SPARQL: Simple Protocol And RDF Query Language

W3C Recommendation

- SPARQL 1.0 Query (2008)
- SPARQL 1.1 Query (2013)

  https://www.w3.org/TR/sparql11-query/
- SPARQL 1.1 Update (2013)

  https://www.w3.org/TR/sparql11-update/

SPARQL 1.1

1. SPARQL 1.1 Overview
2. SPARQL 1.1 Query Language
3. SPARQL 1.1 Update
4. SPARQL1.1 Service Description
5. SPARQL 1.1 Federated Query
6. SPARQL 1.1 Query Results JSON Format
7. SPARQL 1.1 Query Results CSV and TSV Formats
8. SPARQL Query Results XML Format (Second Edition)
9. SPARQL 1.1 Entailment Regimes
10. SPARQL 1.1 Protocol
11. SPARQL 1.1 Graph Store HTTP Protocol

SPARQL

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11. SPARQL 1.1 Graph Store HTTP Protocol

SPARQL 1.1 QUERY LANGUAGE

SPARQL 1.1 Query Language

- Syntax
- Triple Pattern
- Graph Pattern Matching
- Filter
- Query Form
- Statement
- Modifier

SPARQL Syntax

Triple Pattern

- Turtle triple syntax
- Variables

?x a foaf:Person

?x foaf:name "John"

<http://example.org/John> foaf:name ?name

<http://example.org/John> ?p ?v

Select Query

select

from

where

Select Query

select : result

from : target graph

where : query pattern

Select Query

```
select *
where {
        ?x rdf:type foaf:Person .
}
```

Select Query

```
select *
where {
        ?x rdf:type foaf:Person ;
          foaf:name "John" .
}
```

Select Query

```
select *
where {
        ?x rdf:type foaf:Person ;
         foaf:name "John" , ?name .
}
```

Select Query

```
select *
where {
        ?x rdf:type foaf:Person ;
         foaf:name "John", ?name .
        ?y foaf:knows ?x
}
```

Prefix, Namespace

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
select *
where {
  ?x a foaf:Person ;
    foaf:name ?name .
}
```

Prefix, Namespace

```
select *
where {
  ?x a <http://xmlns.com/foaf/0.1/Person> ;
    <http://xmlns.com/foaf/0.1/name> ?name .
}
```

Prefix, Namespace

```
prefix foaf: <http://xmlns.com/foaf/0.1/>
prefix ex:   <http://example.org/ns#>
select *
where {
  ?x a foaf:Person ;
    ex:name ?name .
}
```

Literal

- XSD Datatype

"1930-01-29"^^xsd:date	
"3.14"^^xsd:double	
"12"^^xsd:integer	12
"true"^^xsd:boolean	true
"Never surrender"^^xsd:string	"Never surrender"
…	

Literal

- Language tag

"Person"@en

"Personne"@fr

Literal

"Person"

!=

"Person"@en

<http://example.org/John>

!= "http://example.org/John"

!= "http://example.org/John"^^xsd:anyURI

Blank Node

- *Anonymous* variable
- Value of Blank Node is <u>not returned</u> in result

```
select *
where {
        _:b a foaf:Person ;
          foaf:name ?name
}
```

Blank Node

```
select ?x where {
        ?x a foaf:Person ;
         foaf:knows [ foaf:name "John" ] .
}
```

```
select ?x where {
        ?x a foaf:Person ;
         foaf:knows _:b .
        _:b foaf:name "John"  .
}
```

RDF List

- Retrieve a list with the exact number of elements

```
select * where {
        ?x rdf:value (?y ?z)
}
```

RDF List

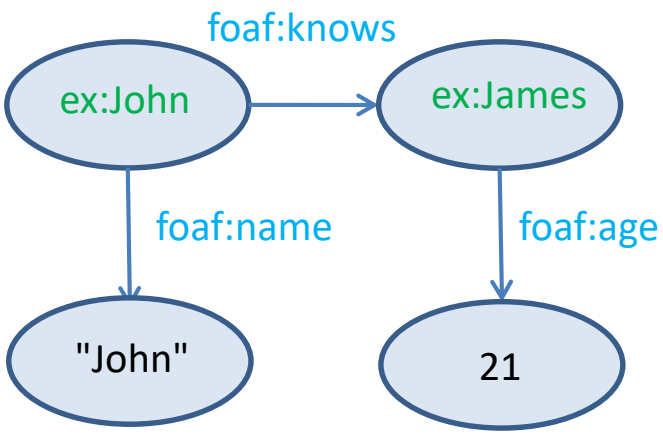
```
select * where {
        ?x rdf:value (?y ?z)
}

select * where {
        ?x rdf:value [
                rdf:first ?y ;
                rdf:rest [ rdf:first ?z ; rdf:rest rdf:nil ]
        ]
}
```

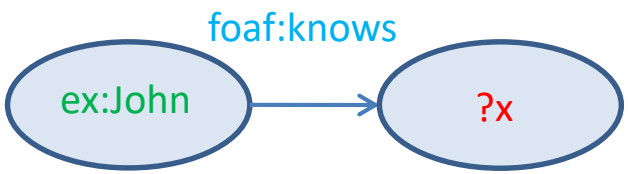
SPARQL Query Processing

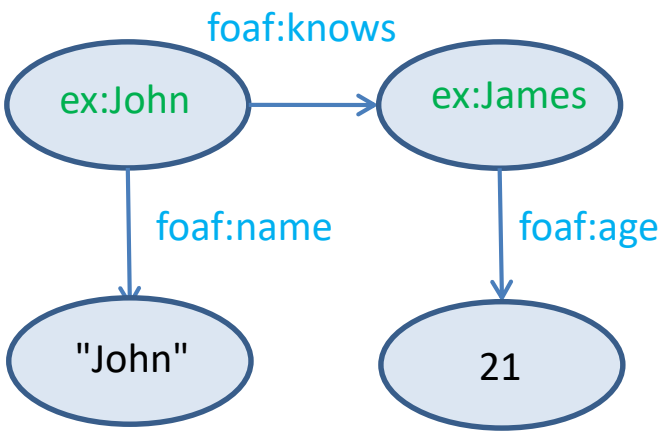
- A query is a Graph Pattern (graph with variables)
- Search occurrences of Graph Pattern in RDF Graph
- Zero, one or several results

Graph Pattern Matching

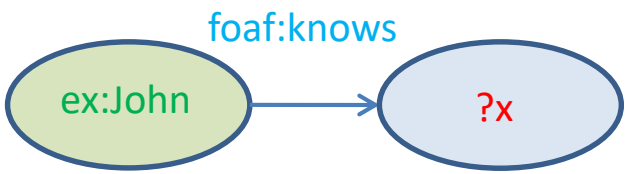


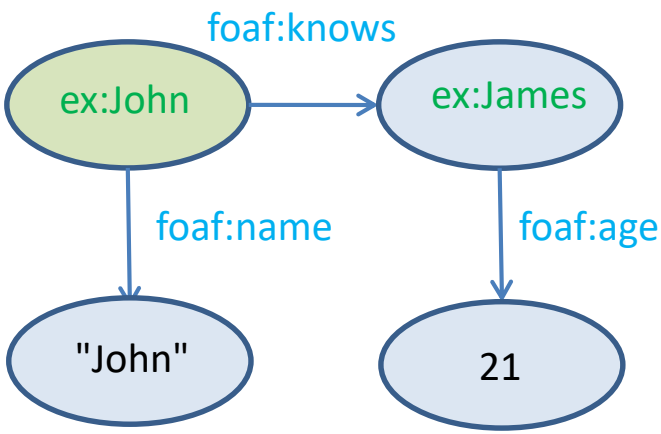
Graph Pattern Matching



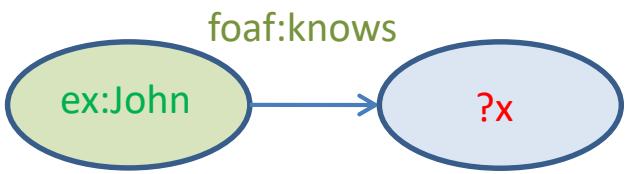


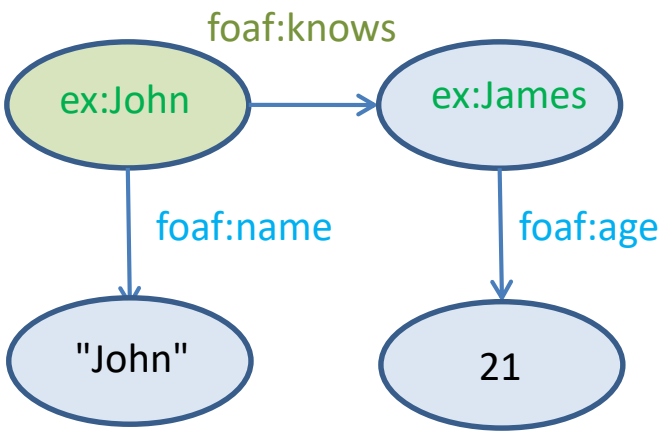
Graph Pattern Matching





Graph Pattern Matching





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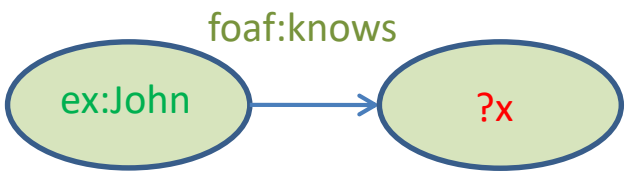

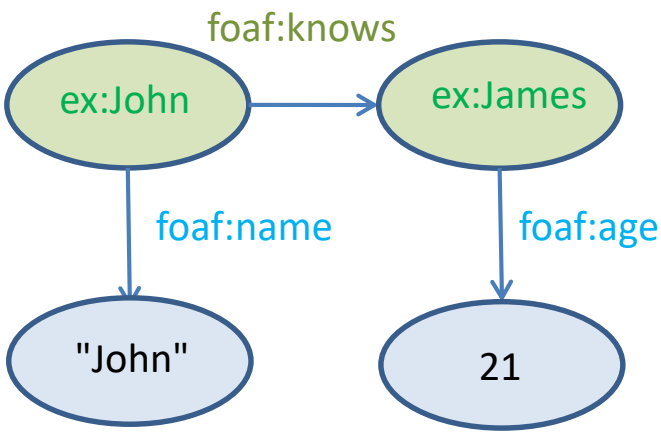

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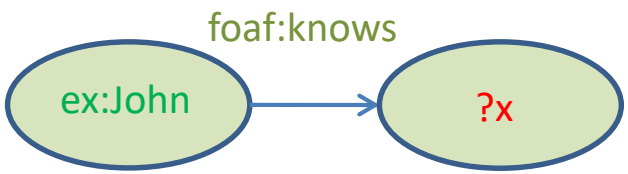
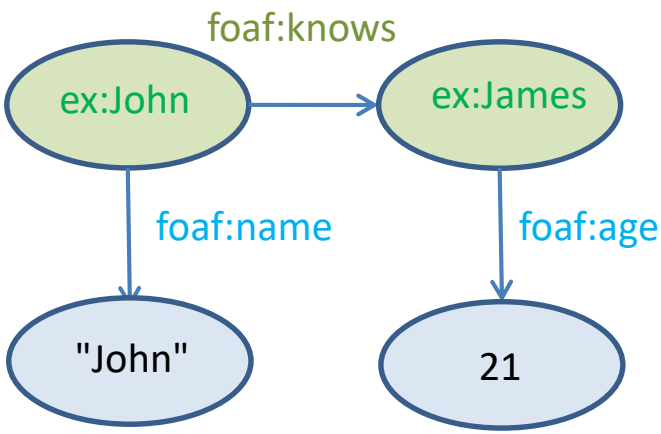
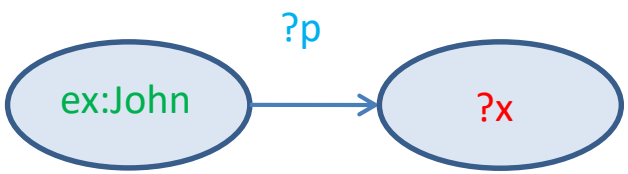


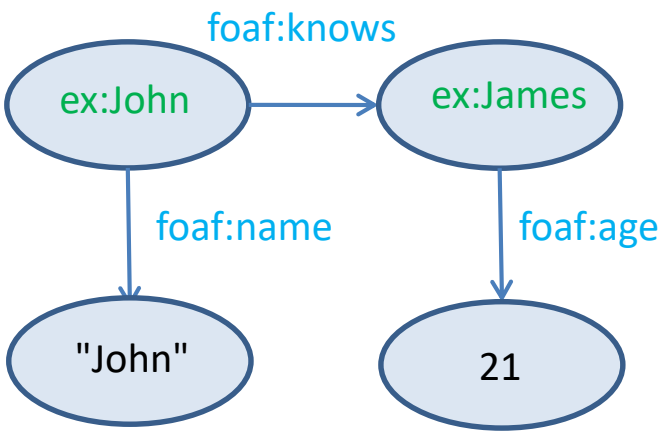


ex:John foaf:knows ?x

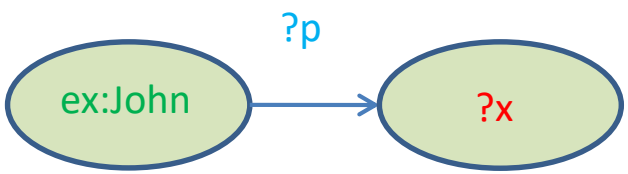
(1) ?x = ex:James

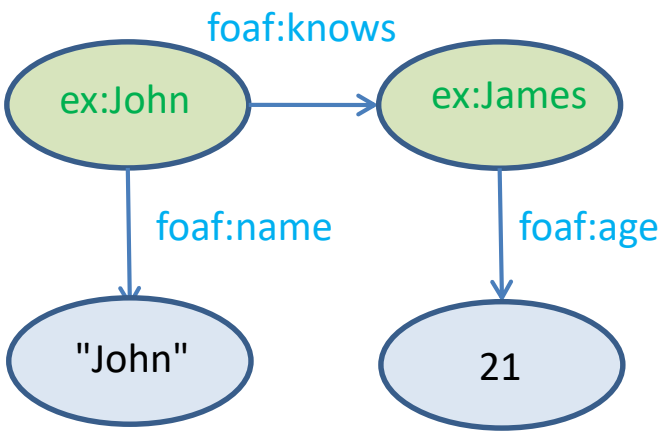
Graph Pattern Matching (2)





Graph Pattern Matching (2)

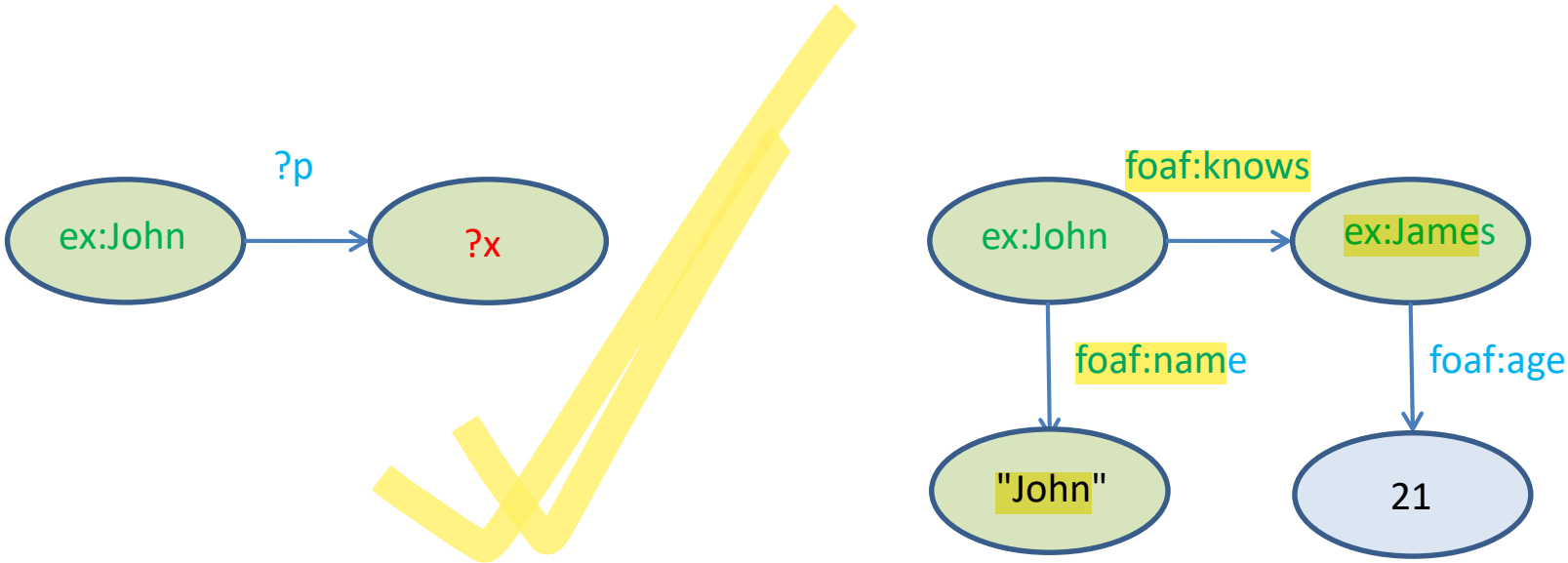




ex:John ?p ?x

(1) ?p = foaf:knows ; ?x = ex:James

Graph Pattern Matching (2)



ex:John ?p ?x

(1) ?p = foaf:knows ; ?x = ex:James
(2) ?p = foaf:name ; ?x = "John"

SPARQL Query Processing

- Result: (multi) set of variable bindings

1. ?x = ex:John ; ?z = ex:Jack
2. ?x = ex:Jim ; ?z = ex:Jesse
3. ?x = ex:John ; ?z = ex:Jack

Multiset of results

```
select ?x ?z where {
   ?x foaf:knows ?y .
   ?y foaf:knows ?z .
}
```

Multiset of results

```
select ?x ?z where {
   ?x foaf:knows ?y .
   ?y foaf:knows ?z .
}
```

ex:John foaf:knows ex:James . ex:James foaf:knows ex:Jack

ex:John foaf:knows ex:Patty . ex:Patty foaf:knows ex:Jack

Multiset of results

```
select ?x ?z where {
   ?x foaf:knows ?y .
   ?y foaf:knows ?z .
}
```

ex:John foaf:knows ex:James . ex:James foaf:knows ex:Jack

ex:John foaf:knows ex:Patty . ex:Patty foaf:knows ex:Jack

Multiset of results

```
select ?x ?z where {
  ?x foaf:knows ?y .
  ?y foaf:knows ?z .
}
```

ex:John foaf:knows ex:James . ex:James foaf:knows ex:Jack
ex:John foaf:knows ex:Patty . ex:Patty foaf:knows ex:Jack

1. ?x = ex:John ; ?z = ex:Jack
2. …
3. ?x = ex:John ; ?z = ex:Jack

Example

- Resources with name "Iannis" and possibly other name(s)

Example

- Resources with name "Iannis" and possibly other name(s)

?x foaf:name "Iannis" , ?name .

Example

- Triple with same subject and object

Example

- Triple with same subject and object

?x ?p ?x

Example

- Triple with property as subject

Example

- Triple with property as subject

?p ?p ?x

Filter

Filter Expression

- Reduce result multiset
- Keep results that match a condition
- Match: expression evaluates to *true*

```
?age >= 10
?name != "John"
isURI(?x) || isBlank(?x)
! us:boring(?course)
```

Filter

- Variable:
  1. bound by triple pattern

```
select * where {
  ?x foaf:age ?age

}
```

Filter

- Variable:
  1. bound by triple pattern
  2. tested by filter

```
select * where {
  ?x foaf:age ?age
  filter (?age >= 18)
}
```

Filter

- Variable:
  1. ~~bound by triple pattern~~
  2. tested by filter

```
select * where {

  filter (?age >= 18)
}
```

Filter Language

- URI, Literal, Variable ex:John, 3.14, ?x
- < <= >= > ?age >= 18, ?n < "John"
- = != ?x != ?y, ?y = "James"
- ( )
- + - * / (?n * (?n + 1))/2
- && || ! ! (?x < 0 && ?y < 0)
- Function datatype(?x)
- Exists exists { ?x foaf:knows ?y}

Example

- Resources with name "Iannis" and with another name

Example

- Resources with name "Iannis" and with another name

```
?x foaf:name "Iannis" ,  ?name .
filter (?name != "Iannis")
```

Example

- Resources with different values for same property

Example

- Resources with different values for same property

```
?x ?p ?y , ?z .
filter (?y != ?z)
```

Example

- Resources with same value for different properties

Example

- Resources with same value for different properties

```
?x ?p ?v ; ?q ?v .
filter (?p != ?q)
```

Conditional Statement

- if then else

```
filter if (lang(?name) = "fr",
                ?age >= 18,
                ?age >= 21)
```

Coalesce

- Result of first expression that does not return an error (e.g. unbound variable)

filter coalesce (exp_1, .. exp_n)

Function

- isBlank(?x)
- isURI(?x)
- isLiteral(?x)
- bound(?x)

Function

- datatype(?x)
- lang(?l)
- langMatches(lang(?l), "fr")
- str(<http://example.org>)
- uri("http://example.org")
- xsd:integer("123")
- xsd:string(12)
- strdt(str, datatype)
- strlang(str, lang)

Function

- now()
- year(?date)
- month(?date)
- day(?date)
- hours(?date)
- minutes(?date)
- seconds(?date)
- …

Function

- contains(str_1, str_2)
- strstarts(str_1, str_2)
- strends(str_1, str_2)
- concat(str_1, str_2)
- substr(str, n)
- strlen(str)
- regex(str, ".*cnrs")
- …

Function

- abs(?x)
- ceil(?x)
- floor(?x)
- round(?x)
- rand()
- …

Extension Function

- Application specific external function

```
prefix  fun:  <function://fr.geo.Extend>
select *
where {
        ?x geo:loc (?lon, ?lat)
        filter  fun:locate(?lon, ?lat)
}
```

Example

- Teenager : age between 13 and 19

Example

- Teenager : age between 13 and 19

```
?x foaf:age ?age
filter (?age >= 13  &&  ?age <= 19)
```

Example

- Resource whose name length is less than 20

Example

- Resource whose name length is less than 20

?x foaf:name ?name

filter (strlen(?name) < 20)

Example

- URI from inria

Example

- URI from inria

?x ?p ?y

filter regex(str(?x), "inria")

Query Form

Query Form

1. Select
2. Ask
3. Construct
4. Describe

Select

- Return variable bindings

```
select * where {
        ?x foaf:knows ?y
}
```

Ask

- Return true/false

```
ask { ?x  rdf:type  ex:Yeti }
```

Construct

- Return new RDF graph

1. Instantiate construct pattern with every results
2. Merge result triples into one new RDF graph

```
construct { ?x rdfs:seeAlso ?z }
where { ?x foaf:knows ?y . ?y foaf:knows ?z }
```

Describe

- Return description of resource(s) as RDF graph

```
describe <http://example.org/John>
```

1 Ex

```
describe ?x
where {  ?x foaf:name "John"  }
```

2 Ex

Statement

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. Property Path
7. Nested Query
8. Bind
9. Values
10. Service

Union

- «Union» of results of alternative graph patterns
- One branch must match
- Both branches may match

```
{ ?x a ex:Good }
union
{ ?x a ex:Evil }
```

Statement

1. Union
2. **Optional**
3. Minus
4. Filter (Not) Exists
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Optional

- Part of a query that is not mandatory
- Optional part may fail

```
?x a foaf:Person
optional { ?x foaf:name ?name }
```

1. ?x = us:John
2. ?x = us:Jack ; ?name = "Jack"

Optional

- Part of a query that is not mandatory
- Optional part may fail

```
?x a foaf:Person
optional { ?x foaf:name ?name }
optional { ?x foaf:age ?age . filter (?age > 50) }
```

Optional

- Part of a query that is not mandatory
- Optional part may fail

```
?x a foaf:Person
optional { ?x foaf:name ?name
        optional { ?x foaf:age ?age . filter (?age > 50) }
}
```

Statement

1. Union
2. Optional
3. **Minus**
4. Filter (Not) Exists
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Minus

- Negation
- Remove result of minus pattern from result of pattern

```
?x a foaf:Person
minus { ?x foaf:age ?age . filter (?age < 18) }
```

Minus

- There must be (at least) one variable in common

```
?x a foaf:Person
minus { ?x foaf:age ?age . filter (?age < 18) }
```

Statement

1. Union
2. Optional
3. Minus
4. **Filter (Not) Exists**
5. Named Graph
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Filter Exists

- Check the existence of a pattern: return true or false

```
?x a foaf:Person
filter exists { ?y foaf:knows ?x }
```

Filter Exists

- Check the existence of a pattern: return true or false

```
?x a foaf:Person
filter ( ?x = ex:JohnDoe ||
         exists { ?y foaf:knows ?x } )
```

Filter Not Exists

- Check the absence of a pattern: return true or false

?x a foaf:Person

filter not exists { ?y foaf:knows ?x }

Exercise

- Find persons *and* the resources they know *union* the resources they are known by

Exercise

```
select * where {
   ?x a foaf:Person
   { ?x foaf:knows ?y } union { ?y foaf:knows ?x }
}
```

Exercise

- Find persons except those who know John Doe

Exercise

```
select * where {
   ?x a foaf:Person
   minus { ?x foaf:knows us:JohnDoe }
}
```

Exercise

Find persons and, if possible, persons they know and their name.

Exercise

```
select * where {
   ?x a foaf:Person
   optional {
         ?x foaf:knows ?y
         ?y foaf:name ?name
   }
}
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. **Named Graph**
6. Property Path
7. Nested Query
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RDF Dataset

- One default graph (mandatory)
- Several named graphs (optional)
- $\{ G, (uri_1, G_1), \ldots (uri_n, G_n) \}$

- Basic Graph Pattern queries the default graph

RDF Dataset

```
select *
where {
        ?x a foaf:Person
}
```

{ G, (ex:g1, G_1), … (ex:g2, G_2) }

From

- Redefine the default graph, for the query, either as:
  - one named graph
  - merge of several named graphs

```
select *
from ex:g1
where {
        ?x a foaf:Person
}
```

$\{ G, (ex:g1, G_1), .. (ex:g2, G_2) \}$

From

- Redefine the default graph, for the query, either as:
  - one named graph
  - merge of several named graphs

```
select *
from ex:g1                    { G, (ex:g1, G1), .. (ex:g2, G2) }
where {
        ?x a foaf:Person              G1
}
```

From

- Redefine the default graph, for the query, either as:
  - one named graph
  - merge of several named graphs

```
select *
from ex:g1
from ex:g2
where {
        ?x a foaf:Person
}
```

$\{ G, (ex:g1, G_1), .. (ex:g2, G_2) \}$

From

- Redefine the default graph, for the query, either as:
  - one named graph
  - merge of several named graphs

```
select *
from ex:g1
from ex:g2
where {
        ?x a foaf:Person
}
```

{ G, (ex:g1, G_1), .. (ex:g2, G_n) }

$G_1 \cup G_2$

Named Graph Pattern

- Query one named graph

```
select * where {
    graph ex:cnrs  {
        ?x foaf:knows ?y
    }
}
```

Named Graph Pattern

- Query all named graphs

```
select * where {
   graph ?g  {
        ?x foaf:knows ?y
   }
}
```

From named

- Query specific named graphs, « *one by one* »

```
select *
from named ex:cnrs
from named ex:uca
where {

        graph ?g  { ?x foaf:knows ?y }
}
```

From and From named

```
select *
from ex:inria
from named ex:cnrs
from named ex:uca
where {
        ?x a foaf:Person
        graph ?g  { ?x foaf:knows ?y }
}
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. **Property Path**
7. Nested Query
8. Bind
9. Values
10. Service

Property Path

Find resources related by several triples:

ex:John $\xrightarrow{\text{foaf:knows}}$ ex:Jack $\xrightarrow{\text{foaf:knows}}$ ex:Jim $\xrightarrow{\text{foaf:knows}}$ ex:James

ex:John foaf:knows ?y

(1) ?y = ex:Jack

Property Path

Find resources related by several triples:

ex:John $\xrightarrow{\text{foaf:knows}}$ ex:Jack $\xrightarrow{\text{foaf:knows}}$ ex:Jim $\xrightarrow{\text{foaf:knows}}$ ex:James

ex:John foaf:knows/foaf:knows ?y

(1) ?y = ex:Jim

Property Path

Find resources related by several triples:

ex:John $\xrightarrow{\text{foaf:knows}}$ ex:Jack $\xrightarrow{\text{foaf:knows}}$ ex:Jim $\xrightarrow{\text{foaf:knows}}$ ex:James

ex:John foaf:knows/foaf:knows/foaf:knows ?y

(1) ?y = ex:James

uncle

Property Path

Find resources related by several triples:

ex:John —foaf:knows→ ex:Jack —foaf:knows→ ex:Jim —foaf:knows→ ex:James

ex:John foaf:knows+ ?y

(1) ?y = ex:Jack

(2) ?y = ex:Jim

(3) ?y = ex:James

Property Path Language

?x exp ?y

exp ::=

uri :	property
!uri :	negation
exp/exp :	sequence
exp|exp :	alternative
exp? :	optional
exp* :	zero or several
exp+ :	one or several
^exp :	reverse

Property Path: Reverse

?x ^(p/q) ?y

::=

?y p/q ?x

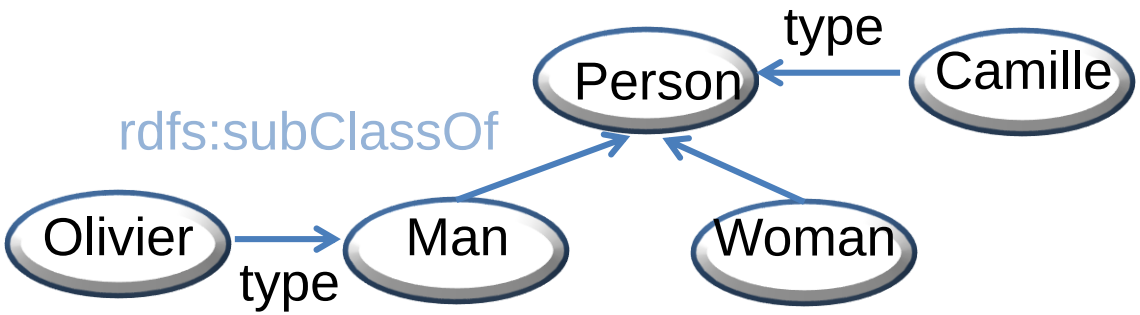
?x ^exp ?y

::=

?y exp ?x

Path Example

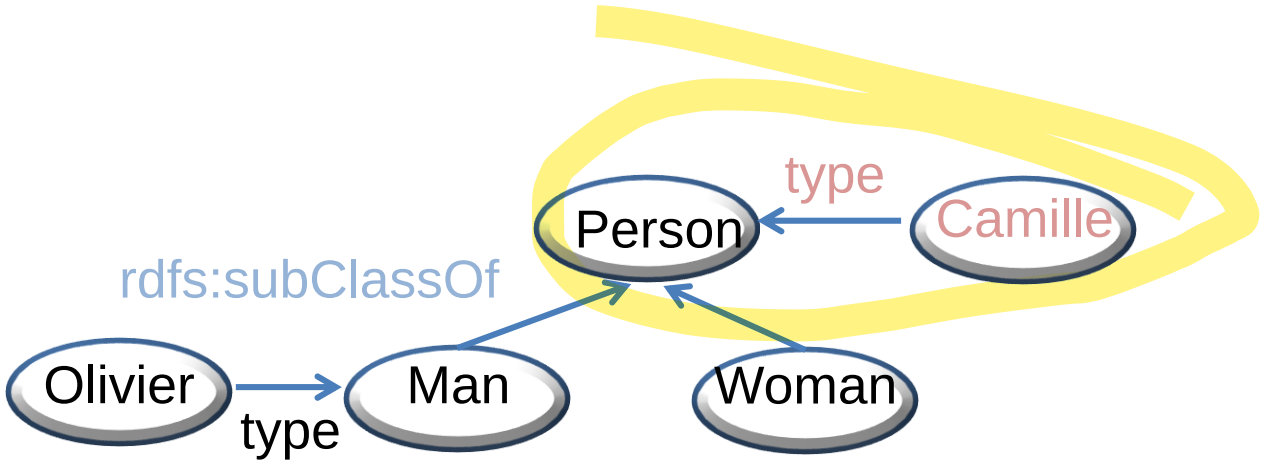
- Emulate class subsumption



Path Example

- Emulate class subsumption

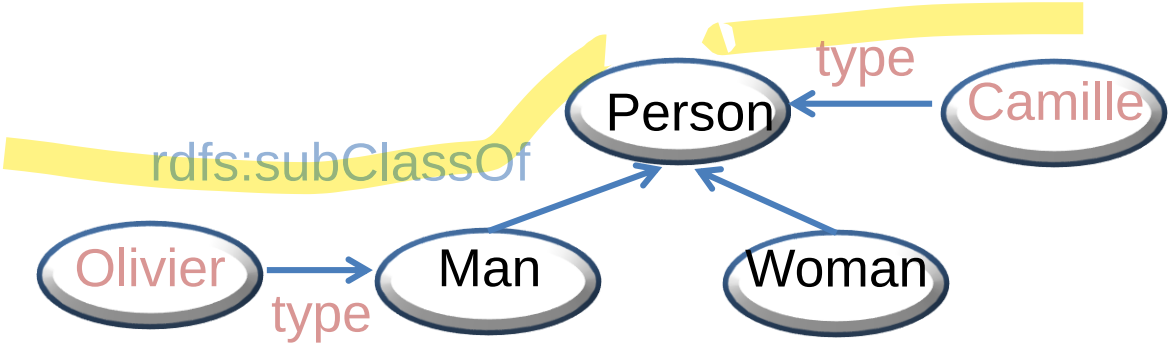
?x rdf:type foaf:Person



Path Example

- Emulate class subsumption

?x rdf:type/rdfs:subClassOf* foaf:Person



Path Example

- Enumerate RDF list elements

?list rdf:rest*/rdf:first ?e

Path Example

- Resources related by several foaf:knows and/or rdfs:seeAlso

Path Example

- Resources related by several foaf:knows and/or rdfs:seeAlso

?x (foaf:knows|rdfs:seeAlso)+ ?y

Path Example

- Enumerate list elements with position

```
select ?val  (count(?mid) as ?pos) where {
   ?list     rdf:rest*  ?mid
   ?mid   rdf:rest*  ?node
   ?node rdf:first   ?val
}
group by ?node ?val
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. Property Path
7. **Nested Query**
8. Bind
9. Values
10. Service

Nested Query

- Subquery within a query

```
select * where {
        {select ?x  (?w * ?l  as  ?area)
         where { ?x ex:width ?w ; ex:length ?l }}
        ?z ex:area ?area
}
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. Property Path
7. Nested Query
8. **Bind**
9. Values
10. Service

Bind

- Bind result of expression to variable

bind (exp as var)

Bind

```
?x geo:width ?w ; geo:length ?l
bind  (?w * ?l  as  ?area)
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. Property Path
7. Nested Query
8. Bind
9. **Values**
10. Service

Values

- Focus variable(s) on predefined constant values

```
select * where {
        ?x rdfs:label ?name
}
values  ?name  {  "Blue"  "Red"  "Yellow"  }
```

Values

- Focus variable(s) on predefined constant values

```
select * where {
        values  ?name  {  "Blue"  "Red"  "Yellow"  }
        ?x rdfs:label ?name
}
```

Statement

1. Union
2. Optional
3. Minus
4. Filter (Not) Exists
5. Named Graph
6. Property Path
7. Nested Query
8. Bind
9. Values
10. **Service**

Service

SPARQL 1.1. Federated Query

Service

- Query remote SPARQL endpoint

```
select * where {
 service  <http://fr.dbpedia.org/sparql> {
        ?x  rdfs:label  "Nice"@fr ;
            rdf:type  ?t
 }

}
```

Service

- Query remote SPARQL endpoint
- Join service results with local results

```
select * where {
  service  <http://fr.dbpedia.org/sparql> {
          ?x  rdfs:label  "Nice"@fr ;
              rdf:type  ?t
  }
  ?y a ?t
}
```

Service

- Query remote SPARQL endpoint with nested query

```
select * where {
 service  <http://fr.dbpedia.org/sparql> {
      select * where {
        ?x  rdfs:label  "Nice"@fr ;
           rdf:type  ?t
      }
      limit 50
 }
}
```

back to

SPARQL 1.1. Query Language

Solution Sequence Modifiers

1. Distinct
2. Order By
3. Limit
4. Offset

Distinct

- Remove similar results with same values for same variables

```
select ?x ?z
where {
        ?x foaf:knows ?y .
        ?y foaf:knows ?z
}
```

1. ?x = ex:John ; ?z = ex:Jack
2. …
3. ?x = ex:John ; ?z = ex:Jack

Distinct

- Remove similar results with same values for same variables

```
select distinct ?x ?z
where {
        ?x foaf:knows ?y .
        ?y foaf:knows ?z
}
```

1. ?x = ex:John ; ?z = ex:Jack
2. …
3. ~~?x = ex:John ; ?z = ex:Jack~~

Order By

- Sort results by numbers, strings, dates, …

```
select * where {
  ?x foaf:name ?name ;
     foaf:age ?age
}
order by desc(?age) ?name
```

Limit, Offset

- Limit number of results
- Slice results with an offset

```
select * where {
        …
}
limit 10
offset 10
```

Select Expression and Aggregates

Select Expression

- Complete the select clause with expressions

```
select  ?s  (?w * ?l  as  ?area)
where {
        ?s ex:width ?w ; ex:length ?l
}
```

Aggregates

- Combine several results into an aggregate value.

```
select (avg(?p) as ?avg)  where {
        ?x ex:price ?p
}
```

1. count
2. sum
3. avg
4. min
5. max
6. group_concat
7. sample

Aggregates and Group By

- Group results with similar values, aggregate in each group

```
select ?x  (avg(?s) as ?score)
where {
        ?x ex:score ?s
}
group by ?x
```

Aggregates, Group By and Having

- Group results with similar values, aggregate in each group, filter aggregate values

```
select ?x  (avg(?s) as ?score)
where {
        ?x ex:score ?s
}
group by ?x
having (?score >= 10)
```

DESIGN PATTERNS

Negation as Failure

```
?x a foaf:Person
optional { ?x dc:creator ?doc }
filter (! bound(?doc))
```

Negation : take care

- Find people that are not fisherman

ex:John a foaf:Person , ex:Fisherman .

```
select * where {
        ?x a ?t
        filter (?t != ex:Fisherman)
}
```

☹ ?x = ex:John ; ?t = foaf:Person

Negation : take care

- Find people that are not fisherman

ex:John a foaf:Person , ex:Fisherman .

```
select * where {
        ?x a ?t
        minus { ?x a ex:Fisherman }
}
```

☺

Named Graph as Context

```
select *
where {

        graph ?g  {
                ?x ex:workAt <http://www.cnrs.fr>
        }
}
```

Named Graph as Context

```
select *
where {
        ?g a ex:Context
        graph ?g  {
                ?x ex:workAt <http://www.cnrs.fr>
        }
}
```

Named Graph as Context

```
select *
where {
        ?g a ex:Context ; ex:date 2001
        graph ?g  {
                ?x ex:workAt <http://www.cnrs.fr>
        }
}
```

Named Graph as Context

```
select *
where {
        ?g1 a ex:Context ; ex:date 2001 .
        ?g1 rdfs:seeAlso ?g2
        graph ?g2  {
                ?x ex:workAt <http://www.cnrs.fr>
        }
}
```

Distinct distinct

```
select distinct ?x ?y
where {
        ?x foaf:knows/foaf:knows ?y

}
```

?x = ex:John ; ?y = ex:Patty
?x = ex:Patty ; ?y = ex:John

Distinct distinct

```
select distinct ?x ?y
where {
        ?x foaf:knows/foaf:knows ?y
        filter (?x < ?y)
}
```

?x = ex:John ; ?y = ex:Patty

~~?x = ex:Patty ; ?y = ex:John~~

SPARQL 1.1 QUERY RESULT

SPARQL Query Result Formats

- XML
- JSON
- CSV, TSV

SPARQL 1.1 UPDATE

SPARQL Update

Manage (modify) the content of RDF Datasets

- Load
- Delete/Insert Data
- Delete/Insert Where
- Copy, Move, Add

Load RDF document

load <http://example.org/data.ttl>

load <http://example.org/data.ttl> into graph ex:g

Insert Data

```
insert data {
        ex:John a foaf:Person ; foaf:age 18 .
        ex:Jill a foaf:Person ; foaf:age 81 .
}
```

Delete Data

```
delete data {
        ex:John a foaf:Person ; foaf:age 18 .
        ex:Jill a foaf:Person ; foaf:age 81 .
}
```

Delete Data

```
delete data {
        [ ] a foaf:Person ; foaf:age 18 .
        ex:Jill a foaf:Person ; foaf:age 81 .
}
```

No Blank Node in a delete clause !!!

Delete Where

```
delete {
        ?x foaf:age ?age
}
where {
        ?x a foaf:Person ; foaf:age ?age
        filter (?age < 0)
}
```

Delete Where

```
delete {
        [ ] foaf:age ?age
}
where {
        ?x a foaf:Person ; foaf:age ?age
        filter (?age < 0)
}
```

No Blank Node in a delete clause !!!

Delete Where

```
delete {
        ?x foaf:age ?age
}
where {
        ?x a foaf:Person ; foaf:age ?age
        filter (?age < 0)
}
```

(1) ?x = ex:John

(2) ?x =_:b1

Insert Where

```
insert {
        ?x foaf:mail ?mail
}
where {
        ?x ex:firstName ?f ; ex:lastName ?l
        bind (concat(?f, ".", ?l, "@acme.com")
        as ?mail)
}
```

Insert Where

```
insert {
        [ ] foaf:mail ?mail
}
where {
        ?x ex:firstName ?f ; ex:lastName ?l
        bind (concat(?f, ".", ?l, "@acme.com")
        as ?mail)
}
```

Update: Delete Insert Where

```
delete { ?x foaf:age ?age }
insert  { ?x foaf:age ?int }
where {
        ?x foaf:age ?age
        filter (datatype(?age) = xsd:string)
        bind (xsd:integer(?age) as ?int)
}
```

1. Compute solutions $\{S_1, .. S_n\}$ of the where clause
2. Apply delete on $\{S_1, .. S_n\}$
3. Apply insert on $\{S_1, .. S_n\}$

Named Graph

```
insert {
        graph ex:info { ?x foaf:mail ?mail }
}
where {
        ?x ex:firstName ?f ; ex:lastName ?l
        bind (concat(?f, ".", ?l, "@acme.com")
        as ?mail)
}
```

Others

- Copy
- Move
- Add

SPARQL 1.1. PROTOCOL

SPARQL Protocol

- SPARQL Endpoint
  - Triple Store embedded in an HTTP server
- SPARQL Protocol
  - Interact with SPARQL endpoint by means of HTTP

SPARQL Protocol

- Interact with SPARQL endpoint by means of HTTP

http://dbpedia.org/sparql?query=
select * where { ?x rdfs:label "Paris"@fr }

http://example.org/sparql?update=
load <http://example.org/data.ttl>