

4 Implementation of the Catalogue of Linked Data Cube Descriptions

4.1. Overview of the Implementation

The Catalogue of Linked Data Cube Descriptions was implemented as an application of the Virtuoso triple store (Virtuoso 2012b). The db2triples library (Db2triples 2012), a software tool for extracting data from relational databases and loading data into an RDF triple store, was used to triplify the resources from the dimensions that populate the catalogue. This tool reads the R2RML mappings created for each dimension and generated the RDF according with the customized mappings. Db2triples implements R2RML and Direct Mapping standards defined by RDB2RDF Working Group (Malhorta et al. 2012).

The interfaces were developed in Java and using Jena, an open source Semantic Web framework. Virtuoso Jena RDF Data Provider, a fully operational Native Graph Model Storage Provider for the Jena Framework, enables Semantic Web applications written using the Jena RDF Frameworks to directly query the Virtuoso RDF Quad Store (Virtuoso 2012a).

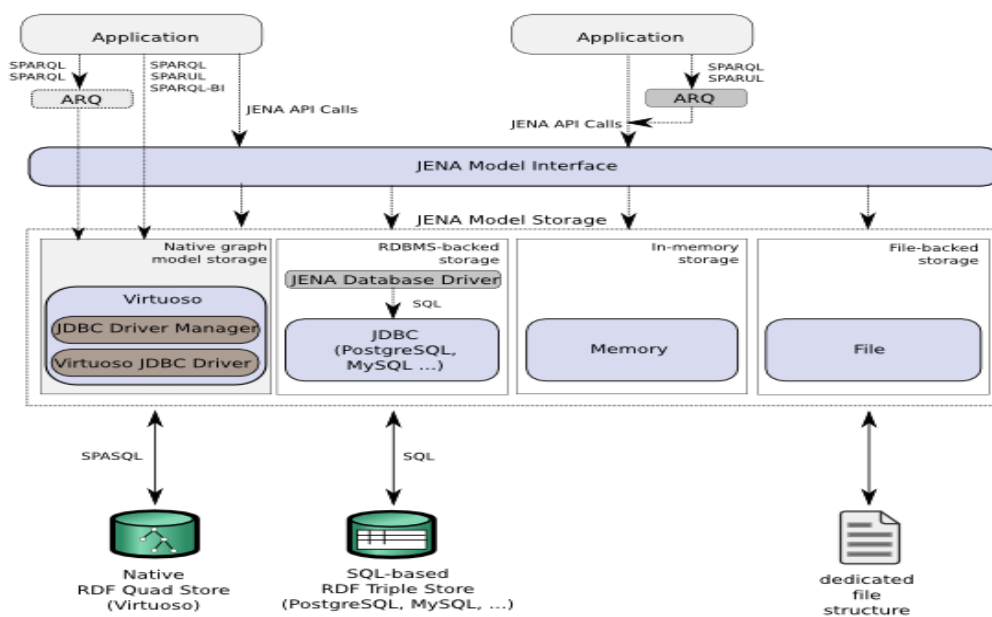


Figure 8 - Architecture of Virtuoso Jena Provider (Virtuoso 2012a)

S	P	O
URI#CHAR	URI#CHAR	ANY
http://purl.org/GovDataCube/resources/dimRegion	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimState	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimYear	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimCountry	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimReligion	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimArea	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimRace	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimAge	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/resources/dimSex	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/properties/numberResidents	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/properties/numberForeigners	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/properties/numberDevotees	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/1999/02/22-rdf-syntax-ns#Property
http://purl.org/GovDataCube/classes/Country	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Religion	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Area	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Race	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Age	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Sex	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Year	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/Region	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/classes/State	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2000/01/rdf-schema#Class
http://purl.org/GovDataCube/resources/dimRegion	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimState	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimYear	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimCountry	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimReligion	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimArea	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimRace	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimAge	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dimSex	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DimensionProperty
http://purl.org/GovDataCube/resources/dataset-residents	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DataSet
http://purl.org/GovDataCube/resources/dataset-foreigners	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DataSet
http://purl.org/GovDataCube/resources/dataset-devotees	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DataSet
http://purl.org/GovDataCube/resources/dsd-residents	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DataStructureDefinition
http://purl.org/GovDataCube/resources/dsd-foreigners	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://purl.org/linked-data/cube#DataStructureDefinition

Figure 9 - RDF triples stored in the catalogue

4.2. Interface

4.2.1. Overview of the Interfaces

The catalogue offers two interfaces, called External and Internal interfaces. The External Interface provides the public description of the data cube chosen by the user through the mediator. If there is interest on the visualization of the data cube, the Internal Interface will give the private information about how to tripify the selected data cube to the mediator, which the mediator uses to actually tripify the data cube, sending the triples to the client application for consumption.

The External Interface offers keyword search to locate data cubes in the catalogue. Figure 10, shows an example of a search made by keyword in the catalogue. Just one cube is retrieved because the word “foreigners” just exist in one of the data cubes.

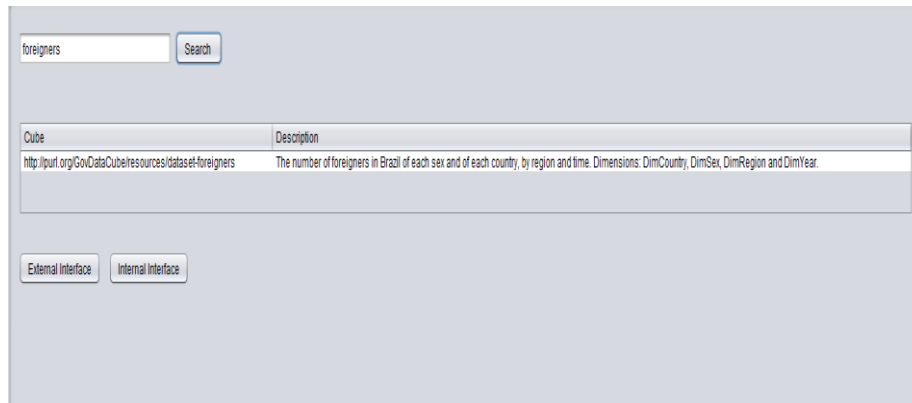


Figure 10 - Cube retrieved for the keyword “foreigners”

Some keywords, as “time”, would retrieve all the data cubes as this word exist in all them, in our running example.

It might be the case that a keyword is introduced and no cube is displayed. This happens when the word does not match any data cube description. A message with that information is shown and the possibility to insert a new keyword and make a new search is given. Figure 11 is an example of this particular case.

It is worth mentioning that, when no keyword is introduced, all cubes are listed.

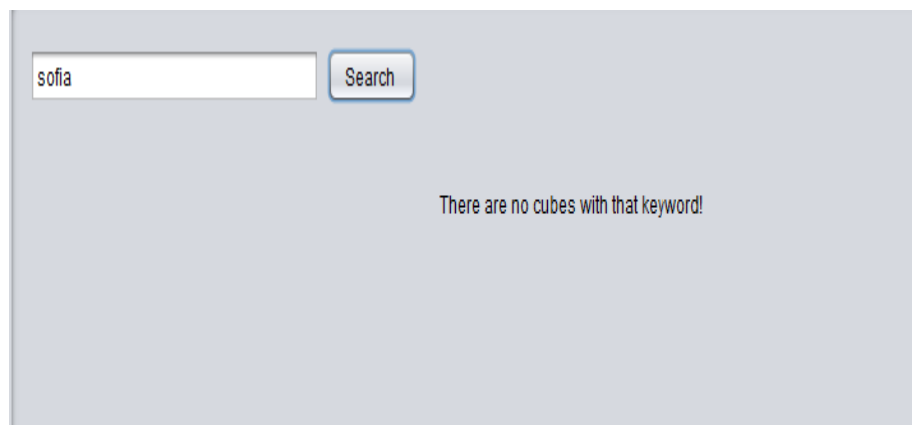


Figure 11 - Message informing that there are no cubes matching the keyword

4.2.2. External Interface

The External Interface or Public Interface provides the metadata about a chosen data cube to the user. These metadata are delivered as a file, in Turtle

format (Beckett et al. 2013), which contains the data cube structure, information about its dimensions and the classes involved.

This application performs SPARQL queries in the catalogue to obtain the desired descriptive RDF triples. The data are delivered to the user by the mediator.

Figure 12 illustrates the output obtained when the External Interface is activated. In this example, the output is related to the cube retrieved for the word “foreigners”.

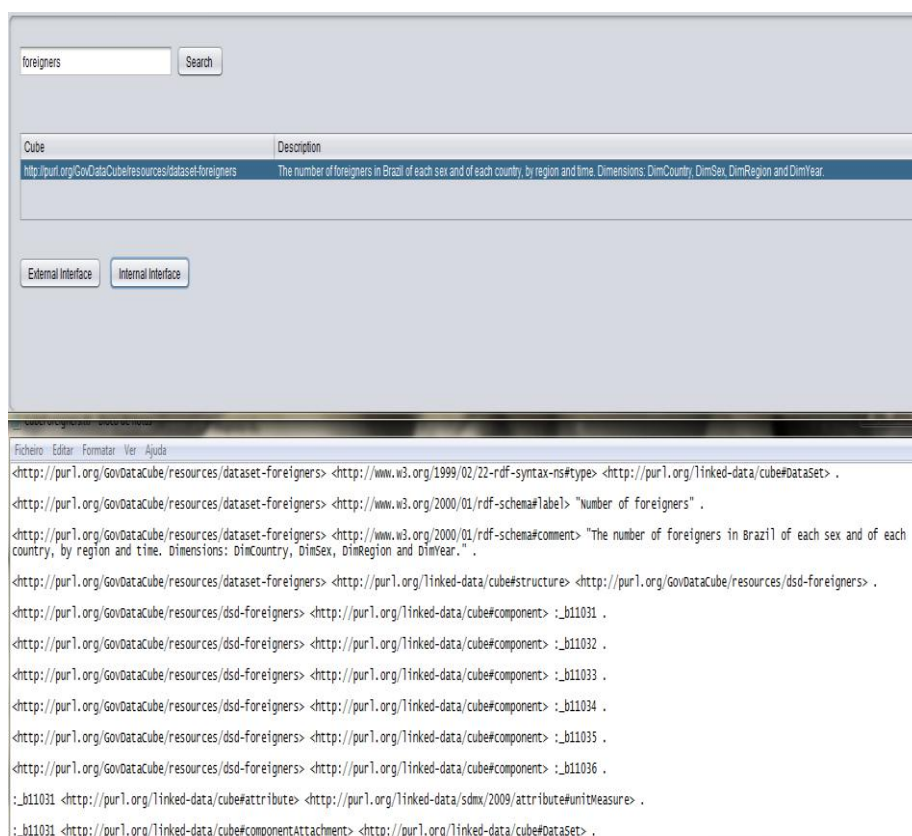


Figure 12 - Output of External Interface for the cube selected

Table 17 illustrates an example of the RDF triples retrieved by this application. The triples exposed describe the Foreigners cube, its structure, description of the dimensions used and the classes related with these dimensions and the description of the measure and attributes.

According to Table 17, the Foreigners cube contains the number of foreigners in Brazil, organized by sex, country of origin, the region they live and the time the data was captured. It also describes its dimensions: DimCountry, DimSex, DimRegion and DimYear and the classes involved in each dimension.

```

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://purl.org/linked-data/cube#DataSet> .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://www.w3.org/2000/01/rdf-schema#label>
"Number of foreigners" .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://www.w3.org/2000/01/rdf-schema#comment>
"The number of foreigners in Brazil of each sex and of each country, by region and time. Dimensions:
DimCountry, DimSex, DimRegion and DimYear." .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#structure>
<http://purl.org/GovDataCube/resources/dsd-foreigners> .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#component>
:_b11031 .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#component>
:_b11032 .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#component>
:_b11033 .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#component>
:_b11034 .

<http://purl.org/GovDataCube/resources/dataset-foreigners>

```

```

<http://purl.org/linked-data/cube#component>
:_b11035 .

<http://purl.org/GovDataCube/resources/dataset-foreigners>
<http://purl.org/linked-data/cube#component>
:_b11036 .

:_b11031
<http://purl.org/linked-data/cube#attribute>
<http://purl.org/linked-data/sdmx/2009/attribute#unitMeasure> .

:_b11031
<http://purl.org/linked-data/cube# componentAttachment >
<http://purl.org/linked-data/cube#DataSet> .

:_b11032
<http://purl.org/linked-data/cube#measure>
<http://purl.org/GovDataCube/properties/numberForeigners> .

:_b11033
<http://purl.org/linked-data/cube#dimension>
<http://purl.org/GovDataCube/resources/dimYear> .

:_b11034
<http://purl.org/linked-data/cube#dimension>
<http://purl.org/GovDataCube/resources/dimSex> .

:_b11035
<http://purl.org/linked-data/cube#dimension>
<http://purl.org/GovDataCube/resources/dimCountry> .

:_b11036
<http://purl.org/linked-data/cube#dimension>
<http://purl.org/GovDataCube/resources/dimRegion> .

```

<http://purl.org/GovDataCube/properties/numberForeigners>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#Property> .

<http://purl.org/GovDataCube/properties/numberForeigners>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://purl.org/linked-data/cube #MeasureProperty> .

<http://purl.org/GovDataCube/properties/numberForeigners>

<http://www.w3.org/2000/01/rdf-schema#label>

"number of foreigners" .

<http://purl.org/GovDataCube/properties/numberForeigners>

<http://www.w3.org/2000/01/rdf-schema#range>

<http://www.w3.org/2001/XMLSchema#integer> .

<http://purl.org/GovDataCube/properties/numberForeigners>

<http://www.w3.org/2000/01/rdf-schema#subPropertyOf>

<http://purl.org/linked-data/sdmx/2009/measure#obsValue> .

<http://purl.org/GovDataCube/resources/dimRegion>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#Property> .

<http://purl.org/GovDataCube/resources/dimRegion>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://purl.org/linked-data/cube#DimensionProperty> .

<http://purl.org/GovDataCube/resources/dimRegion>

<http://www.w3.org/2000/01/rdf-schema#label>

"dimension Region" .

<http://purl.org/GovDataCube/resources/dimRegion>

```

<http://www.w3.org/2000/01/rdf-schema#range>
<http://purl.org/GovDataCube/classes/Region> .

<http://purl.org/GovDataCube/resources/dimRegion>
<http://purl.org/linked-data/cube#concept>
<http://purl.org/linked-data/sdmx/2009/concept#refArea> .

<http://purl.org/GovDataCube/resources/dimRegion>
<http://www.w3.org/2000/01/rdf-schema#subPropertyOf>
<http://purl.org/linked-data/sdmx/2009/dimension#refArea> .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#Property> .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://purl.org/linked-data/cube#DimensionProperty> .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://www.w3.org/2000/01/rdf-schema#label>
"dimension Country" .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://www.w3.org/2000/01/rdf-schema#range>
<http://purl.org/GovDataCube/classes/Country> .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://purl.org/linked-data/cube#concept>
<http://purl.org/linked-data/sdmx/2009/concept#refArea> .

<http://purl.org/GovDataCube/resources/dimCountry>
<http://www.w3.org/2000/01/rdf-schema#subPropertyOf>
<http://purl.org/linked-data/sdmx/2009/dimension#refArea> .

```



```
<http://purl.org/GovDataCube/resources/dimSex>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#Property> .

<http://purl.org/GovDataCube/resources/dimSex>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://purl.org/linked-data/cube#DimensionProperty> .

<http://purl.org/GovDataCube/resources/dimSex>
<http://www.w3.org/2000/01/rdf-schema#label>
"dimension Sex" .

<http://purl.org/GovDataCube/resources/dimSex>
<http://www.w3.org/2000/01/rdf-schema#range>
<http://purl.org/GovDataCube/classes/Sex> .

<http://purl.org/GovDataCube/resources/dimYear>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#Property> .

<http://purl.org/GovDataCube/resources/dimYear>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://purl.org/linked-data/cube#DimensionProperty> .

<http://purl.org/GovDataCube/resources/dimYear>
<http://www.w3.org/2000/01/rdf-schema#label>
"dimension Year" .

<http://purl.org/GovDataCube/resources/dimYear>
<http://www.w3.org/2000/01/rdf-schema#range>
<http://purl.org/GovDataCube/classes/Year> .

<http://purl.org/GovDataCube/resources/dimYear>
```

```
<http://purl.org/linked-data/cube#concept>
<http://purl.org/linked-data/sdmx/2009/concept#refTime> .

<http://purl.org/GovDataCube/resources/dimRegion>
<http://www.w3.org/2000/01/rdf-schema#subPropertyOf>
<http://purl.org/linked-data/sdmx/2009/dimension#refTime> .

<http://purl.org/GovDataCube/classes/Region>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/2000/01/rdf-schema#Class> .

<http://purl.org/GovDataCube/classes/Region>
<http://www.w3.org/2000/01/rdf-schema#label>
"Region" .

<http://purl.org/GovDataCube/classes/Region>
<http://www.w3.org/2000/01/rdf-schema#comment>
"Represents a region" .

<http://purl.org/GovDataCube/classes/Country>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/2000/01/rdf-schema#Class> .

<http://purl.org/GovDataCube/classes/Country>
<http://www.w3.org/2000/01/rdf-schema#label>
"Country" .

<http://purl.org/GovDataCube/classes/Country>
<http://www.w3.org/2000/01/rdf-schema#comment>
"Represents a country" .

<http://purl.org/GovDataCube/classes/Sex>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/2000/01/rdf-schema#Class> .
```

```

<http://purl.org/GovDataCube/classes/Sex>
<http://www.w3.org/2000/01/rdf-schema#label>
"Sex" .

<http://purl.org/GovDataCube/classes/Sex>
<http://www.w3.org/2000/01/rdf-schema#comment>
"Represents a sex gender" .

<http://purl.org/GovDataCube/classes/Year>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/2000/01/rdf-schema#Class> .

<http://purl.org/GovDataCube/classes/Year>
<http://www.w3.org/2000/01/rdf-schema#label>
"Year" .

<http://purl.org/GovDataCube/classes/Year>
<http://www.w3.org/2000/01/rdf-schema#comment>
"Represents a year" .

```

Table 1 - RDF Triples retrieved by the External Interface about the Cube Foreigners

4.2.3. Internal Interface

The Internal Interface or Private Interface provides the metadata about the connection to the RDBs and the R2RML mappings of the data cubes and their dimensions.

This application, most in the same way as the External Interface, performs SPARQL queries in the Catalogue to obtain the desired information about a data cube. The data is retrieved in Turtle format (Beckett et al. 2013) and passed as a file to the mediator, providing the necessary information to triplify the data cube.

Figure 13 illustrates the output obtained when the Internal Interface is activated. In this example, the output is related to the cube retrieved for the word “foreigners”.

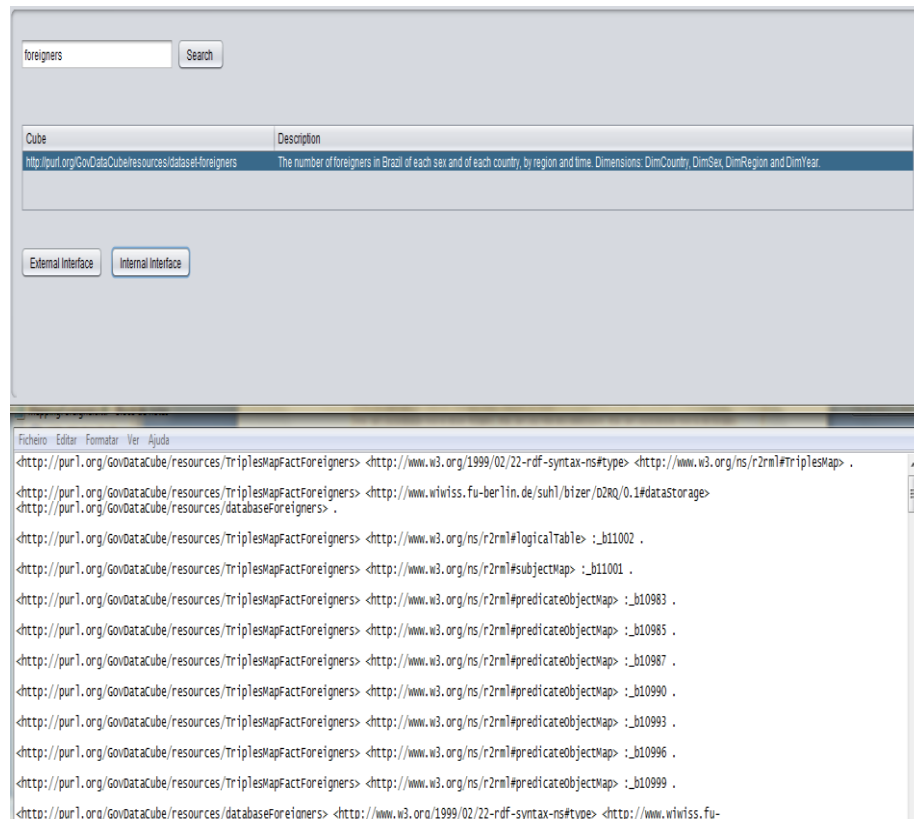


Figure 13 - Output of Internal Interface for the cube selected

Table 18 displays an example of the RDF triples retrieved by this application. This example details the R2RML mappings of the Foreigners cube and the mappings of its dimensions, providing the information about the connections to the underlying RDBs. The Foreigners cube connects to three different RDBs, as indicated by the three different connections shown (different connections mean different RDBs).

The R2RML mapping of the dimension Country has the connection <http://purl.org/GovDataCube/resources/databaseForeigners>, the R2RML mapping of the dimension Region has the connection <http://purl.org/GovDataCube/resources/databaseDevotees> and the R2RML mappings of the dimension Year and dimension Sex have the connection <http://purl.org/GovDataCube/resources/databaseResidents>.

The descriptions of the R2RML mappings also provide, through the SQL Query, how the information is stored in the RDBs.

This set of triples, provided by the Internal Interface, conveys all information that is needed by the mediator to triplify the observations of the Foreigners cube.

```
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>  
<http://www.w3.org/ns/r2rml#TriplesMap> .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#dataStorage>  
<http://purl.org/GovDataCube/resources/databaseForeigners> .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#logicalTable>  
:_b11002 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#subjectMap>  
:_b11001 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#predicateObjectMap>  
:_b10983 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#predicateObjectMap>  
:_b10985 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#predicateObjectMap>  
:_b10987 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#predicateObjectMap>  
:_b10990 .  
  
<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>  
<http://www.w3.org/ns/r2rml#predicateObjectMap>  
:_b10993 .
```

```

<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>
<http://www.w3.org/ns/r2rml#predicateObjectMap>
:_b10996 .

<http://purl.org/GovDataCube/resources/TriplesMapFactForeigners>
<http://www.w3.org/ns/r2rml#predicateObjectMap>
:_b10999 .

<http://purl.org/GovDataCube/resources/databaseForeigners>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#Database> .

<http://purl.org/GovDataCube/resources/databaseForeigners>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#username>
"root" .

<http://purl.org/GovDataCube/resources/databaseForeigners>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#password>
"root" .

<http://purl.org/GovDataCube/resources/databaseForeigners>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDSN>
"jdbc:mysql://localhost/project2" .

<http://purl.org/GovDataCube/resources/databaseForeigners>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDriver>
"com.mysql.jdbc.Driver" .

:_b11002
<http://www.w3.org/ns/r2rml#sqlQuery>
"SELECT DISTINCT idRegionLive, idCountryBorn, idPerson, idTime, numberForeigners
FROM factForeigners WHERE idRegionLive<>1 AND numberForeigners<>0" .

:_b11001

```

```

<http://www.w3.org/ns/r2rml#template>

"http://purl.org/GovDataCube/resources/Observations/{idRegionLive}_{idCountryBorn}_{idPerson}_{idTime}_{nu
mberForeigners}" .

:_b11001

<http://www.w3.org/ns/r2rml#class>

<http://purl.org/linked-data/cube#Observation> .

:_b10983

<http://www.w3.org/ns/r2rml#predicate>

<http://purl.org/linked-data/sdmx/2009/attribute#unitMeasure> .

:_b10983

<http://www.w3.org/ns/r2rml#objectMap>

:_b10984 .

:_b10985

<http://www.w3.org/ns/r2rml#predicate>

<http://purl.org/GovDataCube/properties/numberForeigners> .

:_b10985

<http://www.w3.org/ns/r2rml#objectMap>

:_b10986 .

:_b10987

<http://www.w3.org/ns/r2rml#predicate>

<http://purl.org/GovDataCube/resources/dimYear> .

:_b10987

<http://www.w3.org/ns/r2rml#objectMap>

:_b10988 .

:_b10990

<http://www.w3.org/ns/r2rml#predicate>

<http://purl.org/GovDataCube/resources/dimSex> .

```

:_b10990
<http://www.w3.org/ns/r2rml#objectMap>
:_b10991 .

:_b10993
<http://www.w3.org/ns/r2rml#predicate>
<http://purl.org/GovDataCube/resources/dimCountry> .

:_b10993
<http://www.w3.org/ns/r2rml#objectMap>
:_b10994 .

:_b10996
<http://www.w3.org/ns/r2rml#predicate>
<http://purl.org/GovDataCube/resources/dimRegion> .

:_b10996
<http://www.w3.org/ns/r2rml#objectMap>
:_b10997 .

:_b10999
<http://www.w3.org/ns/r2rml#predicate>
<http://purl.org/linked-data/cube#dataSet> .

:_b10999
<http://www.w3.org/ns/r2rml#objectMap>
:_b11000 .

:_b10984
<http://www.w3.org/ns/r2rml#constant>
<http://dbpedia.org/ontology/Person> .

:_b10986
<http://www.w3.org/ns/r2rml#column>

"numberForeigners" .

:_b10988

<http://www.w3.org/ns/r2rml#parentTriplesMap>

<http://purl.org/GovDataCube/resources/TriplesMapYear> .

:_b10988

<http://www.w3.org/ns/r2rml#joinCondition>

:_b10989 .

:_b10991

<http://www.w3.org/ns/r2rml#parentTriplesMap>

<http://purl.org/GovDataCube/resources/TriplesMapSex> .

:_b10991

<http://www.w3.org/ns/r2rml#joinCondition>

:_b10992 .

:_b10994

<http://www.w3.org/ns/r2rml#parentTriplesMap>

<http://purl.org/GovDataCube/resources/TriplesMapCountry> .

:_b10994

<http://www.w3.org/ns/r2rml#joinCondition>

:_b10995 .

:_b10997

<http://www.w3.org/ns/r2rml#parentTriplesMap>

<http://purl.org/GovDataCube/resources/TriplesMapRegion> .

:_b10997

<http://www.w3.org/ns/r2rml#joinCondition>

:_b10998 .

:_b11000

```
<http://www.w3.org/ns/r2rml#constant>
<http://purl.org/GovDataCube/resources/dataset-foreigners> .

:_b10989
<http://www.w3.org/ns/r2rml#child>
"endTime" .

:_b10989
<http://www.w3.org/ns/r2rml#parent>
"endTime" .

:_b10992
<http://www.w3.org/ns/r2rml#child>
"idPerson" .

:_b10992
<http://www.w3.org/ns/r2rml#parent>
"idPerson" .

:_b10995
<http://www.w3.org/ns/r2rml#child>
"idCountryBorn" .

:_b10995
<http://www.w3.org/ns/r2rml#parent>
"idCountry" .

:_b10998
<http://www.w3.org/ns/r2rml#child>
"idRegionLive" .

:_b10998
<http://www.w3.org/ns/r2rml#parent>
"idRegion" .
```

```

<http://purl.org/GovDataCube/resources/TriplesMapRegion>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/r2rml#TriplesMap> .

<http://purl.org/GovDataCube/resources/TriplesMapRegion>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#dataStorage>
<http://purl.org/GovDataCube/resources/databaseDevotees> .

<http://purl.org/GovDataCube/resources/TriplesMapRegion>
<http://www.w3.org/ns/r2rml#logicalTable>
:_b10937 .

<http://purl.org/GovDataCube/resources/TriplesMapRegion>
<http://www.w3.org/ns/r2rml#subjectMap>
:_b10936 .

<http://purl.org/GovDataCube/resources/TriplesMapRegion>
<http://www.w3.org/ns/r2rml#predicateObjectMap>
:_b10934 .

<http://purl.org/GovDataCube/resources/databaseDevotees>
<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#Database> .

<http://purl.org/GovDataCube/resources/databaseDevotees>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#username>
"root" .

<http://purl.org/GovDataCube/resources/databaseDevotees>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#password>
"root" .

<http://purl.org/GovDataCube/resources/databaseDevotees>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDSN>
"jdbc:mysql://localhost/project3" .

```

```
<http://purl.org/GovDataCube/resources/databaseDevotees>
<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDriver>
"com.mysql.jdbc.Driver" .

:_b10937
<http://www.w3.org/ns/r2rml#sqlQuery>
"SELECT DISTINCT md5(region) as region_md5, region, idRegion
FROM dimregion WHERE region IS NOT NULL" .

:_b10936
<http://www.w3.org/ns/r2rml#template>
"http://purl.org/GovDataCube/resources/Region/{region_md5}" .

:_b10936
<http://www.w3.org/ns/r2rml#class>
<http://purl.org/GovDataCube/classes/Region> .

:_b10934
<http://www.w3.org/ns/r2rml#predicate>
<http://www.w3.org/2000/01/rdf-schema#label> .

:_b10934
<http://www.w3.org/ns/r2rml#objectMap>
:_b10935 .

:_b10935
<http://www.w3.org/ns/r2rml#column>
"region" .

:_b10935
<http://www.w3.org/ns/r2rml#language>
"pt" .

<http://purl.org/GovDataCube/resources/TriplesMapCountry>
```

```

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://www.w3.org/ns/r2rml#TriplesMap> .

<http://purl.org/GovDataCube/resources/TriplesMapCountry>
<http://www.wiiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#dataStorage>
<http://purl.org/GovDataCube/resources/databaseForeigners> .

<http://purl.org/GovDataCube/resources/TriplesMapCountry>
<http://www.w3.org/ns/r2rml#logicalTable>
:_b10965 .

<http://purl.org/GovDataCube/resources/TriplesMapCountry>
<http://www.w3.org/ns/r2rml#subjectMap>
:_b10964 .

<http://purl.org/GovDataCube/resources/TriplesMapCountry>
<http://www.w3.org/ns/r2rml#predicateObjectMap>
:_b10962 .

:_b10965
<http://www.w3.org/ns/r2rml#sqlQuery>
"SELECT md5(portugueseName) as country_md5, portugueseName, idCountry
FROM dimCountry WHERE portugueseName IS NOT NULL" .

:_b10964
<http://www.w3.org/ns/r2rml#template>
"http://purl.org/GovDataCube/resources/Country/{country_md5}" .

:_b10964
<http://www.w3.org/ns/r2rml#class>
<http://purl.org/GovDataCube/classes/Country> .

:_b10962
<http://www.w3.org/ns/r2rml#predicate>
<http://www.w3.org/2000/01/rdf-schema#label> .

```

:_b10962

<http://www.w3.org/ns/r2rml#objectMap>

:_b10963 .

:_b10963

<http://www.w3.org/ns/r2rml#column>

"portugueseName" .

:_b10963

<http://www.w3.org/ns/r2rml#language>

1"pt" .

<http://purl.org/GovDataCube/resources/TriplesMapYear>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://www.w3.org/ns/r2rml#TriplesMap> .

<http://purl.org/GovDataCube/resources/TriplesMapYear>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#dataStorage>

<http://purl.org/GovDataCube/resources/databaseResidents> .

<http://purl.org/GovDataCube/resources/TriplesMapYear>

<http://www.w3.org/ns/r2rml#logicalTable>

:_b10941 .

<http://purl.org/GovDataCube/resources/TriplesMapYear>

<http://www.w3.org/ns/r2rml#subjectMap>

:_b10940 .

<http://purl.org/GovDataCube/resources/TriplesMapYear>

<http://www.w3.org/ns/r2rml#predicateObjectMap>

:_b10938 .

<http://purl.org/GovDataCube/resources/databaseResidents>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#Database> .

<http://purl.org/GovDataCube/resources/databaseResidents>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#username>

"root" .

<http://purl.org/GovDataCube/resources/databaseResidents>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#password>

"root" .

<http://purl.org/GovDataCube/resources/databaseResidents>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDSN>

"jdbc:mysql://localhost/project1" .

<http://purl.org/GovDataCube/resources/databaseResidents>

<http://www.wiwiss.fu-berlin.de/suhl/bizer/D2RQ/0.1#jdbcDriver>

"com.mysql.jdbc.Driver" .

:_b10941

<http://www.w3.org/ns/r2rml#sqlQuery>

"SELECT DISTINCT md5(year) as year_md5, year, idTime

FROM dimtime WHERE year IS NOT NULL" .

:_b10940

<http://www.w3.org/ns/r2rml#template>

"http://purl.org/GovDataCube/resources/Year/{year_md5}" .

:_b10940

<http://www.w3.org/ns/r2rml#class>

<http://purl.org/GovDataCube/classes/Year> .

:_b10938

<http://www.w3.org/ns/r2rml#predicate>

<http://www.w3.org/2000/01/rdf-schema#label> .

:_b10938

<http://www.w3.org/ns/r2rml#objectMap>

:_b10939 .

:_b10939

<http://www.w3.org/ns/r2rml#column>

"year" .

:_b10939

<http://www.w3.org/ns/r2rml#datatype>

<http://www.w3.org/2001/XMLSchema#string> .

<http://purl.org/GovDataCube/resources/TriplesMapSex>

<http://www.w3.org/1999/02/22-rdf-syntax-ns#type>

<http://www.w3.org/ns/r2rml#TriplesMap> .

<http://purl.org/GovDataCube/resources/TriplesMapSex>

<http://www.wiwiw.fu-berlin.de/suhl/bizer/D2RQ/0.1#dataStorage>

<http://purl.org/GovDataCube/resources/databaseResidents> .

<http://purl.org/GovDataCube/resources/TriplesMapSex>

<http://www.w3.org/ns/r2rml#logicalTable>

:_b10945 .

<http://purl.org/GovDataCube/resources/TriplesMapSex>

<http://www.w3.org/ns/r2rml#subjectMap>

:_b10944 .

<http://purl.org/GovDataCube/resources/TriplesMapSex>

<http://www.w3.org/ns/r2rml#predicateObjectMap>

:_b10942 .

:_b10945

<http://www.w3.org/ns/r2rml#sqlQuery>

"SELECT DISTINCT md5(sex) as sex_md5, sex, idPerson


```

FROM dimperson WHERE sex IS NOT NULL" .

:_b10944
<http://www.w3.org/ns/r2rml#template>
"http://purl.org/GovDataCube/resources/Sex/{sex_md5}" .

:_b10944
<http://www.w3.org/ns/r2rml#class>
<http://purl.org/GovDataCube/classes/Sex> .

:_b10942
<http://www.w3.org/ns/r2rml#predicate>
<http://www.w3.org/2000/01/rdf-schema#label> .

:_b10942
<http://www.w3.org/ns/r2rml#objectMap>

:_b10943 .

:_b10943
<http://www.w3.org/ns/r2rml#column>
"sex" .

:_b10943
<http://www.w3.org/ns/r2rml#language>
"pt" .

```

Table 2 - RDF Triples retrieved by the Internal Interface about the Cube Foreigners

4.3. Summary of Chapter 4

This chapter explained the implementation details and the functionalities of the Internal and the External Interfaces of the Catalogue of Linked Data Cube Descriptions. Examples of the catalogue outputs were also given to allow a better understanding of the process described.