Linked Logainm: Enhancing Library Metadata using Linked Data of Irish Place Names

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Abstract. Linked Logainm is the newly created Linked Data version of Logainm.ie, an online database holding the authoritative hierarchical list of Irish and English language place names in Ireland. As a use case to demonstrate the benefit of Linked Data to the library community, the Linked Logainm dataset was used to enhance the Longfield Map collection, a set of digitised 18th-19th century maps held by the National Library of Ireland. This paper describes the process of creating Linked Logainm, including the transformation of the data from XML to RDF, the generation of links to external geographic datasets like DBpedia and the Faceted Application of Subject Terminology, and the enhancement of the Library's metadata records.

1 Introduction

Linked Logainm is a collaborative project that aims to create a Linked Data version of Irish place name data held by Logainm.[5] Logainm includes a list of Irish place names, their validated translations between the English and Irish languages, and administrative hierarchy information (stating in which other place names they are included).

Our example collection, the Longfield Maps, are a collection of 1570 map surveys carried out in Ireland between 1770 and 1840. Derived from the maps themselves, the existing metadata records include subject headings for counties, baronies, and occasionally parishes. The emphasis on baronies and parishes in this metadata, as well as the presence of minor geographical features in the surveys, make this collection particularly suitable for linking to the geographical entities found uniquely in the Logainm dataset. The place names stored in the

[5] http://logainm.ie/

metadata about the maps are in English, preventing any searches for place names represented in the maps to be specified in Irish. We describe ways in which this problem may be overcome by relying on Linked Data from the Linked Logainm project. Our initial approach is to enhance the existing metadata by recording the corresponding identifier in the Linked Data version of Logainm.

Linked Data [2] refers to data published on the Web following a set of principles designed to promote linking between entities on the Web. An essential requirement to enable this linking is that each entity (for example a place name or personal name) is given a unique identifier, generally in the form of a Uniform Resource Identifier (URI). Having determined these URI identifiers, Linked Data reuses other data models such as the Resource Description Framework (RDF) [9] to represent the data about each entity and specify the links, and their type, between two URIs.

The structured data published on the Web enables developers to reuse Logainm's data to build applications, taking advantage of query languages like SPARQL [7] that allow the user to go beyond string matching for searching for place names. For example by using SPARQL one can retrieve only entities of a specified type, with specific values for any property, or simply count the number of entities in a dataset.

We briefly present the project's demonstrator website, which gives an accessible introduction to other potential applications of linked place name data, drawing in digitised content from a range of sources via a Google maps interface.

Related Work. Geographical data forms a substantial portion of the Linked Data landscape. Some of the most relevant data providers and related approaches are LinkedGeoData, GeoLinkedData, Geonames, and DBpedia.

LinkedGeoData [12] consists of a mapping from OpenStreetMap (OSM) data to RDF. The OSM data model contains three types of place names: *nodes*, *ways*, and *relations*. It includes links to DBpedia and GeoNames that are created based on geographical location, the name, and type of place name. GeoLinkedData [4] contains information specific to the Spanish national scenario and mostly relates information about coastal areas with other Spanish national statistics. The UK Ordnance Survey is mapping agency for Great Britain and exposes some of its data as Linked Data [6]. While originally exposing only simple indexes of place names (*gazetteers*) and they have defined custom ontologies to describe the relationships between place names such as topological relations (e.g. *borders*, *spatially contains*).

GeoNames[6] is a worldwide geographical database, freely available and also exposes its data as Linked Data. DBpedia [3] publishes information extracted from Wikipedia as Linked Data. Although not specifically targeted at geographical data, it includes geospatial entities along with point representations for their locations.

[6] `http://geonames.org`

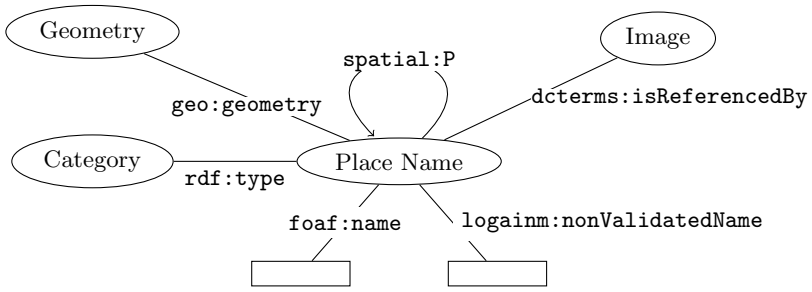

Fig. 1. Initial Schema for representing Logainm place names in RDF

The following section (Section 2) presents the Logainm Placenames database of Ireland. Section 3 details the Linked Logainm project, while Section 4 introduces the project results in the form of the enhanced Longfield Maps metadata and the demonstrator website. Finally, we present the conclusions and future work in Section 5.

2 The Logainm Placenames Database of Ireland

Logainm is an online database containing just over 100,000 Irish geographical names, including authoritative Irish language translations and historical variants. Furthermore approximately 50,000 place names include geographical coordinates. This dataset is generated by the Placenames Branch of the Department of Arts, Heritage and the Gaeltacht, and the database was created and is maintained in collaboration with Fiontar, DCU. The Logainm data is intended as a resource for researchers including educators, students and genealogists. As a bilingual authoritative list of place names, it is also used as the basis for cataloguing and key wording collections from heritage institutions including museums, archives and libraries nationally and internationally. While Logainm's complete dataset has been made available by Fiontar on a request basis, the inclusion of Linked Data in their website allows immediate access to structured data which can be used by cataloguers, as well as computer scientists and application developers.

We next present a set of requirements for the dataset, based on the Linked Data principles and other requirements specific to Logainm:

Place name identifiers: Each place name is identified by a URI under the new sub-domain `http://data.logainm.ie/`. URI identifiers for place names follow the pattern `http://data.logainm.ie/place/{LogainmID}`, where {`LogainmID`} is the place name identifier from the Logainm dataset.

Names in Irish and English: Data representing the Irish and English names is retrievable from the respective URI. To represent the different languages, we use XML "language tags" associated with values of the same property (e.g. `foaf:name`). Another approach would be to use different properties for

English and Irish names, as done by the UK Ordnance Survey: "hasOfficialName" and "hasOfficialWelshName" for Wales [6]. Furthermore, place names include the concept of a validated place name to enable the administrative process of translation, and also include alternate spellings for the place name in Irish.

Types for Place Names: Each place name has a Category, e.g. Barony, Town, County. Each type is identified by a URI `http://data.logainm.ie/category/{categoryID}`, where {`categoryID`} is the category identifier from the Logainm dataset.

Place names are contained in (possibly multiple) other place names: The Logainm dataset contains information regarding hierarchical inclusion of place names. This information represents the administrative structure of the place names.

Geographical Coordinates: Place names are generally represented by one coordinate according to the Irish Grid Format [10]. In some cases, place names can have multiple coordinates: e.g. for Rivers. For town lands and other types the coordinate approximates the geographical centre, while for rivers the two coordinates are used represent the source and mouth.

A depiction of the Linked Logainm schema is presented in Figure 1. The generated RDF follows the NeoGeo vocabulary [11], where each place typed as "Feature". The NeoGeo vocabulary also defines several spatial relations between entities, for our data we are relying on the `is_part_of` relation (`spatial:P`).

3 Linked Logainm

In this section we describe the process for transforming Logainm's dataset into RDF and determining equivalence links to entities in other datasets. The contents of Logainm's database were provided as an XML dump that included all English and Irish place names along with their type, and if available, the geolocation of the place in Irish Grid Reference format. The approach of using an XML dump rather than other techniques, for example RDB2RDF [5], is due to Fiontar's plans to migrate Logainm's database from a relational database to an XML database.

3.1 Creating RDF data

The translation of Logainm's database dump (in XML) into RDF was performed using XSPARQL [1], by developing a query that transforms the input XML into the target RDF schema. A partial example of this query is presented in Figure 2. The presented example creates a subset of the RDF data from the input XML, that contains:

(i) the place name identifiers (generated in line 3 with the help of an auxiliary function);

(ii) the connection to the original page in Logainm's website (line 5); and

```
1 for $place in places/place
2 let $id := fn:data($place/@id)
3 let $URI := local:createURI($id, "place")
4 construct { <{$URI}> a spatial:Feature ;
5                   foaf:isPrimaryTopicOf <{fn:concat("http://
                        logainm.ie/",$id,".aspx")}> .
6           { for $type in $place/type
7             construct { <{$URI}> a <{ local:createURI(fn:data(
                  $type/@id), "category") }> }
8           }.
9           }
```

Fig. 2. XSPARQL transformation

(iii) the (possibly multiple) types of the place name (lines 6–8).

The target RDF representation contains the information in the original Logainm dataset and also includes the geo-location of the place following the World Geodetic System (WGS) coordinates, the reference coordinate system used by the Global Positioning System (GPS). These coordinates were translated from the provided Irish Grid Format coordinates and used to aid the determination of links between the Logainm dataset and other Linked Data sources on the Web.

The Logainm RDF dataset has been deployed in the Logainm website and the SPARQL endpoint is available at `http://data.logainm.ie/sparql/`. The resulting RDF dataset contains approximately 1.3 million triples.

3.2 Linking the datasets

From the relevant sources of Geographical Linked Data (briefly presented in Section 1), we elected to generate links to DBpedia, LinkedGeoData, and Geonames.[7] We used the Silk Link Discovery Framework [8] to generate the links between the Logainm RDF dataset and the other target datasets. The Silk framework compares entities from the different datasets according to a pre-defined set of rules and assigns a normalised value (in the interval $[0, 1]$) to the similarity between entities. The entities with highest similarity value are considered to be equivalent.

Next we present the set of comparison rules that we devised for establishing the links between the datasets. The final rule was based on the following similarity values:

- place name (n);
- type of the place name (t);
- name of the parent place (p); and

[7] Since we are interested in matching Irish names we did not consider the GeoLinkedData dataset.

– geographical coordinates (g) (if available).

For defining the different similarity values we used the functions and aggregation operations provided by the Silk framework. For example for comparing the place names we used the provided string comparison function based on the *jaro* distance metric[8] or for comparing the geographical coordinates we used the provided spatial comparison function *wgs84*.[9] Both p and g allow us to distinguish between place names that have a similar name but are located in different parts of Ireland, e.g. Newcastle in Dublin, Newcastle in Cork, and Newcastle in Galway.

To calculate the aggregated comparison value, we used a weighted comparison, according to the following formula:

$$\frac{1}{2}n + \frac{3}{8}p + \frac{1}{8}g \ . \tag{1}$$

This formula places a higher weight on the string comparison values, both of the place name and the place name it is included in, rather than the geographical location. This meant that we were not overly penalised by any errors in the geographical coordinates of the place names and could still detect links for the place names that do not have any geographical information. This formula can still be iterated, for example a more fine-tuned approach, as presented in [12], can be investigated. However the initial link evaluation (presented in the next section) is positive. Also noteworthy is that for determining the links to GeoNames, we omit p from the formula, since hierarchical information in GeoNames is not freely available. We also generated the GeoNames RDF from the provided data dumps (in tabular separated format) since RDF dumps are another premium feature.

We also take into account the type of the place name, as such this weighted comparison is only performed between entities of types that have been considered similar. This matching of types was a manual process, performed by the domain experts. The results of this matching (for the most relevant types) is presented in Table 1.[10] The most problematic types to match were "townland" and "population centre", as these can be mapped to different types in the target datasets. We have taken the approach of matching against a more general type (as in the case of DBpedia) or matching against several types (as in LinkedGeoData and GeoNames).

Linking to the FAST dataset. Given our interest in enhancing library metadata, we investigated the possibility of linking to existing library subject heading schema available as Linked Data. The Online Computer Library Centre (OCLC)

[8] Further details regarding the comparison functions are provided at `https://www.assembla.com/spaces/silk/wiki/Comparison`.

[9] This function allows to define an approximation value to account for offsets in the geographical locations. We have currently set this value to 1 kilometre.

[10] A description of the GeoNames feature codes can be found at `http://www.geonames.org/export/codes.html`.

Table 1. Mapping of types between the different datasets

Type	DBpedia	LinkedGeoData	GeoNames
townland	Populated Place	Locality	LCTY, PPLF
population centre	Populated Place	Town, Village, Suburb, Locality	PPLS, PPL, PPLL
town	Town	Town, Village	PPL, PPLS
mountain or mountain range	Mountain, Mountain Range	Mountain Pass, Peak	MT, MTS, PASS, PKU, PKSU
village	Village	Village, Hamlet	PPL
island or archipelago	Island	Island	ISL, ISLET
river	River	River	STM
monument	Monument	Monument	MNMT
city	City	City	PPL
valley	Valley	NaturalValley	VAL

has released the Faceted Application of Subject Terminology (FAST) dataset as Linked Data. FAST is a subject heading vocabulary which is derived from the Library of Congress Subject Headings (LCSH), the most widely used subject vocabulary in the library domain. Although the full LCSH dataset has also been published as Linked Data, the simplified FAST syntax and, in particular, the presence of GeoNames references in the FAST data made it an easier target for matching with Linked Logainm. However, since FAST in turn contains links to the Library of Congress Linked Data Service,[11] Linked Logainm will be related to LCSH in the wider Linked Open Data cloud. We looked at reusing the previously described rules and similar process to determine the links, however the FAST data is not structured in such a way that would make this possible. As an alternative, we have decided to leverage the links to GeoNames present in FAST and, combined with our own links to GeoNames, establish an initial set of links from Logainm to FAST.[12] Using this approach we matched approximately one third of the Irish geographical entities present in FAST (500 out of 1,400). In order to obtain a complete matching from Logainm to FAST, the datasets were manually linked along with the link evaluation process (described in the next section). From this manual linking we determined approximately 1,000 links to FAST, and for the remaining entities no adequate match was found.

3.3 Link Evaluation

From the similarity value that the Silk framework assigns to each link we consider only those above 0.95, i.e. the result of Equation (1) is above 0.95. The evaluation of the rules presented in the previous section generated a set of approximately 16,000 links to the different datasets. A breakdown of the number of links by

[11] http://id.loc.gov/

[12] This matching was determined using a SPARQL query.

Table 2. Number of links between the different datasets

Logainm		# Links			
Type	# Entities	DBpedia	LinkedGeoData	GeoNames	Total
townland	61,104	747	4,970	7,024	12,741
population centre	2,226	505	1,151	970	2,626
town	849	560	688	605	1,853
mountain or mountain range	372	63	115	111	289
village	142	79	90	10	179
island or archipelago	1,087	20	26	120	166
river	930	12	4	82	98
monument	245	22	36	39	97
city	8	8	7	5	20
valley	111	1	6	9	16

types and to the different datasets is presented in Table 2. It is noteworthy that the vast majority of links was established for "townlands", which was also the type that was matched to an higher-level type in the target ontologies, and such an approach may introduce errors in the generated links.

In order to determine the accuracy of the links generated between Logainm and the other datasets we manually checked a subset of these links. The task was to examine the information provided by each pair of URIs (via accessing the URI with a web browser) and deciding if the suggested matching was correct or incorrect. Since Logainm is a manually curated database, our mains focus was to ensure the correctness of the generated links, thus maintaining the dataset's reputation of trusted quality data. As such, we are aiming at a higher accuracy of the generated links rather than covering all the place names. From this manual checking of the links we estimate that the overall correctness of the generated set of links is 97%.

Below is a breakdown of the link evaluation per dataset and some of the problems in the matching:

DBpedia: For DBpedia we manually checked all the generated links, and determined an overall accuracy of 98%. Some common issues that were encountered in the generated matching were:

(i) Since Logainm contains more fine-grained information, it can contain different entries for "towns", "population centre", and "townland" with the same name. However DBpedia contains only an entry for "town" or "population centre". For example, Adrigole is a "population centre" and a "townland" in Logainm (with two distinct identifiers, `http://data.logainm.ie/place/1412693` and `http://data.logainm.ie/place/8649`), while in DBpedia Adrigole is only a "village" and both Logainm entities are matched to the same DBpedia entitiy: `http://dbpedia.org/resource/Adrigole`.

(ii) Another issue, although less common, is the discrepancy between types in Logainm and DBpedia. For example, Kentstown is a "townland" in

```
<marc:datafield tag="522" ind1=" " ind2=" ">
  <marc:subfield code="a">
    Barony of Coshma, County Limerick, Province of Munster,
        Ireland.
  </marc:subfield>
</marc:datafield>
<marc:datafield tag="651" ind2="7" ind1="">
  <marc:subfield code="2">logainm.ie</marc:subfield>
  <marc:subfield code="a">Coshma</marc:subfield>
  <marc:subfield code="0">
    http://data.logainm.ie/place/145
  </marc:subfield>
</marc:datafield>
```

Fig. 3. Enhanced MARCXML catalogue record

Logainm (`http://data.logainm.ie/place/38671`), while in DBpedia classifies it as a "village" (`http://dbpedia.org/resource/Kentstown`).

LinkedGeodata: For LinkedGeoData we have checked a random set of 500 links from all the generated links. Within this subset the accuracy was of 96%. Also for LinkedGeoData a common source of errors were "townlands", often matching other types in LinkedGeoData. Also the geographical coordinates in between Logainm and LinkedGeoData are often above the defined offset in our rules (1km), especially for "townlands". This suggests that increasing the value of the offset in our rules may provide further links to LinkedGeoData but may also increase the number of incorrect links.

GeoNames: The links to GeoNames provided very accurate results, from the subset of 500 links we checked, the accuracy was 99.6%.

FAST: The links to the FAST dataset were manually generated, based on an initial set of approximately 500 links with GeoNames. In this initial set of links, 1.2% were found incorrect, possibly due to errors in the links established between Logainm and GeoNames. Overall it was not possible to determine links for approximately 12% of the entities in the FAST dataset to Logainm entities, frequently because no hierarchy nor geographical coordinates are provided and is thus impossible to distinguish between place names with the same name across Ireland. Also the FAST database frequently conflates "town", "townland", "parish", and other types. We followed the approach of matching to "town" in Logainm.

A workflow for editing incorrect links was put in place so that any incorrect links that may be discovered can be fixed.

4 Applying Linked Logainm to Library Metadata

As previously stated, a key use case which motivated the Linked Logainm project was the potential re-use of Logainm data by cultural heritage organisations and

information professionals such as achivists and librarians. Some of the potential benefits identified at the start of the Linked Logainm project were:

- The potential to link to other digital objects or information from other Open Datasets. For example, by relating objects from other projects (e.g. the Royal Irish Academy's Historic Towns Atlas Project) to Logainm entities they could be presented alongside the Longfield maps. Furthermore, by linking Logainm entities to international Open Datasets like GeoNames and DBpedia, contextual information about those locations could also be imported into the library catalogue.
- The potential to enhance discovery by drawing on Irish-language and historical forms of place names found in Logainm. For example, a user searching for "Ceara" or "Cera" could be directed to maps for the barony of Carra.
- The potential to enhance discovery by drawing the hierarchical information in the Logainm dataset. For example, a user searching for a townland name not found in the existing records could be directed to maps for the related barony.
- The potential use Linked Logainm, along with the linking techniques described above, as a source against which to clean and normalise legacy metadata during conversion to a standard schema.

Having established the Linked Data URIs for the Logainm dataset, place names in the National Library's MARCXML metadata records of the Longfield Maps collection were compared and linked to place names in the Logainm dataset. The MARCXML records contained place names as subdivisions of Topical Subject Headings (i.e. the MARC *650* field); however, we decided to use information from the Geographic Coverage Note field (i.e. MARC *522* field). Although, this field normally contains free-text, uncontrolled values, in the case of the Longfield Map records the information had been entered with sufficient consistency to allow predictable parsing. Most importantly, the information in this field not only included a place name (n), but also hierarchical information such that the name of the parent place (p) could also be taken into account as per the linking methods described above. We manually checked approximately 300 of the linked records to determine that the URIs were correct and no errors were found.

In order to show the potential to link to other sources, we have created a demonstrator website that combines information about Irish places from various sources such as DBpedia (via the established links) and the Longfield Maps but also other content from Europeana, the Placenames Branch's digitised archival records, and the Irish Historical Towns Atlas' Dublin volumes. This demonstrator is ongoing work and is available at `http://logainm.deri.ie/demo/`.

In terms of enhancing the National Library's metadata and catalogue, our initial approach is to record the corresponding identifier in the Linked Data version of Logainm in the bibliographic record. An excerpt of an enhanced record is presented in Figure 3. The URIs was stored in the MARCXML record by adding a new Geographic Name Subject Heading (a MARC *651* field). Standard MARC linking practices were followed as closely as possible: for example the provenance of the heading was encoded using the *subfield "2"* with a second indicator

value of *7*, while the URI itself was encoded in the Authority Record Control Number subfield (*subfield "0"*). This approach is adequate for maintaining the relationship between the MARCXML record and Linked Logainm; however, it is hoped that as new library encoding standards such as the BIBFRAME initiative emerge, more standard techniques for relating bibliographic data to Linked Data resources will be agreed.

5 Conclusions and Future Work

In this paper we presented our approach to enhance library records, specifically the National Library of Ireland's Longfield Map Collection, with extra information about the places that are contained in these maps. By using Irish specific Geographical Linked Data, based on Logainm's data, we presented possible options to also extend the library's catalogue to enable searching for place names in Irish.

We also detailed the process of transforming the Logainm dataset into RDF and how to establish the links to other external datasets, namely DBpedia, LinkedGeoData, GeoNames, and the OCLC FAST subject heading schema, along with an initial evaluation of the determined links. Although some issues presented in this paper are specific to the datasets and the Irish language, for example the alternate spellings of place names in Irish or the matching of categories between Logainm and the external datasets, the presented methodology, also similar to [12], can be used in other countries with place name translations in multiple languages.

We are in the process of writing guidelines and use cases that demonstrate the value of Linked Data — along with other available tools — for heritage professionals, aiming to encourage reuse of Linked Logainm in Ireland.

Future Work. Along with the promotion of the Linked Logainm project, further work can be done in the Silk rules to attempt to obtain a larger number of links. However it should be taken into consideration that the accuracy of these links should remain high. Another type of entities whose links can be improved are streets, currently a large number of entities in Logainm refers to street names. Even though streets are present in some of the datasets we are linking to — DBpedia includes information about the most important streets in Dublin and other cities; LinkedGeoData contains streets exported from OpenStreetMap — our current linking rules to not provide adequate links for streets. Further work is planned to enhance discovery of the Longfield Maps with the National Library's online catalogue. Rather than add to or modify Authority Data stored at the Library Management System level at this stage, the planned approach is to index Irish and variant forms of place names found in Linked Logainm into VuFind,[13] the Library's discovery interface. This system has existing functionality to provide serach suggestions based on cross- references found in traditional library

[13] http://www.vufind.org/

authority records (i.e. MARC *4XX* authority fields); this functionality will also work for the Linked Logainm forms once correctly indexed. Furthermore, the National Library is currently evaluating the use of the Linked Logainm dataset to help with vocabulary standardisation as part of a conversion of a legacy metadata set which contains approximately 18,000 distinct, uncontrolled Irish place names.

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References

1. Stefan Bischof, Stefan Decker, Thomas Krennwallner, Nuno Lopes, and Axel Polleres. Mapping between RDF and XML with XSPARQL. *Journal on Data Semantics*, 1:147–185, 2012.
2. Christian Bizer, Tom Heath, and Tim Berners-Lee. Linked Data - The Story So Far. *Int. J. Semantic Web Inf. Syst.*, 5(3):1–22, 2009.
3. Christian Bizer, Jens Lehmann, Georgi Kobilarov, Sören Auer, Christian Becker, Richard Cyganiak, and Sebastian Hellmann. DBpedia - A crystallization point for the Web of Data. *J. Web Sem.*, 7(3):154–165, 2009.
4. Luis Manuel Vilches Blázquez, Boris Villazón-Terrazas, Victor Saquicela, Alexander de León, Óscar Corcho, and Asunción Gómez-Pérez. GeoLinked data and INSPIRE through an application case. In Divyakant Agrawal, Pusheng Zhang, Amr El Abbadi, and Mohamed F. Mokbel, editors, *GIS*, pages 446–449. ACM, 2010.
5. Souripriya Das, Seema Sundara, and Richard Cyganiak. R2RML: RDB to RDF Mapping Language. W3C Recommendation, W3C, September 2012. URL `http://www.w3.org/TR/2012/REC-r2rml-20120927/`.
6. John Goodwin, Catherine Dolbear, and Glen Hart. Geographical linked data: The administrative geography of great britain on the semantic web. *Transactions in GIS*, 12:19–30, 2008.
7. Steve Harris and Andy Seaborne. SPARQL 1.1 Query Language. W3C recommendation, W3C, March 2013. URL `http://www.w3.org/TR/sparql11-query/`.
8. Robert Isele, Anja Jentzsch, and Christian Bizer. Silk server - adding missing links while consuming linked data. In Olaf Hartig, Andreas Harth, and Juan Sequeda, editors, *COLD*, volume 665 of *CEUR Workshop Proceedings*. CEUR-WS.org, 2010.
9. Frank Manola and Eric Miller. RDF Primer. W3C Recommendation, W3C, February 2004. URL `http://www.w3.org/TR/2004/REC-rdf-primer-20040210/`.
10. Ordnance Survey of Ireland. The Irish Grid – A Description of the Co-ordinate Reference System used in Ireland. Technical report, Ordnance Survey of Ireland, 1996. URL `http://osi.ie/OSI/media/OSI/Content/Publications/The-Irish-Grid-A-Description-of-the-Coordinate-Reference-System-Used-in-Ireland_1.pdf`.
11. Juan Martín Salas and Andreas Harth. NeoGeo Vocabulary Specification - Madrid Edition. Public draft, , February 2012. URL `http://geovocab.org/doc/neogeo/`.
12. Claus Stadler, Jens Lehmann, Konrad Höffner, and Sören Auer. Linkedgeodata: A core for a web of spatial open data. *Semantic Web*, 3(4):333–354, 2012.