# SPARQL

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# Content

- Main Idea of SPARQL Queries
- Components of SPARQL Queries
- Graph Patterns
- Constraints on Solutions
- Components of SPARQL Queries: Other feautures
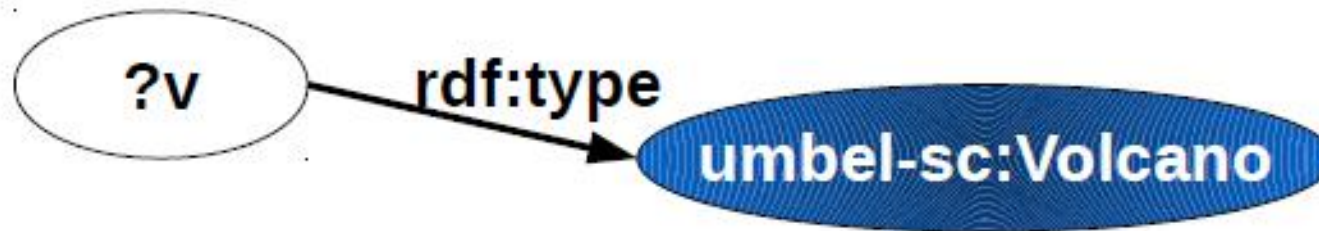- Solution Modifiers
- SPARQL 1.1

# SPARQL in General

**A family of W3C recommendations**

- **SPARQL Query**
  - Declarative query language for RDF data

- **SPARQL Update**
  - Declarative update language for RDF data

- **SPARQL Protocol**
  - Communication between SPARQL processing
  - services (a.k.a. SPARQL endpoints) and clients

- **SPARQL Query Results XML Format**
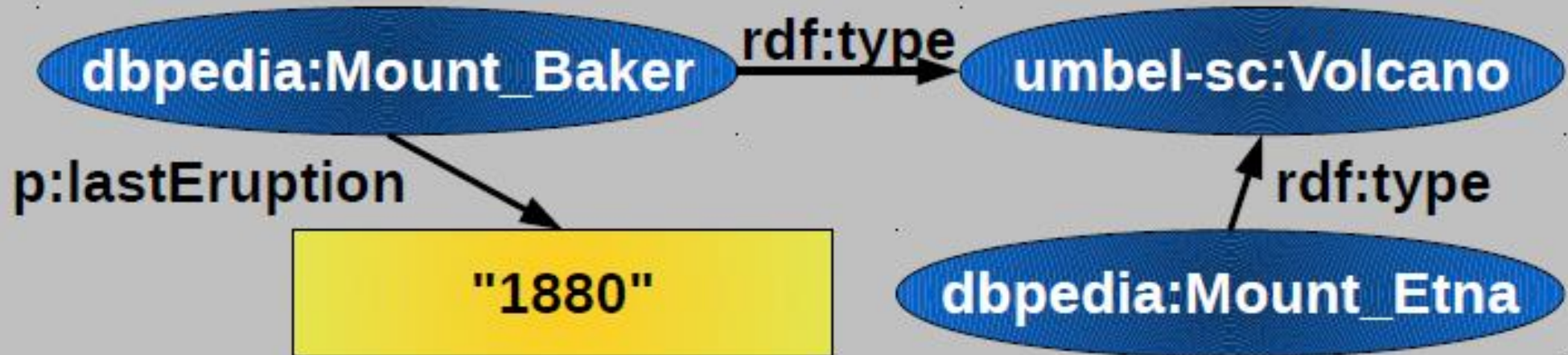  - XML format for serializing query results

# Main Idea of SPARQL Queries

- **Pattern matching:**
  - Describe subgraphs of the queried RDF graph
  - Subgraphs that match your description contribute an answer
  - Mean: graph patterns (i.e. RDF graphs with variables)
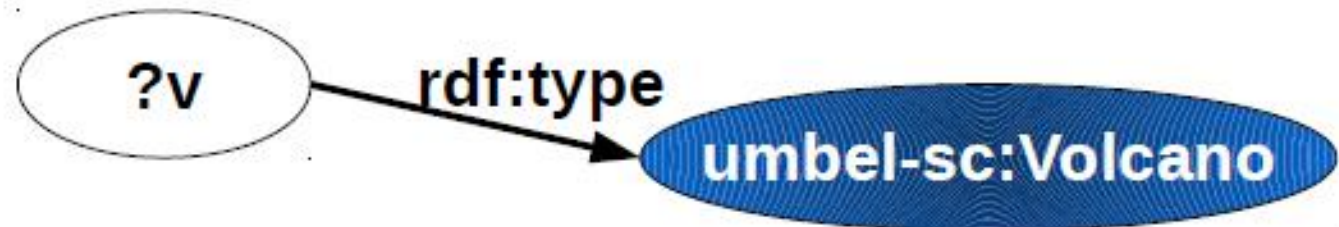
# Main Idea of SPARQL Queries

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# Components of SPARQL Queries

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX umbel-sc: <http://umbel.org/umbel/sc/>
SELECT ?v
FROM <http://example.org/myGeoData>
WHERE {
   ?v rdf:type umbel-sc:Volcano .
}
ORDER BY ?name
```

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}
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```

- **Prologue:**
  - Prefix definitions for using compact URIs
  - Attention (difference to Turtle): No period (".") character as separator

# Components of SPARQL Queries

```
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SELECT ?v
FROM <http://example.org/myGeoData>
WHERE {
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}
ORDER BY ?name
```

- **Result form specification:**
  - SELECT, DESCRIBE, CONSTRUCT, or ASK

# Components of SPARQL Queries

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX umbel-sc: <http://umbel.org/umbel/sc/>
SELECT ?v
FROM <http://example.org/myGeoData>
WHERE {
  ?v rdf:type umbel-sc:Volcano .
}
ORDER BY ?name
```

- **Dataset specification:**
  - Specify the RDF dataset to be queried

# Components of SPARQL Queries

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX umbel-sc: <http://umbel.org/umbel/sc/>
SELECT ?v
FROM <http://example.org/myGeoData>
WHERE {
  ?v rdf:type umbel-sc:Volcano .
}
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```

- **Query Pattern:**
  - WHERE clause specifies the graph pattern to be matched

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# Graph Patterns

- **Different types of graph patterns for the query pattern**

- **(WHERE clause):**
  - Basic graph pattern (BGP)
  - Group graph pattern
  - Optional graph pattern
  - Union graph pattern
  - Graph graph pattern
  - (Constraints)

# Basic Graph Patterns

- **Set of triple patterns (i.e. RDF triples with variables)**
- **Variable names prefixed with "?" or "$" (e.g. ?v, $v)**
- **Turtle syntax**

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX umbel-sc: <http://umbel.org/umbel/sc/>
SELECT ?name
WHERE {
  ?v rdf:type umbel-sc:Volcano .
  ?v rdfs:label ?name .
}
```

# Basic Graph Patterns

- **Set of triple patterns (i.e. RDF triples with variables)**
- **Variable names prefixed with "?" or "$" (e.g. ?v, $v)**
- **Turtle syntax**

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX umbel-sc: <http://umbel.org/umbel/sc/>
SELECT ?name
WHERE {
  ?v rdf:type umbel-sc:Volcano ;
     rdfs:label ?name .
}
```

# Basic Graph Patterns (Example)

```
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;          Data*
                    rdfs:label "Etna" .
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano.
dbpedia:Beerenberg rdf:type umbel-sc:Volcano,
                           umbel-sc:NaturalElevation ;
                    rdfs:label "Beerenberg"@en ;
                    rdfs:label "Бееренберг"@ru   .
```

- **Question: What are the names of all (known) volcanos?**

```
SELECT ?name WHERE {                    Query*
  ?v rdf:type umbel-sc:Volcano ;
     rdfs:label ?name . }
```

Result:

| ?name |
|-------|
| "Etna" |
| "Бееренберг"@ru |
| "Beerenberg"@en |

# Basic Graph Patterns (Example)

```
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;          Data*
                   rdfs:label "Etna" .
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano.
dbpedia:Beerenberg rdf:type umbel-sc:Volcano,
                           umbel-sc:NaturalElevation ;
                   rdfs:label "Beerenberg"@en ;
                   rdfs:label "Бееренберг"@ru   .
```

**Question: List all types of the volcano called "Beerenberg"**

```
SELECT ?type WHERE {          Query
  ?v rdf:type ?type ;
     rdfs:label "Beerenberg" .
}
```

| ?type |
|-------|
|       |
|       |

# Basic Graph Patterns (Example)

```
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;    Data*
                    rdfs:label "Etna" .
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano.
dbpedia:Beerenberg rdf:type umbel-sc:Volcano,
                            umbel-sc:NaturalElevation ;
                    rdfs:label "Beerenberg"@en ;
                    rdfs:label "Бееренберг"@ru   .
```

**Question: List all types of the volcano called "Beerenberg"**

```
SELECT ?type WHERE {                Query
  ?v rdf:type ?type ;
     rdfs:label "Beerenberg"@en .
}
```

| ?type |
|---|
| umbel-sc:Volcano |
| umbel-sc:NaturalElevation |

# Basic Graph Patterns (Example)

```
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano ;                    Data
                        p:location dbpedia:United_States .
dbpedia:United_States rdfs:label "United States" .
```

- **Question: Where are all (known) volcanos located?**

    **(List the names of these locations)**

- **Blank nodes in SPARQL queries**
    - As subject or object of a triple pattern

```
SELECT ?name WHERE {                                   Query
 _:x rdf:type umbel-sc:Volcano ;
     p:location [ rdfs:label ?name ] . }
```

| ?name |
| --- |
| "United States" |

# Basic Graph Patterns (Example)

```
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano ;        Data
            p:location [ rdfs:label "United States"@en ,
                                    "États-Unis"@fr ] .
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;
                 p:location [ rdfs:label "Italy" ] .
```

- **Blank nodes in the queried data**
  - Blank node identifiers may occur in the results

```
SELECT ?l ?name WHERE {        Query
  ?v rdf:type umbel-sc:Volcano ;
     p:location ?l .
  ?l rdfs:label ?name .
}
```

| ?l | ?name |
|----|-------|
| _:x | "United States"@en |
| _:x | "États-Unis"@fr |
| _:y | "Italy" |

# Optional Graph Patterns

```
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;          Data
                   rdfs:label "Etna" .
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano .
dbpedia:Beerenberg rdf:type umbel-sc:Volcano ;
                   rdfs:label "Beerenberg"@en .
```

- **Question: What are all (known) volcanos and their names?**

```
SELECT ?v ?name WHERE {          Query
   ?v rdf:type umbel-sc:Volcano ;
      rdfs:label ?name . }
```

- **Problem: Mount Baker missing (it has no name)**

| ?v | ?name |
|---|---|
| dbpedia:Mount_Etna | "Etna" |
| dbpedia:Beerenberg | "Beerenberg"@en |

# Optional Graph Patterns

- **Keyword OPTIONAL allows for optional patterns**

```
SELECT ?v ?name WHERE {              Query
    ?v rdf:type umbel-sc:Volcano .
    OPTIONAL { ?v rdfs:label ?name }
}
```

| ?v | ?name |
|---|---|
| dbpedia:Mount_Etna | "Etna" |
| dbpedia:Mount_Baker | |
| dbpedia:Beerenberg | "Beerenberg"@en |

- **Optional patterns may result in unbound variables**

# Union Graph Patterns

```
dbpedia:Mount_Etna rdf:type umbel-sc:Volcano ;          Data
                   rdfs:label "Etna" ;
                   p:location dbpedia:Italy .
dbpedia:Mount_Baker rdf:type umbel-sc:Volcano ;
                    p:location dbpedia:United_States .
dbpedia:Beerenberg rdf:type umbel-sc:Volcano ;
                   rdfs:label "Beerenberg"@en ;
                   p:location dbpedia:Norway .
```

- **Question: What volcanos are located in Italy or in Norway?**

```
SELECT ?v WHERE {                                       Query
    ?v rdf:type umbel-sc:Volcano ;

       p:location      ?      . }
```

# Union Graph Patterns

- **Union graph patterns allow for alternatives**

```
SELECT ?v WHERE { ?v rdf:type umbel-sc:Volcano .

                  { ?v p:location dbpedia:Italy }
                  UNION
                  { ?v p:location dbpedia:Norway }

}
```
Query

```
SELECT ?v WHERE {
    { ?v rdf:type umbel-sc:Volcano ;
         p:location dbpedia:Italy }
    UNION
    { ?v rdf:type umbel-sc:Volcano ;
         p:location dbpedia:Norway }
}
```
Query

Semantically
equivalent

# Group Graph Patterns

```
SELECT ?v WHERE { ?v rdf:type umbel-sc:Volcano .
                  { ?v p:location dbpedia:Italy }
                  UNION
                  { ?v p:location dbpedia:Norway }
}
```
Query

**Semantically equivalent**

```
SELECT ?v WHERE { { ?v rdf:type umbel-sc:Volcano }
                  { { ?v p:location dbpedia:Italy }
                    UNION
                    { ?v p:location dbpedia:Norway } }
}
```
Query

# Practica