SPARQL
(and the Regime Entailments)

set of rules that are going to do inference

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SPARQL

SPARQL: SPARQL Protocol And RDF Query Language

- Standard query language for RDF(S) Graphs
- Is a W3C Recommendation
- It supports RDFS (or OWL) under specific entailments under specific set of rules

Based on (navigational) pattern matching

- Simple RDF graphs are used as query patterns

pattern matching
resemble SQL

```
Select x,z where x Lectures y, y TaughtIn z, z rdf:Type Faculty
```

The semantics applied are those of homomorphism

SPARQL: Basics

4 query forms that retrieve either result sets or RDF graphs

- SELECT: Returns all, or a subset of, the variables bound in a query pattern match
- CONSTRUCT: Returns an RDF graph constructed by substituting variables in a set of triple templates
- ASK: Returns a boolean indicating whether a query pattern matches or not
- DESCRIBE: Returns an RDF graph that describes the resources found

if for pattern matching

same as select but returns yes or no based on if pattern matches

SPARQL Endpoints:

It is an endpoint accepting SPARQL queries and returning results via HTTP

semantic bag neighborhood
why called so? because it gives all semantics of neighborhoods for a node - adjacent nodes and edges

SPARQL SELECT Example

Select all pairs lecturer, course such that the lecture lectures the course

```
PREFIX fib: <http://www.fib.edu/elements/>
SELECT ?lecturer ?course
WHERE
  {
      ?lecturer fib:lectures ?course
  }
```

URL part of URI

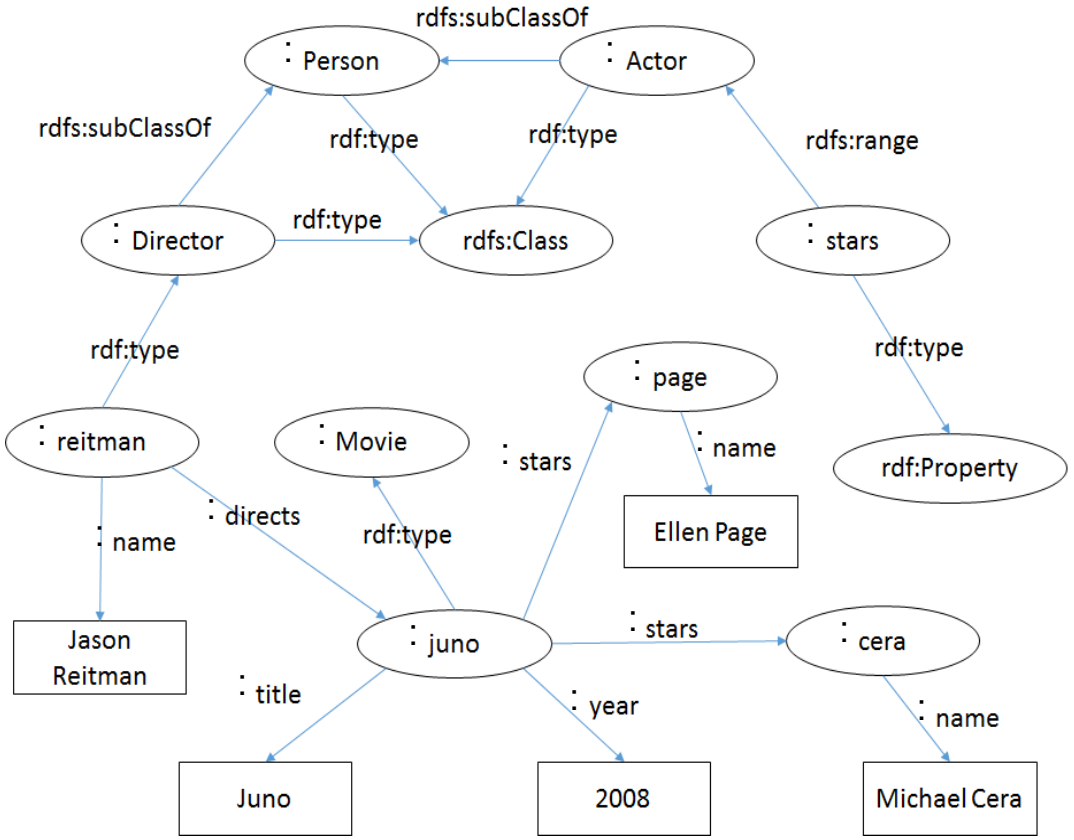
OUTPUT

PATTERN

Which is equivalent to: Select x, y Where x lectures y

SPARQL allows property paths based on regular expressions (check the syntax here): https://www.w3.org/TR/sparql11-property-paths/

Example of RDF(S) Graph



Write the following queries (asuming **no entailment regime**):

a) Get the name of all actors that participated in Juno
b) Get the name of all directors
c) Get the name of all persons
d) Get the title of all movies

can we keep rdf:type here? - Yes
If it is given we can keep it, but if not given won't refer as entailment regime is off

SPARQL 1.1 - Entailment Regimes

no inference

Simple entailment: evaluation of basic graph pattern by means of pattern matching under homomorphism

Advanced entailment regimes have been developed based on inference

- To retrieve solutions that *are logical consequences* of the axioms asserted

Most popular **advanced entailments**:

- RDF Schema entailment,
- OWL 2 RDF-Based Semantics entailment,
- Etc.

Some tools, like GraphDB, allow you to define your own entailment regime or define their own

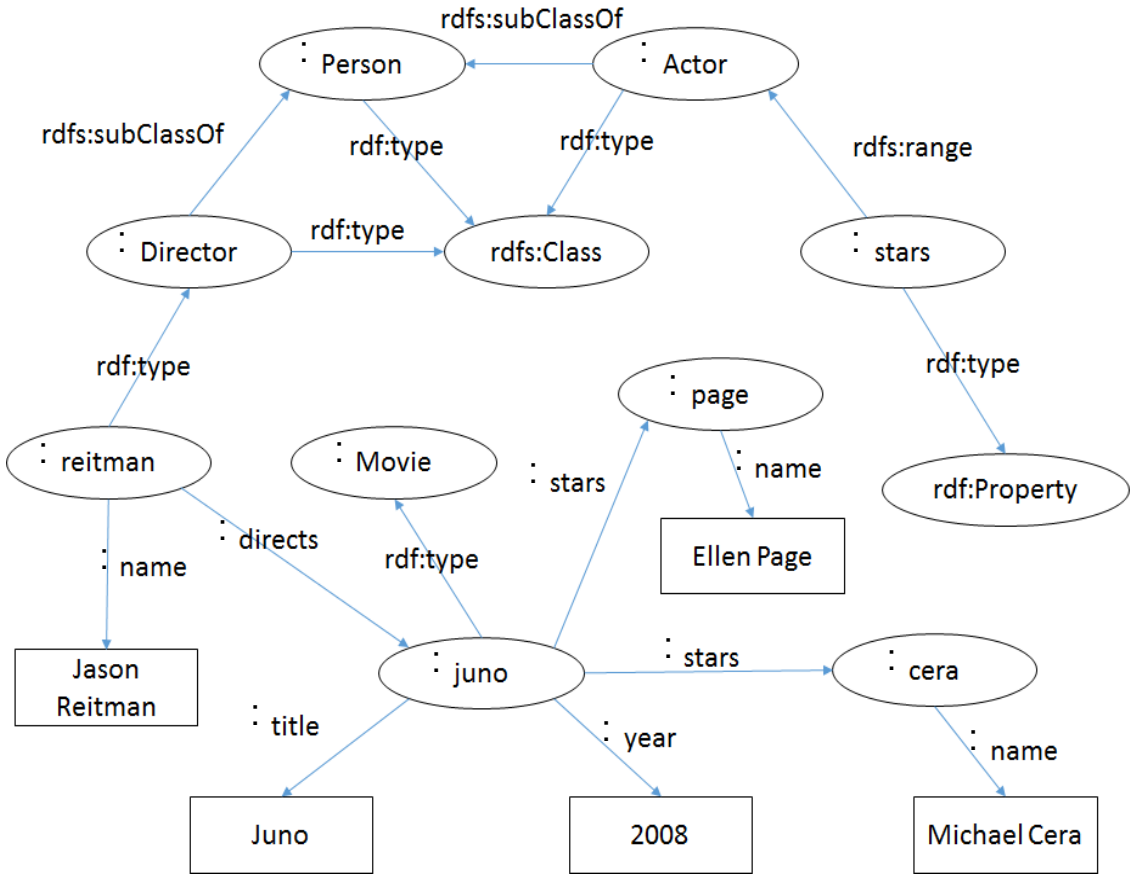
RDFS Regime Entailment (Inference Rules)

RDFS entailment patterns.

	If S contains:	then S RDFS entails recognizing D:
rdfs1	xxx aaa yyy .	aaa rdf:type rdf:Property .
rdfs2	aaa rdfs:domain xxx . yyy aaa zzz .	yyy rdf:type xxx .
rdfs3	aaa rdfs:range xxx . yyy aaa zzz .	zzz rdf:type xxx .
rdfs4a	xxx aaa yyy .	xxx rdf:type rdfs:Resource .
rdfs4b	xxx aaa yyy.	yyy rdf:type rdfs:Resource .
rdfs5	xxx rdfs:subPropertyOf yyy . yyy rdfs:subPropertyOf zzz .	xxx rdfs:subPropertyOf zzz .
~~***rdfs6***~~	~~xxx rdf:type rdf:Property .~~	~~xxx rdfs:subPropertyOf xxx .~~
rdfs7	aaa rdfs:subPropertyOf bbb . xxx aaa yyy .	xxx bbb yyy .
~~***rdfs8***~~	~~xxx rdf:type rdfs:Class .~~	~~xxx rdfs:subClassOf rdfs:Resource .~~
rdfs9	xxx rdfs:subClassOf yyy . zzz rdf:type xxx .	zzz rdf:type yyy .
~~***rdfs10***~~	~~xxx rdf:type rdfs:Class .~~	~~xxx rdfs:subClassOf xxx .~~
rdfs11	xxx rdfs:subClassOf yyy . yyy rdfs:subClassOf zzz .	xxx rdfs:subClassOf zzz .
~~***rdfs12***~~	~~xxx rdf:type rdfs:ContainerMembershipProperty .~~	~~xxx rdfs:subPropertyOf rdfs:member .~~
rdfs13	xxx rdf:type rdfs:Datatype .	xxx rdfs:subClassOf rdfs:Literal .

+ core class inference

Example of RDF(S) Graph



Write the following queries (assuming the **RDFS entailment regime**):

a) Get the name of all actors that participated in Juno
b) Get the name of all directors
c) Get the name of all persons
d) Get the title of all movies

Activity: Learning SPARQL

Go to the last version of the RDF Query Language document by the W3C: http://www.w3.org/TR/2013/REC-sparql11-query-20130321/ and read the following sections:

- 4. SPARQL Syntax,
- 5. Graph Patterns,
- 7. Matching Alternatives,
- 8. Negation,
- 9. Property Paths (equivalent to Navigational Pattern Matching: i.e., regular expressions on paths),
- 10. Assignment,
- 11. Aggregates,
- 12. Subqueries and
- 16. Query forms

A tutorial can be found here: https://www.w3.org/2009/Talks/0615-qbe/

Activity: Learning SPARQL

Solve the exercise handed out by the lecturer (find it attached to this session in the LearnSQL website)

- This is a set of **basic** queries useful to explore a dataset
- Train yourself later to be able to trigger advanced queries

This exercise requires connecting to the DBPedia SPARQL endpoint. There are several of them, for example: http://dbpedia.org/snorql/

Summary

SPARQL is the de facto standard to query knowledge graphs (RDF, RDFS, OWL)

It is based on pattern matching, but it also provides most of the relational operators (e.g., group by, set operators, etc.)

One may want to enable SPARQL entailment regimes, which extend pattern matching with basic reasoning capabilities

Bibliography

SPARQL. W3C Recommendation. Latest at http://www.w3.org/TR/rdf-sparql-query/