

The Semantic Web

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Semantic IE

You
are
here

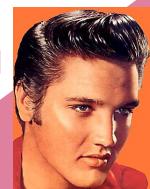
Reasoning



Fact Extraction

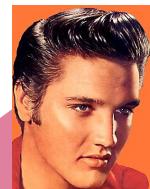


Instance Extraction



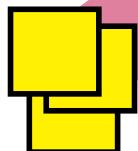
singer

Entity Disambiguation



singer Elvis

Entity Recognition

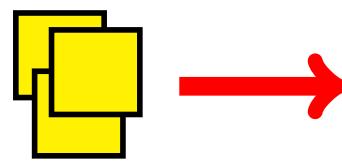


Source Selection and Preparation

Overview

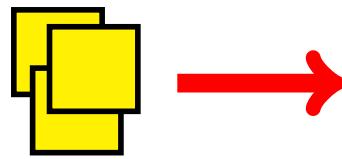
- Motivation
- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- RDFa
- Applications

Great, and now?



Person	Job
Elvis	singer

Data formats are incompatible



Person	Job
Elvis	singer

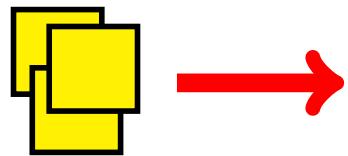


Person	Occupation
Elvis P.	singer



<person>
<occupation>

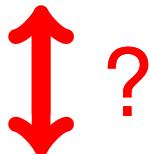
Devices are often incompatible



Person	Job
Elvis	singer



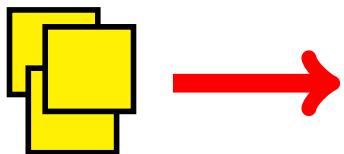
Person	Occupation
Elvis P.	singer



<person>
<occupation>



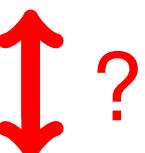
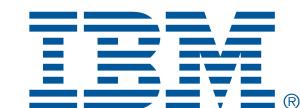
Companies are often incompatible



Person	Job
Elvis	singer



Person	Occupation
Elvis P.	singer



<person>
<occupation>



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

- Buying stuff in a supermarket

Netto App, iPhone, bank account, mail account, Netto homepage

[>more](#)

Where do we need interaction?

- Web service composition

Interaction between client and Web services
and Web services themselves

- Intelligent home

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

- 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

- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- RDFa
- Applications

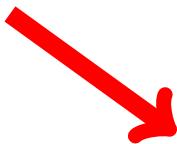
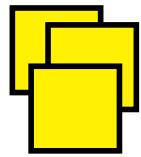
Def: RDF

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

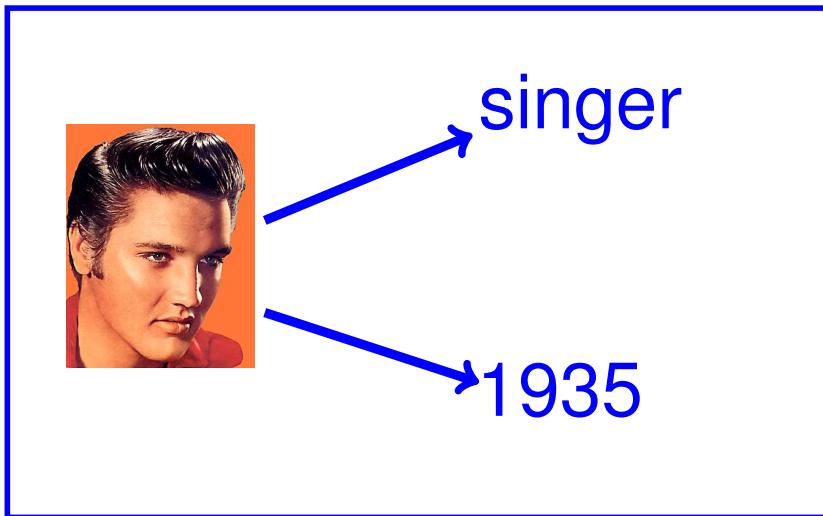
- entities
- classes
- binary relations
- labels

... which is coincidentally the representation that we have been using throughout this lecture.

Knowledge Representation in SW

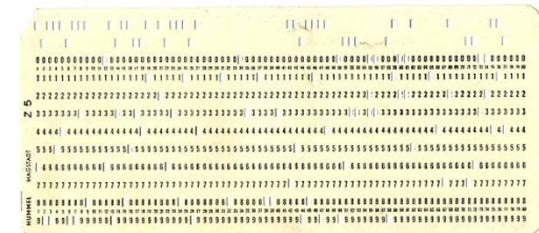


Person	Job	Birth
Elvis	singer	1935

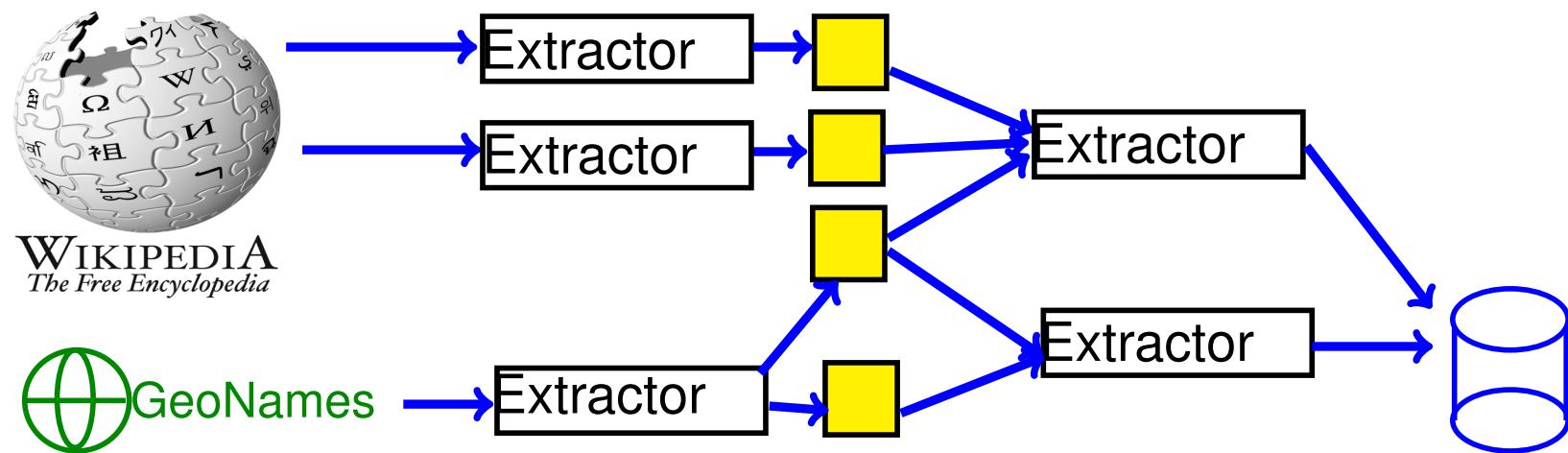


<person>

<occupation>



Example: YAGO

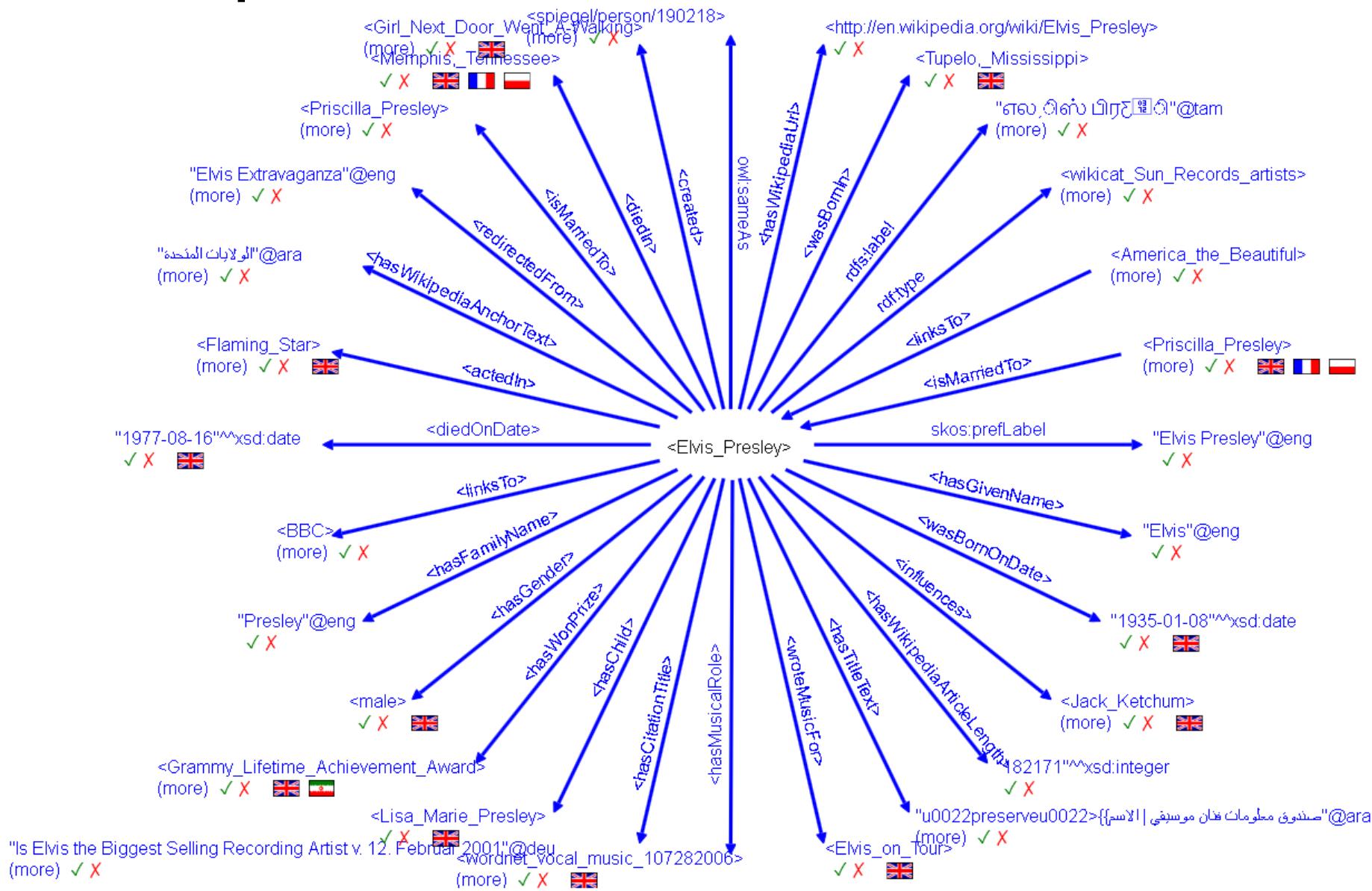


YAGO is a knowledge base that was automatically constructed from Wikipedia and other sources:

- 10m entities, 100m facts
- 95% accuracy
- 1700+ citations on WWW 2007 paper
- 10 languages
- used by IBM Watson, Bloomberg, DBpedia,...

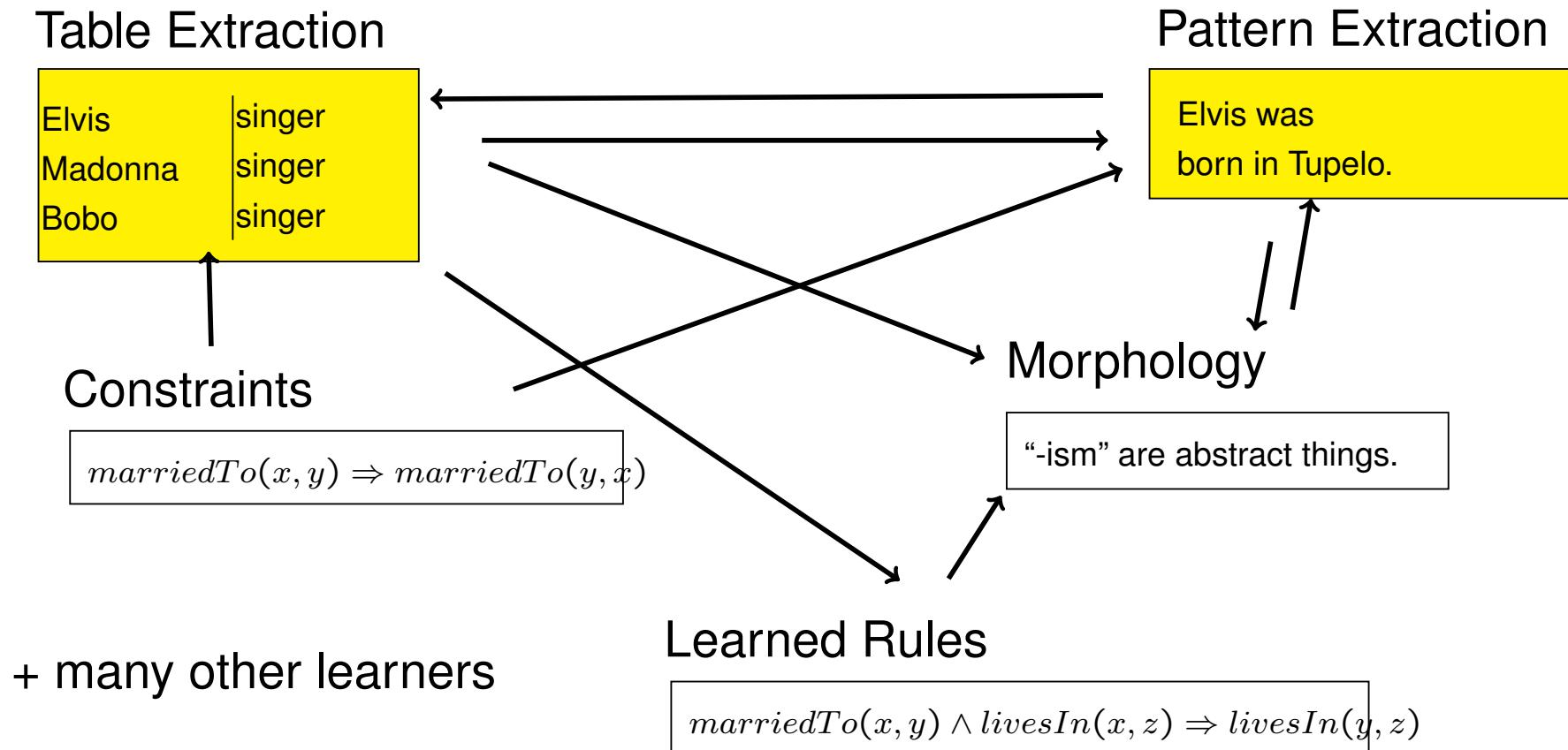


Example: YAGO about Elvis



Example: NELL / Read The Web

NELL (Never Ending Language Learner) is an information extraction project at Carnegie Mellon University. It couples several learners.



Example: NELL about “MacBook”

categories

- product(100.0%)
 - MBL @482 (99.9%) on 09-jan-2012 [Promotion of "product:macbook" productinstanceof "hallwayitem:windows"]
 - SEAL @7 (100.0%) on 13-jan-2010 [[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#) [15](#) [16](#) [17](#) [18](#) [19](#) [20](#) [21](#) [22](#) [23](#) [24](#) [25](#) [26](#) [27](#) [28](#) [29](#) [30](#) [31](#) [32](#) [33](#) [34](#) [35](#) [36](#) [37](#) [38](#) [39](#) [40](#) [41](#) [42](#) [43](#) [44](#) [45](#) [46](#) [47](#) [48](#) [49](#) [50](#) [51](#) [52](#) [53](#) [54](#) [55](#) [56](#) [57](#) [58](#) [59](#) [60](#) [61](#) [62](#) [63](#) [64](#) [65](#) [66](#) [67](#) [68](#) [69](#) [70](#) [71](#) [72](#) [73](#) [74](#)] using macbook
 - OE @806 (88.7%) on 23-jan-2014 [] using macbook

relations

- createdbyagent
 - [apple001](#) (100.0%)
 - CPL @1024 (50.0%) on 27-oct-2016 ["arg1 iPhone and arg2"] using (apple, macbook)
- haswikipediaurl
 - <http://en.wikipedia.org/wiki/MacBook> (95.0%)
 - AliasMatcher @621 (95.0%) on 03-aug-2012 [Freebase 7/9/2012]
- iteminvolvedwithagent
 - [apple001](#) (100.0%)
 - CPL @1010 (87.5%) on 04-aug-2016 ["arg1 iPhone and arg2" "arg1 releases a new version of arg2" "arg2 and iPod are trademarks of arg1"] using (apple, macbook)
- producedby
 - [apple001](#) (100.0%)
 - SEAL @168 (50.0%) on 17-nov-2010 [[1](#)] using (apple, macbook)
 - OE @838 (86.3%) on 16-may-2014 [<http://www.amazon.com/Apple-MacBook-MD313LL-13-3-Inch-VERSION/dp/B005CWIVYI> <http://macbookpro.macrumors.com/> <http://macbookpro.macrumors.com/> <http://macbookpro.macrumors.com/> <http://macbookpro.macrumors.com/> <http://macbookpro.macrumors.com/> <http://macbookpro.macrumors.com/>]

Example: DBpedia

DBpedia is a crowd-sourced community effort to extract structured information from Wikipedia and make this information available on the Web. [[DBpedia.org](http://dbpedia.org)]

About: place

An Entity of Type : [Class](#), from Named Graph : <http://dbpedia.org/resource/classes#>,

Immobile things or locations.

Property	Value
rdf:type	<ul style="list-style-type: none">owl:Class
rdfs:comment	<ul style="list-style-type: none">Immobile things or locations. (en)
rdfs:isDefinedBy	<ul style="list-style-type: none">http://dbpedia.org/ontology/
rdfs:label	<ul style="list-style-type: none">place (en)
rdfs:subClassOf	<ul style="list-style-type: none">owl:Thing
owl:equivalentClass	<ul style="list-style-type: none">dbo:Locationschema:Place

Example: DBpedia about Elvis

About: [Elvis Presley](#) [Goto Sponge](#) [NotDi](#)

An Entity of Type : [yago:WikicatAmericanPeopleOfScotch](#)

Type: [yago:WikicatAmericanPeopleOfScotch-IrishDescent](#) ▾

Elvis Aaron Presley (January 8, 1935 – April 12, 1977) was an American singer and actor who became one of the most significant cultural icons of the 20th century. He was born in Tupelo, Mississippi, as a twin to his brother, Gladys and Vernon Presley. His music career began there in 1948, when he joined his father's band, the Memphis-based Blue Moon Boys.

Attributes

[filename](#)

Values

Power of My Love.ogg
Run On.ogg
That's All Right.ogg

[id](#)

62([xsd:integer](#))

[occupation](#)

Singer, musician, actor

[relatives](#)

[Riley Keough](#)

[religion](#)

Pentecostal

[resting place](#)

Graceland, Memphis,

[spouse](#)

1967([xsd:integer](#))

1973([xsd:integer](#))

[Priscilla Presley](#)

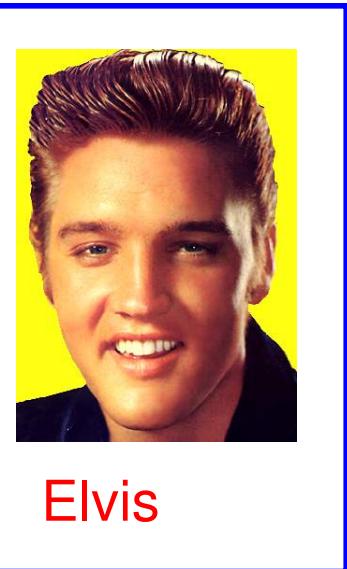
divorced

The Semantic Web

- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- RDFa
- Applications

Globally identifying entities

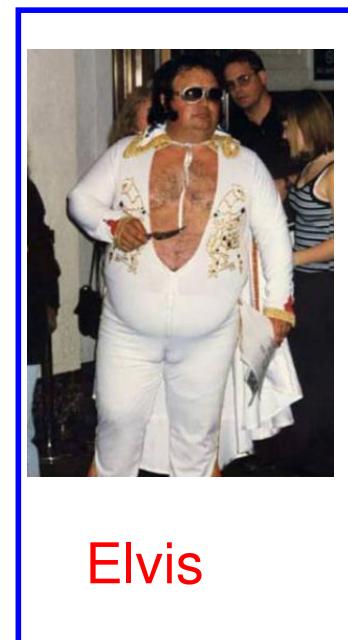
KB1



KB2



KB3



KB4



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

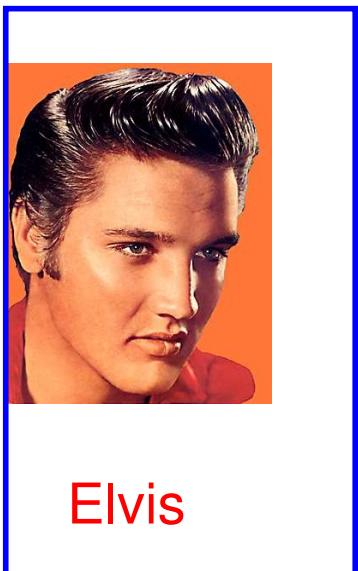
Examples

What if KBs have the same name?

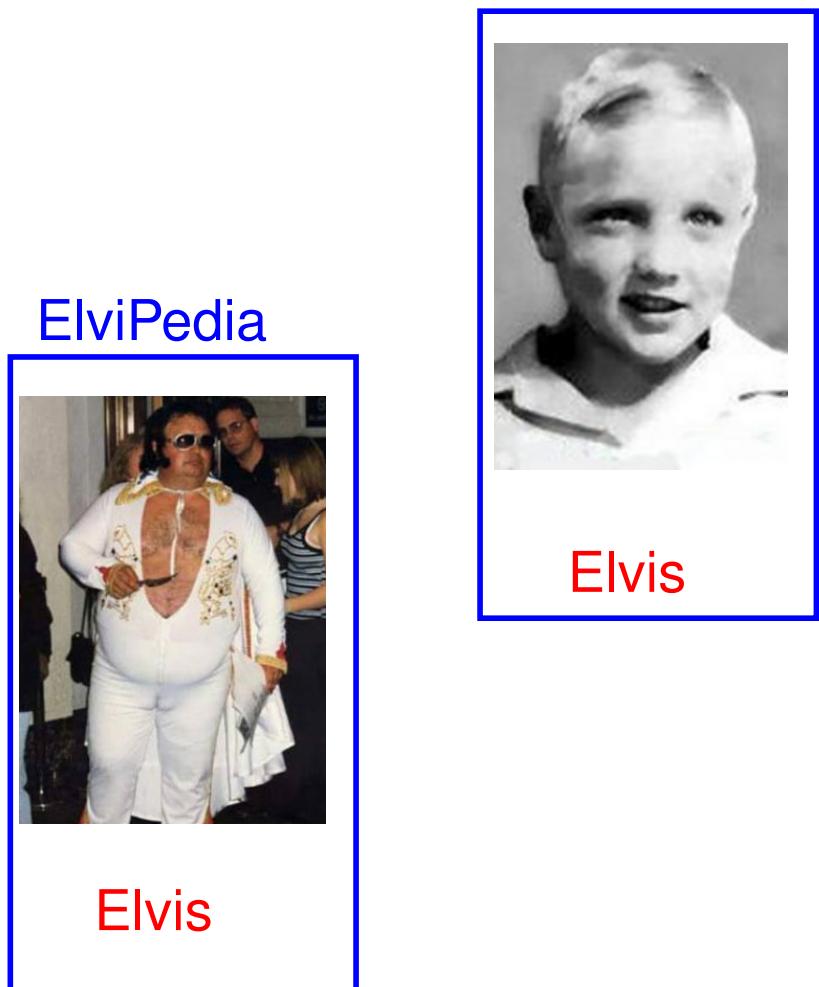
ElvisKB



ElvisKB



ElviPedia



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>

- File identifiers

<file:///c:/users/elvis/tripToMoon.txt>

- FTP

<ftp://elvis@nsa.gov>

- MailTo

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

Not all URIs are dereferenceable

A URI per se is just a string.

It is not necessarily connected to a Web page.

<http://elvis.is/dead>

Not all URIs are dereferenceable

A URI per se is just a string.

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<http://elvis.is/dead>



Error 404

Sorry - this URL could not be found

You probably typed nonsense.

We assign a URI to each KB

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.

URI of ElviPedia:

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

Name in that namespace:

[Priscilla](#)

Qualified name:

[\(again a URI\)](http://elvis.org/kb/Priscilla)

Namespaces

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

World-wide unique
mapping to domain
owner

in the responsibility
of the domain owner

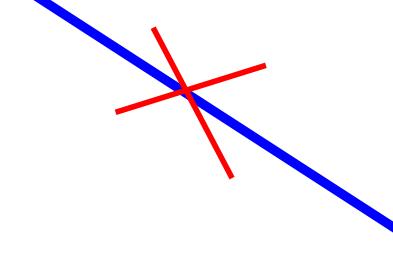
=> There should be no overlap

- 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.

<http://kb.org/Priscilla>

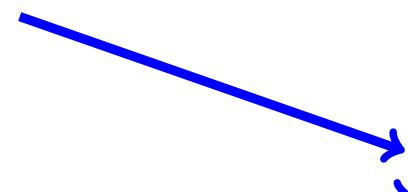


URIs can be synonymous

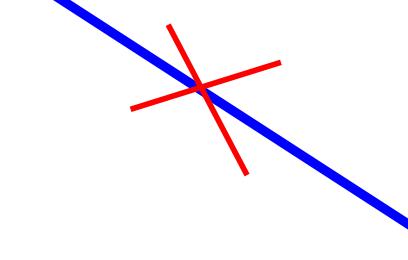
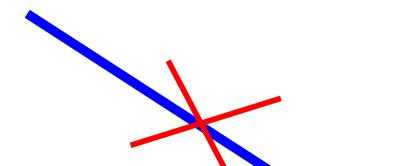
A URI always refers to one entity, never to more entities.

One entity can be referred to by several URIs.

<http://onto.org/Priscilla>



<http://kb.org/Priscilla>



Def: Base URI

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

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

<Elvis relative URI, interpreted wrt. base URI

=

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

Def: Namespace prefix&CURIE

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 ← CURIE (Compact URI)
= or QName (qualified name)
<<http://dbpedia.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

URI—Curie URI—Curie URI—Curie—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.

Data types

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

"literal"^^datatype

The datatype is given by a URI or Curie.

[see them](#)

It is common to use the XML datatypes

[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. Inf, 0, NaN

[xsd:float](#) 32-bit floating point numbers incl. 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

...

Summary: URIs & Turtle

- URIs are identifiers, often look like URLs

`http://sing.it/elvis`

- Curies abbreviate URIs

`y:Elvis`

- Turtle is a syntax for RDF facts

`<http://kb.org/Elvis> y:sings y:AllShookUp .`

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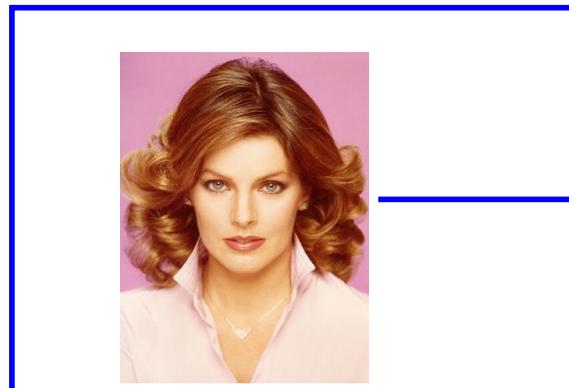
Cross-referencing

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:MikeStone .



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

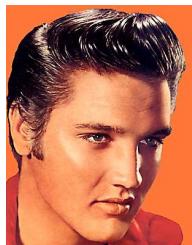
RDF is also a vocabulary (=KB) that defines basic notions of KB representation.

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

rdf:type, rdf:Property, rdf:Statement ...

see this KB

We can use notions from this KB:



rdf:type → y:Singer

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



see Example

Sharing vocabularies

Shared vocabularies mean

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

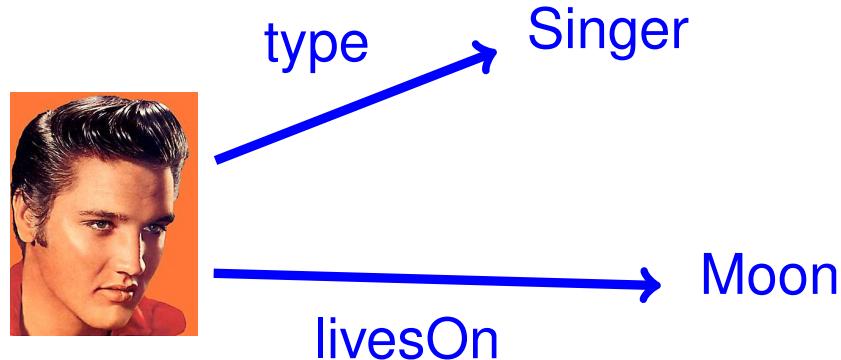
Some shared vocabularies have become standards on the Semantic Web. They have a standard namespace prefix. However, nothing prescribes the use of these vocabularies or prefixes.

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

Task: Turtle & RDF

Write the following facts in Turtle,
using RDF vocabulary where possible.

URI of KB: <<http://whatyoushouldknow.org/>>



Start with

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

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/>

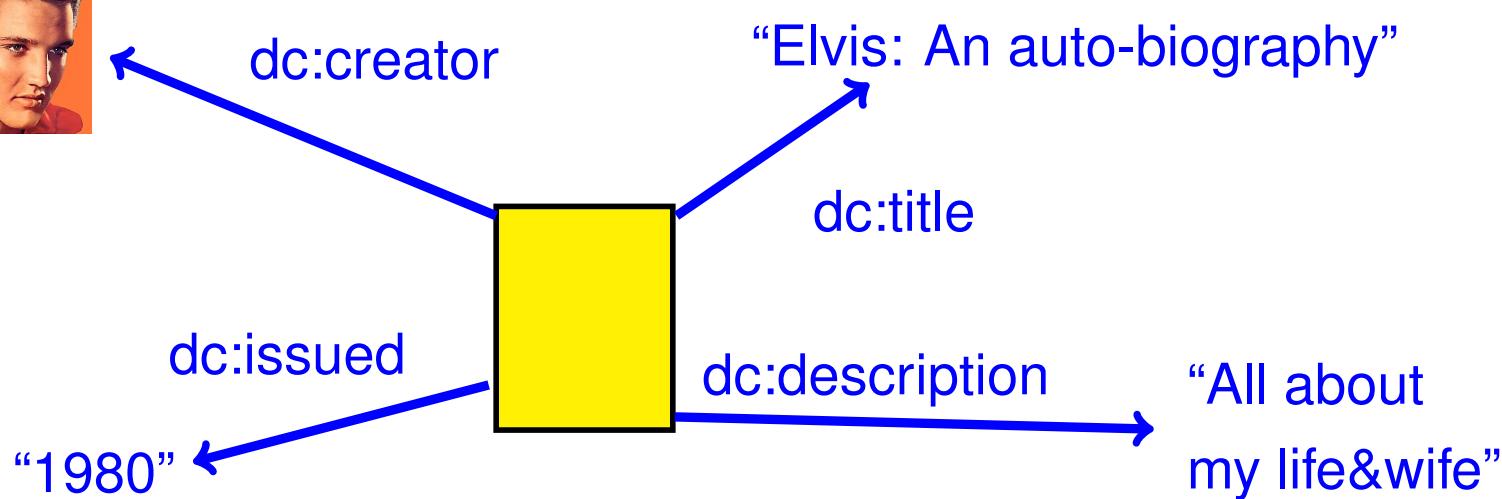
>more

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

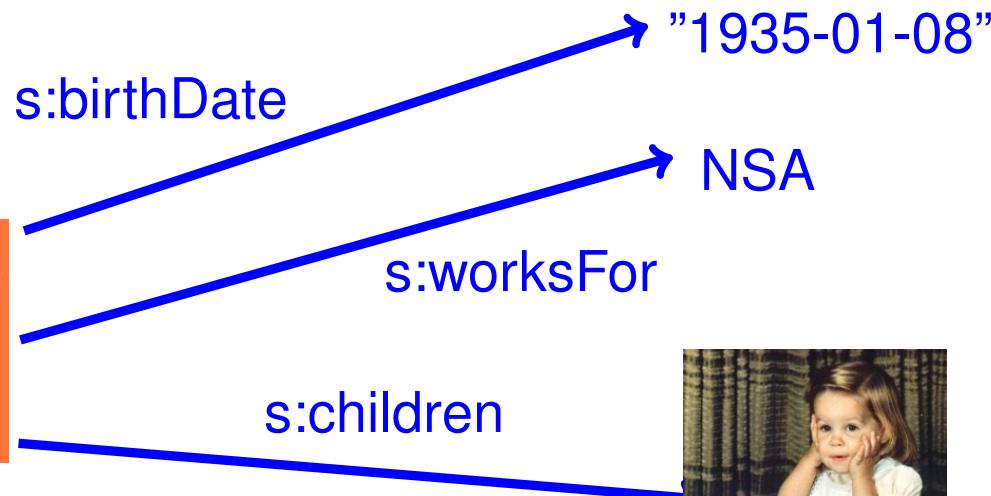
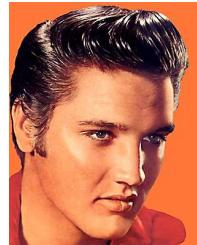


>more

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

Open Graph

Open Graph is a KB by Facebook for describing Web content.

[video:actor](#), [video:duration](#),
[book:author](#), [profile:gender](#), ...

[see this KB](#)

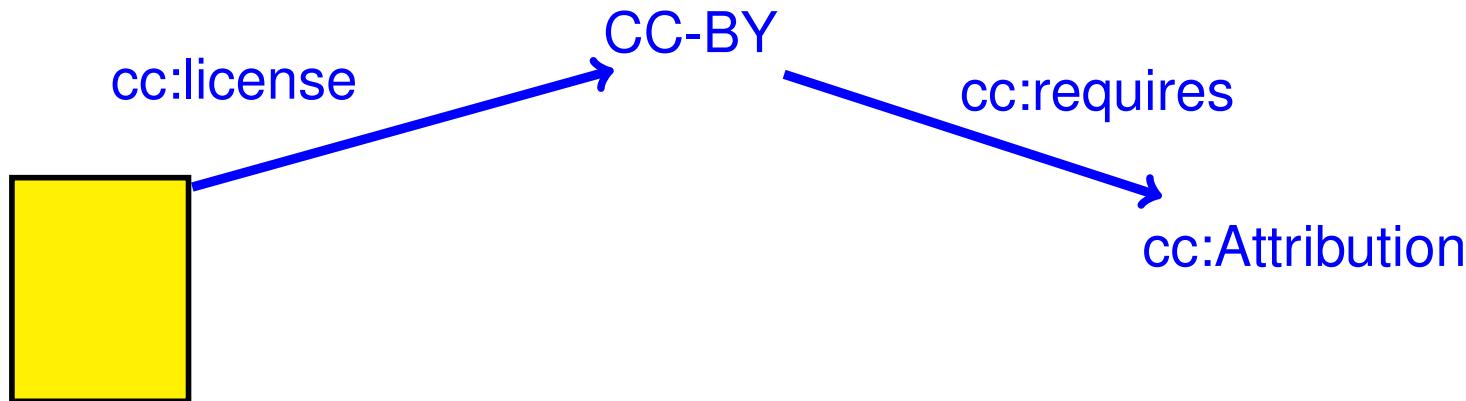
[>more](#)

Creative Commons

Creative Commons provides their vocabulary in RDF.

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

see this KB



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

- Knowledge Representation
- URIs
- Standard Vocabularies
- **Linked Data**
- RDFa
- Applications

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

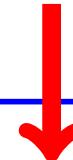
Cool URIs can be traversed

@prefix e: <<http://elvispedia.org/>>

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

e:Priscilla e:loves d:MikeStone

...



<http://dbpedia.org/MikeStone>



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

@prefix rdf: <<http://w3c.org/.../rdf>>

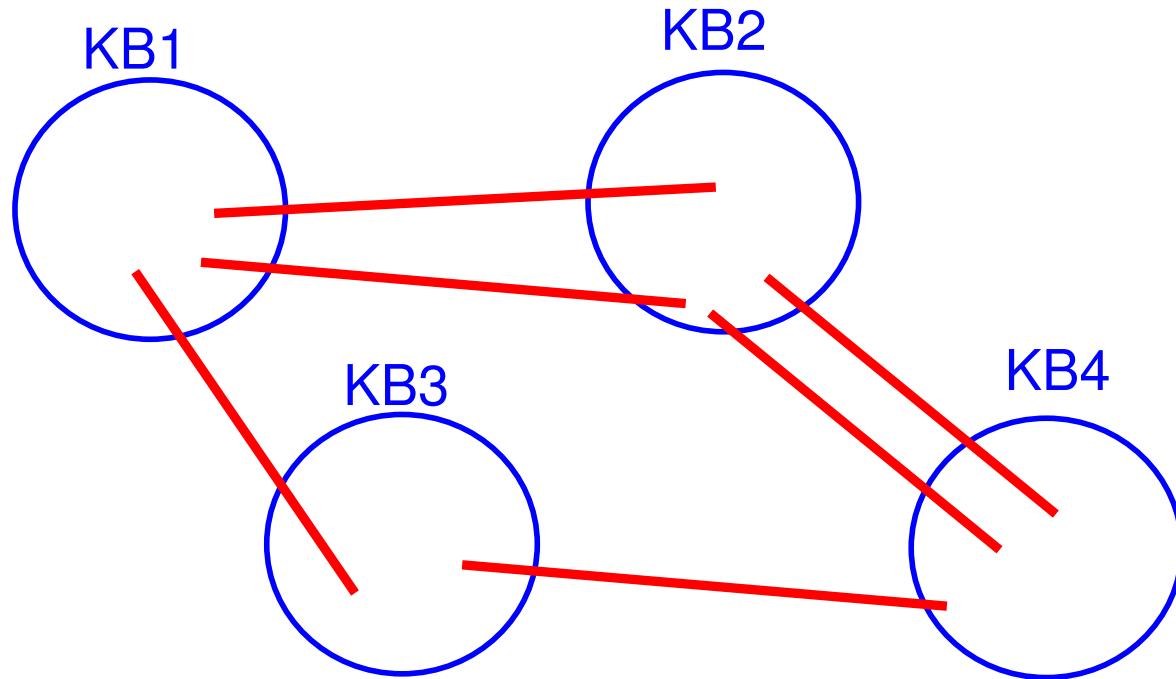
d:MikeStone rdf:type d:KarateClown

d:MikeStone d:livesIn d:LosAngeles

...



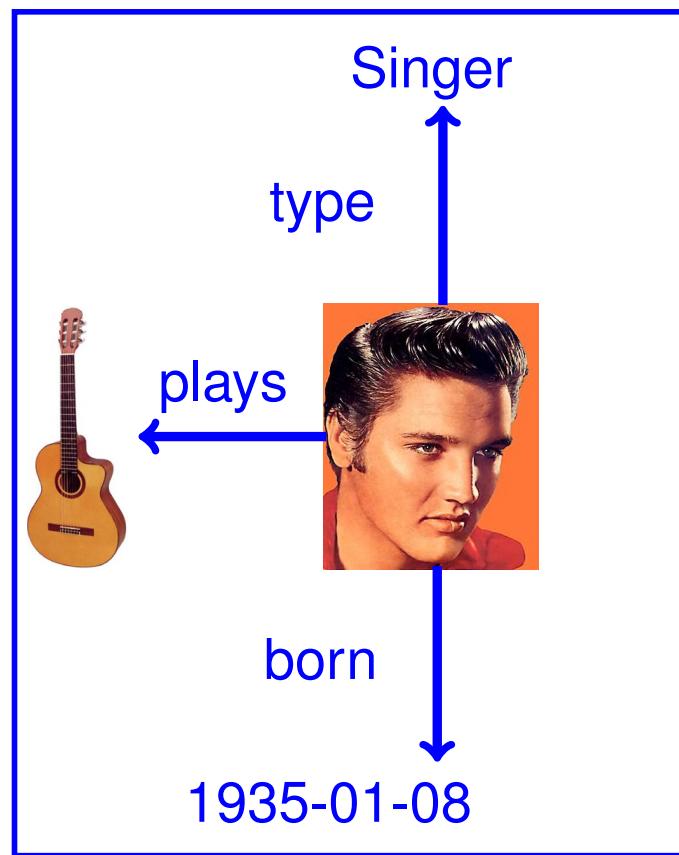
Cool URIs can be traversed



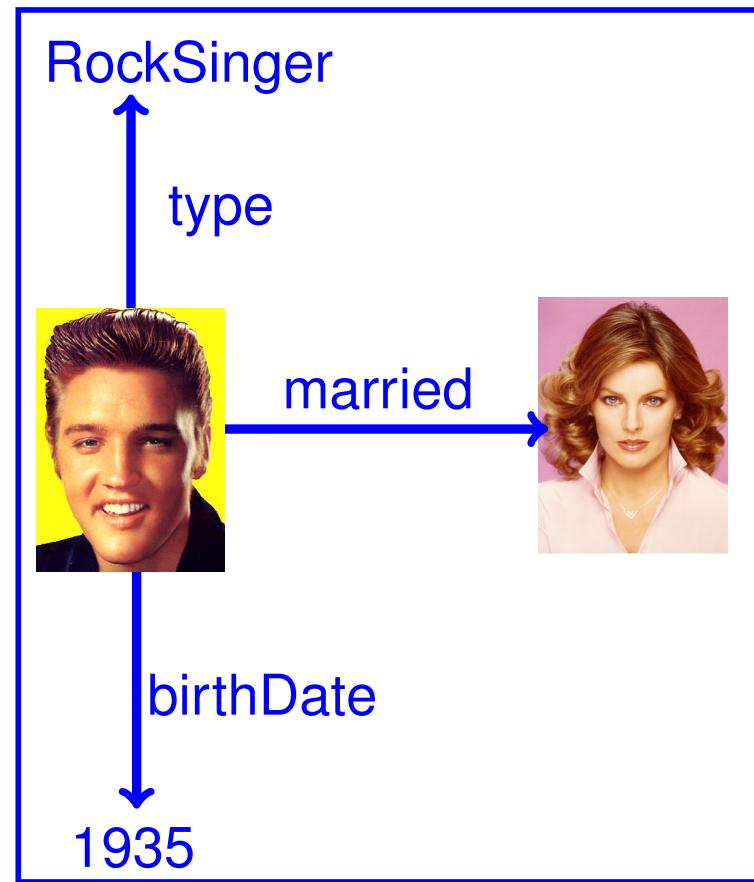
The standard vocabularies (RDF, RDFS, schema.org, Creative Commons, etc.) all provide dereferenceable URIs, as do many KBs.

[try it out](#)

Everybody can create KBs & URIs



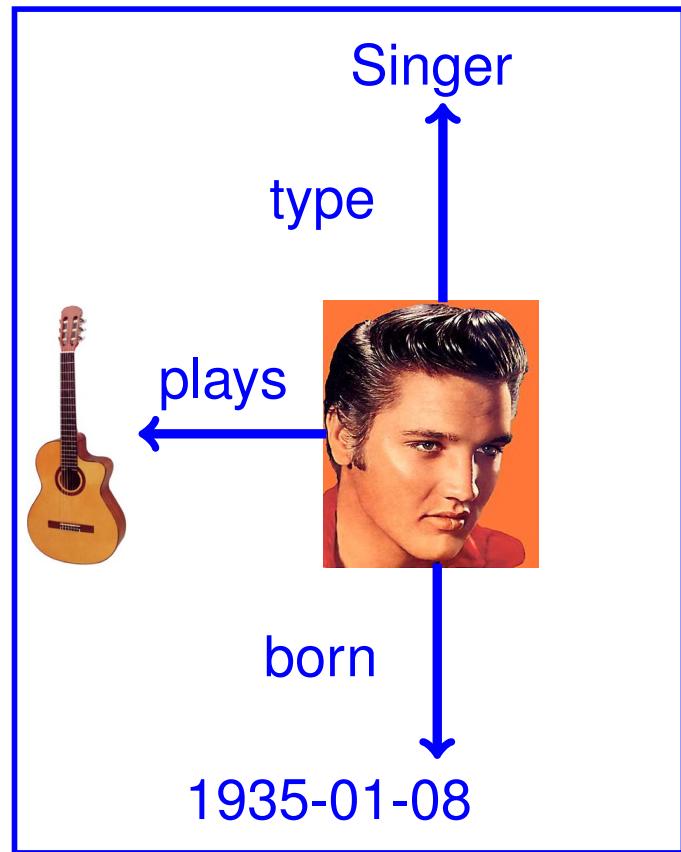
YAGO



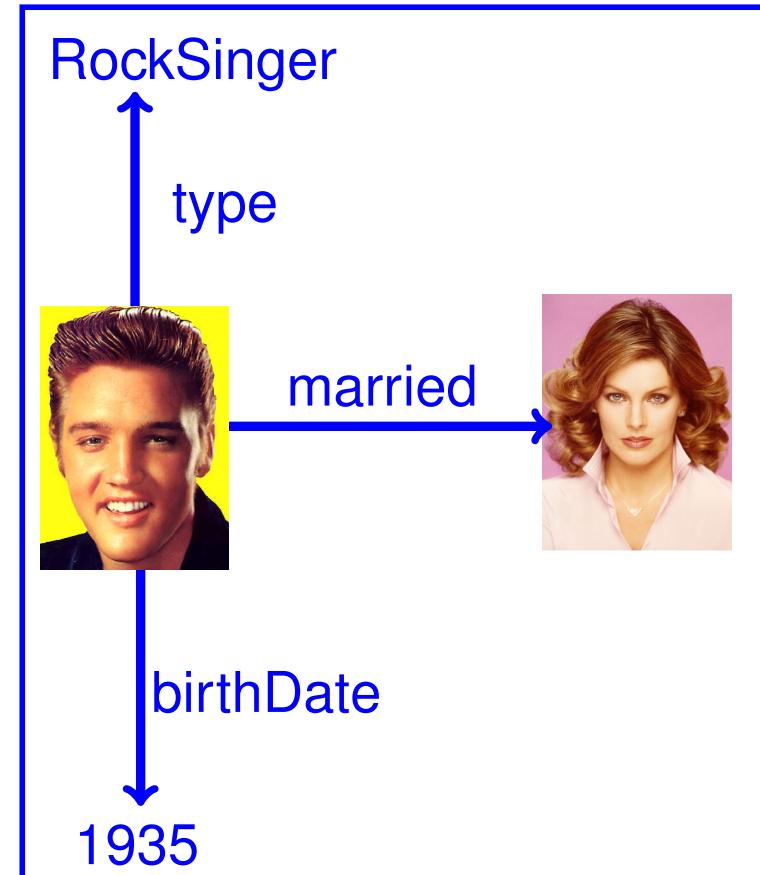
ElvisPedia

Distinct URIs => No use

Who is the spouse of the guitar player?



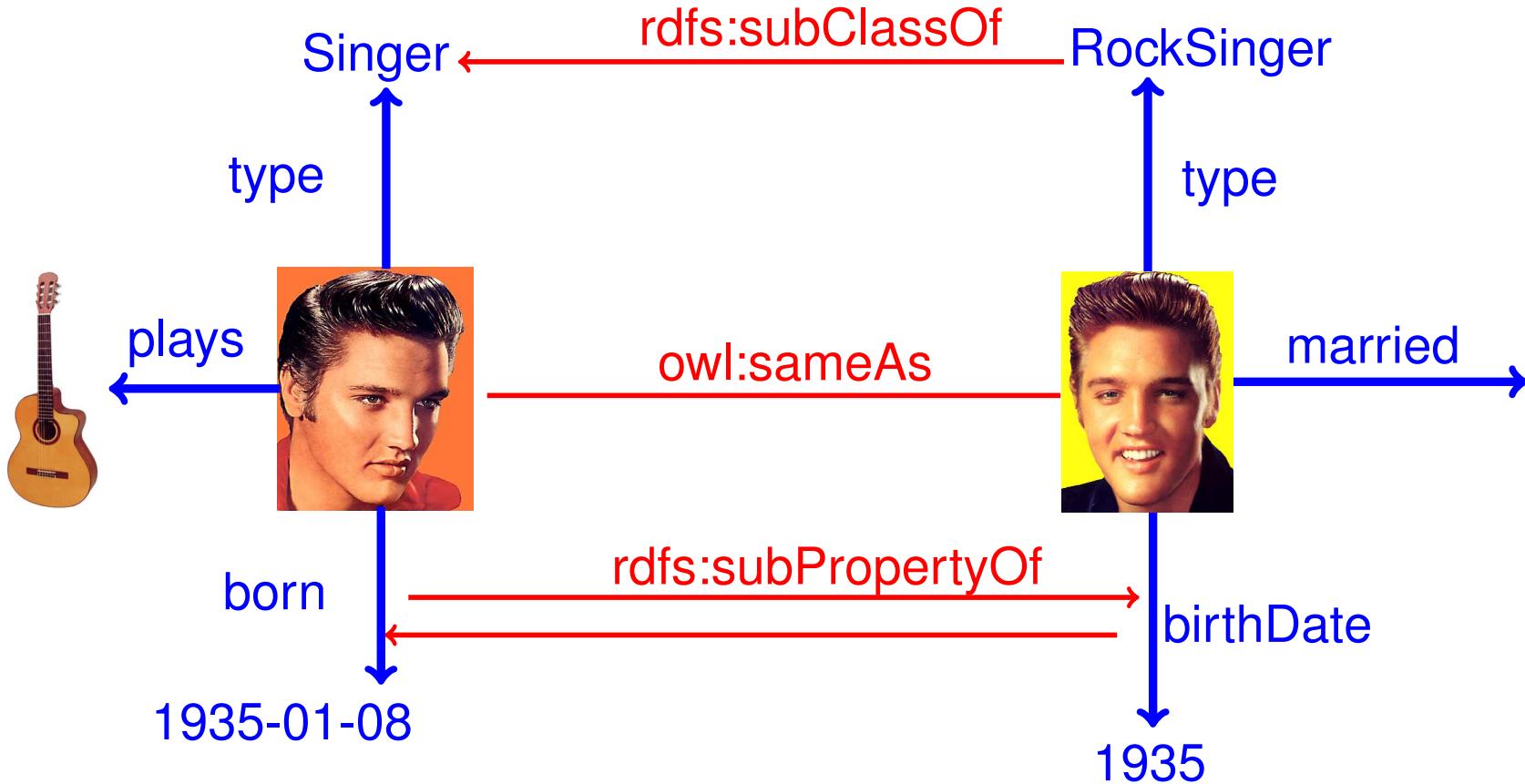
YAGO



ElvisPedia

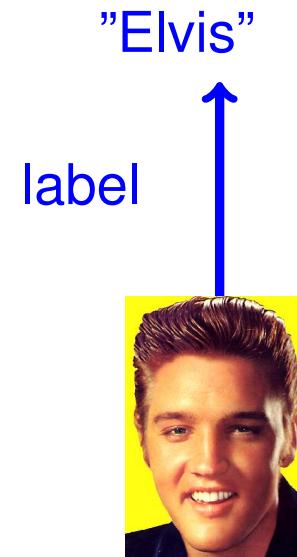
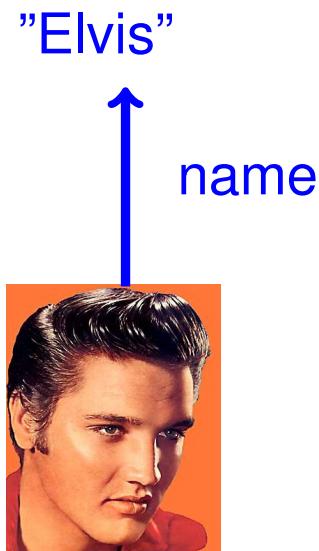
Def: Knowledge Base Alignment

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.



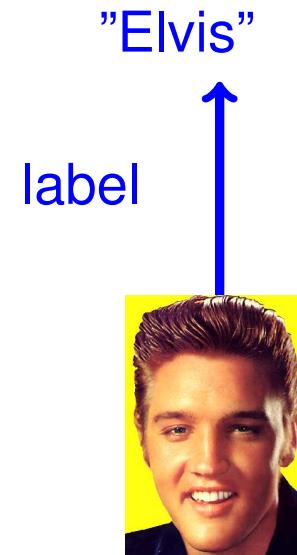
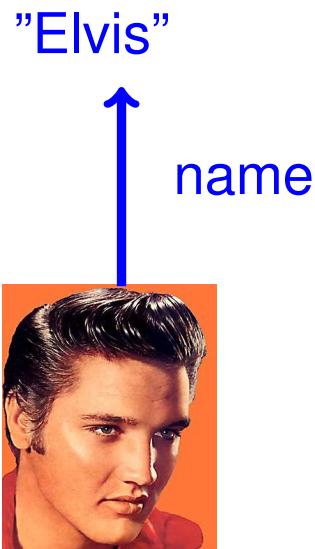
OWL and RDF are standard vocabularies for the linking.

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



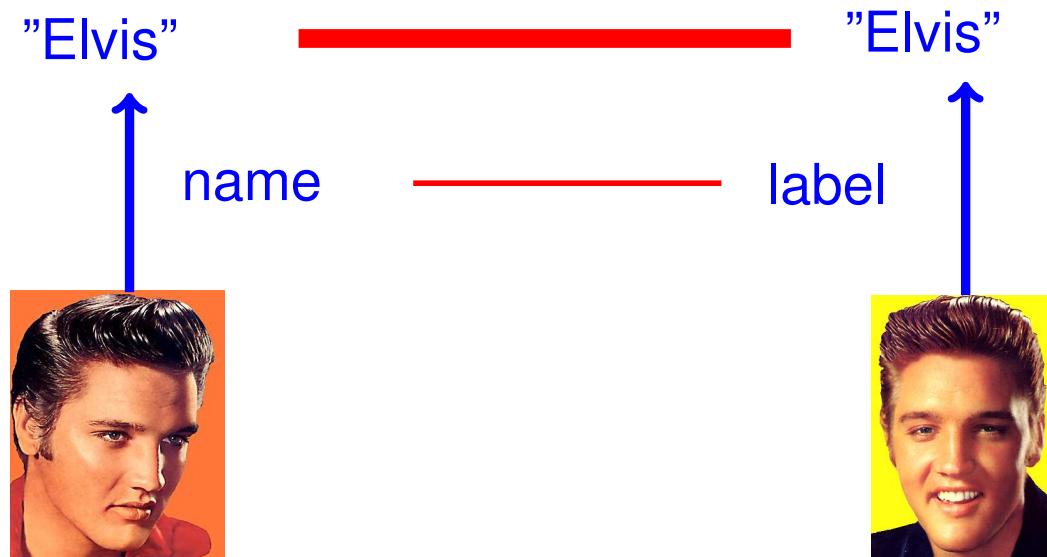
1. Match literals

Match classes, entities, & relations



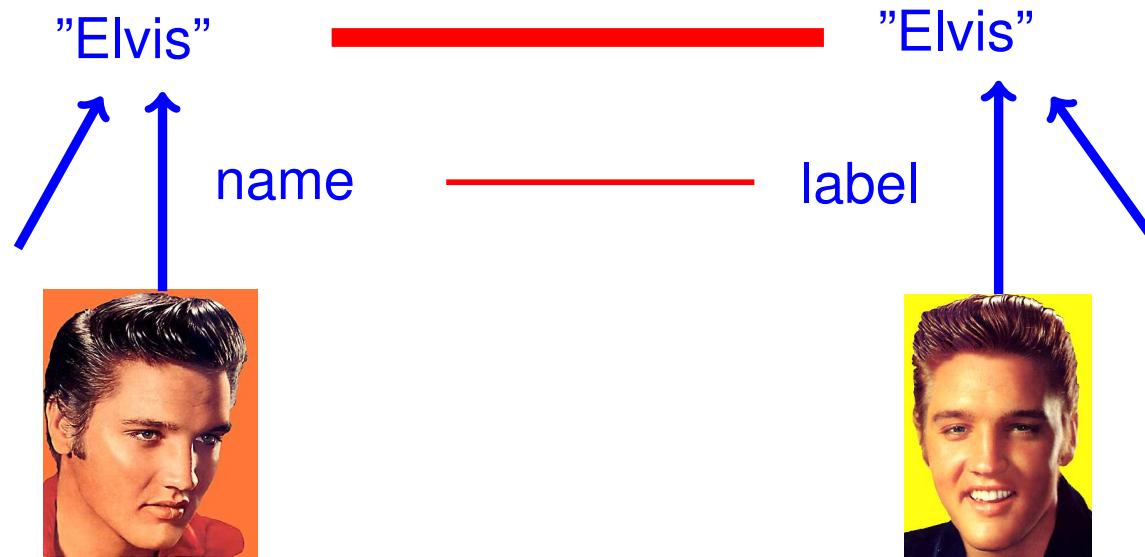
2. Assume small equivalence of all relations

Match classes, entities, & relations



2. Assume small equivalence of all relations

Match classes, entities, & relations



What about matching the entities?

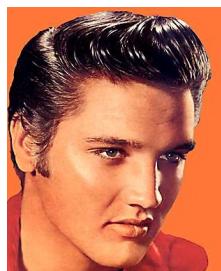
What does it mean that both Elvises share the same name?

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.

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



$$fun(Elvis, born) = 1$$
$$fun(Elvis, sang) = 0.$$

Def: Functionality

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

$$fun(r) = HM_x fun(x, r)$$

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

(corrected sentence)

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

Example:

$fun(hasBirthDate) = 1$ (exactly one object per subject)

$fun(hasDeathDate) = 1$ (at most one object per subject)

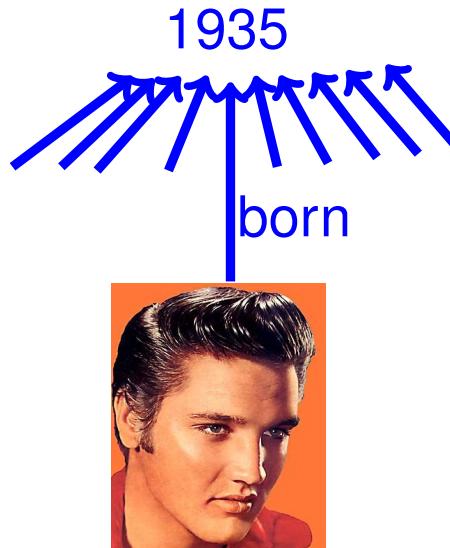
$fun(hasNationality) = 0.9$ (few objects per subject)

$fun(hasFriend) = 0.2$ (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 $r(x, y)$.

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



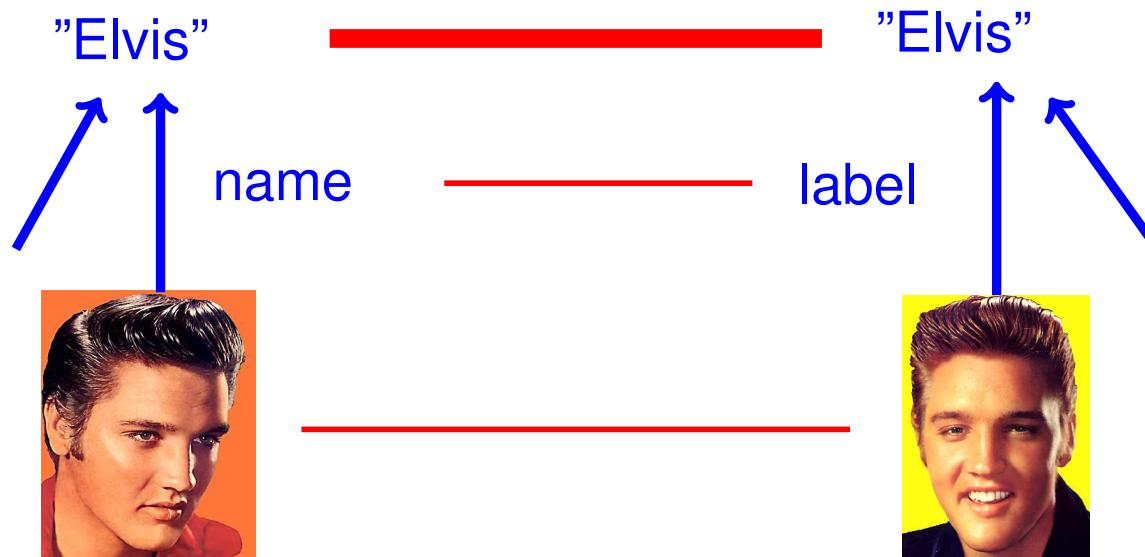
$$ifun(name, Elvis) = \frac{1}{2}$$

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

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

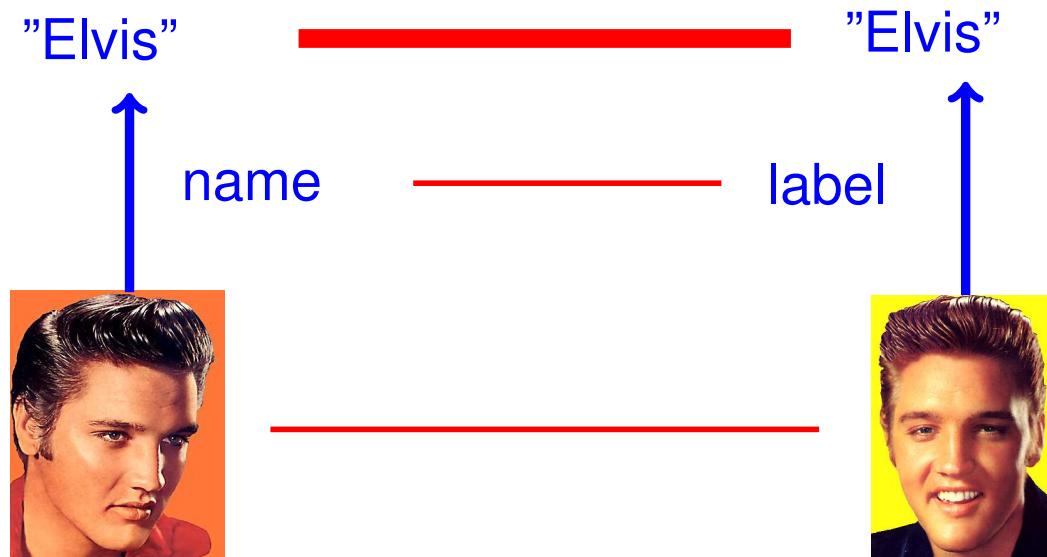
$$ifun(name) = 0.9$$
$$ifun(born) = 0.1$$

Match classes, entities, & relations



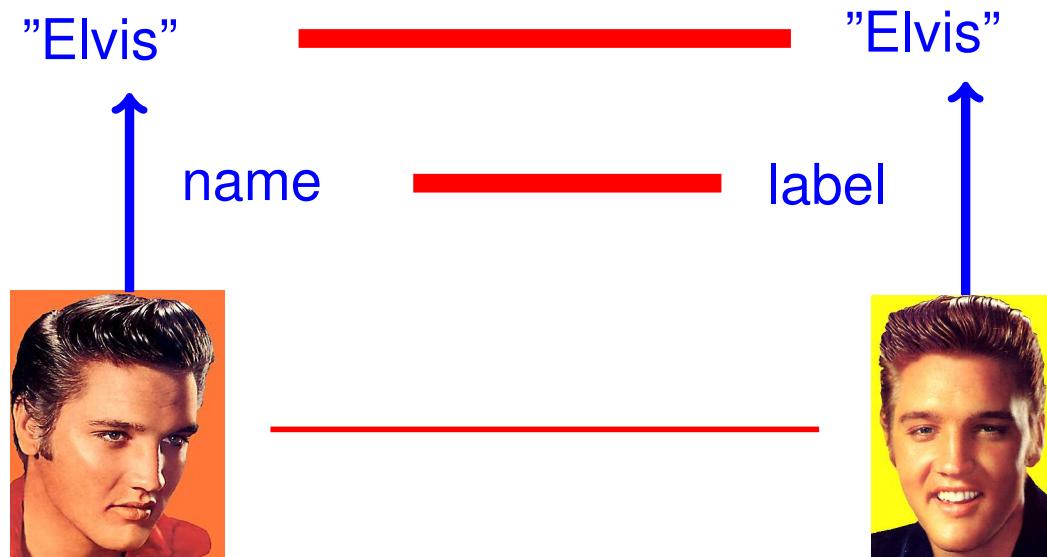
3. If subjects share a relation that is highly inverse functional, and the object is matched, then match the subjects.

Match classes, entities, & relations



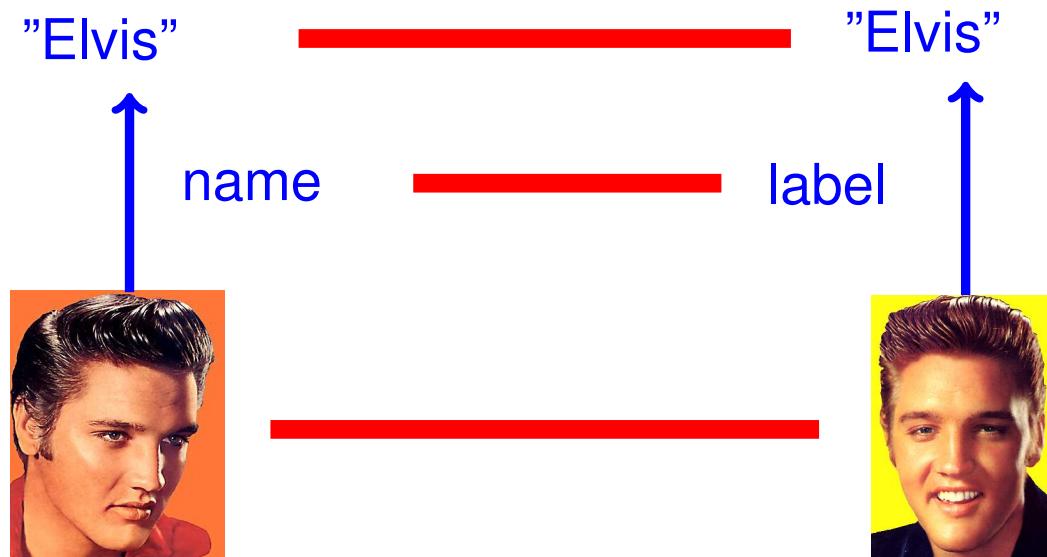
4. If relations share many pairs,
increase their match

Match classes, entities, & relations



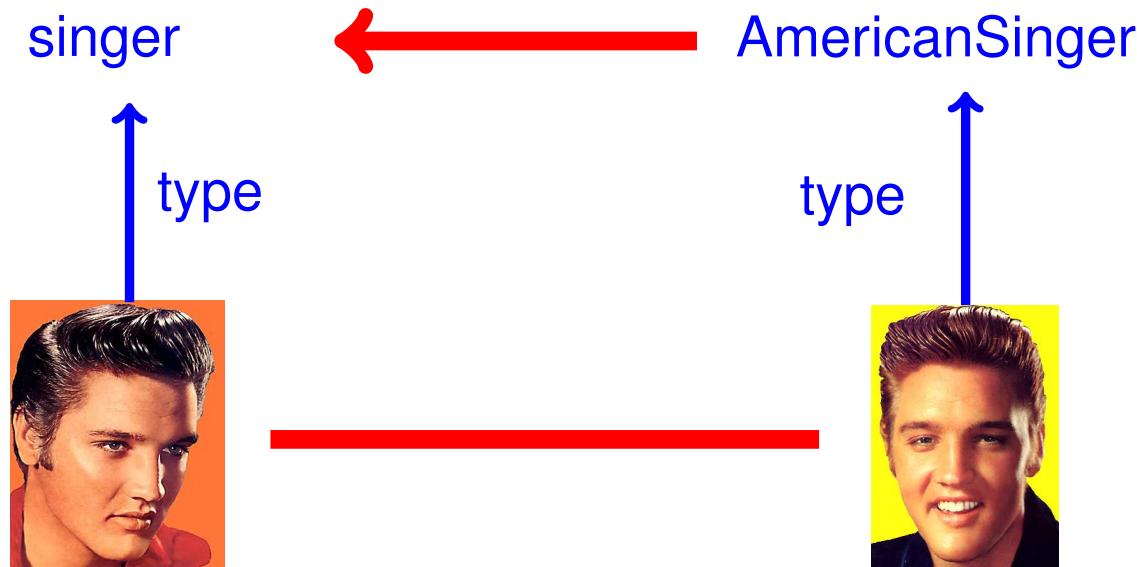
4. If relations share many pairs,
increase their match

Match classes, entities, & relations



5. Iterate

Match classes, entities, & relations

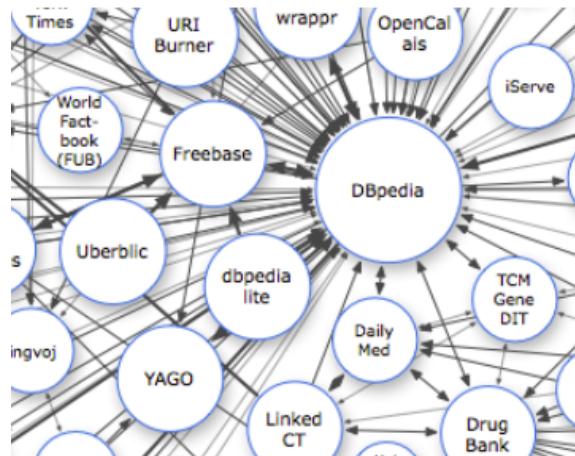


6. Compute class subsumption
(based on the overlap of entities)

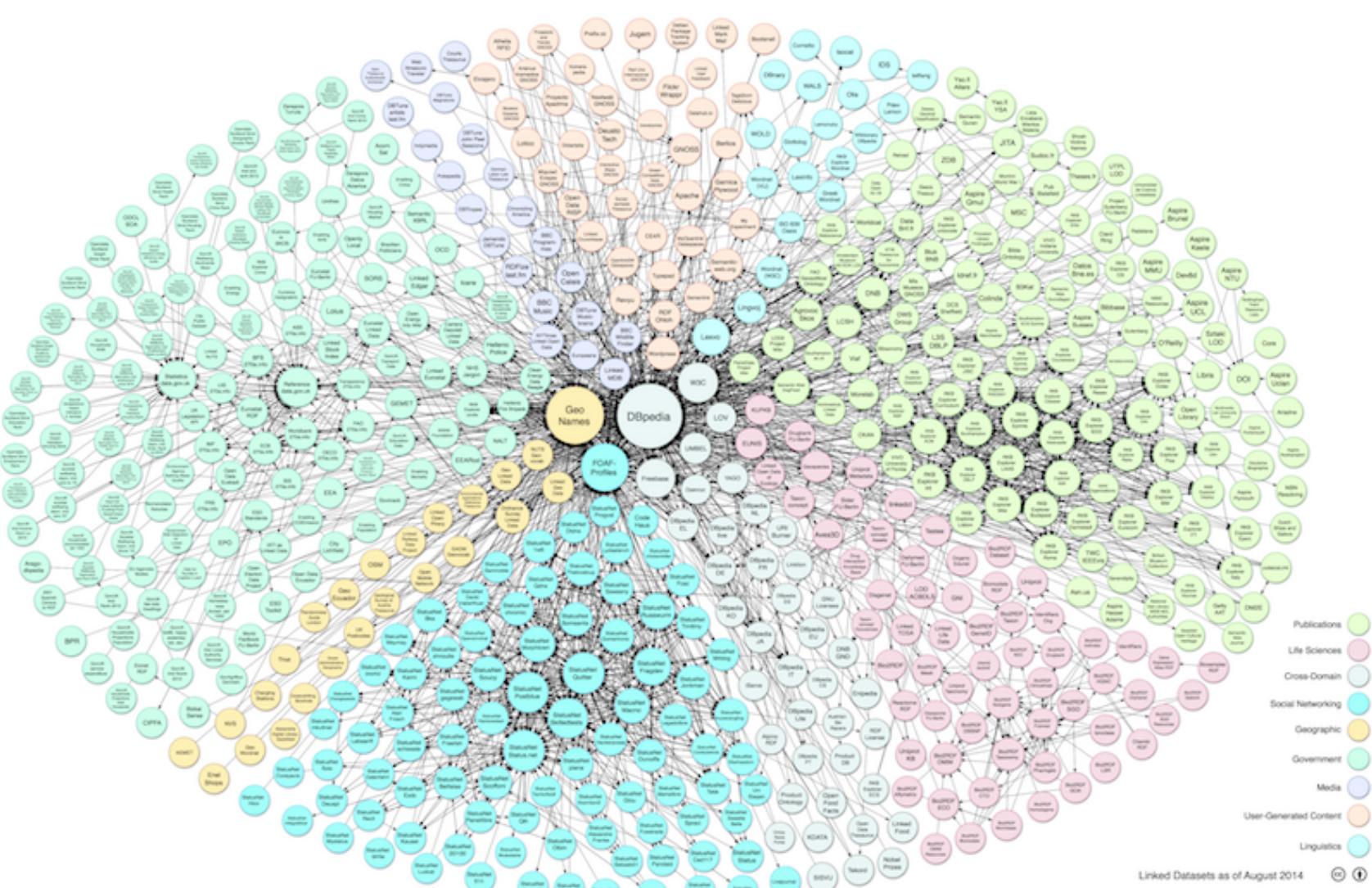
Numerous other approaches exist (e.g. based on name similarity).

Def: Linked Open Data Project

The goal of W3C's Linked Open Data Project is to publish and link open KBs.



The Linked Open Data Project



As of 2014: 1000 Kbs

>details

lod-cloud.net

72

The Linked Open Data Project

Existing KBs include

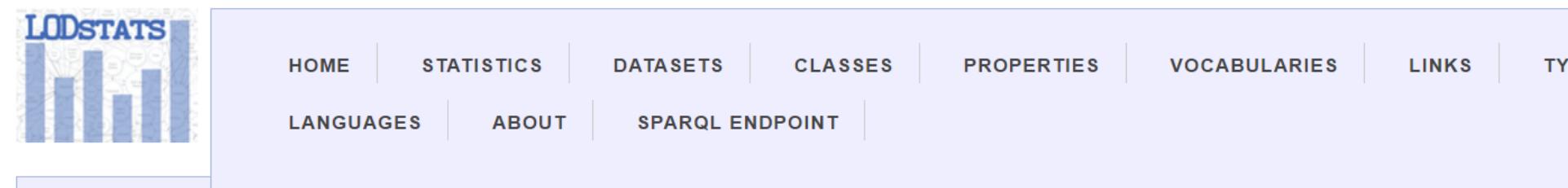
- US census data
 - BBC music database
 - Gene ontologies
 - DBpedia general knowledge, + YAGO, + Cyc etc.
 - UK government data
 - geographical data in abundance
 - national library catalogs (USA, Germany etc.)
 - publications (DBLP)
 - commercial products
 - all Pokemons
- ...and many more

[>details](#)

DataHub lists public KBS

The screenshot shows the DataHub website interface. At the top, there is a dark header bar with the DataHub logo on the left, which includes a stylized square icon and the text "datahub" in lowercase, followed by the tagline "The easy way to get, use and share data". To the right of the logo are three navigation links: "Datasets" (which is highlighted in a light gray box), "Organizations", and "About". Below the header, the main content area has a light gray background. On the left side, there is a sidebar titled "Organizations" with a dropdown arrow icon. It contains a list of organizations with their names and dataset counts: "Global (3433)", "London Datastore Ar... (612)", "Senegal (548)", "Open Hampton Roads (531)", and "Canada (514)". To the right of the sidebar is a large button labeled "Add Dataset" with a plus sign icon. Below it is a search bar with the placeholder text "Search...". At the bottom of the main content area, the text "10,632 datasets found" is displayed in a large, bold, black font.

LOD Stats shows KB Statistics



Cumulative numbers

9960 datasets

130,502,164,357 triples from **2740 datasets** (176,593,214 triples from **2612 dumps**, 130,325,571,143 from **145 datasets via SPARQL**)

Problems with **7203 datasets** (72.4%): **6804 dumps having errors, 399 SPARQL endpoints with errors**

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



The Semantic Web

- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- **RDFa**
- Applications

>details

How do we get HTML pages to RDF?

Paris fête le 14 juillet

SOMMAIRE

BALS DANS LES CASERNES DE POMPIERS

DÉFILE MILITAIRE SUR L'AVENUE DES CHAMPS-ELYSÉES

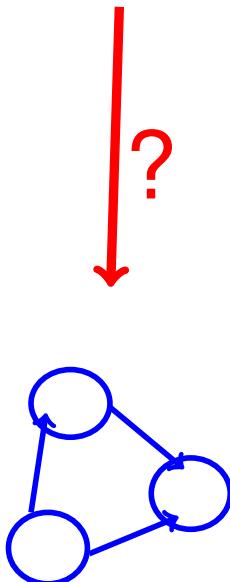
FEU D'ARTIFICE DU 14 JUILLET

LES FRANCIENS 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

Gerhard Weikum

Max-Planck-Institut für Informatik
Department 5: Databases and Information Systems
Building E1.4, Room 402
Campus E1.4
66123 Saarbrücken
Germany

Email: weikum@mpi-inf.mpg.de
Phone: +49 681 9325 500
Fax: +49 681 9325 599

>details

Def: RDFa

RDFa is a syntax to annotate HTML pages with RDF.

RDFa Lite

<div>

Martin Thunderbird

Researcher in Rock'N'Roll Music of 1935-1977

Memphis, Tennessee

</div>

>details

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

RDFa friends/foes

Standards that are similar to RDFa are

- Microformats
- Microdata

RDFa embeds facts 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)

RDFa Example

Kontakt

[Fabian M. Suchanek](#)

[Max-Planck Institut für Informatik](#)

Otto Hahn Research Group "[Ontologies](#)", office 414

Campus E1.4

66123 Saarbrücken

Germany

E-Mail: Vorname@Nachname.name

URL: <http://suchanek.name>



Try it out



```
@prefix og: <http://ogp.me/ns#> .  
@prefix rdfa: <http://www.w3.org/ns/rdfa#> .  
@prefix schema: <http://schema.org/> .  
  
<http://suchanek.name/about/index\_e.php> rdfa:usesVocabulary schema: .  
  
<http://suchanek.name/fabian> a schema:Person;  
  og:description "leader of the Otto Hahn Research Group";  
  og:image <http://suchanek.name/about/fabian.jpg>;  
  og:title "Fabian M. Suchanek";  
  schema:address [ a schema:PostalAddress;  
    schema:addressCountry <http://yago-knowledge.org/resource/Germany>;  
    schema:addressLocality "Saarbrücken";  
    schema:postalCode "66123";  
    schema:streetAddress "Campus E1.4" ];  
  schema:image <http://suchanek.name/about/fabian.jpg>;  
  schema:jobTitle "leader of the Otto Hahn Research Group";  
  schema:name "Fabian M. Suchanek";  
  schema:url <http://suchanek.name>;  
  schema:worksFor <http://mpii.de> .
```

The Semantic Web

- Knowledge Representation
- URIs
- Standard Vocabularies
- Linked Data
- OWL
- RDFa
- Applications

>more

Search engines scrape RDFa

[Sony Cyber-shot DSC-T100 review - Digital Camera - Trusted ...](#)

[www.trustedreviews.com](#) › [Cameras](#) › [Digital Camera](#) ▾

 Rating: 8/10 - Review by Cliff Smith

Feb 5, 2011 - Sony Cyber-shot **DSC-T100** Digital Camera review: Is Sony's flagship compact camera worth the asking price?

[>more](#)

Search engines scrape RDFa

[Sony Cyber-shot DSC-T100 review - Digital Camera - Trusted ...](#)

[www.trustedreviews.com](#) › [Cameras](#) › [Digital Camera](#) ▾

★★★★★ Rating: 8/10 - Review by Cliff Smith

Feb 5, 2011 - Sony Cyber-shot **DSC-T100** Digital Camera review: Is Sony's flagship compact camera worth the asking price?

RDFa embedded in Web page:

```
@prefix v: <http://rdf.data-vocabulary.org/#> .  
[] a v:Review;  
    v:dtreviewed "2011-02-05"@en;  
    v:itemreviewed "Sony Cyber-shot DSC-T100 review"@en;  
    v:rating [ v:best "10"@en;  
              v:rating "8"@en;  
              v:worst "1"@en ];  
    v:reviewer "Cliff Smith"@en .
```

>more

Search engines read licenses

Google Lisa Marie Presley

Web **Images** Maps Shopping More Search tools

Size Color Type Time

labeled for reuse More tools Clear

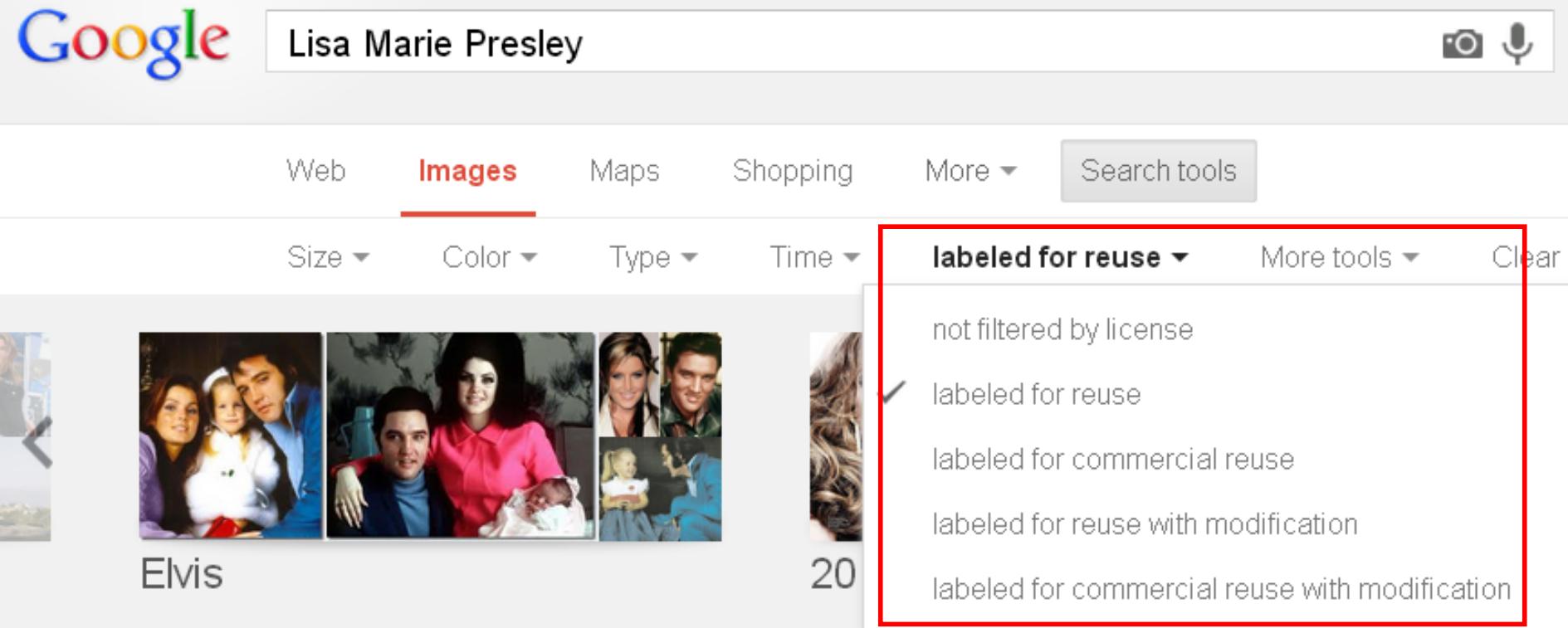
not filtered by license

labeled for reuse

labeled for commercial reuse

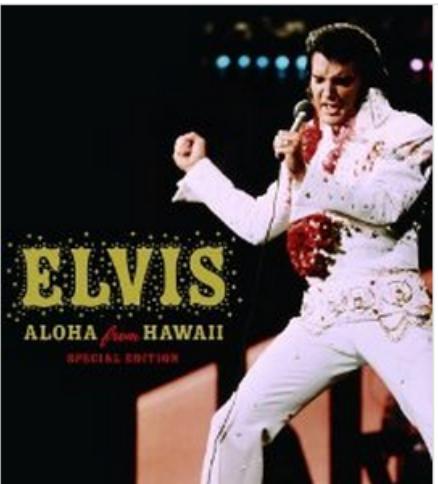
labeled for reuse with modification

labeled for commercial reuse with modification



Elvis 20 >more

Facebook Like Button uses RDFa



Elvis: Aloha from Hawaii

(1973)

TV Special - 87 min - Documentary | Music

More at
[IMDbPro »](#)



Your rating: ★★★★★★★★★★ 7,7 /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](#)

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Gefällt mir

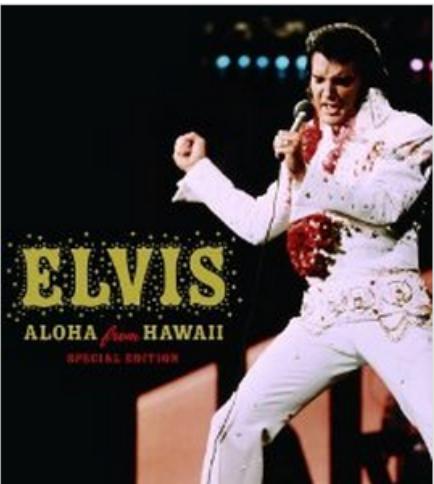


52 Personen gefällt das.

>more

93

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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[Parents Guide](#)

[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

Facebook public pages have RDFa



E-Mail oder Telefon

Passwort

Anmelden

Angemeldet bleiben

[Passwort vergessen?](#)



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

<<https://www.facebook.com/elvis>> og:description "Elvis Aaron Presley"@en;
og:image "<https://fbcdn-profile-a.akamaihd.net/.../elvis.jpg>"@en;
og:sitename "Facebook"@en;
og:title "ELVIS PRESLEY"@en;
og:type "band"@en;
og:url "<https://www.facebook.com/elvis>"@en .

>more

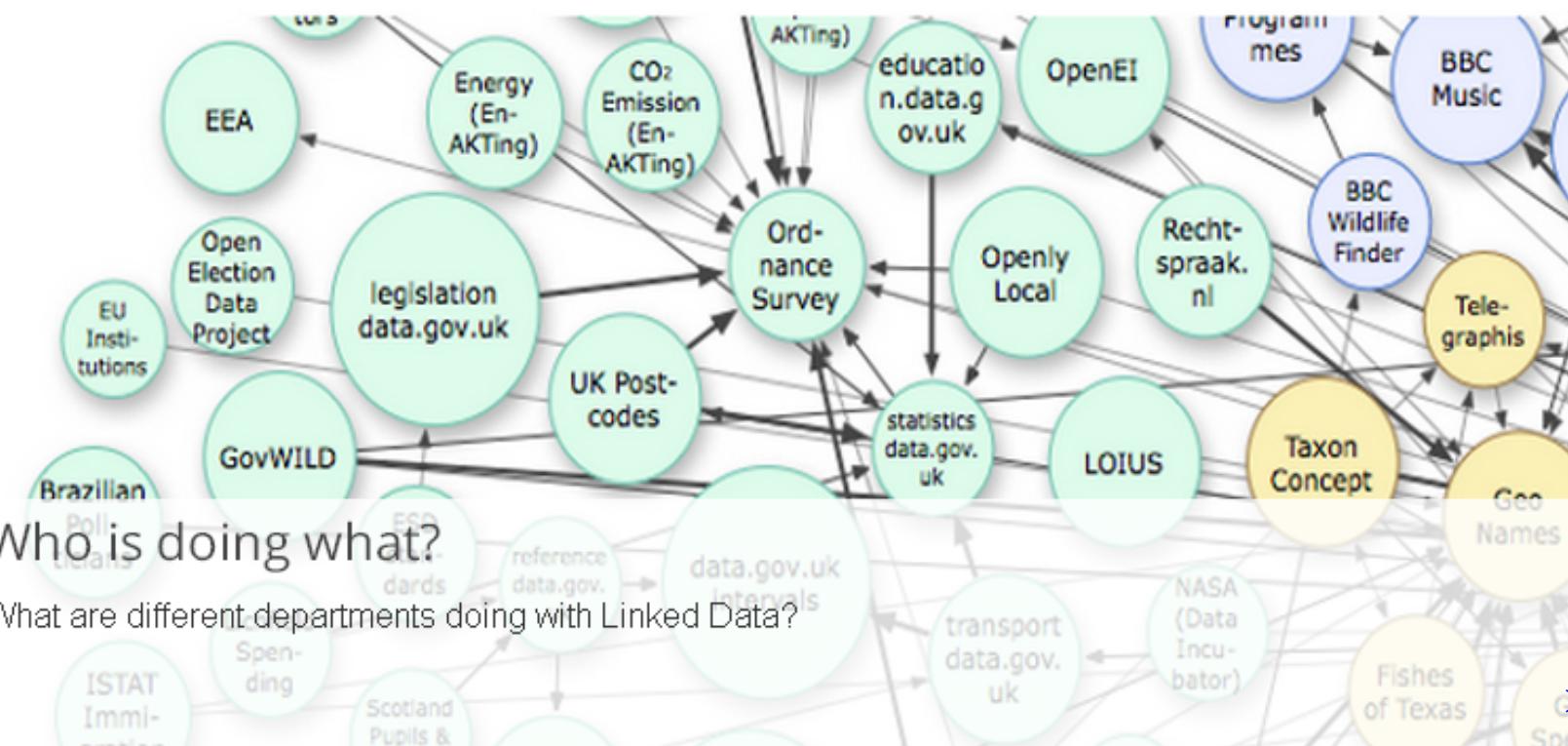
UK and US govts publish RDF



Home Data Participate Data requests Apps Location Linked

Linked data

1



2

Who is doing what?

What are different departments doing with Linked Data?

>more

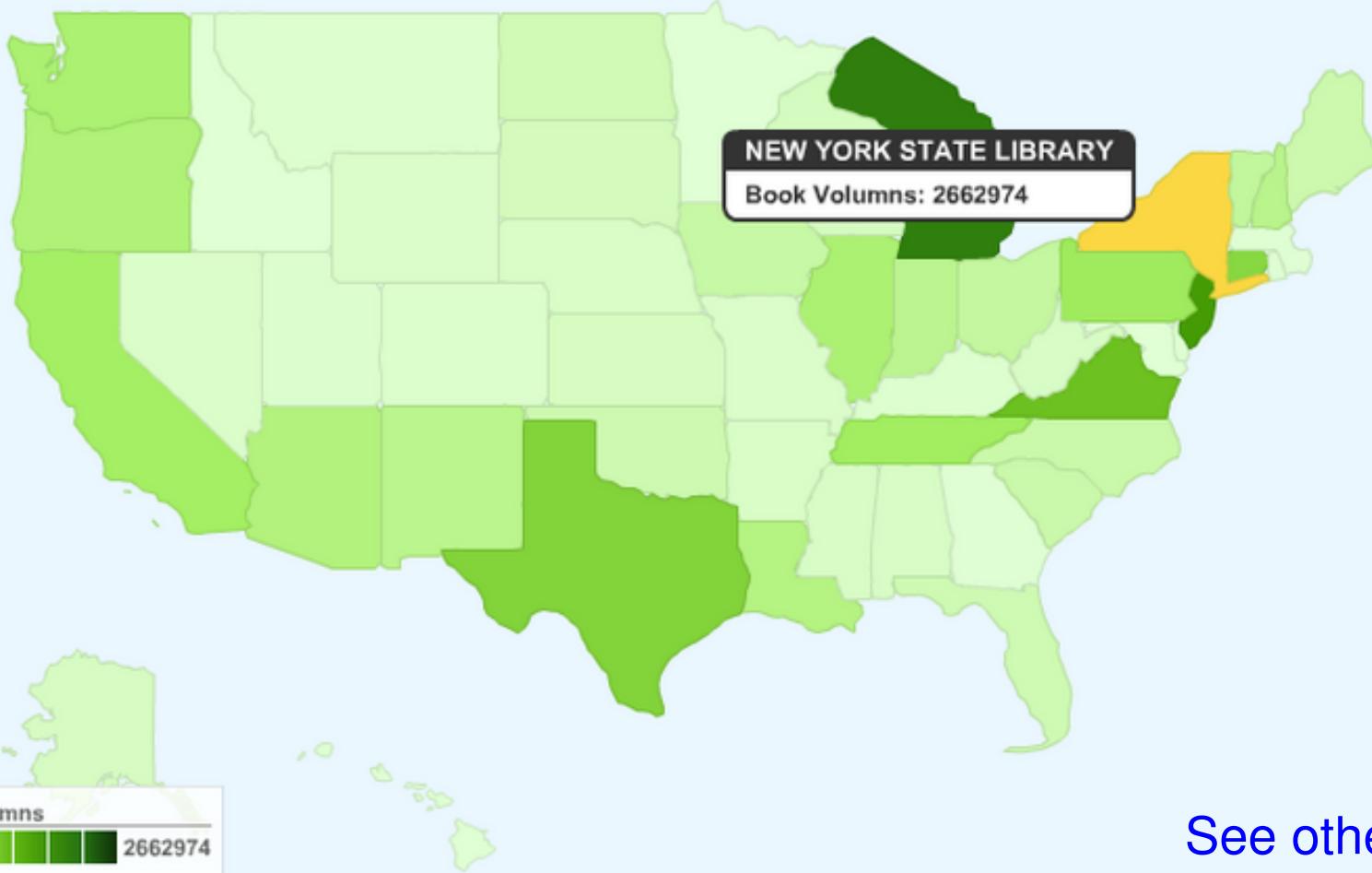
Example of public data use



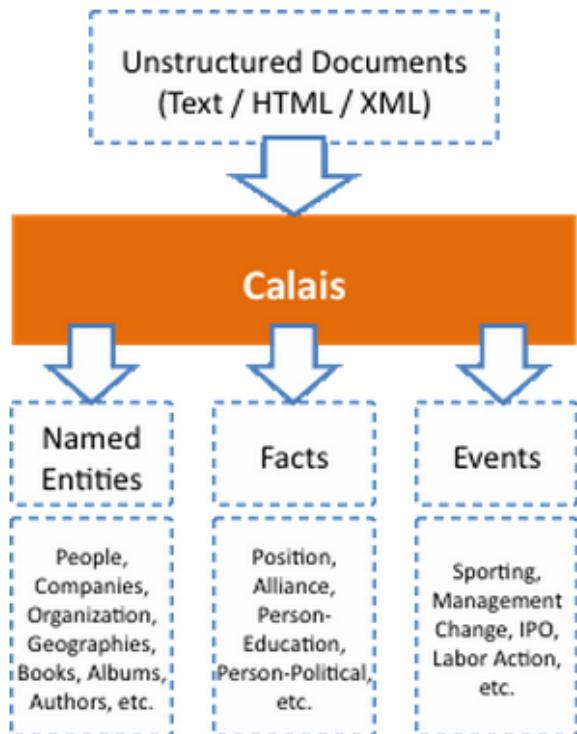
How Knowledgeable is Your State?



library books / # inhabitants, per state



Reuters' Calais uses RDF



RDF
and LOD
identifiers

OpenCalais

The screenshot shows the WikiDO website interface. At the top, there's a logo with the text "Wiki DO" and "BETA 1.0". Below the logo, the navigation path is "Home > CA > Mountain View > Today (165 thin)". There are two main event cards:

- Nima Fadavi - Under the Influence Tour**:
 - Photo of Nima Fadavi.
 - Date: Wed 7/17.
 - Location: Shoreline Amphitheatre - Mountain View, CA.
 - Price: USD 50.00.
 - Comments: 0 COMMENTS.
 - Action buttons: DETAIL, ADD.
- Wiz Khalifa**:
 - Photo of Wiz Khalifa.
 - Date: Wed 7/17 @ 6:00 pm.
 - Location: MOUNTAIN VIEW, CA.
 - Comments: 0 COMMENTS.
 - Action buttons: DETAIL, ADD.

>more

The BBC uses RDF

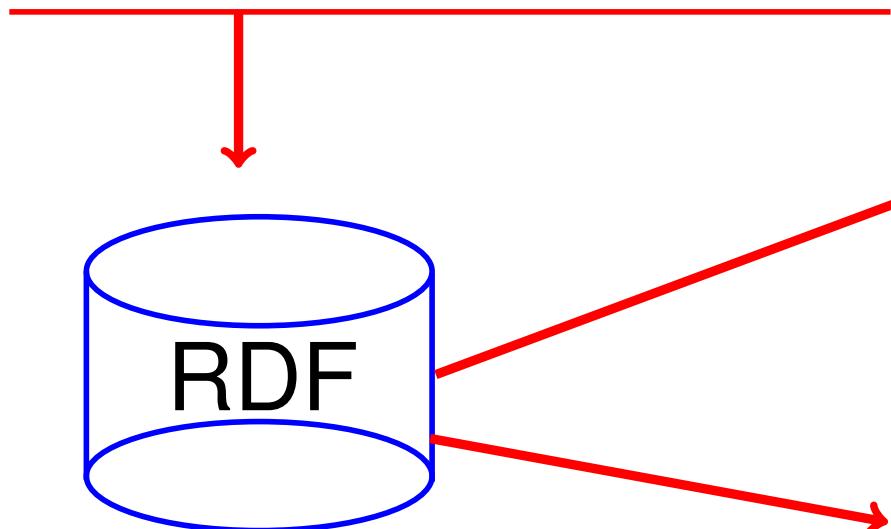
Structured data

Artist:

Release:

Track: 1
Track: 2

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



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

...

>more

BestBuy uses RDFa

Search by Keyword, SKU # or Item #

PRODUCTS SERVICES SHOPS & DEALS GIFTS

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

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



TWO-DISC SPECIAL EDITION
This Is Elvis (Enhanced TV) (DVD) 1981

SKU: 8416252 Release Date: 8/7/20

Rating: PG

Customer Reviews: 4

Search by Keyword, SKU # or Item #

PRODUCTS SERVICES SHOPS & DEALS GIFTS

BestBuy.com > Store Locator > Best Buy - Mountain View

Best Buy - Mountain View



2460 E Charleston Rd
Mountain View, CA 94043
Phone: 650-903-0581
GEO: 37.423073, -122.09568
 Map & Directions
 See full store details
 Weekly Ad

CUSTOMER FEEDBACK & REVIEWS

4.1 of 5

Read reviews (79) or Write a Review

BestBuy

<<http://stores.bestbuy.com/1045/#store1045>> a gr:LocationOfSalesOrServiceProvisioning;
geo:latlong "37.423073, -122.09568";
vcard:adr [a vcard:Address,
vcard:Work;
vcard:geo [vcard:latitude "37.423073";
vcard:longitude "-122.09568"];
vcard:locality "Mountain View, ";
vcard:postal-code "94043";
vcard:region "CA";
vcard:street-address "2460 E Charleston Rd";
vcard:tel "650-903-0591"],
<<http://deals.bestbuy.com/>>,
<<http://stores.bestbuy.com/1045/details/>>,
<<http://www.bestbuy.com/site/olspage.jsp?id=cat12091&type=page&allstores=no&mode=fromResult&storeId=1045>>;
foaf:depiction <<http://stores.bestbuy.com/wp-content/store-images/1045/medium.jpg>> .

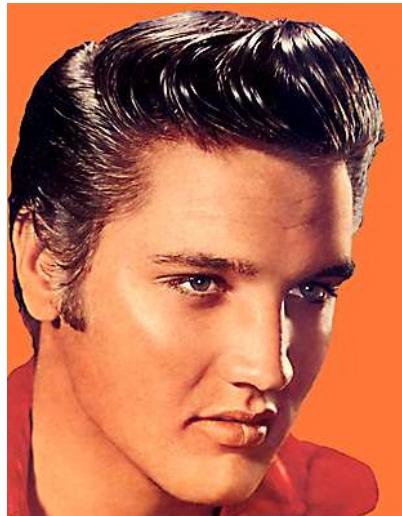
<<http://stores.bestbuy.com/1045/#storehoursfri>> a gr:OpeningHoursSpecification;
gr:closes "21:00:00"XXxsd:time;
gr:hasOpeningHoursDayOfWeek gr:Friday;

The Semantic Web is full of Elvis!



Object [Concept](#)

Elvis Presley



Objects 1 - 5 of 100 for your search **Elvis Presley**

Elvis_Presley

· is sameAs of: **Elvis_Presley**

http://yago-knowledge.org/resource/Elvis_Presley

Elvis Presley - music artist

· type: music artist

· label: **Elvis Presley**

· is primary topic of: RDF Description of **Elvis Presley**

· sameAs: **Elvis_Presley**

· name: **Elvis Presley**

· is maker of: f3c85292-d86c-4dc5-8afa-3dd885188c03

· homepage: <http://www.elvis.com/>

· musicbrainz: 01809552-4f87-45b0-afff-2c6f0730a3be

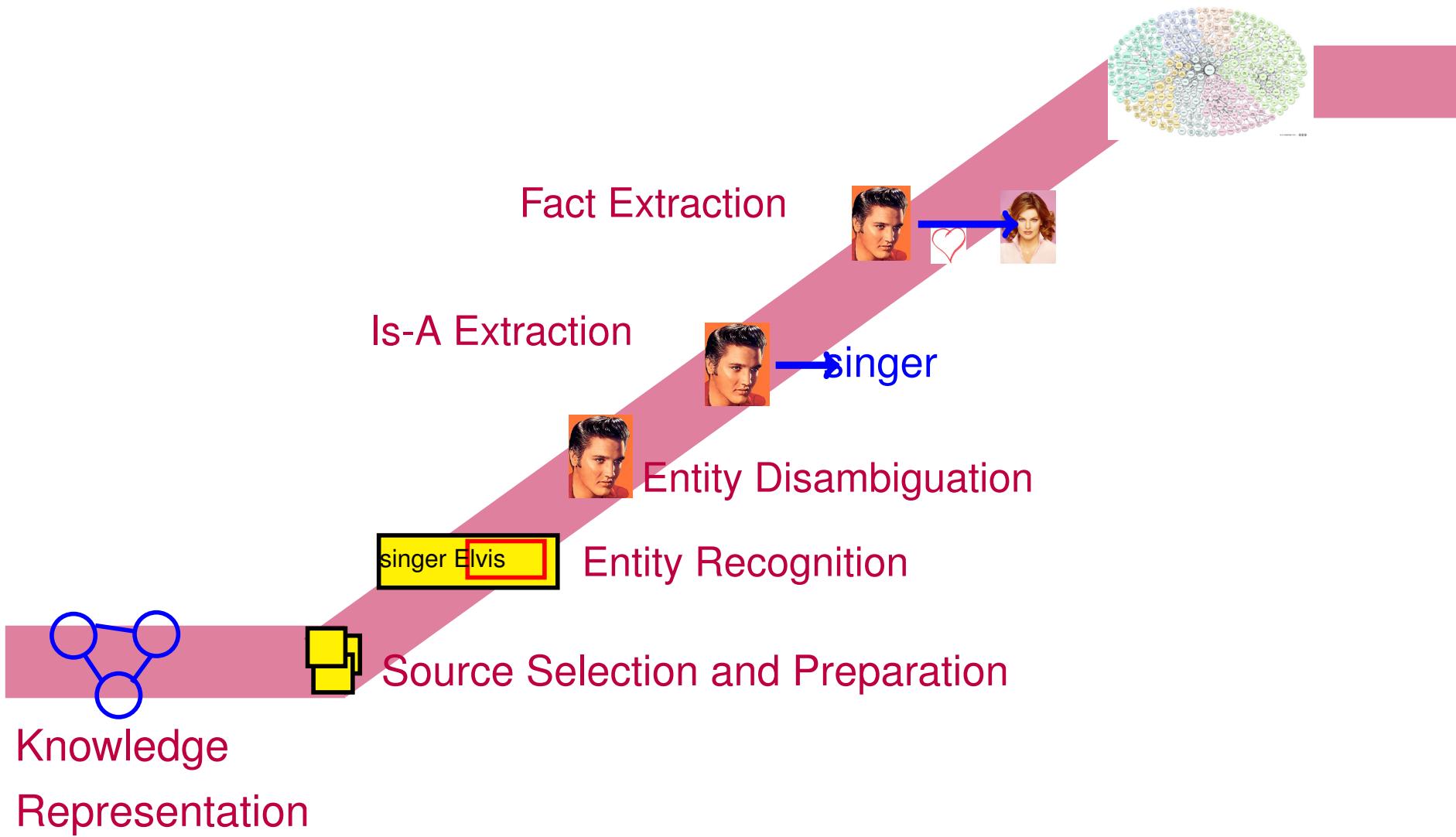
· Life Event: birth

· taggedWithTag: tag/4663

<http://dbtune.org/musicbrainz/resource/artist/01809552-4f87-45b0-afff-2c6f0730a3be>

IE and the Semantic Web

Semantic
Web



Knowledge
Representation

References

W3C: RDF

W3C: RDFS

W3C: Semantic Web

W3C: RDFa lite

Linked Data

PARIS: Probabilistic Alignment of Relations, Instances, and Schema