The SPARQL query language for RDF

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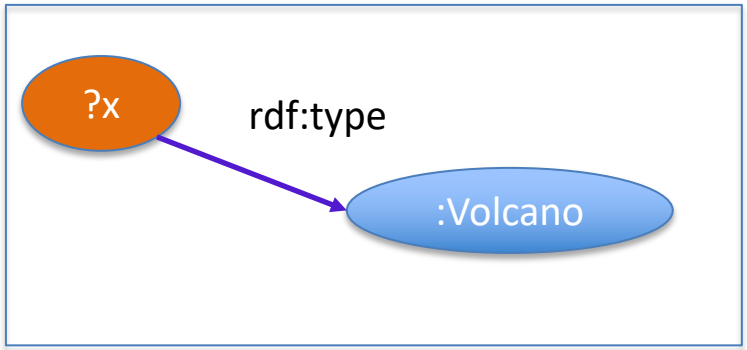
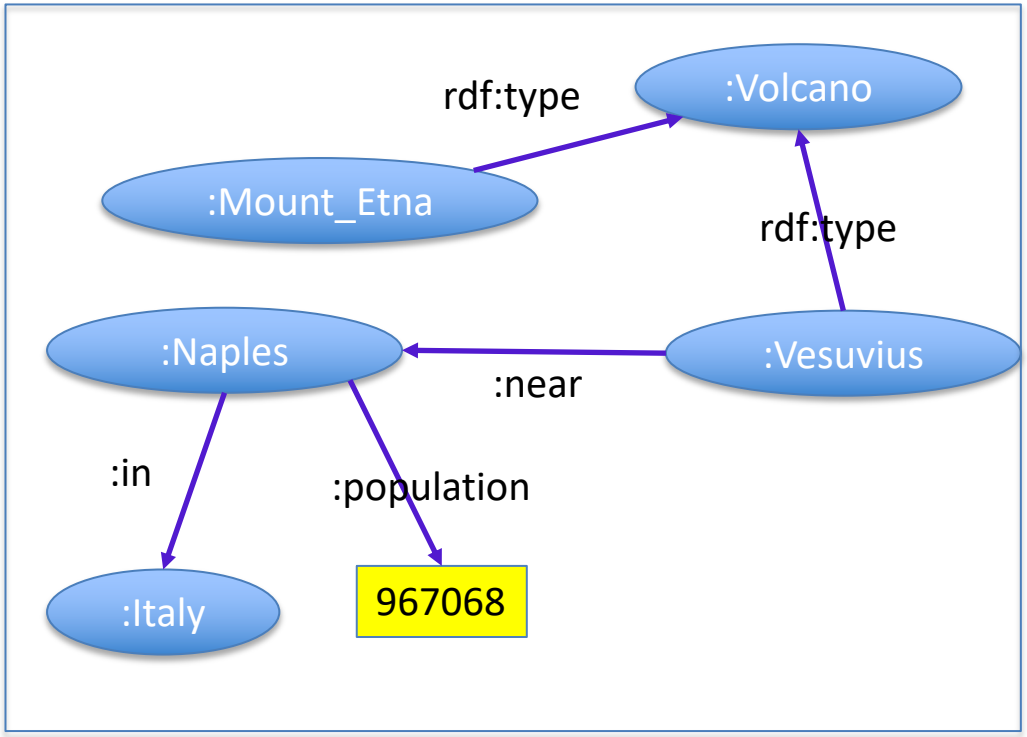
Main idea: Querying by pattern matching



Pattern

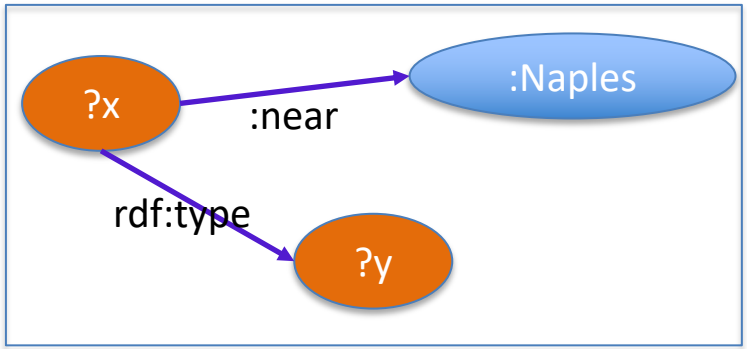
Results

?x
:Vesuvius
:Mount_Etna



Graph

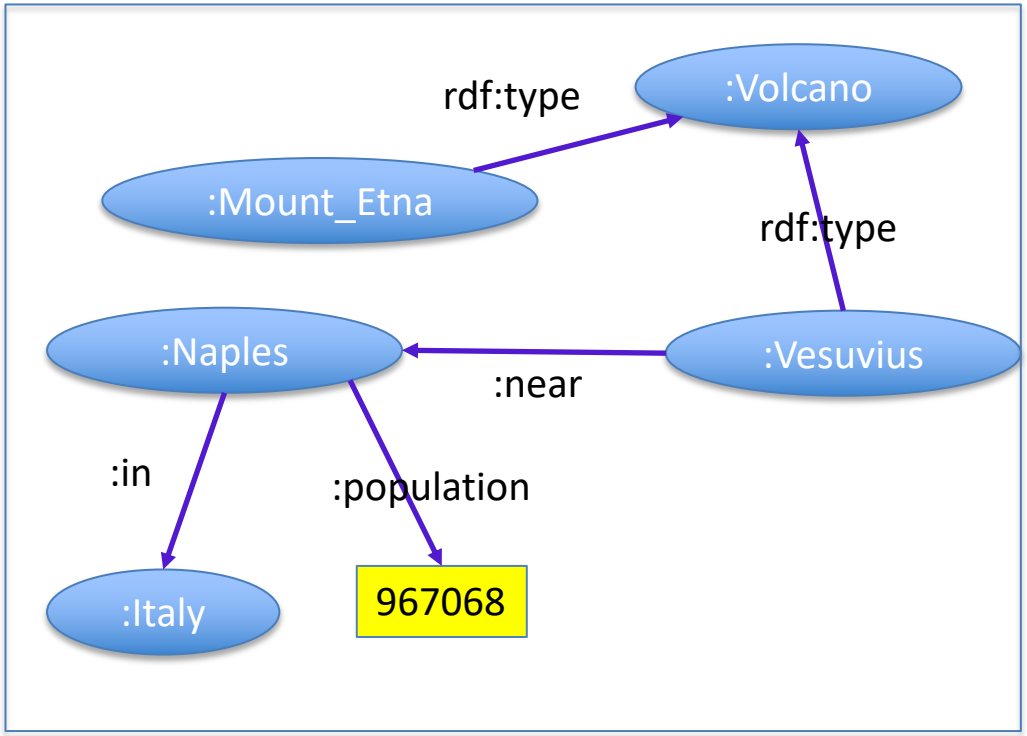
Main idea: Querying by pattern matching



Pattern

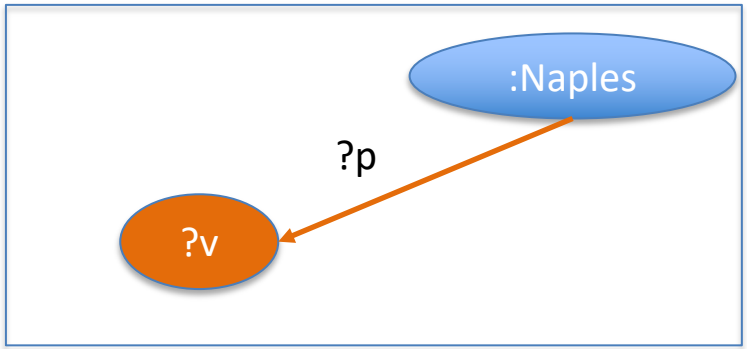
Results

?x	?y
:Vesuvius	:Volcano



Graph

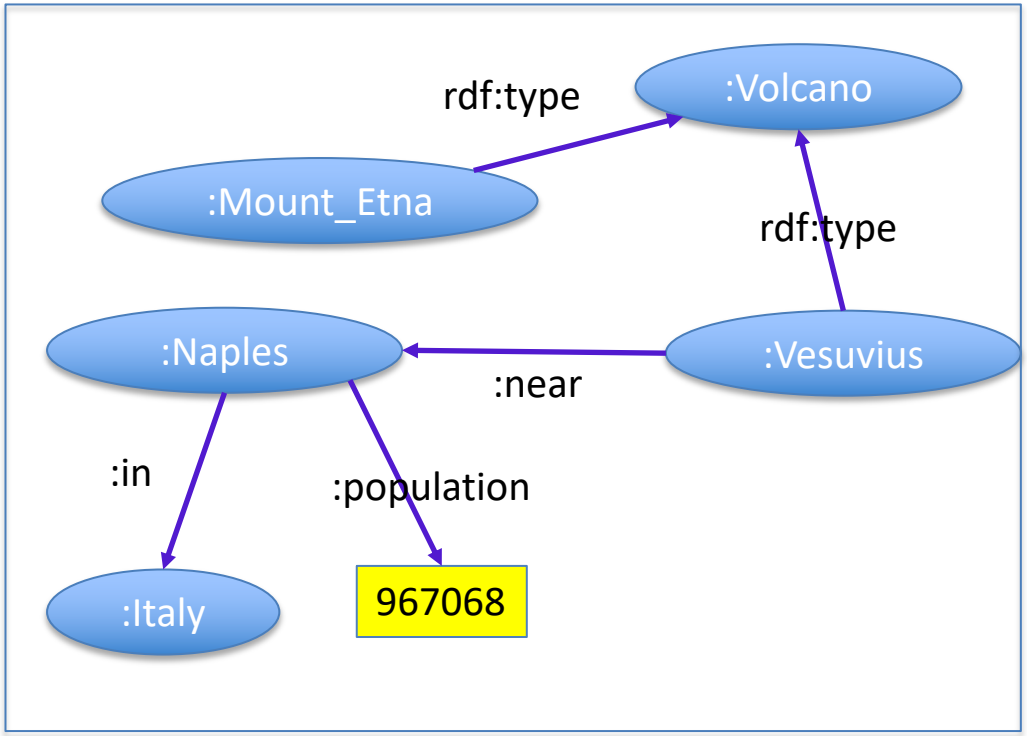
Main idea: Querying by pattern matching



Pattern

Results

?p	?v
:in	:Italy
:population	967068



Graph

SPARQL – based on graph patterns

Triple pattern a triple from

(RDF-Term ∪ Var) × (IRI ∪ Var) x (RDF-Term ∪ Var)

- RDF-Term : IRI or literal or blank
- Var : variable

Graph pattern

- a set of triple patterns

Same syntax as Turtle + Variables

{?x rdf:type :Volcano}

{?x :near :Naples. ?x rdf:tye ?y}

{ :Naples ?p ?v}

{ ?x ex:address _:adr . _:adr ex:city ex:Madrid }

SPARQL Basic Graph Pattern Query

prefix definitions
select *output variables*
[from *graph*]
where { *basic graph pattern* }

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX : <http://cui.unige.ch/geo/>
SELECT ?x ?y
WHERE {?x :near :Naples. ?x rdf:tye ?y}
```

Definition: Basic Graph Pattern Matching

Let BGP be a basic graph pattern and let G be an RDF graph.

μ is a **solution** for BGP from G when

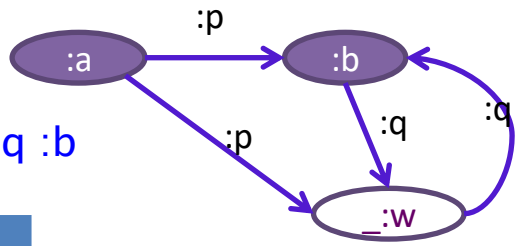
- there is a pattern instance mapping P such that P(BGP) is a subgraph of G
  - P maps variables and blank nodes to RDF-terms

- and μ is the restriction of P to the query variables in BGP.

Example

On the graph

:a :p :b. :a :p _:w. :b :q _:w. _:w :q :b



solutions for { ?x ?y :b }

?x	?y
:a	:p
_:w	:q

solutions for { ?x :p ?y . ?y :q ?z }

?x	?y	?z
:a	:b	_:w
:a	_:w	:b

solutions for { ?x :p _:h . _:h :q ?z }

?x	?z
:a	_:w
:a	:b

Simple Graph Patterns are not Enough

Need to express

- disjunctions (match this or that)
- optional parts in patterns (match if possible)
- negations (match this but not that)
- conditions on variable values (<, >, =, ...)
- multiple paths (path expressions) in patterns

Need to process the results

- combine the solution variables (+, -, ...)
- aggregation functions (sum, average, ...)
- ordering
- grouping

Optional parts

{*pattern*$_1$ OPTIONAL { *pattern*$_2$ }}

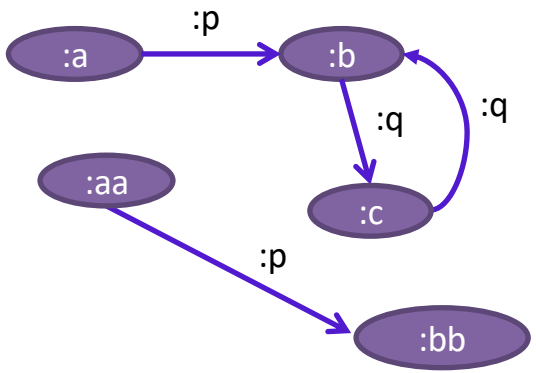
Find solutions for { *pattern*$_1$ *pattern*$_2$ } and for { *pattern*$_1$ }

In the solutions for *pattern*$_1$ only, the variables that appear in *pattern*$_2$ only are unbound.

Example

On the graph

:a :p :b. :aa :p :bb. :b :q :c.



The solutions of

{ ?x :p ?y OPTIONAL {?y :q ?z} }

are

?x	?y	?z
:a	:b	:c
:aa	:bb	UNBOUND

Union

To represent disjunctions

a solution to

pattern1 UNION *pattern2*

is a solution to *pattern1* or to *pattern2* (or both)

Example

"Find people who own a cat or a dog"

```
{?p a :Person. ?p :owns ?a. ?a a :Cat }
UNION
{?p a :Person. ?p :owns ?a. ?a a :Dog }
```

can be simplified by using group graph patterns

```
{?p a :Person. ?p :owns ?a. {{?a a :Cat} UNION {?a a :Dog}}}
```

Filtering with a boolean expression

{*pattern* FILTER(*expression*) }

retain only the solutions to *pattern* for which *expression* evaluates to true

Example

```
{ ?x a :Car. ?x :price ?p. ?x :category ?c
        FILTER(?p < 10000 && ?c != :sport) }
```

Testing For the Absence of a Pattern

Data:

```
:alice rdf:type foaf:Person . :alice foaf:name "Alice" .
:bob rdf:type foaf:Person .
```

Query:

```
SELECT ?person
WHERE { ?person rdf:type foaf:Person .
          FILTER NOT EXISTS { ?person foaf:name ?name } }
```

Query Result:
:bob

Testing For the Presence of a Pattern

Query:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?person
WHERE { ?person rdf:type foaf:Person .
    FILTER EXISTS { ?person foaf:name ?name } }
```

Query Result:

```
<http://example/alice>
```

Removing Possible Solutions

MINUS evaluates both its arguments, then calculates solutions in the left-hand side that are not compatible with the solutions on the right-hand side.

```
:alice foaf:givenName "Alice" ; foaf:familyName "Smith" .
:bob foaf:givenName "Bob" ; foaf:familyName "Jones" .
:carol foaf:givenName "Carol" ; foaf:familyName "Smith" .
```

```
SELECT DISTINCT ?s
WHERE { ?s ?p ?o . MINUS { ?s foaf:givenName "Bob" . } }
```

Results:

```
:carol
:alice
```

Relationship and differences between NOT EXISTS and MINUS

NOT EXISTS and **MINUS** represent two ways of thinking about negation

- one based on testing whether a pattern exists in the data, given the bindings already determined by the query pattern,

- one based on removing matches based on the evaluation of two patterns. In some cases they can produce different answers.

```
@prefix : <http://example/> .
:a :b :c .
```

```
SELECT * { ?s ?p ?o FILTER NOT EXISTS { ?x ?y ?z } }
```

No solutions because { ?x ?y ?z } matches given any ?s ?p ?o

```
SELECT * { ?s ?p ?o MINUS { ?x ?y ?z } }
```

There is no shared variable between the first part (?s ?p ?o) and the second (?x ?y ?z) so no bindings are eliminated.

Results:

```
:a :b :c
```

Property path

iri	
^elt	inverse path
elt / elt	sequence
elt | elt	alternative
elt*	repetition (0...n)
elt+	repetition (1...n)
elt?	option
!*iri* or !(iri_1| ...|iri_n)	negation
!^*iri* or !(^iri_1| ...|^iri_n)	negation of the inverse
!(iri_1| ...|iri_j|^iri_{j+1}| ...|^iri_n)	

Using property path to access lists

Recall that a list structure, written as

:france :flagColors (:blue :white :red) .

is an abbreviation for:

```
:france :flagColors [
      rdf:type rdf:List ;
      rdf:first :blue ;
      rdf:rest [
                  rdf:type rdf:List ;
                  rdf:first :white ;
                  rdf:rest [
                              rdf:type rdf:List ;
                              rdf:first :red ;
                              rdf:rest rdf:nil ]]]
```

Some queries over such structures can only be solved by using property path expressions.[1]

Find all the colors in the french flag

```
select ?c
where {:france :flagColors/rdf:rest*/rdf:first ?c }
```

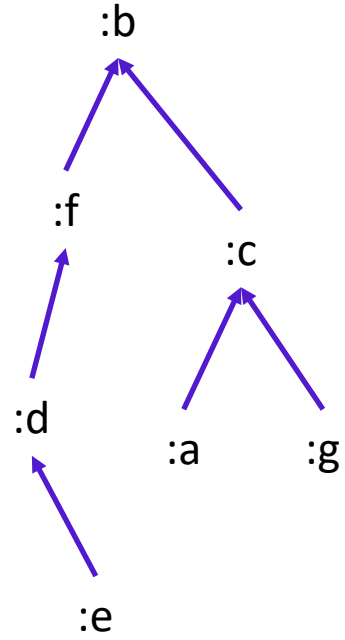
Find the last color of the french flag

```
select ?c
where {:france :flagColors/rest* ?last.
          ?last rdf:rest rdf:nil. ?last rdf:first ?c }
```

1. Or with entailment regimes that take into account transitive properties

Accessing Trees

Example: a part is decomposed into subparts, sub-subparts, etc. linked through a :partOf property.



Display all the parts that belong to :b

```
select ?p where {?p :partOf* :b. }
```

If part :a belongs to part :b, display its part number

```
select ?pn where {:a :partOf* :b. :a :partNo ?pn }
```

What are the subparts of :b that have more than 10 subparts (at any level)

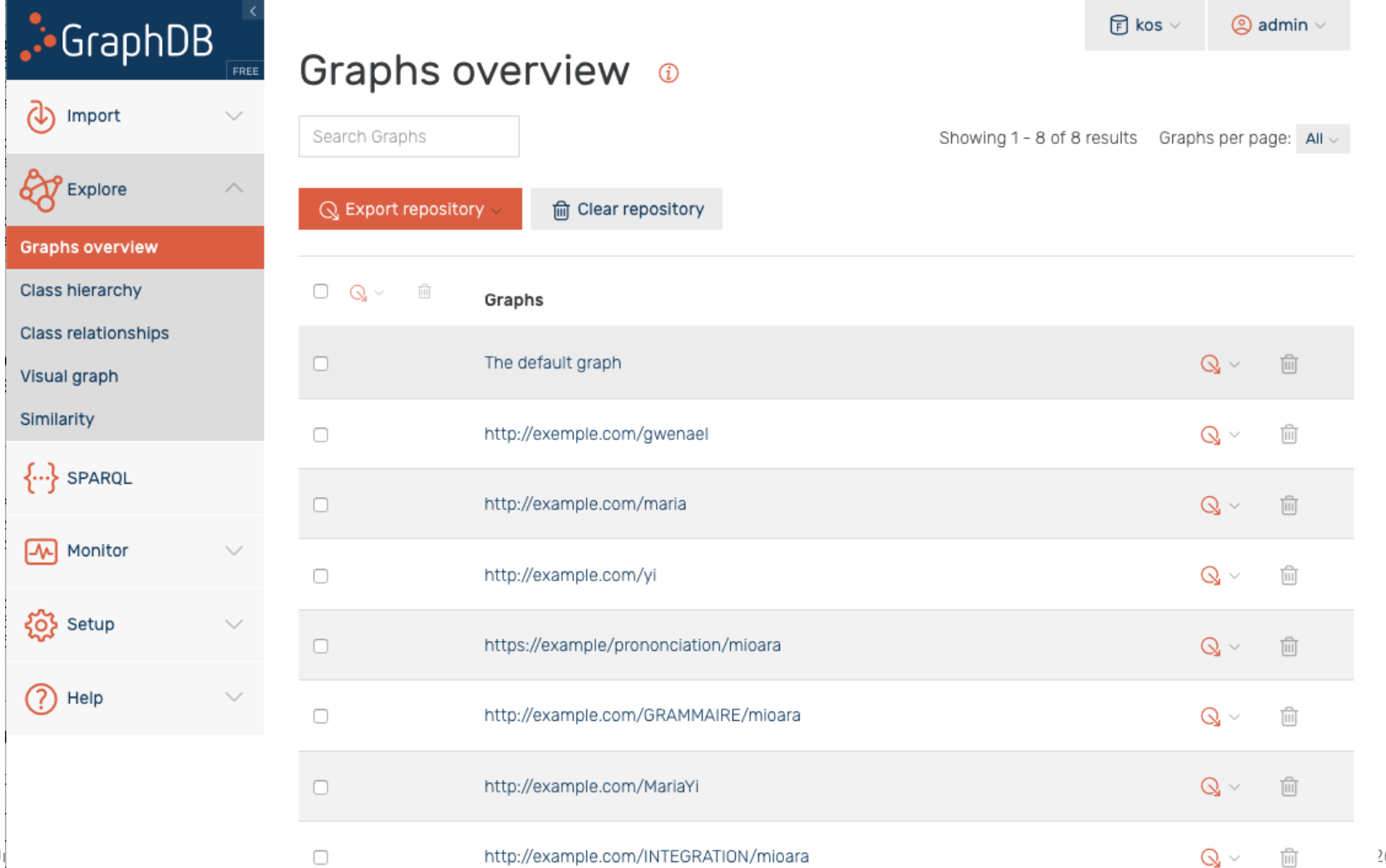
```
select ?p where {?p :partOf* :b.
filter count(select ?q where {?q partOf* ?p}) > 10 }
```

RDF Datasets

- Many RDF data stores hold multiple RDF graphs
- A SPARQL query is executed against an RDF Dataset
- An RDF Dataset comprises
  - the default graph, which does not have a name
  - zero or more named graphs identified by IRIs.
- A SPARQL query can match different parts of the query pattern against different graphs
  - The graph that is used for matching a basic graph pattern is the active graph.
  - The GRAPH keyword is used to make the active graph one of all of the named graphs in the dataset for part of the query.

In SPARQL

```
PREFIX ...
SELECT ...
FROM <...>       # add this graph to the default graph of the query dataset
FROM NAMED <...> # add this graph as a named graph of the query dataset
WHERE { ... }
```


GraphDB
FREE
Import
Explore
Graphs overview
Class hierarchy
Class relationships
Visual graph
Similarity
SPARQL
Monitor
Setup
Help
kos
admin
Graphs overview
Search Graphs
Showing 1 - 8 of 8 results
Graphs per page: All
Export repository
Clear repository
Graphs
The default graph
http://exemple.com/gwenael
http://example.com/maria
http://example.com/yi
https://example/prononciation/mioara
http://example.com/GRAMMAIRE/mioara
http://example.com/MariaYi
http://example.com/INTEGRATION/mioara

```
select (count(*) as ?nbTriples)
from  <http://exemple.com/gwenael>
where { # query the default graph
    {?s ?p ?o .}
}

Results
nbTriples
4562
```

```
select (count(*) as ?nbTriples)
from  <http://exemple.com/gwenael>
from  <http://example.com/maria>
where {  # query the default graph
    {?s ?p ?o .}
}
```

Results

```
nbTriples
7066
```

```
select (count(*) as ?nbTriples)
from named <http://exemple.com/gwenael>
where {  # query over the default graph
    {?s ?p ?o .}
}

Results
nbTriples
0
```

```
select (count(*) as ?nbTriples)
from named <http://exemple.com/gwenael>
where {
    graph <http://exemple.com/gwenael> {?s ?p ?o .}
}
```

Results

nbTriples
4562

```
select (count(*) as ?nbTriples)
from named <http://exemple.com/gwenael>
from  <http://example.com/maria>
where {
    graph <http://exemple.com/gwenael> {?s ?p ?o .}
}
```

Results

```
nbTriples
4562
```

The default default graph is the merge of the graphs

```
select (count(*) as ?nbTriples)
where {
    ?s ?p ?o .
}
```

Results

```
nbTriples
18595
```

Blank nodes in graphs and results

- Blank nodes are local
- They have no URI
- They cannot be "exported" to the answer
- The answer mapping must "invent" blank nodes

```
ex:MITPress
  ex:published ex:bk1 ;
  ex:published _:2 .
```

```
select ?pub where {ex:MITPress ex:published ?pub}
```

Infinitely many possible answers ?

?pub
ex:every
_:cx323322

?pub
ex:every
_:abc

?pub
ex:every
_:u123

Scoping Graph – to avoid infinite answers

- Since SPARQL treats blank node identifiers in a results format document as scoped to the document, they cannot be understood as identifying nodes in the active graph of the dataset.

- If DS is the dataset of a query, pattern solutions are therefore understood to be not from the active graph of DS itself, but from an RDF graph, called the *scoping graph*, which is graph-equivalent to the active graph of DS but shares no blank nodes with DS or with BGP.

- The same scoping graph is used for all solutions to a single query.