Knowledge Graphs in Python

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Vocabularies

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- Families of related notions are grouped into *vocabularies*.
- Some important, well-known namespaces—and prefixes:

  Modelling vocabulary:

  `rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#>` – RDF

  `rdfs:  <http://www.w3.org/2000/01/rdf-schema#>` – RDF Schema

  `owl:  <http://www.w3.org/2002/07/owl#>` – OWL

  Support vocabularies:

  `foaf:  <http://xmlns.com/foaf/0.1/>` – Friend of a friend

  `dc:  <http://purl.org/dc/terms/>` – Dublin Core

  `bfo:  <http://purl.obolibrary.org/obo/bfo.owl#>` – Basic Formal Ontology

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- Usually, a description is published at the namespace base URI.
- Note that the prefix is not standardised.

Example vocabularies: RDF, RDFS

RDF: describing RDF graphs.

- `rdf:Statement`
- `rdf:subject`, `rdf:predicate`, `rdf:object`
- `rdf:type`

RDFS: describing RDF vocabularies.

- `rdfs:Class`
- `rdfs:subClassOf`, `rdfs:subPropertyOf`
- `rdfs:domain`, `rdfs:range`
- `rdfs:label`

Examples:

```
dbr:London rdf:type dbo:City .
dbr:London rdfs:label "London"@en .
dbo:City rdfs:subClassOf dbo:Place .
```

Example vocabularies: OWL

OWL: describing ontologies

- `owl:inverseOf`
- `owl:equivalentClass`
- `owl:disjointWith`
- `owl:sameAs`

Examples:

```
dbr:London owl:sameAs ex:London .
dbo:location owl:inverseOf dbo:isLocatedIn .
dbo:City owl:disjointWith dbo:Person .
dbo:City owl:equivalentClass ex:City .
```

Example vocabularies: FOAF, Dublin Core

FOAF: person data and relations.

- `foaf:Person`
- `foaf:knows`
- `foaf:firstName`,
  `foaf:lastName`,
  `foaf:gender`

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Examples:

```
city:ernesto rdf:type foaf:Person .
city:ernesto foaf:knows city:carlos .
city:IN3067-INM713 dc:creator city:ernesto .
```

Example vocabularies: BFO

- Basic Formal Ontology:
  `http://www.obofoundry.org/ontology/bfo.html`
- It is an “upper level ontology”
- Lays the foundations of many ontologies in the biological domain.
- *e.g.*, `http://bioportal.bioontology.org/`

Recap: Other vocabularies

From KGs like DBpedia:

- Prefix `dbr:` `<http://dbpedia.org/resource/>`
- Prefix `dbo:` `<http://dbpedia.org/ontology/>`
- Prefix `dbp:` `<http://dbpedia.org/property/>`
- Examples:

```
dbr:london rdf:type dbo:City .
```

New vocabularies:

- Prefix `city:` `<http://www.example.org/university/london/city#>`
- Prefix `phdcourse:` `<http://www.semanticweb.org/ernesto/aalborg/phd/>`

RDF in Python

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- Saves and RDF graph:
  `g.serialize(destination='beatles.rdf', format='xml')`

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- Saves and RDF graph:
  ```
  g.serialize(destination='beatles.rdf', format='xml')
  ```
- Iterates over a graph:
  ```
  for s, p, o in g:
      print((s.n3(), p.n3(), o.n3()))
  ```

RDF in Python with RDFLib (ii)

- Basic triple elements: `from rdflib import URIRef, BNode, Literal`
- Creates an URI:
  `ernesto = URIRef("http://ex.org/univ/city#ernesto")`
- Creates a blank node: `bnode = BNode()`
- Creates a literal: `year = Literal('2021', datatype=XSD.gYear)`

RDF in Python with RDFLib (iii)

– Namespaces:

```
from rdflib import Namespace
```

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  `from rdflib import Namespace`
- Default namespaces and vocabulary: `from rdflib.namespace import OWL, RDF, RDFS, FOAF, XSD`
  - *e.g.*, RDF.type is equivalent to
    `URIRef("http://www.w3.org/1999/02/22-rdf-syntax-ns#type")`

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  - *e.g.*, RDF.type is equivalent to
    `URIRef("http://www.w3.org/1999/02/22-rdf-syntax-ns#type")`
- User defined:
  `city = Namespace("http://ex.org/univ/city#")`
  - *e.g.*, `city.ernesto` is equivalent to
    `URIRef("http://ex.org/univ/city#ernesto")`

RDF in Python with RDFLib (iv)

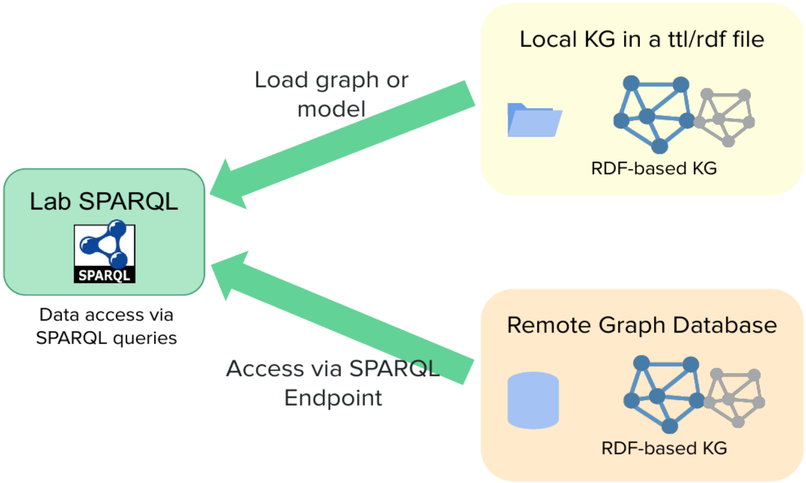
– Adding triples:

```
g.add((city.ernesto, RDF.type, FOAF.Person))
g.add((city.ernesto, FOAF.name, name))
g.add((city.ernesto, city.teaches, city.inm713))
```

– Prefixes: `g.bind("city", city)`

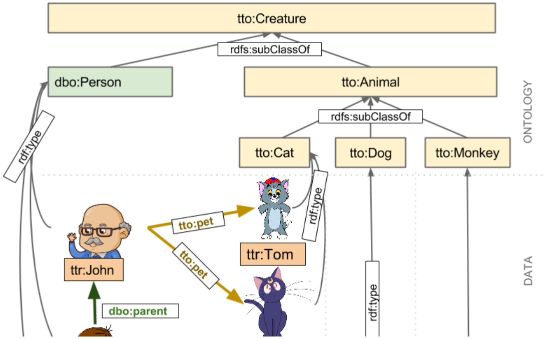
SPARQL in Python

SPARQL: local and remote KG access


Local KG in a ttl/rdf file
RDF-based KG
Load graph or model
Lab SPARQL
SPARQL
Data access via SPARQL queries
Access via SPARQL Endpoint
Remote Graph Database
RDF-based KG

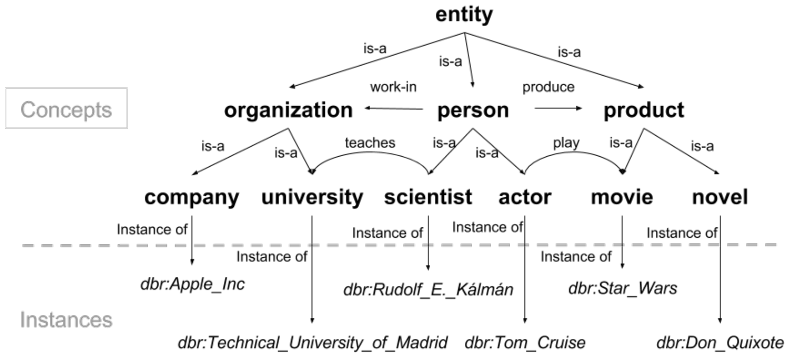
SPARQL Playground

– Based on discontinued platform to learn SPARQL.
  `http://sparql-playground.sib.swiss/`



DBpedia Knowledge Graph (i)

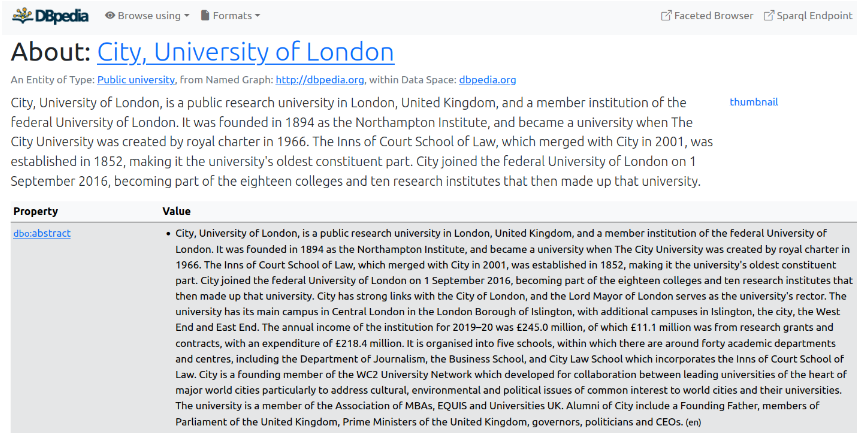
– Ontology/KG: `https://www.dbpedia.org/resources/ontology/`



(*) Image from `https://github.com/gsi-upm/sematch/`

DBpedia Knowledge Graph (ii)

– Linked data Interface: `https://www.dbpedia.org/resources/linked-data/`



About: City, University of London

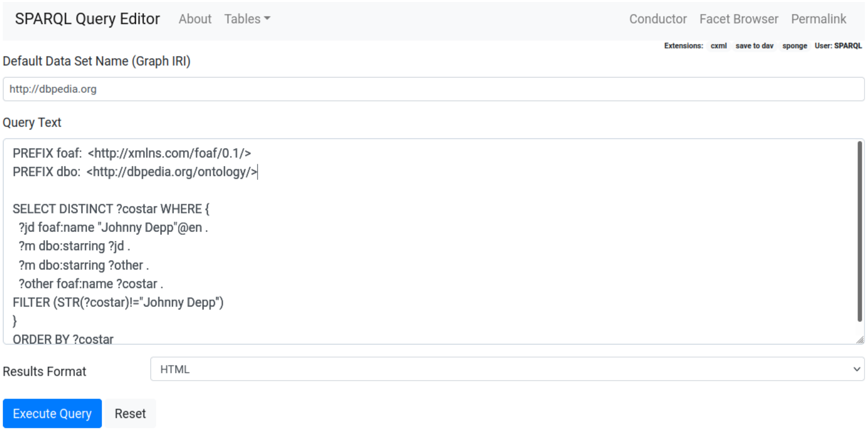
An Entity of Type: Public university, from Named Graph: http://dbpedia.org, within Data Space: dbpedia.org

City, University of London, is a public research university in London, United Kingdom, and a member institution of the federal University of London. It was founded in 1894 as the Northampton Institute, and became a university when The City University was created by royal charter in 1966. The Inns of Court School of Law, which merged with City in 2001, was established in 1852, making it the university's oldest constituent part. City joined the federal University of London on 1 September 2016, becoming part of the eighteen colleges and ten research institutes that then made up that university.

Property	Value
dbo:abstract	• City, University of London, is a public research university in London, United Kingdom, and a member institution of the federal University of London. It was founded in 1894 as the Northampton Institute, and became a university when The City University was created by royal charter in 1966. The Inns of Court School of Law, which merged with City in 2001, was established in 1852, making it the university's oldest constituent part. City joined the federal University of London on 1 September 2016, becoming part of the eighteen colleges and ten research institutes that then made up that university. City has strong links with the City of London, and the Lord Mayor of London serves as the university's rector. The university has its main campus in Central London in the London Borough of Islington, with additional campuses in Islington, the city, the West End and East End. The annual income of the institution for 2019–20 was £245.0 million, of which £11.1 million was from research grants and contracts, with an expenditure of £218.4 million. It is organised into five schools, within which there are around forty academic departments and centres, including the Department of Journalism, the Business School, and City Law School which incorporates the Inns of Court School of Law. City is a founding member of the WC2 University Network which developed for collaboration between leading universities of the heart of major world cities particularly to address cultural, environmental and political issues of common interest to world cities and their universities. The university is a member of the Association of MBAs, EQUIS and Universities UK. Alumni of City include a Founding Father, members of Parliament of the United Kingdom, Prime Ministers of the United Kingdom, governors, politicians and CEOs. (en)

DBPedia Knowledge Graph (iii)

– SPARQL Endpoint: `http://dbpedia.org/sparql`



Default Data Set Name (Graph IRI)

http://dbpedia.org

Query Text

```
PREFIX foaf:  <http://xmlns.com/foaf/0.1/>
PREFIX dbo:  <http://dbpedia.org/ontology/>

SELECT DISTINCT ?costar WHERE {
  ?jd foaf:name "Johnny Depp"@en .
  ?m dbo:starring ?jd .
  ?m dbo:starring ?other .
  ?other foaf:name ?costar .
FILTER (STR(?costar)!="Johnny Depp")
}
ORDER BY ?costar
```

Results Format: HTML

SPARQL in Python: Querying Local Graph with RDFLib

– Querying a local Graph:

```
qres = g.query(
    """SELECT ?thing ?name WHRE {
        ?thing tto:sex "female" .
        ?thing dbp:name ?name .
    }""")
```

– Iterate over the results:

```
for row in qres:
    print("%s is female with name ‘%s’" % (str(row.thing),str(row.name)))
```

– `row` is a dictionary with the RDF terms that match the output variables.

SPARQL in Python: Remote Access with SPARQLWrapper (i)

- SPARQLWrapper: deals with the connection to a SPARQL endpoint
- A SPARQL Endpoint is a service to receive and process SPARQL queries following a protocol.
- Connection: `sparql_web = SPARQLWrapper("http://dbpedia.org/sparql")`
- Set results format (default XML): `sparql_web.setReturnFormat(JSON)`

SPARQL in Python: Remote Access with SPARQLWrapper (ii)

– Set SPARQL query:

```
sparql_web.setQuery("""
    SELECT DISTINCT ?costar WHERE {
        ?jd foaf:name "Johnny Depp"@en .
        ?m dbo:starring ?jd .
        ?m dbo:starring ?costar .  }
""")
```

– Get (json) results: `results = sparql_web.query().convert()`

– Iterate over the (json) results:

```
for result in results["results"]["bindings"]:
    print(result["costar"]["value"])
```