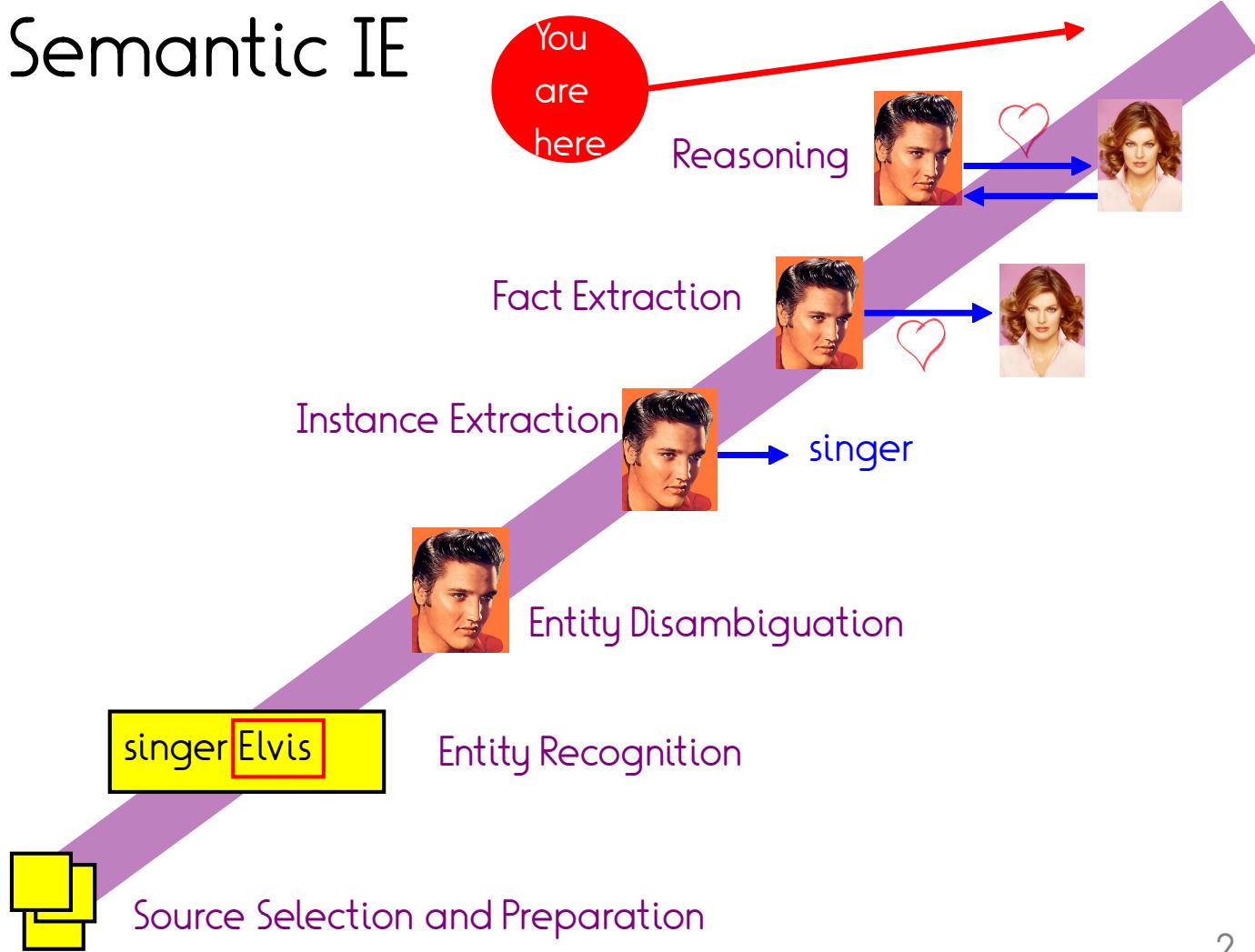


The Semantic Web

Nada Mimouni

Based on slides by:
Fabian M. Suchanek

Semantic IE



Overview

- Motivation
- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- SPARQL & OWL
- RDFa, JSON-LD & friends
- Applications

We can do I.E. – what now?



Sources of incompatibility

Airport	Location
Heathrow	London



Airport Name	City
Heathrow Airport	Londres



<airport>
<placeOrCity>

Sources of incompatibility



Airport	Location
Heathrow	London



Airport Name	City
Heathrow Airport	Londres



<airport>
<placeOrCity>

Sources of incompatibility



Airport	Location
Heathrow	London



Airport Name	City
Heathrow Airport	Londres



<airport>
<placeOrCity>



[Images from Wikicommons, except Oracle. Company logos for illustration only]

> more

Where do we need interaction?

- Booking a flight

Interaction between office computer, flight company, travel agency, shuttle services, hotel, my calendar

- Finding a restaurant

Interaction between mobile device, map service, recommendation service, restaurant reservation

- Intelligent home

Fridge knows my calendar, orders food if I am planning a dinner

> more

Where do we need interaction?

- Web service composition

Interaction between client and Web services
and Web services themselves

- Personal assistant

Connects calendar, email, restaurants, secretary, etc.

- Intelligent cars

Car knows my schedule, where and when
to get gas, how not to hit other cars, what
are the legal regulations

> more

Where do we need interaction?

- Adding data to a database

From XML files, from other databases

- Merging data after company mergers

(e.g. Apple buys Microsoft)

Different terminology has to be bridged,
accounts to be merged

- Merging data in research

e.g. biochemical, genetic , pharmaceutical research data

Def: Semantic Web

Idea: We need an infrastructure that allows computers to "understand" their data.

This infrastructure shall

- allow machines to process data from others
- ensure interoperability between schemas, devices and organizations
- allow data to describe data
- allow machines to reason on the data
- allow machines to answer semantic queries

This is what the Semantic Web aims at

The Semantic Web is an evolving extension of the World Wide Web, in which data is made available in one standardized semantic format.

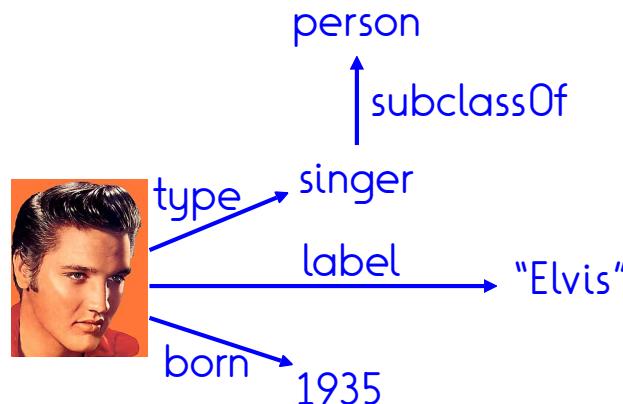
The Semantic Web

- Motivation
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Def: RDF

RDF (Resource Description Framework) is a knowledge representation based on

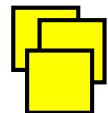
- entities
- classes
- binary relations
- labels



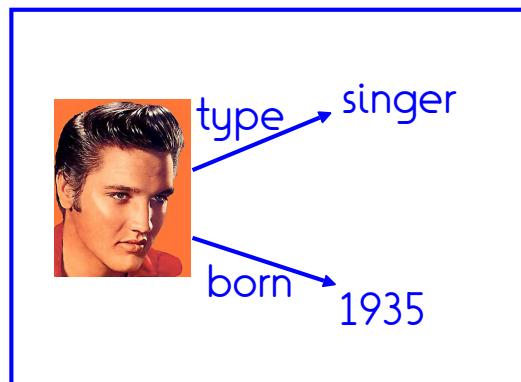
->knowledge-representation

[>details](#)

Knowledge Representation in SW



Person	Job	Birth
Elvis	singer	1935



<person>

<occupation>

->knowledge-bases



The Semantic Web

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Globally identifying entities

KB1



Elvis

KB2



Elvis

KB3



Elvis

KB4



Elvis

>details

Def: Namespace / Qualified Name

A **namespace** is a named set of (so-called "local") names.

[Wikipedia/Namespace]

namespace: KB1

contains local names: Elvis, Priscilla, Lisa

namespace: KB2

contains local names: Elvis, Michael

A **qualified name** consists of a namespace name and a local name.

KB1:Elvis

KB1:Priscilla

KB2:Elvis

Examples

What if KBs have the same name?

ElvisKB



Elvis



Elvis

ElviPedia



Elvis

ElviPedia



Elvis

Def: URI

A **URI** (Uniform Resource Identifier) is a string that follows the syntax

<scheme name> : <hierarchical part> [<query>] [# <fragment>]

Examples:

- URLs

`http://elvis.com/biography.html#Birth`

All URLs are URIs,

but not all URIs

are URLs

("dereferenceable")

- File identifiers

`file:///c:/users/elvis/tripToMoon.txt`

- FTP

`ftp://elvis@nsa.gov`

- Mail To

`mailto:him@elvis.com?subject=Where%20%are%20you`

[>details](#)

Each KB & each entity has a URI

Each KB on the Semantic Web has a URI:

ElviPedia: <http://elvis-alive.org/>
ElviPedia': <http://elvipedia.com/>
ElvisKB: <http://elvis.org/kb/>
YAGO: <http://yago-knowledge.org/>

Each of them
forms a
namespace.

Each entity in a KB has a qualified name, which is also a URI:

URI of ElviPedia:

<http://elvis.org/kb/>

Name in that namespace:

Elvis

Qualified name of Elvis in ElviPedia:

<http://elvis.org/kb/Elvis>

(again a URI)

Each KB & each entity has a URI

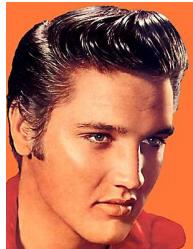
<http://elvipedia.com/>



<http://yago-knowledge.org/>



<http://elvis-alive.org/>



<http://elvipedia.com/Elvis>

<http://elvis-alive.org/Elvis>

<http://elvis.org/kb/>



<http://elvis.org/kb/Elvis>

<http://yago-knowledge.org/Elvis>

>namespace
>namespace

=> Every entity has a globally unique id

Namespaces

<http://elvis.is/king/of/sing>

World-wide unique
mapping to domain
owner

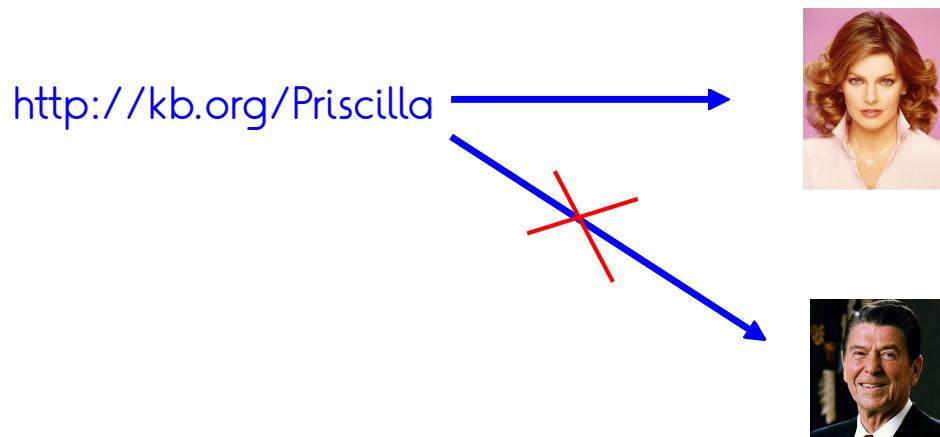
in the responsibility
of the domain owner

=> There should be no overlap

- a company can create URIs to identify its products
- an organization can assign sub-domains and each sub-domain can define URIs
- individual people can create URIs from their homepage
- people can create URIs from any URL for which they have exclusive rights to create URIs

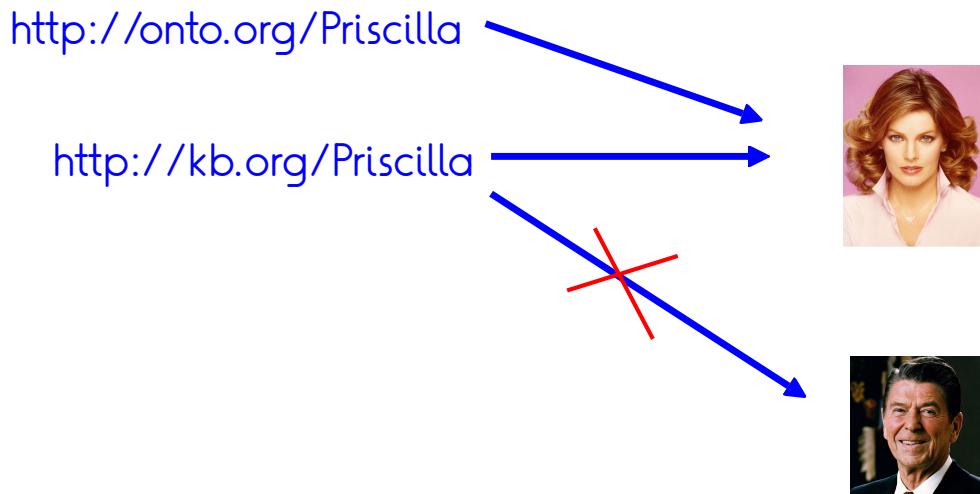
URIs are never ambiguous

A URI always refers to one entity, never to more entities.



URIs can be synonymous

A URI always refers to one entity, never to more entities.
One entity can be referred to by several URIs.



Def: Namespace prefix, CURIE, base

A **namespace prefix** is an abbreviation for the first part of a URI.

A prefix with a local name yields a **CURIE** (also: QName).

@prefix dbp: <<http://dbpedia.org/>> .

dbp:Elvis

=

<<http://dbpedia.org/Elvis>>

CURIE (Compact URI)

or QName (qualified name)

A **base URI** is a URI relative to which URIs in the same document are interpreted.

@base <<http://yago-knowledge.org/>> .

<Elvis> = <<http://yago-knowledge.org/Elvis>>

Def: Turtle

Turtle (Terse RDF Triple Language) is a particular syntax for writing RDF facts.

Turtle can declare namespace prefixes and a base as follows:

@prefix P: <URI> .

@base <URI> .

see Example

A simple Turtle fact has the form

URI1Curie URI2Curie URI3Curie|literal .

Example:

@prefix y: <http://yago-knowledge.org/>

y:Elvis y:loves y:Priscilla .

y:Priscilla y:loves <http://kb.org/cake>.

y:Elvis y:isCalled "The King" .

Each line is a triple of 3 URIs. Each URI identifies an entity.

The URI in the middle identifies a relation entity.

Each URI can be given explicitly or as a Curie. The object can also be a literal.

>literals

Literals with data types

Turtle allows attaching a **datatype** to a literal in the form

"literal"^^datatype

The datatype is given by a URI or Curie.

It is common to use the XML datatypes α

xsd:boolean	true, false
xsd:decimal	Arbitrary-precision decimal numbers
xsd:integer	Arbitrary-size integer numbers IEEE floating-point
xsd:double	64-bit floating point numbers incl. $\pm\text{Inf}$, ± 0 , NaN
xsd:float	32-bit floating point numbers incl. $\pm\text{Inf}$, ± 0 , NaN
xsd:date	Dates (yyyy-mm-dd) with or without timezone
xsd:time	Times (hh:mm:ss.sss...) with or without timezone
xsd:dateTime	Date and time with or without timezone

...

see them

Summary: URIs & Turtle

- URIs are identifiers for entities, often look like URLs

([IRIs](#), an extension of URIs, allow internationalized characters)

<http://sing.it/elvis>

- Curies abbreviate URIs

[y:Elvis](#)

- Turtle is a syntax for RDF facts

<<http://kb.org/Elvis>> [y:sings](#) [y:AllShookUp](#) .

([TriG](#), an extension of Turtle, allows dealing with named graphs)

->[total-2018](#)

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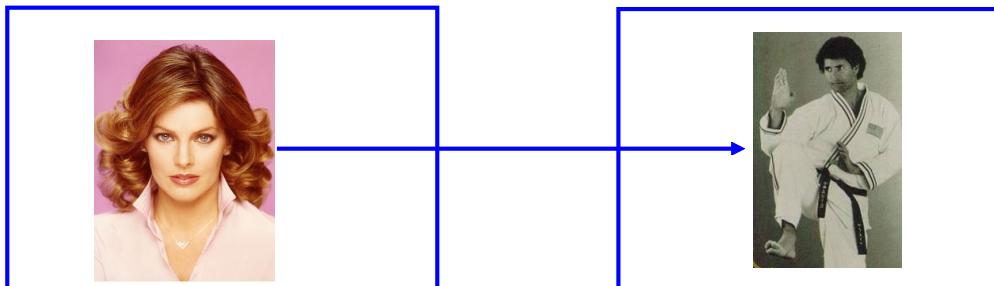
Cross-referencing

A KB can make statements about entities defined in other KBs.

@prefix y: <<http://yago-knowledge.org/>>

@prefix d: <<http://dbpedia.org/>>

y:Priscilla y:loves d:Mike Stone .



Standard vocabulary

A KB can define vocabulary that is used by other KBs.



y:Singer

- subclasses
- superclasses
- label
- ...

AlizéeKB

y:Singer

↑ type



Def: RDF Vocabulary

RDF is also a vocabulary (=KB) that defines basic notions of KB representation.

@prefix rdf: <<http://www.w3.org/.../rdf/>>
rdf:type, rdf:Property, rdf:Statement ...

see this KB

We can use notions from this KB:



Def: RDFS Vocabulary

RDFS is a vocabulary (=KB) that defines basic notions for class representation.

@prefix rdfs: <http://www.w3.org/.../rdfs/>

rdfs:label, rdfs:subClassOf,

rdfs:domain, rdfs:range,

rdfs:Class, rdfs:Resource

see this KB

entity



see Example

Sharing vocabularies

Shared vocabularies mean

- shared work in defining entities
- inter-operability of KBs

Some shared vocabularies have become standards on the Semantic Web. They have a standard namespace prefix. However, nothing prescribes the use of these vocabularies or prefixes.

```
@prefix rdf: <http://really.dumb.fellow.org/>
rdf:TheKing rdf:type rdf:monarch .
```

More vocabularies

- Dublin Core (for describing documents)
<http://purl.org/dc/elements/1.1/>
- Schema.org (for Web content)
<http://schema.org>
- Creative Commons (types of licences)
<http://creativecommons.org/ns#>
- Facebook Open Graph (for Web content)
<http://ogp.me/>
- FOAF (Friend of a Friend; for contact information)
<http://xmlns.com/foaf/spec/>

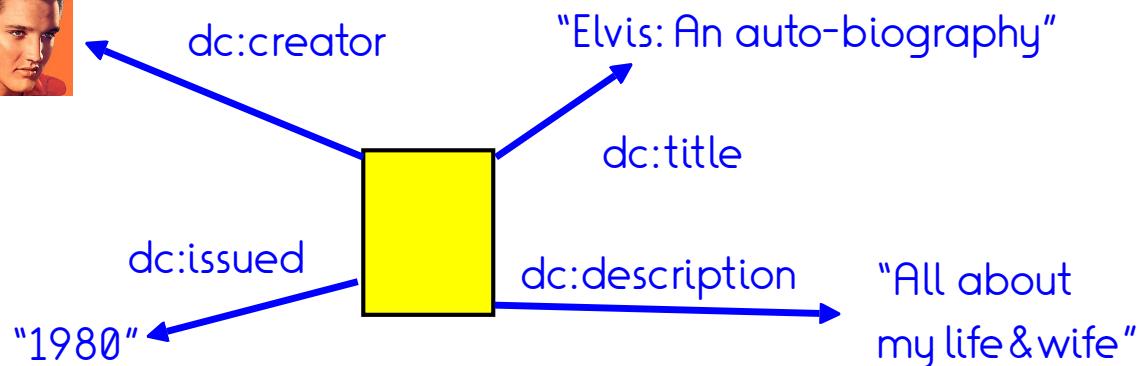
>more

Dublin Core

Dublin Core is a vocabulary (=KB) of terms (=entities) for describing documents.

dc:creator, dc:title, dc:format,
dc:MediaType, dc:language...

see this KB

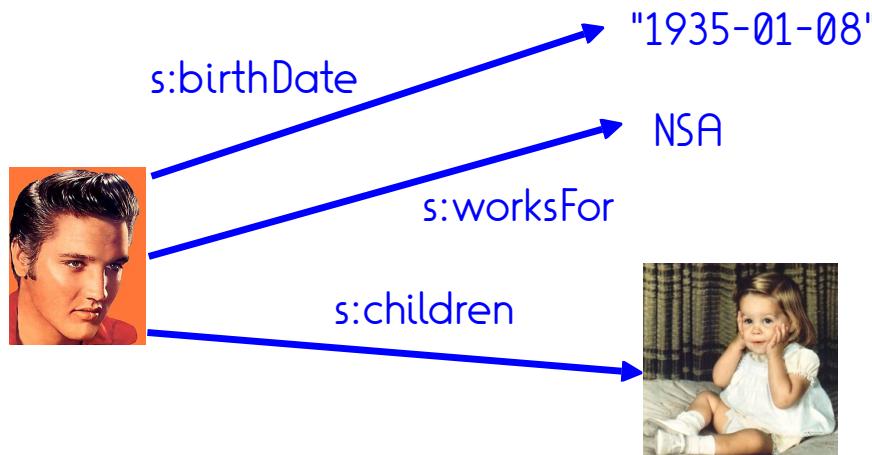


>more

Schema.org

Schema.org is a KB by Google, Yahoo & Microsoft for describing Web content.

s:Person, s:Movie, s:address,
s:follows, s:worksFor, ...
[see this KB](#)



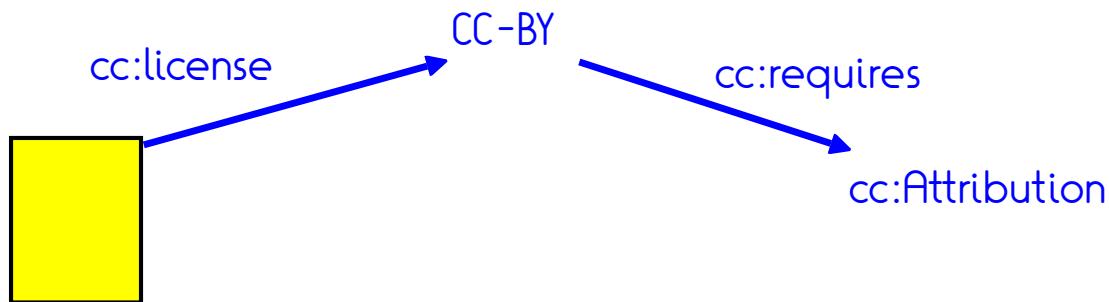
>more

Creative Commons

Creative Commons provides their vocabulary in RDF.

cc:license, cc:attributionName,
cc:permits, cc:Reproduction, ...

[see this KB](#)

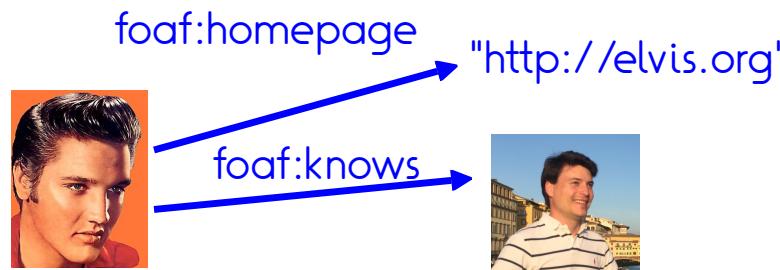


FOAF

FOAF is an RDF vocabulary for describing persons.

foaf:familyName, foaf:givenName,
foaf:knows, foaf:based_near,
foaf:age, ...

see this KB



Seems to be superceded by schema.org

Summary: Standard Vocabulary

- Vocabulary can be re-used across KBs
- This brings advantages such as less design effort, interoperability
- Some standard vocabularies have evolved

[RDF](#), [RDFS](#), [schema.org](#)

The Semantic Web

- Motivation
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- URIs
- Standard Vocabularies
- **Linked Data**
- SPARQL & OWL
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Def: Dereferenceable / Cool URI

A **dereferenceable URI** (also: Cool URI) is a URI that returns an RDF snippet if accessed on the Internet by an RDF client.

[W3C/Cool URIs](#)

<http://elvispedia.org/Elvis>



```
@prefix e:<http://elvispedia.org/>
e:Elvis e:sings e:aSong .
e:Elvis e:born e:Tupelo .
...
```

For this to work, the data has to be stored at the domain of the URI

Cool URIs can be traversed

```
@prefix e:<http://elvispedia.org/>
@prefix d:<http://dbpedia.org/>
e:Priscilla e:loves d:MikeStone
...
...
```



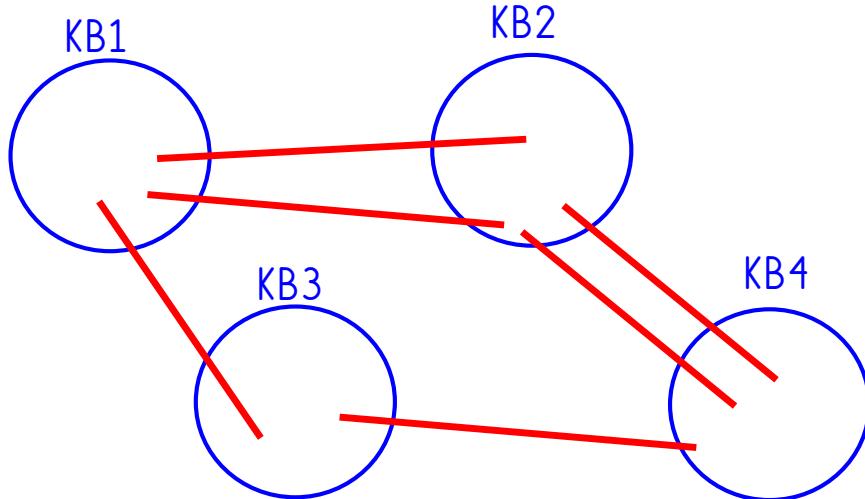
<http://dbpedia.org/MikeStone>

```
@prefix d:<http://dbpedia.org/>
@prefix rdf:<http://w3c.org/.../rdf>
d:MikeStone rdf:type d:KarateClown
d:MikeStone d:livesIn d:LosAngeles
...
...
```



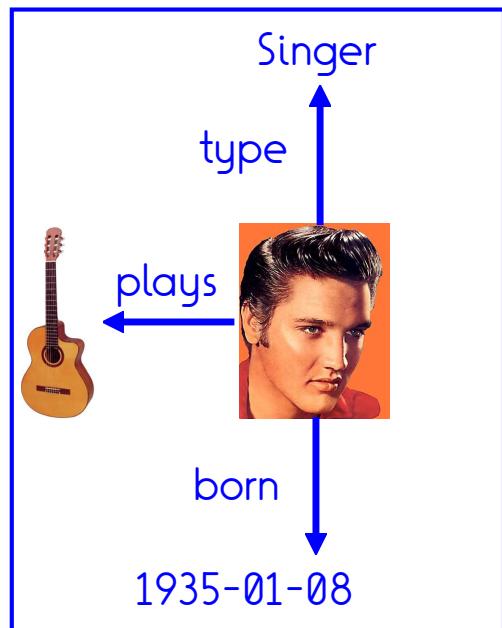
The real URI of DBpedia is <http://dbpedia.org/resource/>

Cool URIs can be traversed

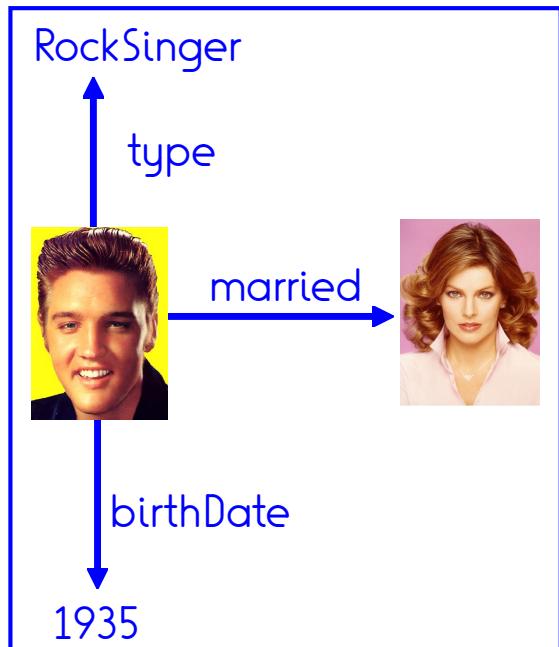


The standard vocabularies (RDF, RDFS, schema.org, Creative Commons, etc.) all provide dereferenceable URIs, as do many KBs.

Everybody can create KBS & URIs



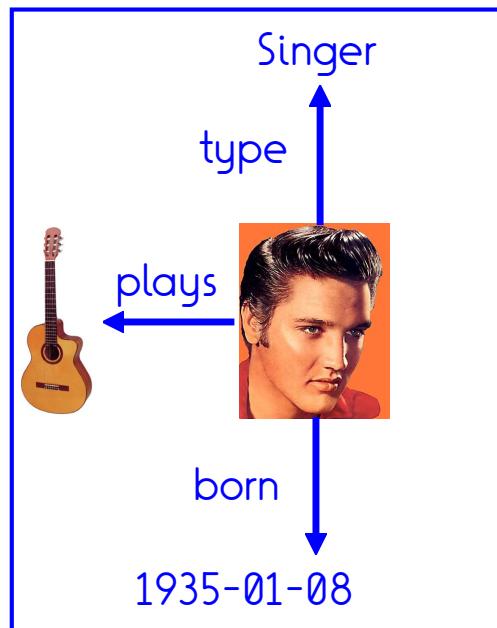
YAGO



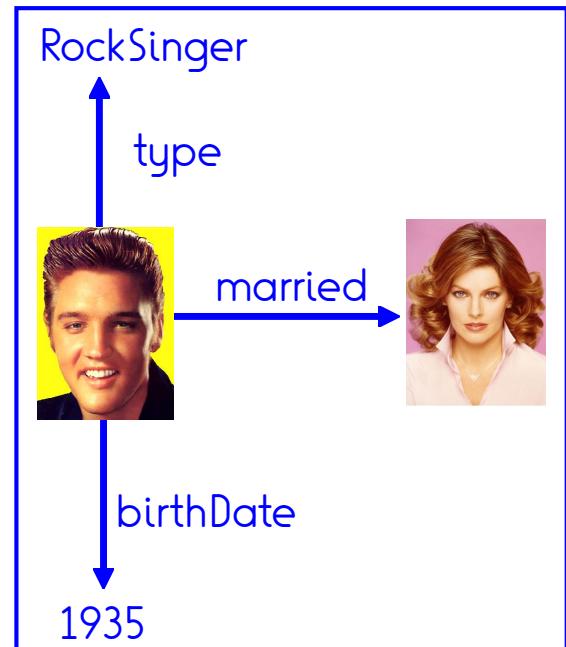
ElvisPedia

Distinct URIs => No use

Who is the spouse of the guitar player?



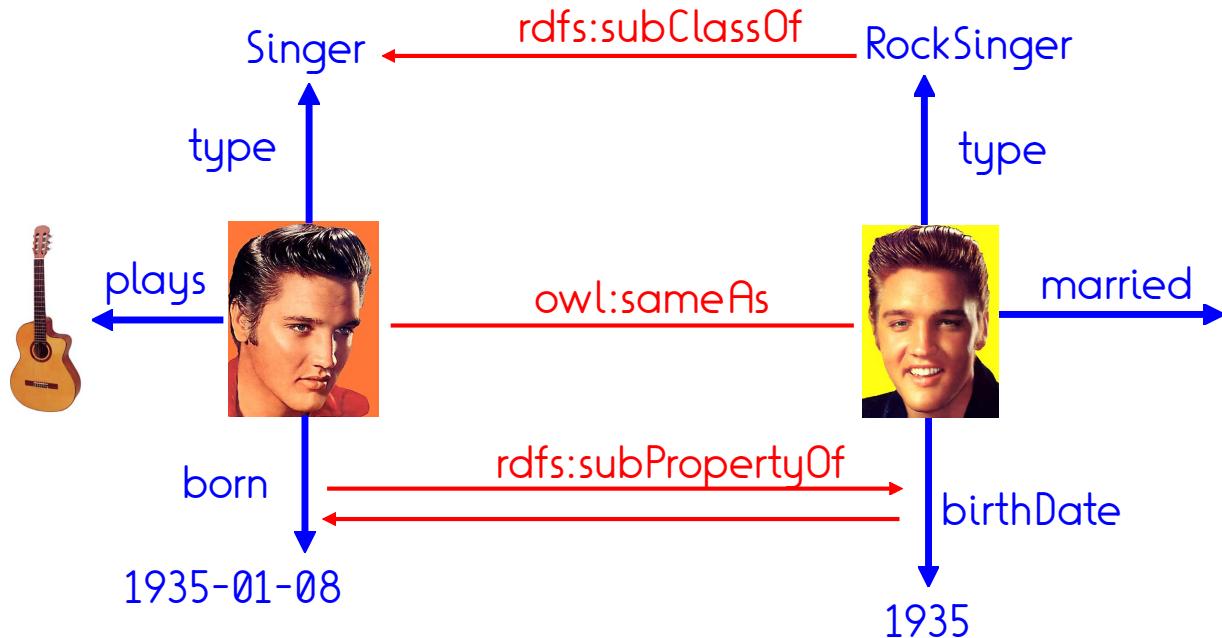
YAGO



ElvisPedia

Def: Knowledge Base Alignment

KB alignment (also: KB mapping, KB linking) is the task of mapping the entities, classes, and relations of one KB to their pendants in the other.



OWL and RDF are standard vocabularies for the linking.

Match classes, entities, & relations



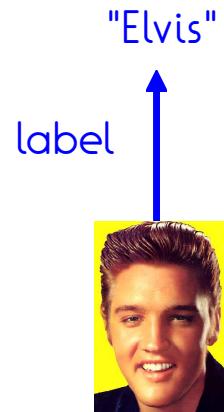
There are numerous approaches for KB linking. We show here

F. Suchanek, S. Abiteboul, P. Senellart:

"PARIS: Probabilistic Alignment of Relations, Instances, and Schema"

VLDB 2012

Match classes, entities, & relations

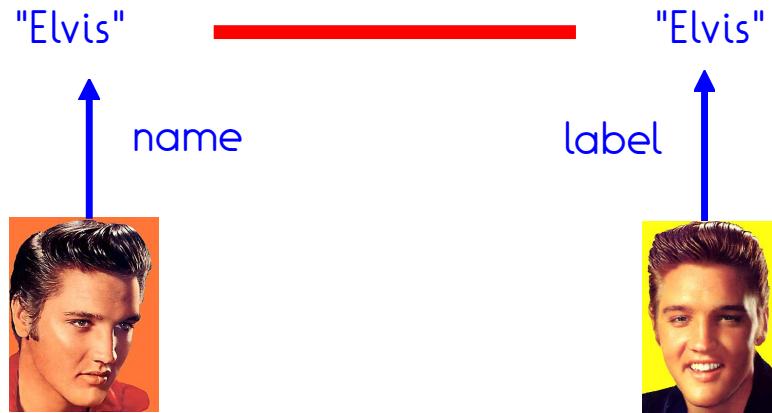


1. Match literals

(either by identity or with a similarity function)

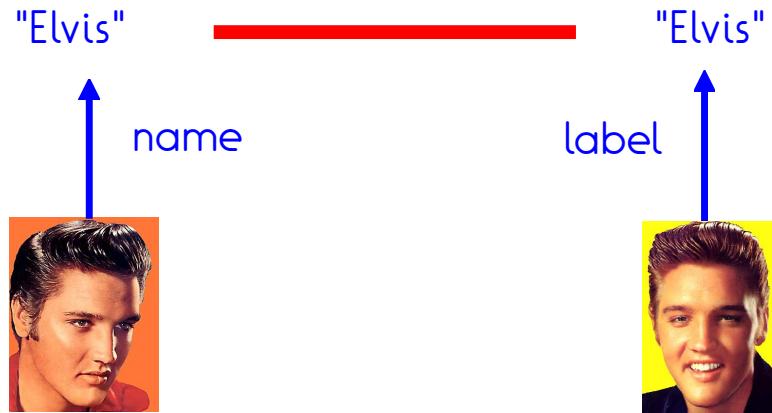
Identical literals are equivalent by definition.

Match classes, entities, & relations



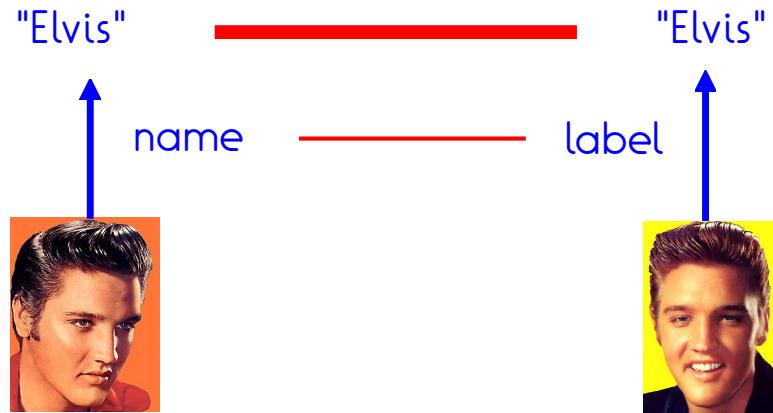
1. Match literals

Match classes, entities, & relations



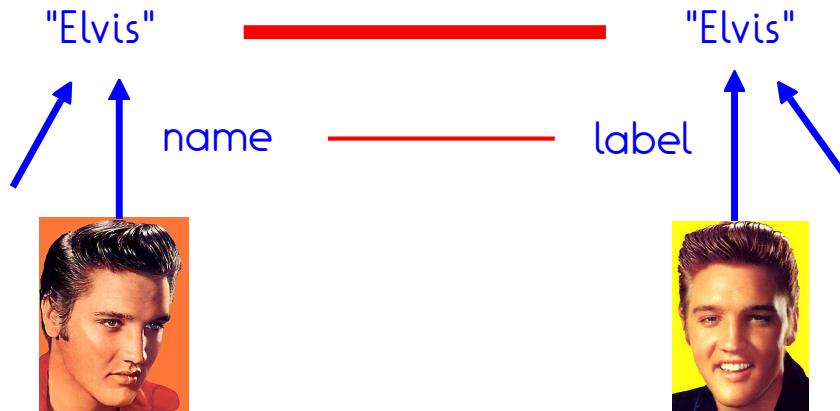
2. Assume small equivalence of all relations

Match classes, entities, & relations



2. Assume small equivalence of all relations

Match classes, entities, & relations



What about matching the entities?

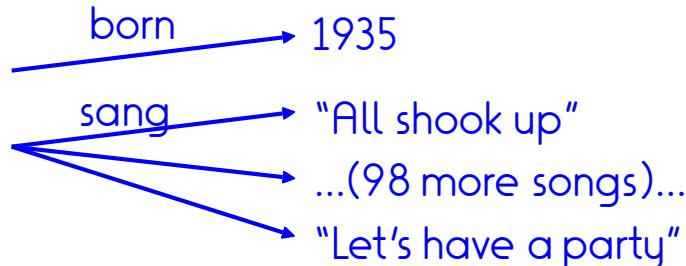
What does it mean that both Elvises share the same name?

What does it mean if both Elvises share the same birth year?

Def: Local Functionality

The **local functionality** of a relation r and a subject s is one over the number of its objects.

$$\text{fun}(x, r) = \frac{1}{\# y: r(x, y)}$$



$$\begin{aligned}\text{fun}(\text{Elvis}, \text{born}) &= 1 \\ \text{fun}(\text{Elvis}, \text{sang}) &= 0.01\end{aligned}$$

Def: Functionality

The **functionality** of a relation r is the harmonic mean of the local functionalities for all its subjects.

$$\text{fun}(r) = \text{HM}_x \text{ fun}(x, r)$$

It is equivalent to the number of its subjects divided by the number of its facts:

$$\text{fun}(r) = \frac{\# x: \exists y: r(x, y)}{\# x, y: r(x, y)}$$

Example:

$\text{fun}(\text{hasBirthDate})=1$ (exactly one object per subject)

$\text{fun}(\text{hasDeathDate})=1$ (at most one object per subject)

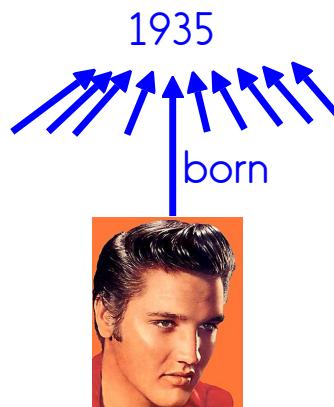
$\text{fun}(\text{hasNationality})=0.9$ (few objects per subject)

$\text{fun}(\text{hasFriend})=0.2$ (several objects per subject)

Def: Inverse Functionality

The **inverse local functionality** for an object y and a relation r is the number of subjects x with $r(x, y)$.

$$ifun(r, y) = \frac{1}{\# x: r(x, y)}$$



$$ifun(name, \text{ Elvis}) = \frac{1}{2}$$

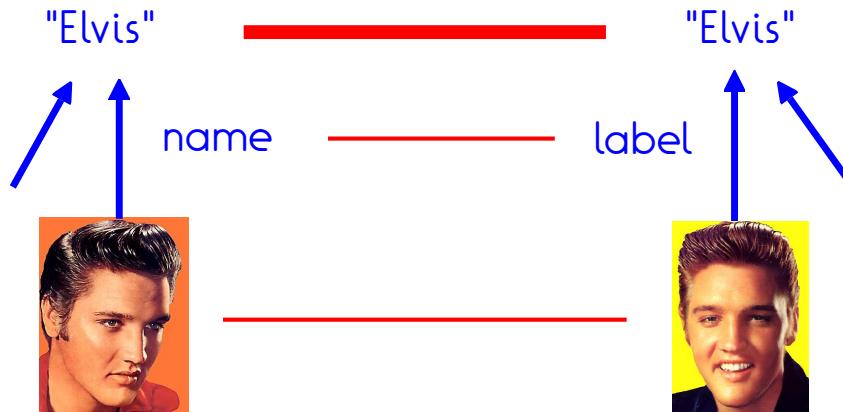
$$ifun(born, \text{ Elvis}) = \frac{1}{10}$$

The **inverse functionality** of a relation r is defined analogously to the functionality.

$$ifun(name) = 0.9$$

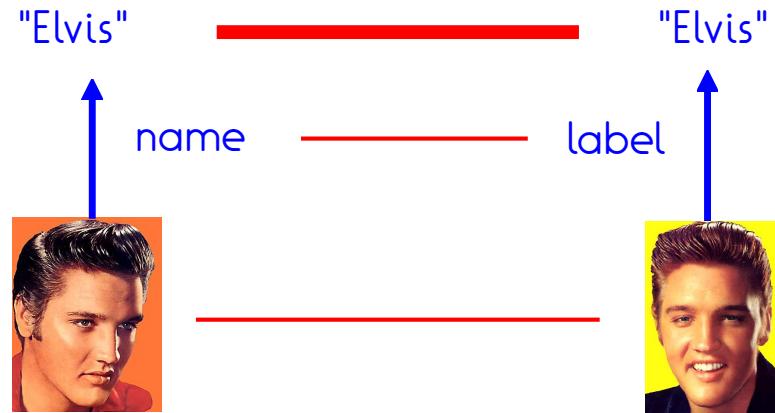
$$ifun(born) = 0.1$$

Match classes, entities, & relations



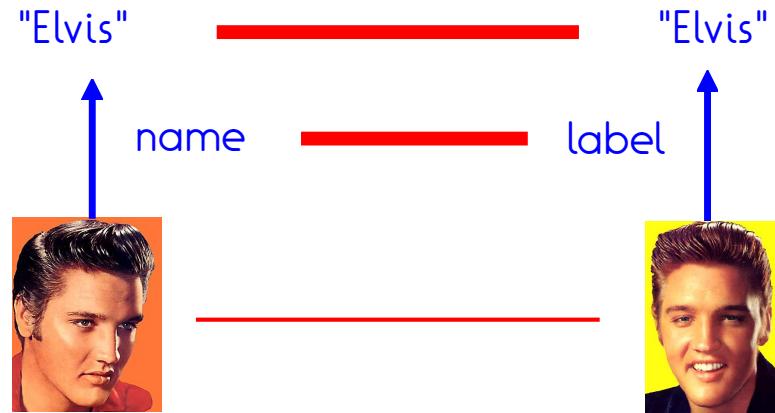
3. If subjects share a relation that is highly inverse functional, and the object is matched, then match the subjects.

Match classes, entities, & relations



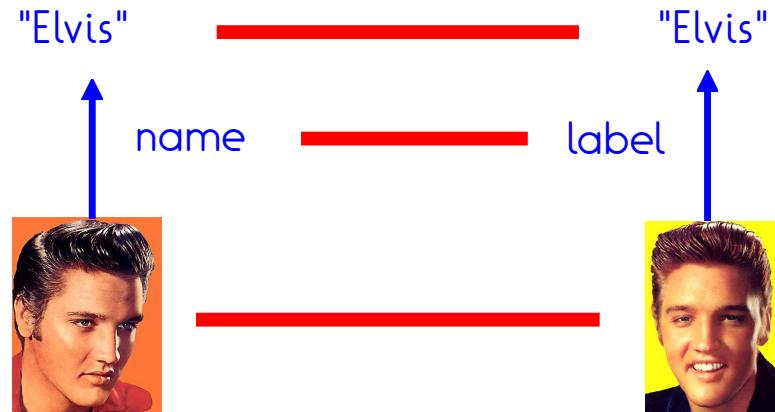
4. If relations share many pairs,
increase their match

Match classes, entities, & relations



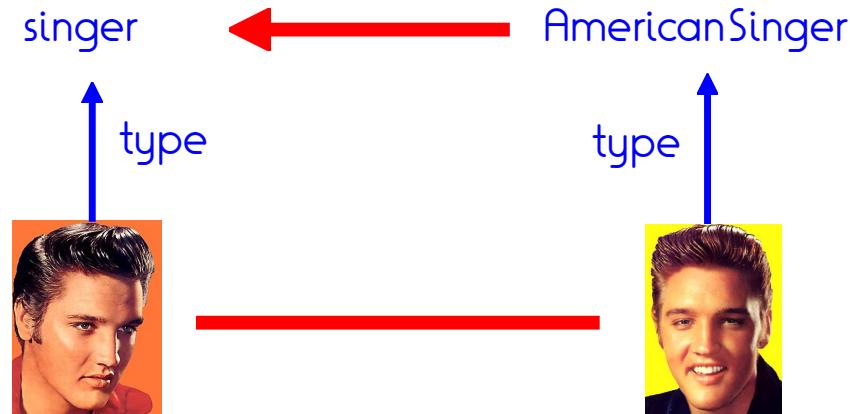
4. If relations share many pairs,
increase their match

Match classes, entities, & relations



5. Iterate

Match classes, entities, & relations

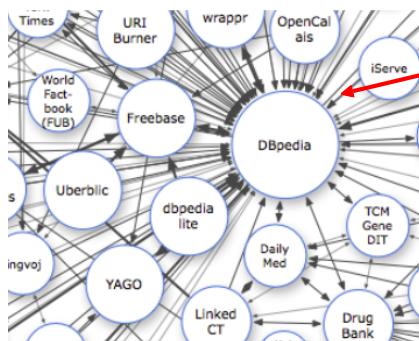


6. Compute class subsumption
(based on the overlap of entities)

Numerous other approaches exist (e.g. based on name similarity).

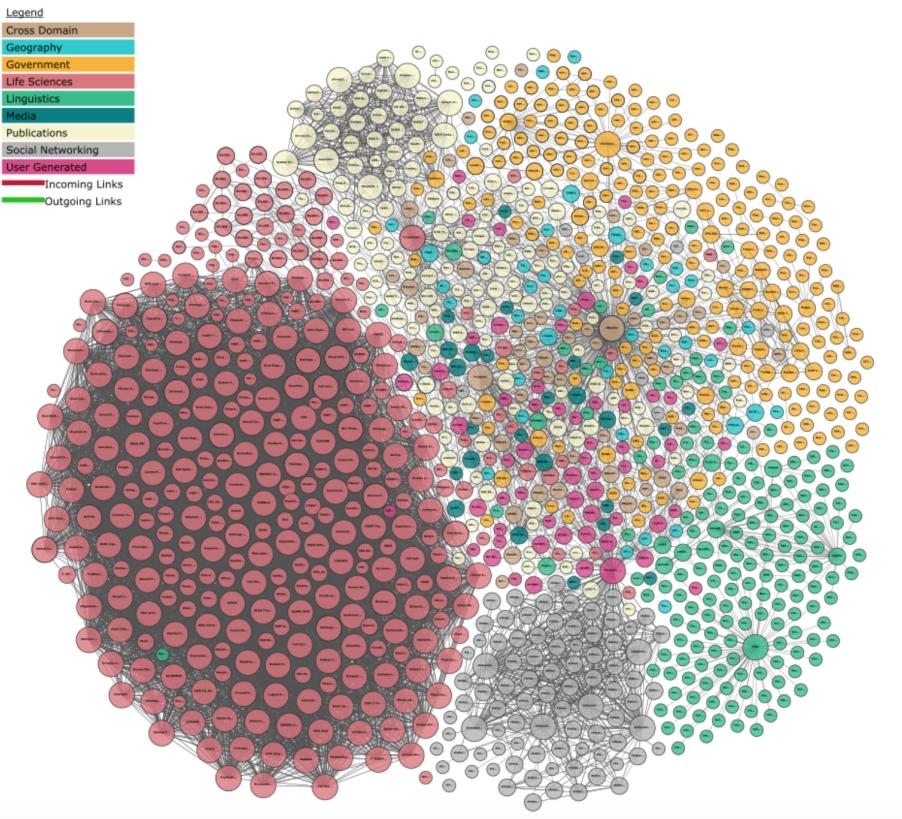
Def: Linked Open Data Project

The goal of W3C's Linked Open Data Project is to publish and link open KBs. The project links equivalent entities and equivalent relations across different KBs.



This arrow means:
equivalent entities
between iServe
and DBpedia have
been linked.

The Linked Open Data Project



As of 2017: 10,000 KBs

>details

lod-cloud.net 63

The Linked Open Data Project

Existing KBs include

- US census data
- BBC music database
- Gene ontologies
- DBpedia general knowledge, + YAGO, + Cyc etc.
- UK government data
- geographical data in abundance
- national library catalogs (USA, Germany etc.)
- publications (DBLP)
- commercial products
- all Pokemons
- ...and many more

Summary: Linked Data

The Linked Data project aims to make KBs machine-accessible through

- Public RDF KBs on the Internet
- Dereferenceable/Cool URIs
- Links between the KBs



->total-2018

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SPARQL

SPARQL (the “Sparql Protocol and RDF Query Language”) is the standard query language for RDF data.

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?email
WHERE {
  ?person a foaf:Person .
  ?person foaf:name ?name .
  ?person foaf:mbox ?email .
  ?person foaf:birth "1935-01-08" .
  FILTER regex(?name, "Elvis", "i") .
}
```

Definition of namespace prefixes

Output variables

Abbreviates rdf:type

Triple patterns

Variables start with “?”

Literals in quotes

Filters by regex or other functions

Other keywords include UNION, GRAPH (for named graphs), FROM (to specify a source KB), and OPTIONAL (to make triple patterns optional). 67

Running SPARQL queries

SPARQL queries can be run

- on a local triple store (e.g., Jena)
- programmatically in a (Java or Python) program
- on a SPARQL endpoint via API

<https://query.wikidata.org/bigdata/namespace/wdq/sparql?query=SELECT%20?s%20?p%20?o%20WHERE%20{?s%20?p%20?o}%20LIMIT%2010>

- on a SPARQL endpoint with a user interface



The screenshot shows a browser window with the URL <https://query.wikidata.org>. The page has a header with a refresh icon and a lock icon. Below the header, there are two buttons: "Wikidata Query" (highlighted in blue) and "Examples". The main content area contains a code editor with a numbered line counter on the left. The query is:

```
1 #Cats
2 SELECT ?item ?itemLabel
3 WHERE
4 {
5   ?item wdt:P31 wd:Q146.
6 }
```

On the right side of the code editor, there are two small links: ">owl" and "->total-2018".

<https://www.w3.org/wiki/SparqlEndpoints>

OWL

The **Web Ontology Language** (OWL) is a family of languages for KBs, in particular to allow reasoning. It comes in different syntaxes:

If x married y , then x knows y

- Description Logics: $\text{married} \sqsubseteq \text{knows}$
- Manchester syntax: `ObjectProperty: married SubPropertyOf: knows`
- RDFS syntax: `:married rdfs:subPropertyOf :knows`
- XML syntax: `<Ontology><Prefix ...><Declaration>...`

OWL statements allow deducing assertions from the KB:

`:married rdfs:subPropertyOf rdfs:knows`

`:Elvis :married :Priscilla`

`:Elvis :knows :Priscilla`

| KB

| deduced implicitly

[>details](#)

OWL Profiles

OWL comes in different flavors:

- RDFS: only simple statements (subclass, subproperty, etc.)
- OWL EL: for KBs with many properties and classes
- OWL QL: for KBs with many instances
- OWL RL: for rules

Different OWL profiles allow different types of statements, e.g.,

OWL 2 QL supports the following axioms:

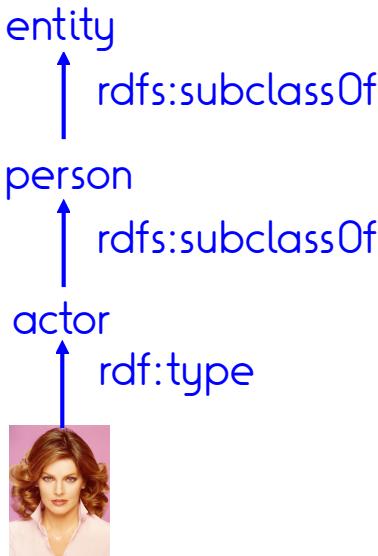
- subclass axioms (`SubClassOf`)
- class expression equivalence (`EquivalentClasses`)
- class expression disjointness (`DisjointClasses`)
- inverse object properties (`InverseObjectProperties`)
- ...

These restrictions are there to make the statements decidable, and to limit the reasoning complexity.

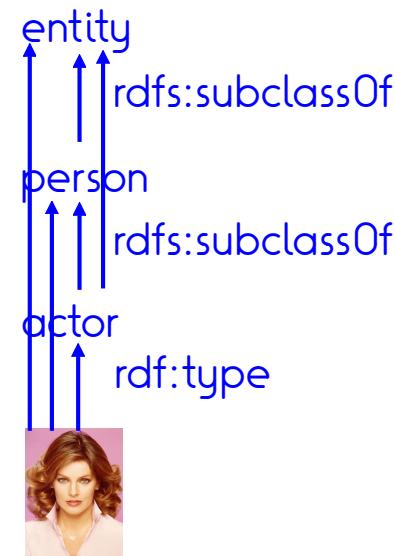
[>details](#)

OWL in Practice

In practice, OWL reasoning on large KBs is slow. Therefore, large KBs (Wikidata, YAGO, DBpedia) use only very simple OWL constructions, most notably [type](#) and [subclassOf](#).



OWL
semantics



Computing all implied assertions is already quadratic.

The Semantic Web

- Motivation
- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- SPARQL & OWL
- RDFa, JSON-LD & friends
- Applications

How do we get HTML pages to RDF?

Paris fête le 14 juillet

SOMMAIRE

BALS DANS LES CASERNES DE POMPIERS

DÉFILÉ MILITAIRE SUR L'AVENUE DES CHAMPS-ÉLYSÉES

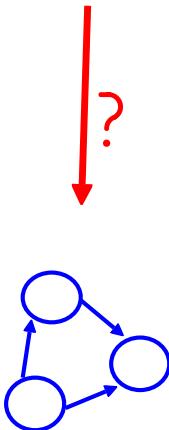
FEU D'ARTIFICE DU 14 JUILLET

LES FRANCILIENS ACCUEILLENT LEURS SOLDATS

LES BONS PLANS DE LA JOURNÉE DE FÊTE NATIONALE



Basic Specifications	
Resolution:	8.00 Megapixels
Sensor size:	1/2.5"
Lens:	5.00x zoom (35-175mm eq.)
Viewfinder:	LCD
ISO:	80-3200
Shutter:	2-1/1000
Max Aperture:	3.5
Dimensions:	3.6 x 2.3 x 0.9 in. (92 x 59 x 22 mm)
Weight:	6.1 oz (172 g) includes batteries
MSRP:	\$400
Availability:	03/2007



Homepage

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Fax: +49 681 9325 599

-> JSON-LD
>details

Def: RDFa

RDFa is a syntax to annotate HTML pages with RDF.

RDFa Lite

```
<div>
  Martin Thunderbird<br>
  Researcher in Rock'N'Roll Music of 1935-1977<br>
  Memphis, Tennessee
</div>
```

>details

74

Defining the vocabulary

All local names in an HTML node live in the namespace given by "vocab".

```
<div vocab="http://schema.org/">  
    Martin Thunderbird<br>  
    Researcher in Rock'N'Roll Music of 1935-1977<br>  
    Memphis, Tennessee  
</div>
```

>details

Defining the subject

All properties in the HTML node take as subject the entity given by "resource".

```
<div vocab="http://schema.org/"  
      resource="http://martin.org/me">  
    Martin Thunderbird<br>  
    Researcher in Rock'N'Roll Music of 1935-1977<br>  
    Memphis, Tennessee  
</div>
```

>details

Defining a type

The type of the subject is given by "typeOf".

```
<div vocab="http://schema.org/"  
resource="http://martin.org/me" typeOf="Person">  
Martin Thunderbird<br>  
Researcher in Rock'N'Roll Music of 1935-1977<br>  
Memphis, Tennessee  
</div>
```

<http://martin.org/me> rdf:type <http://schema.org/Person> .

>details

Defining a fact with a literal object

A tag with "property" defines a fact between subject and that tag's text value.

```
<div vocab="http://schema.org/"  
resource="http://martin.org/me" typeOf="Person">  
  <span property="name">Martin</span><br>  
  Researcher in Rock'N'Roll Music of 1935-1977<br>  
  Memphis, Tennessee  
</div>
```

<http://martin.org/me> <http://schema.org/name> "Martin".

>details

Defining a fact with an entity object

A tag with "property" and "resource" defines a fact between subject and URI.

```
<div vocab="http://schema.org/"  
      resource="http://martin.org/me" typeOf="Person">  
  <span property="name">Martin Th</span><br>  
  <span property="homeLocation" resource=  
        "http://yago.org/Memphis">Memphis</span>  
</div>
```

<<http://martin.org/me>> <<http://schema.org/homeLocation>>
<<http://yago.org/Memphis>> .

>details

Nested facts

A tag with "property" and "typeof" creates a new entity.

...

```
<span property="address" typeof="postalAddress"
<span property=streetAddress>42 Elvis Rd</span>
<span property=postalCode>12345</span>
</span>
```

```
<http://martin.org/me> <http://schema.org/address> ADR .
ADR rdf:type <http://schema.org/postalAddress> .
ADR <http://schema.org/streetAddress> "42 Elvis Rd" .
ADR <http://schema.org/postalCode> "12345" .
```

>details

Summary: RDFa embeds into HTML

Advantages:

- Grass root appeal
(everybody can start annotating pages)
- No data duplication
(all data in one file)
- Publisher independence
(everybody can use his own attributes)

Standards that are similar to RDFa are

- Microformats
- Microdata

Def: JSON-LD

JSON-LD is a JSON-based format for RDF facts.

[json-ld.org, W3C specification]

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "foaf": "http://xmlns.com/foaf/0.1/"  
  }  
  "@id": "http://martin.org",  
  "@type": "http://schema.org/Person"  
  "name": "Martin Thunderbird",  
  "homepage": "http://martin.org"  
}
```

defines the schema
says that all properties and values are relative to schema.org
defines a prefix
defines the URI of this resource
defines the type of this resource

JSON-LD in HTML

JSON-LD can be embedded in HTML.

```
<script type="application/ld+json">
{
  "@context": {
    "@vocab": "http://schema.org/",
    "foaf": "http://xmlns.com/foaf/0.1/"
  }
  "@id": "http://martin.org",
  "@type": "http://schema.org/Person"
  "name": "Martin Thunderbird",
  "homepage": "http://martin.org"
}
</script>
```

Advantages:

- less messy than RDFa
- encouraged by [Google](#)

Disadvantages:

- danger of inconsistency between visible HTML and JSON-LD

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>more

Search engines scrape RDFa&JSON-LD

[iPhone X review: The best iPhone challenges you to think different ...](#)

<https://www.cnet.com/products/apple-iphone-x/review/> ▾

★★★★★ Rating: 4.5 - Review by Scott Stein - \$999.00 to \$999.99

Dec 22, 2017 - Apple iPhone X (64GB, Space Gray) ... The Good A great blend of handheld comfort and a big, gorgeous OLED screen. ... I had shaved my beard to test Face ID, Apple's new method for unlocking your iPhone by simply looking at it.

>more

Search engines scrape RDFa&JSON-LD

[iPhone X review: The best iPhone challenges you to think different ...](https://www.cnet.com/products/apple-iphone-x/review/)

[https://www.cnet.com/products/apple-iphone-x/review/ ▾](https://www.cnet.com/products/apple-iphone-x/review/)

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Dec 22, 2017 - Apple iPhone X (64GB, Space Gray) ... The Good A great blend of handheld comfort and a big, gorgeous OLED screen. ... I had shaved my beard to test Face ID, Apple's new method for unlocking your iPhone by simply looking at it.

JSON-LD embedded in Web page:

```
<script type="application/ld+json">
{
  "@context": "http://schema.org",
  "@type": "Product",
  "name": "Apple iPhone X",
  "description": "iPhone X is an overdue and winning evolution of the iPhone",
  "image": "https://cnet1.cbsistatic.com/img/ZQICw4aW2fNpbmN34CSTJ
  "brand": {
    "@type": "Thing",
    >more
  }
}
```

Search engines read licenses

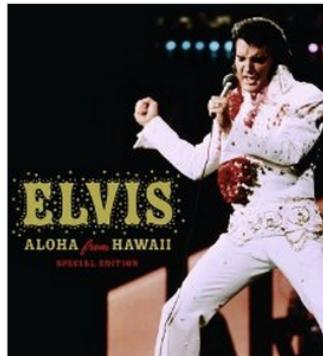
A screenshot of a Google Images search results page. The search query "Lisa Marie Presley" is entered in the search bar. The "Images" tab is selected, indicated by a red underline. Below the search bar are filter options: Size, Color, Type, Time, and a dropdown menu labeled "labeled for reuse". A red box highlights this dropdown menu and its sub-options: "not filtered by license", "labeled for reuse" (which is checked, indicated by a checked checkbox icon), "labeled for commercial reuse", "labeled for reuse with modification", and "labeled for commercial reuse with modification". The search results show several images of Lisa Marie Presley and her family. On the left, there is a sidebar with a thumbnail of a landscape image and the word "Elvis". On the right, there is a page number "20" and a "more" link.

labeled for reuse

- not filtered by license
- ✓ labeled for reuse
- labeled for commercial reuse
- labeled for reuse with modification
- labeled for commercial reuse with modification

>more

Facebook Like Button uses RDFa



Elvis: Aloha from Hawaii

(1973)

TV Special - 87 min - Documentary | Music

More at
IMDbPro »



Your rating: ★★★★★★★★★★1 /10

Ratings: 7,7/10 from 690 users

Reviews: 30 user | 3 critic

A 1973 concert by Elvis Presley taped at the Convention Center in Honolulu, Hawaii. This was the first program to ever be beamed around the world by satellite.

Quick Links

[Full Cast and Crew](#)

[Trivia](#)

[Quotes](#)

[Awards](#)

[Message Board](#)

[Plot Summary](#)

[Parents Guide](#)

[User Reviews](#)

[Release Dates](#)

[Company Credits](#)

[Explore More](#)



Gefällt mir

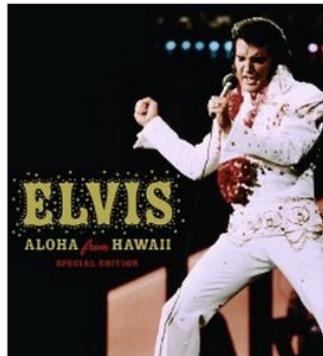


52 Personen gefällt das.

>more

88

Facebook Like Button uses RDFa



Elvis: Aloha from Hawaii

(1973)

TV Special - 87 min - Documentary | Music

More at
IMDbPro »



Your rating: ★★★★★★★★★★ 7,7 / 10

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[User Reviews](#)

[Release Dates](#)

[Company Credits](#)

[Explore More](#)



Gefällt mir



52 Personen gefällt das.

@prefix og: <<http://ogp.me/ns#>> .

<<http://www.imdb.com/title/tt0167923/?ref=fnaltt2>> og:description "A 1973 concert by Elvis Presley taped in Honolulu, Hawaii";
og:sitename "IMDb";
og:title "Elvis: Aloha from Hawaii (1973)";
og:type "video.tv-show";
og:url "<http://www.imdb.com/title/tt0167923/>";
ns1:fbmlapp_id "115109575169727".

>more

89

Facebook public pages have JSON-LD



E-Mail oder Telefon

Passwort

Anmelden

Angemeldet bleiben

[Passwort vergessen?](#)



ELVIS PRESLEY
ist bei Facebook. GRACELAND • MEMPHIS, TN • AUGUST 10–17

Um dich mit ELVIS PRESLEY zu verbinden, registriere dich noch heute für Facebook.

[Registrieren](#) [Anmelden](#)

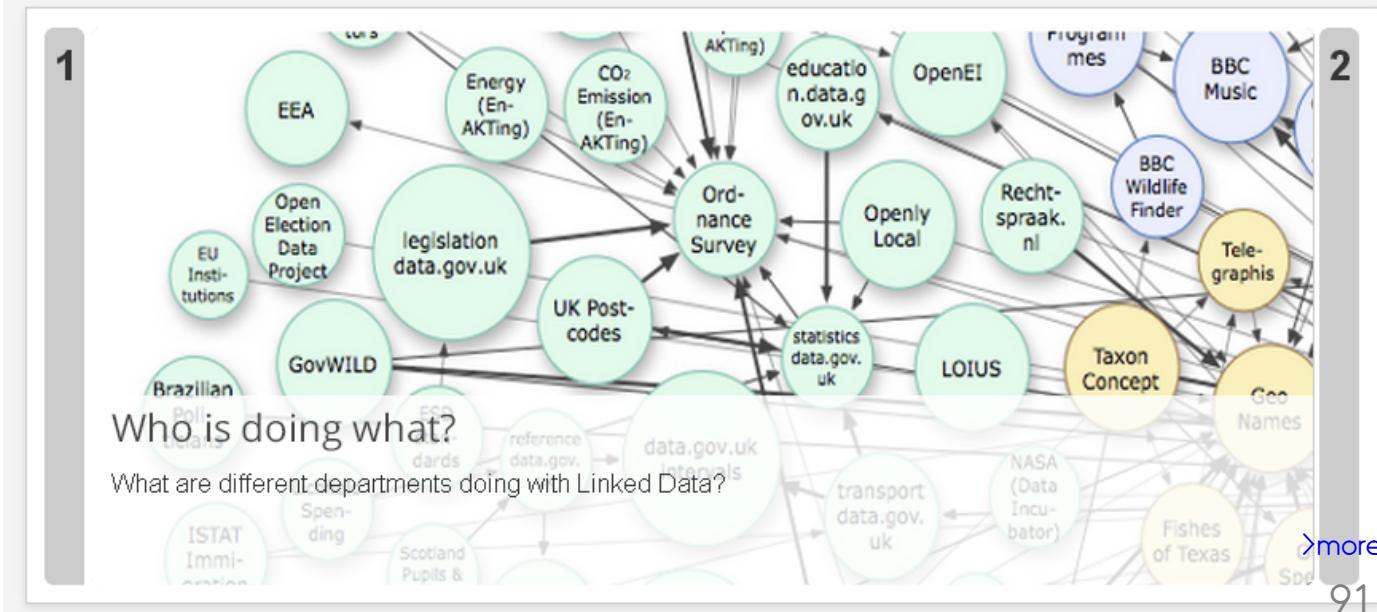
```
<script type="application/ld+json">
{"@context":"http://schema.org",
"@type":"Organization",
"name":"ELVIS PRESLEY", ...}
```

[>more](#)

UK and US govts publish RDF



Linked data



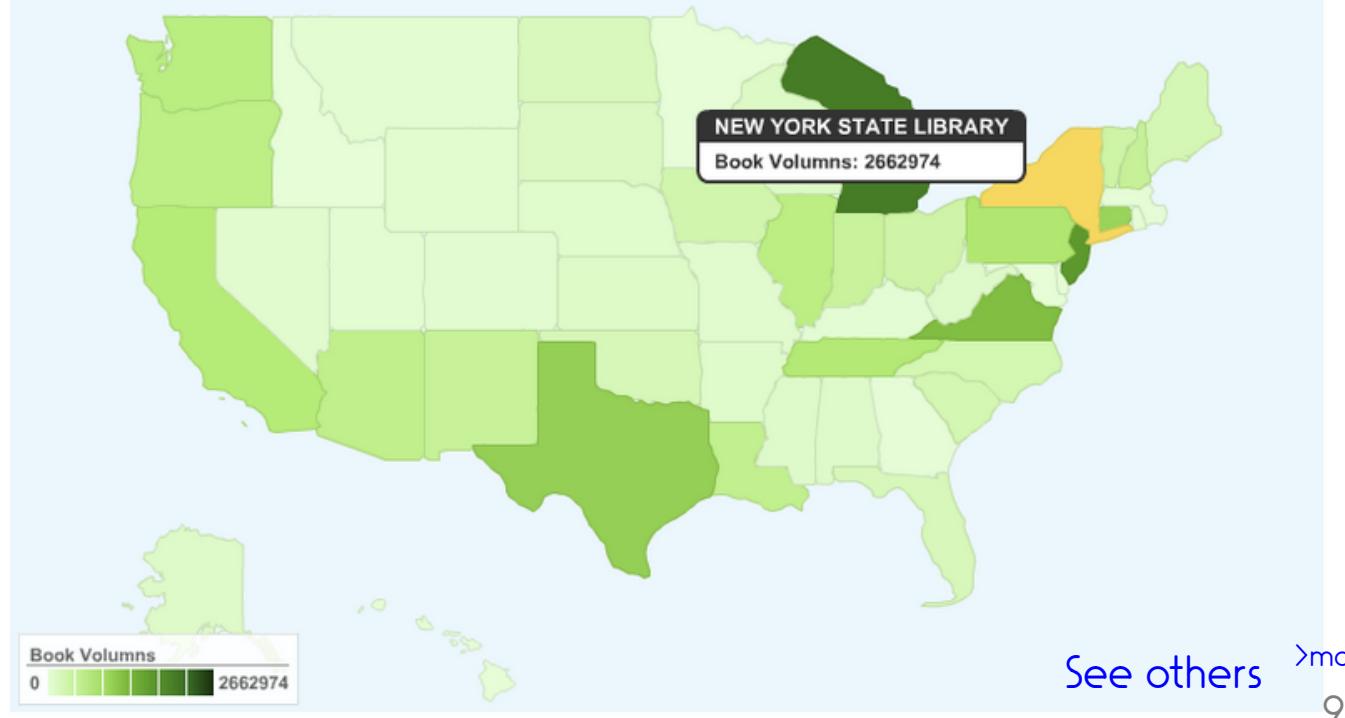
Example of public data use



How Knowledgeable is Your State?



library books / # inhabitants, per state



The BBC uses RDF

Structured data

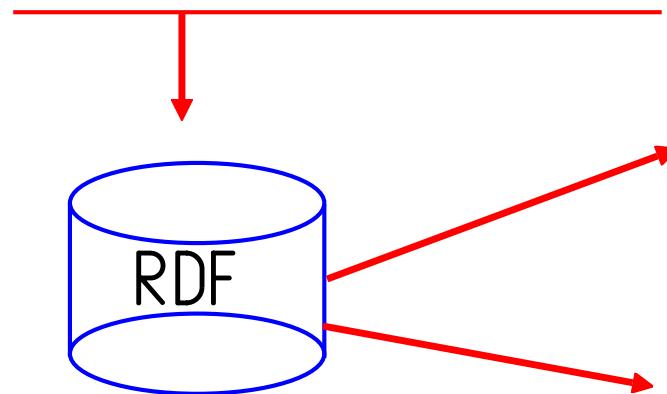
Artist: Bat for Lashes

Release:

Track: 1

Track: 2

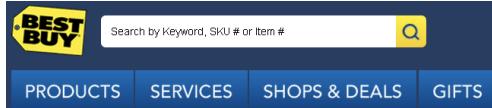
- + Peer Review
- + User community
- + Wikipedia
- + MusicBrainz



```
@prefix bbc: <...>  
bbc:Elvis rdf:type bbc:King .  
...
```

>more

BestBuy uses JSON-LD



We've improved shipping times to APO/FPO/DOD addresses.

Best Buy > Movies & Music > Movies & TV Shows > Product Info



This Is Elvis (Enhanced TV) (DVD) 1981

SKU: 8416252 Release Date: 9/7/2

Rating: PG

Customer Reviews: ★★★★☆ 4



Best Buy - Mountain View



2460 E Charleston Rd

Mountain View, CA 94043

Phone: 650-903-0591

GEO: 37.439073,-122.09568

Map & Directions

See full store details

Weekly Ad

CUSTOMER FEEDBACK & REVIEWS

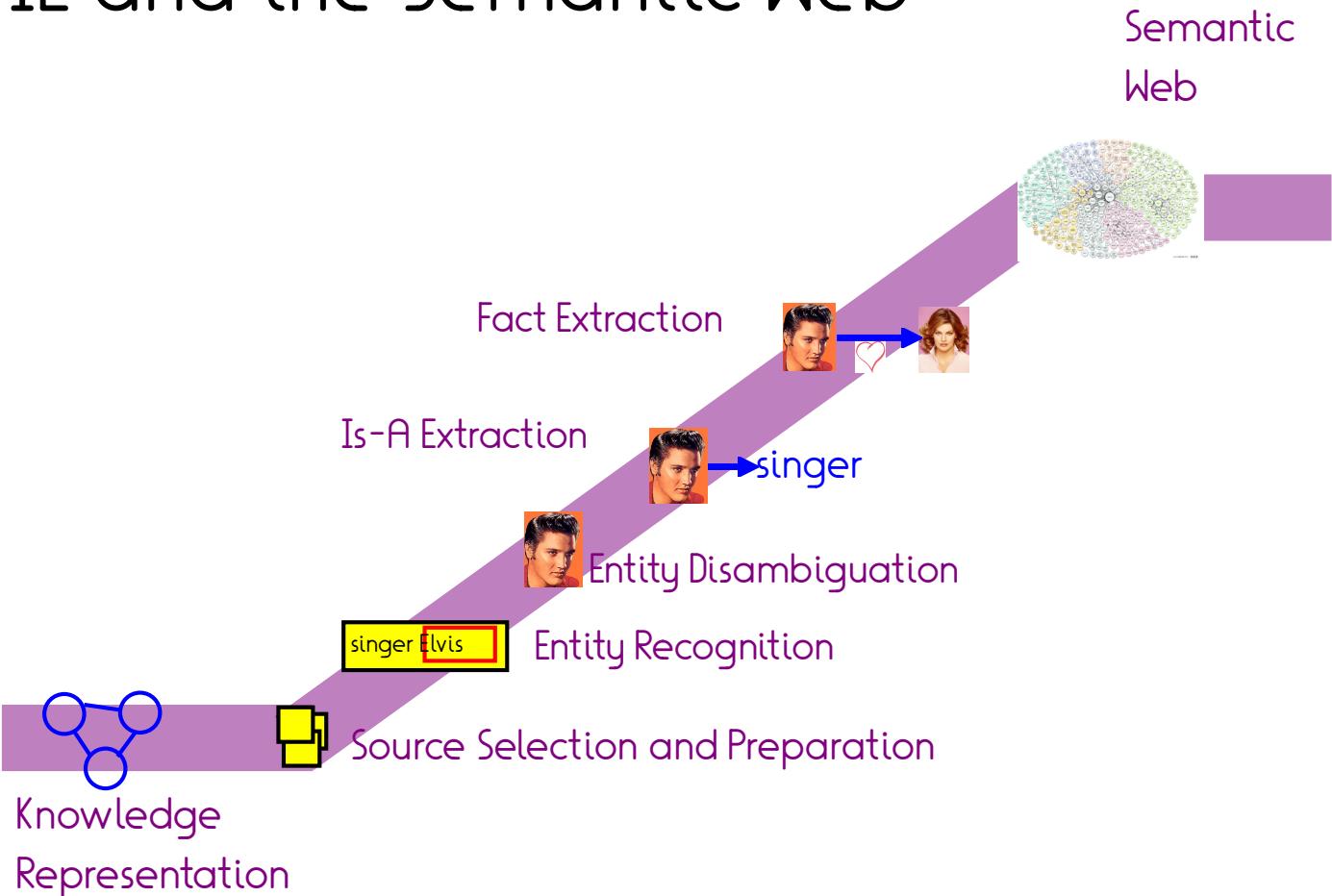
★★★★☆ 4.1 of 5

Read reviews (78) or Write a Review

BestBuy

```
<script type="application/ld+json">
{@context:"http://schema.org/",
@type:"Product",
"offers": {
"@type":"Offer",
"itemCondition": "http://schema.org/NewCondition",
"availability": "http://schema.org/InStock",
"seller": {"@type ":"Organization", "name ":"Best Buy"},
"priceCurrency": "USD",
"price": "34.99",
"image": "http://img.bbystatic.com/BestBuy_US/images/products/2644/26446259_sa.jpg",
"name": "Showroom Internationale: Live At the International Hotel, Dinner Show, August 12, 1970 [LP] - VINYL",
...
}
```

IE and the Semantic Web



References

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W3C: RDFS

W3C: Semantic Web

W3C: RDFa lite

JSON-LD

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