

# Senozon Mobility Model: Analytics and Examples of microscopic and dynamic mobility data

Michael Balmer

MScIDS: MSc in Applied Information and Data Science

Domaine Experience: Geospatial Data Analysis for Smart Communities

HSLU

Senozon AG, Zürich

# Dynamic Geo-Data in transport planning

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# About...

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Michael Balmer:

- PhD am IVT, ETH Zurich
- Focus: Development of the first MATSim Software (transport planning) in Java
- Founder of Senozon AG (ETH Spin-Off)
- Lecturer at IVT, ETH Zurich

Senzon:

- Application of research projects into mobility models, solutions and products
- Demand modeling, public transit optimization, location assessment

# Overview

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- What are (geo-)data?
- From data to geo-data
- What are projections?
- From (geo-)data to (geo-)analysis and (geo-)information
- What are (geo-)data in transport planning?
- What are dynamic (geo-)data?

What are (geo-)data

# What are data? What are geo-data?

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Survey:

- schedules
- pictures
- 0/1
- etc.....
- Geo-data: It's the same but with XYZ

From data to geo-data

# Data or Geo-Data?

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# Data or Geo-Data?



A photograph showing a man in a blue jacket and jeans working on a wooden fence in a grassy field. In the background, a large city skyline is visible under a blue sky with scattered clouds.

**Eigenschaften von 20140902\_162957.jpg**

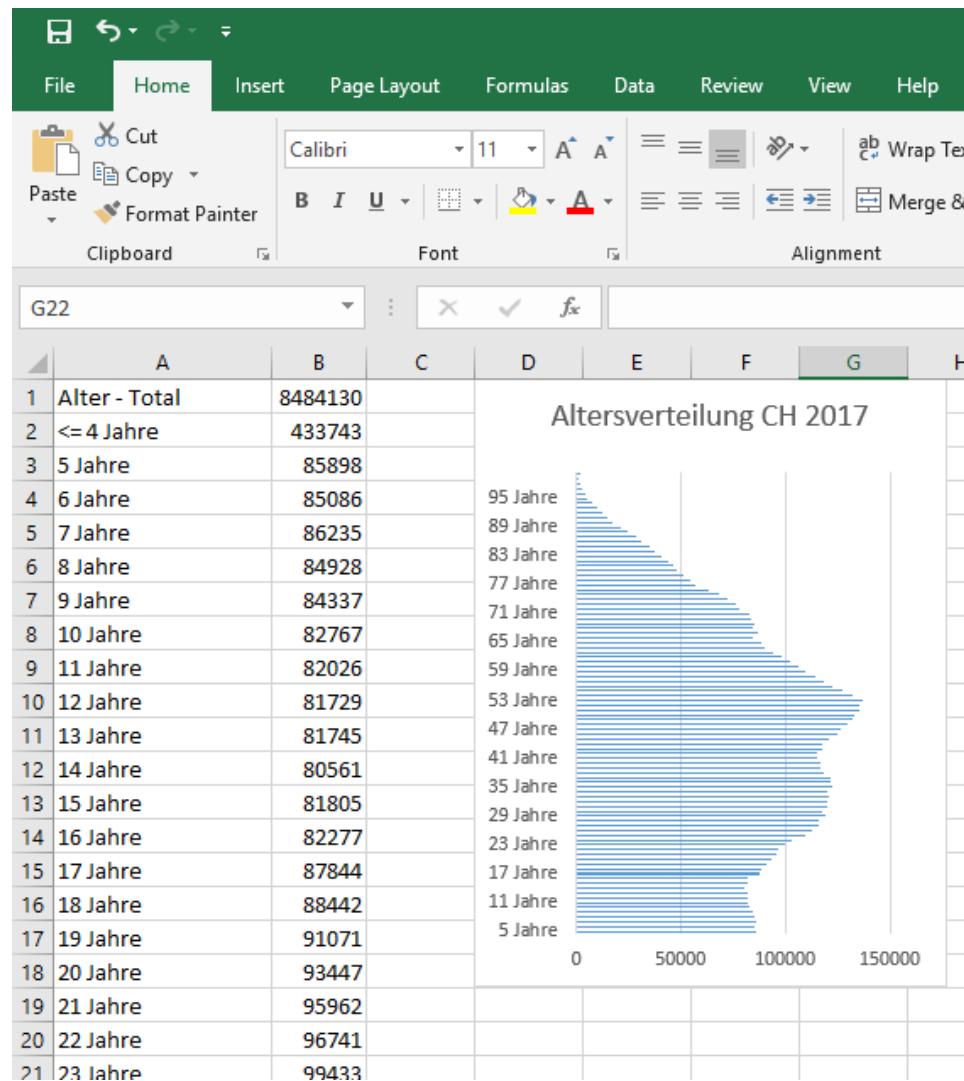
Eigenschaft	Wert
Digitalzoom	0220
EXIF-Version	0220
<b>GPS</b>	
Breitengrad	46; 55; 11
Längengrad	7; 26; 22
Höhe über Normal-Null	894
<b>Datei</b>	
Name	20140902_162957.jpg
Elementtyp	JPG-Datei
Ordnerpfad	D:\Users\balmemmi\Bilder...
Erstelldatum	22/01/2017 10:11
Änderungsdatum	02/09/2014 16:29
Größe	3.20 MB
Attribute	A
Verfügbarkeit	
Offlinestatus	
Freigegeben für	
Besitzer	BUILTIN\Administratoren

[Eigenschaften und persönliche Informationen entfernen](#)

OK Abbrechen Übernehmen

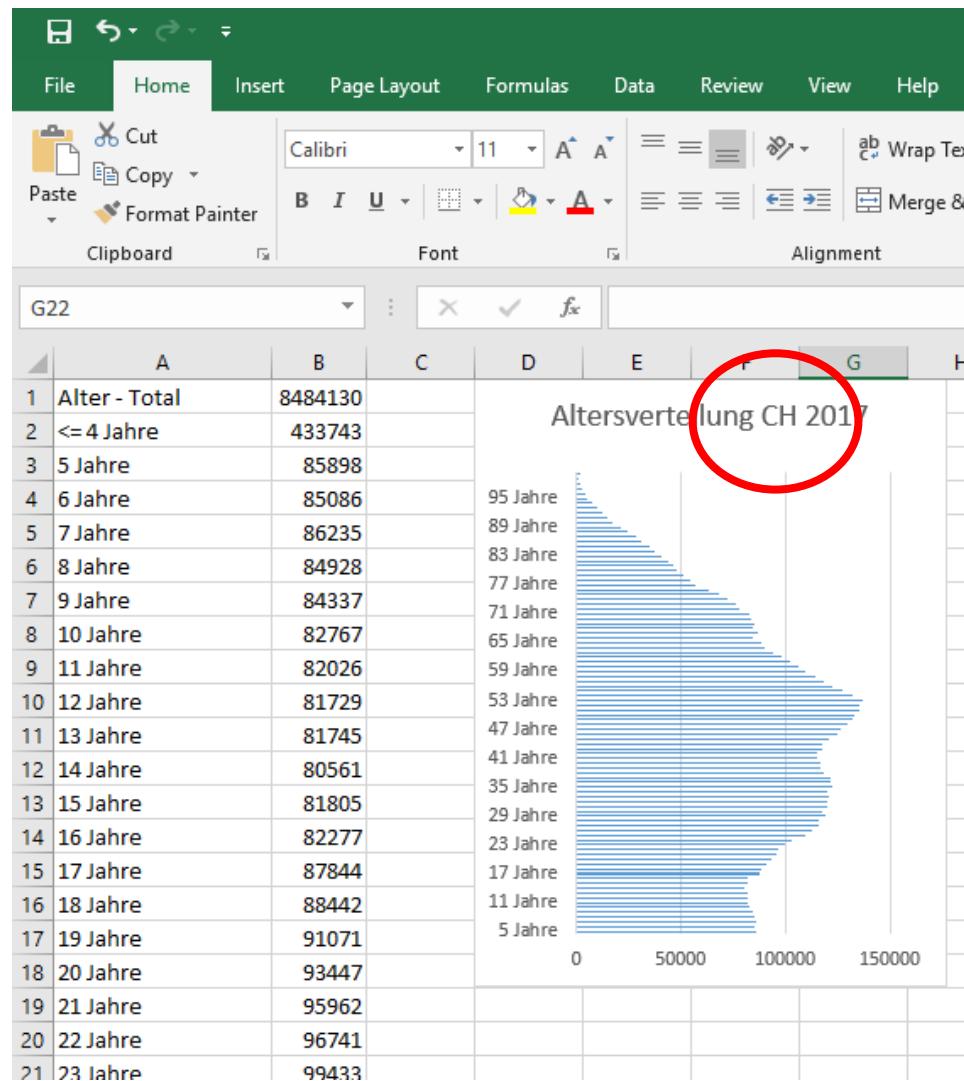
# Data or Geo-Data?

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# Data or Geo-Data?

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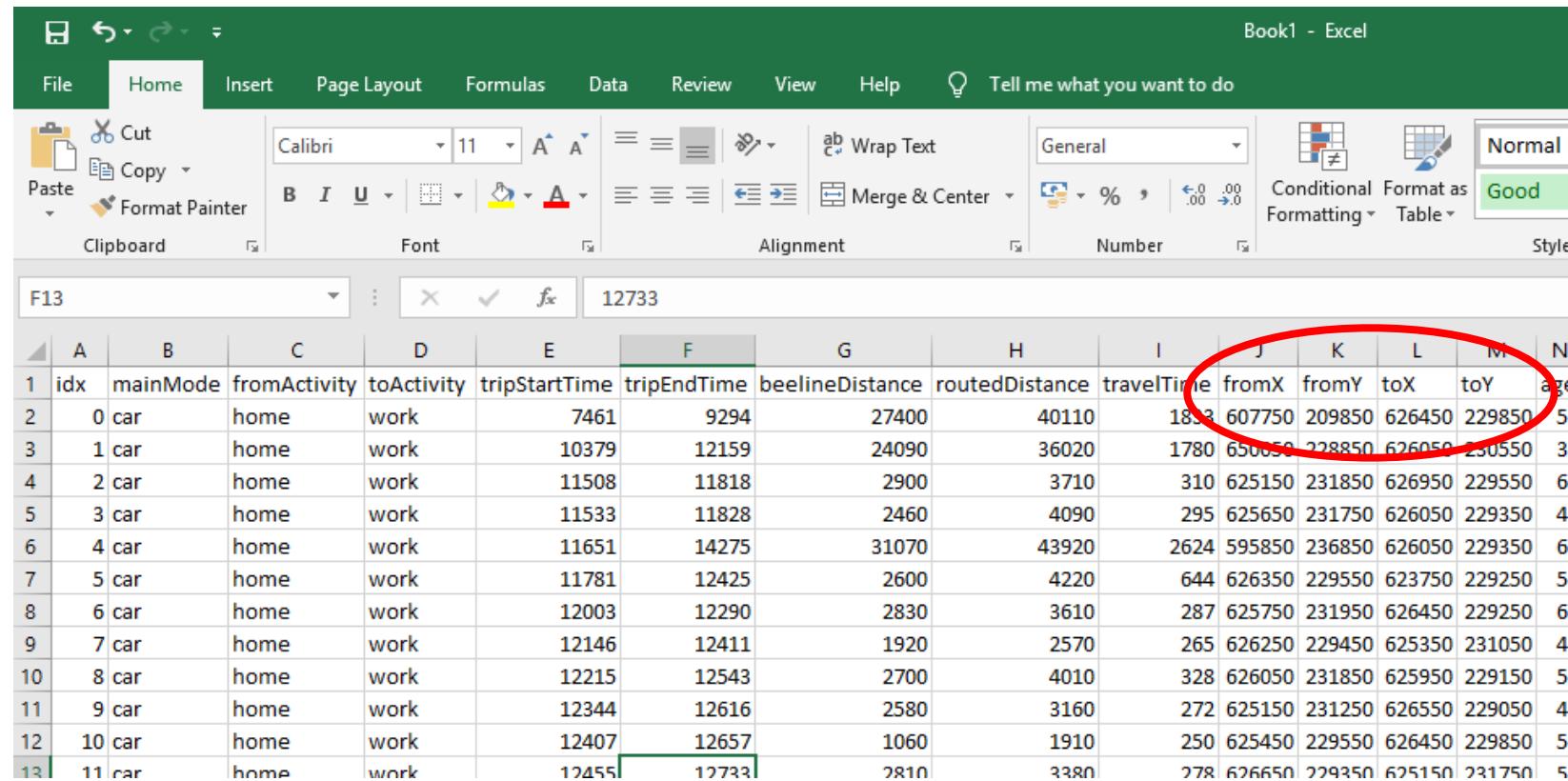


# Data or Geo-Data?

The screenshot shows a Microsoft Excel spreadsheet titled "Book1 - Excel". The ribbon menu is visible at the top, with the "Home" tab selected. The table below consists of 13 rows and 15 columns. The columns are labeled as follows:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	idx	mainMode	fromActivity	toActivity	tripStartTime	tripEndTime	beelineDistance	routedDistance	travelTime	fromX	fromY	toX	toY	age
2	0	car	home	work	7461	9294	27400	40110	1833	607750	209850	626450	229850	5
3	1	car	home	work	10379	12159	24090	36020	1780	650050	228850	626050	230550	3
4	2	car	home	work	11508	11818	2900	3710	310	625150	231850	626950	229550	6
5	3	car	home	work	11533	11828	2460	4090	295	625650	231750	626050	229350	4
6	4	car	home	work	11651	14275	31070	43920	2624	595850	236850	626050	229350	6
7	5	car	home	work	11781	12425	2600	4220	644	626350	229550	623750	229250	5
8	6	car	home	work	12003	12290	2830	3610	287	625750	231950	626450	229250	6
9	7	car	home	work	12146	12411	1920	2570	265	626250	229450	625350	231050	4
10	8	car	home	work	12215	12543	2700	4010	328	626050	231850	625950	229150	5
11	9	car	home	work	12344	12616	2580	3160	272	625150	231250	626550	229050	4
12	10	car	home	work	12407	12657	1060	1910	250	625450	229550	626450	229850	5
13	11	car	home	work	124551	12733	2810	3380	278	626650	229350	625150	231750	5

# Data or Geo-Data?



The screenshot shows a Microsoft Excel spreadsheet titled "Book1 - Excel". The ribbon menu is visible at the top, with the "Home" tab selected. The main area displays a data table with 13 columns and 13 rows. The columns are labeled from A to N. Row 1 contains the column headers. Rows 2 through 12 contain data, and row 13 is the last row of the table. The "fromX" column (column K) is highlighted with a red oval. The value in the "fromX" cell of row 13 is 229850.

idx	mainMode	fromActivity	toActivity	tripStartTime	tripEndTime	beelineDistance	routedDistance	travelTime	fromX	fromY	toX	toY	age
2	0	car	home	work	7461	9294	27400	40110	1833	607750	209850	626450	229850
3	1	car	home	work	10379	12159	24090	36020	1780	650050	228850	626050	230550
4	2	car	home	work	11508	11818	2900	3710	310	625150	231850	626950	229550
5	3	car	home	work	11533	11828	2460	4090	295	625650	231750	626050	229350
6	4	car	home	work	11651	14275	31070	43920	2624	595850	236850	626050	229350
7	5	car	home	work	11781	12425	2600	4220	644	626350	229550	623750	229250
8	6	car	home	work	12003	12290	2830	3610	287	625750	231950	626450	229250
9	7	car	home	work	12146	12411	1920	2570	265	626250	229450	625350	231050
10	8	car	home	work	12215	12543	2700	4010	328	626050	231850	625950	229150
11	9	car	home	work	12344	12616	2580	3160	272	625150	231250	626550	229050
12	10	car	home	work	12407	12657	1060	1910	250	625450	229550	626450	229850
13	11	car	home	work	124551	127233	2810	3380	278	626650	229350	625150	231750

# Geo-Data

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- «geographically localized»
- Coordinates (XY or XYZ)
- Data with reference to geographically localized data
- [<https://what3words.com/ausweiten.abbildbar.kinos>]

What are projections?

# Projections

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- Interactive projections  
<https://www.jasondavies.com/maps/transition/>
- Mercator → Shape retaining (not surface retaining)  
<https://geopuzzle.org/puzzle/easy/>
- Gall-Peters: → surface retaining  
<https://de.wikipedia.org/wiki/Peters-Projektion>
- Mollweide → somewhat both
- Dymaxion → land connecting  
[https://en.wikipedia.org/wiki/Dymaxion\\_map](https://en.wikipedia.org/wiki/Dymaxion_map)
- Gnomonik → shortest distance as a straight line  
<https://bl.ocks.org/mbostock/3795048>
- Spatial Reference  
<http://spatialreference.org/ref/epsg/>

# Projections – Tips

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- Standards versus «self made»
- Geo-data are always subject to a projection
- Geo-data are only complete if the projection is included!

From (geo-)data to (geo-)analysis and (geo-)information

# Examples

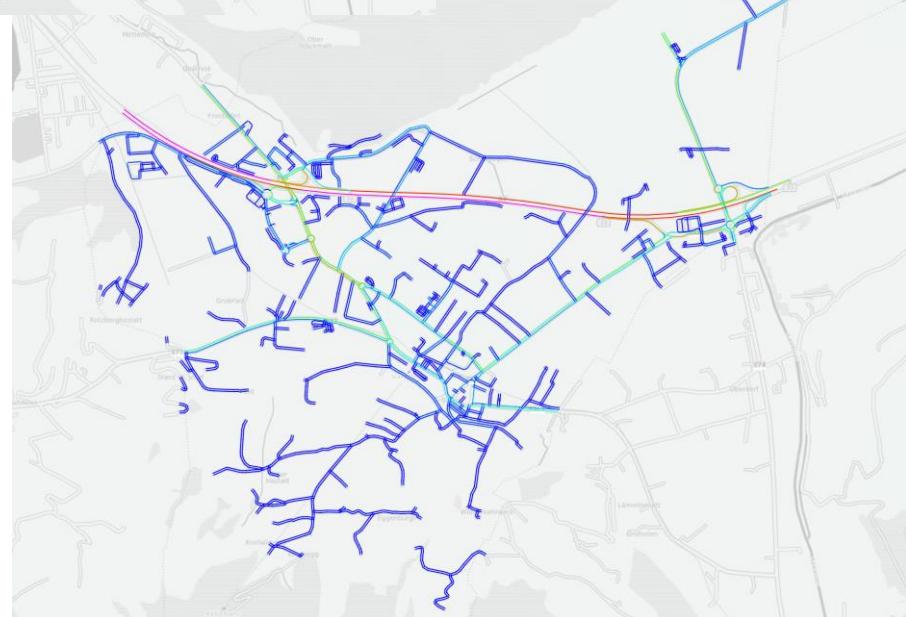
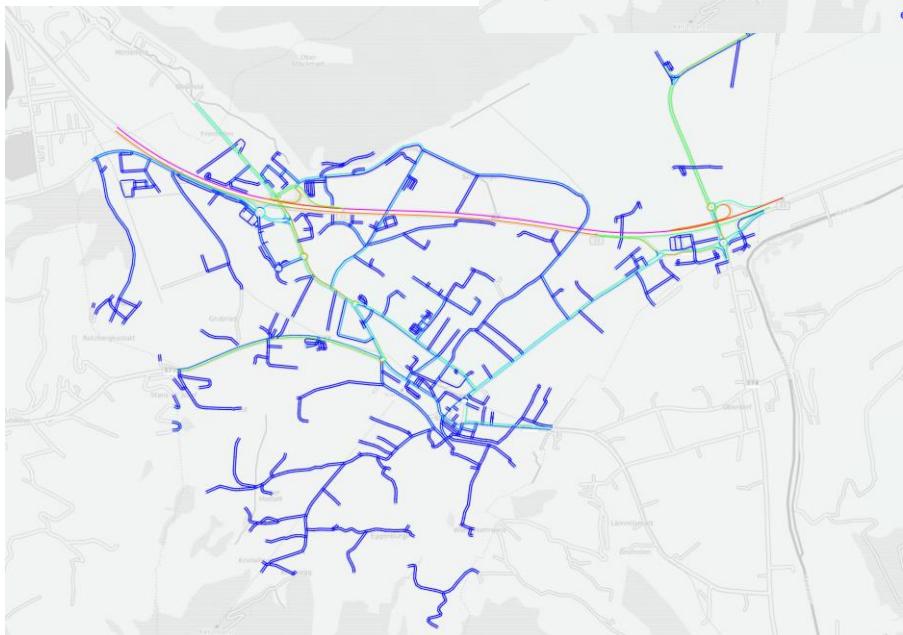
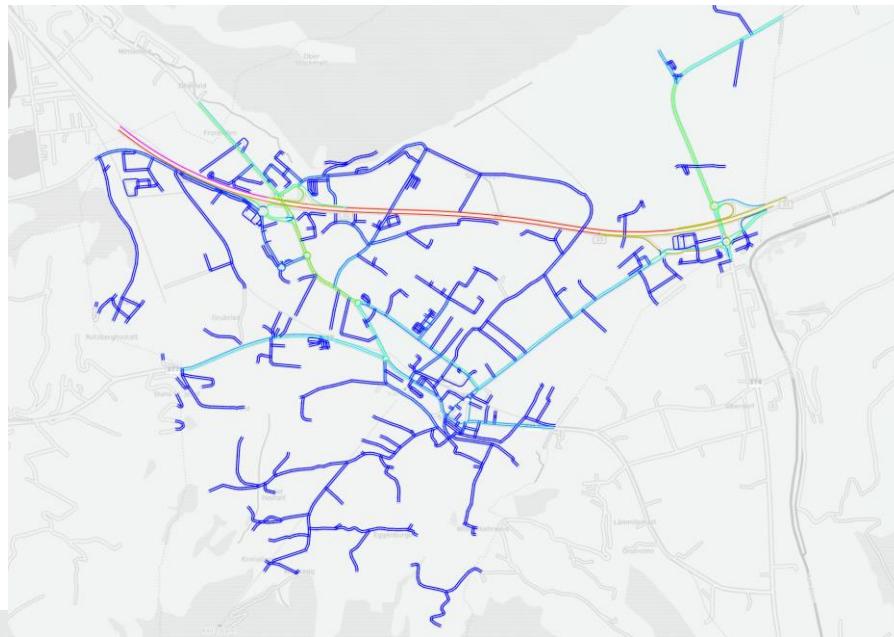
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- GPS Tracks
- Maps
- Transport demand
- <http://apps.senozon.com>  
→ Einfach Registrieren
- <https://maps.senozon.com>  
→ U:public / P:EnjoyOurMaps
- <https://online.tableau.com>  
→ U:insights@senozon.com / P:SenozonInsights2019!

What are (geo-)data in transport planning?

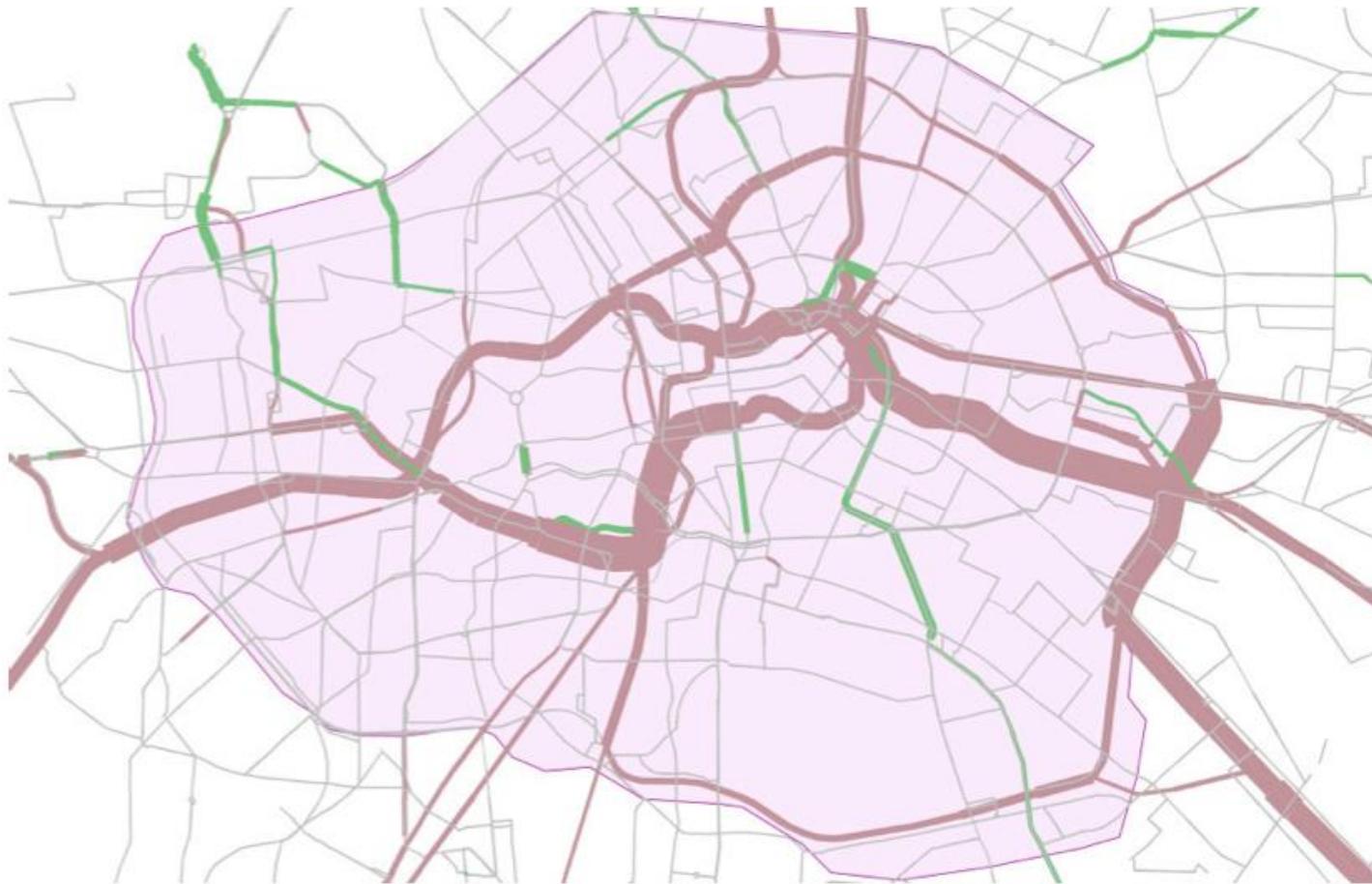
## Traffic volumes

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# Changes in public transit demand 2015 versus 2008

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# Pedestrian frequencies

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Passantenströme, alle Aktivitäten

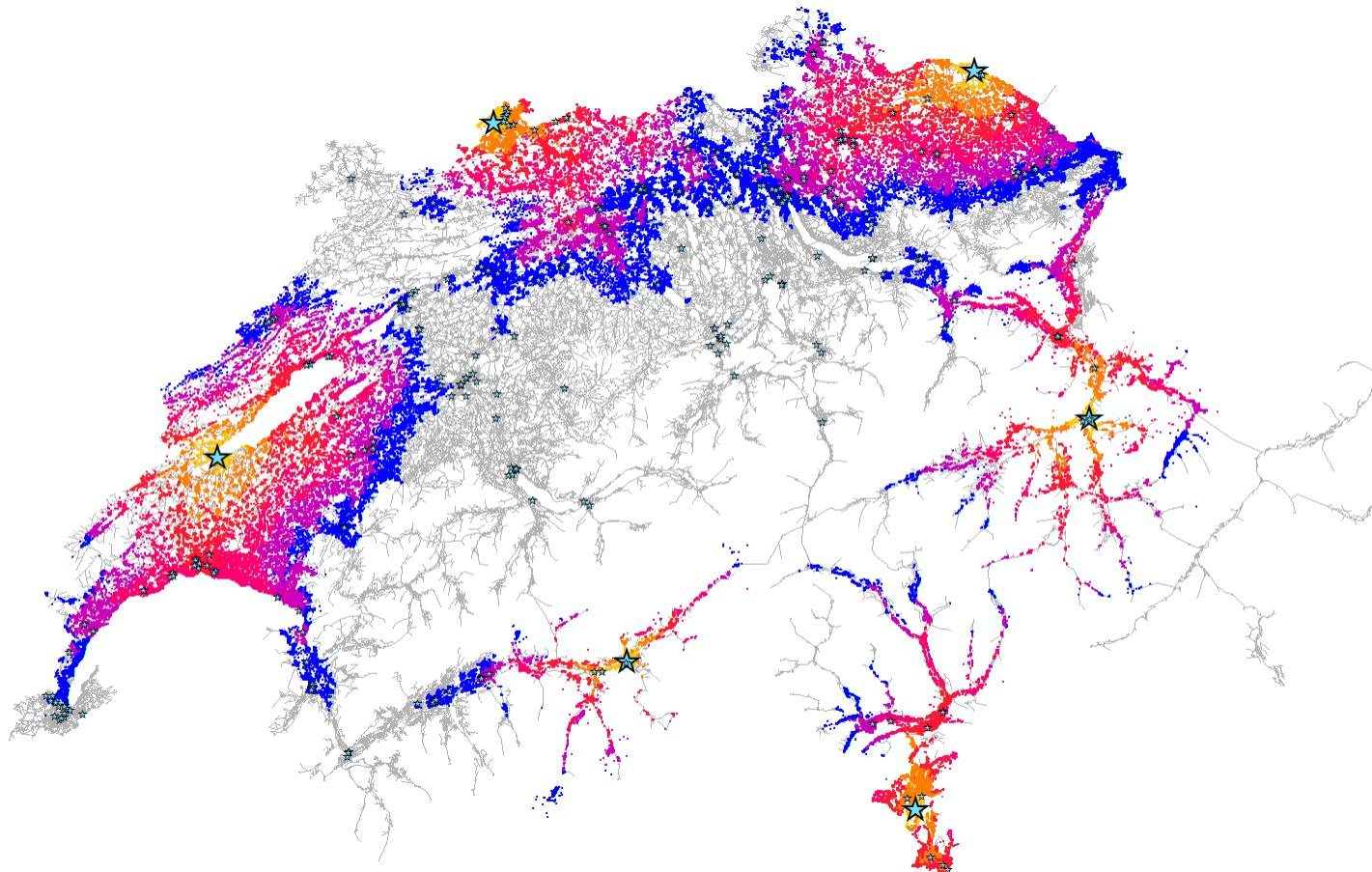


Passantenströme, von / nach Einkauf

# Travel times

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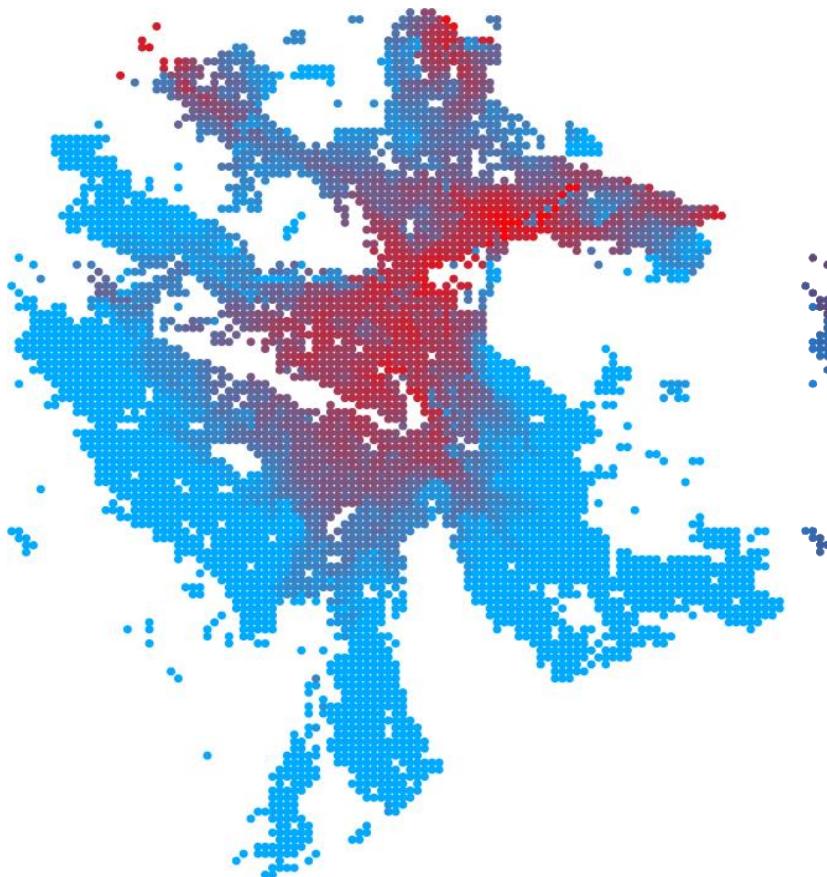
Travel times of shopping malls (by car, 60 Min.)



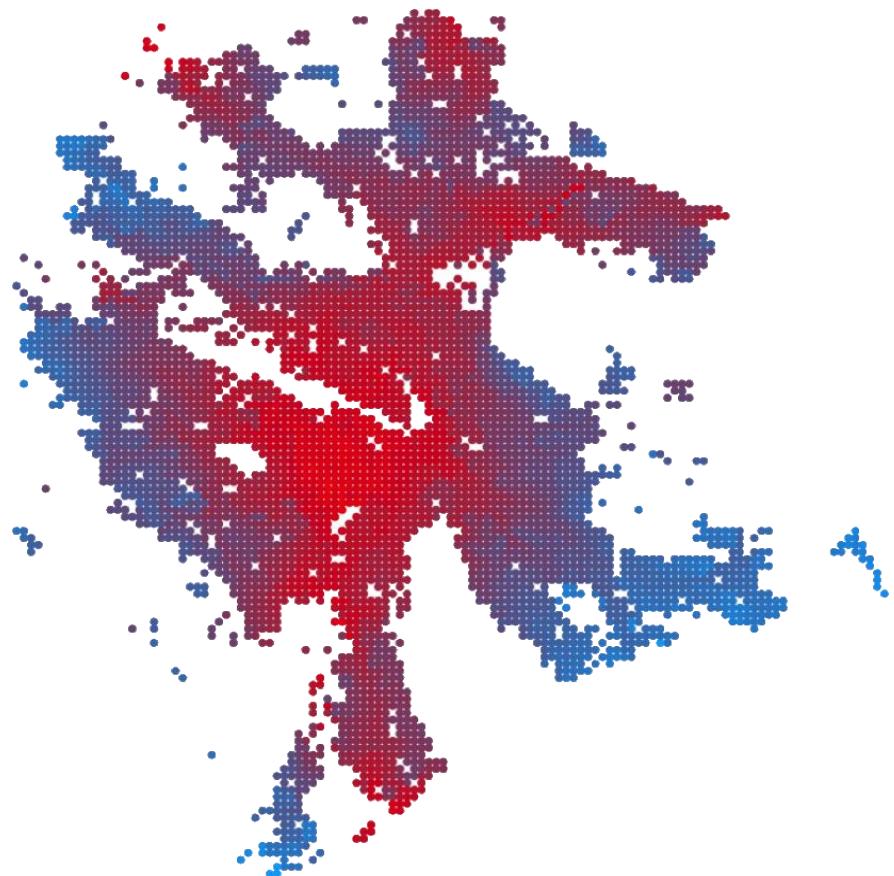
# Reachability of people

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Number of persons, car, 20 min



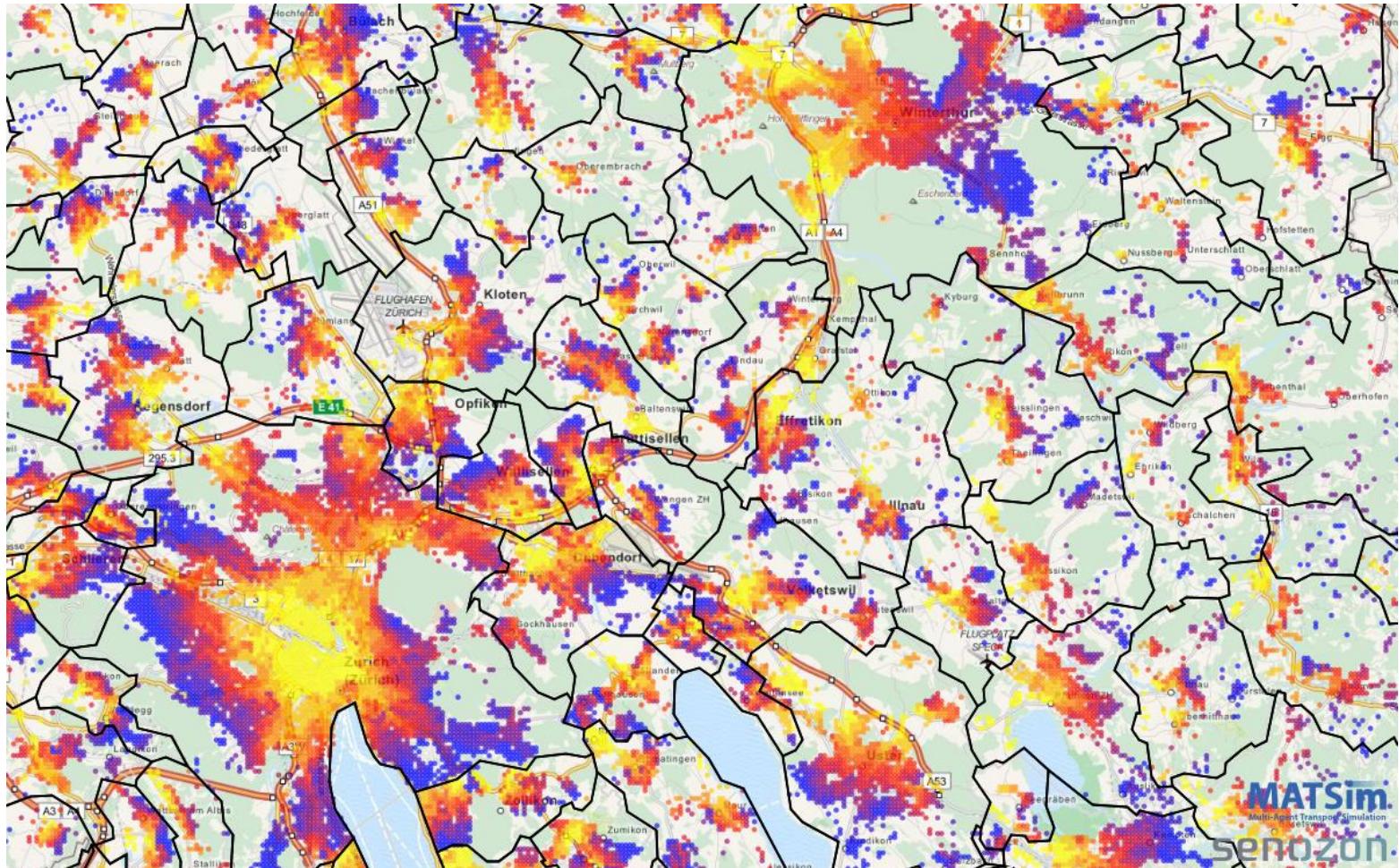
Number of persons, car, 40 min



# Reachability of people

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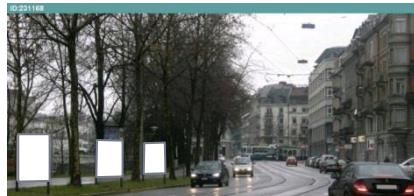
Reachability at hectare level of details per municipality



# Location Assessment: Billboards



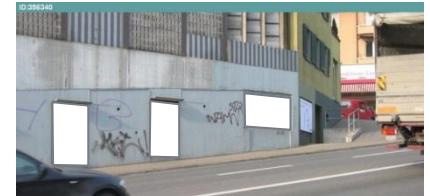
Merkurstrasse



Kasernenstr.



Schaffhauserstr.



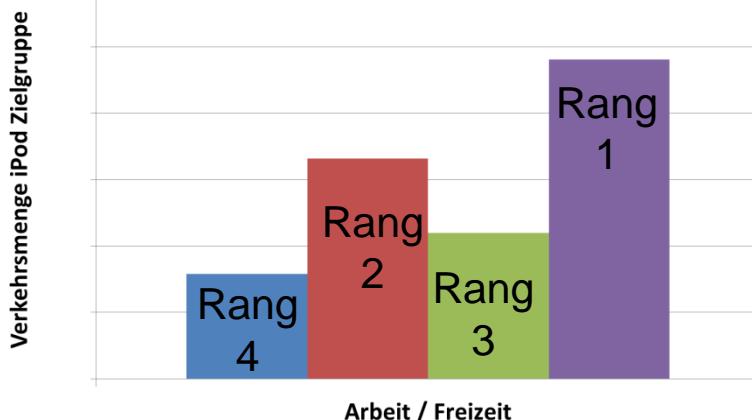
Rosengartenstr.

## iPod Touch

Target group:  
Age 15-34, towards  
work or leisure



■ Merkurstr. ■ Kasernenstr. ■ Schaffhauserstr. ■ Rosengartenstr.

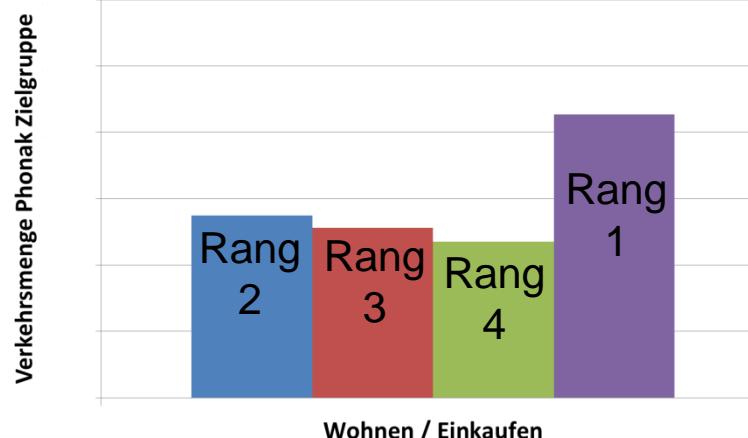


## Hearing aid

Target group:  
Age 55-84, towards home or  
shopping

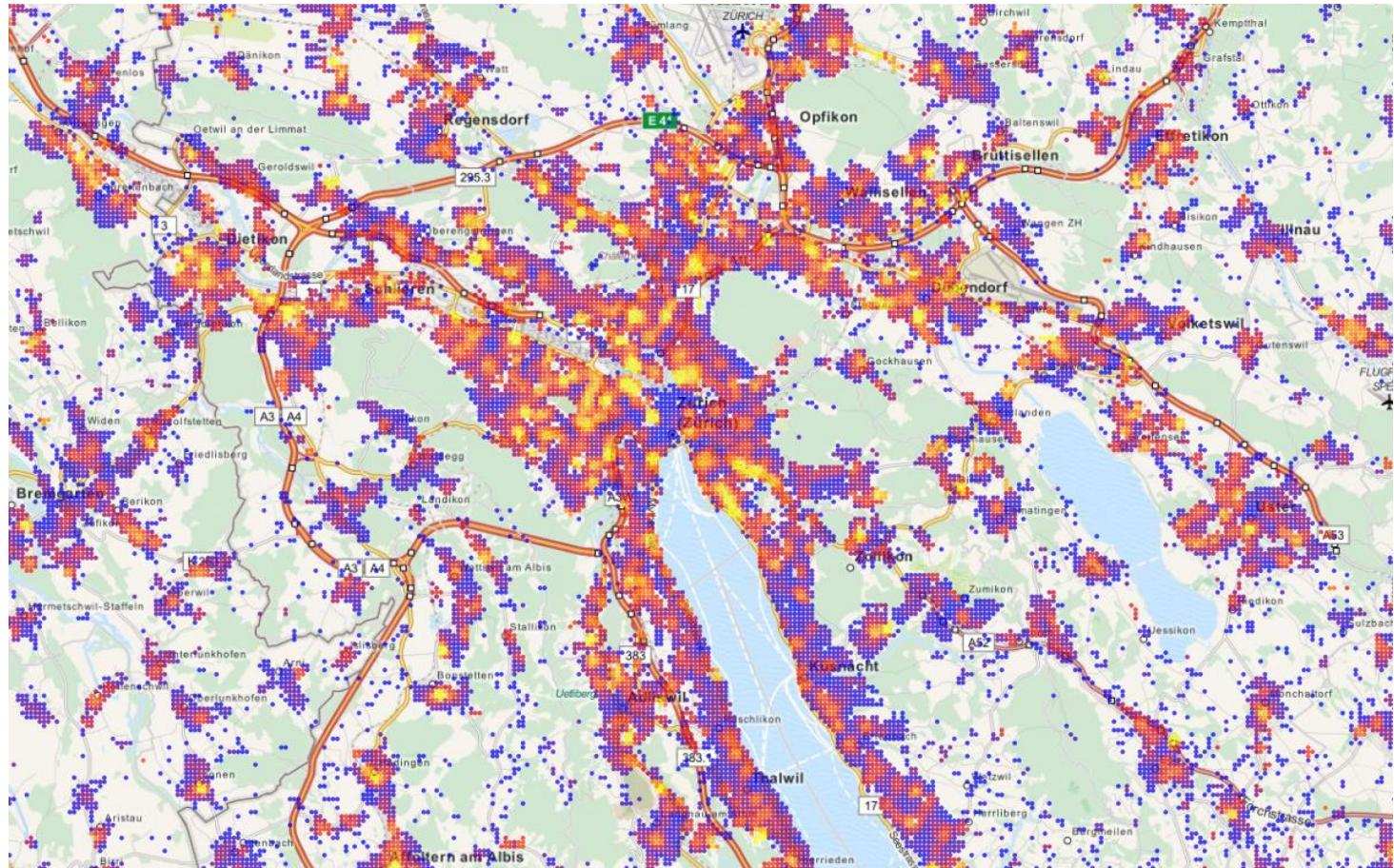


■ Merkurstr. ■ Kasernenstr. ■ Schaffhauserstr. ■ Rosengartenstr.



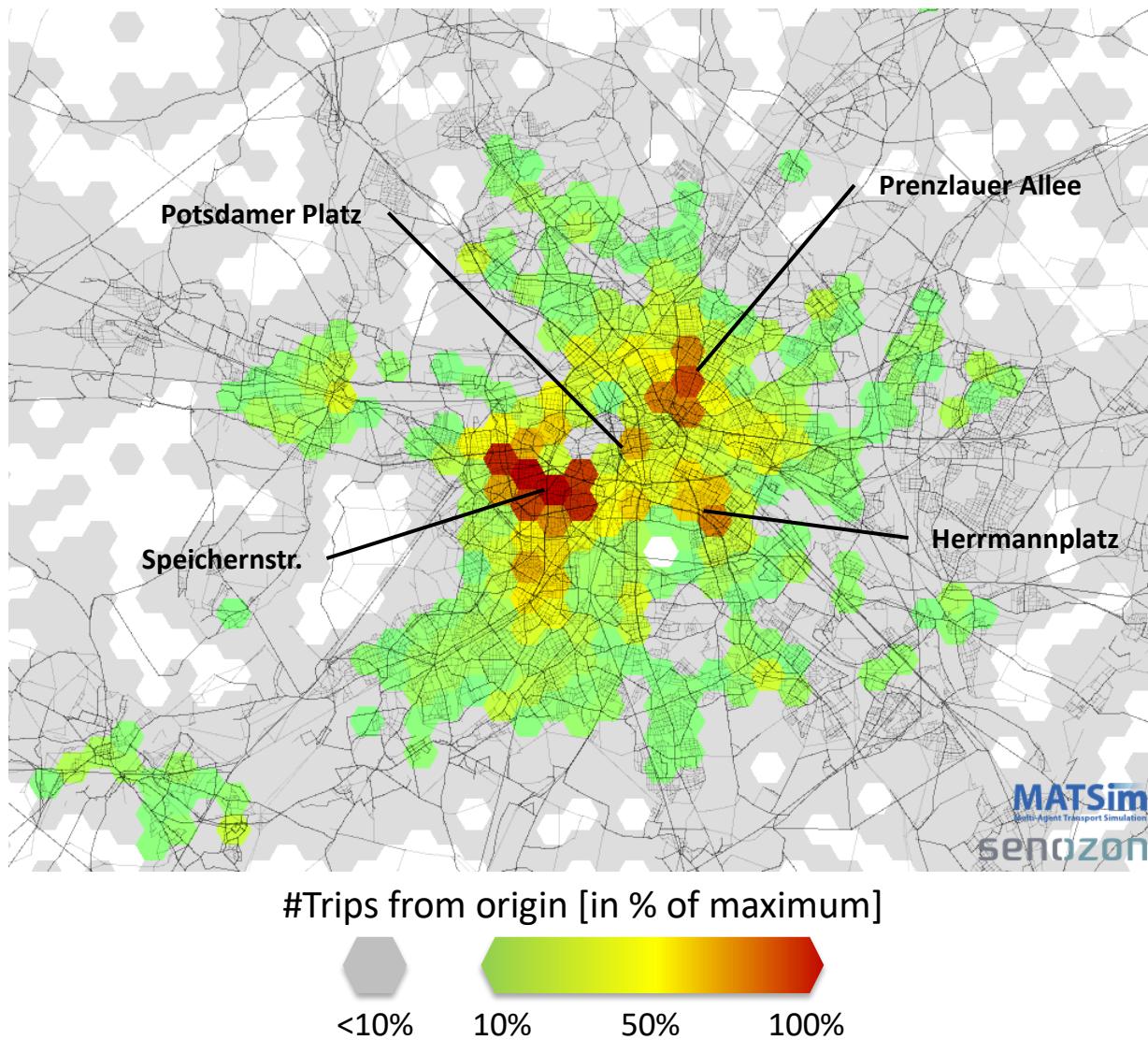
# Hotspot / Whitespot Analysis

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# Target group assessment – and where they are

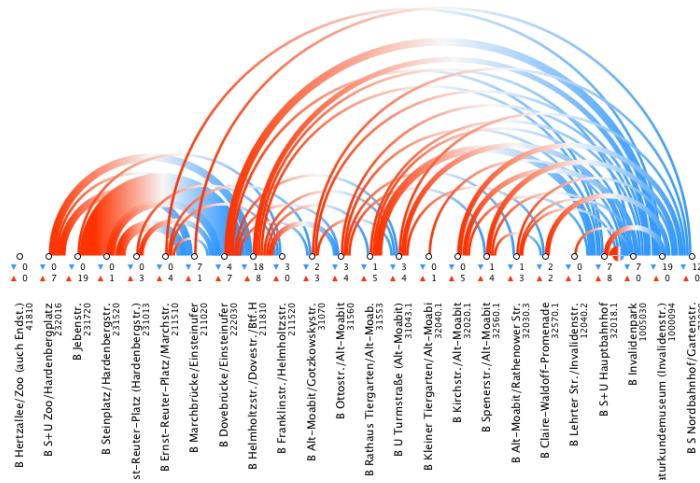
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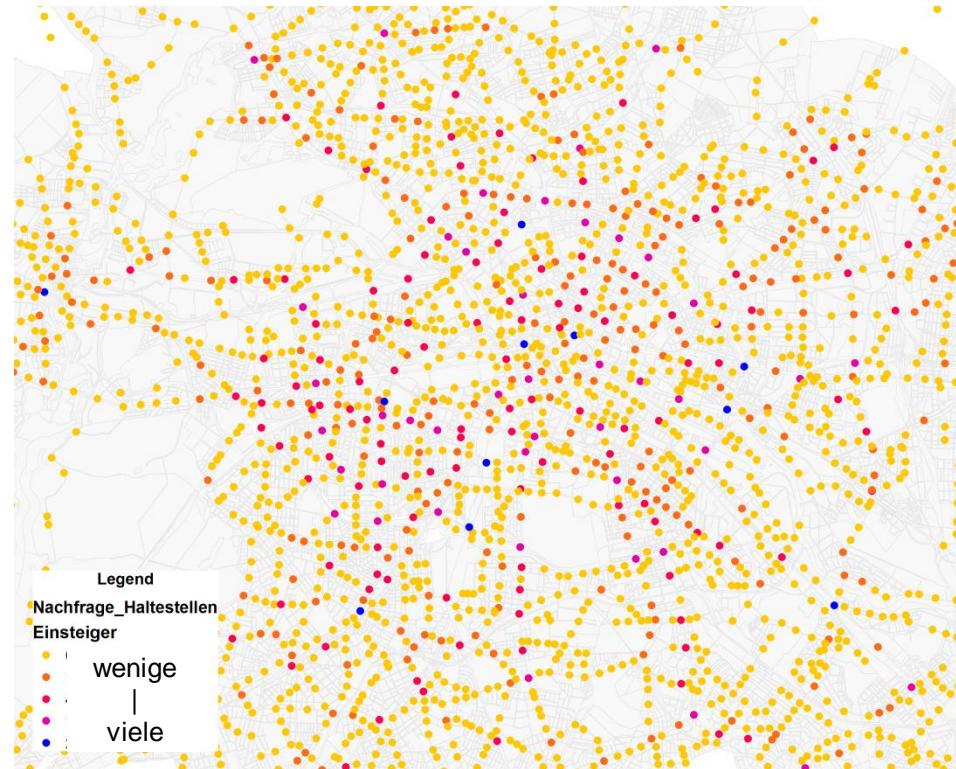
# Public transit analysis

245-B-245 / 245-B-245.5.2.H

6 departures between 07:00:00 and 08:00:00

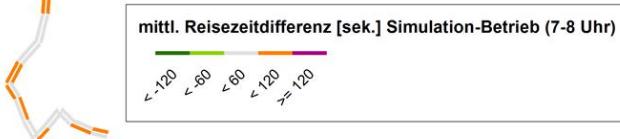


Übersicht



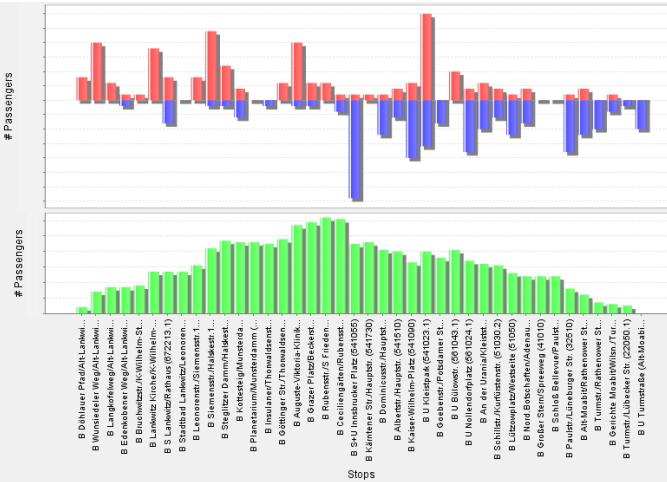
# Public transit – passenger counts (“pax”)

Mittlere Reisezeitdifferenzen (7-8 Uhr) von Haltestelle zu Haltestelle zwischen Simulation und Betriebsdaten, resp. Fahrplan (Linie 187 links, Linie M41 rechts)

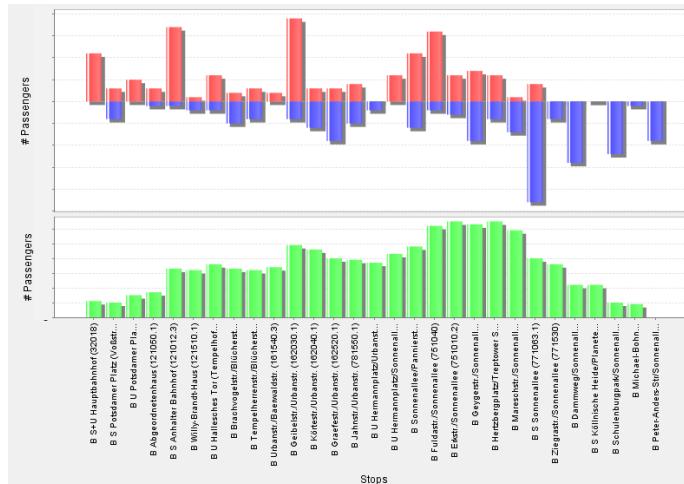


Übersicht

Linie 187 – Fahrgäste – 7-8 Uhr



Linie M41 – Fahrgäste – 7-8 Uhr



What are dynamic (geo-)data?

# Dynamic geo-data?

idx	mainMode	fromActivity	toActivity	tripStartTime	tripEndTime	beelineDistance	routedDistance	travelTime	fromX	fromY	toX	toY	age
0	car	home	work	7461	9294	27400	40110	1833	607750	209850	626450	229850	5
1	car	home	work	10379	12159	24090	36020	1780	650050	228850	626050	230550	3
2	car	home	work	11508	11818	2900	3710	310	625150	231850	626950	229550	6
3	car	home	work	11533	11828	2460	4090	295	625650	231750	626050	229350	4
4	car	home	work	11651	14275	31070	43920	2624	595850	236850	626050	229350	6
5	car	home	work	11781	12425	2600	4220	644	626350	229550	623750	229250	5
6	car	home	work	12003	12290	2830	3610	287	625750	231950	626450	229250	6
7	car	home	work	12146	12411	1920	2570	265	626250	229450	625350	231050	4
8	car	home	work	12215	12543	2700	4010	328	626050	231850	625950	229150	5
9	car	home	work	12344	12616	2580	3160	272	625150	231250	626550	229050	4
10	car	home	work	12407	12657	1060	1910	250	625450	229550	626450	229850	5
11	car	home	work	12455	12733	2810	3380	278	626650	229350	625150	231750	5
12	car	home	work										
13	car	home	work										

# Dynamische Geodaten?

The screenshot shows an Excel spreadsheet titled "Book1 - Excel". The ribbon menu is visible at the top, with "Home" selected. The main area displays a data table with 13 rows and 16 columns. The first row (row 1) contains column headers: idx, mainMode, fromActivity, toActivity, tripStartTime, tripEndTime, beelineDistance, routedDistance, travelTime, fromX, fromY, toX, toY, and age. Rows 2 through 12 show data for individual trips, with columns for idx, mainMode, fromActivity, toActivity, tripStartTime, tripEndTime, beelineDistance, routedDistance, travelTime, fromX, fromY, toX, toY, and age. The last row (row 13) is highlighted with a green border and contains the values: 11, car, home, work, 124551, 12733, 2810, 3380, 278, 626650, 229350, 625150, 231750, and 5. The cell F13 contains the value 12733. The cell F13 is also circled in red.

idx	mainMode	fromActivity	toActivity	tripStartTime	tripEndTime	beelineDistance	routedDistance	travelTime	fromX	fromY	toX	toY	age
2	0	car	home	work	7461	9294	27400	40110	1833	607750	209850	626450	229850
3	1	car	home	work	10379	12159	24090	36020	1780	650050	228850	626050	230550
4	2	car	home	work	11508	11818	2900	3710	310	625150	231850	626950	229550
5	3	car	home	work	11533	11828	2460	4090	295	625650	231750	626050	229350
6	4	car	home	work	11651	14275	31070	43920	2624	595850	236850	626050	229350
7	5	car	home	work	11781	12425	2600	4220	644	626350	229550	623750	229250
8	6	car	home	work	12003	12290	2830	3610	287	625750	231950	626450	229250
9	7	car	home	work	12146	12411	1920	2570	265	626250	229450	625350	231050
10	8	car	home	work	12215	12543	2700	4010	328	626050	231850	625950	229150
11	9	car	home	work	12344	12616	2580	3160	272	625150	231250	626550	229050
12	10	car	home	work	12407	12657	1060	1910	250	625450	229550	626450	229850
13	11	car	home	work	124551	12733	2810	3380	278	626650	229350	625150	231750

# Dynamic Geo-Data

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- «geographically localized»
- Coordinates (XY or XYZ)
- Data with reference to geographically localized data
- AND: time information

# Network

---

```
<network>
  <nodes>
    <node id="1" x="0.0" y="0.0" />
    <node id="2" x="80.0" y="0.0" />
    ...
  </nodes>
  <links capperiod="01:00:00">
    <link id="100" from="1" to="2" length="90.0" freespeed="7.5"
          capacity="1800.0" permlanes="1" oneway="1" />
    <link id="101" from="2" to="3" length="90.0" freespeed="7.5"
          capacity="1800.0" permlanes="1" oneway="1" />
    <link id="102" from="3" to="4" length="90.0" freespeed="7.5"
          capacity="1800.0" permlanes="1" oneway="1" />
    ...
  </links>
</network>
```

# Travel demand

---

„plans“:

```
<person id="1" sex="f" age="20" license="yes"
    car_avail="never" employed="yes">
    <plan>
        <act type="home" link="110" start_time="00:00:00"
            dur="08:00:00" end_time="08:00:00" />
        <leg num="0" mode="car"> <route> 12 1 </route> </leg>
        <act type="shop" link="100" start_time="08:00:00"
            dur="04:00:00" end_time="12:00:00" />
        <leg num="1" mode="car"> <route> </route> </leg>
        <act type="work" link="100" start_time="12:00:00"
            dur="04:00:00" end_time="16:00:00" />
        <leg num="2" mode="car"> <route> 2 3 </route> </leg>
        <act type="home" link="102" start_time="16:00:00"
            dur="04:00:00" end_time="20:00:00" />
        <leg num="3" mode="car"> <route> 4 9 10 11 </route>
    </leg>
    <act type="home" link="110" start_time="20:00:00"
        dur="04:00:00" end_time="24:00:00" />
</plan>
</person>
```

# «Events»

---

```
<event time="26303.0" type="actend" person="101" link="1112" actType="h" />
<event time="26303.0" type="departure" person="101" link="1112" legMode="transit_walk" />
<event time="26938.0" type="arrival" person="101" link="11" legMode="transit_walk" />
<event time="26938.0" type="actstart" person="101" link="11" actType="pt interaction" />
<event time="26938.0" type="actend" person="101" link="11" actType="pt interaction" />
<event time="26938.0" type="departure" person="101" link="11" legMode="pt" />
<event time="27023.0" type="PersonEntersVehicle" person="101" vehicle="tr_1" />
<event time="27253.0" type="PersonLeavesVehicle" person="101" vehicle="tr_1" />
<event time="27253.0" type="arrival" person="101" link="12" legMode="pt" />
<event time="27253.0" type="actstart" person="101" link="12" actType="pt interaction" />
<event time="27254.0" type="actend" person="101" link="12" actType="pt interaction" />
<event time="27254.0" type="departure" person="101" link="12" legMode="transit_walk" />
<event time="27550.0" type="travelled" person="101" distance="NaN" />
<event time="27550.0" type="arrival" person="101" link="2333" legMode="transit_walk" />
<event time="27550.0" type="actstart" person="101" link="2333" actType="w" />
<event time="63642.0" type="actend" person="101" link="2333" actType="w" />
<event time="63642.0" type="departure" person="101" link="2333" legMode="transit_walk" />
<event time="63924.0" type="arrival" person="101" link="32" legMode="transit_walk" />
<event time="63924.0" type="actstart" person="101" link="32" actType="pt interaction" />
<event time="63924.0" type="actend" person="101" link="32" actType="pt interaction" />
<event time="63924.0" type="departure" person="101" link="32" legMode="pt" />
<event time="64017.0" type="PersonEntersVehicle" person="101" vehicle="tr_1" />
<event time="64249.0" type="PersonLeavesVehicle" person="101" vehicle="tr_1" />
<event time="64249.0" type="arrival" person="101" link="11" legMode="pt" />
<event time="64249.0" type="actstart" person="101" link="11" actType="pt interaction" />
```