

Knowledge Graph

- What Knowledge Graph (KG)?
- Data sources
- Linked Data
- Google Knowledge Graph and the Web of Data

Knowledge Graph

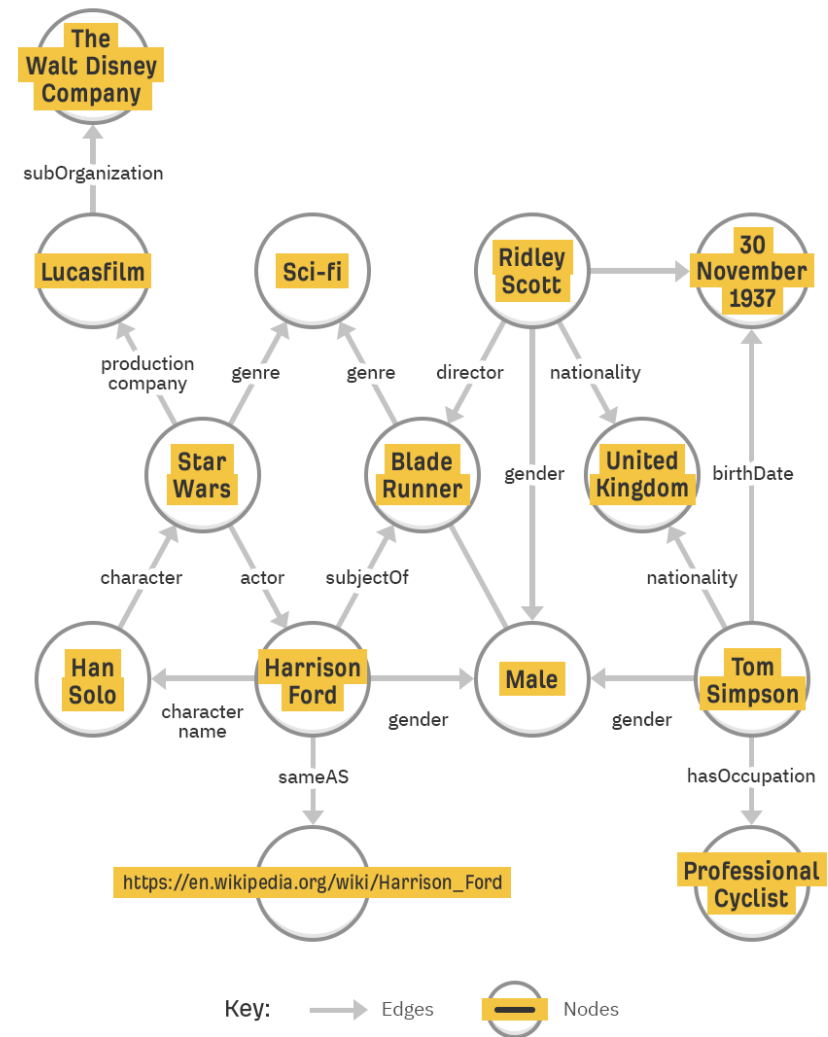
- **knowledge graph represents a collection of interlinked descriptions of entities – objects, events or concepts.**
- Knowledge graphs combine characteristics of several data management paradigms:
 - **Database**, because the data can be explored via structured queries;
 - **Graph**, because they can be analyzed as any other network data structure;
 - **Knowledge base**, because they bear formal semantics, which can be used to interpret the data and infer new facts.

What is Knowledge

Graph:

Knowledge Graph is a knowledge base of entities and relationships between them.

What Google's Knowledge Graph Looks Like



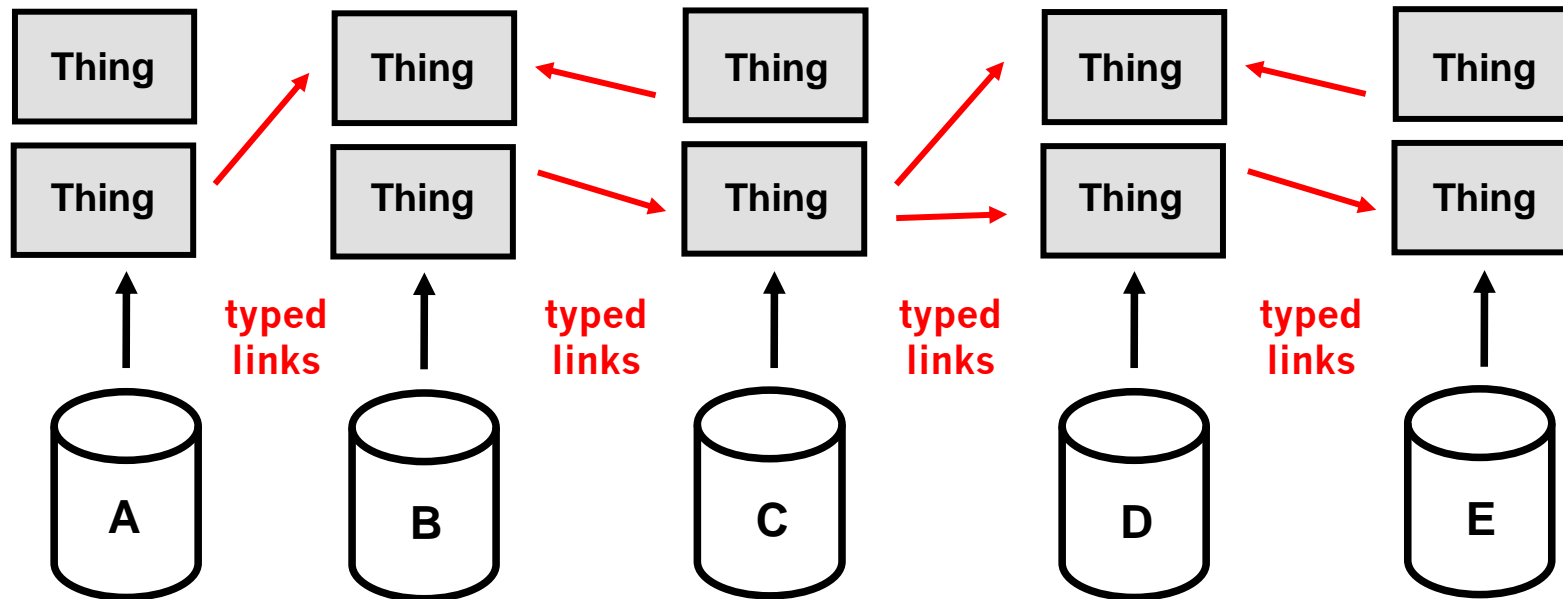
© <https://ahrefs.com/blog/google-knowledge-graph/>

ahrefs

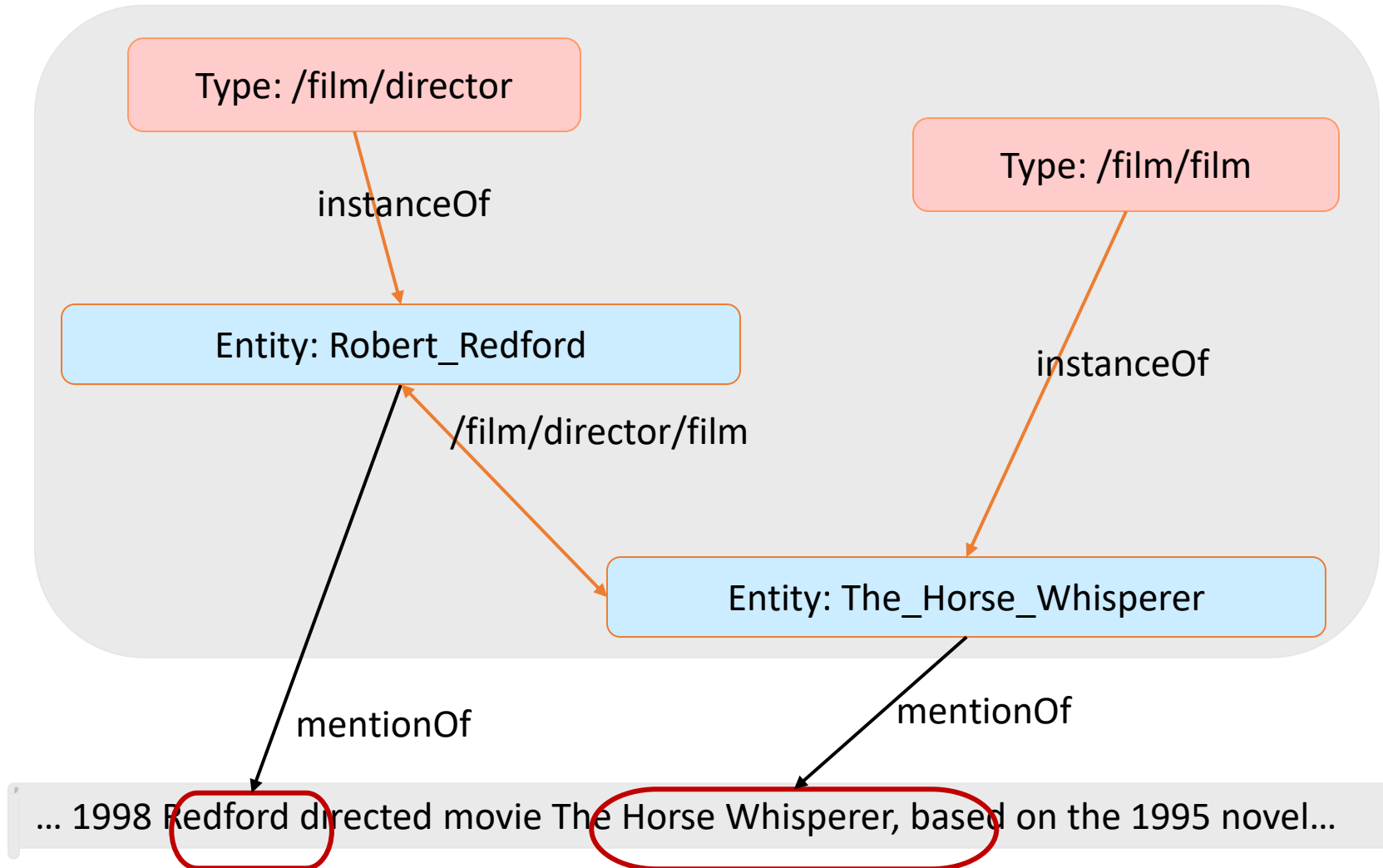
Linked Data

Use Semantic Web technologies to

- 1. publish structured data on the Web,**
- 2. set links between data from one data source to data within other data sources.**



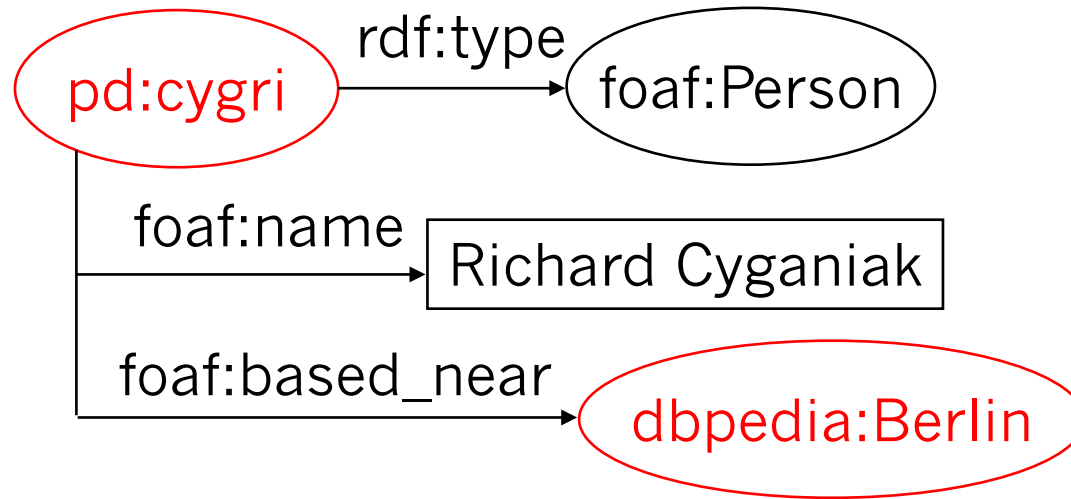
Annotated Web Resources



Annotated document

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Data objects are identified with HTTP URIs

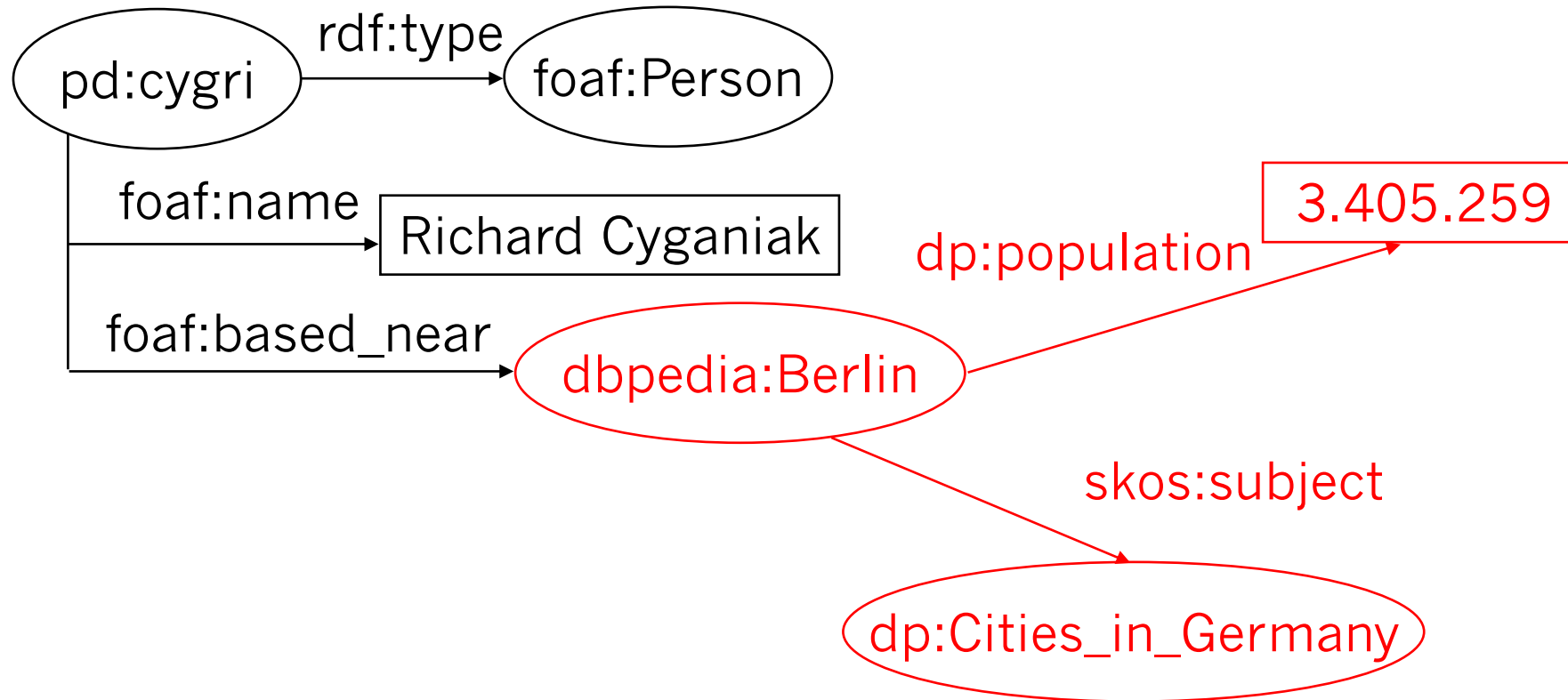


pd:cygri = <http://richard.cyganiak.de/foaf.rdf#cygri>

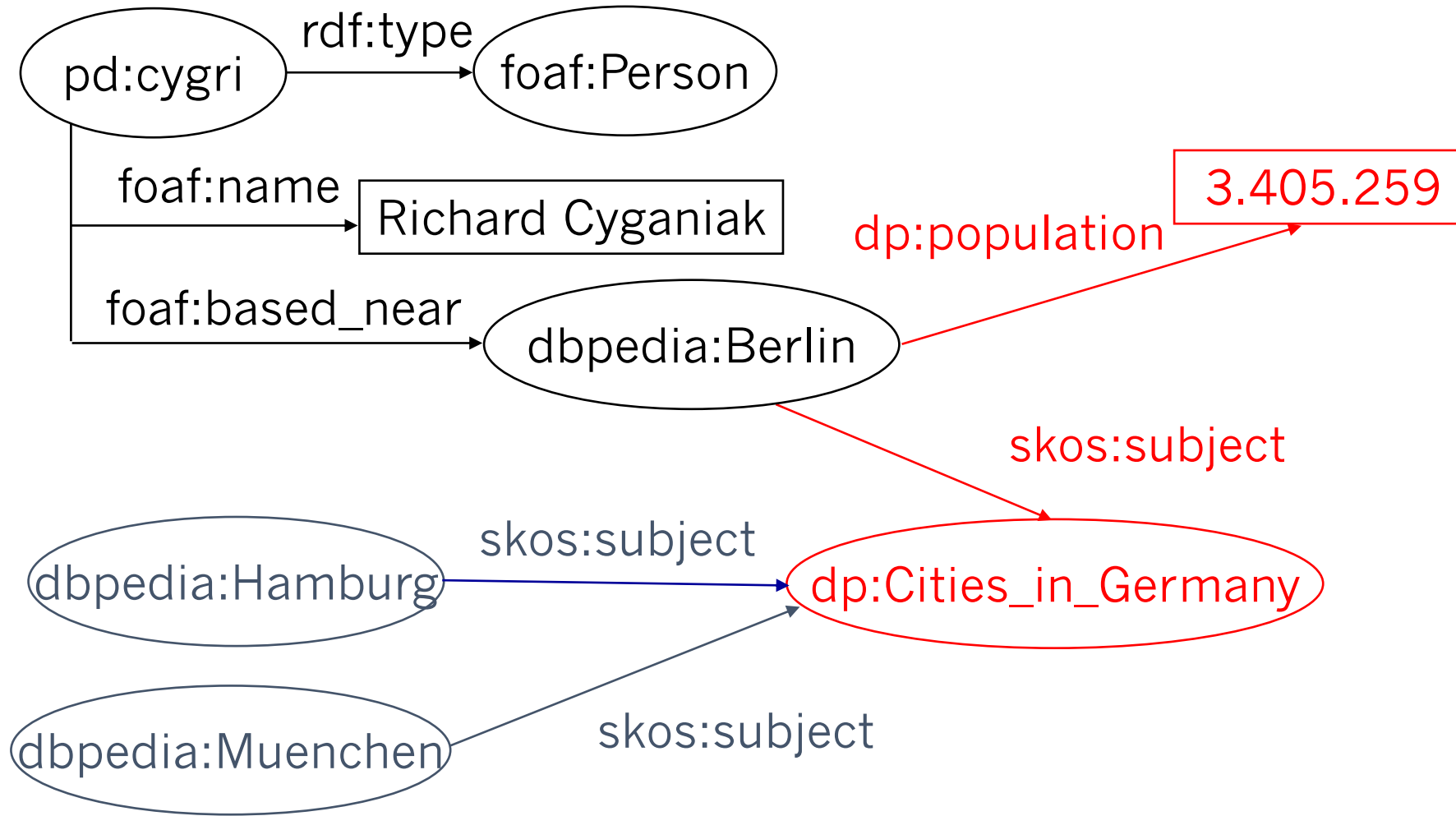
dbpedia:Berlin = <http://dbpedia.org/resource/Berlin>

Forms an RDF link between two data sources.

Expanding data extraction over the Web

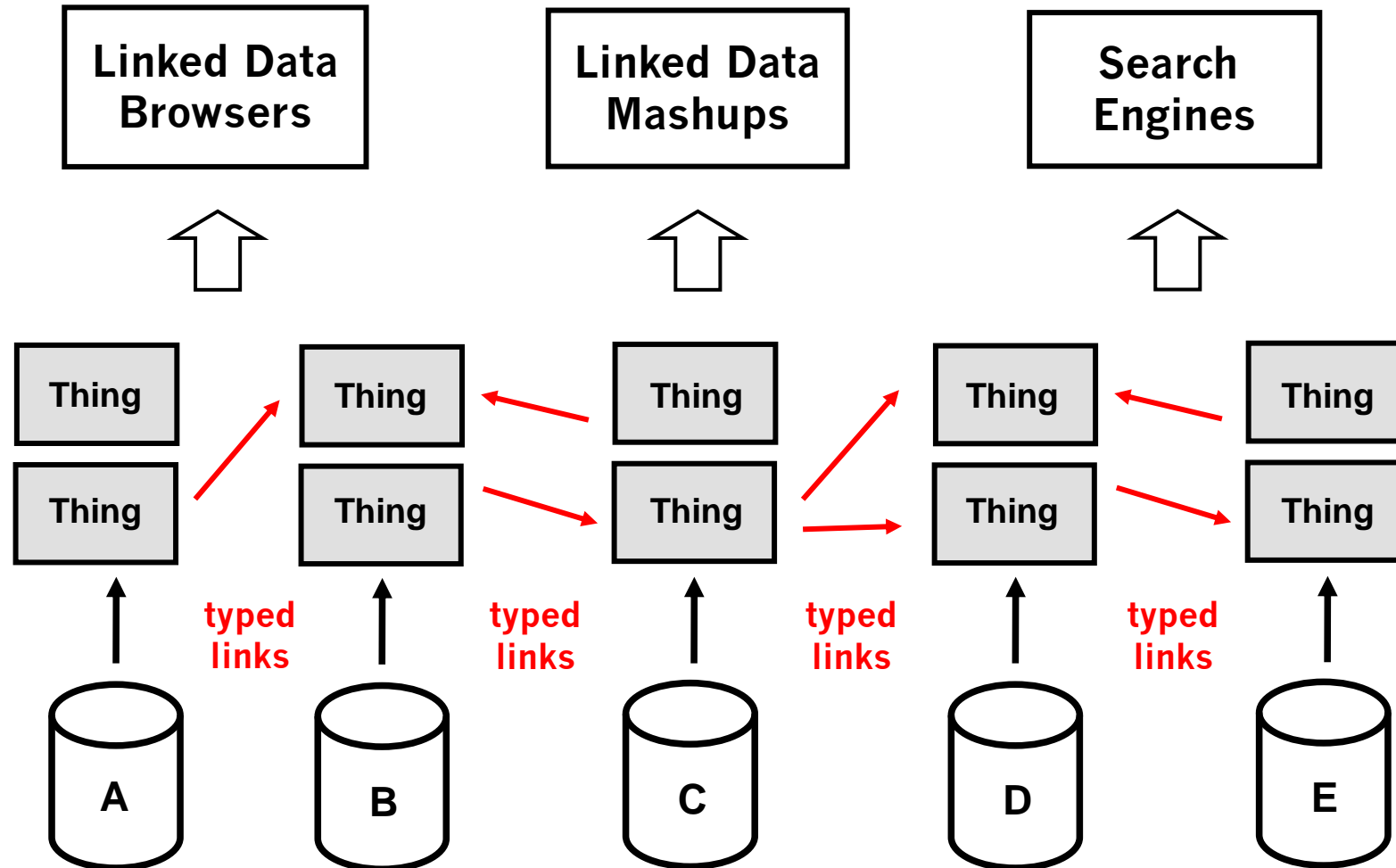


Expanding data extraction over the Web



Applications

■ What can I do with this?



SPARQL Endpoints

Virtuoso SPARQL Query Editor

[About](#) | [Namespace Prefixes](#) | [Inference rules](#) | [RDF views](#) | [iSPARQL](#)

Default Data Set Name (Graph IRI)

Query Text

```
select * where {[] a ?Concept} LIMIT 100
```

(Security restrictions of this server do not allow you to retrieve remote RDF data, see [details](#).)

Results Format:

Execution timeout: milliseconds (values less than 1000 are ignored)

Options:

- ☒ Strict checking of void variables
- ☐ Log debug info at the end of output (has no effect on some queries and output formats)
- ☐ Generate SPARQL compilation report (instead of executing the query)

(The result can only be sent back to browser, not saved on the server, see [details](#))

[Text Search](#)[Entity Label Lookup](#)[Entity URI Lookup](#)[Featured](#)[Demo Queries](#)[About](#)

Precision Search & Find

Search Text

Hint: You can [add this engine](#) in search bar of an OpenSearch - capable browser

Faceted Search & Find service v1.17_git93 as of Oct 15 2021



[OpenLink Virtuoso](#) version 08.03.3322 as of Oct 25 2021, on Linux (x86_64-generic-linux-glibc25), Single-Server Edition (61 GB total memory, 60 GB memory in use)

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<https://dbpedia.org/fct/#>

Property	Value
dbo:wikiPageID	•761572 (xsd:integer)
dbo:wikiPageRevisionID	•918581648 (xsd:integer)
dbp:wikiPageUsesTemplate	<ul style="list-style-type: none"> •dbt:About •dbt:Commons_category •dbt:Portal •dbt:Cat_main
rdf:type	• skos:Concept
rdfs:label	•Berlin (en)
skos:broader	<ul style="list-style-type: none"> •dbc:Cities_in_Germany •dbc:Wikipedia_categories_named_after_populated_places_in_Germany •dbc:Capitals_in_Europe •dbc:German_city-states •dbc:German_state_capitals •dbc:States_of_Germany •dbc:Wikipedia_categories_named_after_capitals
skos:prefLabel	•Berlin (en)
prov:wasDerivedFrom	• wikipedia-en:Category:Berlin?oldid=918581648&ns=14
is dbo:wikiPageWikiLink of	<ul style="list-style-type: none"> •dbr:Berlin •dbr:Permanent_Forest_Contract
is dct:subject of	<ul style="list-style-type: none"> •dbr:Berlin •dbr:Permanent_Forest_Contract



Object Search [Concept Search](#)

Beijing

Search Objects

Supports Boolean operators, quotes, and wildcard characters.

Falco

All

Artifact

Institution

Organization

Capital City

Landmark

Person

City

Location

Publication

Document

Noun Synset

Subject

Group

Ontology

System

Objects 1 - 10 of 8634 for your search **Beijing** (1.223 seconds)

Beijing

Types: Capital, City

Labels: 北京" || Pekin || Пекин" || 北京市" || Pequim || Pechino || **Beijing** || Pékin" || Peking || Pekín"

<http://dbpedia.org/resource/Beijing> - [Described in 184 documents](#)

Beijing

Types: Subject,

Labels: **Beijing**

<http://ontoworld.org/wiki/Special:URIResolver/Beijing> - [Described in 11 documents](#)

Beijing Guoan

Types: Club

Labels: **Beijing Hyundai** || 北京国安" || 北京国安足球俱乐部" || **Beijing Guoan**

http://dbpedia.org/resource/Beijing_Guoan - [Described in 30 documents](#)

Beijing

The declaration of this URI may be unauthorized.

Types: Capital City

Labels: **Beijing**

<http://lonely.org/russia#Beijing> - [Described in 5 documents](#)

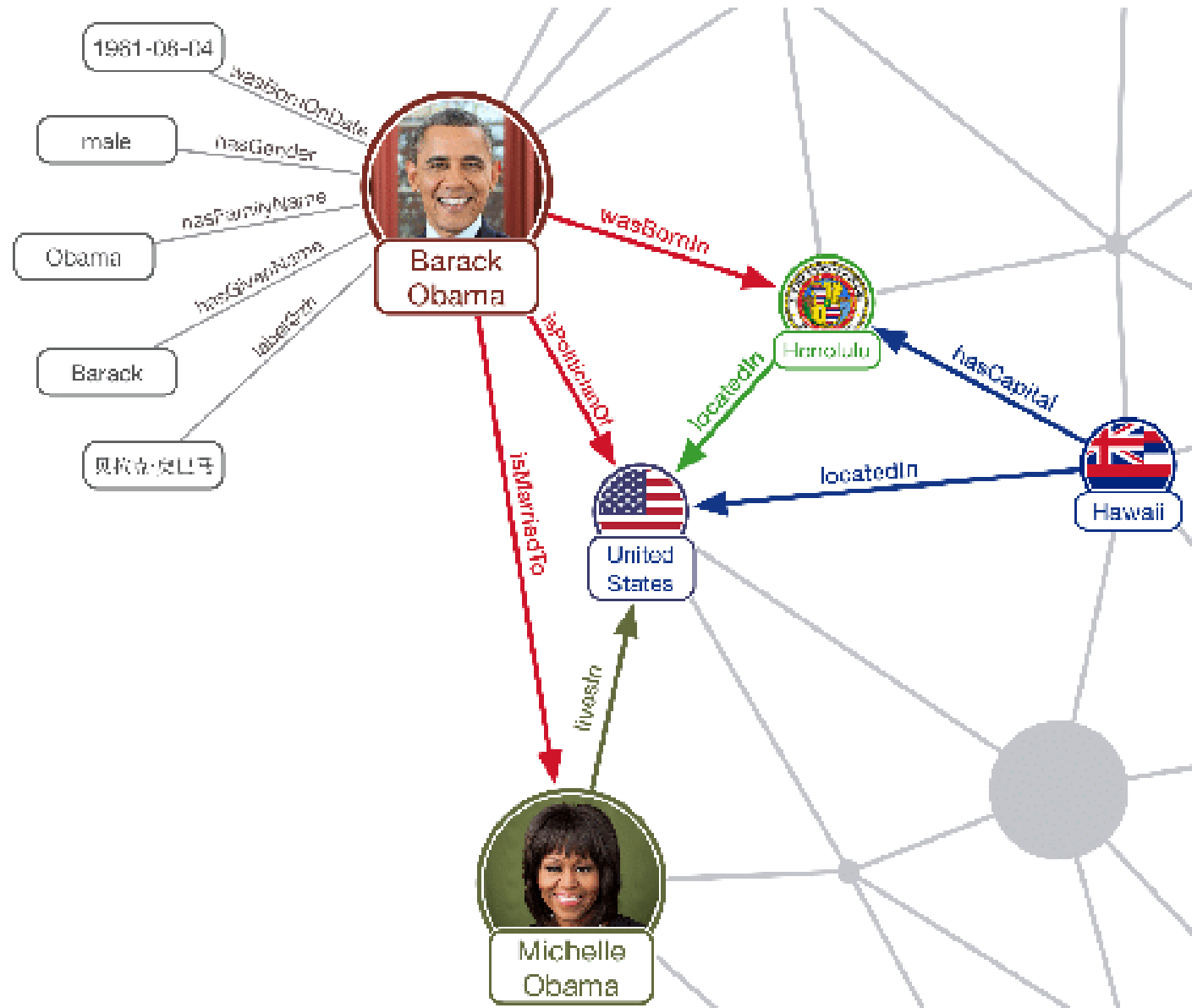
What do we need?

- Heavily used vocabularies
 - Schema.org, Wikidata, DBpedia, YAGO, ...
- **Schema.org** provides a collection of shared vocabularies.
- Launched in June 2011 by Bing, Google and Yahoo
- To Create a common set of schemas for webmasters to mark-up with structured data their websites.



Equality statements (owl:sameAs, skos:exactMatch)

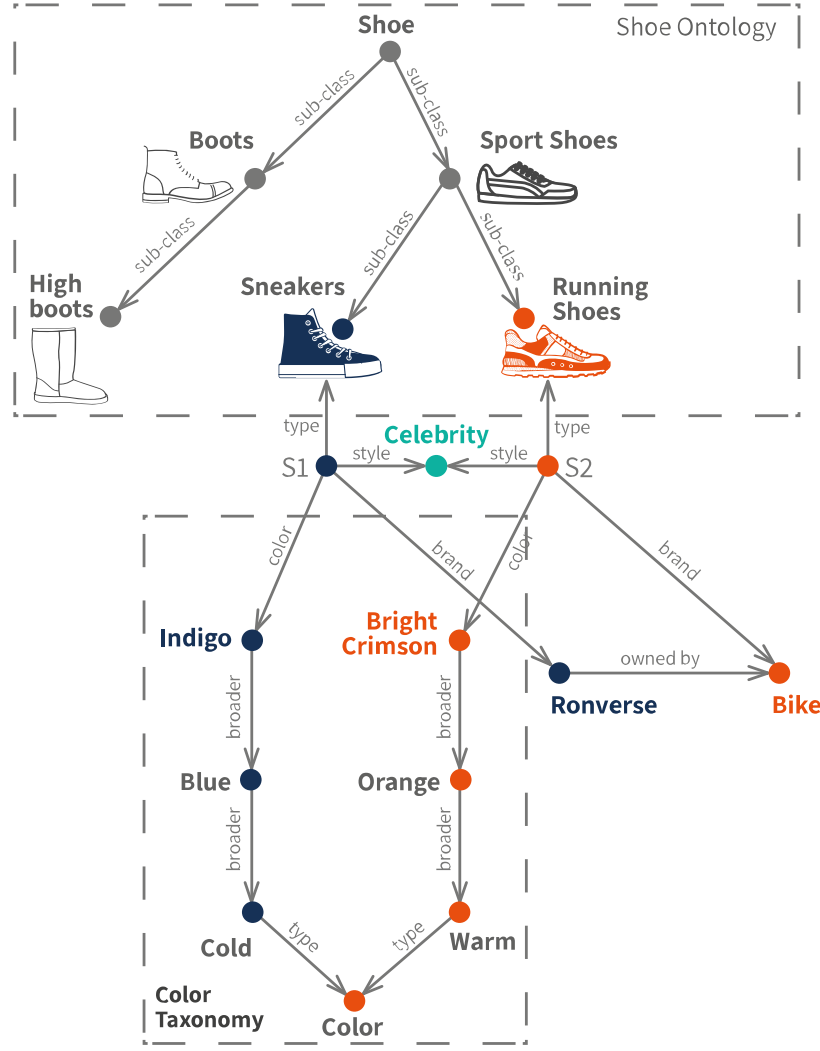
Example of Knowledge Graph



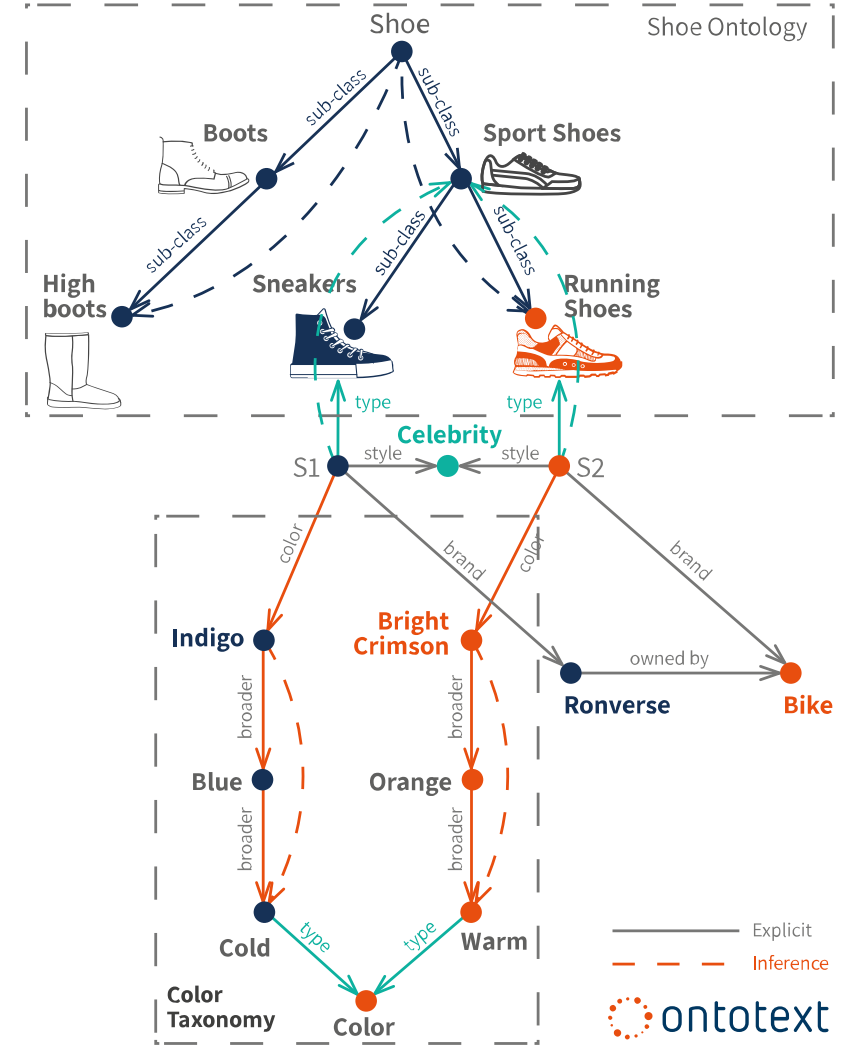
Plain Graph



Knowledge Graph



Knowledge Graph with Inference



Examples of Big Knowledge Graphs

Google Knowledge Graph. Google made this term popular with the announcement of its knowledge graph in 2012. However, there are very few technical details about its organization, coverage and size. There are also very limited means for using this knowledge graph outside Google's own projects.

DBPedia. This project leverages the structure inherent in the infoboxes of Wikipedia to create an enormous dataset of 4.58 things (link <https://wiki.dbpedia.org/about>) . This dataset is at the heart of the Open Linked Data movement.

Geonames. Under a creative commons, users of Geonames dataset have access to 25 million geographical entities and features.

Wordnet. One of the most well-known lexical databases for the English language, often used to enhance the performance of NLP and search applications.

DBpedia

- Each thing in the DBpedia data set is identified by a URI reference of the form

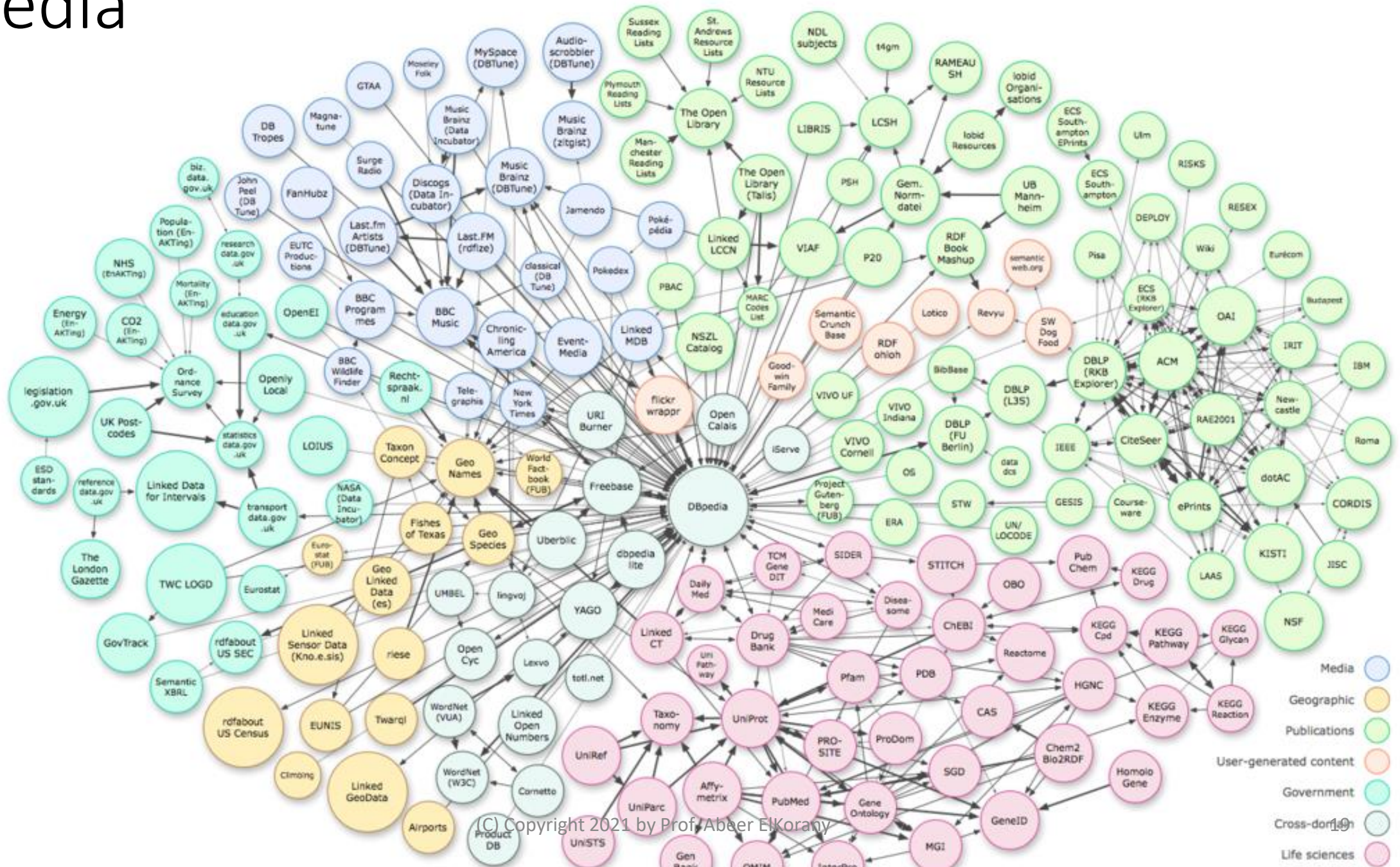
<http://dbpedia.org/resource/Name>

- where Name is taken from the URL of the source Wikipedia article, which has the form

<http://en.wikipedia.org/wiki/Name>

- Thus, each resource is tied directly to an English-language Wikipedia article.

DBpedia



DBpedia

Class	Examples
City	Cambridge, Berlin, Manchester
Country	Spain, Iceland, South Korea
Politician	George W. Bush, Nicolas Sarkozy, Angela Merkel
Musician	AC/DC, Diana Ross, Röyksopp
Music album	Led Zeppelin III, Like a Virgin, Thriller
Director	Woody Allen, Oliver Stone, Takashi Miike
Film	Pulp Fiction, Blindness, Breakfast at Tiffany's
Book	The Lord of the Rings, The Adventures of Tom Sawyer, The Holy Bible
Computer Game	Tetris, World of Warcraft, Sam & Max hit the Road
Technical Standard	HTML, RDF, URI

Case Study : Google Knowledge Graph (GKG)

- *“A huge knowledge graph of interconnected entities and their attributes”.*

Amit Singhal, Senior Vice President at Google

- *“A knowledge based used by Google to enhance its search engine’s results with semantic-search information gathered from a wide variety of sources”*

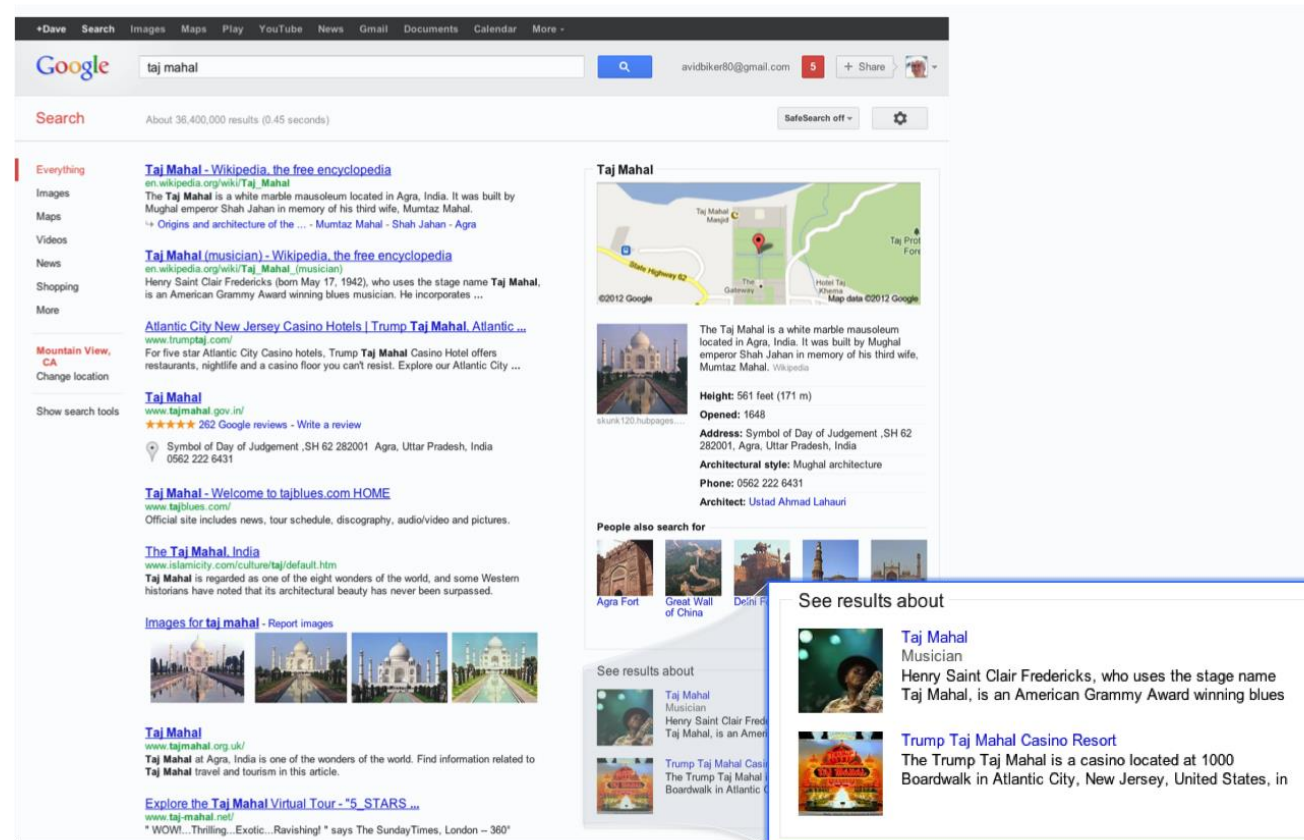
http://en.wikipedia.org/wiki/Knowledge_Graph



What is it?

GKG enhances Google Search in **three main ways**:

- ***Find the right thing***
 - deals with the ambiguity of the language



What is it?

- **Summaries**

- summarize relevant content around that topic, including key facts about the entity

The image shows a Google search interface for 'Marie Curie'. The search results include a Wikipedia snippet, a biography from Nobelprize.org, and a gallery of images. A blue-bordered summary box is overlaid on the right side of the page, providing a concise overview of Marie Curie's life and achievements.

Marie Curie

Marie Skłodowska-Curie was a French-Polish physicist and chemist famous for her pioneering research on radioactivity. She was the first person honored with two Nobel Prizes—in physics and chemistry. [Wikipedia](#)

Born: November 7, 1867, Warsaw

Died: July 4, 1934, Sancellemoz

Spouse: Pierre Curie (m. 1895–1906)

Children: Irène Joliot-Curie, Ève Curie

Discovered: Radium, Polonium

Education: École Supérieure de Physique et de Chimie Industrielles de la Ville de Paris, University of Paris

People also search for

[Albert Einstein](#) [Pierre Curie](#) [Ernest Rutherford](#) [Louis Pasteur](#) [John Dalton](#)

[Report a problem](#)

What is it?

- **Deeper and broader information**

- reveal new facts
- anticipate what the next questions and provide the information beforehand (based on what other users asked before)

The screenshot shows a Google search for "matt groening". The search bar at the top contains "matt groening" and the Google logo. Below the search bar, the results are categorized into "Everything", "Images", "Maps", "Videos", "News", "Shopping", and "More". The "Everything" section lists several search results, including a Wikipedia entry, an IMDb entry, a Biography.com entry, an interview with Matt Groening, and two news articles. To the right of the search results is a knowledge panel for "Matt Groening". The panel includes a photo of Matt Groening, a brief biography, and a list of his parents and siblings. A blue box highlights the text "Parents: Margaret Groening, Homer Groening" and "Siblings: Lisa Groening". Below the knowledge panel is a section for "Books" featuring covers of "The Simpsons Library", "Bart Simpson's Guide to...", "The Simpsons: A Complete Guide to...", "The Simpsons Uncensored, Uncut, and Unrated", and "The Simpsons Forever...". At the bottom of the knowledge panel is a section for "People also search for" with photos of Seth MacFarlane, David X. Cohen, James L. Brooks, Dan Castellaneta, and Nancy Cartwright.

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