

GeoVis Linked Data Query and Visualisation WebApp for data.gov.ie

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Introduction

The data.gov.ie portal hosts a wide range of datasets covering a diverse range of areas of interest to Irish citizens. In previous work conducted by the ADAPT centre, it was found that most of these do not have an openness score of 4 or higher, which means they are not available as RDF and, by consequence, also not linked with other internal or external Linked Data datasets. Existing work conducted by the ADAPT centre and funded by the ODEF has examined the linking of Open Data (OD) datasets with Ordnance Survey Ireland's authoritative Linked Data.

In this work ADAPT builds on that process by examining extensions to an ADAPT inhouse tool for visualising RDF data with a geospatial component by integrating OD datasets alongside OSi data into a single visualization WebApp called **GeoVis** -<http://geovis.adaptcentre.ie/>

GeoVis supports integration of multiple datasets into one visualisation and selection is based on geospatial functions (e.g. areas), functionality data.gov.ie does not support as yet.

ADAPT applied to the Open Data Engagement Fund *Innovative Use of Data* to support the **GeoVis Linked Data Query and Visualisation WebApp** project driven by Dr. Kris McGlinn.

Building on previous work by ADAPT researchers Christophe Debruyne and Declan O'Sullivan, this project makes use of a lightweight method and a set of tools to interlink datasets and generate enriched CSV files. With enriched CSV files, we mean CSV files that contain additional columns with links (URIs) to other resources. This data is then accessed by GeoVis, which provides a map with selection capabilities to query and select data sets, and present information about those data sets to the user.

Converting data.gov.ie CSV datasets into RDF with added Geospatial

The goal of the project is to add a geospatial dimension to datasets available on data.gov.ie using Ordnance Survey Ireland (OSi's) authoritative Linked Data datasets available on data.geohive.ie, which is the result of an ongoing collaboration between the OSi and the ADAPT Centre.

We have proposed a methodology (Fig. 1) for 1) analysing data sets 2) generating an ontology 3) transforming tabular data (e.g. CSV files, relational database) into RDF – a process called uplift, which allows us to 4) create links with other datasets and 5) publish this data on a triple store RDF server, which can then be accessed by a web service.

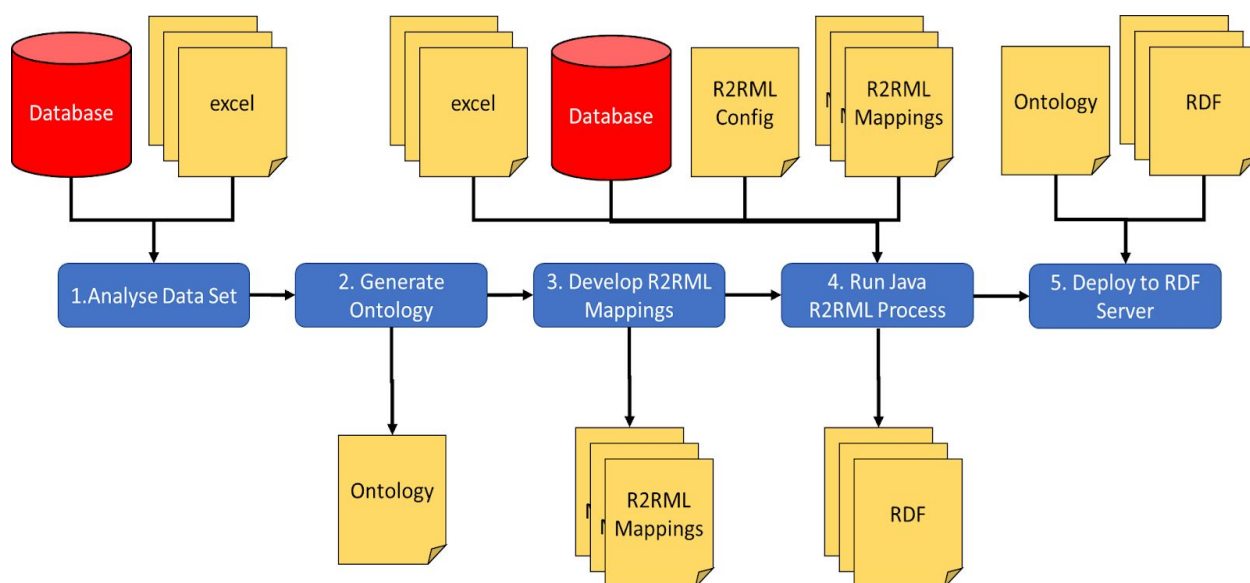


Fig. 1 Methodology for publishing RDF generated from tabular data

This work was not so concerned with the development of the ontology, but rather the conversion and publication of data.gov.ie datasets as RDF (3-5) for consumption by the WebApp. As a basis for this conversion we made use of the OSi building ontology, developed by ADAPT in collaboration with the OSi - <http://ontologies.geohive.ie/osi/building>

The project has made use of several data sets to support the visualisation app. The data sets will adhere to two criteria; 1) be available in a structure format (e.g. CSV, XML) and 2) have an explicit spatial component. The types of data set we will explore on data.gov.ie are all related to building data. Uplifting these additional data sources, will provide a richer set of descriptions for buildings available through Data.geohive.ie.

Three data.gov.ie data sets were chosen to uplift (along with the uplifted data properties):

- <https://data.gov.ie/dataset/churches-and-convents1>
 - ID, Name, Address, Organisation, GeoSpatial Point (Longitude and Latitude)
- <https://data.gov.ie/dataset/schools1>
 - ID, Address, Phone, School Level, Mixed Status, Fee Paying, GeoSpatial Point
- <https://data.gov.ie/dataset/roscommon-thatch-building-survey>
 - ID, Address, Image URI, GeoSpatial Point

An additional data set was also used, which were provided directly by OSi (all Garda stations buildings in Ireland) which includes the LD URI and additional data for form and function of each building, information that is maintained by OSi.

The tools for uplift, downlift and generation of RDF have all been made available with accessible MIT licenses (see the references below). The R2RML Mappings can also be found in Appendix A:

- <https://data.gov.ie/dataset/churches-and-convents1>
 - Appendix A: Listing 2
- <https://data.gov.ie/dataset/schools1>
 - Appendix A: Listing 3
- <https://data.gov.ie/dataset/roscommon-thatch-building-survey>
 - Appendix A: Listing 4

The mappings make reference to the OSi ontology. Some of the properties used are currently not modelled within the OSi ontology, and were added as place holders for future possible extensions. It is possible that there are other more appropriate ontologies also which could be used for these mappings, but this work could not be conducted within the scope of the ODEF project, and should be considered as possible future work.

To demonstrate how users can engage with the data, we published the converted data onto an internal Adapt triplestore which supports geospatial data called Parliament (<http://parliament.semwebcentral.org/>), and exposed the port to external web clients. The next section describes this WebApp.

The GeoVis WebApp for Querying and Visualising RDF with Geospatial component

This section describes the client-side query interface for RDF that we have extended to support GeoSPARQL (an OGC standard for representing and querying geospatial data on the Linked Data Web). This work, is mostly developed in the context of our ongoing collaboration with the OSi, and has been extended here to support additional data integration of data.gov.ie datasets.

The GeoVis WebApp

GeoVis consists of two main components, an internal server powered by Node.js, express, HTML5 and mongoDB to handle authorised log in (see Fig. 2) and then the main WebApp which runs entirely on the client browser for querying the triplestore and visualizing the data, built upon JS, HTML5, Ajax, Google Maps API and WebGL (Fig. 3). The login page allows a user to login using username: odef_adapt and password: geo123. Currently we cannot support HTTPS, due to parliament not supporting it. Next we describe the relevant functionality of the GeoVis tool. The GeoVis screen extends Google Maps API to provide additional functionality on screen.

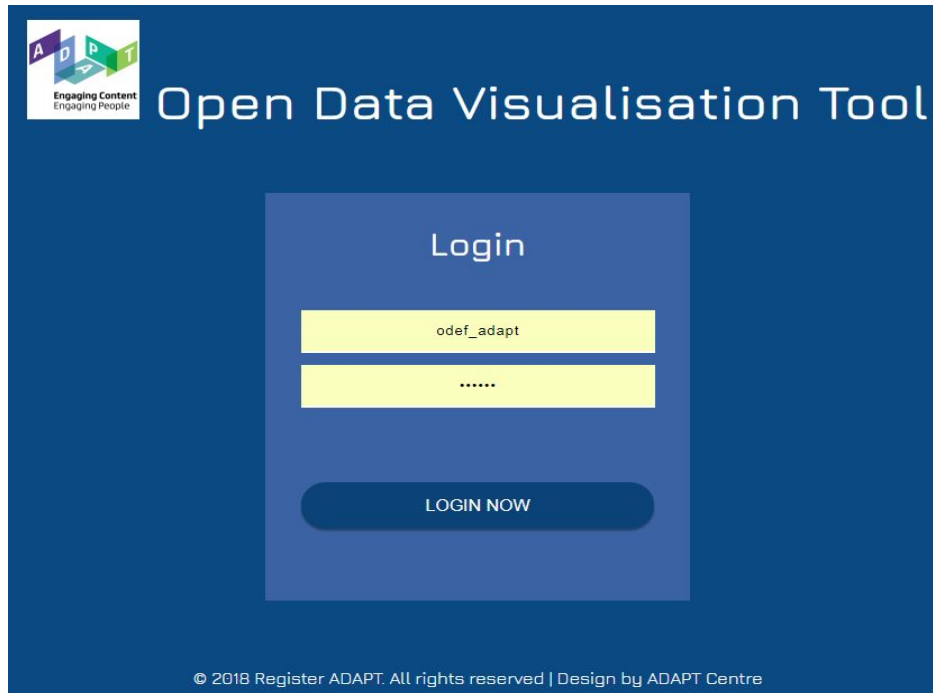


Fig. 2 Login Screen to GeoVis. Username: odef_adapt, password: geo123

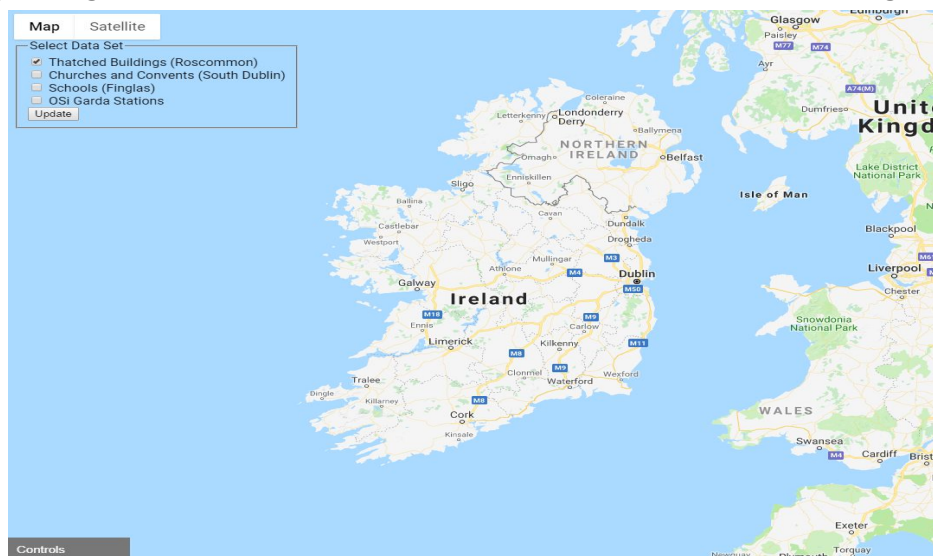


Fig. 3 GeoVis App for Querying and Visualising RDF Geospatial Data

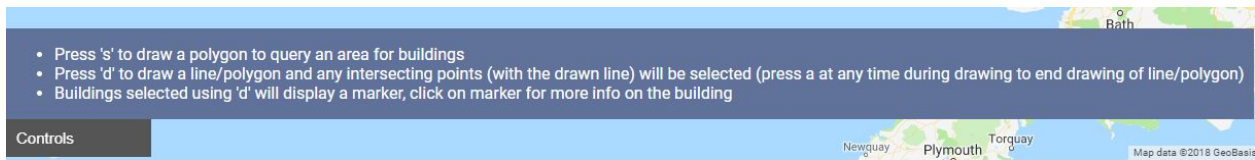


Fig. 4 Instructions for Querying Data

On the bottom left of the screen is the **controls** description. This is provided to inform a user about the functionality for querying the datasets which is supported using key presses. Clicking on controls 'button' displays this information (Fig. 4). The instructions are as follows:

- Press 's' to draw a polygon to query an area for buildings
- Press 'd' to draw a line/polygon and any intersecting points (with the drawn line) will be selected (press a at any time during drawing to end drawing of line/polygon)
- Buildings selected using 'd' will display a marker, click on marker for more info on the building

Pressing 's' key on the keyboard allows the user to draw a polygon (it must be a closed polygon) on the screen (Fig. 5). Once a polygon is closed, a query is sent to the server, and all geospatial points within that polygon will be queried using a sparql query with added geospatial functions. **Listing 1** gives the generate query.

The query is **hard coded** into the JS, and must be updated along with the SPARQL queries, to support new properties for new data sets. These extensions to the code are driven by the R2RML mappings, and so could potentially be generated automatically from these.

Listing. 1 A sample SPARQL query to parliament

```
SELECT
?uri ?form ?function ?address ?iuri ?phone ?org ?fee ?mixed ?level ?poly_geom
WHERE {
?uri <http://www.opengis.net/ont/geosparql#hasGeometry> ?geom.
OPTIONAL{?uri <http://ontologies.geohive.ie/geoff#hasForm> ?form.}
OPTIONAL{?uri <http://ontologies.geohive.ie/geoff#hasFunction> ?function.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasAddress> ?address.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasImageURI> ?iuri.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasPhone> ?phone.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasOrganisation> ?org.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasFeePaying> ?fee.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasMixedStatus> ?mixed.}
OPTIONAL{?uri <http://ontologies.geohive.ie/osi#hasSchoolLevel> ?level.}
?geom <http://www.opengis.net/ont/geosparql#asWKT> ?poly_geom
.FILTER(geof:sfWithin(?poly_geom, "POLYGON((-8.84875046875004 54.09632741172031,
-9.62877976562504 52.66126550188105, -4.9486039843750405 53.32254658410386,
-8.84875046875004 54.09632741172031))"^^geo:wktLiteral ).})
```

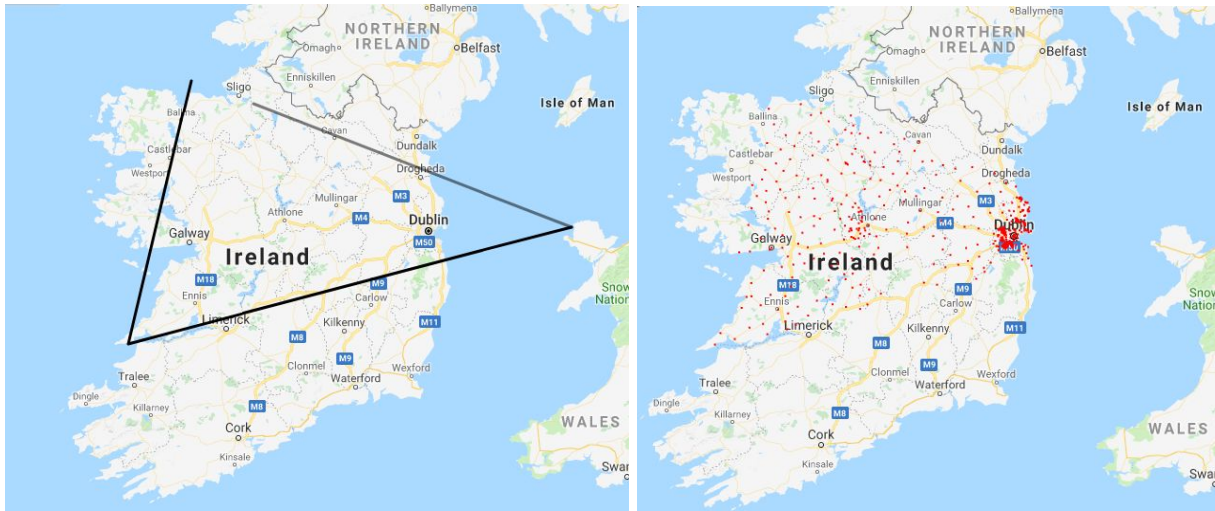


Fig. 5 Pressing 's' and then drawing a polygon, and the resulting selection

Pressing 'd' key allows the user to draw a line/polygon to the screen (Fig. 6). At any point the user can press 'a' to end the drawing. Any geospatial point (red dot) under the line will display a marker, which can be clicked on to reveal some information about the building (Fig. 7).

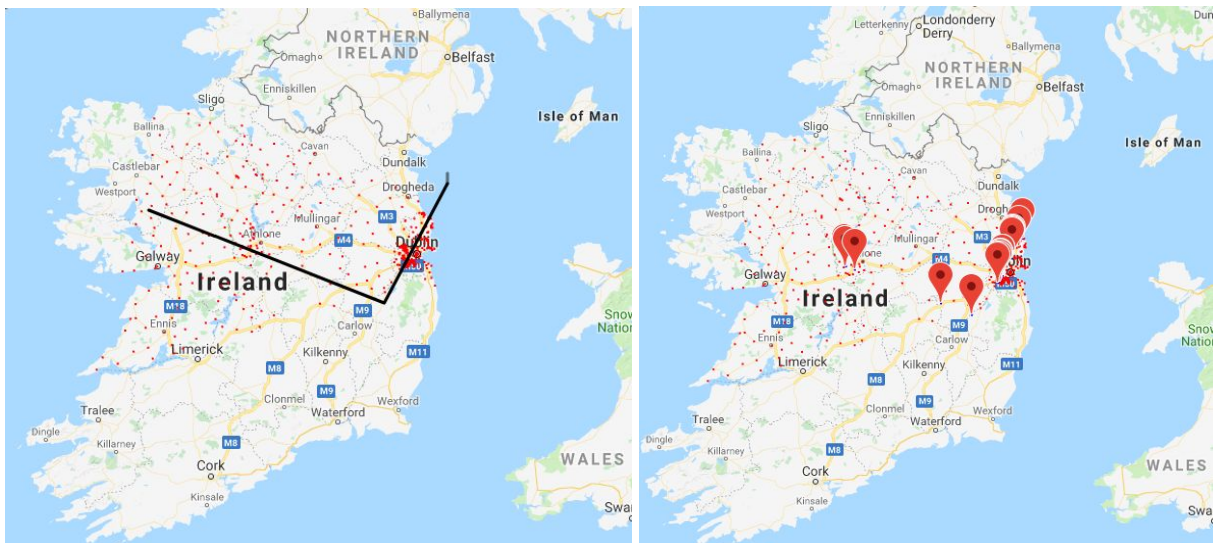


Fig. 6 Pressing 'd' and then drawing a line through the building points, pressing 'a' to end line, and the resulting selection

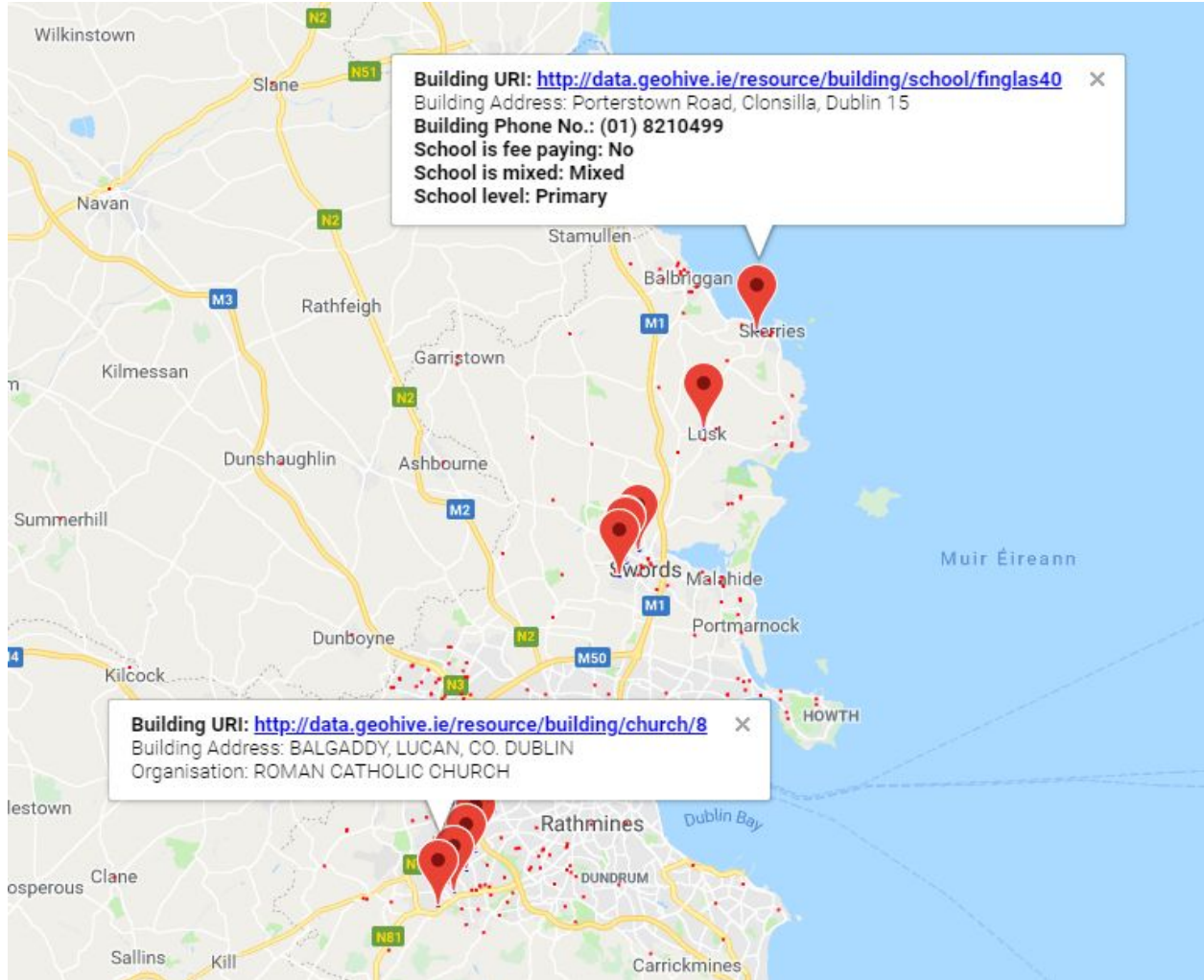


Fig. 7 Data displayed by clicking on 2 data points

On the top left of the screen is a further selection tool (Fig. 8) to support selecting a particular data set. By ticking a box and pressing update, all the building within the selection polygon of a particular type can be displayed (Fig. 9). Again, this functionality is hard coded, and would need to be adapted for any new data sets. A video also exists to demonstrate the tool in action (<https://www.scss.tcd.ie/~mcglink/video/tutorial/geovis/geovis.html>).

Select Data Set

- Thatched Buildings (Roscommon)
- Churches and Convents (South Dublin)
- Schools (Finglas)
- OSi Garda Stations

Fig. 8 Data displayed by clicking on 2 data points

A **known bug** here is related to WebGL, which on refresh does not properly destroy all references to polygons. As such, running the 'update' select in the top left will eventually cause the WebApp to slow and become unresponsive. This is a known issue with WebGL and would require further exploration to fix.

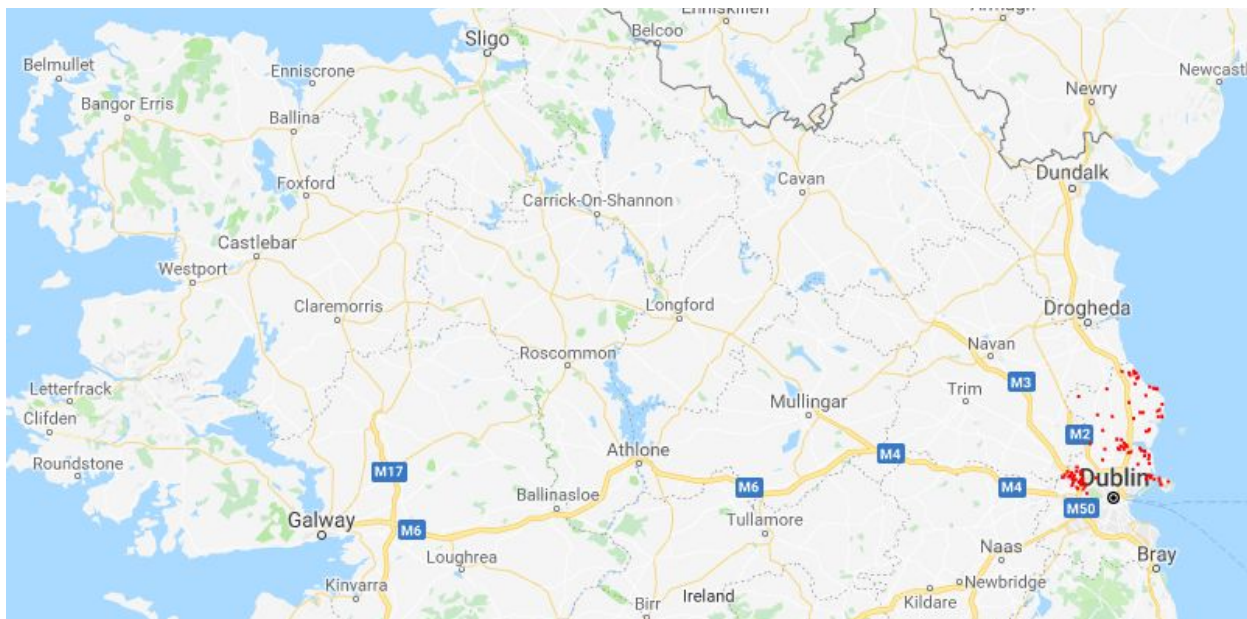


Fig. 9 Data displayed by selecting Schools (Finglas)

Conclusion and Future Work

This ODEF funding for this project has supported integrating data.gov.ie data sets into the GeoVis WebApp, as well as the extension of GeoVis to support new functionality, such as the integration of WebGL for visualisation.

It has been shown here that RDF can support the existing functionality of the data.gov.ie portal, and in fact support additional functionality in the form of queries with a geospatial component, that is to return geometries within a certain geospatial area.

The use of WebGL also has the potential for extending the visualisation of geometries beyond points, to polygons and even 3D geometries. Thus, the extensibility of this approach is ensured, although some issues remain related to WebGL, such as raised in this report.

The additional advantage, as discussed in earlier collaborations between ADAPT and the ODEF, is that through the use of RDF, the data sets can potentially be described and interlinked using available vocabularies, thus improving the semantics of the data. The use of URIs, also can support better identification of buildings, and authoritative data sets like those provided by

OSi can potentially provide authoritative URIs for all buildings in Ireland. While this work was not concerned with the adding of semantics to the data sets, or the accurate identification of data sets, this potential exists as future work.

One interesting possibility for exploration is the use of geolocation to integrate data sets, i.e. by taken two data sets with the same location, assuming these are the same and integrating the data to support more semantically rich queries.

Acknowledgements

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References

1. R2RML Implementation: <https://opengogs.adaptcentre.ie/debruync/r2rml>
2. Christophe Debruyne, Kris McGlinn, Lorraine McNerney, and Declan O'Sullivan. 2017. A lightweight approach to explore, enrich and use data with a geospatial dimension with semantic web technologies. In Proceedings of the Fourth International ACM Workshop on Managing and Mining Enriched Geo-Spatial Data (GeoRich '17). ACM, New York, NY, USA, Article 1, 6 pages. DOI: <https://doi.org/10.1145/3080546.3080548>
3. Generate Mapping Tool: <https://opengogs.adaptcentre.ie/debruync/generate-mapping>

APPENDIX A

Listing 2: R2RML Mapping for South Dublin Churches and Convents Buildings

```

@prefix rr: <http://www.w3.org/ns/r2rml#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix geo: <http://www.opengis.net/ont/geosparql#> .
@prefix ifcowl: <http://ifcowl.openbimstandards.org/IFC2X3_TC1#> .
@prefix osi: <http://ontologies.geohive.ie/osi#> .
@prefix geoff: <http://ontologies.geohive.ie/geoff#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix prov: <http://www.w3.org/ns/prov#> .

<#ChurchBuilding>
  rr:logicalTable [ rr:tableName "CNC" ];

    rr:subjectMap [
      rr:template "http://data.geohive.ie/resource/building/church/{OBJECTID}";
      rr:class geo:Feature ;
      rr:class osi:Building ;
    ];

    rr:predicateObjectMap [
      rr:predicate rdfs:label ;
      rr:objectMap [
        rr:column "NAME" ;
        rr:language "en" ;
      ];
    ];

    rr:predicateObjectMap [
      rr:predicate osi:hasAddress;
      rr:objectMap [
        rr:template "{ADD1}, {ADD2}, {ADD3}";
        rr:datatype geo:wktLiteral ;
      ];
    ];

    rr:predicateObjectMap [
      rr:predicate osi:hasOrganisation ;
      rr:objectMap [ rr:column "ORGANISATION" ];
    ];

    rr:predicateObjectMap [
      rr:predicate geo:hasGeometry ;
      rr:objectMap [
        rr:template "BlankBuildingNodeCNC{OBJECTID}";

```

```

        rr:termType rr:BlankNode;
    ];
];
.
<#ChurchBuildingPointGeom>
  rr:logicalTable [ rr:tableName "CNC" ];

  rr:subjectMap [
    rr:class geo:Geometry ;
    rr:template "BlankBuildingNodeCNC{OBJECTID}";
    rr:termType rr:BlankNode;
  ];

  rr:predicateObjectMap [
    rr:predicate geo:asWKT ;
    rr:objectMap [
      rr:template "POINT({X} {Y})" ;
      rr:datatype geo:wktLiteral ;
    ];
  ];
];
.

```

Listing 3: R2RML Mapping for Finglas County Council School Buildings

```

<#FinglassSchoolBuilding>
  rr:logicalTable [ rr:tableName "FCCS" ];

  rr:subjectMap [
    rr:template "http://data.geohive.ie/resource/building/school/finglas{ID}" ;
    rr:class geo:Feature ;
    rr:class osi:Building ;
  ];

  rr:predicateObjectMap [
    rr:predicate rdfs:label ;
    rr:objectMap [
      rr:column "NAME" ;
      rr:language "en" ;
    ];
  ];

  rr:predicateObjectMap [
    rr:predicate osi:hasAddress ;
  ];

```

```

        rr:objectMap [
            rr:template "{ADDRESS1}, {ADDRESS2}, {ADDRESS3}";
            rr:datatype geo:wktLiteral ;
        ];
];

rr:predicateObjectMap [
    rr:predicate osi:hasPhone ;
    rr:objectMap [ rr:column "PHONE" ];
];

rr:predicateObjectMap [
    rr:predicate osi:hasSchoolLevel ;
    rr:objectMap [ rr:column "SCHOOLLEVEL" ];
];

rr:predicateObjectMap [
    rr:predicate osi:hasMixedStatus ;
    rr:objectMap [ rr:column "MIXEDSTATUS" ];
];

rr:predicateObjectMap [
    rr:predicate osi:hasFeePaying ;
    rr:objectMap [ rr:column "FEEPAYING" ];
];

rr:predicateObjectMap [
    rr:predicate geo:hasGeometry ;
    rr:objectMap [
        rr:template "BlankBuildingNodeFCC{ID}";
        rr:termType rr:BlankNode;
    ];
];
];

```

<#RoscommonBuildingPointGeom>

```

    rr:logicalTable [ rr:tableName "FCCS" ];

    rr:subjectMap [
        rr:class geo:Geometry ;
        rr:template "BlankBuildingNodeFCC{ID}";
        rr:termType rr:BlankNode;
    ];

    rr:predicateObjectMap [
        rr:predicate geo:asWKT ;
    ];

```

```

        rr:objectMap [
            rr:template "POINT({LONG} {LAT})" ;
            rr:datatype geo:wktLiteral ;
        ] ;
    ];
.

```

Listing 4: R2RML Mapping for Roscommon Thatched Buildings

```

@prefix rr: <http://www.w3.org/ns/r2rml#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix geo: <http://www.opengis.net/ont/geosparql#> .
@prefix ifcowl: <http://ifcowl.openbimstandards.org/IFC2X3_TC1#> .
@prefix osi: <http://ontologies.geohive.ie/osi#> .
@prefix geoff: <http://ontologies.geohive.ie/geoff#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix prov: <http://www.w3.org/ns/prov#> .

<#RoscommonBuilding>
  rr:logicalTable [ rr:tableName "ROSCOMMON" ];

  rr:subjectMap [
    rr:template "http://data.geohive.ie/resource/building/{OBJECTID}" ;
    rr:class geo:Feature ;
    rr:class osi:Building ;
  ];

  rr:predicateObjectMap [
    rr:predicate osi:hasAddress ;
    rr:objectMap [ rr:column "ADDRESS" ];
  ];

  rr:predicateObjectMap [
    rr:predicate osi:hasImageURI ;
    rr:objectMap [ rr:column "PHOTO" ];
  ];

  rr:predicateObjectMap [
    rr:predicate geo:hasGeometry ;
    rr:objectMap [
      rr:template "BlankBuildingNode{OBJECTID}" ;
      rr:termType rr:BlankNode;
    ] ;
  ];
.

```

```
<#RoscommonBuildingPointGeom>
  rr:logicalTable [ rr:tableName "ROSCOMMON" ];

  rr:subjectMap [
    rr:class geo:Geometry ;
    rr:template "BlankBuildingNode{OBJECTID}";
    rr:termType rr:BlankNode;
  ];

  rr:predicateObjectMap [
    rr:predicate geo:asWKT ;
    rr:objectMap [
      rr:template "POINT({XCOORD} {YCOORD})" ;
      rr:datatype geo:wktLiteral ;
    ];
  ];
.
```