Routing on rails with OpenStreetMap

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Current solutions
Travic
filtering the planet using osmfilter, routing with OSRM, rumours about tag replacement
OSRM, support of left/right track, reversing
Railway tracks in OpenStreetMap

- connected
- one way per track
- 1,841,430 km tracks (608,055 km in Europe)
- 1,239,753 possible points (634,524 in Europe)
- 289,423 points tagged with railway=switch (208,078 in Europe)
Railway tracks in OpenStreetMap
Simple points
double slip point (railway=switch + railway:switch=double_slip)
Railway tracks in OpenStreetMap

Slip points

single slip point (railway=switch + railway:switch=single_slip)
Railway tracks in OpenStreetMap
Slip points

crossing (railway=railway_crossing)
Railway tracks in OpenStreetMap
Tags

- railway=rail/light_rail/tram/subway/narrow_gauge
- gauge=* 
- electrified=no/yes/contact_line/rail 
- voltage=* 
- frequency=* 
- See Railways at OpenStreetMap at SotM 2016 for more.
Features

- power systems
- gauges
- preconfigured profiles
  - freight train and TGV profiles for France and Germany/Austria/Switzerland
  - universal diesel train (any gauges), max. 120 kph
  - universal electric train (any gauges, any power system), max. 140 kph
- profile customization via YAML file
- reversing
- reduced default speeds for crossovers and other slower tracks
- map matching (CSV, GPX)
Demo

OSM data
Features
Demo
Performance
Implementation
Future
Performance

- `osmium tags-filter -o planet-rail.osm.pbf planet.osm.pbf nw/railway` 6 minutes on a fast server, 1–2 GB RAM
- 168 MB .osm.pbf file
- import: about 1 minute, 1200 MB RAM without contraction hierarchies
- graph: 204 MB
- 2450 routes through Germany
  - 2352 successful routes
  - 2 minutes 8 seconds, 1 thread
  - average length per route: 409 km
Implementierung
FlagEncoder

com.graphhopper.routing.util

interface FlagEncoder

AbstractFlagEncoder

de.geofabrik.railway_routing

RailFlagEncoder
Implementierung

RailFlagEncoder

- electrifiedValues: ArrayList<String>
- acceptedVoltages: ArrayList<Integer>
- acceptedFrequencies: ArrayList<Double>
- acceptedGauges: ArrayList<Integer>
- speedCorrectionFactor: double

+ RailFlagEncoder(properties: PMap)
RailFlagEncoder

- electrifiedValues: ArrayList<String>
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RailFlagEncoder(properties: PMap)

YAML config
name
electrified
voltages
frequencies
gauges
maxspeed
speedFactor
Experiences with GraphHopper

+ suitable for routing on any routeable OSM network
  - introduction into FlagEncoder could be more verbose
  - TurnCostExtension without good documentation → misconceptions
  - no different penalties for reversing for each FlagEncoder
  - a library for car routing only
    * flag encoders designed to be extensible
    * addition of turn restrictions not designed to be extensible
    * reading of OSM files not extensible → fork of GraphHopper

+ forum
  * Read the unit tests!
Space for improvement
Left/right track on double-tracked lines
Space for improvement
Tag to distinguish left and right tracks

railway:preferred_direction=forward/backward
Space for improvement
Estimation of travel times

currently 0.9 · speed limit
Space for improvement

Estimation of travel times

currently $0.9 \cdot \text{speed limit}$

Comparison of timetables of nonstop IC trains using the TGV profile (max. 160 kph due to old infrastructure)

<table>
<thead>
<tr>
<th></th>
<th>timetable</th>
<th>routing</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC Koblenz–Mainz</td>
<td>1:05</td>
<td>0:50</td>
</tr>
<tr>
<td>IC Magdeburg–Dessau</td>
<td>0:42</td>
<td>0:36</td>
</tr>
</tbody>
</table>
Space for improvement
Specify heading direction
Space for improvement
Specify heading direction
Missing data
Gradients

Hansueli Krapf, Wikimedia Commons, CC-BY-SA 3.0
Problems

- SRTM resolution too low
  - cuttings and embankments in SRTM data
  - narrow valleys
  - vertical precision
Missing data
Gradients

Problems
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Solutions?
- Use railway lines to correct elevation data?
- elevation profiles provided by operator of infrastructure
- Measure elevation profiles data ourselves?
Missing data
Lines for special purpose (S-train, RER, ...), diesel engine bans

Poudou99, Wikimedia Commons, CC-BY-SA 4.0
Missing data
Loading gauge

Falk2, Wikimedia Commons, CC-BY-SA 4.0
Missing data
Loading gauge

current solutions
OSM data
Features
Demo
Performance
Implementation
Future

FlagEncoder

.osm.pbf file

shape file/PostGIS database
polygons around lines with special properties
The development of this software has been sponsored by

Source code:
https://github.com/geofabrik/railway_routing