Comparing Vocabularies for Representing Geographical Features and Their Geometry

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Abstract. The need for geolocation is crucial for many applications for both human and software agents. More and more data is opened and interlinked using Linked Data principles, and it is worth modeling geographic data efficiently by reusing as much as possible from existing ontologies or vocabularies that describe both the geospatial features and their shapes. In this paper, we survey different modeling approaches used by the Geographic Information System (GIS) and the Linked Open Data (LOD) communities. Our aim is to contribute to the actual efforts in representing geographic objects with attributes such as location, points of interest (POI) and addresses in the web of data. We focus on the French territory and we provide examples of representative vocabularies that can be used for describing geographic objects. We propose some alignments between various vocabularies (DBpedia, Geonames, Schema.org, LinkedGeoData, Foursquare, etc.) in order to enable interoperability while interconnecting French geodata with other datasets. We tackle the complex geometry representation issues in the Web of Data, describing the state of implementations of geo-spatial functions in triple stores and comparing them to the new GeoSPARQL standard. We conclude with some challenges to be taken into account when dealing with the descriptions of complex geometries.

Keywords: Geodata, GeoSPARQL, Geographic information, Schema Alignment, Datalift

1 Introduction

The increasing number of initiatives for sharing geographic information on the web of data has significantly contribute to the interconnection of many data sets exposed as RDF based on the Linked Data principles. Many domains are represented in the web of data (media, events, academic publications, libraries, cultural heritage, life science, government data, etc.) while DBpedia is the most used dataset for interconnection. For many datasets published, geospatial information is required for rendering data on a map. In the current state of the art, different approaches and vocabularies are used to represent the "features" and their geometric shape although the POINT is the most common representation making use of the latitude/longitude properties defined in the W3C Geo vocabulary. Other geometries from the OpenGIS standard (POLYGON, LINESTRING, etc.) are more rarely exploited (e.g. LinkedGeoData, GeoLinkedData) while fine-grained geometry representations are often required.

In France, the National Geographic Institute (IGN) has started to publish more and more data in RDF, as illustrated by the recent experimental LOD service `http://data.ign.fr`. IGN maintains large databases composed of descriptions of addresses, buildings, topographic information, occupied zones, etc. A few years ago, IGN has developed a core ontology named GeOnto for describing all types of buildings located in the French territory. Integrating these databases will enable answering more complex queries than current GIS systems can handle, such as: "*show all buildings used as tribunal courts in the 7th Arrondissement of Paris*". Another use-case is the possibility to reason over parts of a structure: "*show the points where the river Seine touches a boundary of a district in Paris that contain an activity zone*".

In this paper, we address some of these uses cases, starting from the selection of the right vocabularies to represent the data and their alignment to ease future dataset interlinking. We first analyze the use of geographical information in the web of data (Section 2). Then, we survey the existing approaches for modeling both the features and their geometries (Section 3). We define the scenario of modeling the 7^{th} arrondissement of Paris to highlight the diversity of these approaches (Section 4). We then propose alignments between vocabularies to describe features or points of interest using GeOnto as our pivot ontology (Section 5). To address geometry modeling, we also survey existing approaches, leading to an extension of GeOnto to support geometry. We look at the triple stores supporting all types of geometry and discuss some challenging issues regarding geodata as the GeoSPARQL[1] standard has recently been adopted by the Open Geospatial Consortium (Section 6). Finally, we give our conclusions and outline future work (Section 7).

2 Geographic information in the Web of Data

2.1 LOD Cloud Review

The recent publication of statistics concerning the actual usage of vocabularies on the LOD cloud[2] provides not only an overview of best practice usage recommended by Tim Berners-Lee[3], but also provides a rapid view of the vocabularies re-used in various datasets and domains. Concerning the geographic domain, the results show that W3C Geo[4] is the most widely used vocabulary, followed by the `spatialrelations`[5] ontology of Ordnance Survey (OS). At the same time, the analysis reveals that the property `geo:geometry` is used in $1,322,302,221$ triples, exceeded only by the properties `rdf:type` ($6,251,467,091$ triples) and

[1] `http://www.opengeospatial.org/standards/geosparql`
[2] `http://stats.lod2.eu`
[3] `http://www.w3.org/DesignIssues/LinkedData.html`
[4] `http://www.w3.org/2003/01/geo/wgs84_pos`
[5] `http://data.ordnancesurvey.co.uk/ontology/spatialrelations`

`rdfs:label`(1, 586, 115, 316 triples). This shows the importance of geodata on the web. Table 1 summarizes the results for four vocabularies (WGS84, OS spatial relation, Geonames ontology and OS admin geography) where the number of datasets using these vocabularies and the actual number of triples are computed.

Ontologies	#Datasets using	#Triples	SPARQL endpoint
W3C Geo	21	15 543 105	LOD cache
OS spatialrelations	10	9 412 167	OS dataset
Geonames ontology	5	8 272 905	LOD cache
UK administrative-geography	3	229 689	OS dataset

Table 1. Statistics on the usage of the four main geographic vocabularies (LOD cache should be understood as `http://lod.openlinksw.com/sparql/`). There are many more vocabularies used in the LOD cloud that contain also geographical information but that are never re-used.

2.2 Geodata Provider and Access

So far, the Web of data has taken advantage of geocoding technologies for publishing large amounts of data. For example, Geonames provides more than 10 millions records (e.g. 5, 240, 032 resources of the form `http://sws.geonames.org/10000/`) while LinkedGeoData has more than 60, 356, 364 triples. All the above mentioned data are diverse in their structure, the access point (SPARQL endpoint, web service or API), the entities they represent and the vocabularies used for describing them. Table 2 summarizes for different providers the number of geodata available (resources, triples) and how the data can be accessed.

Provider	**#Geodata**	**Data access**
DBpedia	727 232 triples	SPARQL endpoint
Geonames	5 240 032 (feature).	API
LinkedGeoData	60 356 364 triples	SPARQL endpoint, Snorql
Foursquare	n/a	API
Freebase	8,5MB	RDF Freebase Service
Ordnance Survey(Cities)	6 295 triples	Talis API
GeoLinkedData.es	101 018 triples	SPARQL endpoint
Google Places	n/a	Google API
GADM project data	682 605 triples	Web Service
NUTS project data	316 238 triples	Web Service
IGN experimental	629 716 triples	SPARQL endpoint

Table 2. Geodata by provider and their different access type

3 Geodata Modeling Approach

3.1 Vocabularies for Features

Modeling of features can be grouped into four categories depending on the structure of the data, the intended purpose of the data modeling, and the (re)-use of other resources.

- (i): One way for structuring the features is to define high level codes (generally using a small finite set of codes) corresponding to specific types. Further, sub-types are attached to those codes in the classification. This approach is used in the Geonames ontology[6] for codes and classes (A, H, L, P, R, S, T, U, V), with each of the letter corresponding to a precise category (e.g: A for administrative borders). Classes are then defined as `gn:featureClass a skos:ConceptScheme`, while codes are `gn:featureCode a skos:Concept`.
- (ii): A second approach consists in defining a complete standalone ontology that does not reuse other vocabularies. A top level class is used under which a taxonomy is formed using the `rdfs:subClassOf` property. The LinkedGeoData ontology[7] follows this approach, where the 1294 classes are built around a nucleus of 16 high-level concepts which are: `Aerialway, Aeroway, Amenity, Barrier, Boundary, Highway, Historic, Landuse, Leisure, ManMade, Natural, Place, Power, Route, Tourism` and `Waterway`. The same approach is used for the French GeOnto ontology (Section 5), which defined two high-level classes `ArtificialTopographyEntity` and `NaturalTopographyEntity` with a total of 783 classes.
- (iii): A third approach consists in defining several smaller ontologies, one for each sub-domain. An ontology network is built with a central ontology used to interconnect the different other ontologies. One obvious advantage of this approach is the modularity of the conceptualizing which should ease as much as possible the reuse of modular ontologies. Ordnance Survey (OS) follows this approach providing ontologies for administrative regions[8], for statistics decomposition[9] and for postal codes[10]. The `owl:imports` statements are used in the core ontology. Similarly, GeoLinkedData makes use of three different ontologies covering different domains.
- (iv): A fourth approach consists in providing a *nearly flat list* of features or points of interest. This is the approach followed by popular Web APIs such as Foursquare types of venue[11] or Google Place categories[12]. For this last approach, we have built an associated OWL vocabulary composed of alignments with other vocabularies.

3.2 Vocabularies for Geometry Shape

The geometry of a point of interest is also modeled in different ways. We complete here the survey started by Salas and Harth [8]:

- *Point representation*: the classical way to represent a location by providing the latitude and longitude in a given coordinate reference system (the most

[6] http://geonames.org/ontology/ontology_v3.0.rdf
[7] http://linkedgeodata.org/ontology
[8] http://www.ordnancesurvey.co.uk/ontology/admingeo.owl
[9] http://statistics.data.gov.uk/def/administrative-geography
[10] http://www.ordnancesurvey.co.uk/ontology/postcode.owl
[11] http://aboutfoursquare.com/foursquare-categories/
[12] https://developers.google.com/maps/documentation/places/supported_types

used on the web is the WGS84 datum represented in RDF by the W3C Geo vocabulary). For example, Geonames defines the class `gn:Feature a skos:ConceptScheme` as a `SpatialThing` in the W3C Geo vocabulary.
- *Rectangle* ("bounding box"): which represents a location with two points or four segments making a geo-referenced rectangle. In this way of modeling, the vocabulary provides more properties for each segment. The FAO Geopolitical ontology[13] uses this approach.
- *List of Points*: the geometry shape is a region represented by a collection of points, each of them being described by a unique RDF node identified by a lat/lon value. The `Node` class is used to connect one point of interest with its geometry representation. The POI are modeled either as `Node` or as `Waynode` (surfaces). This approach is followed by LinkedGeoData [1].
- *Sequence of Points*: the geometry shape is represented by a group of RDF resources called a "curve" (similar to LineString of GML). The POI is connected to its geometry by the property `formedBy` and an attribute `order` to specify the position of each node in the sequence. This approach is the one used in GeoLinkedData [3].
- *Literals*: the vocabulary uses a predicate to include the GML representation of the geometry object, which is embedded in RDF as a literal. This approach is followed by Ordance Survey [4].
- *Structured representation*: the geometry shape is represented as a typed resource. In particular, polygons and lines are represented with an RDF collection of basic W3C Geo points. This approach is used by the NeoGeo vocabulary[14].

4 Scenario: 7^{th} Arrondissement of Paris

The 7^{th} arrondissement of Paris is one of the 20 arrondissements (administrative districts) of the capital city of France. It includes some of Paris's major tourist attractions such as the Eiffel Tower, some world famous museums (e.g: *musée d'Orsay*) and contains a number of French national institutions, including numerous government ministries[15]. We use it throughout this paper to highlight the diversity of representations one can use for this geographical entity. We assume that this district should be modeled as a POLYGON composed of a number of POINTs needed to "interpolate" its effective boundaries. We assume the use of the WGS84[16] geodetic system.

4.1 DBpedia Modeling

We provide below an excerpt of the DBpedia description for this resource.

[13] http://www.fao.org/countryprofiles/geoinfo/geopolitical/resource/
[14] http://geovocab.org/doc/neogeo/
[15] http://en.wikipedia.org/wiki/7th_arrondissement_of_Paris
[16] http://en.wikipedia.org/wiki/World_Geodetic_System

```
dbpedia:7th_arrondissement_of_Paris a gml:_Feature ;
  a <http://dbpedia.org/class/yago/1900SummerOlympicVenuEs>
  rdfs:label "7. arrondissementti (Pariisi)"@fi; (14 different languages)
  dbpprop:commune "Paris" ;
  dbpprop:département  dbpedia:Paris ;
  dbpprop:région dbpedia:Île-de-France_(region) ;
  grs:point "48.85916666666667 2.312777777777778" ;
  geo:geometry "POINT(2.31278 48.8592)" ;
  geo:lat "48.859165"^^xsd:float;
  geo:long "2.312778"^^xsd:float.
```

First, we observe that the type `gml:_Feature` and the property `grs:point` are not resolvable since there are no OWL ontologies that provide a description of them. Second, the property `geo:geometry` used by DBpedia is not defined in the WGS84 vocabulary. For the geometry, the 7^{th} arrondissement is a simple POINT defined by a latitude and a longitude.

4.2 Geonames Modeling

In Geonames, the 7^{th} arrondissement is considered as a 3^{rd} order administrative division, represented by a POINT for the geometry model. The RDF description of this resource gives other information such as the alternate name in French, the country code and the number of inhabitants.

```
gnr:6618613 a gn:Feature ;
  gn:name "Paris 07";
  gn:alternateName "7ème arrondissement";
  gn:featureClass gn:A [
    a skos:ConceptScheme ;
    rdfs:comment "country, state, region ..."@en .
  ] ;
  gn:featureCode gn:A.ADM4 [
    a skos:Concept ;
    rdfs:comment "a subdivision of a third-order administrative division"@en .
  ];
  gn:countryCode "FR";
  gn:population "57410";
  geo:lat "48.8565";
  geo:long "2.321".
```

4.3 LinkedGeoData Modeling

In LinkedGeoData, the district is a `lgdo:Suburb rdfs:subClassOf ldgo:Place`. Its geometry is still modeled as a POINT and not as a complex geometry of type POLYGON as we could have expected for this type of spatial object.

```
lgd:node248177663 a lgdo:Suburb ;
  rdfs:label "7th Arrondissement"@en , "7e Arrondissement" ;
  lgdo:contributor lgd:user13442 ;
  lgdo:ref%3AINSEE 75107 ;
  lgdp:alt_name "VIIe Arrondissement" ;
  georss:point "48.8570281 2.3201953" ;
  geo:lat 48.8570281 ;
  geo:long 2.3201953 .
```

4.4 Discussion

These samples from DBpedia, Geonames and LinkedGeoData give an overview of the different views of the same reality, in this case the district of the 7^{th} Arrondissement in Paris. Regarding the “symbolic representation”, two datasets opted for "Feature" (DBpedia and Geonames) while LGD classifies it as a "Suburb" or "Place". They all represent the shape of the district as a POINT which is not very efficient if we consider a query such as *show all monuments located within the 7^{th} arrondissement of international importance*. To address this type of query and more complicated ones, there is a need for more advanced modeling as we describe in the next section.

5 Aligning Geo Vocabularies

IGN is a public service in France in charge of describing, from the physical and geometry point of view, the surface of the French territory and the occupation of the land, and to elaborate and update continuously the forestal resources. They are also experimenting in exposing some of their data as Linked Data and act as an important provider in the `http://data.gouv.fr` portal.

5.1 Existing Vocabularies

IGN has developed two complementary vocabularies (GeOnto and bdtopo) which differ in their provenance but have the same scope, which is to describe geographic entities in the French territory. GeOnto is the product of a research project[17] aiming at building and aligning heterogeneous ontologies in the geographic domain. The "light" version of the final ontology[18] defines two top classes for a total of 783 classes and 17 properties (12 DP / 5 OP). GeOnto has labels in both French and English, but has no comments specified for the resources. The bdtopo ontology is derived from a geospatial database with the same name. It contains 237 classes and 51 properties (47 DP / 4 OP). All the labels and comments are in French.

5.2 GeOnto Alignment Process

The first step towards interoperability of French geographic features and the existing vocabularies is to align GeOnto to other vocabularies. We choose GeOnto because it covers a large number of categories and also has labels in English. We have performed the alignment with five OWL vocabularies (bdtopo, LGD, DBpedia, Schema.org and Geonames) and two flat taxonomies (Foursquare, Google Place). For the latter, we have transformed the flat list of types and categories into an OWL ontology. For each alignment performed, we only consider `owl:equivalentClass` axioms. We use the Silk tool [9] to compute the alignment using two metrics for string comparison: the *levenshteinDistance* and *jaro* distances. They work on the English labels except for the alignment with bdtopo where we use the French labels. We apply the average aggregation function on these metrics with an empirically derived threshold. However, for generating

[17] `http://geonto.lri.fr/Livrables.html`
[18] `http://semantics.eurecom.fr/datalift/tc2012/vocabs/GeOnto/`

the final mapping file for vocabularies of small size, we manually validate and insert relations of type `rdfs:subClassOf`. The threshold to validate the results is set to 100% for links considered to be correct and greater than 40% for links to be verified. The alignment with Geonames is special, considering the property restriction used in the ontology for codes.

Table 3 summarizes the result of the alignment process between GeOnto and the existing vocabularies/taxonomies. All the resources of this work are available at `http://semantics.eurecom.fr/datalift/tc2012/`.

Vocabulary	#Classes	#Aligned Classes
LGD	`owl:Class`:1294	178
DBpedia	`owl:Class`:366	42
Schema.org	`owl:Class`:296	52
Geonames	`skos:ConceptScheme`:12 `skos:Concept`:699	– 287
Foursquare	359	46
Google Place	126	41
bdtopo	`owl:Class`:237	153

Table 3. Results of the alignment process between GeOnto and existing vocabularies/taxonomies.

In general, we obtain good results with Silk, with precision beyond 80%: Google Place: 94%, LGD: 98%, DBpedia: 89%, Foursquare: 92% , Geonames: 87% and bdtopo: 92%. We obtained a precision of only 50% with schema.org due to numerous fine-grained categories that are badly aligned (e.g. `ign:Berge owl:equivalentClass schema:Park`).

6 Challenges

6.1 GeoSPARQL

OGC has adopted the GeoSPARQL standard to support both representing and querying geospatial data on the Semantic Web. The standard document [7] contains 30 requirements. It also defines a vocabulary for representing geospatial data in RDF and provides an extension to the SPARQL query language for processing geospatial data. The proposed standard follows a modular design with five components: (i) A *core component* defining top-level RDFS/OWL classes for spatial objects; (ii) a *geometry component* defining RDFS data types for serializing geometry data, RDFS/OWL classes for geometry object types, geometry-related RDF properties, and non-topological spatial query functions for geometry objects; (iii) a *geometry topology component* defining topological query functions; (iv) a *topological vocabulary component* defining RDF properties for asserting topological relations between spatial objects; and (iv) a *query rewrite component* defining rules for transforming a simple triple pattern that tests a topological relation between two features into an equivalent query involving concrete geometries and topological query functions. Each of the components described above has associated requirements. Concerning the vocabulary requirements, Table 4 summarizes the seventeen requirements presented in the GeoSPARQL draft document.

Geographic Aspect	Requirement	Implementation Definition
Feature	Req 2	The Class `SpatialObject` should be defined & accepted
	Req 3	Defines `Feature rdfs:subClassOf SpatialObject`
	Req 4	Defines 8 Simple Features Object Properties(OP)
	Req 5	Defines 8 Egenhofer OP with domain and range
	Req 6	Defines 8 RCC OP with domain and range
Geometry	Req 7	Defines `Geometry rdfs:subClassOf SpatialObject`
	Req 8	Defines OP `hasGeometry` and `defaultGeometry`
	Req 9	Defines 6 Data Properties: e.g: `dimension, isEmpty, etc.`
Serialization	Req 10-13	`wktLiteral` definitions & URI encoding
	Req 14	Defines `asWKT` to retrieve WKTLiteral
	Req 15-17	GMLLiteral should be accepted
	Req 18	Defines `asGML` to retrieve GMLLiteral

Table 4. Requirements and implementations for vocabulary definitions in GeoSPARQL.

Based on the GeoSPARQL requirements, we were interested in comparing some geospatial vocabularies[19] to see how far they take already into account topological functions and which are the standard they followed among OpenGIS Simple Features (SF), Region Connection Calculus (RCC) and Egenhofer relations. We find that the NeoGeo (Spatial and Geometry) and OS Spatial vocabularies have integrated in their modeling partial or full aspects of topological functions as summarized in Table 5.

As geodata has to be stored in triple stores with efficient geospatial indexing and querying capabilities, we also survey the current state of the art in supporting simple or complex geometries and topological functions compatible with SPARQL 1.1. Table 6 shows which triple stores can support part of the GeoSPARQL standard regarding serialization and spatial functions.

6.2 Some Recommendations

The alignment of GeOnto provided in the previous section enables interoperability of symbolic descriptions. The need for a better choice of geometric structure, typically the choice between literal versus structured representations depends on three criteria: (i) the coverage of all the complex geometries as they appear

[19] `http://labs.mondeca.com/dataset/lov/vocabularySpace_Space.html`

Geo-vocabulary	Topological Functions	GeoSPARQL Requirements	Standard Followed
Ordnance Survey Spatial	`easting`, `northing`, `touches`, `within`, `contains`	Part of Req 4	OpenGIS Simple Feature
Ordnance Survey Topography	`contains`, `isContainedIn`	Very small part of Req 4	OpenGIS Simple Feature
Place Ontology	`in`, `overlaps`, `bounded_by`	Small part of Req 4	N/A
NeoGeo Spatial	All RCC8 relations	Part of Req 3; Req 6	Region Connection Calculus (RCC)
NeoGeo Geometry	—	Req 10 - 14	N/A
FAO Geopolitical	`isInGroup`, `hasBorderWith`	–	–
OntoMedia Space	`adjacent-below`, `adjacent-above`, `orbit-around`, `is_boundary-of`, `has-boundary`	–	–

Table 5. Comparison of some geo-vocabularies with respect to the GeoSPARQL requirements.

in the data; (ii) a rapid mechanism for connecting "features" to their respective "geometry"; (iii) the possibility to serialize geodata into traditional formats used in GIS applications (GML, KML, etc.) and (iv) the choice of triple stores supporting as many as possible functions to perform quantitative reasoning on geodata. It is clear that a trade-off should be taken depending on the technological infrastructure (e.g: data storage capacity, further reasoning on specific points on a complex geometry).

- **Complex Geometry Coverage:** We have seen that on the Web of Data, there are few modeling of geodata with their correct shape represented as a LINE or POLYGON. However, some content providers (e.g. IGN) need to publish all types of geodata including complex geometries representing roads, rivers, administrative regions, etc. Two representations are suitable: *OS Spatial* and *NeoGeo* ontologies (Table 4). Direct representation of the GeoSPARQL vocabulary is also suitable.
- **Features connected to Geometry:** In modeling geodata, we advocate a clear separation between the features and their geometry. This is consistent with the consensus obtained from the different GeoVocamps[20] and the outcome of this approach is expressed in the modeling design of NeoGeo. The top level classes `spatial:Feature` and `geom:Geometry`are connected with the property `geom:geometry`.

[20] `http://www.vocamp.org`

– **Serialization and Triple stores:** We also advocate the use of properties that can provide compatibility with other formats (GML, KML, etc.). This choice can be triple store independent, as there could be ways to use content-negotiation to reach the same result. In Table 6, `Open Sahara`[21], `Parliament` [22], `Virtuoso`[23] are WKT/GML-compliant with respectively 23 and 13 functions dealing with geodata.
– **Literal versus structured Geometry:** Decomposing a LINE or a POLYGON into multiple results in an "explosion" in the size of the dataset and the creation of numerous blank nodes. However, sharing points between descriptions is a use case with such a need. IGN has such use-cases and the natural solution at this stage is to consider reusing the NeoGeo ontology in the extended version of GeOnto. The choice of the triple store (e.g.,Virtuoso vs Open Sahara) is not really an issue, as the IndexingSail[24] service could also be wrapped on-top of Virtuoso to support full OpenGIS Simple Features functions[25].

Triple store	WKT-compliance	GML-compliance	Geometry supported	Geospatial Functions	GeoVocab
Virtuoso	Yes	Yes	Point	13 functions	W3C Geo + Typed Literal
Allegro-Graph	-	–	Point	3 functions	"strip" mapping data
OWLIM-SE	–	–	Point	4 functions	W3C Geo
Open Sahara	Yes	Yes	Point, Line, Polygons	23 functions	Typed Literal
Parliament	Yes	Yes	Point, Line, Polygons	23 functions	GeoSPARQL vocabulary

Table 6. Triple stores survey with respect to geometry types supported and geospatial functions implemented.

7 Conclusions and Future Work

We have presented in this paper a first step towards interoperability of French geodata in the Semantic Web. The survey of existing modeling of points of interest and geometry shows the different vocabularies and modeling choices used

[21] `http://www.opensahara.com`
[22] `http://geosparql.bbn.com`
[23] `http://www.openlinksw.com`
[24] `https://dev.opensahara.com/projects/useekm/wiki/IndexingSail`
[25] `http://www.opengeospatial.org/standards/sfs`

to represent them. In France, there is a currently a joint effort to publish geographic information in RDF and interlink them with relevant datasets. GeOnto is an ontology describing geospatial features for the French territory. We have proposed to align GeOnto with other popular vocabularies in the geospatial domain. We have used Silk for schema mapping and we have evaluated the results. We studied how to extend the model to take into account efficient modeling for complex geometries. By doing so, we revisited current implementations of geo-vocabularies and triple stores to check out their compatibility with respect to the new GeoSPARQL standard . We finally made some recommendations and advocate for the reuse of the NeoGeo ontology within GeOnto to better address the IGN requirements. Our future work includes the conversion and publication of a large RDF dataset of geographic information of the French territory together with alignments with other datasets at the instance level.

Acknowledgments

This work has been partially supported by the French National Research Agency (ANR) within the Datalift Project, under grant number ANR-10-CORD-009.

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