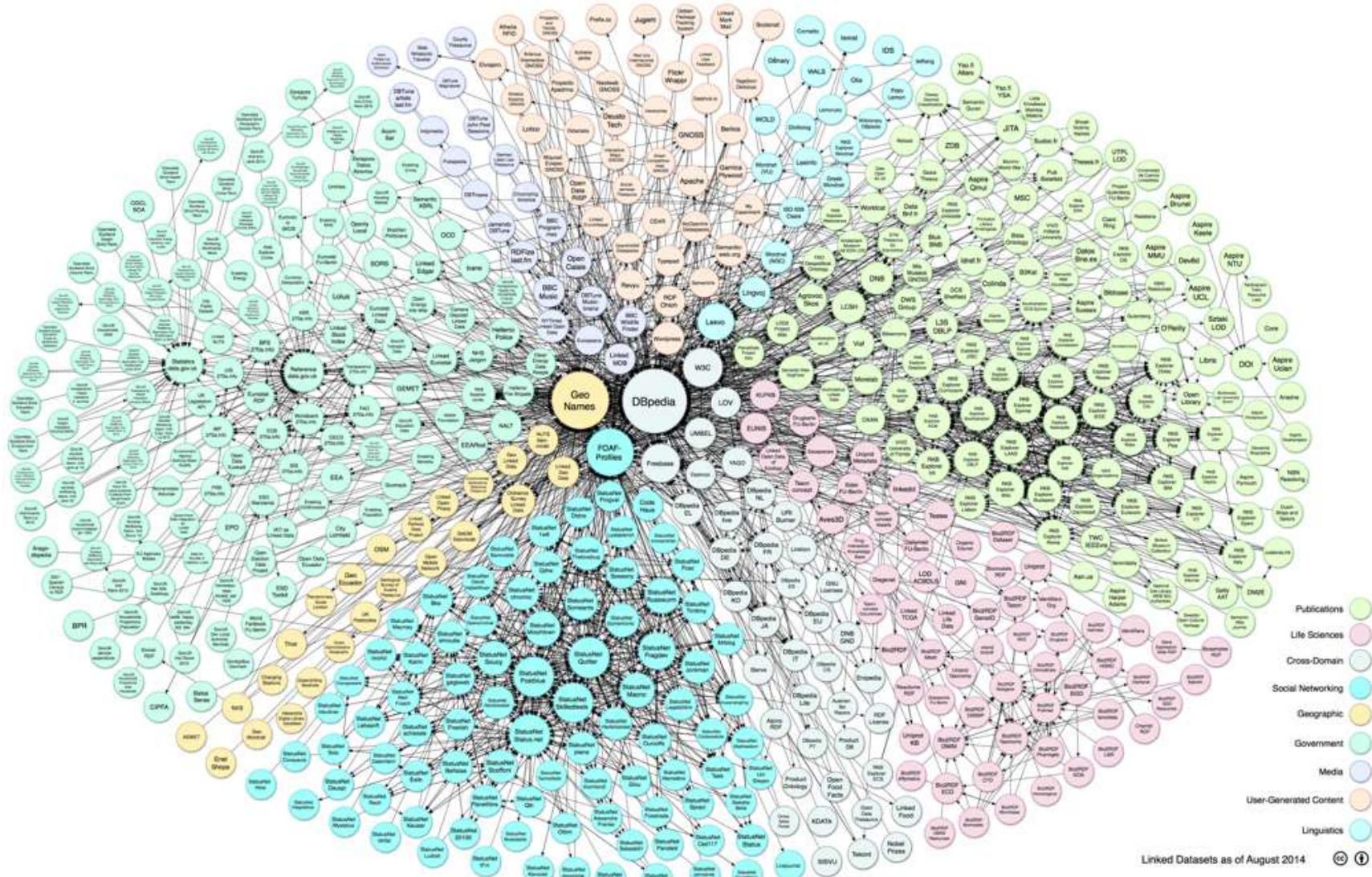
SELECT DISTINCT (COUNT(DISTINCT ?a) AS ?f)
WHERE {
  ?a a dbpedia-owl:Island.
  ?a dbpprop:population ?b.
  FILTER(?b >= 10000).
  {
    ?a dbpprop:location/rdfs:label ?c.
    ?a dbpprop:areaKm ?d.
    FILTER(contains(ucase(?c), ucase("Asia"))
      && ?d >= 1000).
  } UNION {
    ?a dbpprop:location/rdfs:label ?e.
    FILTER(contains(ucase(?e), ucase("Europe"))).
  }.
```



Linking Open Data



Linking Open Data (LOD) Cloud

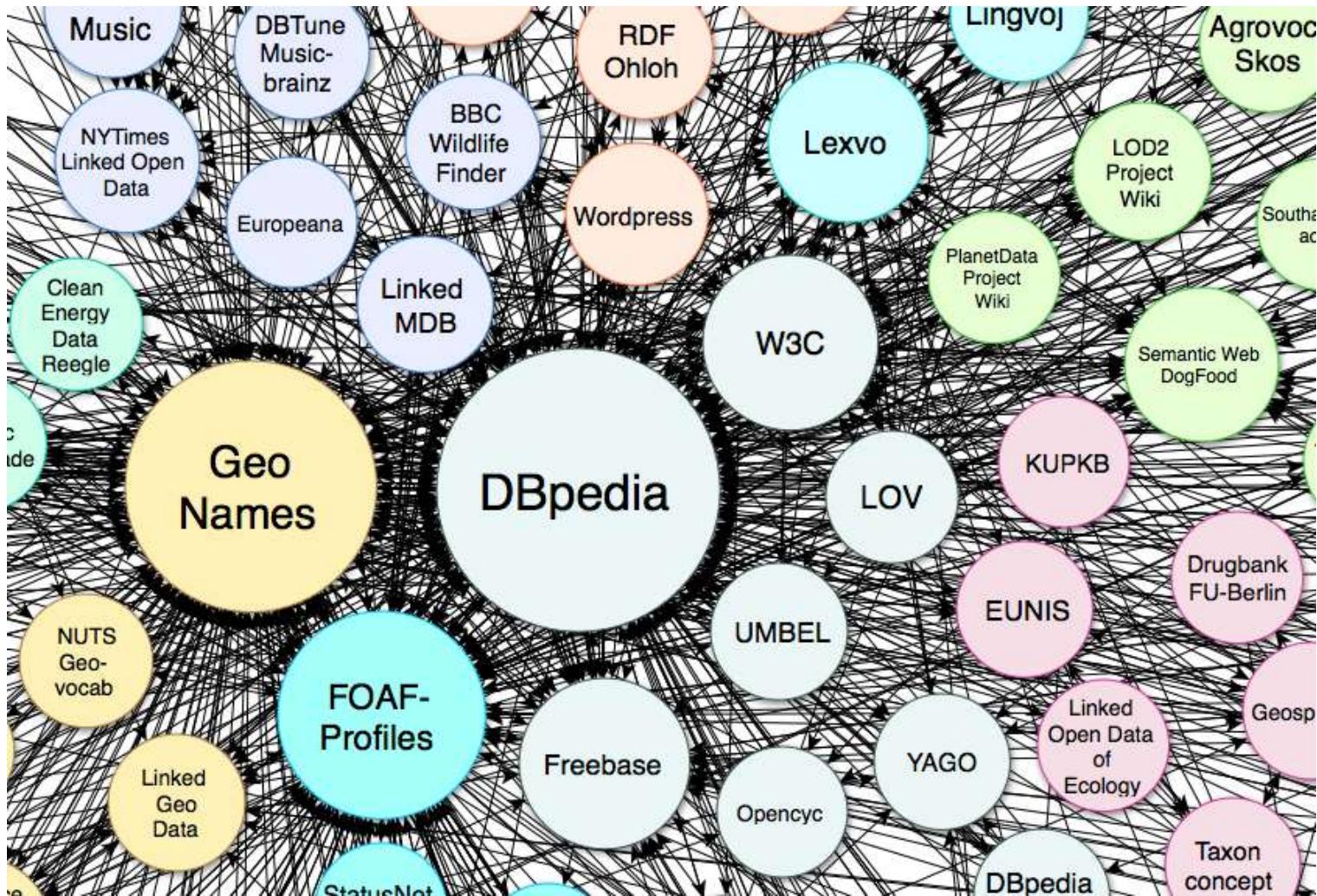


<http://lod-cloud.net>

Linked Datasets as of August 2014



Linking Open Data (LOD) Cloud



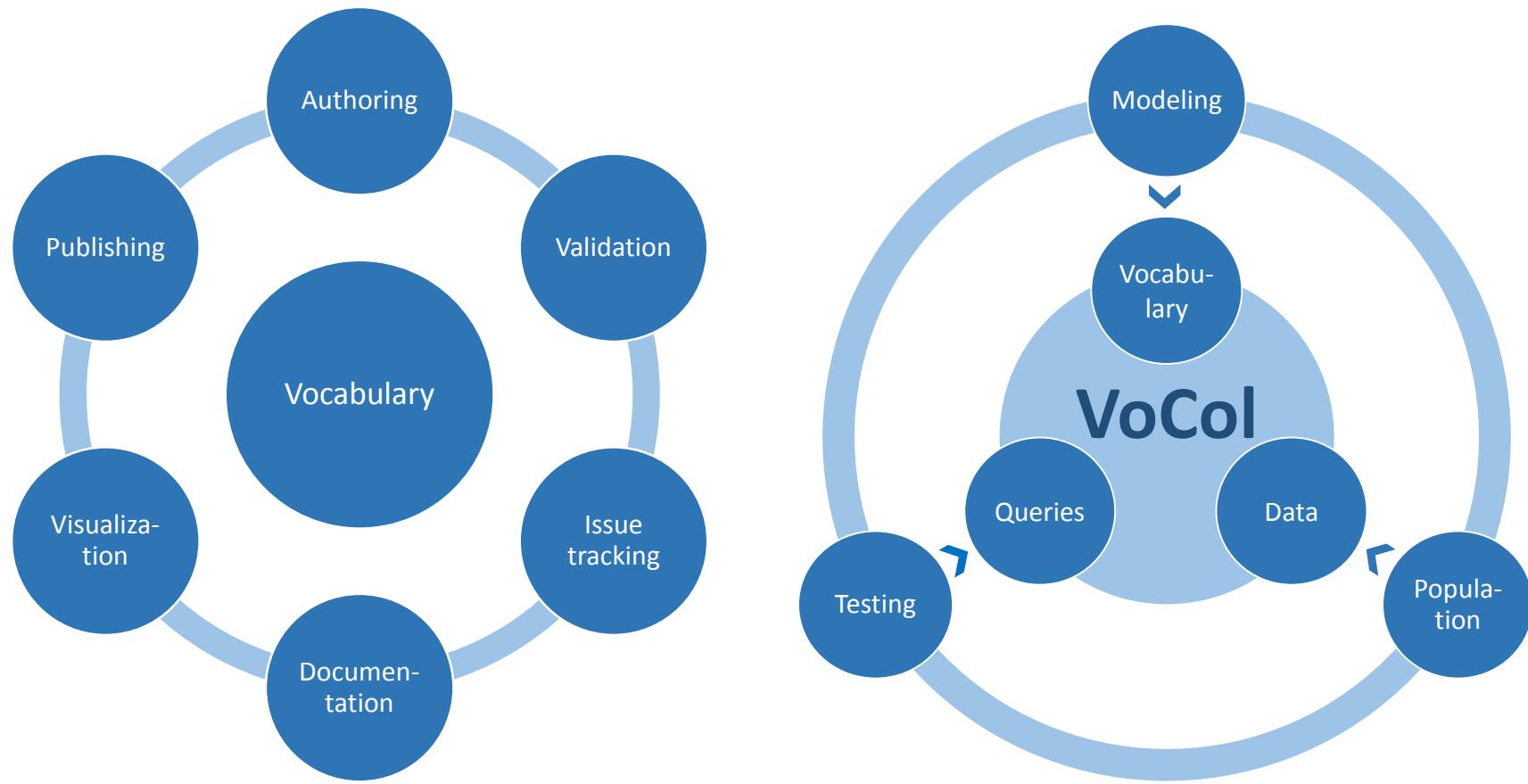
[http://lod-cloud.net/VERSIONS/2014-08-30/lod-cloud_colored.png](http://lod-cloud.net VERSIONS/2014-08-30/lod-cloud_colored.png)

Linked Data Principles

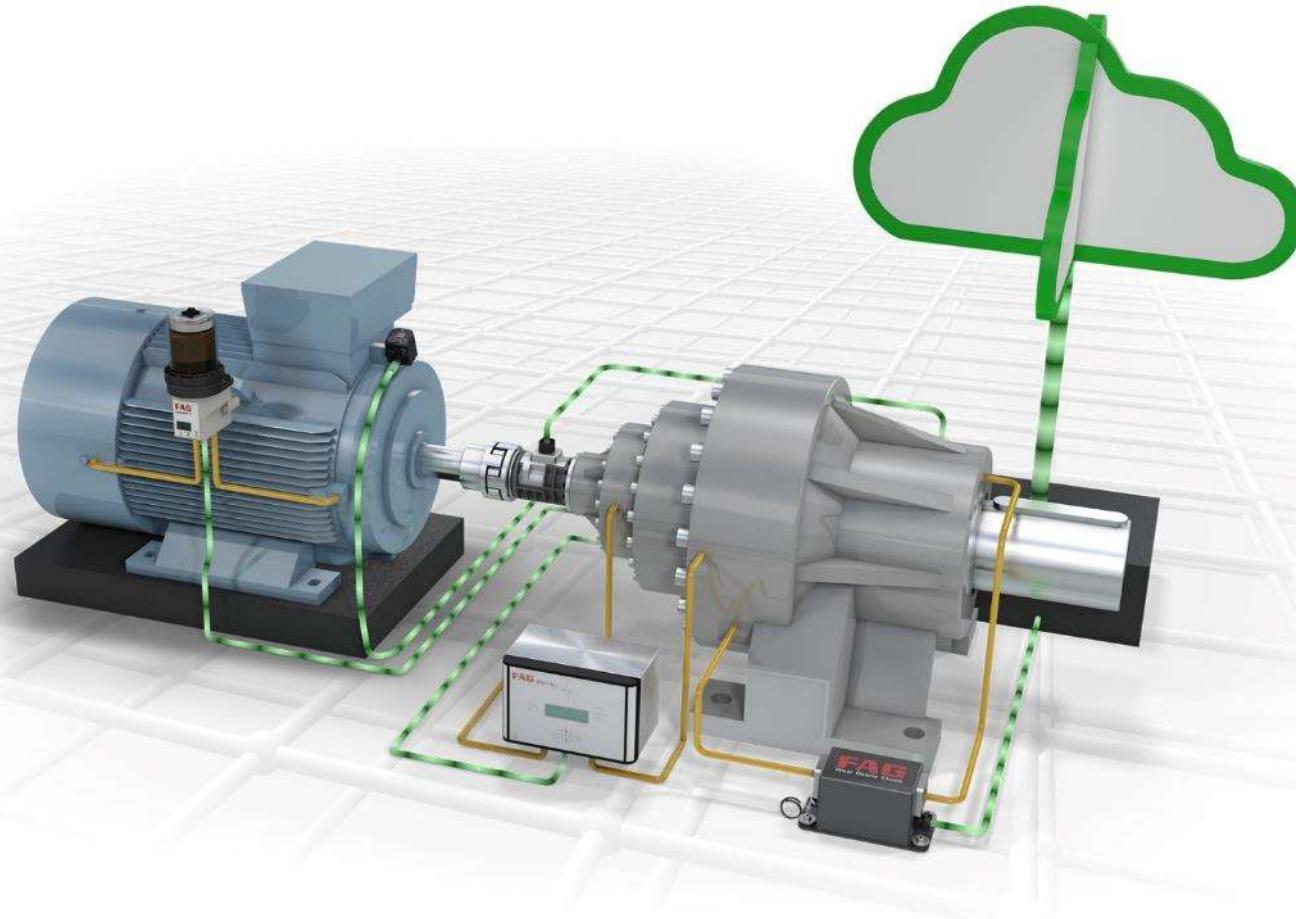
1. Use **URIs** to identify the “things” in your data
2. Use **HTTP URIs** so people (and machines) can look them up on the web
3. When a URI is **looked up**, **return a description** of the thing (in RDF format)
4. Include **links to related things**



Vocabulary Development (VoCol)

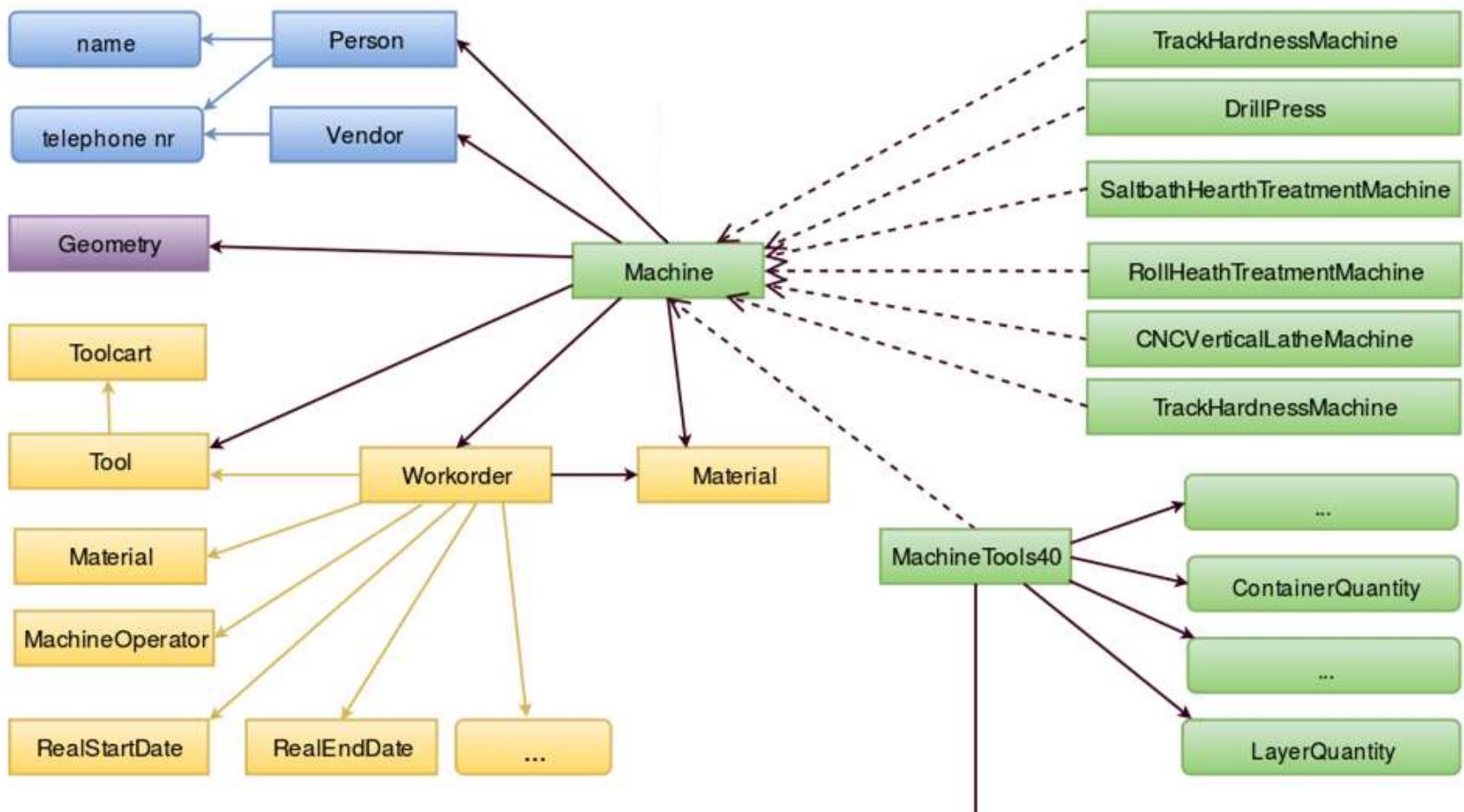


Example: Linked Machine Data



© Schaeffler, 2016

Example: Linked Machine Data

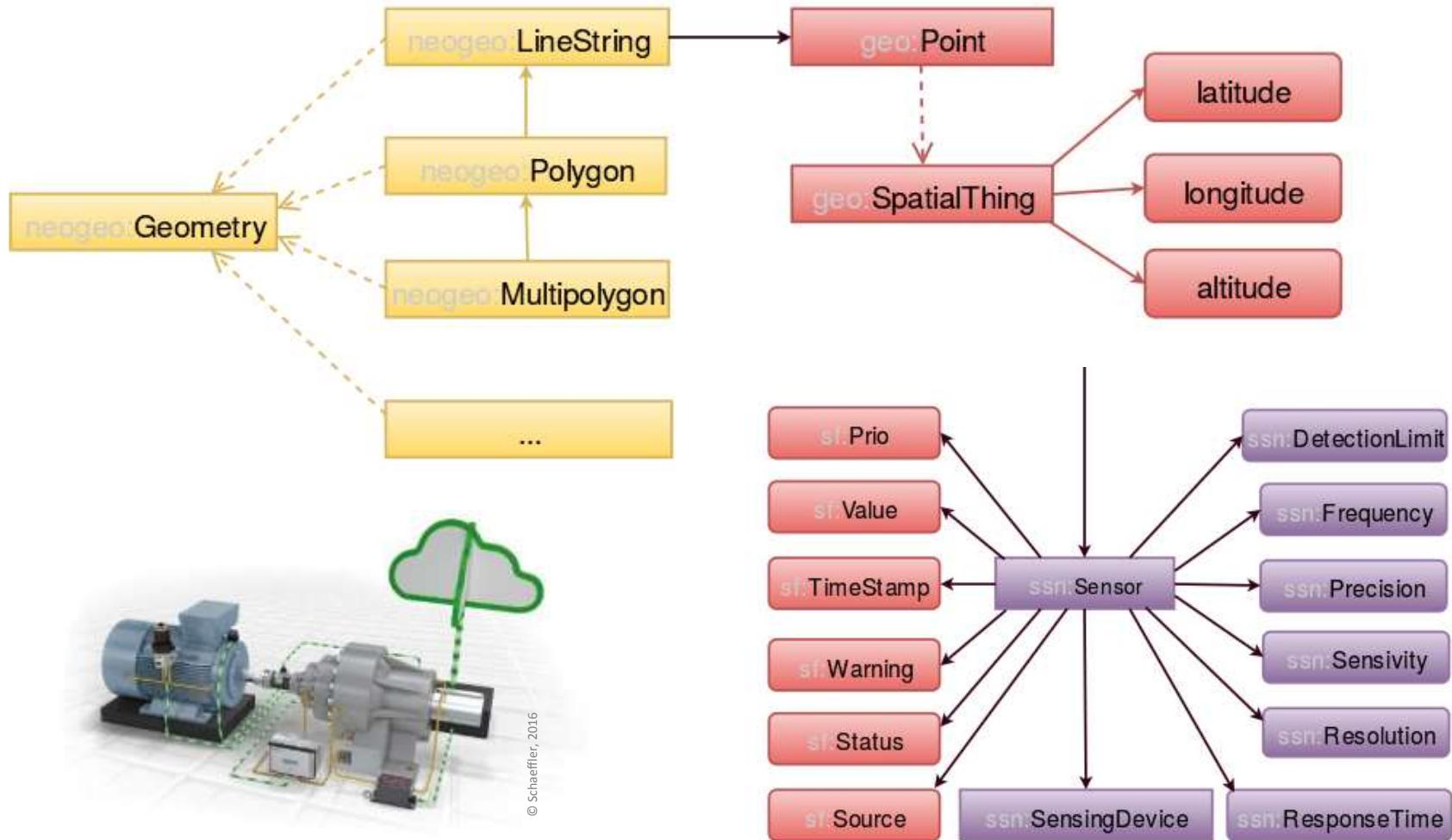


Example: Linked Machine Data

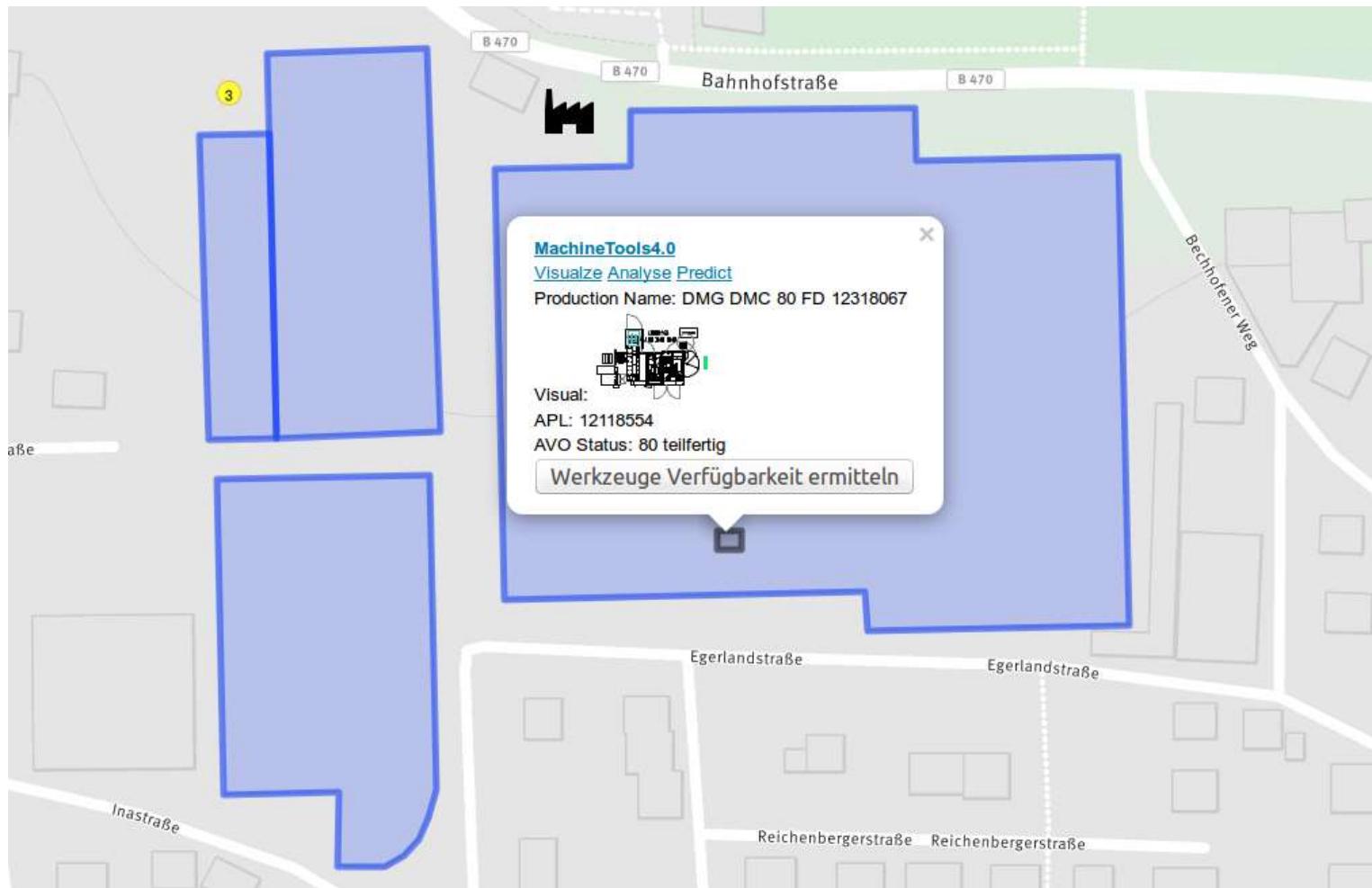
Properties of Machine	Value
PrefLabel	Maschine@de; Machine@en;
Definition	A generic Machine class for grouping all machine together.@en
SeeAlso	http://dbpedia.org/page/Machine

Properties of Machine	Expected Type	Description
hasInstallationDate	date	Date when the Machine installation was completed.
hasMachineStatus	string	Points to a specific status of the machine.
hasNote	string	Points to a note of the machine.
hasOperator	MachineOperator	Person(s) who operates the Machine.
hasPlannedEndTime	date	Points to the date in which the machine is planned to end a certain order.
hasPlannedStartTime	dateTime	Points to the date in which the machine is planned to start a certain order.
hasRealEndTime	date	Points to the date in which the machine actually ended a certain order.
hasRealStartTime	date	Points to the date in which the machine actually started a certain order.
hasVersionDescription	string	Describes the version of the machine.
inInPlant	Plant	Points to the location of a machine.
isDevelopedBy	string	Points to the original manufacturer of the machine.

Example: Linked Machine Data



Example: Querying Machine Data



Example: Querying Machine Data

MachineTools4.0 Informationen

Werk	Bezeichnung	API	Aktueller FAUF
0072	Deckel Maho Gildenmeister DMC 80 FD	12118554	1773564



[View on map](#)

-> Open work orders

Auftragsnummer	AVO	APO-Text	Status1	Arbeitsplatz	Mat.-Nr.	Materialtext	Sollmenge	Ist-Menge	Gutmenge
1773564	0060	BO.U GR KPL	80	85076863	0618346530000	IR.RTC260-0011	23 St.	5 St.	5 St.
1773178	0050	BO U GR 1.SEITE KOMPL. 2.SEITE GR V.HAND	45	85076863	0729496190000	AU.ZKLDL325-0311	23 St.	0 St.	0 St.
1827634	0030	DREH u Bohren kpl Z-0013	45	85076863	0588227200000	F-227870.01-0011.EXR.DML3E	220 St.	0 St.	0 St.

[Query work orders](#)

Example: Querying Temperature

Analytics

Graph Type: Query:

SPARQL endpoint:

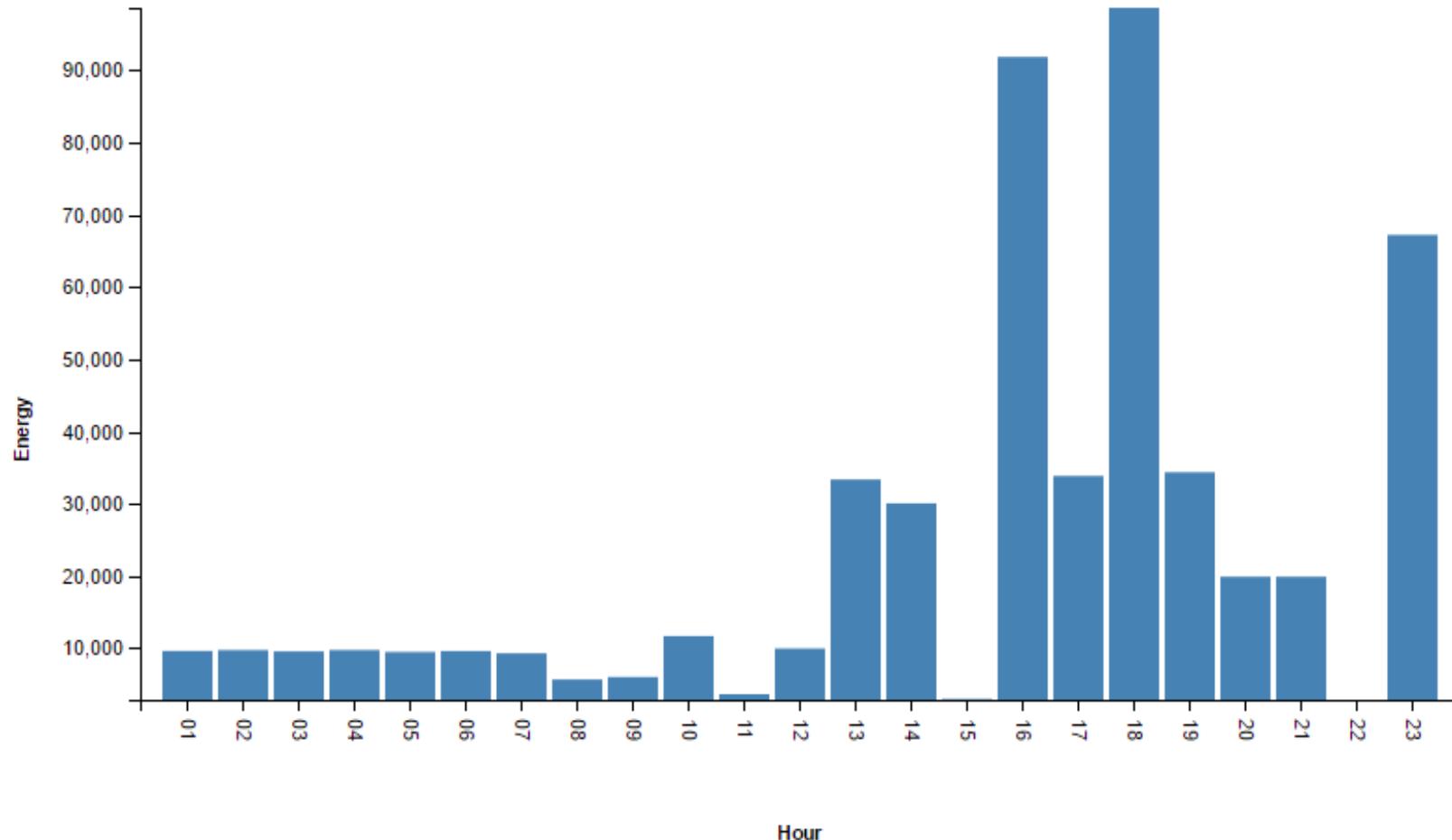
```
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX om: <http://www.wurvoc.org/vocabularies/om-1.8/>
PREFIX rami: <http://w3id.org/i40/rami/>

SELECT ?time ?value WHERE {
    ?measurement rami:recordedTime ?time ;
                  om:Temperature ?value .
    FILTER (xsd:dateTime(?time) >= "2015-01-29T10:00:00Z"^^xsd:dateTime)
    FILTER (xsd:dateTime(?time) <= "2015-01-29T11:00:00Z"^^xsd:dateTime)
}
ORDER BY DESC(?value) LIMIT 20
```

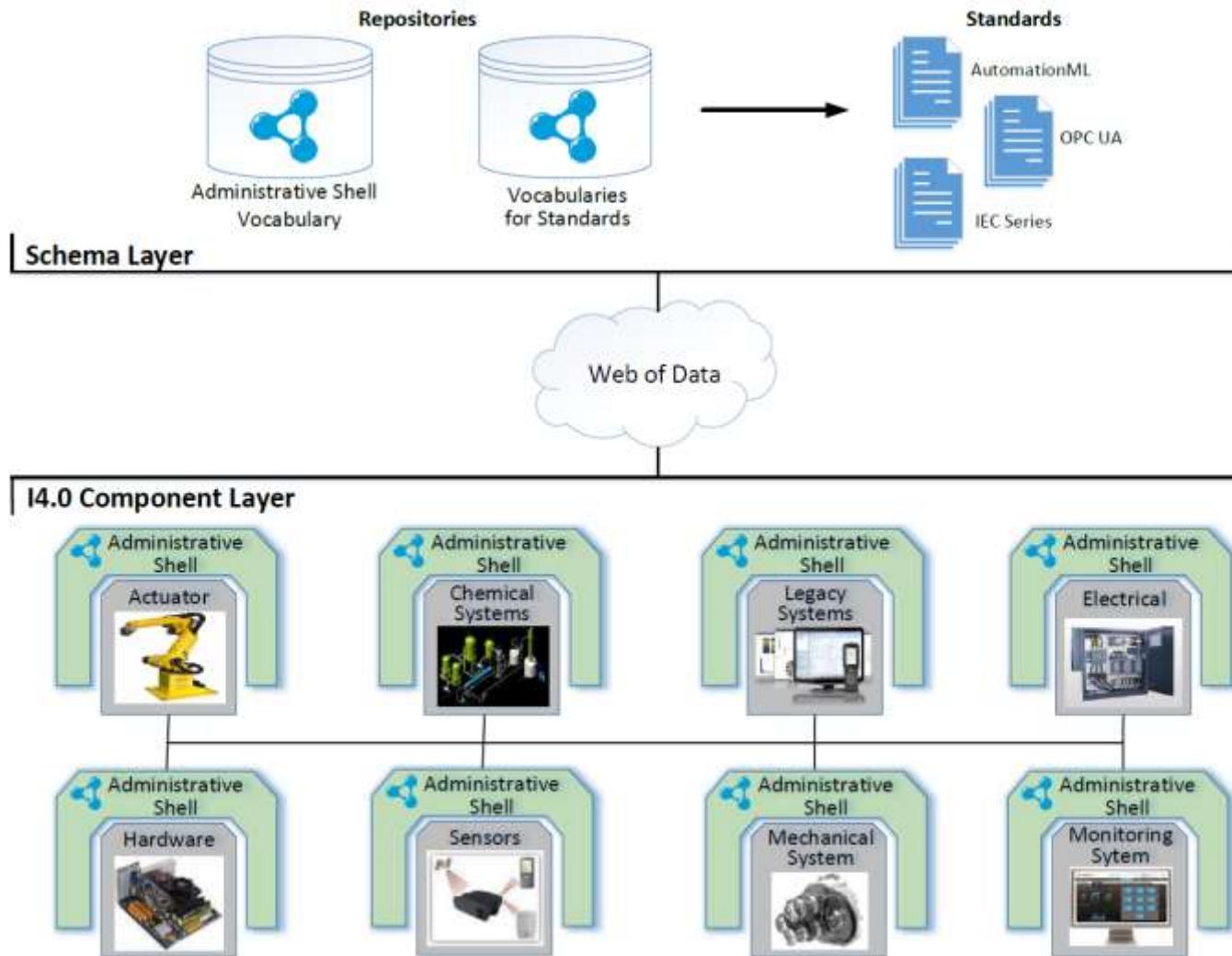
Example: Querying Temperature

Analytics

Example: Energy Consumption



Example: Linked Machine Data



Industrial Data Space



Industrial Data Space

INDUSTRIAL DATA
SPACE ASSOCIATION



Fraunhofer-Institut für Intelligente Analyse- und Informationssysteme

Do more with Data!

Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS



- Data Integration
- Data Analysis
- Data Visualization
- Linked Data

Organized Knowledge

Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS



- Vocabulary Development
- Semantic Technologies
- Industry 4.0
- Internet of Things



Dr. Steffen Lohmann

Fraunhofer Institute for Intelligent Analysis and Information
Systems (IAIS)

Enterprise Information Systems (University of Bonn)