Linked Data – an MRDB at web scale?

Stefan Hahmann and Dirk Burghardt

Zürich, 12.09.2010
Outline

1. Semantic Web
2. Linked Data
3. Linked Data vs. MRDB
4. Challenges
5. Ongoing Work

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1. Semantic Web

- 1989:
  - Tim Berners-Lee – „inventor“ of the World Wide Web (WWW)
  - WWW initially developed for human consumption

- Late 1990’s, Vision:
  - From „machine-readable“ web of documents
  - To „machine-understandable“ web of data

- 1999:
  - W3C
  - Resource Description Framework (RDF)
1 Semantic Web

1. Semantic Web
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• Resource Description Framework (RDF)

• Resource
  ▪ arbitrary thing
  ▪ identified by a URI

• e.g.:
  ▪ LinkedGeoData
    • Project that publishes OpenStreetMap data in the Semantic Web using RDF
  ▪ POI Café „B’Liebig“ Dresden
  ▪ URI: http://linkedgeodata.org/triplify/node264695865
1. Semantic Web

- **Subject** (Resource)
- **Predicate** (Named Property)
- **Object** (Resource or Literal)

**RDF Triple**

- E.g.: The **LinkedGeoData Feature** with ID=264695865 has the RDF type **LinkedGeoData**

```
http://linkedgeodata.org/triplify/node264695865
```

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

```
http://linkedgeodata.org/ontology/pub
```

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1. Semantic Web

• RDF-Graph

- München
- 48.13
- 11.57

rdfs:label  geo:lat  geo:long

http://linkedgeodata.org/triplify/node17780035

OpenStreetMap (LinkedGeoData)

owl:sameAs

http://dbpedia.org/resource/Munich

Wikipedia (DBpedia)

dbpedia-owl:postalCode  dbpedia-owl:populationTotal

80331 - 81929  1356594
2 Linked Data

- Linked Open Data Cloud

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3 Linked Data vs. MRDB - Similarities

- a database (environment), which contains several representations of the same geographic entity (Sarjakoski 2007)

- different views of the same object are linked with each other (Sarjakoski 2007)

- geometry driven feature matching

- semantic matching: database schemas, RDF vocabularies, OWL ontologies
### 3 Linked Data vs. MRDB - Differences

<table>
<thead>
<tr>
<th>MRDB</th>
<th>Linked Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>• database</td>
<td>• web</td>
</tr>
<tr>
<td>• focus on different geometric and semantic abstraction levels</td>
<td>• focus on different representations of the same entity: different (media) type and content of information</td>
</tr>
<tr>
<td>• Level of Detail strongly considered</td>
<td>• Level of Detail sparsely considered</td>
</tr>
<tr>
<td>• corresponding objects at different scales are explicitly linked</td>
<td>• marginal resolution dependent representation of geodata</td>
</tr>
<tr>
<td>• persistence and consistency can supervised by the producer</td>
<td>• persistence and consistency cannot be guaranteed by web links</td>
</tr>
<tr>
<td>• catalogs that contain verbal descriptions of attributes and class hierarchies, UML diagrams</td>
<td>• use of RDF (owl descriptions) for meta data</td>
</tr>
<tr>
<td>• corporate data</td>
<td>• web / distributed data</td>
</tr>
<tr>
<td>• authority-driven</td>
<td>• community-driven</td>
</tr>
</tbody>
</table>

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A map producer’s point of view to Linked Data:

- **Linked Data**: a technology that can simplify access to geodata

- **Advantage over Web Feature Service (WFS)?**
  - RDF adds semantic descriptions

- **However**: Lack of standard semantic vocabularies
  - For both spatial and non-spatial terms
  - RDF is only a framework for describing semantics, not the semantics itself
4 Challenges

- **Basic Geo Vocabulary** (point, lat, long, alt)
  - http://www.w3.org/2003/01/geo/wgs84_pos

- **W3C Geospatial Vocabulary**
  - http://www.w3.org/2005/Incubator/geo/XGR-geo-20071023/
  - in discussion
  - uses a subset of gml classes and properties

- Geometric matching remains
- Semantic matching remains
  - As long as no standard (commonly accepted and used) semantic descriptions exist
  - Growing Motivation to use formalized semantic descriptions by using RDF?!
5 Ongoing Work

- RDF-Graph

OpenStreetMap

- München
- rdfs:label
- geo:long 11.57
- geo:lat 48.13

Geonames

- http://sws.geonames.org/2867714/about.rdf
- owl:sameAs
- owl:sameAs
- gn:alternateNameJp
- gn:alternateNameIt

Wikipedia

- http://dbpedia.org/resource/Munich
- dbprop:PLZ 80331 – 81929

RDF-Graph

http://linkedgeodata.org/triplify/node17780035

OpenStreetMap

- Geonames
- Wikipedia

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5 Ongoing Work

„residential areas“ within 2 datasets
study area: Germany

<table>
<thead>
<tr>
<th>Place</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>102</td>
</tr>
<tr>
<td>Town</td>
<td>2297</td>
</tr>
<tr>
<td>Village</td>
<td>36183</td>
</tr>
<tr>
<td>Suburb</td>
<td>7895</td>
</tr>
<tr>
<td>Hamlet</td>
<td>22349</td>
</tr>
<tr>
<td>Sum</td>
<td>68826</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Feature description</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPPL</td>
<td>populated place ... where people live and work</td>
<td>73990</td>
</tr>
<tr>
<td>P.PPLL</td>
<td>populated locality ... only with small group of buildings</td>
<td>2236</td>
</tr>
<tr>
<td>P.PPLX</td>
<td>section of populated place</td>
<td>2297</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>78551</td>
</tr>
</tbody>
</table>

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1. **Semantics**
   - Residential area type of both datasets
   - City, Town, Village, Suburb, Hamlet (OSM Tags)
   - PPL, PPLA, PPLL, PPLX (Geonames, featureCodes)

2. **Geometry**
   - Buffer
   - Bounding Box
   - (0.05 x 0.05 deg.)
   - Overlapping Boxes

3. **Name Similarity**
   - Levenshtein Distance
   - Threshold \(\leq 1\)

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## 5 Ongoing Work

<table>
<thead>
<tr>
<th>Place</th>
<th>Matching percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>81</td>
</tr>
<tr>
<td>Town</td>
<td>84</td>
</tr>
<tr>
<td>Village</td>
<td>89</td>
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<tr>
<td>Suburb</td>
<td>73</td>
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<tr>
<td>Hamlet</td>
<td>49</td>
</tr>
<tr>
<td>Sum</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature Code</th>
<th>Matching (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.PPL</td>
<td>67</td>
</tr>
<tr>
<td>P.PPLA</td>
<td>100</td>
</tr>
<tr>
<td>P.PPLL</td>
<td>20</td>
</tr>
<tr>
<td>P.PPLX</td>
<td>53</td>
</tr>
<tr>
<td>Sum</td>
<td>65</td>
</tr>
</tbody>
</table>
5 Ongoing Work

- **SPARQL** *(SPARQL Protocol and RDF Query Language)*
  - Similar to SQL
  - Query RDF Graphs
  - Use results as input for thematic mapping
  - Performance - according cross domain queries?

- Validation of user generated data by comparing different data sets with each other
  - Consistency
  - Completeness
  - Syntactic correctness (toponym ambiguity)
Linked Data – an MRDB at web scale?

- Linked Data is more a webwide Geodatabase than a webwide MRDB
- Methods of MRDB are needed to produce resolution dependent Linked Data
- Our own experiments showed that
  - the task on geometric matching remains
  - there is a need for standard RDF descriptions for Cartography / Geography to enable semantic interoperability
»Wissen schafft Brücken.«

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Dirk.Burghardt@tu-dresden.de
1. Semantic Web

Prefix lgd: <http://linkedgeodata.org/triplify/>
Prefix lgdo:<http://linkedgeodata.org/ontology/>

Prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns>
Prefix rdfs:<http://www.w3.org/2000/01/rdf-schema>

Prefix geo: <http://www.w3.org/2003/01/geo/wgs84_pos>

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2 Linked Data

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2 Linked Data

- **Linked Data rules (according to Tim Berners-Lee):**
  - (HTTP-) URI to identify things
  - Link data to other data
  - Make data accessible
  - Shared vocabularies!
## 5 Outlook

### MRDB

- **Major Methods**: generalisation
- **Purpose**: high quality and effective map production
  - derive different type of maps from different representation levels
- **Research areas**: automated generalisation
  - updates
  - context modelling

### Linked Data

- **Major Methods**: semantic web technology (RDF, OWL)
- **Purpose**: access to spatial and nonspatial Information
  - cross domain data access (SPARQL)
- **Research areas**: Standard semantic descriptions of geographic features (shared vocabularies)
  - semantic interoperability
  - self validating data
5 Outlook

- **SPARQL (SPARQL Protocol and RDF Query Language)**
  - Similar to SQL
  - Query RDF Graphs
  - Use results as input for thematic mapping
  - Performance - according cross domain queries?
- Validation of user generated data by comparing different data sets with each other
  - Consistency
  - Completeness
  - Syntactic correctness (toponym ambiguity)
- Validation of user generated data through logical reasoning
  - E.g. no streets with speed limit above 50km/h within cities