

# Routing on rails with OpenStreetMap

Michael Reichert (Nakaner)



Michael  
Reichert  
(Nakaner)

Current  
solutions

OSM data

Features

Demo

Performance

Implemen-  
tation

Future





# Current solutions

## Mentz

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Performance

Implementation

Future

The screenshot shows a web browser window with the URL <https://www.kvv.de/fahrt-plane/fahrplanauskunft.html>. The page displays travel details for a route from Karlsruhe to Stuttgart. The route is shown on a map and includes the following details:

- Fahrtdetails**
- Verkehrsmittel + Fußweg:
- Früher:
- 13:28 - 14:04: ICE 9573
- 13:28 Karlsruhe Hbf (Gleis 7)
- 13:28 Stuttgart Hauptbahnhof (oben) Ankunft 14:04
- Bordrestaurant
- Fahrzeuggebundene Einstiegshilfe vorhanden
- Ohne Zwischenhalt
- 14:04 Stuttgart, Hauptbahnhof (oben)
- 14:05 - 14:58: ICE 19041 (53 Min.)

A large red watermark reading "Proprietary" is overlaid diagonally across the center of the image.

# Current solutions

Raildar.fr

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OSM data

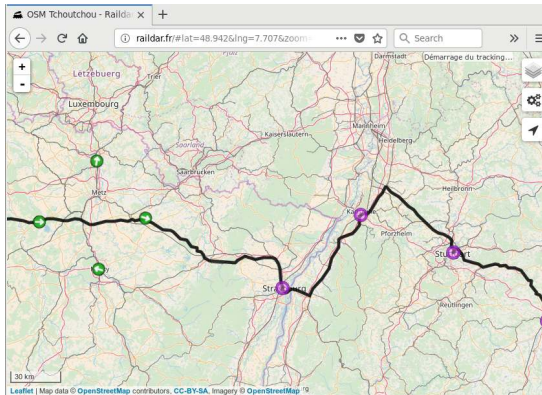
Features

Demo

Performance

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tation

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filtering the planet using osmfilter, routing with OSRM,  
rumours about tag replacement

# Current solutions

Signal.eu.org

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Current solutions

OSM data

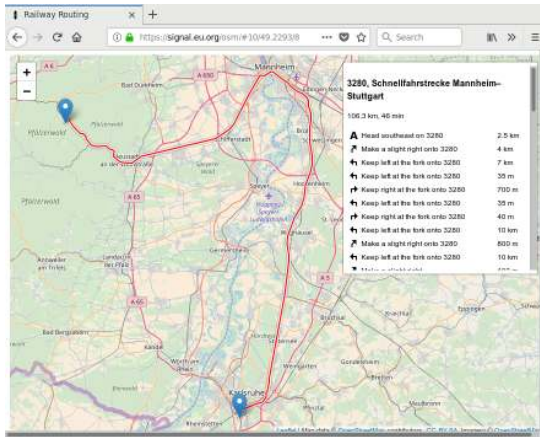
Features

Demo

Performance

Implementation

Future



OSRM, support of left/right track, reversing

# Railway tracks in OpenStreetMap

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Features

Demo

Performance

Implemen-  
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Future

- 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

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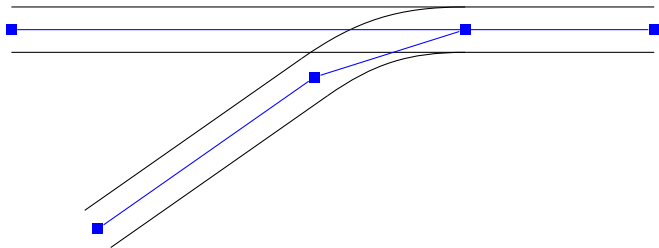
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# Railway tracks in OpenStreetMap

## Slip points

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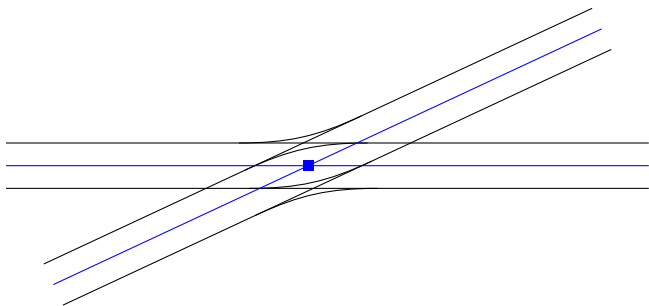
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Demo

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double slip point (railway=switch +  
railway:switch=double\_slip)

# Railway tracks in OpenStreetMap

## Slip points

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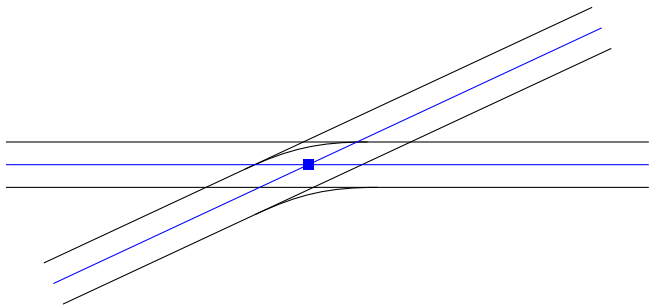
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single slip point (railway=switch +  
railway:switch=single\_slip)

# Railway tracks in OpenStreetMap

## Slip points

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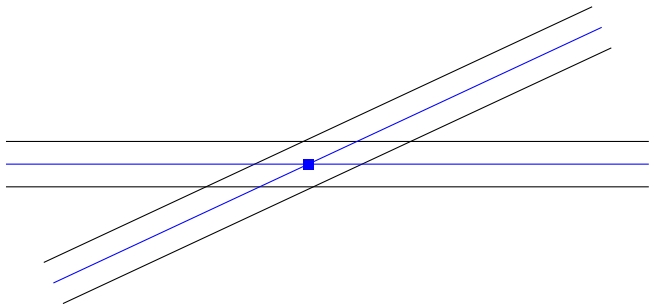
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crossing (railway=railway\_crossing)

# Railway tracks in OpenStreetMap

## Tags

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- `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

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Demo

Performance

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- 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

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Features

**Demo**

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Future

# Demo

# Performance

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Features

Demo

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- `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

# Implementation

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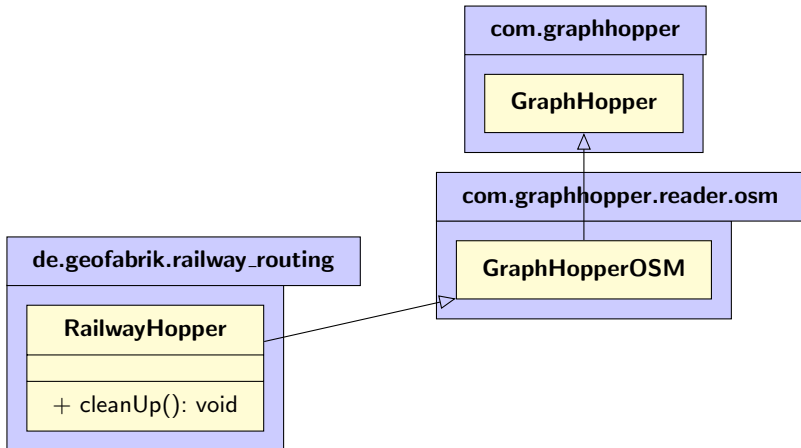
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Demo

Performance

Implement-  
ation

Future





# Implementierung FlagEncoder

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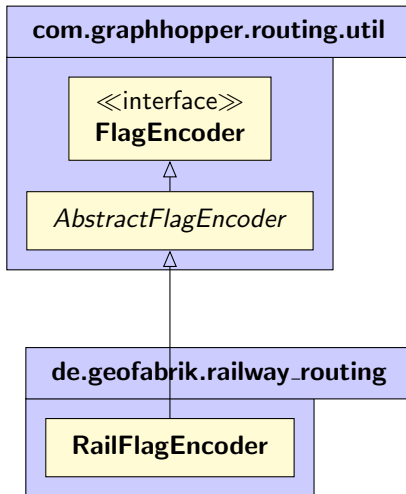
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Demo

Performance

Implemen-  
tation

Future



# Implementierung

## RailFlagEncoder

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Demo

Performance

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### RailFlagEncoder

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

+ RailFlagEncoder(properties: PMap)

# Implementierung

## RailFlagEncoder

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OSM data

Features

Demo

Performance

Implement-  
ation

Future

### RailFlagEncoder

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

+ RailFlagEncoder(properties: PMap)

### YAML config

name

electrified

voltages

frequencies

gauges

maxspeed

speedFactor

# Experiences with GraphHopper

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Features

Demo

Performance

Implemen-  
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- + 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

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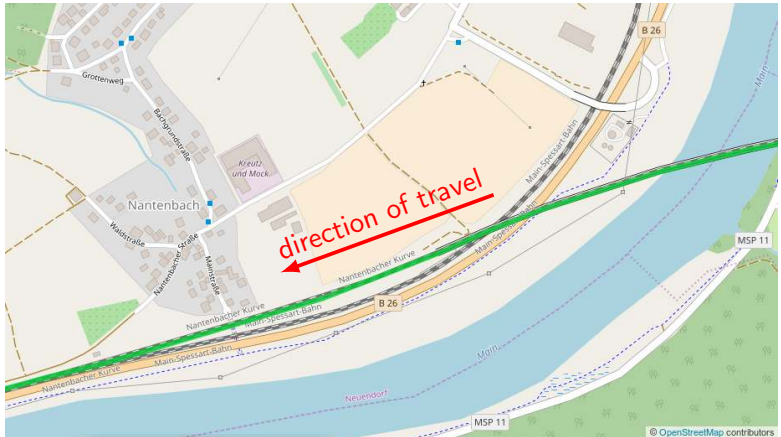
Features

Demo

Performance

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# Space for improvement

## Tag to distinguish left and right tracks

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Features

Demo

Performance

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railway:preferred\_direction=forward/backward

# Space for improvement

Estimation of travel times

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

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Features

Demo

Performance

Implemen-  
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# Space for improvement

Estimation of travel times

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Features

Demo

Performance

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currently  $0.9 \cdot$  speed limit

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

	<b>timetable</b>	<b>routing</b>
IC Koblenz–Mainz	1:05	0:50
IC Magdeburg–Dessau	0:42	0:36

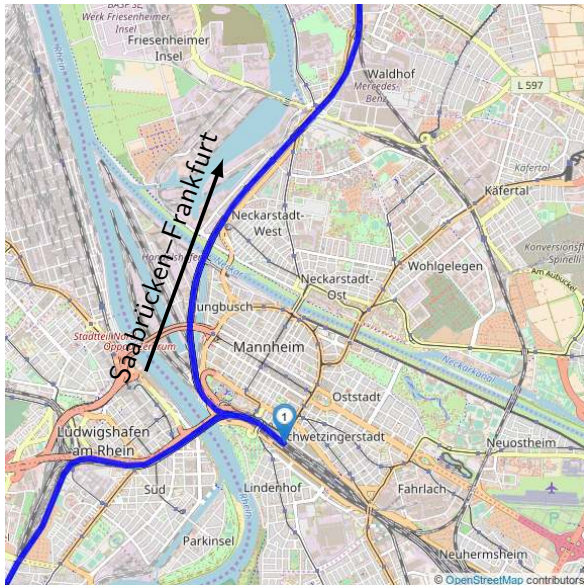


# Space for improvement

Specify heading direction

Michael Reichert (Nakaner)

- Current solutions
- OSM data
- Features
- Demo
- Performance
- Implementation
- Future



# Space for improvement

Specify heading direction

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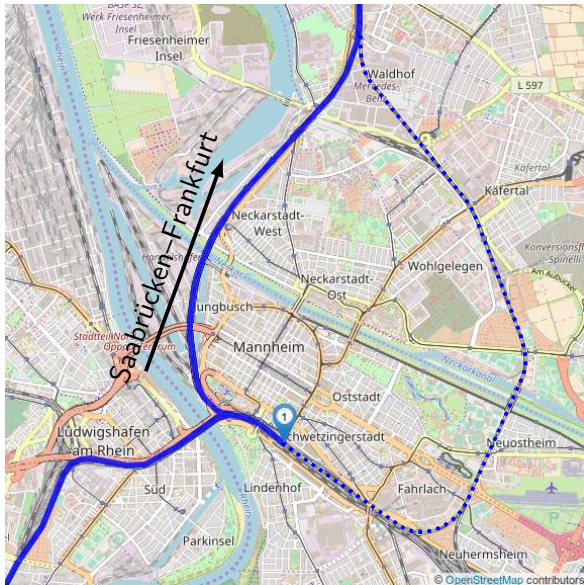
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Demo

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Implementation

Future



# Missing data

## Gradients

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# Missing data

## Gradients

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Features

Demo

Performance

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Future

## Problems

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

# Missing data

## Gradients

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OSM data

Features

Demo

Performance

Implemen-  
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## Problems

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

## 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

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# Missing data

## Loading gauge

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# Missing data

Loading gauge

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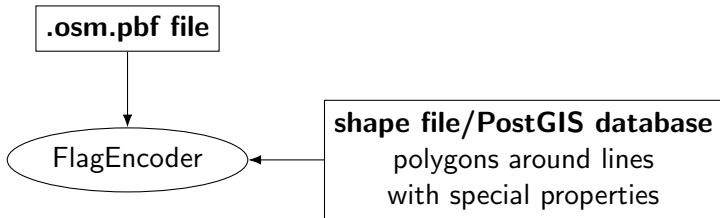
Features

Demo

Performance

Implemen-  
tation

Future





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solutions

OSM data

Features

Demo

Performance

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**GEOFABRIK**   
neogeografie // software // beratung

Source code:

[https://github.com/geofabrik/railway\\_routing](https://github.com/geofabrik/railway_routing)