NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS

Student's full-name: Spanos Nikolaos

Academic Number: 7115112100023

Teacher: Koumparakis Manolis

1st academic homework exercise of course Knowledge Graphs

Academic year: 2022-2023

Master of Science in Computer Science

Athens, November 2022

Contents

Exercise 1 (DBpedia)

Part 1: Familiarize with DBpedia and Wikipedia knowledge

Please note that you may also find the code of this part in the file *exercise1_code.txt.*

To familiarize with DBpedia and SPARQL queries I have queried the resource of the Greek writer Nikos Kazantzakis as described in the outline of the exercise.

An example of a SPARQL query I wrote to return:

- resource IRI
- Nationality of the Greek writer
- Death place of the Greek writer
- Abstract of the resource (in Greek «Βίος»)

Query

```
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX dbr: <http://dbpedia.org/resource/>
PREFIX dbo: http://dbpedia.org/ontology/

SELECT ?musician ?nationality ?deathDate (GROUP_CONCAT(?deathPlaceLabel; separator=", ")
AS ?deathPlaceLabels) ?abstract
WHERE
{
   VALUES ?musician { dbr:Nikos_Kazantzakis }

   ?musician dbo:nationality ?nationality ;
         dbo:deathDate ?deathDate ;
         dbo:deathPlace/rdfs:label ?deathPlaceLabel ;
         dbo:abstract ?abstract .

   FILTER(lang(?abstract) = 'en') .
   FILTER(lang(?deathPlaceLabel) = 'en') .
} GROUP BY ?musician ?nationality ?deathDate ?abstract
```

Result

SPARQL | HTML5 table

musician	nationality	deathDate	deathPlaceLabels	abstract
http://dbpedia.org/resource/Nikos_Kazantzakis	http://dbpedia.org/resource/Greeks	1957-10-26	West Germany, Freiburg im Breisgau, Germany	"Nikos Kazantzakis (Greek: Νίκος Καζαντζάκης [ˈnikos kazanˈd͡zacis]; 2 March (OS 18 Fe

Part 2: Use of the public SPARQL endpoint over DBpedia to execute assigned queries

2.1 Find all Greek wines known by DBpedia and the region of Greece where they are produced.

Initially, I used the resource IRI: Greek_wine. My method had the following steps:
- Retrieve all the wikiLinks from the Greek_wine resource.
- Filter out the wikiLinks with rdf:type dbo:Species. Basically, keep only the links that described a grape specie.
- From those filtered out, select their wikiLinks with rdf:type dbo:Location.
- Finally, we have Greek wines from a grape specie and their origin of type Location.

(First try) Query

```
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX dbr: <http://dbpedia.org/resource/>

SELECT ?pageLink ?wineName (GROUP_CONCAT(?wineRegion; separator=", ") AS ?wineRegions)
WHERE
{
    VALUES ?winePage { dbr:Greek_wine }
    ?winePage dbo:wikiPageWikiLink ?pageLink .
    ?pageLink rdfs:label ?wineName .
    ?pageLink dbo:abstract ?desc .
    ?pageLink dbo:wikiPageWikiLink ?pageRegion .
    ?pageRegion rdfs:label ?wineRegion .
    FILTER EXISTS { ?pageLink rdf:type dbo:Species }
    FILTER EXISTS { ?pageRegion rdf:type dbo:Location }
    FILTER ( regex(?desc, "Greek") ) .
    FILTER ( lang(?wineName) = 'en') .
    FILTER ( lang(?wineRegion) = 'en' ) .
} GROUP BY ?pageLink ?winePage ?wineName
```

Result of the first try query

SPARQL | HTML5 table

pageLink	wineName	wineRegions
http://dbpedia.org/resource/Kotsifali	"Kotsifali"@en	Cyclades, Crete, Heraklion (regional unit)
http://dbpedia.org/resource/Xinomavro	"Xinomavro"@en	Amyntaio, Velventos, Gansu, Goumenissa, Naousa, Imathia, Trikomo, Greece, Mount Athos, Greece, Macedonia (Greece), Magnesia (regional unit), Siatista, Im
http://dbpedia.org/resource/Athiri	"Athiri"@en	Rhodes, Greece
http://dbpedia.org/resource/Mandilaria	"Mandilaria"@en	Greece
http://dbpedia.org/resource/Agiorgitiko	"Agiorgitiko"@en	Beaujolais, Argolis, Epirus (region), Naousa, Imathia, Greece, Macedonia (Greece), Peloponnese, Corinthia, Metsovo
http://dbpedia.org/resource/Debina_(grape)	"Debina (grape)"@en	Albania, Epirus (region), Greece, Zitsa
http://dbpedia.org/resource/Malagousia	"Malagousia"@en	Nafpaktia
http://dbpedia.org/resource/Moschofilero	"Moschofilero"@en	Greece, Mantineia, Peloponnese
http://dbpedia.org/resource/Assyrtiko	"Assyrtiko"@en	Santorini (wine), Santorini, Chalkidiki, Clare Valley, Aegean Sea, South Australia, Greece, Paros
http://dbpedia.org/resource/Limnio	"Limnio"@en	Mount Athos, Greece, Macedonia (Greece), Lemnos

Even though the filtered wines have a Greek origin, from the output we are missing other also well-known Greek wines, like Mavrodaphne, Rhoditis, etc. In my second try I used the resource IRI: Grape_varieties_of_Greece. After trying different IRI's such as Greek_wine and Wine.

Query

```
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX dbr: <http://dbpedia.org/resource/>

SELECT ?winePage ?wineName (GROUP_CONCAT(?wineRegion; separator=", ") AS
?wineRegions)
WHERE
{
    VALUES ?wine { dbc:Grape_varieties_of_Greece }
    ?wine ^dbo:wikiPageWikiLink ?winePage .
    ?winePage rdfs:label ?wineName .
    ?winePage dbo:abstract ?desc .
    ?winePage dbo:wikiPageWikiLink ?pageLink .
    ?pageLink rdfs:label ?wineRegion .
    FILTER EXISTS { ?pageLink rdf:type  dbo:Location }
    FILTER NOT EXISTS { ?winePage rdf:type  dbo:WineRegion }
    FILTER ( regex(?desc, "Greek") ) .
    FILTER ( lang(?wineName) = 'en' ) .
    FILTER ( lang(?wineRegion) = 'en' ) .
}
GROUP BY ?winePage ?wineName
```

Result

SPARQL | HTML5 table

winePage	wineName	wineRegions
http://dbpedia.org/resource/Muscat_Blanc_à_Petits_Grains	"Muscat Blanc à Petits Grains"@en	France, Australia, Frontignan, Alsace, Samos, Ancient Rome, Germany, Marseille, Italy, Moscato d'Asti, Narbonne, La Mancha (DO
http://dbpedia.org/resource/Kotsifali	"Kotsifali"@en	Cyclades, Crete, Heraklion (regional unit)
http://dbpedia.org/resource/Grechetto	"Grechetto"@en	Umbria, Italy, Torgiano, Tuscany, Cervaro, Lazio, Greece, Foiano della Chiana, Todi, Orvieto, Spoleto
http://dbpedia.org/resource/Mavrodafni	"Mavrodafni"@en	Achaea, Peloponnese
http://dbpedia.org/resource/Assyrtiko	"Assyrtiko"@en	Santorini (wine), Clare Valley, Santorini, Aegean Sea, Chalkidiki, South Australia, Greece, Paros
http://dbpedia.org/resource/Athiri	"Athiri"@en	Rhodes, Greece
http://dbpedia.org/resource/Negoska	"Negoska"@en	Goumenissa, Central Macedonia
http://dbpedia.org/resource/Vidiano	"Vidiano"@en	Rethymno (regional unit), Crete, Heraklion (regional unit)
http://dbpedia.org/resource/Lagorthi	"Lagorthi"@en	Macedonia (Greece)
http://dbpedia.org/resource/Moschofilero	"Moschofilero"@en	Greece, Mantineia, Peloponnese
http://dbpedia.org/resource/Limnio	"Limnio"@en	Mount Athos, Greece, Macedonia (Greece), Lemnos
http://dbpedia.org/resource/Malagousia	"Malagousia"@en	Nafpaktia
http://dbpedia.org/resource/Aidini	"Aidini"@en	Santorini (wine), Aegean Sea
http://dbpedia.org/resource/Robola	"Robola"@en	Ionian Islands, Cephalonia
http://dbpedia.org/resource/Rhoditis	"Rhoditis"@en	Volos, Pomorie, Bulgaria, Greece, Peloponnese, Thessaly, Patras
http://dbpedia.org/resource/Vilana	"Vilana"@en	Crete, Greece
http://dbpedia.org/resource/Thrapsathiri	"Thrapsathiri"@en	Cyclades, Crete
http://dbpedia.org/resource/Romeiko	"Romeiko"@en	Byzantine Empire, Chania, Crete, Greece, Sherry, Kissamos
http://dbpedia.org/resource/Xinomavro	"Xinomavro"@en	Velventos, Amyntaio, Gansu, Goumenissa, Mount Athos, Naousa, Imathia, Trikomo, Greece, Greece, Macedonia (Greece), Magnesia (r

With the second try and the IRI: Grape_varieties_of_Greece, I managed to return more Greek wines from Greek grape varieties. Thus, making my second sparql query more complete. Even though both queries are correct and returned desired results, the second query returns a broader variety of Greek wines.

Please note that some Greek wines like for example *Retsina* is not returned in the results. Even though, we know that is a Greek white wine. This is because in DBpedia, *Retsina* is documented as a type of Company property and not in the family of grape species.

2.2 Find all the Greek universities known to DBpedia. Output their name, the city that they are located and the number of prime ministers of Greece that have graduated from them (order answers by this number).

To answer this question, I have used the IRI List_of_universities_in_Greece.
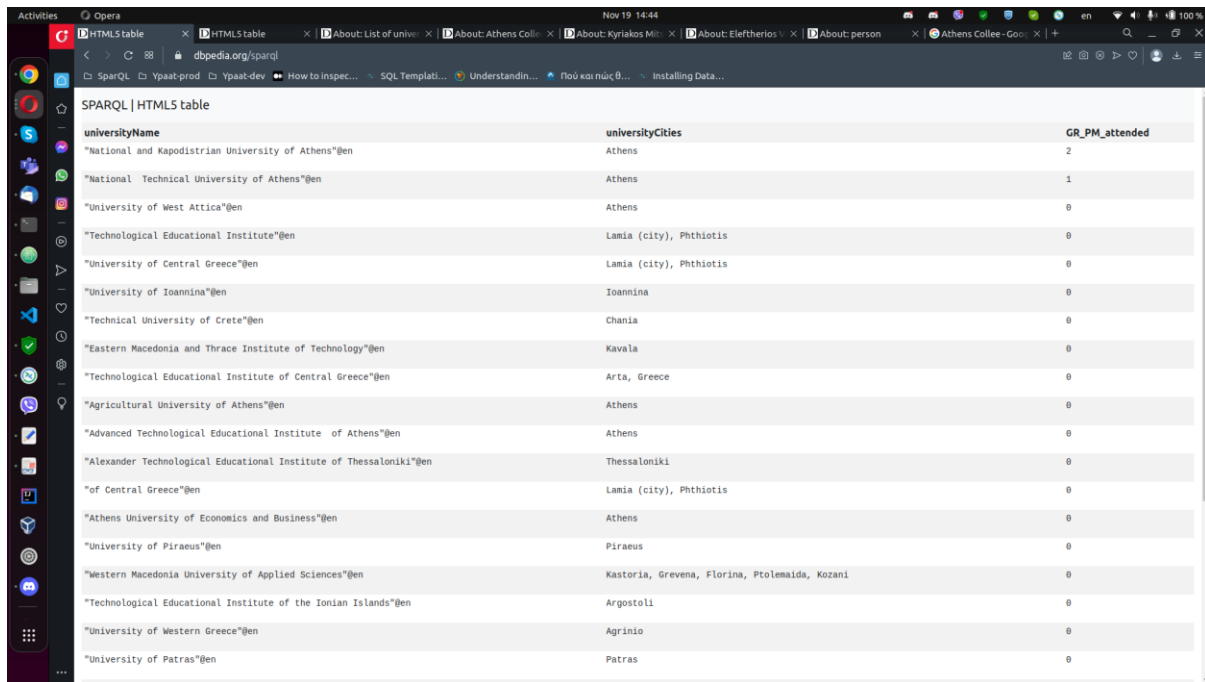
Query

```
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX dbr: <http://dbpedia.org/resource/>

SELECT ?universityName (GROUP_CONCAT(?universityCity; separator=", ") AS
?universityCities) COALESCE(?GR_PM_attended,0) AS ?GR_PM_attended
WHERE
{
  VALUES ?universityURI { dbr:List_of_universities_in_Greece }
  ?universityURI ^dbo:type ?universityPage .
  ?universityPage dbp:name ?universityName .
  OPTIONAL { ?universityPage dbp:city/rdfs:label ?universityCity . }
  FILTER(lang(?universityCity) = 'en') .
  OPTIONAL {
    SELECT ?universityPage  (COUNT(?primeMinisterResource) as ?GR_PM_attended)
    WHERE {
      VALUES ?primeMinisterURI { dbr:Prime_Minister_of_Greece }
      ?primeMinisterURI ^dbp:title ?primeMinisterResource .
      OPTIONAL { ?primeMinisterResource dbo:education ?universityPage }
      FILTER EXISTS { ?primeMinisterResource rdf:type/rdfs:subClassOf* dbo:Person }
      FILTER (STRLEN(?universityPage) != 0)
    }
    GROUP BY ?universityPage
  }
}
GROUP BY ?universityPage ?universityName ?GR_PM_attended
ORDER BY DESC(?GR_PM_attended)
```

Result

For validation, there are three educational institutions where a Greek Prime Minister have attended. However, since Athens_College is not listed as a Greek University it's not present in the final result (check screenshot above).

Below I present an investigation SPARQL query to return the education institution attended by the Greek Prime Ministers.

Investigation Query

```
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX dbp: <http://dbpedia.org/property/>
PREFIX dbr: <http://dbpedia.org/resource/>

SELECT ?universityName ?primeMinisterResource
WHERE {
    VALUES ?primeMinisterURI { dbr:Prime_Minister_of_Greece }
    ?primeMinisterURI ^dbp:title ?primeMinisterResource .
    OPTIONAL { ?primeMinisterResource dbo:education ?universityName }
    ?universityName dbo:abstract ?desc .
    FILTER EXISTS { ?primeMinisterResource rdf:type/rdfs:subClassOf*
dbo:Person }
    FILTER (STRLEN(?universityName) != 0)
    FILTER ( CONTAINS ( STR (?desc), 'Greece' ) )
}
```

Result

SPARQL | HTML5 table

universityName	primeMinisterResource
http://dbpedia.org/resource/Athens_College	http://dbpedia.org/resource/Kyriakos_Mitsotakis
http://dbpedia.org/resource/National_Technical_University_of_Athens	http://dbpedia.org/resource/Alexis_Tsipras
http://dbpedia.org/resource/National_and_Kapodistrian_University_of_Athens	http://dbpedia.org/resource/Georgios_Athanasiadis-Novas
http://dbpedia.org/resource/National_and_Kapodistrian_University_of_Athens	http://dbpedia.org/resource/Panagis_Tsaldaris

Kyriakos Mitsotakis is the Greek Prime Minister to not have attended a Greek University.

Exercise 2 (Querying the Greek administrative geography dataset using SPARQL)

Please not that you may also found the results of each query in the folder *exercise2_results* in the project's deliverables folder. Because some of the queries had a great number of rows retuned, I couldn't present all the results in one screenshot. That's why I have also printed the stdout of the java code to txt files.

Question 1

Give the official name and population of each municipality (δήμος) of Greece.

Query

```
//Give the official name and population of each municipality (δήμος) of Greece.
String queryString1 = "PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?municipalityName ?municipalityPopulation " +
        " WHERE { " +
        "     ?municipalityGreece rdf:type gag:Δήμος ." +
        "     ?municipalityGreece gag:έχει_επίσημο_όνομα ?municipalityName ;" +
        "                          gag:έχει_πληθυσμό ?municipalityPopulation ." +
        "}";
```

Result

```
result.hasNext(): true
[municipalityName="ΔΗΜΟΣ ΣΙΦΝΟΥ";municipalityPopulation="2442"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΑΛΑΜΑ";municipalityPopulation="19144"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΛΕΡΟΥ";municipalityPopulation="8207"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΝΕΣΤΟΥ";municipalityPopulation="23486"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΣΤΥΠΑΛΑΙΑΣ";municipalityPopulation="1238"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΛΑΤΑΝΙΑ";municipalityPopulation="18622"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΛΙΜΟΥ";municipalityPopulation="38047"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΜΦΙΛΟΧΙΑΣ";municipalityPopulation="21445"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΧΑΛΚΙΔΕΩΝ";municipalityPopulation="92202"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΤΗΛΟΥ";municipalityPopulation="1139"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΝΕΑΣ ΖΙΧΝΗΣ";municipalityPopulation="13579"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΝΑΥΠΑΚΤΙΑΣ";municipalityPopulation="29842"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΔΡΑΜΑΣ";municipalityPopulation="56062"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΟΛΥΓΥΡΟΥ";municipalityPopulation="22189"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΕΟΡΔΑΙΑΣ";municipalityPopulation="44497"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΜΥΚΗΣ";municipalityPopulation="15724"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΛΗΜΝΟΥ";municipalityPopulation="18104"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΛΕΙΨΩΝ";municipalityPopulation="698"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΗΝΕΙΟΥ";municipalityPopulation="20232"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΥΛΑΙΑΣ-ΧΟΡΤΙΑΤΗ";municipalityPopulation="46904"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΜΑΡΚΟΠΟΥΛΟΥ ΜΕΣΟΓΑΙΑΣ";municipalityPopulation="15608"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΤΡΙΠΟΛΗΣ";municipalityPopulation="23665"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΑΡΑΝΕΣΤΙΟΥ";municipalityPopulation="5925"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΑΠΑΓΟΥ - ΧΟΛΑΡΓΟΥ";municipalityPopulation="45373"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΗΡΑΚΛΕΙΑΣ";municipalityPopulation="22021"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΚΙΜΩΛΟΥ";municipalityPopulation="769"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΕΔΕΣΣΑΣ";municipalityPopulation="29799"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΣΙΚΙΝΟΥ";municipalityPopulation="238"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΓΡΙΝΙΟΥ";municipalityPopulation="55110"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΒΟΪΟΥ";municipalityPopulation="22447"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΖΙΤΣΑΣ";municipalityPopulation="17293"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΝΔΡΑΒΙΔΑΣ-ΚΥΛΛΗΝΗΣ";municipalityPopulation="22364"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΡΧΑΝΩΝ - ΑΣΤΕΡΟΥΣΙΩΝ";municipalityPopulation="14503"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΗΡΑΚΛΕΙΟΥ";municipalityPopulation="45926"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΑΡΓΙΘΕΑΣ";municipalityPopulation="6084"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΟΙΧΑΛΙΑΣ";municipalityPopulation="14987"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΣΚΥΡΟΥ";municipalityPopulation="2602"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΕΛΛΗΝΙΚΟΥ - ΑΡΓΥΡΟΥΠΟΛΗΣ";municipalityPopulation="34832"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΜΑΛΕΒΙΖΙΟΥ";municipalityPopulation="20159"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΥΡΓΟΥ";municipalityPopulation="51777"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΜΗΛΟΥ";municipalityPopulation="4771"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΚΑΡΠΕΝΗΣΙΟΥ";municipalityPopulation="18449"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΙΕΡΑΣ ΠΟΛΗΣ ΜΕΣΟΛΟΓΓΙΟΥ";municipalityPopulation="32830"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityName="ΔΗΜΟΣ ΠΑΓΓΑΙΟΥ";municipalityPopulation="33683"^^<http://www.w3.org/2001/XMLSchema#integer>]
```

Question 2

For each region (περιφέρεια) of Greece, give its official name, the official name of each regional unit (περιφερειακή ενότητα) that belongs to it, and the official name of each municipality (δήμος) in this regional unit. Organize your answer by region, regional unit and municipality.

Query

```
//For each region (περιφέρεια) of Greece, give its official name, the official name of each
//regional unit (περιφερειακή ενότητα) that belongs to it, and the official name of each
//municipality (δήμος) in this regional unit. Organize your answer by region, regional unit
//and municipality.
String queryString2 =
        " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?regionOfficialName ?regionalUnitOfficialName ?municipalityOfficialName " +
        " WHERE { " +
        "    ?regionURI rdf:type gag:Περιφέρεια ." +
        "    ?regionUnitURI rdf:type gag:Περιφερειακή_Ενότητα ." +
        "    ?regionURI gag:έχει_επίσημο_όνομα ?regionOfficialName ." +
        "    ?regionUnitURI gag:ανήκει_σε ?regionURI ." +
        "    ?regionUnitURI gag:έχει_επίσημο_όνομα ?regionalUnitOfficialName ." +
        "    {SELECT ?regionalUnitOfficialName ?municipalityOfficialName " +
        "    WHERE { " +
        "        ?regionUnitURI rdf:type gag:Περιφερειακή_Ενότητα ." +
        "        ?municipalityURI rdf:type gag:Δήμος . " +
        "        ?regionUnitURI gag:έχει_επίσημο_όνομα ?regionalUnitOfficialName ." +
        "        ?municipalityURI gag:ανήκει_σε ?regionUnitURI ." +
        "        ?municipalityURI gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "    }" +
        "  }" +
        "} " +
        "  ORDER BY ASC(?regionOfficialName) ASC(?regionalUnitOfficialNames)";
```

Result

```
result.hasNext(): true
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΝΕΣΤΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΒΑΛΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΠΑΓΓΑΙΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΒΑΛΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΚΑΒΑΛΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΒΑΛΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΔΡΑΜΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΠΑΡΑΝΕΣΤΙΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΔΟΞΑΤΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΚΑΤΩ ΝΕΥΡΟΚΟΠΙΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΠΡΟΣΟΤΣΑΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΜΥΚΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΤΟΠΕΙΡΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΞΑΝΘΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΑΒΔΗΡΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΑΡΡΙΑΝΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΚΟΜΟΤΗΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΜΑΡΩΝΕΙΑΣ-ΣΑΠΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΙΑΣΜΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΟΡΕΣΤΙΑΔΟΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΣΟΥΦΛΙΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΑΛΕΞΑΝΔΡΟΥΠΟΛΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΣΑΜΟΘΡΑΚΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΔΙΔΥΜΟΤΕΙΧΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔΟΝΙΑΣ ΘΡΑΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΘΑΣΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΑΣΟΥ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΑΛΙΜΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΕΛΛΗΝΙΚΟΥ - ΑΡΓΥΡΟΥΠΟΛΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΠΑΛΑΙΟΥ ΦΑΛΗΡΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΑΓΙΟΥ ΔΗΜΗΤΡΙΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΜΟΣΧΑΤΟΥ - ΤΑΥΡΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΚΑΛΛΙΘΕΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΓΛΥΦΑΔΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
[regionOfficialName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";municipalityOfficialName="ΔΗΜΟΣ ΝΕΑΣ ΣΜΥΡΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ"]
```

Question 3

For each municipality of the region Peloponnese with population more than 5,000 people, give its official name, its population, and the regional unit it belongs to. Organize your answer by municipality and regional unit.

Query

```
//For each municipality of the region Peloponnese with population more than 5,000 people,
//give its official name, its population, and the regional unit it belongs to. Organize your
//answer by municipality and regional unit.
String queryString3 =
        " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?municipalityOfficialName ?regionalUnitOfficialName ?municipalityPopulation" +
        " WHERE { " +
        "    ?municipalityURI rdf:type gag:Δήμος ." +
        "    ?municipalityURI gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "    ?municipalityURI gag:έχει_πληθυσμό ?municipalityPopulation ." +
        "    ?municipalityURI gag:ανήκει_σε ?regionalUnit ." +
        "    ?regionalUnit gag:έχει_επίσημο_όνομα ?regionalUnitOfficialName ." +
        "    ?regionalUnit gag:ανήκει_σε ?region ."   +
        "    ?region gag:έχει_επίσημο_όνομα \"ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ\" ." +
        "    FILTER (?municipalityPopulation > 5000) " +
        "} ORDER BY ASC(?municipalityPopulation) ASC(?regionalUnitOfficialName)";
```

Result

```
result.hasNext(): true
[municipalityOfficialName="ΔΗΜΟΣ ΝΕΜΕΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="7774"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΔΥΤΙΚΗΣ ΜΑΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="8647"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΝΟΤΙΑΣ ΚΥΝΟΥΡΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ";municipalityPopulation="9001"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΕΠΙΔΑΥΡΟΥ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ";municipalityPopulation="9275"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΕΡΜΙΟΝΙΔΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ";municipalityPopulation="12624"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΒΟΡΕΙΑΣ ΚΥΝΟΥΡΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ";municipalityPopulation="12825"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΓΑΛΟΠΟΛΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ";municipalityPopulation="13152"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΟΙΧΑΛΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="14987"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΛΟΥΤΡΑΚΙΟΥ-ΑΓ.ΘΕΟΔΩΡΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="17116"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΑΝΑΤΟΛΙΚΗΣ ΜΑΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ";municipalityPopulation="17157"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΒΕΛΟΥ-ΒΟΧΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="18323"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΓΟΡΤΥΝΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ";municipalityPopulation="18327"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΕΥΡΩΤΑ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ";municipalityPopulation="18345"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΚΑΛΑΜΑΤΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="19418"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΞΥΛΟΚΑΣΤΡΟΥ-ΕΥΡΩΣΤΙΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="20084"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΠΥΛΟΥ-ΝΕΣΤΟΡΟΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="20315"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΠΟΛΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ";municipalityPopulation="23665"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΑΡΓΟΥΣ-ΜΥΚΗΝΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ";municipalityPopulation="23735"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΜΟΝΕΜΒΑΣΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ";municipalityPopulation="23853"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΣΙΚΥΩΝΙΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="24666"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΣΣΗΝΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="27521"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΝΑΥΠΛΙΕΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ";municipalityPopulation="33406"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΦΥΛΙΑΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ";municipalityPopulation="33581"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΣΠΑΡΤΗΣ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ";municipalityPopulation="38079"^^<http://www.w3.org/2001/XMLSchema#integer>]
[municipalityOfficialName="ΔΗΜΟΣ ΚΟΡΙΝΘΙΩΝ";regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ";municipalityPopulation="55258"^^<http://www.w3.org/2001/XMLSchema#integer>]
```

Question 4

For each municipality of Peloponnese for which we have no seat (έδρα) information in the dataset, give its official name.

Query

```
//For each municipality of Peloponnese for which we have no seat (έδρα) information in
//the dataset, give its official name.
String queryString4 =
        " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?municipalityOfficialName" +
        " WHERE { " +
        "    ?municipalityURI rdf:type gag:Δήμος ." +
        "    ?municipalityURI gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "    ?municipalityURI gag:ανήκει_σε ?regionalUnit ." +
        "    ?regionalUnit gag:ανήκει_σε ?region ." +
        "    ?region gag:έχει_επίσημο_όνομα \"ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ\" ." +
        "    FILTER NOT EXISTS { ?municipalityURI gag:έχει_έδρα ?hasSeat } " +
        "}";
```

Result

```
result.hasNext(): true
[municipalityOfficialName="ΔΗΜΟΣ ΟΙΧΑΛΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΚΑΛΑΜΑΤΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΠΥΛΟΥ-ΝΕΣΤΟΡΟΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΔΥΤΙΚΗΣ ΜΑΝΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΣΣΗΝΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΦΥΛΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΒΕΛΟΥ-ΒΟΧΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΣΙΚΥΩΝΙΩΝ"]
[municipalityOfficialName="ΔΗΜΟΣ ΞΥΛΟΚΑΣΤΡΟΥ-ΕΥΡΩΣΤΙΝΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΛΟΥΤΡΑΚΙΟΥ-ΑΓ.ΘΕΟΔΩΡΩΝ"]
[municipalityOfficialName="ΔΗΜΟΣ ΚΟΡΙΝΘΙΩΝ"]
[municipalityOfficialName="ΔΗΜΟΣ ΝΕΜΕΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΕΥΡΩΤΑ"]
[municipalityOfficialName="ΔΗΜΟΣ ΜΟΝΕΜΒΑΣΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΣΠΑΡΤΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΕΛΑΦΟΝΗΣΟΥ"]
[municipalityOfficialName="ΔΗΜΟΣ ΑΝΑΤΟΛΙΚΗΣ ΜΑΝΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΠΟΛΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΒΟΡΕΙΑΣ ΚΥΝΟΥΡΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΓΑΛΟΠΟΛΗΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΓΟΡΤΥΝΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΝΟΤΙΑΣ ΚΥΝΟΥΡΙΑΣ"]
[municipalityOfficialName="ΔΗΜΟΣ ΝΑΥΠΛΙΕΩΝ"]
[municipalityOfficialName="ΔΗΜΟΣ ΑΡΓΟΥΣ-ΜΥΚΗΝΩΝ"]
[municipalityOfficialName="ΔΗΜΟΣ ΕΠΙΔΑΥΡΟΥ"]
[municipalityOfficialName="ΔΗΜΟΣ ΕΡΜΙΟΝΙΔΑΣ"]
```

Question 5

For each municipality of Peloponnese, give its official name and all the administrative divisions of Greece that it belongs to according to Kallikratis. Your query should be the simplest one possible, and it should not use any explicit knowledge of how many levels of administration are imposed by Kallikratis.

Query

```
//For each municipality of Peloponnese, give its official name and all the administrative
//divisions of Greece that it belongs to according to Kallikratis. Your query should be the
//simplest one possible, and it should not use any explicit knowledge of how many levels
//of administration are imposed by Kallikratis.
String queryString5 =
        " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?municipalityOfficialName ?superclassNames" +
        " WHERE " +
        " { " +
        "     { " +
        "         SELECT ?municipalityOfficialName (GROUP_CONCAT(?superclassName; separator=\", \") AS ?superclassNames) "+
        "         WHERE " +
        "         { " +
        "             ?municipalityURI rdf:type gag:Δήμος ." +
        "             ?municipalityURI gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "             ?municipalityURI (gag:ανήκει_σε*) ?superclass ." +
        "             ?superclass gag:έχει_επίσημο_όνομα ?superclassName ." +
        "             FILTER( ?superclassName != ?municipalityOfficialName )" +
        "         } GROUP BY ?municipalityOfficialName ORDER BY ASC(?superclassName) " +
        "     } " +
        "     FILTER( REGEX(?superclassNames, \"ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ\") )" +
        " } ORDER BY ASC(?municipalityOfficialName)";
```

Result

```
result.hasNext(): true
[municipalityOfficialName="ΔΗΜΟΣ ΑΝΑΤΟΛΙΚΗΣ ΜΑΝΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ
[municipalityOfficialName="ΔΗΜΟΣ ΑΡΓΟΥΣ-ΜΥΚΗΝΩΝ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ Ε
[municipalityOfficialName="ΔΗΜΟΣ ΒΕΛΟΥ-ΒΟΧΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑ
[municipalityOfficialName="ΔΗΜΟΣ ΒΟΡΕΙΑΣ ΚΥΝΟΥΡΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ
[municipalityOfficialName="ΔΗΜΟΣ ΓΟΡΤΥΝΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ
[municipalityOfficialName="ΔΗΜΟΣ ΔΥΤΙΚΗΣ ΜΑΝΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛ
[municipalityOfficialName="ΔΗΜΟΣ ΕΛΑΦΟΝΗΣΟΥ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΕΠΙΔΑΥΡΟΥ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔ
[municipalityOfficialName="ΔΗΜΟΣ ΕΡΜΙΟΝΙΔΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑ
[municipalityOfficialName="ΔΗΜΟΣ ΕΥΡΩΤΑ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ-ΙΟ
[municipalityOfficialName="ΔΗΜΟΣ ΚΑΛΑΜΑΤΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΚΟΡΙΝΘΙΩΝ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΛΟΥΤΡΑΚΙΟΥ-ΑΓ.ΘΕΟΔΩΡΩΝ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-Δ
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΓΑΛΟΠΟΛΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔ
[municipalityOfficialName="ΔΗΜΟΣ ΜΕΣΣΗΝΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΜΟΝΕΜΒΑΣΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔ
[municipalityOfficialName="ΔΗΜΟΣ ΝΑΥΠΛΙΕΩΝ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΓΟΛΙΔΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΝΕΜΕΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ-Ι
[municipalityOfficialName="ΔΗΜΟΣ ΝΟΤΙΑΣ ΚΥΝΟΥΡΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ
[municipalityOfficialName="ΔΗΜΟΣ ΞΥΛΟΚΑΣΤΡΟΥ-ΕΥΡΩΣΤΙΝΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-Δ
[municipalityOfficialName="ΔΗΜΟΣ ΟΙΧΑΛΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΠΥΛΟΥ-ΝΕΣΤΟΡΟΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ Ε
[municipalityOfficialName="ΔΗΜΟΣ ΣΙΚΥΩΝΙΩΝ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΡΙΝΘΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
[municipalityOfficialName="ΔΗΜΟΣ ΣΠΑΡΤΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΑΚΩΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ-Ι
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΠΟΛΗΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΚΑΔΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ-
[municipalityOfficialName="ΔΗΜΟΣ ΤΡΙΦΥΛΙΑΣ";superclassNames="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΜΕΣΣΗΝΙΑΣ, ΠΕΡΙΦΕΡΕΙΑ ΠΕΛΟΠΟΝΝΗΣΟΥ, ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑ
```

Question 6

For each region of Greece, give its official name, how many municipalities belong to it, the official name of each regional unit (περιφερειακή ενότητα) that belongs to it, and how many municipalities belong to that regional unit.

Query

```
//For each region of Greece, give its official name, how many municipalities belong to it,
//the official name of each regional unit (περιφερειακή ενότητα) that belongs to it, and how
//many municipalities belong to that regional unit.
String queryString6 =
        " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        " SELECT ?regionName ?regionalUnitOfficialName ?NumberRegionMunicipalities (COUNT(?municipalityOfficialName) AS ?NumberRegionalUnitMunicipalities)" +
        " WHERE { " +
        "   ?regionURI rdf:type gag:Περιφέρεια ." +
        "   ?regionalURI rdf:type gag:Περιφερειακή_Ενότητα ." +
        "   ?regionURI gag:έχει_επίσημο_όνομα ?regionName ." +
        "   ?regionalURI gag:ανήκει_σε ?regionURI ." +
        "   ?regionalURI gag:έχει_επίσημο_όνομα ?regionalUnitOfficialName ." +
        "   ?municipality gag:ανήκει_σε ?regionalURI ." +
        "   ?municipality gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "   { SELECT ?regionName (COUNT(?municipalityOfficialName) AS ?NumberRegionMunicipalities)" +
        "     WHERE { " +
        "       ?regionURI rdf:type gag:Περιφέρεια ." +
        "       ?regionalURI rdf:type gag:Περιφερειακή_Ενότητα ." +
        "       ?regionURI gag:έχει_επίσημο_όνομα ?regionName ." +
        "       ?regionalURI gag:ανήκει_σε ?regionURI ." +
        "       ?regionalURI gag:έχει_επίσημο_όνομα ?regionalUnitOfficialName ." +
        "       ?municipality gag:ανήκει_σε ?regionalURI ." +
        "       ?municipality gag:έχει_επίσημο_όνομα ?municipalityOfficialName ." +
        "     } GROUP BY ?regionName" +
        "   }" +
        " } GROUP BY ?regionName ?regionalUnitOfficialName ?NumberRegionMunicipalities "+
        "   ORDER BY ASC(?regionName) ASC(?regionalUnitOfficialName)";
```

Result

```
result.hasNext(): true
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΡΑΜΑΣ";NumberRegionalUnitMunicipalities="5"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΕΒΡΟΥ";NumberRegionalUnitMunicipalities="5"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΘΑΣΟΥ";NumberRegionalUnitMunicipalities="1"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕΔ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΒΑΛΑΣ";NumberRegionalUnitMunicipalities="3"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΞΑΝΘΗΣ";NumberRegionalUnitMunicipalities="4"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚΕ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΡΟΔΟΠΗΣ";NumberRegionalUnitMunicipalities="4"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΝ. ΜΑΚ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΝΑΤΟΛΙΚΗΣ ΑΤΤΙΚΗΣ";NumberRegionalUnitMunicipalities="13"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΒΟΡΕΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ";NumberRegionalUnitMunicipalities="12"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ";NumberRegionalUnitMunicipalities="5"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΔΥΤΙΚΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ";NumberRegionalUnitMunicipalities="7"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΕΝΤΡΙΚΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ";NumberRegionalUnitMunicipalities="8"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΗΣΩΝ";NumberRegionalUnitMunicipalities="8"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΑΤΤΙΚΗΣ";
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΝΟΤΙΟΥ ΤΟΜΕΑ ΑΘΗΝΩΝ";NumberRegionalUnitMunicipalities="8"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΠΕΙΡΑΙΩΣ";NumberRegionalUnitMunicipalities="5"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΙΚΑΡΙΑΣ";NumberRegionalUnitMunicipalities="2"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΕΣΒΟΥ";NumberRegionalUnitMunicipalities="1"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΛΗΜΝΟΥ";NumberRegionalUnitMunicipalities="2"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ.
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΣΑΜΟΥ";NumberRegionalUnitMunicipalities="1"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ Α
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΧΙΟΥ";NumberRegionalUnitMunicipalities="3"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΒΟΡΕΙΟΥ ΑΙ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΙΤΩΛΟΑΚΑΡΝΑΝΙΑΣ";NumberRegionalUnitMunicipalities="7"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΧΑΪΑΣ";NumberRegionalUnitMunicipalities="5"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗΣ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΗΛΕΙΑΣ";NumberRegionalUnitMunicipalities="7"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗΣ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΓΡΕΒΕΝΩΝ";NumberRegionalUnitMunicipalities="2"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΑΣΤΟΡΙΑΣ";NumberRegionalUnitMunicipalities="3"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΚΟΖΑΝΗΣ";NumberRegionalUnitMunicipalities="4"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗΣ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΦΛΩΡΙΝΑΣ";NumberRegionalUnitMunicipalities="3"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΔΥΤΙΚΗ
[regionalUnitOfficialName="ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ ΑΡΤΑΣ";NumberRegionalUnitMunicipalities="4"^^<http://www.w3.org/2001/XMLSchema#integer>;regionName="ΠΕΡΙΦΕΡΕΙΑ ΗΠΕΙΡΟΥ";
```

Question 7

Check the consistency of the dataset regarding stated populations: the sum of the populations of all administrative units A of level L must be equal to the population of the administrative unit B of level L+1 to which all administrative units A belong to. (You have to write one query only.)

Query

```
//Check the consistency of the dataset regarding stated populations: the sum of the
//populations of all administrative units A of level L must be equal to the population of the
//administrative unit B of level L+1 to which all administrative units A belong to. (You
//have to write one query only.)
String queryString7 = "PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
        "SELECT ?child_name ?child_pop ?parent_name (SUM ( xsd:integer(?parent_pop)) AS ?total_parent_pop)"+
        "WHERE " +
        "{" +
        "   ?child gag:ανήκει_σε ?parent; " +
        "           gag:έχει_πληθυσμό ?child_pop;" +
        "           gag:έχει_επίσημο_όνομα ?child_name ." +
        "   ?parent gag:έχει_επίσημο_όνομα ?parent_name ;" +
        "           gag:έχει_πληθυσμό ?parent_pop ." +
        "} GROUP BY ?child_name ?child_pop ?parent_name"+
        "   ORDER BY ASC(?parent_name) ";
```

Result

However, since the result of question 7 is not very intuitive (many rows to check), I have created the below verification query to assert the validity of the main point of the question *the sum of the populations of all administrative units A of level L must be equal to the population of the administrative unit B of level L+1.*

To do so, I created a logical comparison for the population of the parent (L+1) with the total sum of population for the children (L). The statement checks

> If total child population != total parent population, then 1
>
> Else If total child population = total parent population, then 0

Verification Query

```
//this is the verification of the answer (optional)
String queryString7_1 = "PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>" +
    "SELECT ( SUM ( IF (?total_child_pop != ?total_parent_pop, 1, 0) ) as ?conditionCount)" +
    "WHERE "+
    "{ " +
    "    {" +
    "        SELECT ?parent_name ?total_parent_pop (SUM (?child_pop) AS ?total_child_pop) " +
    "        WHERE " +
    "        {"+
    "            SELECT ?child_name ?child_pop ?parent_name (SUM ( xsd:integer(?parent_pop)) AS ?total_parent_pop)"+
    "            WHERE " +
    "            {" +

    "                ?child gag:ανήκει_σε ?parent; " +
    "                    gag:έχει_πληθυσμό ?child_pop;" +
    "                    gag:έχει_επίσημο_όνομα ?child_name ." +

    "                ?parent gag:έχει_επίσημο_όνομα ?parent_name ;" +
    "                    gag:έχει_πληθυσμό ?parent_pop ." +

    "            } GROUP BY ?child_name ?child_pop ?parent_name"+
    "            ORDER BY ASC(?parent_name) " +

    "        } GROUP BY ?parent_name ?total_parent_pop" +
    "    }" +
    "}";
```

Result

Thus, we can conclude that the child population (L) is equal to the parent population (L+1) per administrative level.

Question 8

Give the decentralized administrations (αποκεντρωμένες διοικήσεις) of Greece that consist of more than two regional units. (You cannot use SPARQL 1.1 aggregate operators to express this query.)

Query

```
//Give the decentralized administrations (αποκεντρωμένες διοικήσεις) of Greece that
//consist of more than two regional units. (You cannot use SPARQL 1.1 aggregate
//operators to express this query.)
String queryString8 =
    " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>\n" +
    " SELECT DISTINCT ?decentralizedAdminName" +
    " WHERE { " +
    "   ?adminUri rdf:type gag:Αποκεντρωμένη_Διοίκηση . "+
    "   ?adminUri gag:έχει_επίσημο_όνομα ?decentralizedAdminName ." +
    "   ?region gag:ανήκει_σε ?adminUri . " +
    "   ?regionalUnit_1 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_1 gag:έχει_επίσημο_όνομα ?ru_1 . " +
    "   ?regionalUnit_2 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_2 gag:έχει_επίσημο_όνομα ?ru_2 . " +
    "   ?regionalUnit_3 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_3 gag:έχει_επίσημο_όνομα ?ru_3 . " +
    "   FILTER(?regionalUnit_1 != ?regionalUnit_2 && ?regionalUnit_1 != ?regionalUnit_3 && ?regionalUnit_2 != ?regionalUnit_3)" +
    "} ";
```

The answer is hidden in the filter statement. I have queried the object property ΠΕΡΙΦΕΡΕΙΑΚΗ ΕΝΟΤΗΤΑ (regional unit) three different times. And I have returned the decentralized administrations with at least three different regional units. The rules are:
- The first regional unit should differ from the second and the third regional unit(s).
- The second regional unit should differ from the first and the third regional unit(s).
- The third regional unit should differ from the first and the second regional unit(s).

Thus, returning decentralized administrations with at least three (more that two) different regional units.

Result

```
result.hasNext(): true
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΠΕΛΟΠΟΝΝΗΣΟΥ-ΔΥΤΙΚΗΣ ΕΛΛΑΔΑΣ-ΙΟΝΙΟΥ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΑΤΤΙΚΗΣ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΜΑΚΕΔΟΝΙΑΣ-ΘΡΑΚΗΣ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΗΠΕΙΡΟΥ-ΔΥΤΙΚΗΣ ΜΑΚΕΔΟΝΙΑΣ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΘΕΣΣΑΛΙΑΣ-ΣΤΕΡΕΑΣ ΕΛΛΑΔΑΣ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΑΙΓΑΙΟΥ"]
[decentralizedAdminName="ΑΠΟΚΕΝΤΡΩΜΕΝΗ ΔΙΟΙΚΗΣΗ ΚΡΗΤΗΣ"]
```

To verify the results, I have also written the query below that print three different regional units per decentralized administration.

Verification query

```
//verification_query
String queryString8_1 =
    " PREFIX gag: <http://geo.linkedopendata.gr/gag/ontology/>\n" +
    " SELECT DISTINCT ?decentralizedAdminName ?ru_1 ?ru_2 ?ru_3" +
    " WHERE { " +
    "   ?adminUri rdf:type gag:Αποκεντρωμένη_Διοίκηση . "+
    "   ?adminUri gag:έχει_επίσημο_όνομα ?decentralizedAdminName ." +
    "   ?region gag:ανήκει_σε ?adminUri . " +
    "   ?regionalUnit_1 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_1 gag:έχει_επίσημο_όνομα ?ru_1 . " +
    "   ?regionalUnit_2 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_2 gag:έχει_επίσημο_όνομα ?ru_2 . " +
    "   ?regionalUnit_3 gag:ανήκει_σε ?region . " +
    "   ?regionalUnit_3 gag:έχει_επίσημο_όνομα ?ru_3 . " +
    "   FILTER(?regionalUnit_1 != ?regionalUnit_2 && ?regionalUnit_1 != ?regionalUnit_3 && ?regionalUnit_2 != ?regionalUnit_3)" +
    "} ";
```

Result

Exercise 3 (http://schema.org)

Please not that you may also found the results of each query in the folder **exercise3_results** in the project's deliverables folder. Because some of the queries had a great number of rows retuned, I couldn't present all the results in one screenshot. That's why I have also printed the stdout of the java code to txt files.

Also note that the four (4) questions have been reported as eight (8). Four with inference and 8 without inference.

The question pairs are as follows:
- Question 1 – Question 5
- Question 2 – Question 6
- Question 3 – Question 7
- Question 4 – Question 8

The results and the SPARQL queries should be compared only among each pair.

Question 1

(With inference) Find all subclasses of class CollegeOrUniversity (note that http://schema.org/ prefers to use the equivalent term "type" for "class").

Query

```
//-------------------------------------------------
// WITH INFERENCE
// Find all subclasses of class CollegeOrUniversity
String queryString1 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?subclassName" +
        " WHERE { " +
        "    ?entity rdf:type rdfs:Class ." +
        "    ?type rdfs:subClassOf schema:CollegeOrUniversity ." +
        "    ?type rdfs:label ?subclassName ." +
        "    FILTER ( ?type != schema:CollegeOrUniversity )" +
        " }";
```

Result

No subclasses returned. Since no subclass exist, without inference we will have the same results (check results below in question 5).

Question 2

Find all the superclasses of class CollegeOrUniversity.

Query

```
// WITH INFERENCE
String queryString2 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?superclassName " +
        " WHERE { " +
        "     ?superclass ^rdfs:subClassOf schema:CollegeOrUniversity ." +
        "     ?superclass rdfs:label ?superclassName ." +
        "     FILTER ( ?superclass != schema:CollegeOrUniversity )" +
        " }" ;
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/n
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?
[superclassName="EducationalOrganization"]
[superclassName="CivicStructure"]
[superclassName="Organization"]
[superclassName="Place"]
[superclassName="Thing"]
```

Below I present a different approach with similar results. Basically, I make use of the GROUP_CONCAT method of SPARQL 1.1 endpoint.

Alternative Query

```
// Find all the superclasses of class CollegeOrUniversity.
String queryString2_1 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?className (GROUP_CONCAT(?superclassName; separator=',') AS ?superclassNames) " +
        " WHERE { " +
        "     schema:CollegeOrUniversity rdfs:label ?className ." +
        "     ?superclass ^rdfs:subClassOf schema:CollegeOrUniversity ." +
        "     ?superclass rdfs:label ?superclassName ." +
        "     FILTER ( ?superclass != schema:CollegeOrUniversity )" +
        " } GROUP BY ?className " ;
```

Alternative Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScComputerScience/Fall2022/KnowledgeTechnologies/eclipse/plugin
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?className (GROUP_CONCAT(?superclassName; separator=',') AS ?superclassNames)
[className="CollegeOrUniversity";superclassNames="EducationalOrganization,CivicStructure,Organization,Place,Thing"]
```

Question 3

Find all properties defined for the class CollegeOrUniversity together with all the properties inherited by its superclasses.

Query

```
//-------------------------------------------------------------------------------------------
// Find all properties defined for the class CollegeOrUniversity together with all the properties inherited by its superclasses.
// WITH INFERENCE
String queryString3 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT DISTINCT ?superclassName ?property ?propertyValue " +
        " WHERE { " +
        "    schema:CollegeOrUniversity rdfs:subClassOf ?superclass ." +
        "    ?superclass rdfs:label ?superclassName ." +
        "    ?property rdfs:label ?propertyValue ." +
        "    ?property schema:domainIncludes ?superclass ." +
        "    FILTER ( ?property not in ( rdf:type ) )" +
        " } ORDER BY ASC(?superclassName) ASC(?property)" ;
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScComputerScience/Fall2022/KnowledgeTechnologies/eclipse/plugins/org.ecl
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT DISTINCT ?superclassName ?property ?propertyValue  WHERE {      schema:CollegeOrUniver
[property=https://schema.org/openingHours;propertyValue="openingHours";superclassName="CivicStructure"]
[property=https://schema.org/alumni;propertyValue="alumni";superclassName="EducationalOrganization"]
[property=https://schema.org/actionableFeedbackPolicy;propertyValue="actionableFeedbackPolicy";superclassName="Organization"]
[property=https://schema.org/address;propertyValue="address";superclassName="Organization"]
[property=https://schema.org/aggregateRating;propertyValue="aggregateRating";superclassName="Organization"]
[property=https://schema.org/alumni;propertyValue="alumni";superclassName="Organization"]
[property=https://schema.org/areaServed;propertyValue="areaServed";superclassName="Organization"]
[property=https://schema.org/award;propertyValue="award";superclassName="Organization"]
[property=https://schema.org/awards;propertyValue="awards";superclassName="Organization"]
[property=https://schema.org/brand;propertyValue="brand";superclassName="Organization"]
[property=https://schema.org/contactPoint;propertyValue="contactPoint";superclassName="Organization"]
[property=https://schema.org/contactPoints;propertyValue="contactPoints";superclassName="Organization"]
[property=https://schema.org/correctionsPolicy;propertyValue="correctionsPolicy";superclassName="Organization"]
[property=https://schema.org/department;propertyValue="department";superclassName="Organization"]
[property=https://schema.org/dissolutionDate;propertyValue="dissolutionDate";superclassName="Organization"]
[property=https://schema.org/diversityPolicy;propertyValue="diversityPolicy";superclassName="Organization"]
[property=https://schema.org/diversityStaffingReport;propertyValue="diversityStaffingReport";superclassName="Organization"]
[property=https://schema.org/duns;propertyValue="duns";superclassName="Organization"]
[property=https://schema.org/email;propertyValue="email";superclassName="Organization"]
[property=https://schema.org/employee;propertyValue="employee";superclassName="Organization"]
[property=https://schema.org/employees;propertyValue="employees";superclassName="Organization"]
[property=https://schema.org/ethicsPolicy;propertyValue="ethicsPolicy";superclassName="Organization"]
[property=https://schema.org/event;propertyValue="event";superclassName="Organization"]
[property=https://schema.org/events;propertyValue="events";superclassName="Organization"]
[property=https://schema.org/faxNumber;propertyValue="faxNumber";superclassName="Organization"]
[property=https://schema.org/founder;propertyValue="founder";superclassName="Organization"]
[property=https://schema.org/founders;propertyValue="founders";superclassName="Organization"]
[property=https://schema.org/foundingDate;propertyValue="foundingDate";superclassName="Organization"]
[property=https://schema.org/foundingLocation;propertyValue="foundingLocation";superclassName="Organization"]
[property=https://schema.org/funder;propertyValue="funder";superclassName="Organization"]
[property=https://schema.org/funding;propertyValue="funding";superclassName="Organization"]
[property=https://schema.org/globalLocationNumber;propertyValue="globalLocationNumber";superclassName="Organization"]
[property=https://schema.org/hasCredential;propertyValue="hasCredential";superclassName="Organization"]
[property=https://schema.org/hasMerchantReturnPolicy;propertyValue="hasMerchantReturnPolicy";superclassName="Organization"]
[property=https://schema.org/hasOfferCatalog;propertyValue="hasOfferCatalog";superclassName="Organization"]
[property=https://schema.org/hasPOS;propertyValue="hasPOS";superclassName="Organization"]
[property=https://schema.org/interactionStatistic;propertyValue="interactionStatistic";superclassName="Organization"]
[property=https://schema.org/isicV4;propertyValue="isicV4";superclassName="Organization"]
[property=https://schema.org/iso6523Code;propertyValue="iso6523Code";superclassName="Organization"]
[property=https://schema.org/keywords;propertyValue="keywords";superclassName="Organization"]
[property=https://schema.org/knowsAbout;propertyValue="knowsAbout";superclassName="Organization"]
[property=https://schema.org/knowsLanguage;propertyValue="knowsLanguage";superclassName="Organization"]
[property=https://schema.org/legalName;propertyValue="legalName";superclassName="Organization"]
[property=https://schema.org/leiCode;propertyValue="leiCode";superclassName="Organization"]
[property=https://schema.org/location;propertyValue="location";superclassName="Organization"]
[property=https://schema.org/logo;propertyValue="logo";superclassName="Organization"]
[property=https://schema.org/makesOffer;propertyValue="makesOffer";superclassName="Organization"]
```

Question 4

Find all classes that are subclasses of class Thing and are found in at most 2 levels of subclass relationships away from Thing.

With the use of the inference, I couldn't find a way to produce the results asked by the question. Having tried different ways, I either managed to return all the subclasses/classes of the ontology or results starting from the last layer of the ontology. For example, classes like Radiography.

Question 5

The first question without the use of inference.

Query

```
// WITHOUT INFERENCE
// Find all subclasses of class CollegeOrUniversity
String queryString5 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?subclassName" +
        " WHERE { " +
        "    ?entity rdf:type rdfs:Class ." +
        "    ?type rdfs:subClassOf schema:CollegeOrUniversity ." +
        "    ?type rdfs:label ?subclassName ." +
        "    FILTER ( ?type != schema:CollegeOrUniversity )" +
        " }";
//------------------------------------------------------
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/M
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?subclassName WHERE
```

The result is also empty as in Question 1.

Question 6

The second question without the use of inference.

Query

```
// WITHOUT INFERENCE
// Find all the superclasses of class CollegeOrUniversity.
String queryString6 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?superclassName " +
        " WHERE { " +
        "    ?superclass ^rdfs:subClassOf* schema:CollegeOrUniversity ." +
        "    ?superclass rdfs:label ?superclassName ." +
        "    FILTER ( ?superclass != schema:CollegeOrUniversity )"+
        " }" ;
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScCom
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?superclassName  WHERE {
[superclassName="EducationalOrganization"]
[superclassName="CivicStructure"]
[superclassName="Organization"]
[superclassName="Place"]
[superclassName="Thing"]
```

Alternative Query (with same result)

```
// (Alternative approach) Find all the superclasses of class CollegeOrUniversity.
String queryString6_1 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?className (GROUP_CONCAT(?superclassName; separator=',') AS ?superclassNames) " +
        " WHERE { " +
        "    schema:CollegeOrUniversity rdfs:label ?className ." +
        "    ?superclass ^rdfs:subClassOf* schema:CollegeOrUniversity ." +
        "    ?superclass rdfs:label ?superclassName ." +
        "    FILTER ( ?superclass != schema:CollegeOrUniversity )" +
        " } GROUP BY ?className " ;
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScComputerScience/Fall2022/KnowledgeTechnologies/eclipse/plugins/org.eclipse
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?className (GROUP_CONCAT(?superclassName; separator=',') AS ?superclassNames)  WHERE {
[className="CollegeOrUniversity";superclassNames="EducationalOrganization,CivicStructure,Organization,Place,Thing"]
```

Question 7

The third question without the use of inference.

Query

```
// Find all properties defined for the class CollegeOrUniversity together with all the properties inherited by its superclasses.
// WITHOUT INFERENCE
String queryString7 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT DISTINCT ?superclassName ?property ?propertyValue " +
        " WHERE { " +
        "    schema:CollegeOrUniversity rdfs:subClassOf* ?superclass ." +
        "    ?superclass rdfs:label ?superclassName ." +
        "    ?property rdfs:label ?propertyValue ." +
        "    ?property schema:domainIncludes ?superclass ." +
        "    FILTER ( ?property not in ( rdf:type ) )" +
        " } ORDER BY ASC(?superclassName) ASC(?property)" ;
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScComputerScience/Fall2022/KnowledgeTechnologies/eclipse/plugins/org.eclipse.ju
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT DISTINCT ?superclassName ?property ?propertyValue  WHERE {        schema:CollegeOrUniversity
[property=https://schema.org/openingHours;propertyValue="openingHours";superclassName="CivicStructure"]
[property=https://schema.org/alumni;propertyValue="alumni";superclassName="EducationalOrganization"]
[property=https://schema.org/actionableFeedbackPolicy;propertyValue="actionableFeedbackPolicy";superclassName="Organization"]
[property=https://schema.org/address;propertyValue="address";superclassName="Organization"]
[property=https://schema.org/aggregateRating;propertyValue="aggregateRating";superclassName="Organization"]
[property=https://schema.org/alumni;propertyValue="alumni";superclassName="Organization"]
[property=https://schema.org/areaServed;propertyValue="areaServed";superclassName="Organization"]
[property=https://schema.org/award;propertyValue="award";superclassName="Organization"]
[property=https://schema.org/awards;propertyValue="awards";superclassName="Organization"]
[property=https://schema.org/brand;propertyValue="brand";superclassName="Organization"]
[property=https://schema.org/contactPoint;propertyValue="contactPoint";superclassName="Organization"]
[property=https://schema.org/contactPoints;propertyValue="contactPoints";superclassName="Organization"]
[property=https://schema.org/correctionsPolicy;propertyValue="correctionsPolicy";superclassName="Organization"]
[property=https://schema.org/department;propertyValue="department";superclassName="Organization"]
[property=https://schema.org/dissolutionDate;propertyValue="dissolutionDate";superclassName="Organization"]
[property=https://schema.org/diversityPolicy;propertyValue="diversityPolicy";superclassName="Organization"]
[property=https://schema.org/diversityStaffingReport;propertyValue="diversityStaffingReport";superclassName="Organization"]
[property=https://schema.org/duns;propertyValue="duns";superclassName="Organization"]
[property=https://schema.org/email;propertyValue="email";superclassName="Organization"]
[property=https://schema.org/employee;propertyValue="employee";superclassName="Organization"]
[property=https://schema.org/employees;propertyValue="employees";superclassName="Organization"]
[property=https://schema.org/ethicsPolicy;propertyValue="ethicsPolicy";superclassName="Organization"]
[property=https://schema.org/event;propertyValue="event";superclassName="Organization"]
[property=https://schema.org/events;propertyValue="events";superclassName="Organization"]
[property=https://schema.org/faxNumber;propertyValue="faxNumber";superclassName="Organization"]
```

Question 8

The fourth question without the use of inference.

Query

```
// Find all classes that are subclasses of class Thing and are found in at most 2 levels of subclass relationships away from Thing.
// WITHOUT INFERENCE
String queryString8 =
        " PREFIX schema: <https://schema.org/>" +
        " SELECT ?sub_level_one_name ?sub_level_two_name" +
        " WHERE { " +
        "     ?type rdfs:subClassOf schema:Thing ." +
        "     ?type rdfs:label ?sub_level_one_name ." +
        "     OPTIONAL { ?type_levelOne rdfs:subClassOf ?type ." +
        "                ?type_levelOne rdfs:label ?sub_level_two_name . }" +
        "     FILTER ( ?type != schema:Thing )" +
        " } ORDER BY ASC(?sub_level_one_name)";
```

Result

```
<terminated> TestWithRDFS [Java Application] /home/nspanos/Documents/MScComputerScience/Fall2022/Knowled
Repository loaded
Query:
 PREFIX schema: <https://schema.org/> SELECT ?sub_level_one_name ?sub_level_two_name WHERE {
[sub_level_one_name="Action";sub_level_two_name="ConsumeAction"]
[sub_level_one_name="Action";sub_level_two_name="SolveMathAction"]
[sub_level_one_name="Action";sub_level_two_name="AchieveAction"]
[sub_level_one_name="Action";sub_level_two_name="TradeAction"]
[sub_level_one_name="Action";sub_level_two_name="SearchAction"]
[sub_level_one_name="Action";sub_level_two_name="InteractAction"]
[sub_level_one_name="Action";sub_level_two_name="ControlAction"]
[sub_level_one_name="Action";sub_level_two_name="OrganizeAction"]
[sub_level_one_name="Action";sub_level_two_name="FindAction"]
[sub_level_one_name="Action";sub_level_two_name="SeekToAction"]
[sub_level_one_name="Action";sub_level_two_name="TransferAction"]
[sub_level_one_name="Action";sub_level_two_name="CreateAction"]
[sub_level_one_name="Action";sub_level_two_name="PlayAction"]
[sub_level_one_name="Action";sub_level_two_name="MoveAction"]
[sub_level_one_name="Action";sub_level_two_name="AssessAction"]
[sub_level_one_name="Action";sub_level_two_name="UpdateAction"]
[sub_level_one_name="BioChemEntity";sub_level_two_name="Gene"]
[sub_level_one_name="BioChemEntity";sub_level_two_name="MolecularEntity"]
[sub_level_one_name="BioChemEntity";sub_level_two_name="ChemicalSubstance"]
[sub_level_one_name="BioChemEntity";sub_level_two_name="Protein"]
[sub_level_one_name="CreativeWork";sub_level_two_name="MediaReviewItem"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Comment"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Statement"]
[sub_level_one_name="CreativeWork";sub_level_two_name="ComicStory"]
[sub_level_one_name="CreativeWork";sub_level_two_name="SpecialAnnouncement"]
[sub_level_one_name="CreativeWork";sub_level_two_name="PublicationVolume"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Photograph"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Painting"]
[sub_level_one_name="CreativeWork";sub_level_two_name="DefinedTermSet"]
[sub_level_one_name="CreativeWork";sub_level_two_name="ExercisePlan"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Chapter"]
[sub_level_one_name="CreativeWork";sub_level_two_name="HowToDirection"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Blog"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Movie"]
[sub_level_one_name="CreativeWork";sub_level_two_name="MathSolver"]
[sub_level_one_name="CreativeWork";sub_level_two_name="HyperTocEntry"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Code"]
[sub_level_one_name="CreativeWork";sub_level_two_name="ShortStory"]
[sub_level_one_name="CreativeWork";sub_level_two_name="LearningResource"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Legislation"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Guide"]
[sub_level_one_name="CreativeWork";sub_level_two_name="Book"]
[sub_level_one_name="CreativeWork";sub_level_two_name="WebPageElement"]
[sub_level_one_name="CreativeWork";sub_level_two_name="SheetMusic"]
```

Exercise 4

The deliverable of the fourth exercise is an excel spreadsheet included in the project's deliverables folder. Based on the homework description the spreadsheet,

has two tabs -one for each task- named: "Quadruples" (task (i)) and "NL Questions" (task (ii)). The "Quadruples" will have the following columns: Question, Paraphrase (optional), Query, Answer. The "NL Questions" will have two columns: Question, Missing Knowledge (where in the Missing Knowledge column you will add the classes and the properties that would enable the generation of the query).

References - Resources

1. https://www.dbpedia.org/
2. https://dbpedia.org/sparql (SPARQL endpoint of DBPedia)
3. http://www.linkedopendata.gr/dataset (dataset: Greek Administrative Geography)
4. http://geo.linkedopendata.gr/gag/page/id/9186 (Δήμος Αθηναίων)
5. https://schema.org/
6. https://schema.org/docs/full.html (full list of item types of schema.org ontology)
7. https://cgi.di.uoa.gr/~pms509/projects/pemfc_ssn_15_10_22.owl (pem fuel cells ontology)