Ontology-based Access to Streaming Data

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Abstract. The availability of streaming data sources is progressively increasing thanks to the deployment of ubiquitous data capturing technologies such as sensor networks. We present an ontology-based streaming data access service, based on extensions to the $\mathsf{R_2O}$ mapping language and its query processor ODEMapster, and to the C-SPARQL RDF stream query language. A preliminary implementation of the approach is also presented. With this proposal we expect to set the basis for future efforts in ontology-based streaming data integration.

1 Ontology-based Streaming Data Access

Our approach consists in creating an Ontology-based Streaming Data Access service, depicted in Fig 1. The service receives $\text{SPARQL}_{\text{STR}}$ queries specified in terms of an ontology. Then the original query is transformed into queries in terms of the sources (*query canonisation*), using a set of $\mathsf{S_2O}$ mappings. These are based on the $\mathsf{R_2O}$ mapping language, which has been extended to support streaming queries and data, most notably window and stream operators. The transformed queries are written in a continuous query language (e.g. SNEEql), that is expressive enough to deal with both streaming and stored sources, and to apply window, aggregates and window-to-stream operations.

Afterwards, the query processing phase starts to extract the relevant data from the sources and perform the required operations. The result of the query processing will be a set of tuples that will be passed to a *data decanonisation* process, which will transform these tuples to ontology instances.

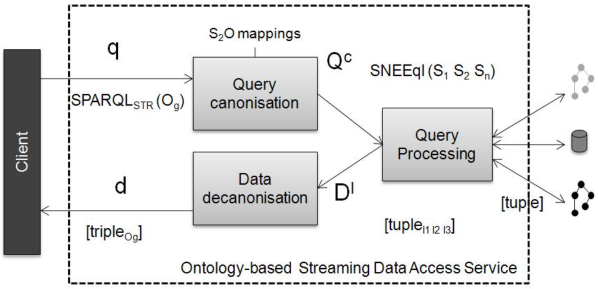
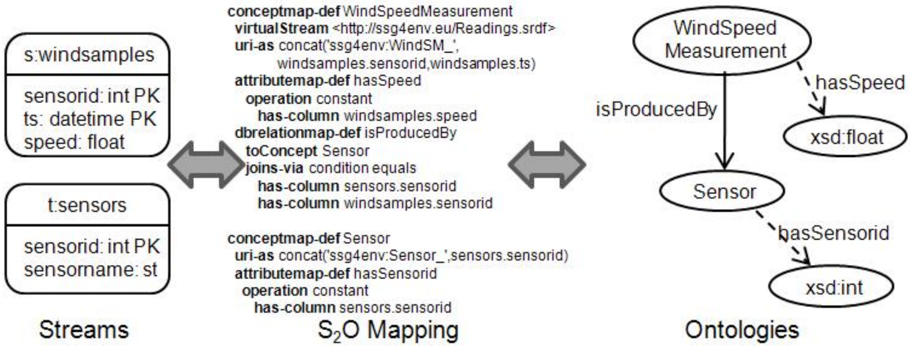


Fig. 1. Ontology-based Streaming Data Access service

2 Implementation

This approach has been implemented as an extension to the ODEMapster processor [2]. This implementation generates queries that can be executed by the SNEE streaming query processor using the SNEEql query language [3].

In the example, consider a stream `windsamples` and a table `sensors`, and the $\mathsf{S_2O}$mapping to a *WindSpeedMeasurement* concept:



```
conceptmap-def WindSpeedMeasurement
 virtualStream <http://ssg4env.eu/Readings.srdf>
 uri-as concat('ssg4env:WindSM_',
        windsamples.sensorid,windsamples.ts)
 attributemap-def hasSpeed
  operation constant
   has-column windsamples.speed
 dbrelationmap-def isProducedBy
  toConcept Sensor
  joins-via condition equals
   has-column sensors.sensorid
   has-column windsamples.sensorid

conceptmap-def Sensor
 uri-as concat('ssg4env:Sensor_',sensors.sensorid)
 attributemap-def hasSensorid
  operation constant
   has-column sensors.sensorid
```

Fig. 2. $\mathsf{S_2O}$ mapping from stream to ontologies

Now we can pose a query over the ontology using $\mathrm{SPARQL_{STR}}$ for example to obtain the wind speed measurements taken in the last 10 minutes:

```
PREFIX fire: <http://www.ssg4env.eu#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?speed
FROM STREAM <www.ssg4env.eu/SensorReadings.srdf> [RANGE 10 MINUTE STEP 1 MINUTE]
WHERE { ?WindSpeed a fire:WindSpeedMeasurement; fire:hasSpeed ?speed;}
```

The query atoms $WindSpeedMeasurement(x)$ and $hasSpeed(x, z)$ can be extracted from the $\mathrm{SPARQL_{STR}}$ query. The window specification is also obtained. As it is defined in the $\mathsf{S_2O}$ mapping the $WindSpeedMeasurement$ instances are generated based on the `sensorid` and `ts` attributes of the `windsamples` stream. Similarly the $\mathsf{S_2O}$ mapping defines that *hasSpeed* properties are generated from the values of the speed attribute of the `windsamples` stream. The query generated in the SNEEql language is the following:

```
SELECT RSTREAM concat('http://ssg4env.eu#WindSM',windsensor.id,windsensor.ts )
as  id ,( windsamples.speed ) as  speed
FROM windsamples[FROM NOW - 10 MINUTE]
```

References

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2. Barrasa, J., Óscar Corcho, Gómez-Pérez, A.: R2O, an extensible and semantically based database-to-ontology mapping language. In: SWDB2004. (2004) 1069–1070
3. Brenninkmeijer, C.Y., Galpin, I., Fernandes, A.A., Paton, N.W.: A semantics for a query language over sensors, streams and relations. In: BNCOD '08. (2008) 87–99