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Generation of Meaningful Location References

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Overview

- Motivation
- Location Referencing Systems (LRS)
- Problem Definition and Related Work
- Approach: Qualitative Location Referencing (QLR)
- Methodology – 3-Steps-Approach
- Generation Process for Location References
- Plausibility Check
- Conclusion and Future Work
Motivation

„On motorway A1 Westautobahn in travel direction Salzburg between exit Wallersee and Salzburg Nord at kilometer 286 be aware of a broken vehicle.“

<table>
<thead>
<tr>
<th>Message parts</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>On motorway A1 Westautobahn</td>
<td>Road: Category, road code and name</td>
</tr>
<tr>
<td>in travel direction Salzburg</td>
<td>Direction: Qualitative direction concept</td>
</tr>
<tr>
<td>between exit Wallersee and Salzburg Nord</td>
<td>Junction: Name</td>
</tr>
<tr>
<td>at kilometer 286</td>
<td>Section: between two junctions</td>
</tr>
<tr>
<td>be aware of a broken vehicle</td>
<td>Linear Reference: Location</td>
</tr>
<tr>
<td></td>
<td>Traffic Event: broken vehicle</td>
</tr>
</tbody>
</table>

**Location Referencing**: How to digitally model location references
Location Referencing Systems (LRS)

- **Static LRS**
  - Digital Road Network, e.g. GDF, GIP.at

- **Dynamic LRS**
  - TMC / TPEG Location Catalogue
  - OpenLR
  - TPEG-ULR
Location Referencing
- Nyerges (1990): location referencing strategies for highways
- Vonderohe et al. (1997): generic data model for location referencing
- Scarponcini (2002): generalized model for linear referencing
- Curtin et al. (2007): process for linear referencing

Research Gap

Conceptual modelling approaches
- Timpf et al. (1992): conceptual model for highway navigation
- Car and Frank (1994): hierarchical algorithm for path search
- Timpf (2002): ontology of wayfinding from a traveller’s perspective
Our Approach: Qualitative Location Referencing (QLR)

Qualitative Location References

Roads

- Directions

Junctions

- Directions

Sections

- Linear References

Generation Process: Ontology and Rules

Conceptual Match

Qualitative Location References

Roads

- Directions

Junctions

- Directions

Sections

- Linear References

Segments

Road Network A

e.g. GIP.at

Road Network B

e.g. OSM
Overall Methodology – 3-Steps-Approach

1. Road Network Graph

2. Ontology and Rules

3. Generation of Location References
Generation Process for Location References

1. Import road network graph (e.g. as graph model in Neo4J database) and ontology (e.g. as OWL – Web Ontology Language)

2. Generate individuals and relationships for Roads and Sections (using road codes/names and topological information)

3. Generate individuals and relationships for Junctions (including on/off ramps)

4. Determine Directions of Roads and Sections (e.g. Cardinal Directions)

Individuals and relationships may be stored as OWL in the database or exported
Plausibility Check

- Q1: Are roads and sections adequately represented on different levels of abstraction?
- Q2: How well does the modelling of junctions work?
- Q3: How can we use junctions as selector for between-sections?
- Q4: Does the qualitative direction concept proof useful?

Test dataset
- Austria’s National Transport Graph (GIP.at) -> available as OGD
- Import of the topologically connected road network from the provided CSV file
- Filter on functional road classes (FRC) 0-4 resulted in 223,328 road segments
- Execution of the proposed generation process

Results
- 25,072 roads and 66,987 road sections
Q1: Modelling of Roads and Road Sections

Sections and Local Roads (Sections)
B179 Fernpassstraße in Tyrol

Individuals of all sections belonging to the B179 Fernpassstraße in Tyrol
Modelling of a complex motorway junction with several slip roads as sections
Example: Junction A1 Westautobahn with B158/B150 at Salzburg North
Q3 and Q4: Section Queries and Qualitative Directions

Qualitative Spatial Query to retrieve all sections sections of “B1 – Wiener Straße” (federal highway) between roundabout “Kreisel Eugendorf A1” and roundabout “B1 - KV Hans Schmid Platz”.

MATCH (j:Roundabout {name: 'Kreisel Eugendorf A1'})-[[:hasJunctionSection]]->(n:Section)
WITH startSec LIMIT 1
MATCH (j:Roundabout {name: 'B1 - KV Hans Schmid Platz'})-[[:hasJunctionSection]]->(n:Section)
WITH endSec LIMIT 1
MATCH (r:Road {roadName: 'B1 – Wiener Straße'})-[[:hasSection]]->(sec)
WITH sec
MATCH p=shortestPath((startSec)-[:connectsSectionTo]*0..9999)->( endSec))
WHERE p IN sec
WITH p
MATCH (p)- [:hasDirection]-(d:CardinalDirection)
RETURN p, d
Conclusions and Outlook

- **Conclusions**
  - Approach for qualitative location referencing on multiple levels of abstraction
  - Provides human-readable, meaningful location references
  - Closes the gap between static and dynamic location referencing
  - Plausibility check with a nation-wide network graph has been accomplished
  - The quality of the generated location references depends on the quality of the network graph

- **Future Work**
  - Evaluation with different network graphs (e.g. GIP.at, OpenStreetMap,…)
  - Optimized recognition of complex junctions
  - More sophisticated qualitative direction concepts
  - Empirical evaluation
Thanks for your attention!
Any questions?

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