4. SPARQL (SPARQL Protocol and RDF Query Language)

SPARQL = Query Language for RDF/OWL

Like SQL for databases, but for knowledge graphs.

Basic SPARQL Structure

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>

SELECT ?variable
WHERE {
    ?subject predicate ?object .
}
```

- `PREFIX` → Namespace shortcut
- `SELECT` → What to retrieve
- `WHERE` → Pattern to match

Example 1: Who Eats Apple?

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>

SELECT ?person WHERE {
    ?person food:eats food:Apple .
}
```

Result:

```
food:Alice
```

Variables vs Fixed Values

Variables start with `?`:

- `?person` → matches anyone
- `?food` → matches any food

Fixed values are specific:

- `food:Apple` → only Apple
- `food:Alice` → only Alice

Example 2: What Does Alice Eat?

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>

SELECT ?food WHERE {
    food:Alice food:eats ?food .
}
```

Result:

```
food:Apple
food:Pizza
```

Example 3: Who Eats What?

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>

SELECT ?person ?food WHERE {
    ?person food:eats ?food .
}
```

Result:

```
?person        ?food
food:Alice     food:Apple
food:Alice     food:Pizza
```

Example 4: Multiple Conditions

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT ?person ?fruit WHERE {
    ?person food:eats ?fruit .
    ?fruit rdf:type food:Fruit .
}
```

Result:

```
food:Alice     food:Apple
```

Example 5: Counting

```
PREFIX food: <http://www.semanticweb.org/.../food-ontology#>

SELECT (COUNT(?food) as ?count) WHERE {
    food:Alice food:eats ?food .
}
```

Result:

```
?count
2
```

Useful Keywords

Keyword	Purpose
`SELECT`	Retrieve variables
`WHERE`	Pattern matching
`LIMIT`	Limit results
`DISTINCT`	Remove duplicates
`COUNT`	Count results
`ASK`	Yes/no question
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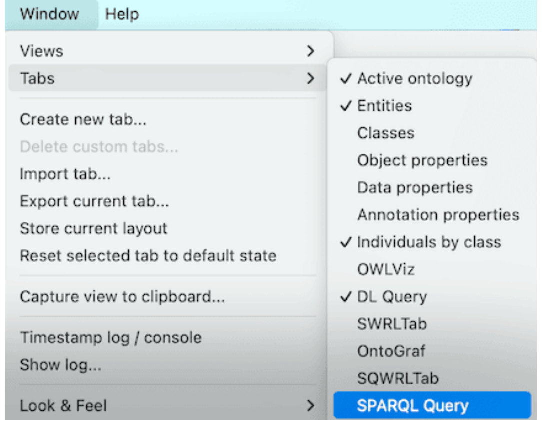
`SELECT`	Retrieve variables
`WHERE`	Pattern matching

Using SPARQL in Protege

1. SPARQL is supported via plugins in Protege.
2. To use SPARQL in Protege:
    - Install the "SPARQL Query" plugin (preinstalled in most cases).
    - Open the plugin from the "Window" menu.
    - Enter your SPARQL query and execute it.



Using SPARQL in GraphDB

1. Open GraphDB: `http://localhost:7200`
2. Select your repository
3. Click "SPARQL" tab
4. Enter query
5. Click "Execute"

Using SPARQL from Python

```python
import requests

endpoint = "http://localhost:7200/repositories/food-repo"
query = """
PREFIX food: <http://...food-ontology#>
SELECT ?person WHERE {
    ?person food:eats food:Apple .
}
"""

response = requests.get(
    endpoint,
    headers={"Accept": "application/sparql-results+json"},
    params={"query": query}
)
data = response.json()

for row in data["results"]["bindings"]:
    print(row["person"]["value"])
```

Summary

SPARQL lets you query knowledge graphs:

- Use `?variables` to find unknown values
- Use fixed values for specific resources
- Combine patterns for complex queries
- Execute in GraphDB or via Python