Is OSM Good Enough for Vehicle Routing? A Study Comparing Street Networks in Vienna

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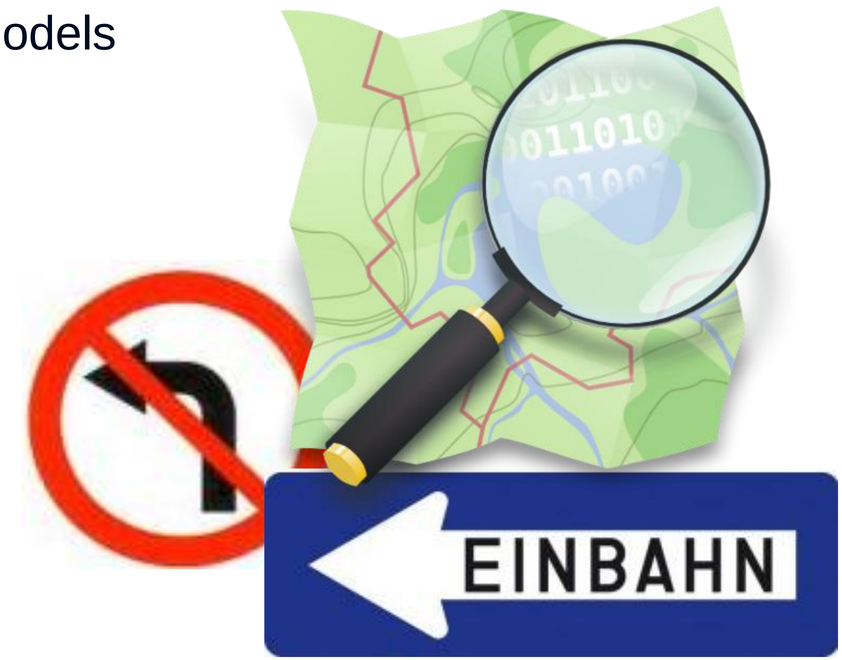
Outline

- Introduction to OSM and GIP street models
- Basic quality indicators
- Vehicle routing quality indicators
- Routing comparison
- Conclusion



Motivation

- Street network quality is essential for a wide range of applications
- OSM is global and open

  BUT concerns about the quality for applications in the mobility context

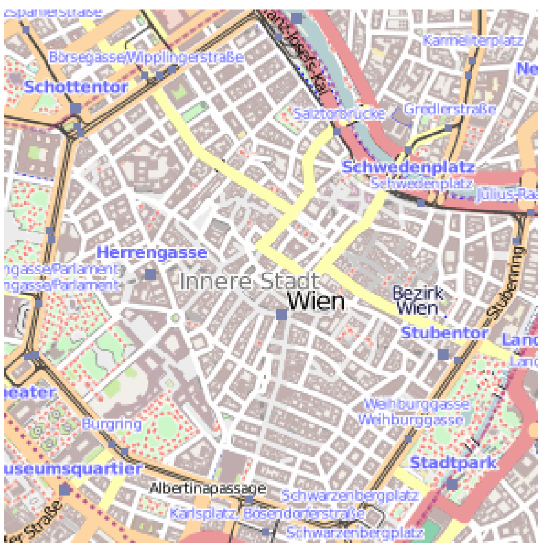
Introduction to OSM & GIP street models

OSM

www.openstreetmap.org

Open user-generated world map

- Everybody can edit
- Everybody can use



GIP

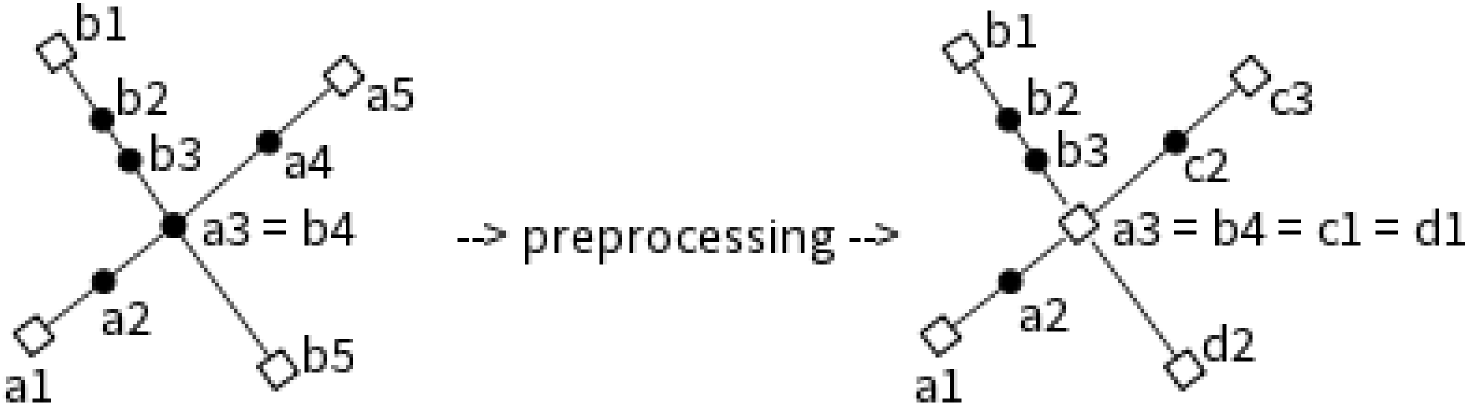
www.gip.gv.at

Official Austrian reference graph

- From official authorities
- Limited access

OSM street graph preprocessing

… making OSM routable



Street network modeling – classification

… matching OSM highway tag and GIP FRC

GIP FRC

OSM highway

	0	1	2	3	4	5	6	7	8	11 or 108
motorway	A									
trunk		B	B							
primary		B	B							
secondary				C	C					
tertiary				C	C					
unclassified						D	D	D		
living_street						D	D	D		
service						D	D	D		
residential						D	D	D	D	
track										E

Street network modeling – driving permissions

OSM

- Default driving permissions for street classes
  + specific restrictions
  + oneway attribute

eg.
vehicle=no & bicycle=yes
→ no driving access except for bicycles

GIP

- Binary-coded driving permissions for each mode of transport and driving direction

Street network modeling – turn restrictions

OSM

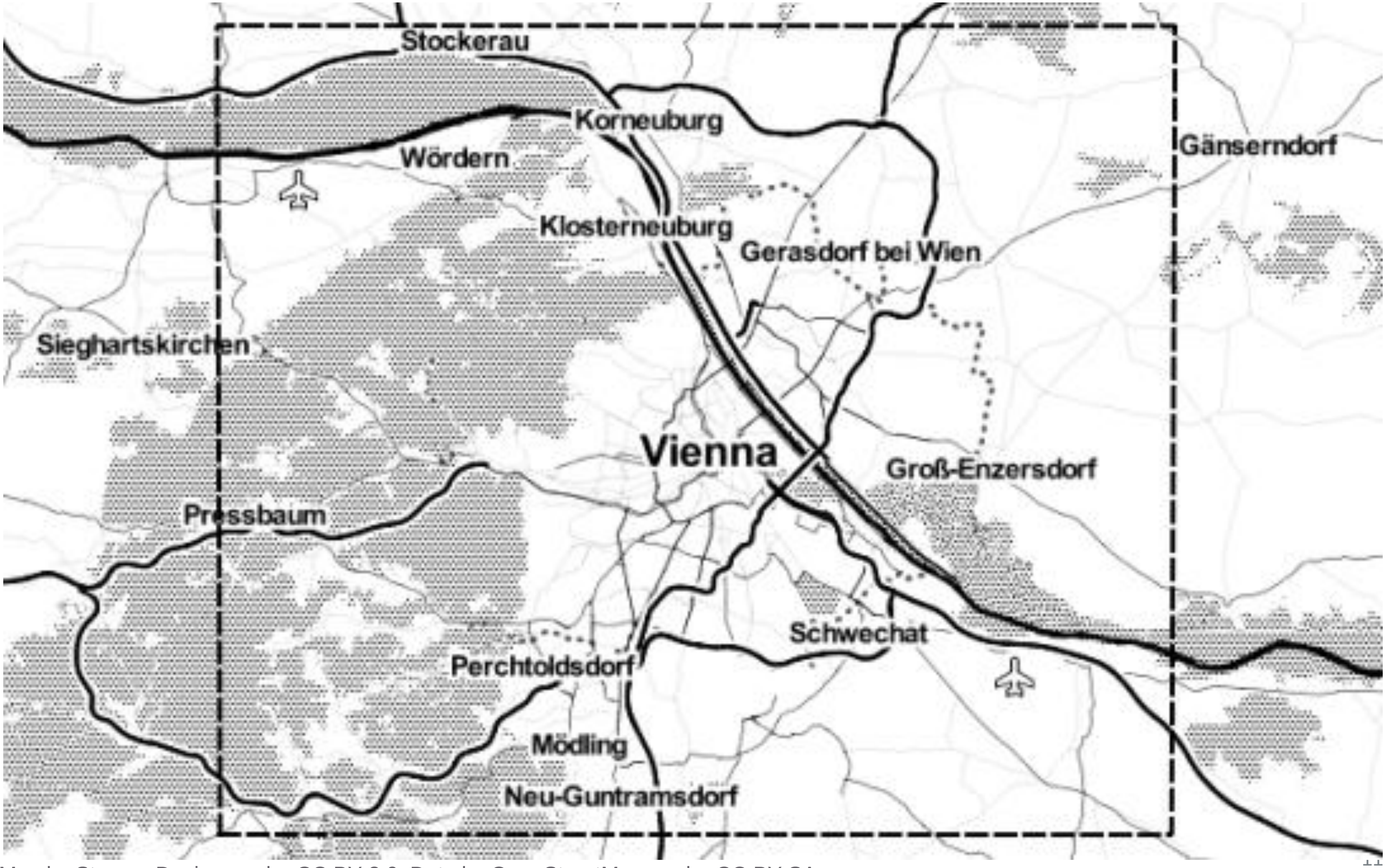
- By default, every possible turn is allowed
  + explicit restrictions and commands

GIP

- Explicitly modeled turn relations
  ➔ every other turn is forbidden

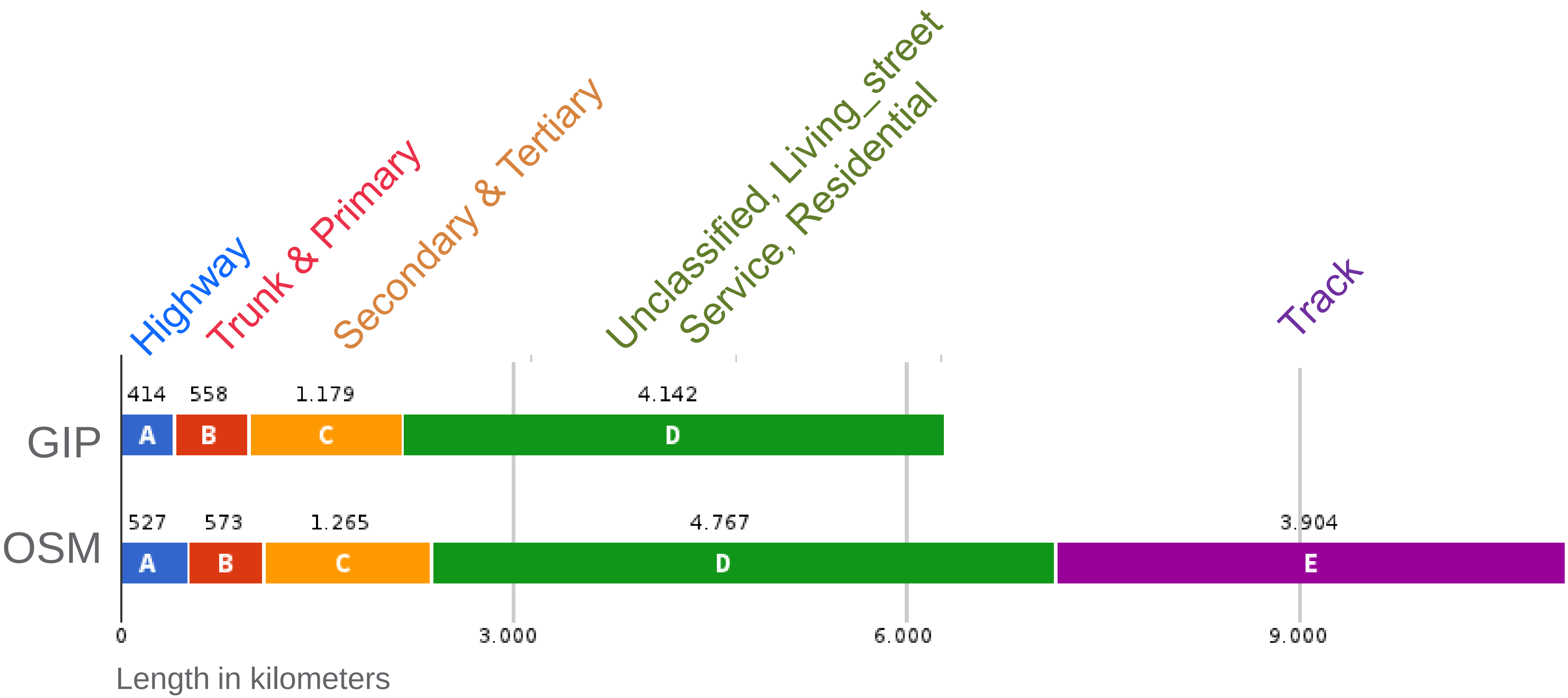
Basic quality indicators

Study area

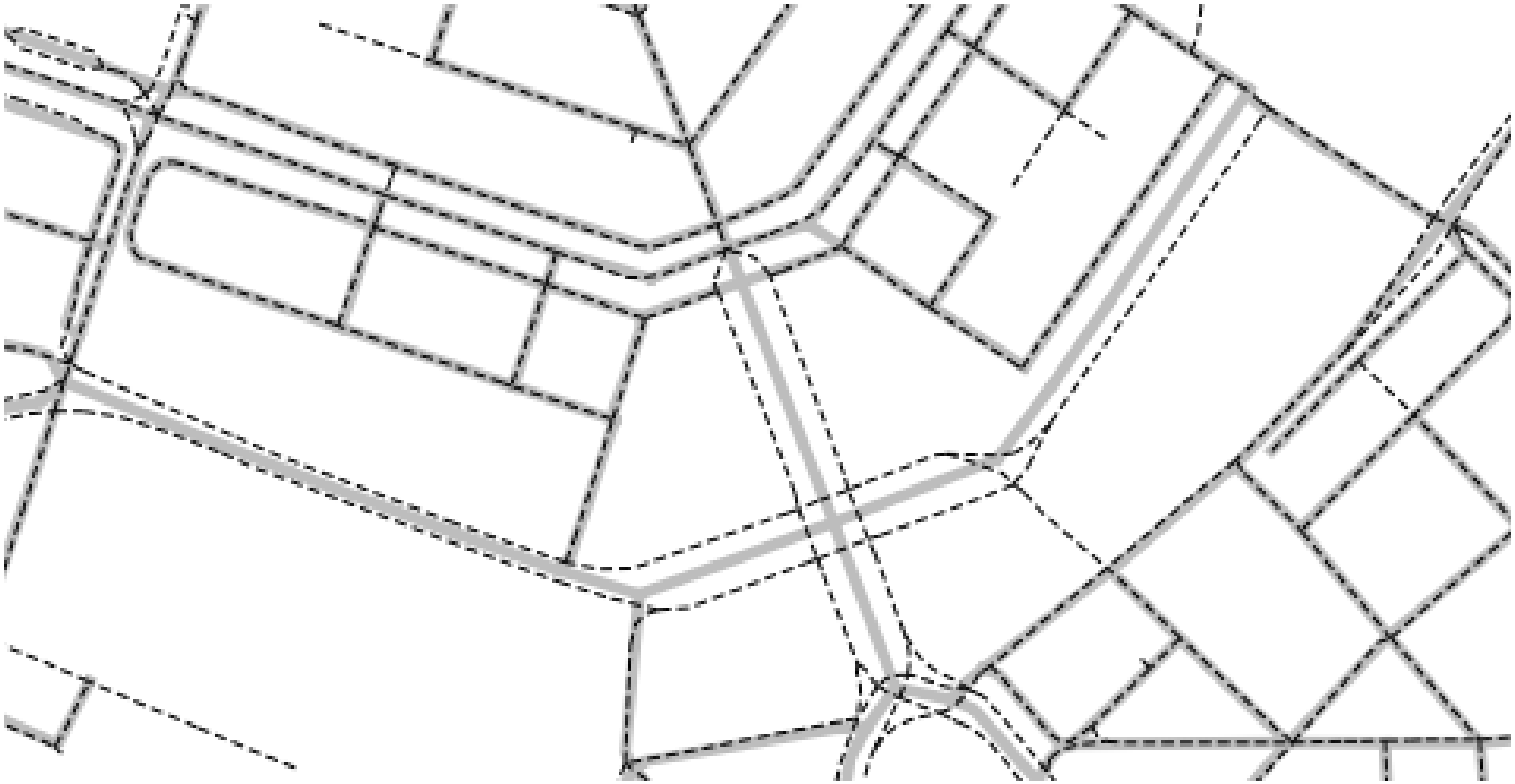


Stockerau
Korneuburg
Wördern
Gänserndorf
Klosterneuburg
Gerasdorf bei Wien
Sieghartskirchen
Vienna
Groß-Enzersdorf
Pressbaum
Schwechat
Perchtoldsdorf
Mödling
Neu-Guntramsdorf

Basic indicators I: network length



Basic indicators I: network length



OSM (black dashed) – GIP (grey solid)

Basic indicators II: attribute completeness

	Name		Speed	
	OSM	GIP	OSM	GIP
Total network (without tracks)	5,540 km (78 %)	5,936 km (94 %)	3,079 km (43 %)	6,294 km (100 %)
Class A	359 km (68 %)	402 km (97%)	395 km (75 %)	414 km (100 %)
Class B	429 km (75 %)	555 km (100 %)	452 km (79 %)	558 km (100 %)
Class C	981 km (78 %)	1,153 km (98 %)	813 km (64 %)	1,179 km (100 %)
Class D	3,770 km (79 %)	3,826 km (92 %)	1,418 km (30 %)	4,142 km (100 %)

Basic indicators III: turn restriction count

	OSM	GIP
Number of turn restrictions	691	2,500

Modeling differences make comparing counts unreliable!

Vehicle routing quality indicators

Vehicle routing quality indicators I: turn restrictions

black arrows violating restrictions

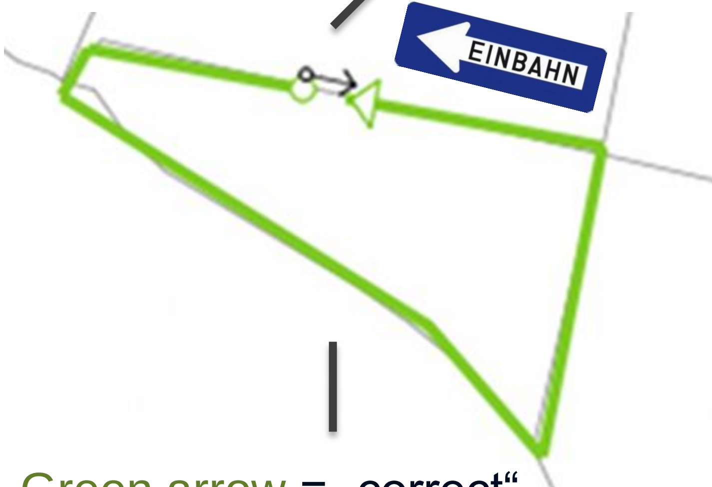
Green arrow = „correct“
an alternative route was generated
→ Both OSM & GIP contain the same turn restriction

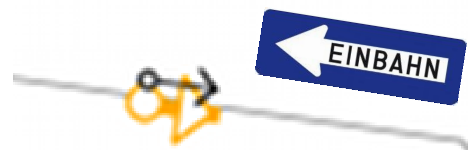
Orange arrow = „wrong“
route ignores the restriction
→ OSM & GIP don’t agree

A. Graser, M. Straub, M. Dragaschnig: “Towards an Open Source Analysis Toolbox for Street Network Comparison: Indicators, Tools and Results of a Comparison of OSM and the Official Austrian Reference Graph”; in Transactions in GIS, 18: 510–526. doi: 10.1111/tgis.12061 (2014)

Vehicle routing quality indicators II: one-way streets

black arrows against one-way direction





Green arrow = „correct“
an alternative route was generated
→ Both OSM & GIP contain the same one-way information

Orange arrow = „wrong“
route ignores the restriction
→ OSM & GIP don’t agree

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One-way and turn restriction comparison

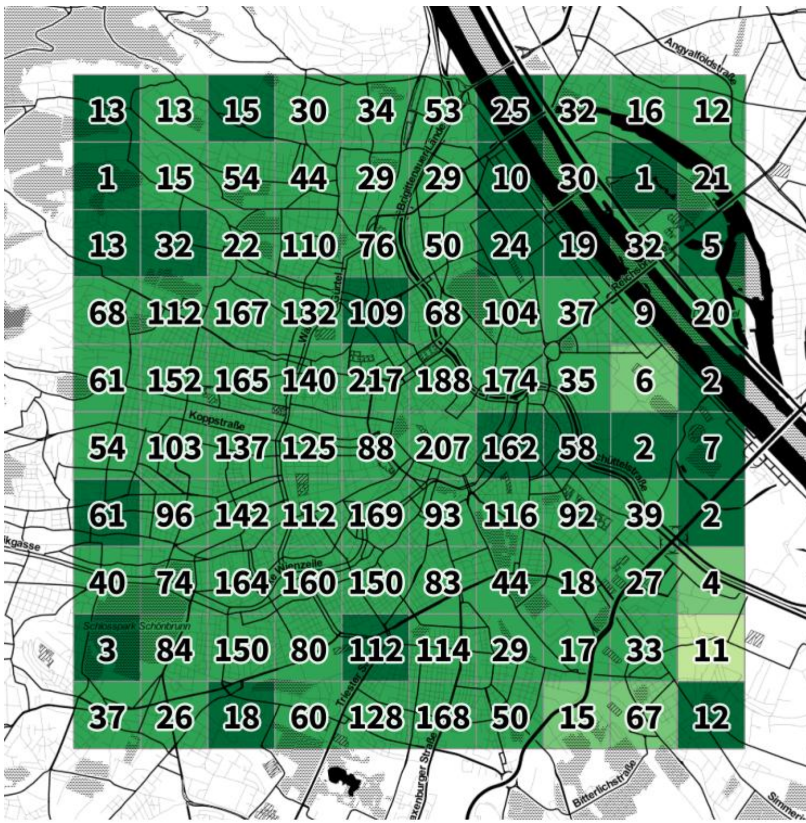
	Total	Matches	Differences
One-way streets	6,595	6,289 (95.4 %)	306 (4.6 %)
Turn restrictions	1,232	842 (68.3 %)	390 (31.7 %)

Manual evaluation in the 9th district of Vienna

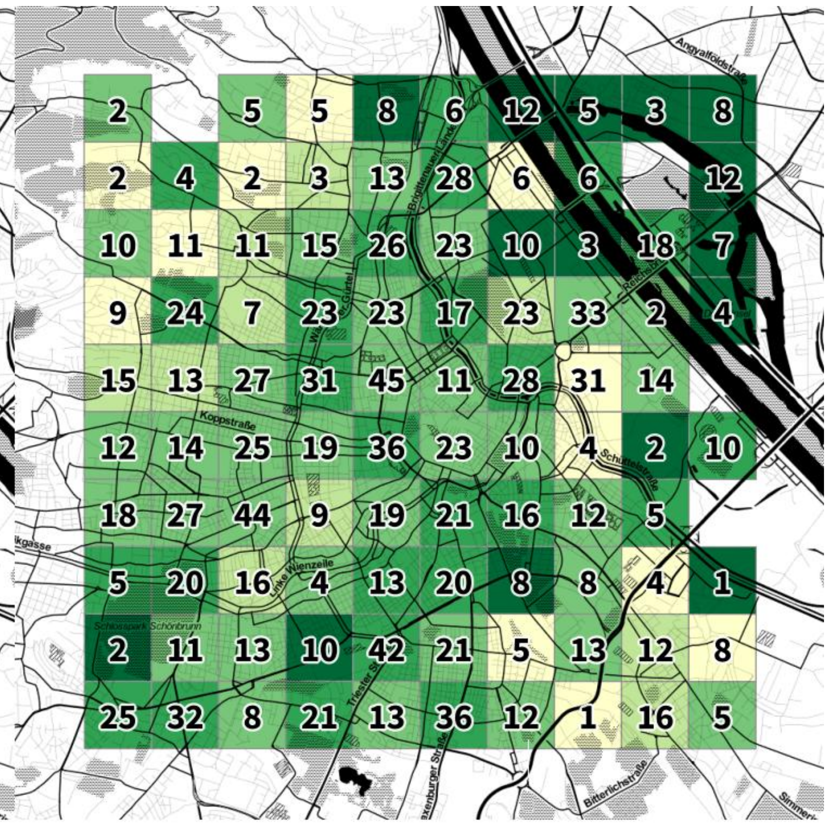
	Differences	OSM errors	GIP errors	Other
One-way streets	9	7	2 (22.2 %)	
Turn restrictions	20	11	6 (30.0 %)	3

Spatial distribution of one-way streets & turn restrictions and matching features

One-way streets



Turn restrictions



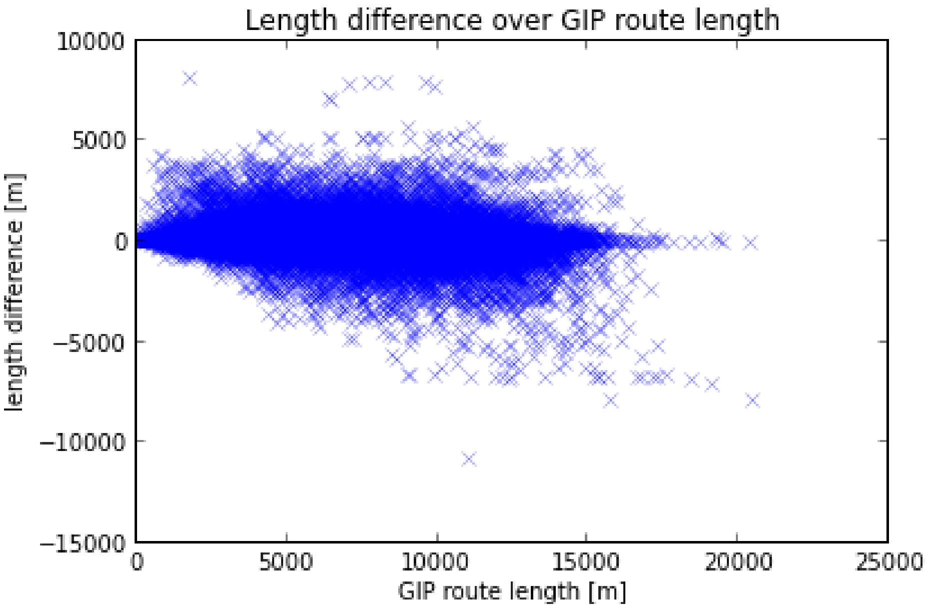
perfect match | < 100% | < 75% | < 50% | < 25% | no features

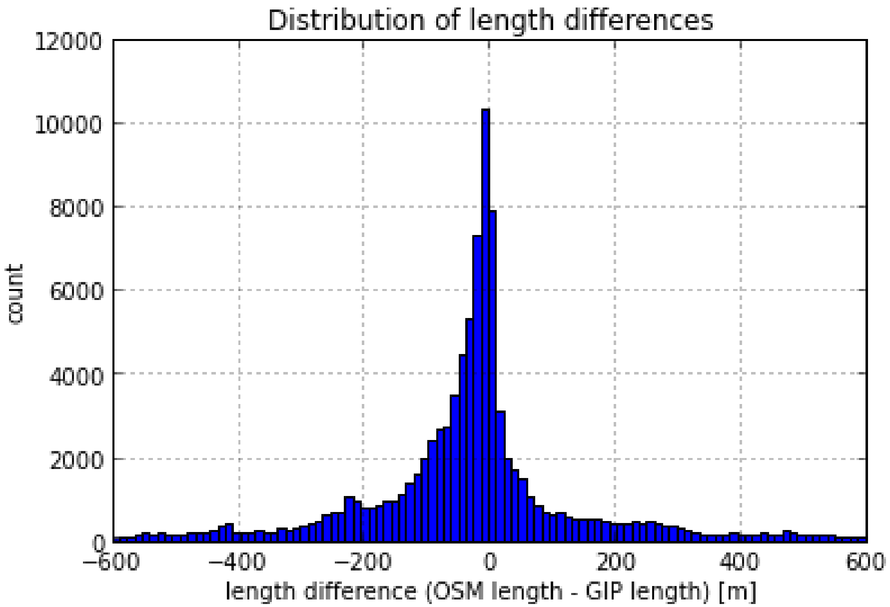
Routing comparison

Routing comparison

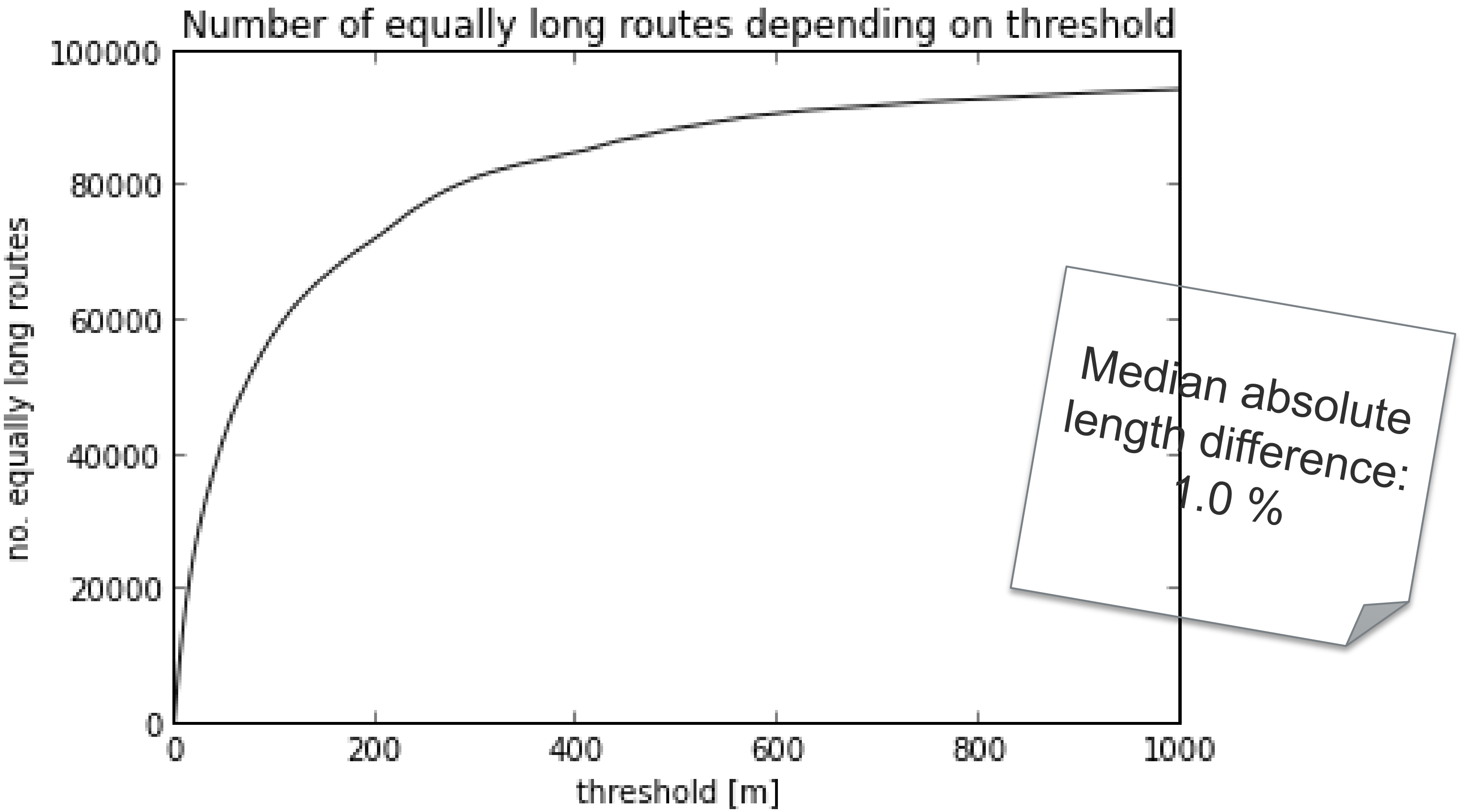
99,000 route pairs (10 per cell pair):

- Average GIP route length: 6,812 m (min: 54 m; max: 20,465 m)
- Mean length difference (OSM-GIP): -17.3 m





How similar are OSM & GIP route lengths?



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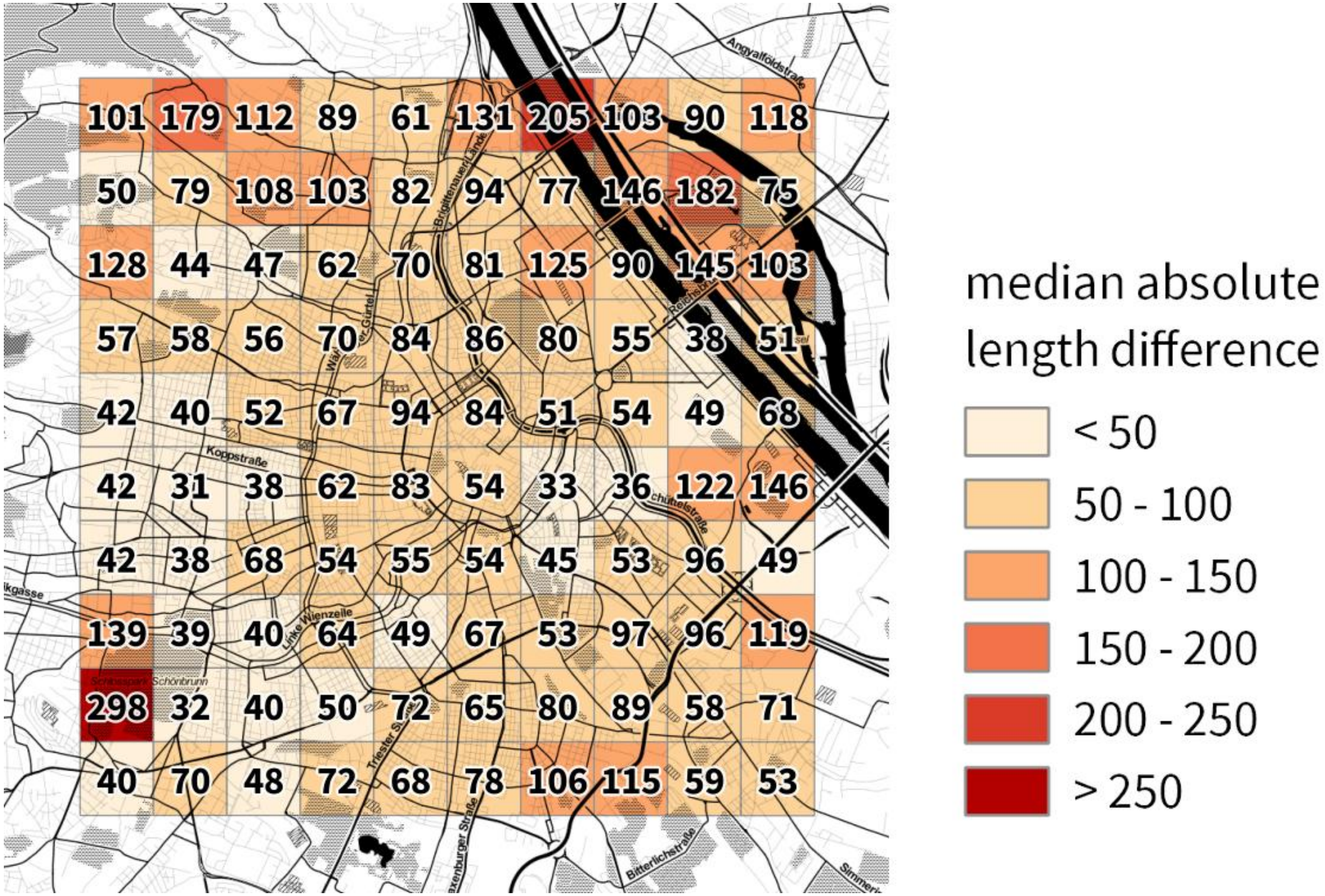
Spatial distribution of length differences

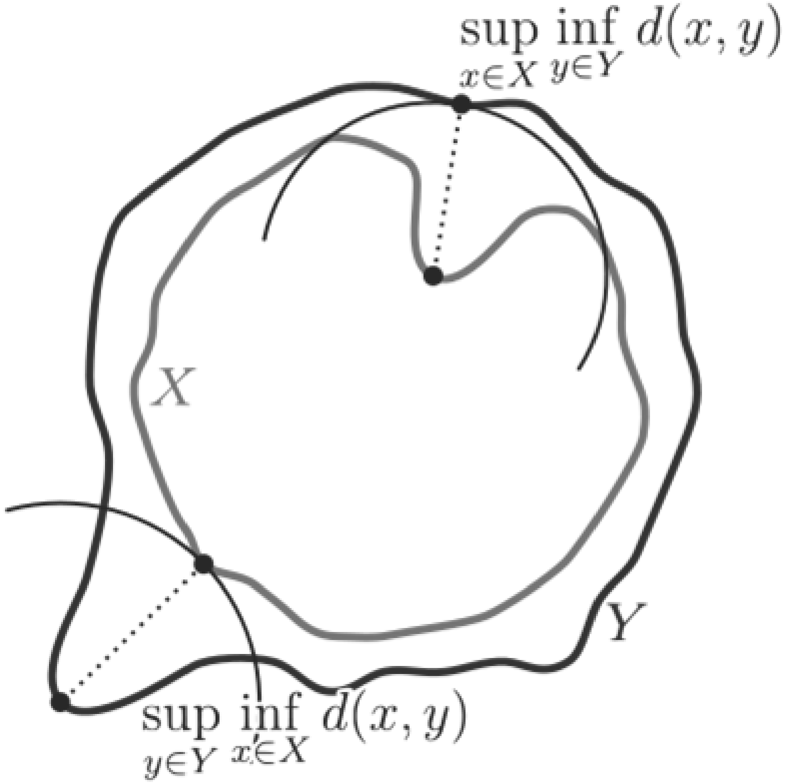


Route Geometry Similarity

Hausdorff distance

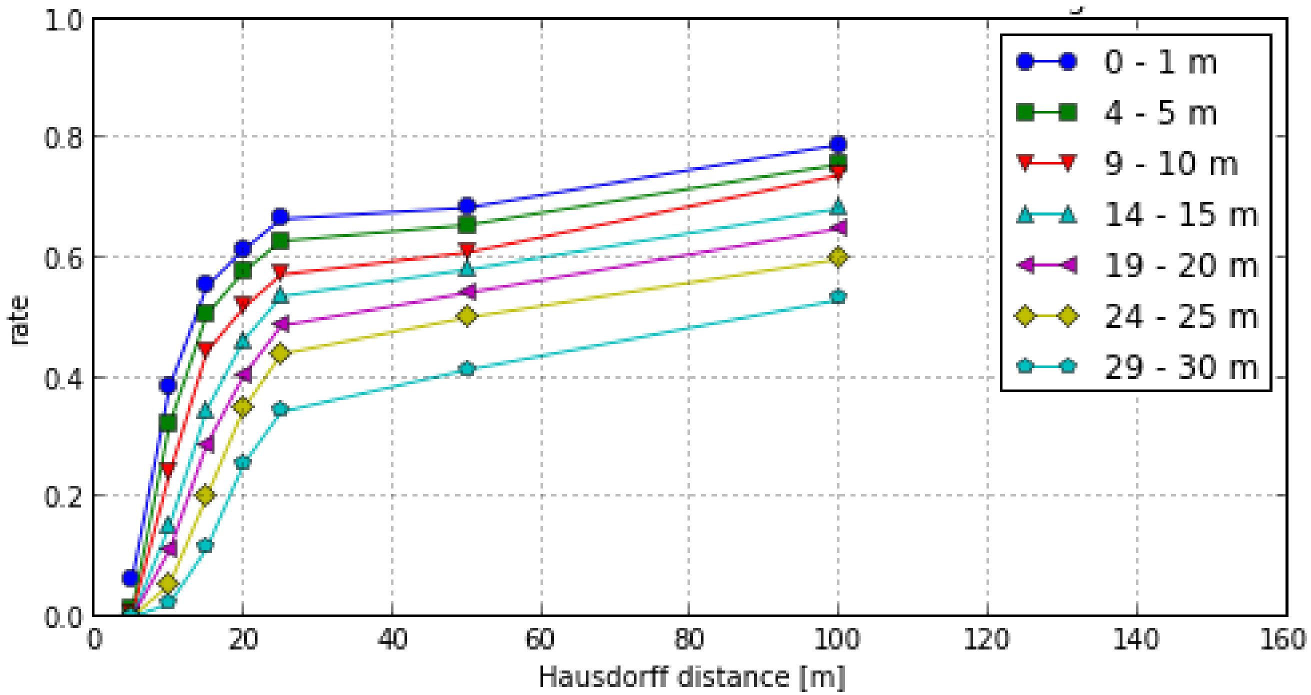
Maximum minimum distance

between both routes



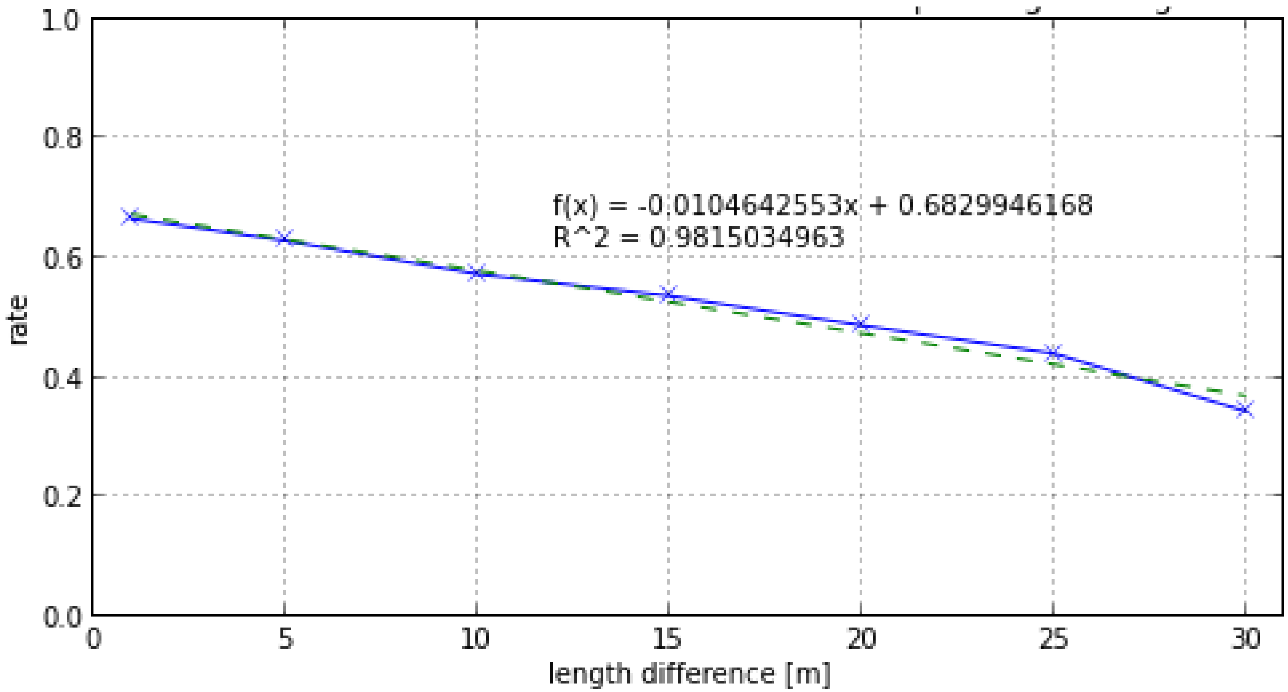
Correlation of length difference and Hausdorff distance

Rate of similar routes for 7 length difference classes



Route geometry similarity

Pairs with length difference < 25 m and Hausdorff dist. < 25 m: **16,903 (17.1 %)**



A closer look at conspicuous routes I

Error source #1:

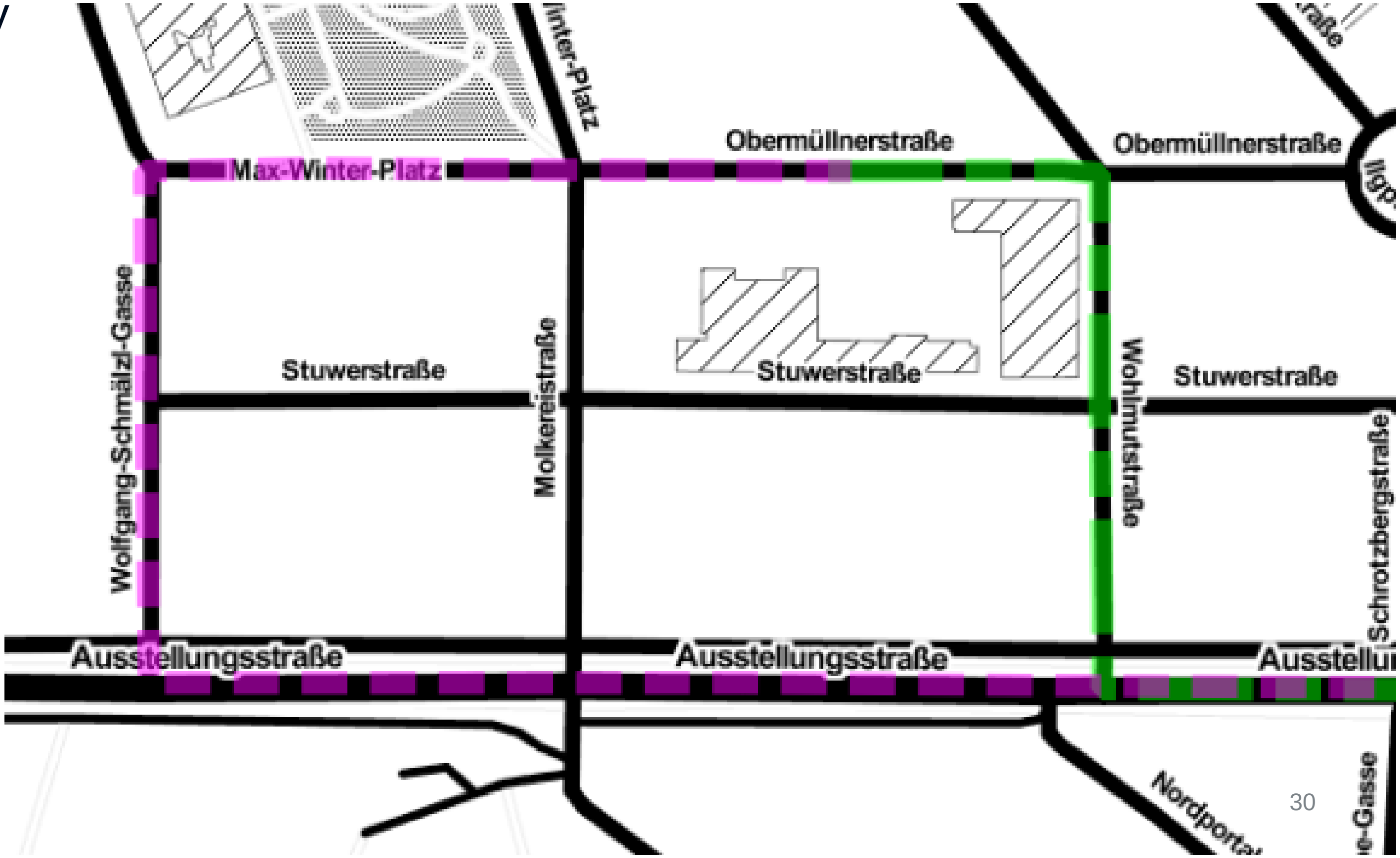
Different one-way

information

A closer look at conspicuous routes II

Error source #1:

Different one-way information

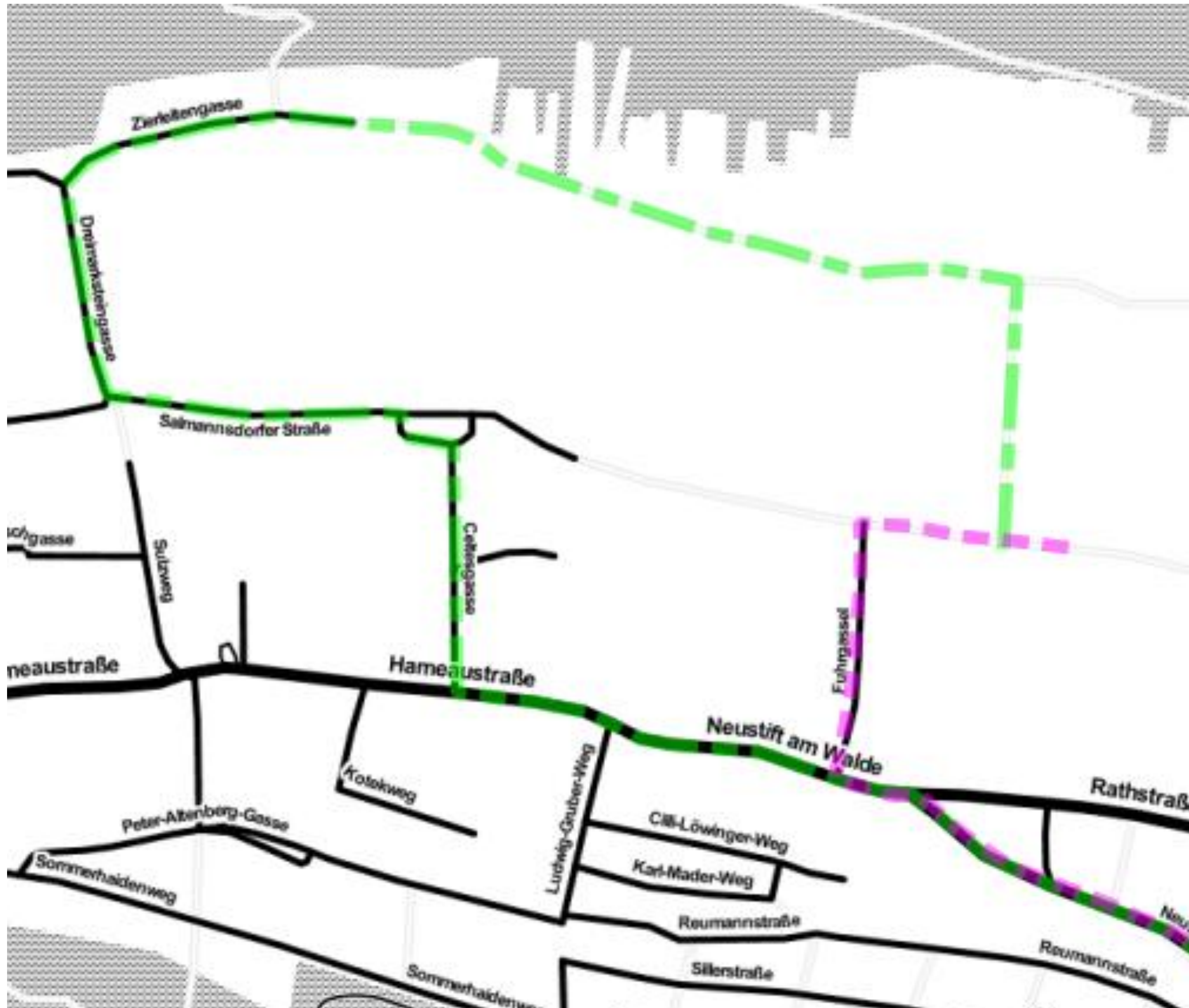


A closer look at conspicuous routes III

Error source #2:

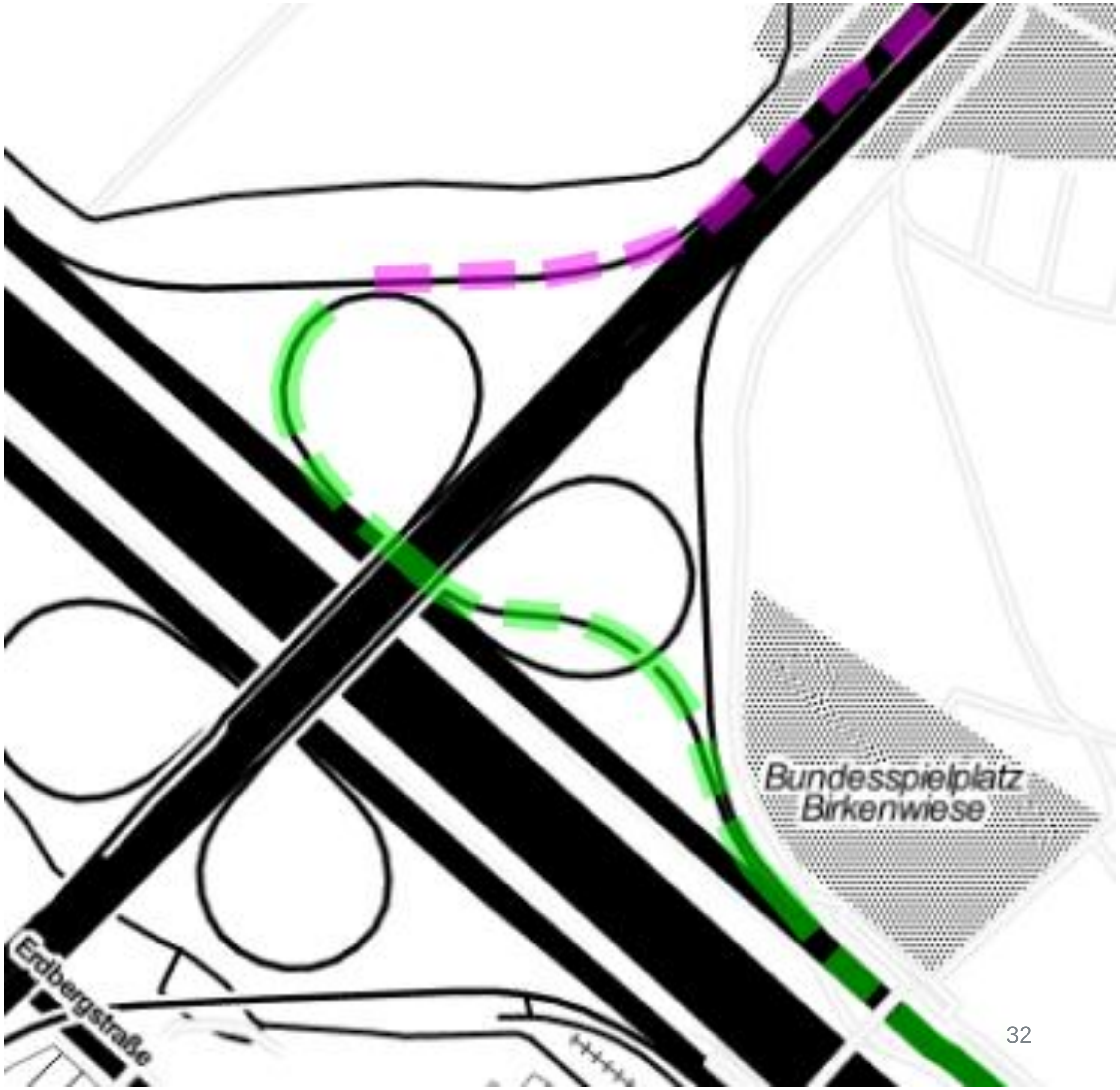
Different driving

permissions



A closer look at conspicuous routes IV

Challenge: Automated test route generation



Conclusion

Conclusion

Routing comparison

- Good agreement of route lengths:

  1.0 % median absolute length difference (relative to original GIP route length)

- Different route geometries based on Hausdorff distance:

  17.1 % of pairs with similar route geometry

Future work

- effects on specific applications (e.g. floating car data systems)
- other modes of transport such as walking and cycling

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