Developing a Landmark-based Pedestrian Navigation System using OSM



Plaza Mayor - cc-by Kris Arnold on Flicker

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Our point of departure

We want to ...

- ➔ Compute realistic pedestrian routes
- Compute pedestrian navigation instructions with landmarks
- → Use only commonly available data, i.e. OSM

|)ir | OpenStreetMap ections | × |
|------|---------------------------------------|------|
| ista | ance: 213m. Time: 0:03. | |
| t | Go north on Augustinerstraße. | 10m |
| ١ | Bear left. | 30m |
| ነ | Turn left onto Josefsplatz. | 50m |
| 7 | Turn right to stay on Josefsplatz. | 100m |
| 1 | Continue. | 20m |
| ٦ | Turn left. | 10m |
| • | You have arrived at your destination. | |





Outline

- 1. Constructing a pedestrian routing graph from OSM
- 2. Extracting landmarks from OSM
- 3. Generating landmark-based pedestrian instructions
- 4. Challenges



Topic 1: Constructing a pedestrian routing graph from OSM

- using information from globally available **OpenStreetMap** database
- based on sidewalks not on roads
- considering way quality criteria (based on selected route attributes)
- including road crossing and square crossing



 Naumann S. and Kovalyov M.Y. (accepted) Pedestrian Route Search based on OpenStreetMap. 3th SCIENTIFIC AND TECHNICAL CONFERENCE TRANSPORT SYSTEMS THEORY AND PRACTICE, Katowice, Poland, September 19-21, 2016.
 Naumann, S., Czogalla, O., Kühner, F. (2015) A Safety Index for Road Crossing, Future Active Safety Technology Towards zero traffic accidents, FASTzero 2015 Symposium, Gothenburg, Sweden.



Integration of pedestrian squares into the routing graph



Graser, A. (2016) Integrating Open Spaces Into OpenStreetMap Routing Graphs for Realistic Crossing Behavior in Pedestrian Navigation. GI_Forum – Journal for Geographic Information Science, 1-2016, 217-230, doi:10.1553/giscience2016_01_s217.



Visibility Graph

experimental implementation in QGIS





Visibility Graph

experimental implementation in QGIS





Routing through the pedestrian square

experimental implementation in QGIS



Graser, A. (2016) Integrating Open Spaces Into OpenStreetMap Routing Graphs for Realistic Crossing Behavior in Pedestrian Navigation. GI_Forum – Journal for Geographic Information Science, 1-2016, 217-230, doi:10.1553/giscience2016_01_s217.



Topic 2: Extracting Potential Landmarks from OSM



OSM import with ogr2ogr PERRON views





Point landmarks

CREATE OR REPLACE VIEW osm20150130 vienna.landmark points AS SELECT ogc_fid, wkb geometry, . . . FROM osm20150130 vienna.points WHERE other tags -> 'amenity' IN ('restaurant', 'telephone', 'bus station', 'embassy', 'cafe', 'pub' OR other tags -> 'shop' IN ('supermarket', 'bakery', 'chemist', 'clothes', OR other tags -> 'building' IN ('church', 'mosque', 'synagogue', 'cathedre **Points** OR other tags -> 'tourism' IN ('museum', 'attraction', 'hotel') OR other tags -> 'historic' IN ('memorial', 'archaelogical site') OR other tags -> 'leisure' IN ('park', 'playground') OR other tags -> 'railway' IN ('subway entrance') OR other tags -> 'public transport' IN ('platform', 'stop position') OR points.highway = 'bus stop' OR points.highway = 'traffic signal';



Polygon landmarks

CREATE OR REPLACE VIEW osm20150130 vienna.landmark polygons AS SELECT ogc fid, wkb geometry, . . . WHERE (amenity IN ('restaurant', 'cafe', 'pub', 'bar', 'hospital', 'pharmacy', 'place of worship', 'school', 'university', 'bank', 'theatre', 'cinema', 'bicycle rental', 'fuel', 'toilets', 'police', 'prison', 'fire station', 'library', 'post box', 'post office', 'bus station', 'embassy', 'telephone', 'fountain') Poly-OR shop IN ('supermarket', 'bakery', 'chemist', 'clothes', 'jewelry', 'kiosk', gons OR building IN ('church', 'mosque', 'synagogue', 'cathedral', 'school', 'univer OR tourism IN ('museum', 'attraction', 'hotel') OR historic IN ('memorial', 'archaelogical site') OR leisure IN ('park', 'playground') OR other tags -> 'railway' = 'subway entrance'::text OR other tags -> 'public transport' IN ('platform','stop position') OR other tags -> 'highway' IN ('bus stop', 'traffic signals')) AND NOT (other tags is not null and exist(other tags, 'layer') AND (other tags



Weights for landmarks

```
CREATE OR REPLACE VIEW osm20150130 vienna.landmark points AS
SELECT ogc fid,
    wkb geometry,
    osm id,
    name,
    barrier,
   highway,
   ref,
   address,
   is in,
   place,
   man made,
    other tags,
                                                                                          Descriptive
    CASE WHEN name is null THEN other tags -> 'amenity'
        WHEN other tags -> 'tourism' = 'hotel' THEN 'Hotel' || ' ' || name
                                                                                              name
        WHEN other tags -> 'bus' = 'yes' THEN 'bus stop' || ' ' || name
        WHEN other tags -> 'subway' = 'yes' THEN 'metro entrance' || ' ' || name
        WHEN exist (other tags, 'amenity') THEN other tags -> 'amenity' || ' ' || name
        ELSE name
         END
         as nav name,
    other tags->'addr:street' as nav addr str,
    CASE WHEN other tags -> 'shop' IN ('supermarket') THEN 100
        WHEN other tags -> 'amenity' IN ('restaurant','cafe', 'pub', 'bar') THEN 80
                                                                                             Weight
        ELSE 1
         END
        as nav_priority
  FROM osm20150130 vienna.points
  WHERE
other tags -> 'amenity' IN ('restaurant', 'telephone', 'bus station', 'embassy', 'cafe', 'pub'
```



Topic 3: Generating landmark-based pedestrian instructions

Pedestrian-centered navigation instructions

- using information from globally available **OpenStreetMap** database
- automatic selection of **most suitable landmark**



Graser, A., & Straub, M. (2015). Improving Navigation: Automated Name Extraction for Separately Mapped Pedestrian and Cycle Links. GI_Forum – Journal for Geographic Information Science, 1-2015, 546-556, doi:10.1553/giscience2015s546.

Graser, A., Straub, M., Sellitsch, D., Schwarz, S., Olaverri-Monreal C. (2015) Why Pedestrians are still stuck with Navigation Tools Designed for Cars, Vienna Walk21 conference, Vienna, Austria.



Landmark navigation model workflow





1. Splitting the route at decision points

- Direction change
- Road name change
- Change in type of way (sidewalk, stairs, square/plaza crossing, ...)



2. Computing turning instructions





3. Selecting landmarks

Approaches

- All named buildings in buffer [Elias & Sester 2002]
- Most unique building at decision point [Elias 2003]
- Rule-based using categories [Duckham et al. 2010, Dräger & Koller 2012]
- Features with highest "landmarkness" [Quesnot & Roche 2014]
- Neuronal network [Zhu & Karimi 2015]



3. Selecting landmarks



$$S = (d_{max} - d) * w_d - (c_{max} - c * \frac{d_{max}}{c_{max}}) * w_c + s * w_s + l * w_l + v * w_v$$

where

d Distance between decision point and landmark

 d_{max} ... Maximum distance for a candidate to be considered

- c..... Landmark category suitability
- cmax ... Maximum landmark category suitability value
- l Location of the landmark relative to the route: before (1) or after (0) the decision point
- v...... Visibility of the landmark: visible (1) or hidden (0)

and w_d, w_c, w_s, w_l, w_v are the weights for the terms for distance, category suitability, side, location, and visibility.



4. Computing landmark prepositions





5. Generating the final route description

Edge: sidewalk along <street name 1> Turn instruction: right Landmark: Polygon LM1 Preposition: at Edge: pedestrian crossing of <street name 1> Turn instruction: left Polygon LM1 Landmark: Point IM2 Preposition: before Edge: sidewalk along <street name 1> Turn instruction: right Landmark: Point LM2 Preposition: after Point LM2 Edge: sidewalk along <street name 2>



5. Generating the final route description

Navigation Instructions

- Start at Sacher Cafe Wien (amenity=cafe) on Philharmonikerstraße heading E. Continue for 67 meters towards Hotel Sacher vivaldi yildizi (amenity=cafe)
- Turn sharp left after Hotel Sacher vivaldi yildizi (amenity=cafe) on footpath along Herbert-von-Karajan-Platz. Continue for 13 meters
- Turn slight left at Starbucks (amenity=cafe) on Kärntner Straße. Continue for 109 meters towards Lubella (amenity=restaurant)
- Turn right at Lubella (amenity=restaurant) on Annagasse. Continue for 112 meters towards Weinbotschaft (amenity=restaurant)
- 5. You reached your destination before Weinbotschaft (amenity=restaurant) on Annagasse





Open Route format

| Personal | Open source | Business | Explore | Pricing | Blog | Support | This repository | Search | | Sign in | Sig | n up |
|------------------|---------------|-----------------|---------|------------|------|---------|-----------------|-----------|-------|---------|-------|------|
| 📮 dts-ait / spro | ute-json-rout | e-format | | | | | | • Watch 2 | ★ Sta | ar O | ¥ For | k 0 |
| <>Code ① Ⅰ | ssues 0 🕅 P | oull requests 0 | Pulse | III Graphs | 5 | | | | | | | |

JSON exchange format for routes developed by the Austrian Institute of Technology (AIT) and Fluidtime

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|---|------------------------------------|----------------------------|---------------------------|---------------------------|--|--|--|--|
| Branch: master - | New pull request | New file Find file | HTTPS - https://github.co | m/dts-ai 🛱 😫 Download ZIP | | | | |
| ∕⊪⊤ dts-ait more tests for RouteSegmentMerger & better TestUtils Latest commit 0305af0 an hour a | | | | | | | | |
| example | update examples, minor fixes | | | 3 months ago | | | | |
| src | more tests for RouteSegmentMer | rger & better TestUtils | | an hour ago | | | | |
| .gitignore | change package name, | | | a year ago | | | | |
| | Initial commit | | | a year ago | | | | |
| README.md | specify public transport represent | tation | | 9 days ago | | | | |
| pom.xml | round arrival/departure time to se | conds in route request, ma | ke defaul | 28 days ago | | | | |

https://github.com/dts-ait/sproute-json-route-format



Challenge I Decision points on zig-zag routes

Navigation Instructions

- Start at Sky Cafe, Restaurant, Bar (amenity=restaurant) on Kärntner Straße heading N. Continue for 79 meters towards Pizzeria Ristorante Venezia (amenity=restaurant)
- 2. Turn right at Pizzeria Ristorante Venezia (amenity=restaurant) on Weihburggasse. Continue for 41 meters
- Turn right before Hotel Kaiserin Elisabeth (tourism=hotel) on sidewalk along Weihburggasse. Continue for 3 meters
- Turn left after Hotel Kaiserin Elisabeth (tourism=hotel) on Weihburggasse. Continue for 56 meters towards Dornbirner Sparkasse (amenity=bank)
- 5. You reached your destination after Dornbirner Sparkasse (amenity=bank) on sidewalk along Weihburggasse





Challenge I Decision points on zig-zag routes





Challenge I Decision points on zig-zag routes





Challenge II Landmark visibility: point LMs inside polygons



Rousell, A., Hahmann, S., Bakillah, M., & Mobasheri, A. (2015). Extraction of landmarks from OpenStreetMap for use in navigational instructions. In *Proceedings of the AGILE Conference on Geographic Information Science*(Vol. 83).



Challenge III Direction-dependant landmark salience





Challenge IV Prepositions at huge polygon landmarks





Challenge V Generating text for text-to-speech instructions

Appropriate level of detail





Ongoing and future work

- → Implementation of developed methods for PERRON prototype
- → Field tests in Vienna and Magdeburg





Contact

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