Using Virtual Knowledge Graphs for ML

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Ontopic

Bolzano, 3 September 2019

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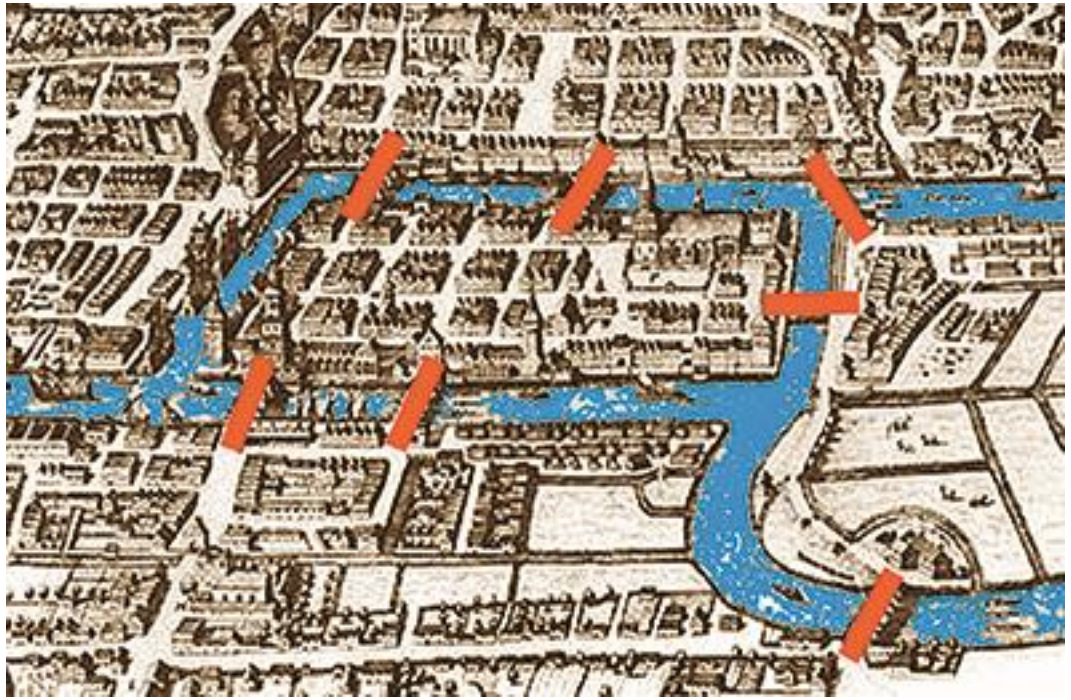
What is a graph?

Origin:

Euler‘s issues with the 7 bridges of Königsberg:

Is it possible to have a walk through all 4 parts of the city crossing each bridge once and only once?

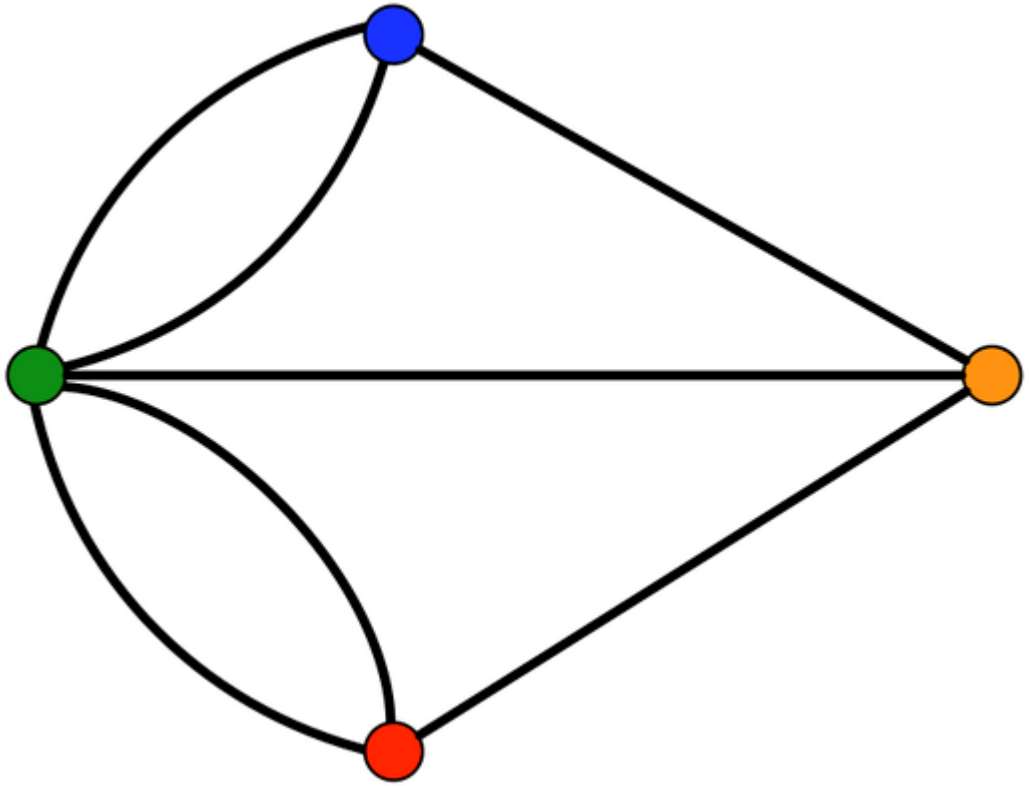


What is a graph?

Heuristic definition:

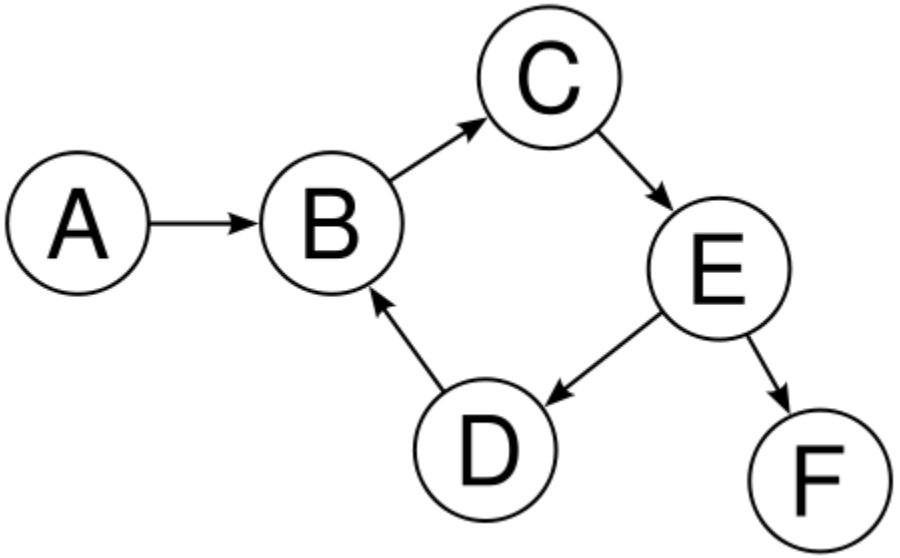
A mathematical structure

- To model pairwise relations
- Made of verteces (entities, nodes, …)
- And edges (relations, connections, …)



Directed Graphs

The connection between two nodes has a direction.



Knowledge Graphs

Name first appeared a the Google post in 2012

Official Blog

Insights from Googlers into our products, technology, and the Google culture

Introducing the Knowledge Graph: things, not strings

May 16, 2012

Cross-posted on the Inside Search Blog

Search is a lot about discovery—the basic human need to learn and broaden your horizons. But searching still requires a lot of hard work by you, the user. So today I'm really excited to launch the Knowledge Graph, which will help you discover new information quickly and easily.

https://googleblog.blogspot.com/2012/05/introducing-knowledge-graph-things-not.html#

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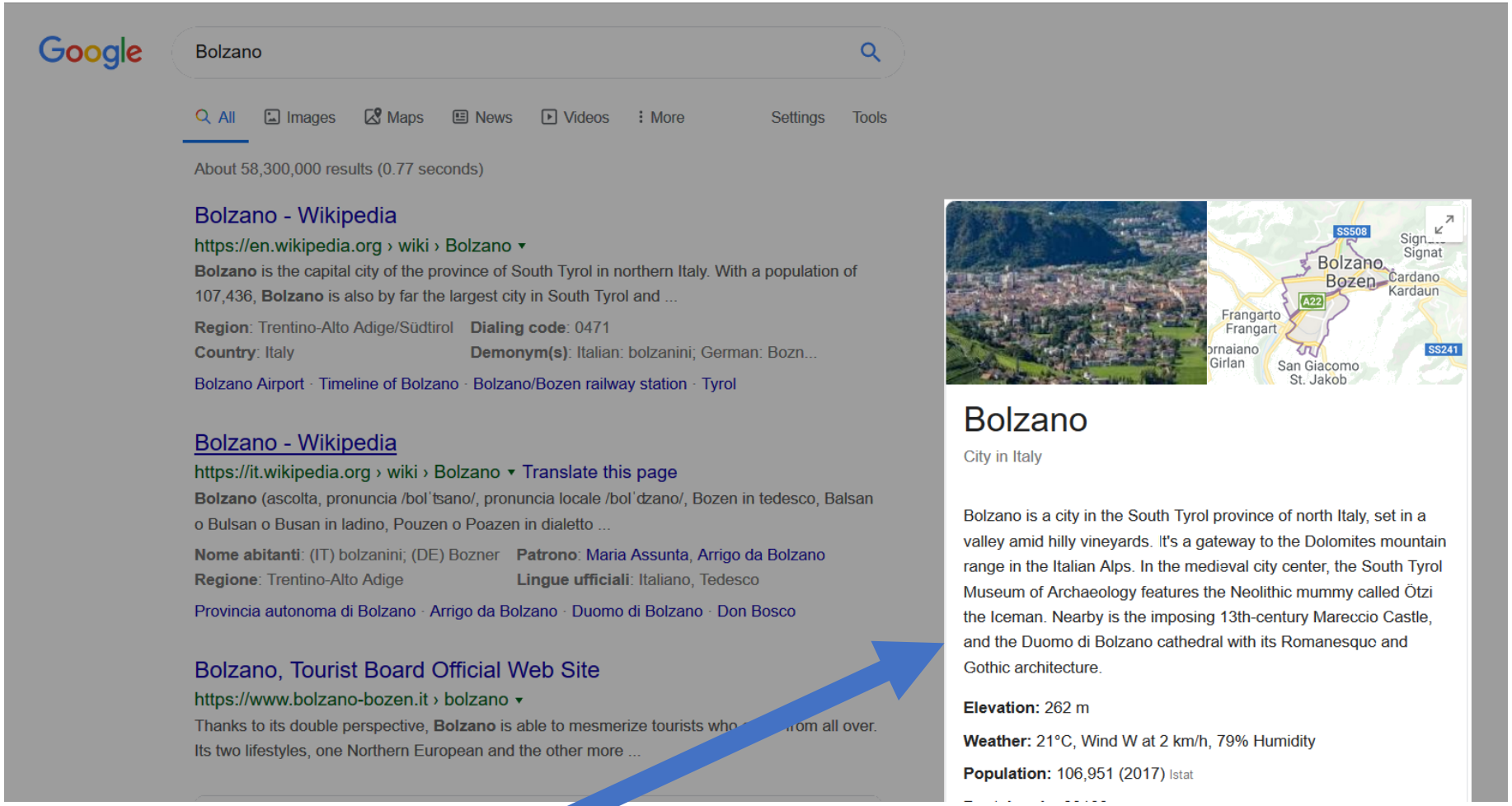
Googles Knowledge Graphs in practice

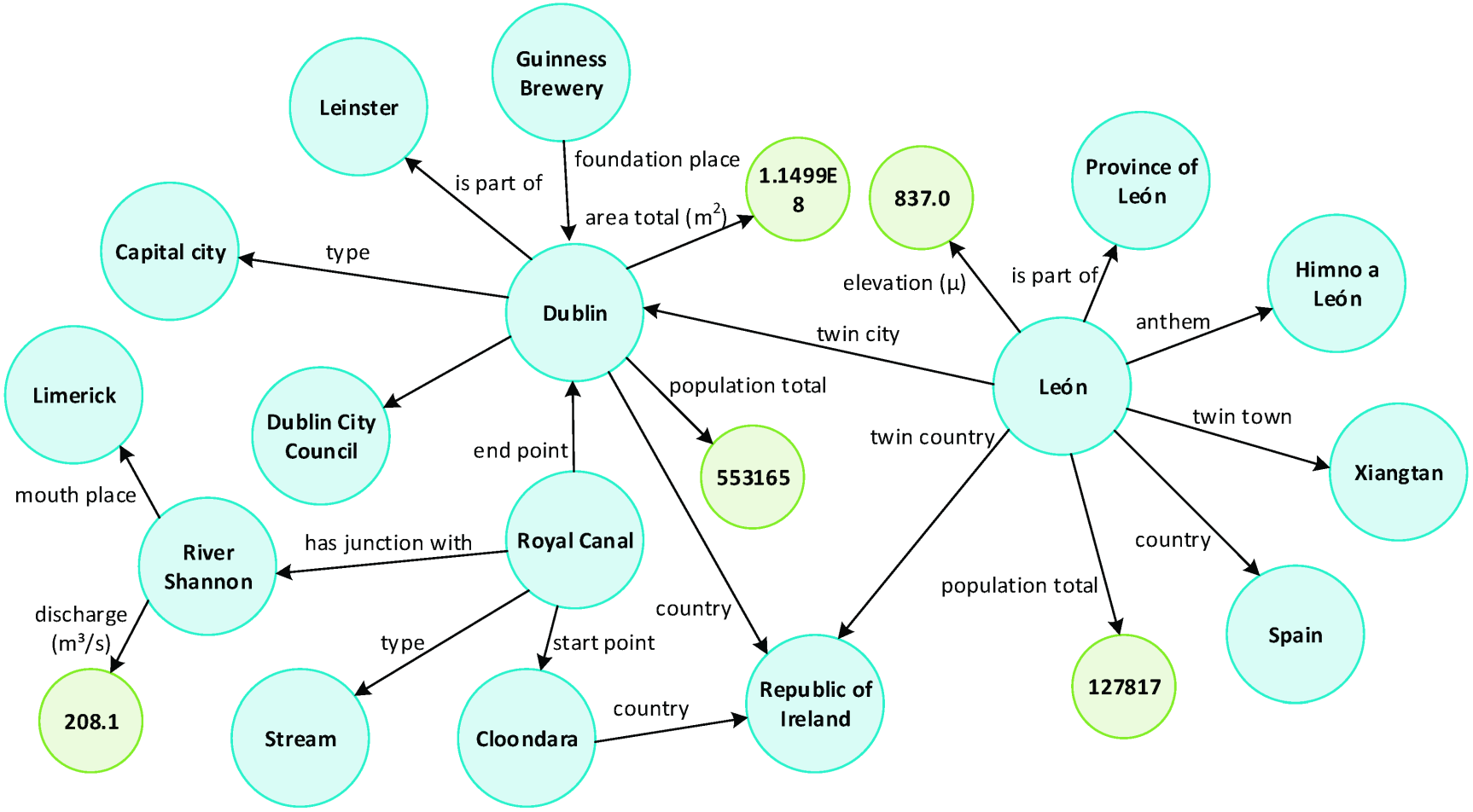


This comes from the Google Knowledge Graph

Put knowledge into digital memories

Nodes are resources

Edges define the kind of relationship between resources



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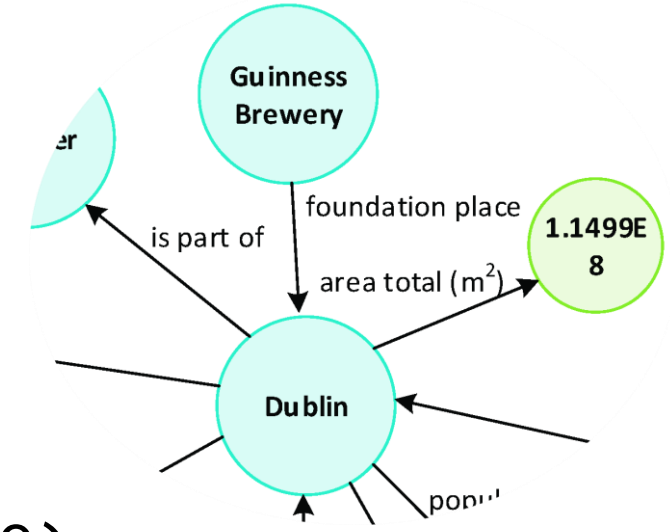
RDF - Resource Description Framework

RDF is a W3C standard.

Characteristic element is the triple



Guiness Brewery - founded in - Dublin.

Subject (S) - Predicate (P) - Object (O)

Dublin - total area (m²) - 1.1499E8

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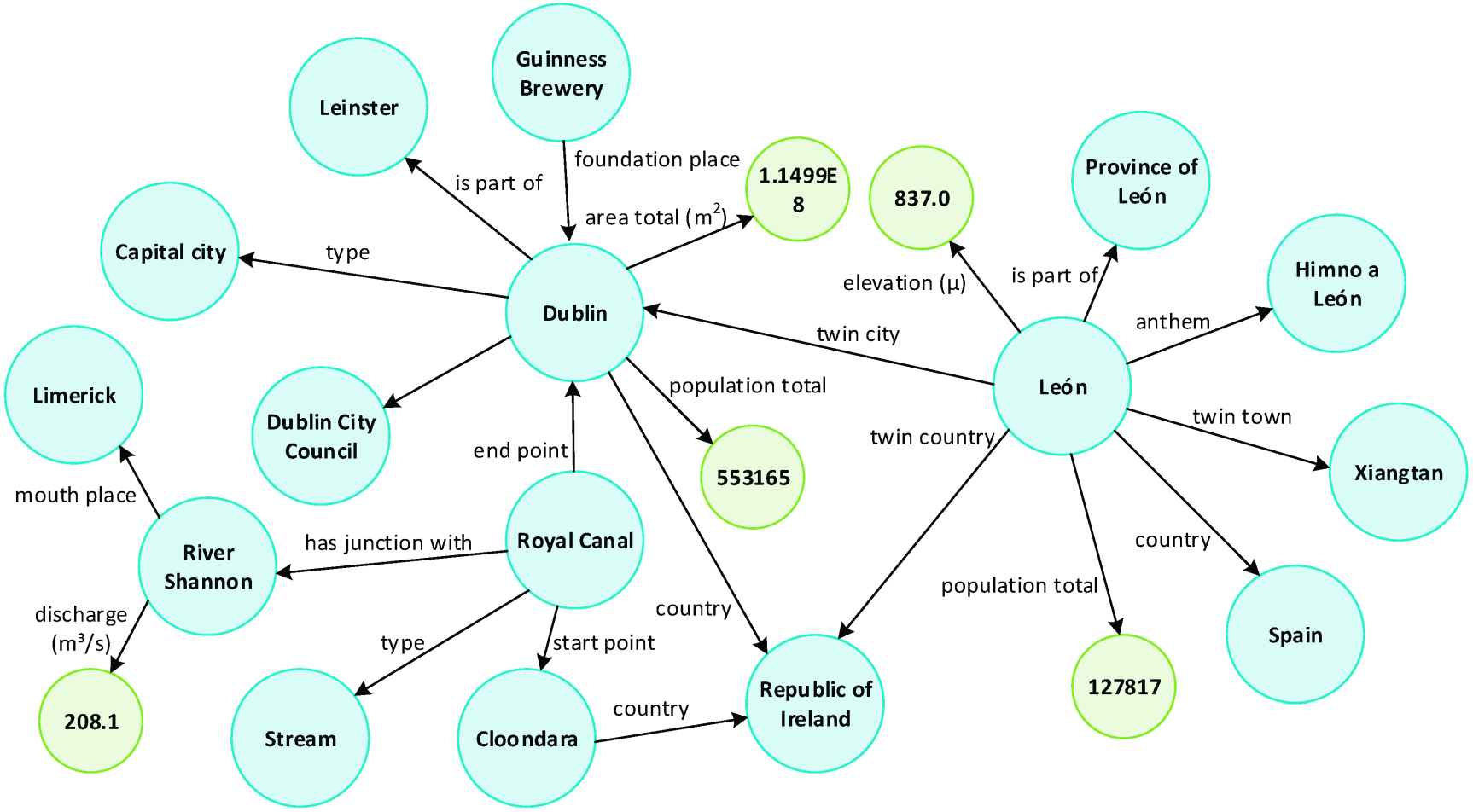
Graphs are very flexible

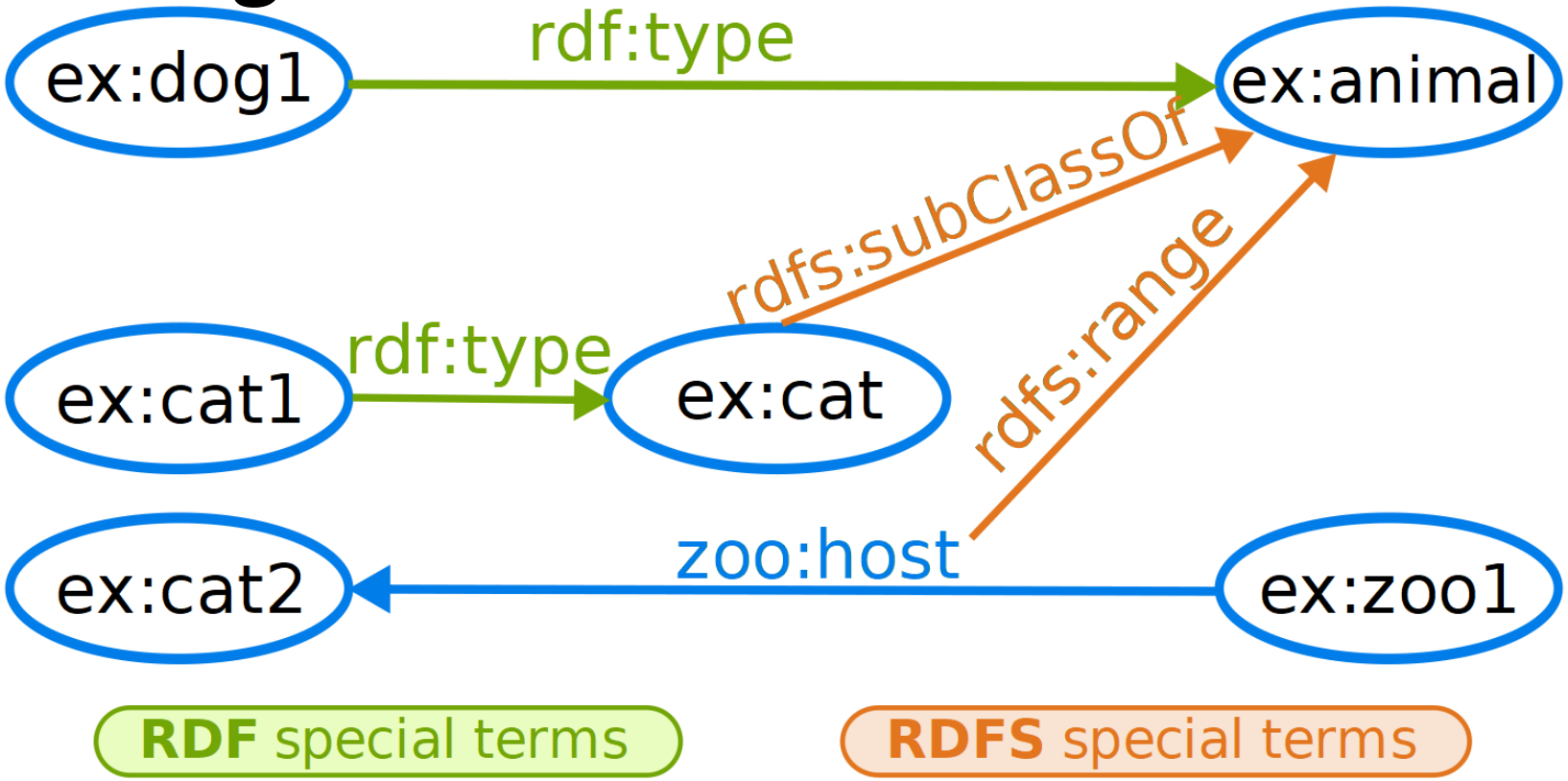
Yet,
Knowledge is not only tons of information.

=>

Some structure is needed.



RDFS: bring some structure to it



Classes and properties are called vocabularies

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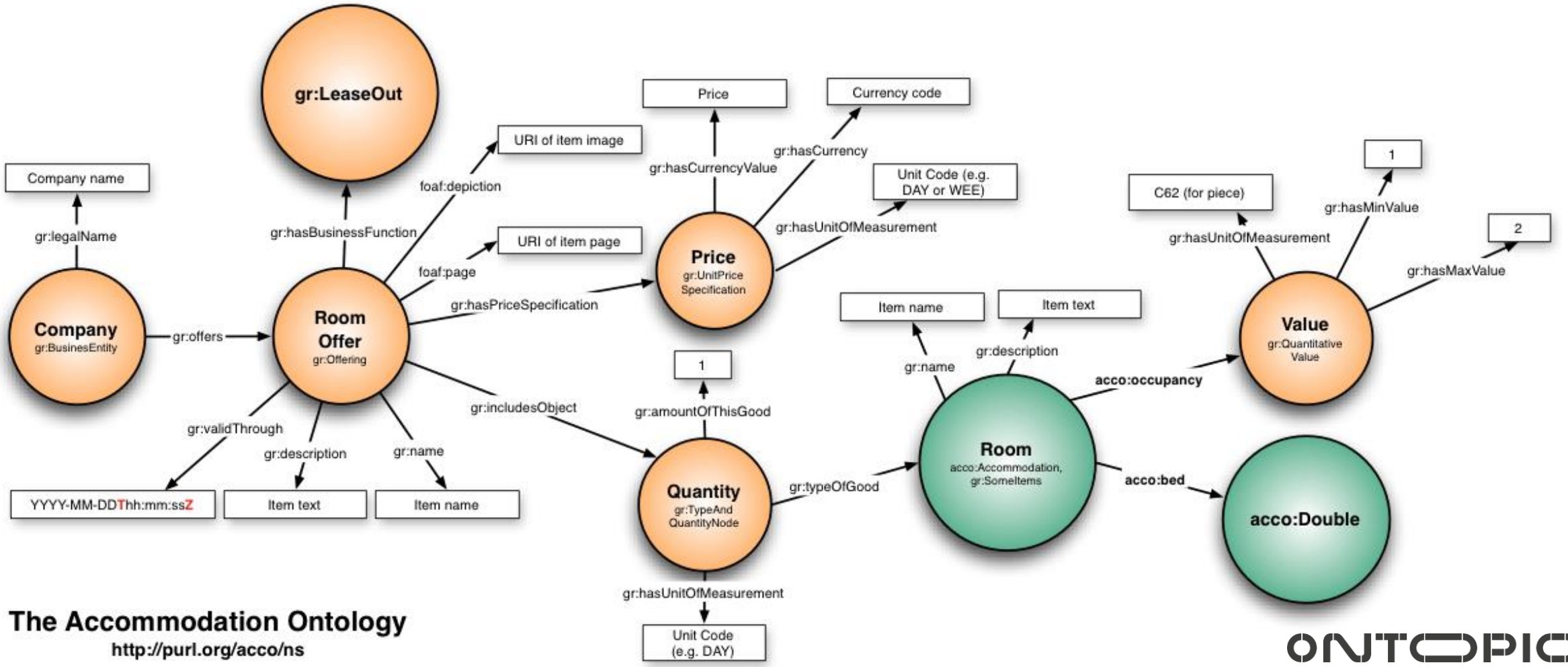
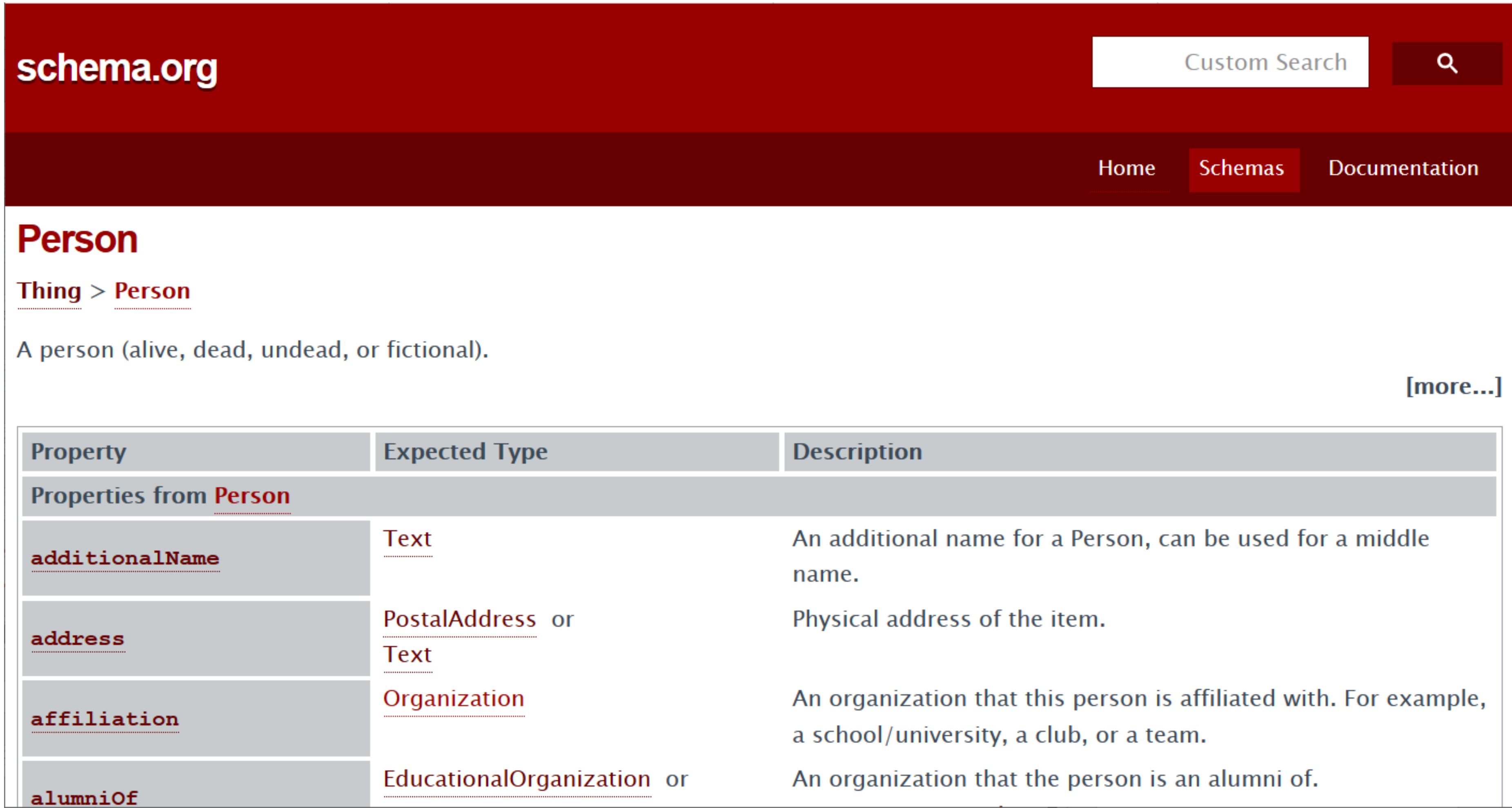
More expressive ontology languages: OWL (Web Ontology Language)



The importance of common vocabularies

Common vocabularies allow sharing of information


schema.org

Custom Search

Home Schemas Documentation

Person

Thing > Person

A person (alive, dead, undead, or fictional).

[more...]

Property	Expected Type	Description
Properties from Person		
additionalName	Text	An additional name for a Person, can be used for a middle name.
address	PostalAddress or Text	Physical address of the item.
affiliation	Organization	An organization that this person is affiliated with. For example, a school/university, a club, or a team.
alumniOf	EducationalOrganization or	An organization that the person is an alumni of.

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Google structured data

Google Structured Data Testing Tool

https://ontopic.biz/ NEW TEST

```
<!doctype html>
<html lang="en">
    <head>
        <!-- Required meta tags -->
        <meta charset="utf-8">
        <meta name="viewport" content="width=device-width, initial-scalew=1, shrink-to-fit=no">
        <meta name="description" content="Virtual Knowledge Graph, OBDA, Onthology Based Data Access, Data Integration">
        <meta name="author" content="Peter Hopfgartner, Ontopic">
        <link rel="stylesheet" href="bs/css/bootstrap.min.css" >
        <link href="css/ontopic.css" rel="stylesheet">
        <title>Ontopic - The Virtual Knowledge Graph Company</title>
<script type="application/ld+json">
{
   "@context" : "https://schema.org",
   "@type" : "Organization",
   "name" : "Ontopic",
   "url" : "https://ontopic.biz",
   "slogan": "The Virtual Knowledge Graph Company",
   "address" : {
      "@type" : "PostalAddress",
      "streetAddress" : "via Alessandro Volta, 13/A",
      "addressCountry" : "Italy"
```

Organization 0 ERRORS 0 WARNINGS

@type	Organization
name	Ontopic
url	https://ontopic.biz/
slogan	The Virtual Knowledge Graph Company
logo	https://ontopic.biz/img/logo-corto-01.png
address	
@type	PostalAddress
streetAddress	via Alessandro Volta, 13/A
addressLocality	Bolzano
postalCode	39100
addressCountry	
@type	Country
name	Italy
contactPoint	
@type	ContactPoint

What‘s the the thing with „virtual“?

Classical RDF data is kept in *triple stores.*

For analysing data from enterprise databases, this means:

- Another copy of the data
- Latency for data
- Latency for changes in the schema
- Does not scale well with ontologies

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What‘s the thing with „virtual“?

Virtual Knowledge Graphs: data is kept in the original databases.

Mapping:

The recipe for describing how the data in the database is linked to the graph is called „*mapping*“.

Ontop does exactly this.

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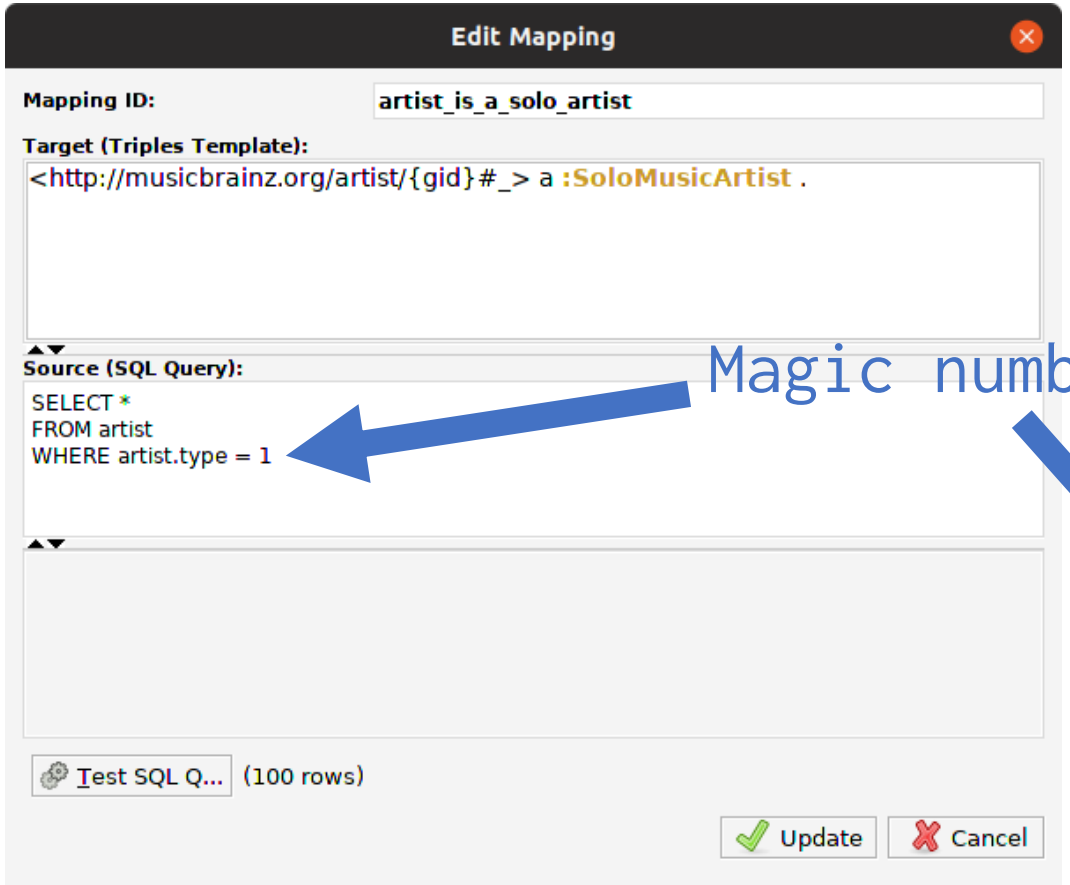
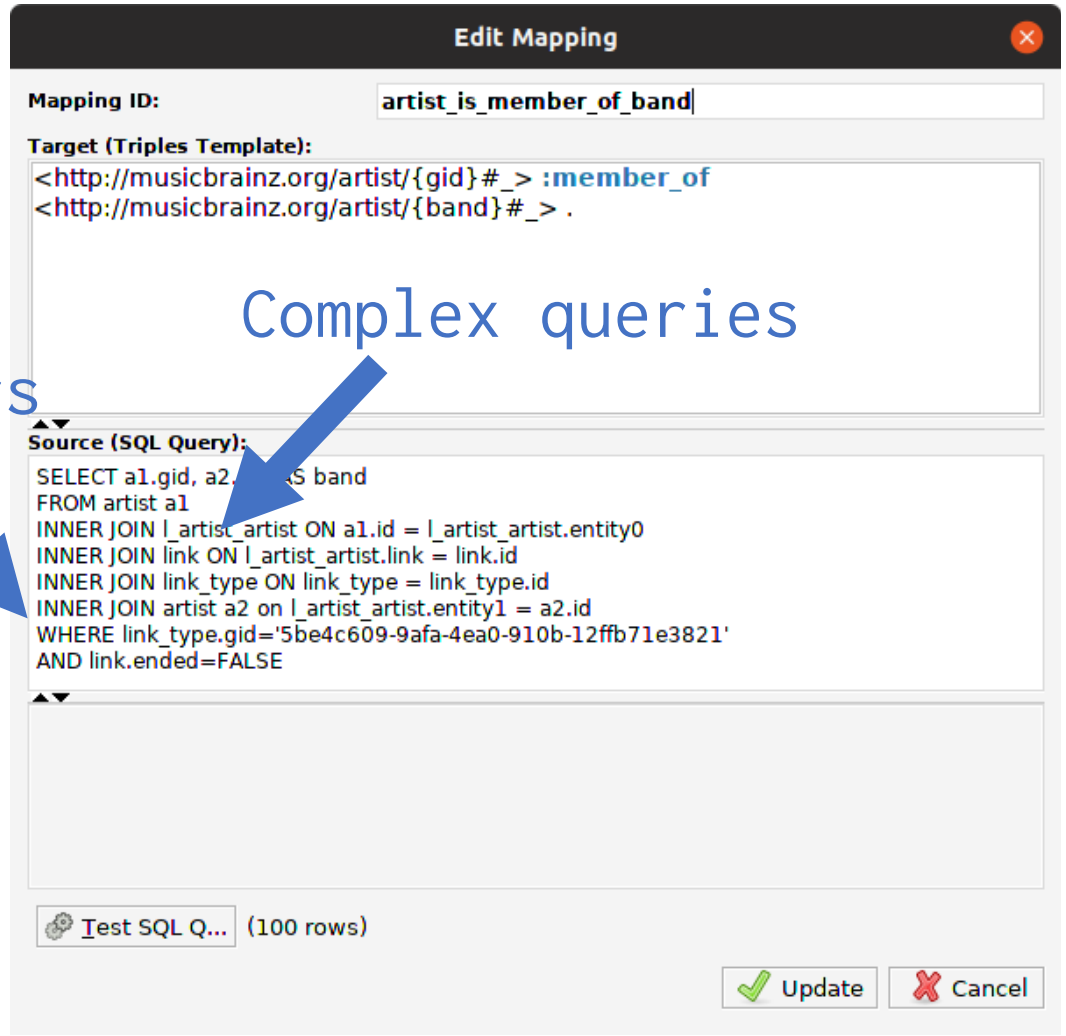
Mapping the Knowledge Graph to data sources



Magic numbers

Complex queries



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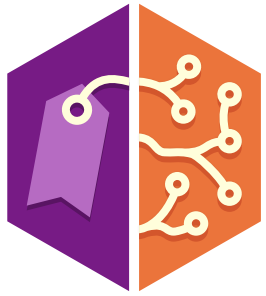
SPARQL: The query language for RDF

- Carries many ideas from SQL for relational databases.
- Operates on triples, not on tables

- Uses HTTP as a transfer protocol

Practical Example

Data from MusicBrainz



Ontology by

Mapping : https://github.com/metabrainz/MusicBrainz-R2RML

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SPARQL: An example

```
# Simple example
PREFIX foaf:  <http://xmlns.com/foaf/0.1/>
PREFIX mo: <http://purl.org/ontology/mo/>

SELECT  *
WHERE {
    ?artist rdf:type mo:MusicArtist;
        foaf:name "Herbert Pixner" .
}
```

artist
<http://musicbrainz.org/artist/0c7785bb-1d2e-4384-a572-7e69954508e9#_>

SPARQL: More infos

```
# local artists' friends
PREFIX : <http://purl.org/ontology/mo/>
PREFIX foaf:  <http://xmlns.com/foaf/0.1/>
PREFIX mo: <http://purl.org/ontology/mo/>

SELECT  *
WHERE {
    ?artist rdf:type mo:MusicArtist;
        foaf:name ?name ;
        foaf:based_near ?area .
    ?area rdfs:label ?area_name .
    ?artist foaf:name "Herbert Pixner" ;
}
```

artist	name	area	area_name
<http://musicbrainz.org/artist/0c7785bb-1d2e-4384-a572-7e69954508e9#_>	Herbert Pixner"	<http://musicbrainz.org/area/c6500277-9a3d-349b-bf30-41afdbf42add#_>	"Italy"

SPARQL: Connections matter

```
# local artists' friends
PREFIX : <http://purl.org/ontology/mo/>
PREFIX foaf:  <http://xmlns.com/foaf/0.1/>
PREFIX mo: <http://purl.org/ontology/mo/>

SELECT  DISTINCT ?name ?name2
WHERE {
    ?artist rdf:type mo:MusicArtist;
        foaf:name ?name ;
        foaf:based_near ?area;
        foaf:made ?something .
    ?area rdfs:label ?area_name .
    ?artist2 foaf:made ?something ;
        foaf:based_near ?area2;
        foaf:name ?name2 .
    ?area2 rdfs:label ?area_name2 .
    FILTER ( ?area_name =  "Bolzano" ||
        ?area_name =  "Trentino-Alto Adige" ||
        ?area_name =  "Italy" ||
        ?area_name =  "Austria" )
}
```

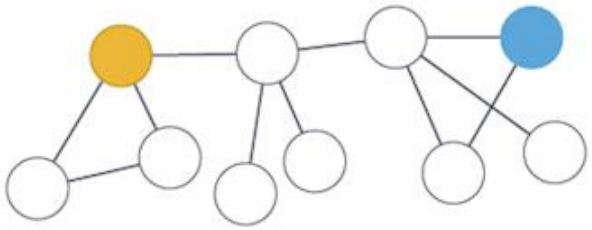
name	name2	
Andreas Fulterer	G.G. Anderson	
Wicked & Bonny	Wicked & Bonny	
Andreas Fulterer	Bernhard Brink	
Dominik Plangger	Papermoon	
Andreas Fulterer	Die Paldauer	
Andreas Fulterer	Andy Borg	
Voices of Decay	Voices of Decay	
Andreas Fulterer	Oliver Haidt	
Kinderchor der Kantorei Leonhard Lechner	Barry Faldner	
Kinderchor der Kantorei Leonhard Lechner	Orchestra Haydn di Bolzano e Trento	
Andreas Fulterer	Michael Morgan	
. . .	. . .	

Cooperate with others

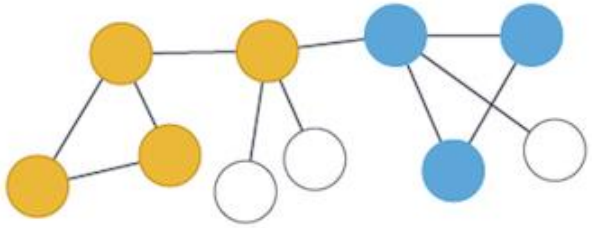
Results from the graph can be used as attributes for your input vectors.

Specialized software for Big Data, e.g. with Apache Spark:

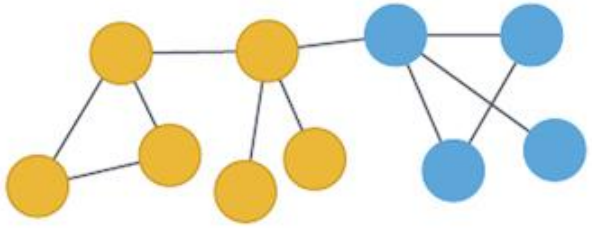
e.g. Label Propagation



Pass 1



Pass 2



URI	Name	Label
http://musicbrainz.org/artist/bfcc6d75-a6a5-4bc6-8282-47aec8531818#_	Cher	0
http://musicbrainz.org/artist/1aacd39b-8731-4923-a37d-884e2176ef93#_	Giorgia	0
http://musicbrainz.org/artist/a641ad4b-4b45-4a7b-b076-711f4775094d#_	Patsy Kensit	0
http://musicbrainz.org/artist/9072df14-b61e-42e2-b4f4-6bbb7fdb5586#_	Tina Turner	0
http://musicbrainz.org/artist/70ea63ea-70dc-4b63-951a-2c249d2b3b0a#_	Ricky Martin	0
http://musicbrainz.org/artist/0102e395-e4bd-476e-9a57-80e8335ba64a#_	Sonologyst	1
http://musicbrainz.org/artist/0548426a-7265-4671-8a08-19ca2baa47e2#_	Juda	3
http://musicbrainz.org/artist/062fceb6-81ab-4769-a6c2-a4d866350cd0#_	Elepharmers	5
http://musicbrainz.org/artist/08a5240a-0a45-43cd-af95-49b9a7d6bece#_	Lorenzo Campani	8
http://musicbrainz.org/artist/5bb63765-2282-4f6c-b823-20b95956fbef#_	Dynamic Base	9
http://musicbrainz.org/artist/d0e3329d-f909-490b-b755-dfa31f446eaf#_	Giorgia Angiuli	9
http://musicbrainz.org/artist/098acbe6-c428-4ae2-9cd0-3ba80162befb#_	Corona	9

Conclusions

- Virtual Knowledge Graphs can be easily integrated with your existing IT landscape
- SPARQL is very flexible for data preparation, e.g. based on topological properties
- These can be elaborated with 3rd party software, like Apache Spark, for calculating connection based attributes for improved ML

Thank you for attending

Still some questions?

Ontop is on GitHub

https://github.com/ontop/ontop

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