Web Information Systems
SPARQL

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Objectives

1. Querying RDF: SPARQL

What have we gained?

Current – no structure

In modern molecular biology, the **genome** is the entirety of an organism's hereditary information. It is encoded either in DNA or, for many types of virus, in RNA.

The genome includes both the genes and the non-coding sequences of the DNA.[1] The term was adapted in 1920 by Hans Winkler, Professor of Botany at the University of Hamburg, Germany. The Oxford English Dictionary suggests the name to be a portmanteau of the words ***gen****e* and *chromos****ome***. A few related *-ome* words already existed, such as *biome* and *rhizome*, forming a vocabulary into which *genome* fits systematically.[2]

Future – structured by RDF (subject, predicate, object)

```
b:genome    b:field         b:molecular-bio
b:DNA       b:encode        b:genes
b:DNA       b:encode        b:non-coding-seq
b:genome    b:include       b:non-coding-seq
b:genome    b:include       b:gene
b:genome    b:related-to    b:rhizome
```

- RDF is meant to assert knowledge (**statements**) about **entities** (**resources**)
- By convention is clear what the **subject**, **predicate**, and **object** are
- With extra knowledge more inferences can be made
  (e.g.: John Doe is a person)

What have we gained?

Current – no structure

```
<lecturer name="John Doe">
  <teaches>XML Technologies</teaches>
</lecturer>
```

Future – structured by RDF
(subject, predicate, object)

```
uni:john-doe    a               terms:lecturer .
uni:john-doe    terms:teaches   crs:xml        .
crs:xml         a               terms:course   .
```

- RDF is meant to assert knowledge (**statements**) about **entities** (**resources**)
- By convention is clear what the **subject**, **predicate**, and **object** are
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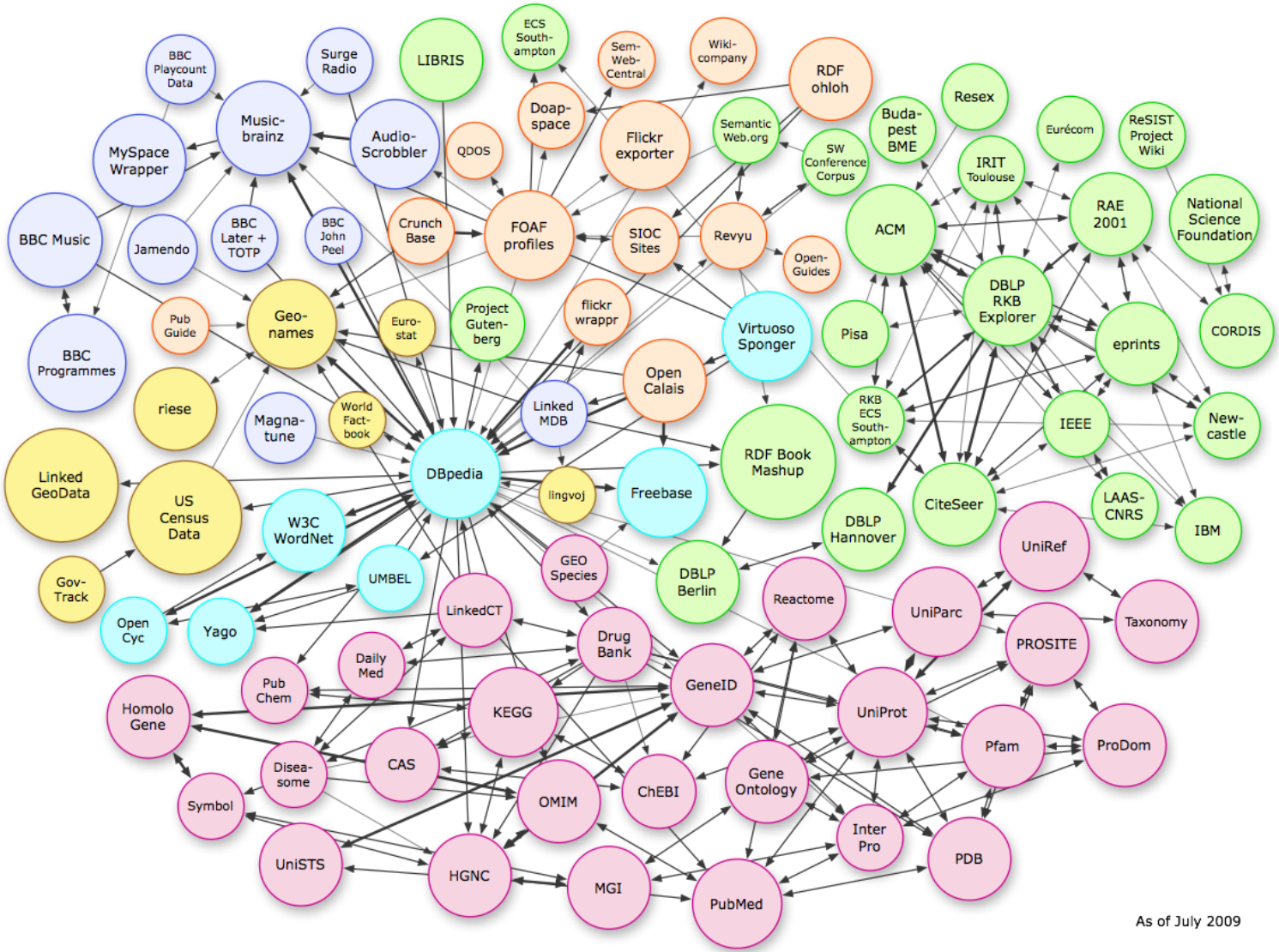
  (e.g.: John Doe is a person)

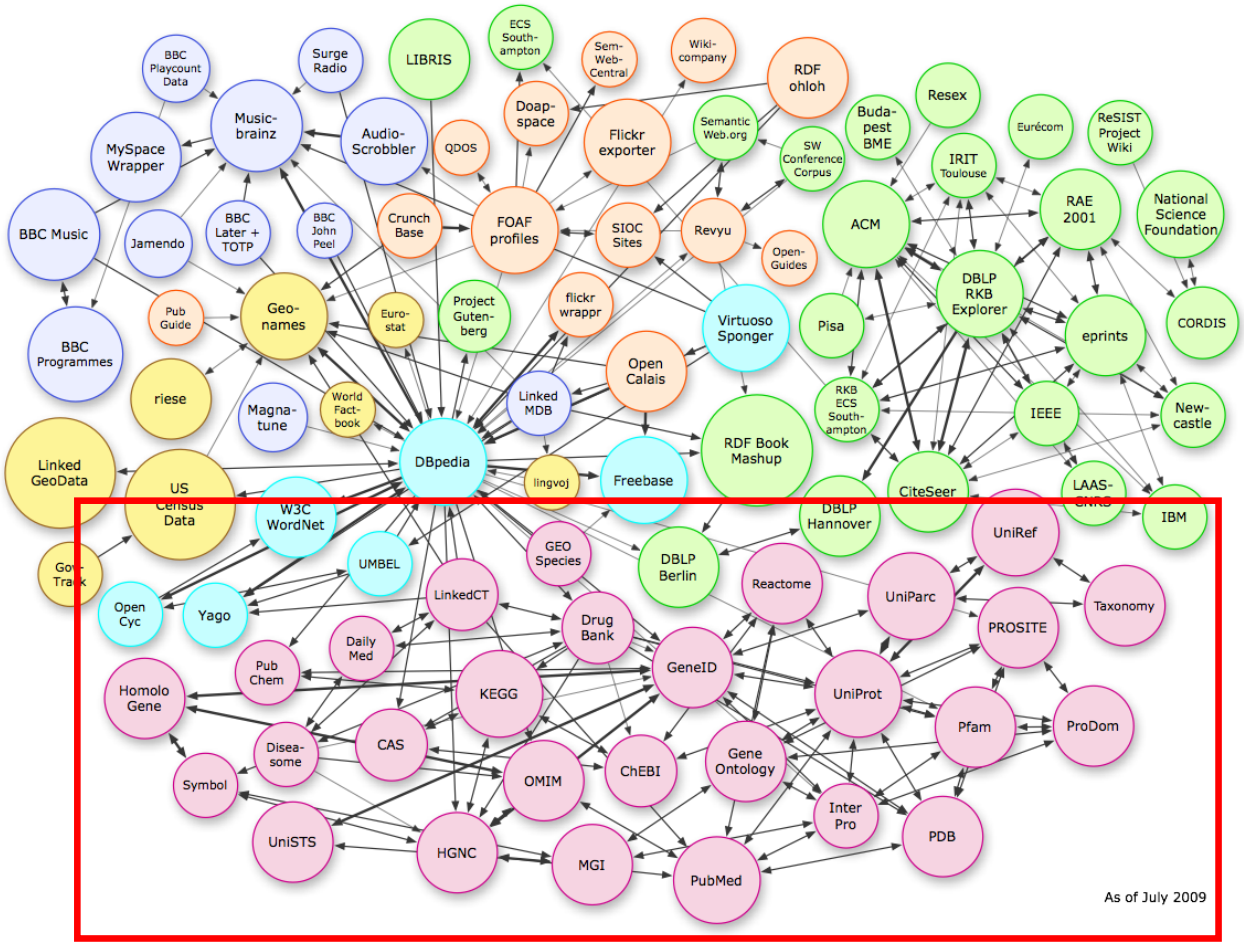
The Web of Linked Data

Envisions the Web as a single HUGE database consisting of RDF data

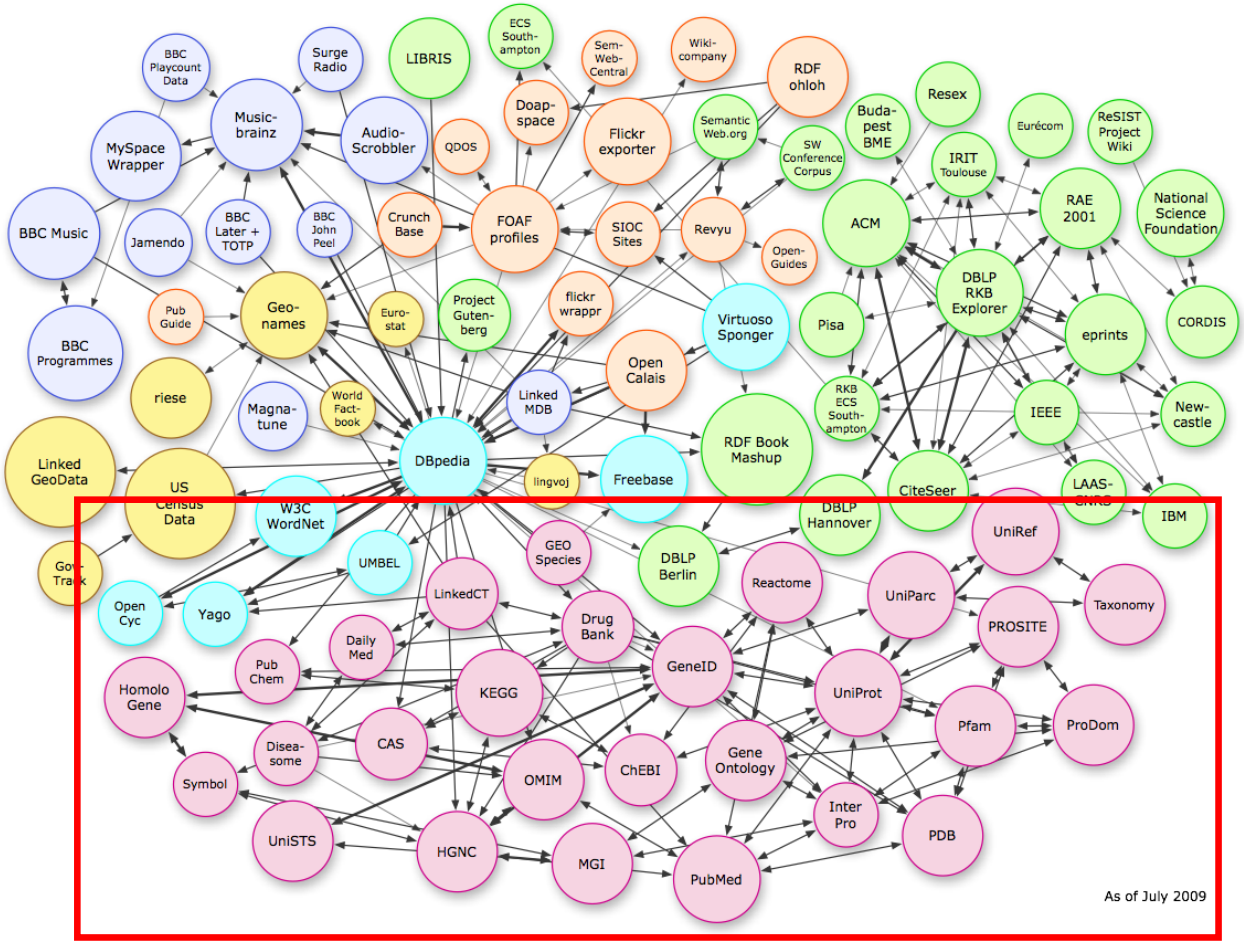


As of July 2009

Application: E-Science

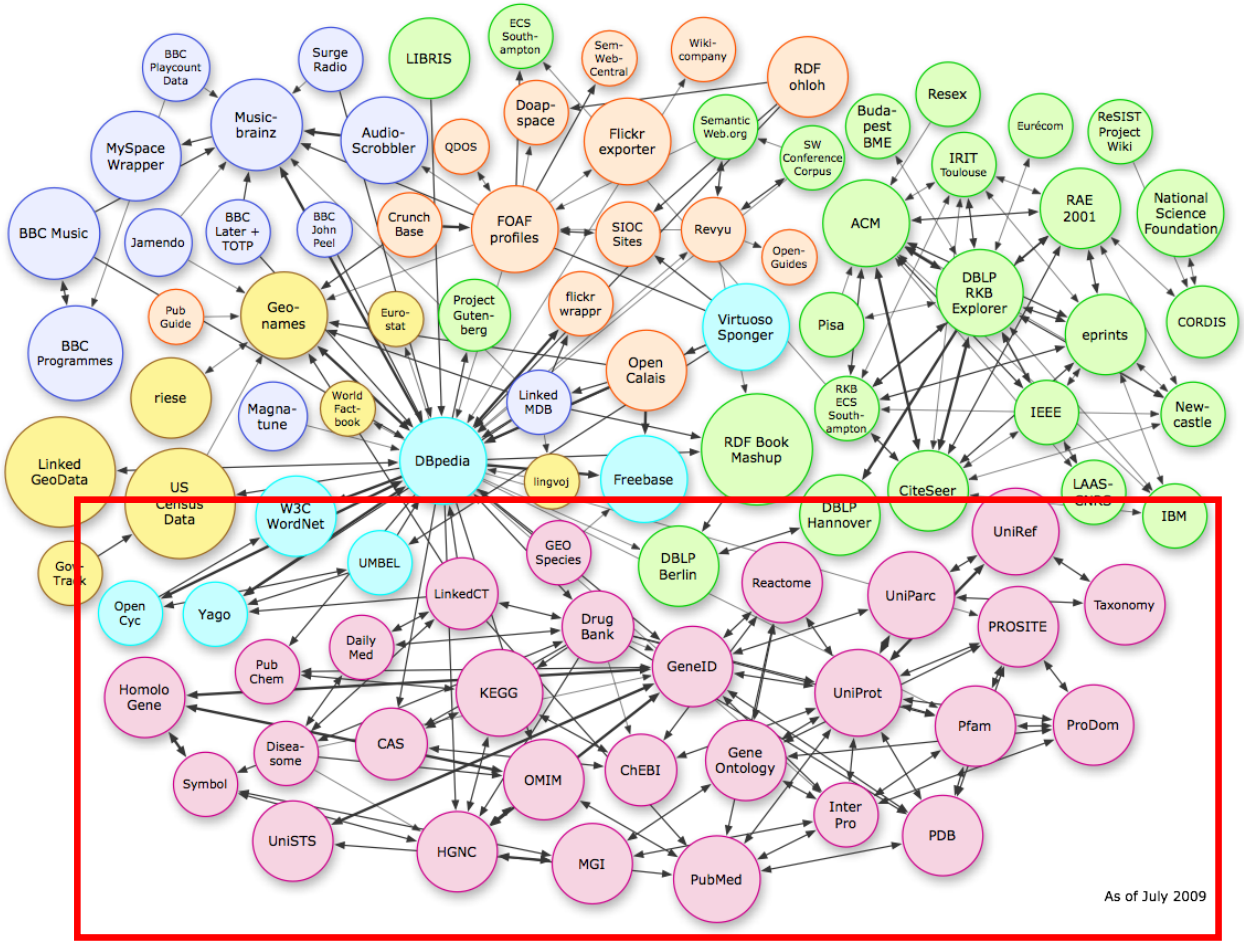


Application: E-Science



- **Query:** What proteins are absent in diabetes patients?

Application: E-Science



- **Query:** What proteins are absent in diabetes patients?
- **Required:** A means to query RDF

SPARQL

- To support **structured queries** like "What proteins are absent in diabetes patients?", the W3C has proposed **SPARQL**: Simple Protocol and RDF Query Language
- SPARQL is essentially the SQL for RDF

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Example

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PREFIX bio: <http://science.org/biology/terms>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?prot_name
WHERE {




}
```

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subject

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subject predicate

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subject predicate object

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     ?disease      bio:symptom_lack_of  ?protein .


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```

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WHERE {
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     ?disease      bio:symptom_lack_of ?protein .
     ?protein      rdf:type            bio:protein .

}
```

subject | predicate | object

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     ?protein      bio:name            ?prot_name .
}
```

subject predicate object

SPARQL

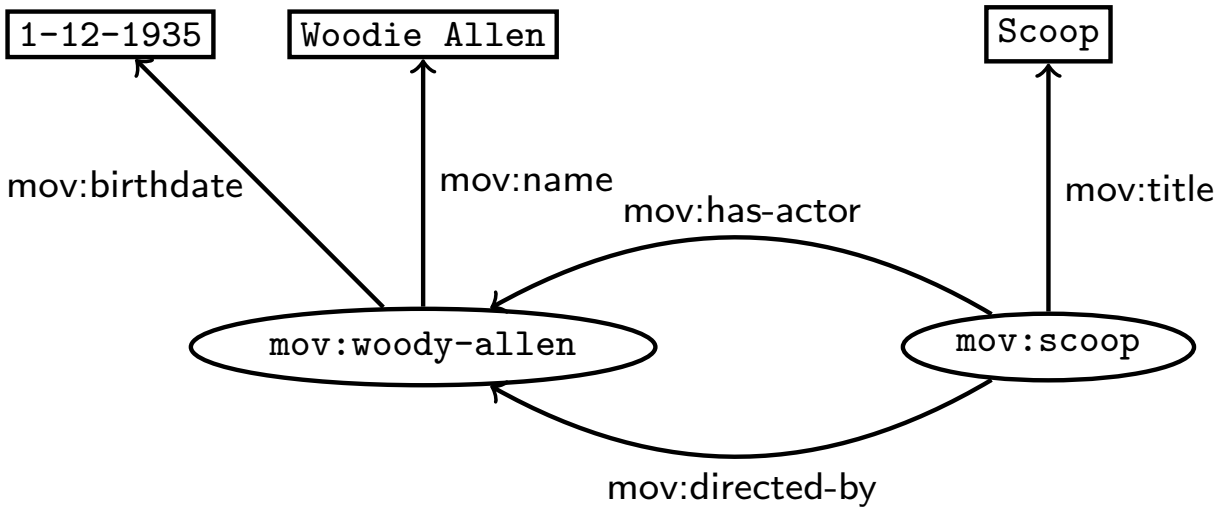
- `PREFIX` directives can be used to abbreviate URIs
- The basic syntax is a `SELECT` - `WHERE` clause
- A `FROM` clause is optional
- The where clause consists of **graph patterns**: RDF triples with variables
- Variables are denoted by `?var` with `var` a variable name

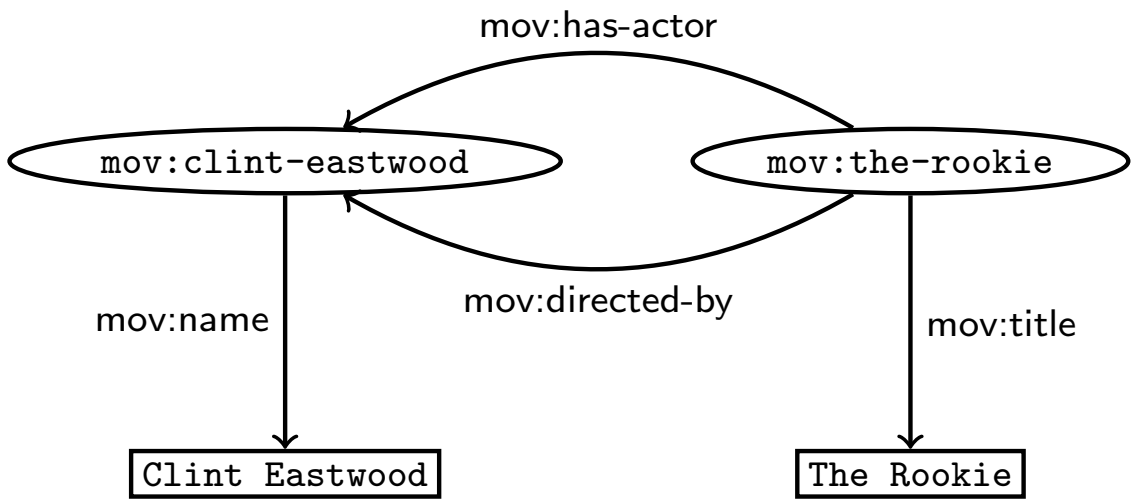
Example: directors who have acted in their own movies

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director ?movie
WHERE {
     ?movie         mov:directed-by     ?director .
     ?movie         mov:has-actor       ?director .
}
```

SPARQL

Example Input:





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     ?movie        mov:has-actor       ?director .
}
```

?director	?movie
mov:woody-allen	mov:scoop
mov:clint-eastwood	mov:the-rookie

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Example: directors who have acted in their own movies

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director ?movie
FROM <http://example.org/mdb.ttl>
WHERE {
     ?movie        mov:directed-by     ?director .
     ?movie        mov:has-actor       ?director .
}
```

?director	?movie
mov:woody-allen	mov:scoop
mov:clint-eastwood	mov:the-rookie

SPARQL: OPTIONAL

- `OPTIONAL` clauses allow you to use information in the RDF graph if it is present, but does not eliminate solutions if it is missing

Example: director must have a birthdate

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director ?movie ?bd
WHERE {
     ?movie        mov:directed-by     ?director .
     ?movie        mov:has-actor       ?director .
     ?director     mov:birthdate       ?bd .
}
```

?director	?movie	?bd
mov:woody-allen	mov:scoop	"1-12-1935"

SPARQL: OPTIONAL

- `OPTIONAL` clauses allow you to use information in the RDF graph if it is present, but does not eliminate solutions if it is missing

Example: return birthdate if available

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director ?movie ?bd
WHERE {
     ?movie        mov:directed-by     ?director .
     ?movie        mov:has-actor       ?director .
     OPTIONAL {?director  mov:birthdate   ?bd . }
}
```

?director	?movie	?bd
mov:woody-allen	mov:scoop	"1-12-1935"
mov:clint-eastwood	mov:the-rookie	

SPARQL: FILTER

- `FILTER` clauses allow you to specify additional constraints on candidate solutions
- These constraints can use a small set of operators from XPath 2.0
- the operator `bound` can be used to test if a variable is bound or not
- the operator `regex` can be used to test if a variable matches a regular expression
- the operators <, >, <=, >=, = can be used to compare

Example: directors that do not have a birthdate

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director
WHERE {
       ?movie        mov:directed-by     ?director .
       OPTIONAL {?director  mov:birthdate   ?bd . }
       FILTER (!bound(?bd))
}
```

?director
mov:clint-eastwood

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- the operator `regex` can be used to test if a variable matches a regular expression
- the operators <, >, <=, >=, =, != can be used to compare

Example: directors who's name contains "allen" as a substring

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director
WHERE {
       ?movie        mov:directed-by     ?director .
       ?director     mov:name            ?name .
       FILTER regex(?name, "allen", "i")
}
```

?director
mov:woody-allen

SPARQL: FILTER

- `FILTER` clauses allow you to specify additional constraints on candidate solutions
- These constraints can use a small set of operators from XPath 2.0
- the operator `bound` can be used to test if a variable is bound or not
- the operator `regex` can be used to test if a variable matches a regular expression
- the operators <, >, <=, >=, =, != can be used to compare

Example: movies that have rating at least 3

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?movie
WHERE {
       ?movie        mov:rating          ?x .
       FILTER (?x >= 3)
}
```

SPARQL: UNION

- Using the `UNION` keyword, we can let patterns be evaluated independently

Example:

Directors who's name contains "allen" as a substring or do not have a birthdate

```
PREFIX mov: <http://movies-in-rdf.org>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?director
WHERE {
    {
       ?movie        mov:directed-by     ?director .
       ?director     mov:name            ?name .
       FILTER regex(?name, "allen", "i")
    }
UNION
    {
       ?movie        mov:directed-by     ?director .
       OPTIONAL {?director  mov:birthdate   ?bd . }
       FILTER (!bound(?bd))
    }
}
```

SPARQL: CONSTRUCT

- `SELECT` queries returns tables listing variable bindings
- `CONSTRUCT` queries construct a new RDF graph

Example: assign all courses to John Doe

```
PREFIX terms: <http://ulb.be/terms>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
CONSTRUCT
{
    <http://ulb.ac.be/staff/jdoe> terms:teaches ?x
}
WHERE { ?x rdf:type terms:course }
```

SPARQL: CONSTRUCT

- `SELECT` queries returns tables listing variable bindings
- `CONSTRUCT` queries construct a new RDF graph

Example: assign all courses to John Doe and give them 5 credits

```
PREFIX terms: <http://ulb.be/terms>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
CONSTRUCT
{
    <http://ulb.ac.be/staff/jdoe> terms:teaches ?x .
    ?x terms:credits "5"
}
WHERE { ?x rdf:type terms:course }
```

References

- P. Hitzler, M. Krötzsch, S. Rudolph. *Foundations of Semantic Web technologies*. Chapter 7 (7.1.1 – 7.1.8).
- B. Ducharme. *Learning SPARQL*.