# The role of LBS and visualization for digital mobility

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**LBS 2014** **Vienna, 26–28 Nov. 2014**

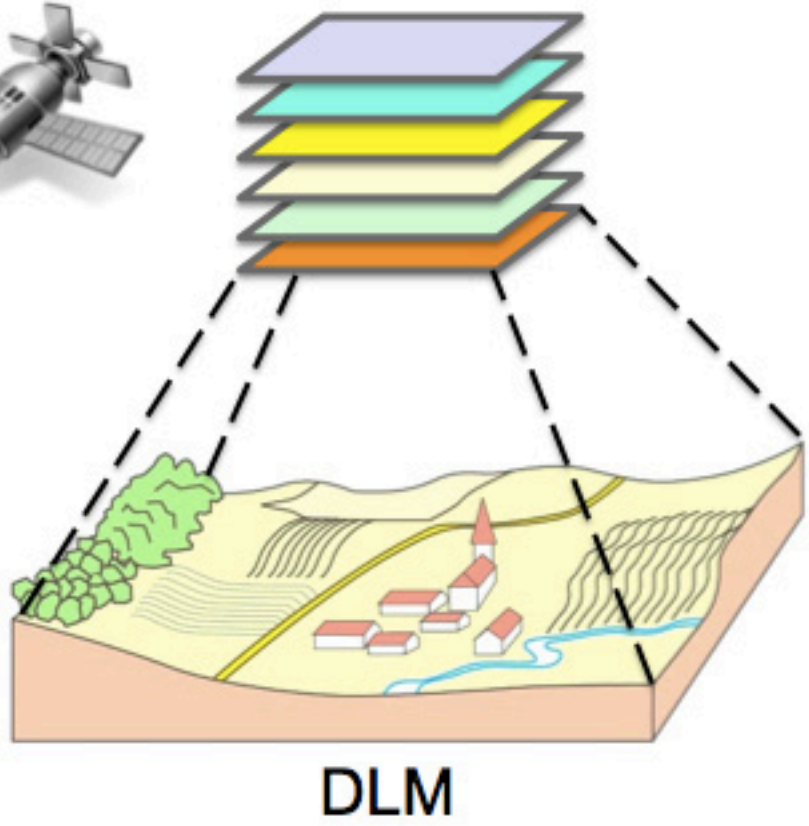
Location

Global positioning

Digitization of the Earth

- Global coverage
- Multiple resolutions
- Frequent updating

All locations are equal.




# Digitization of the Earth

# Level of Detail of 3D city

www.sig3d.org

LOD 0
Regional landscape

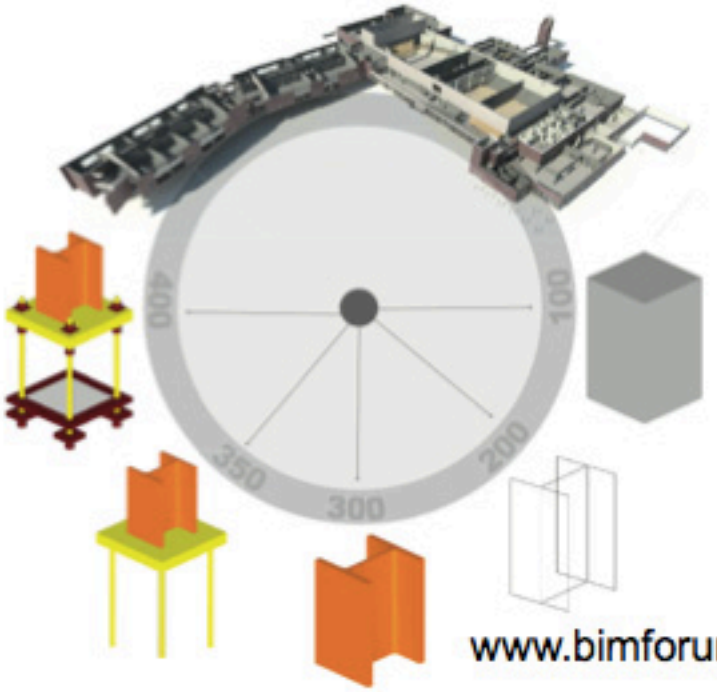
LOD 1
Box model
6m x 6m

LOD 2
With root types
4m x 4m

LOD 3
Architecture model
2m x 2m

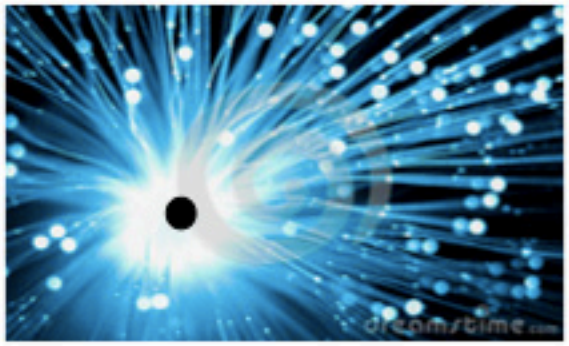
LOD 4
Indoor model
0.2m x 0.2m

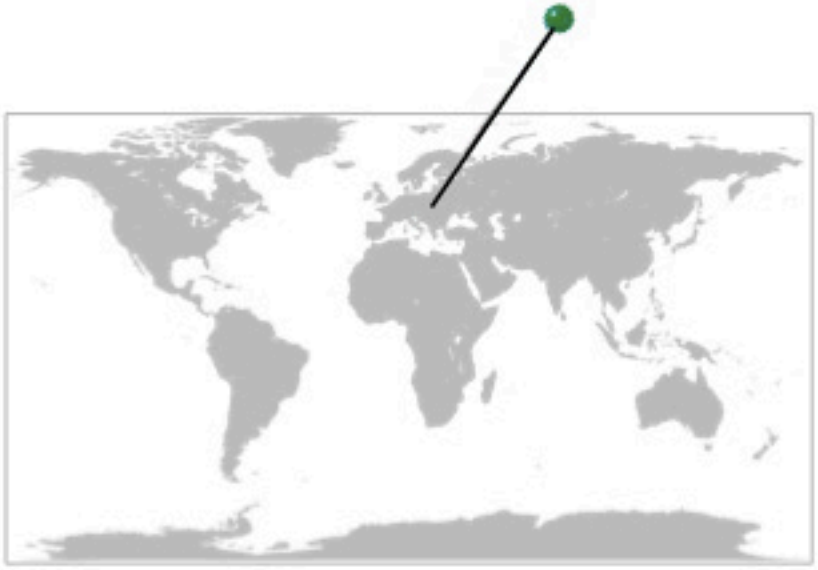
# Level of Development of BIM



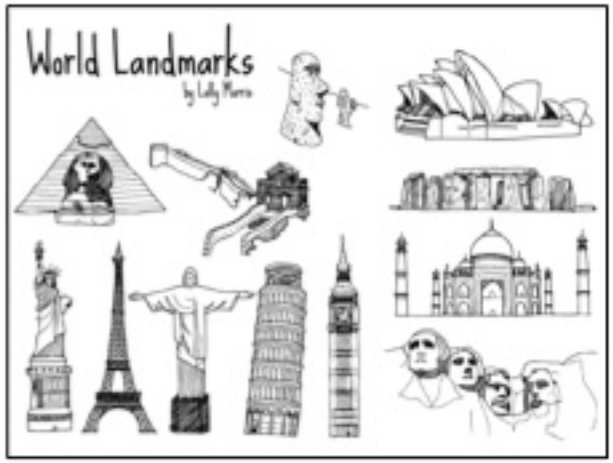

www.bimforum.org

then as a black hole





Semantic information from the location as a pinhole





“All locations are equal, some locations are more equal than others”

- a priori
- a posteriori
- ad hoc

# Impacts of the digital Earth

## 1. Mobility

### Humans

- unknown route / unknown environment
- unknown route / known environment
- known route / unknown environment
- known route / known environment

### Goods

- customers to goods
- goods to customers

### Mobile infotainment

- kill the saved time
- virtual vs. real life

## 2. Visuality

static objects
dynamic objects

a single object
a group of objects of the same type
networked objects of different types

info-graphics
indoor vs. outdoor

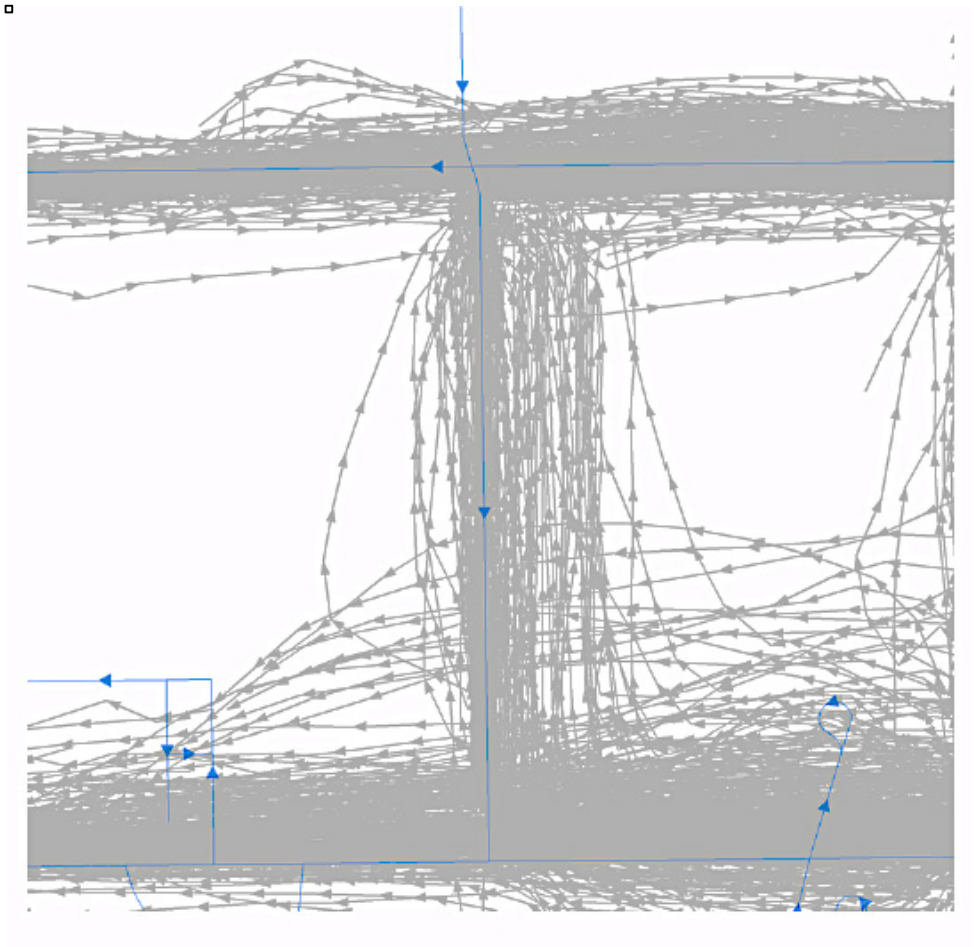
# LBS and visualization

I. Dynamic data-mining from movement trajectories

II. Multimodal routing and navigation services

III. Geovisualization services

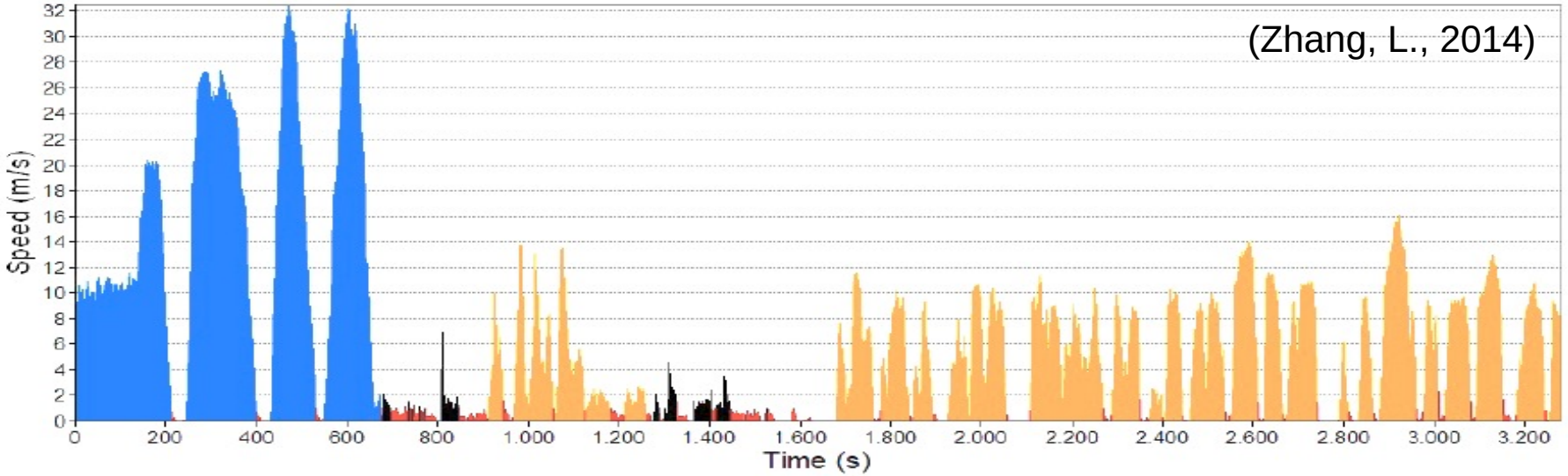
# I. Dynamic data mining from movement trajectories

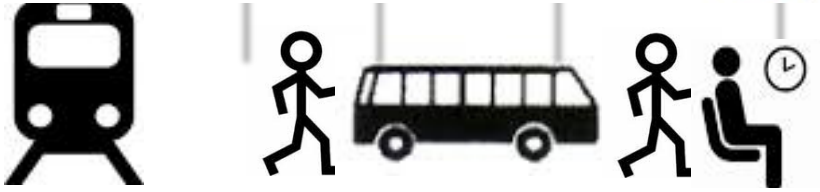


(Zhang, L. 2014)

Self-healing OSM

GPS trajectories

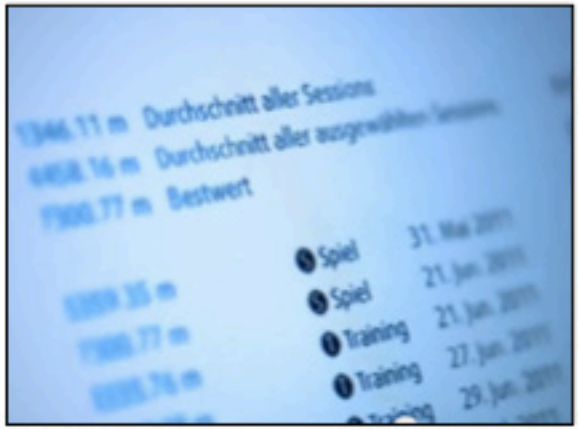


Detection of traffic mode and mobile behavior

# The beauty of football



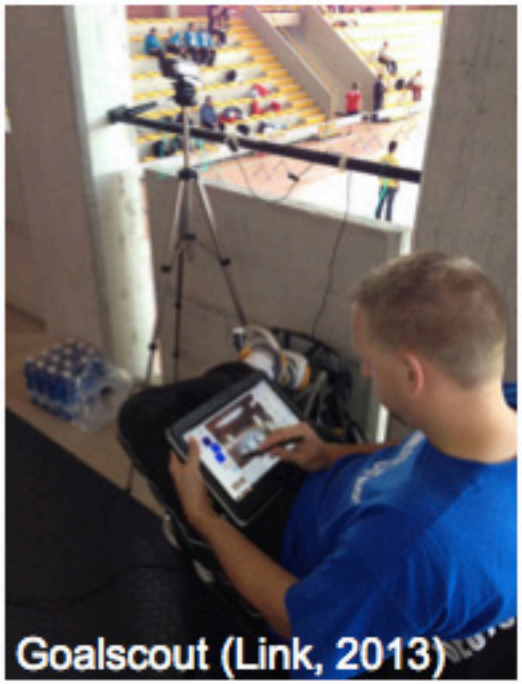




blog.conrad.de/statistik-2-0-die-tracking-technik-im-modernen-fussball



# The tiki-taka style of FC Barcelona

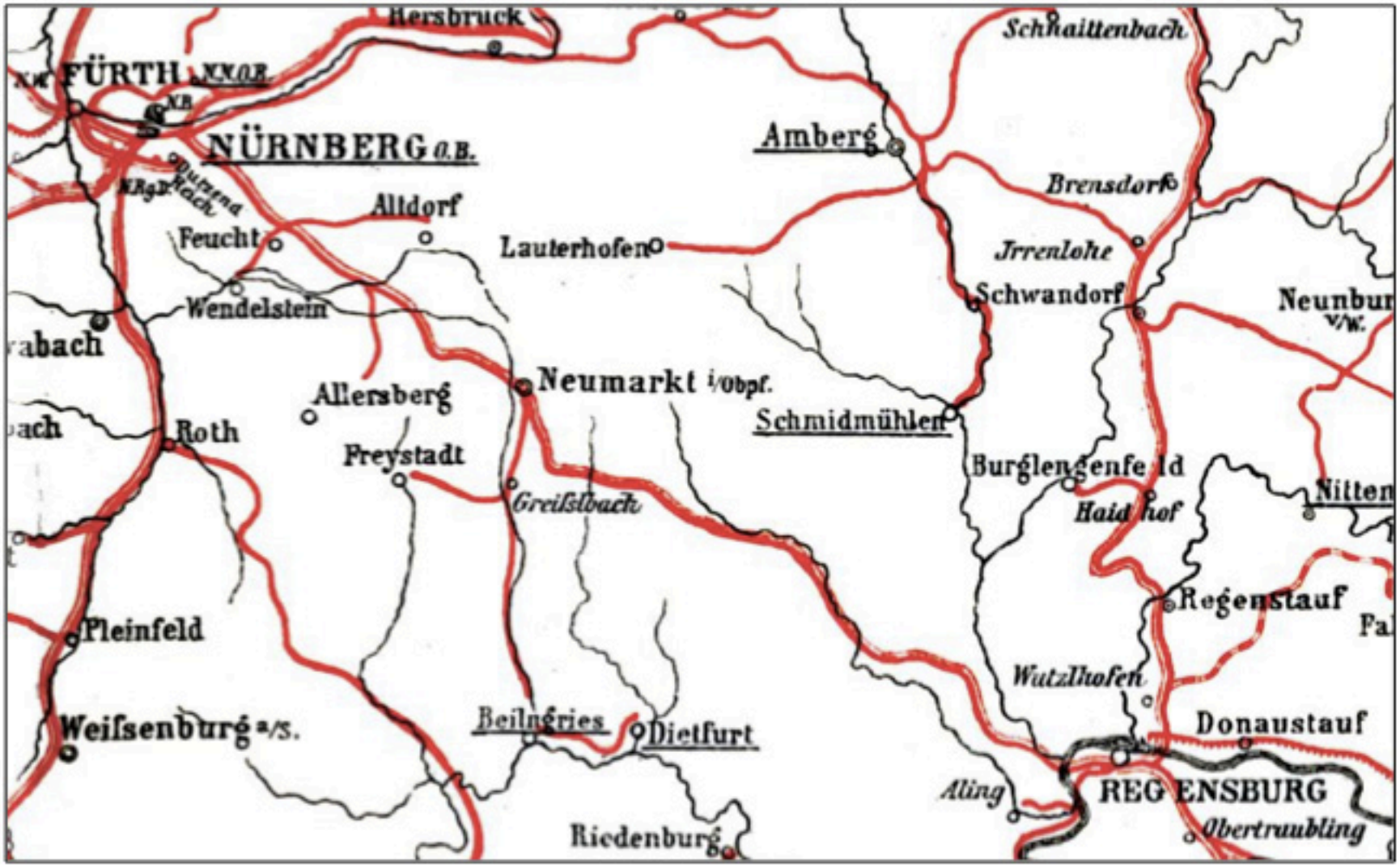



How can we see through the competitors without being seen through?

# Restore the road geometry from GPS trajectories

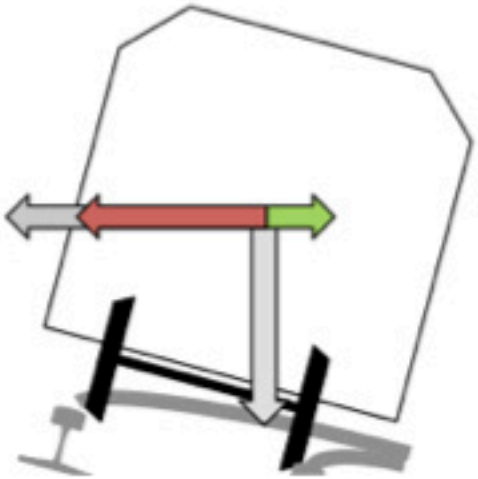
(Yang, J. 2014)

What if the GPS trajectories are too noisy?

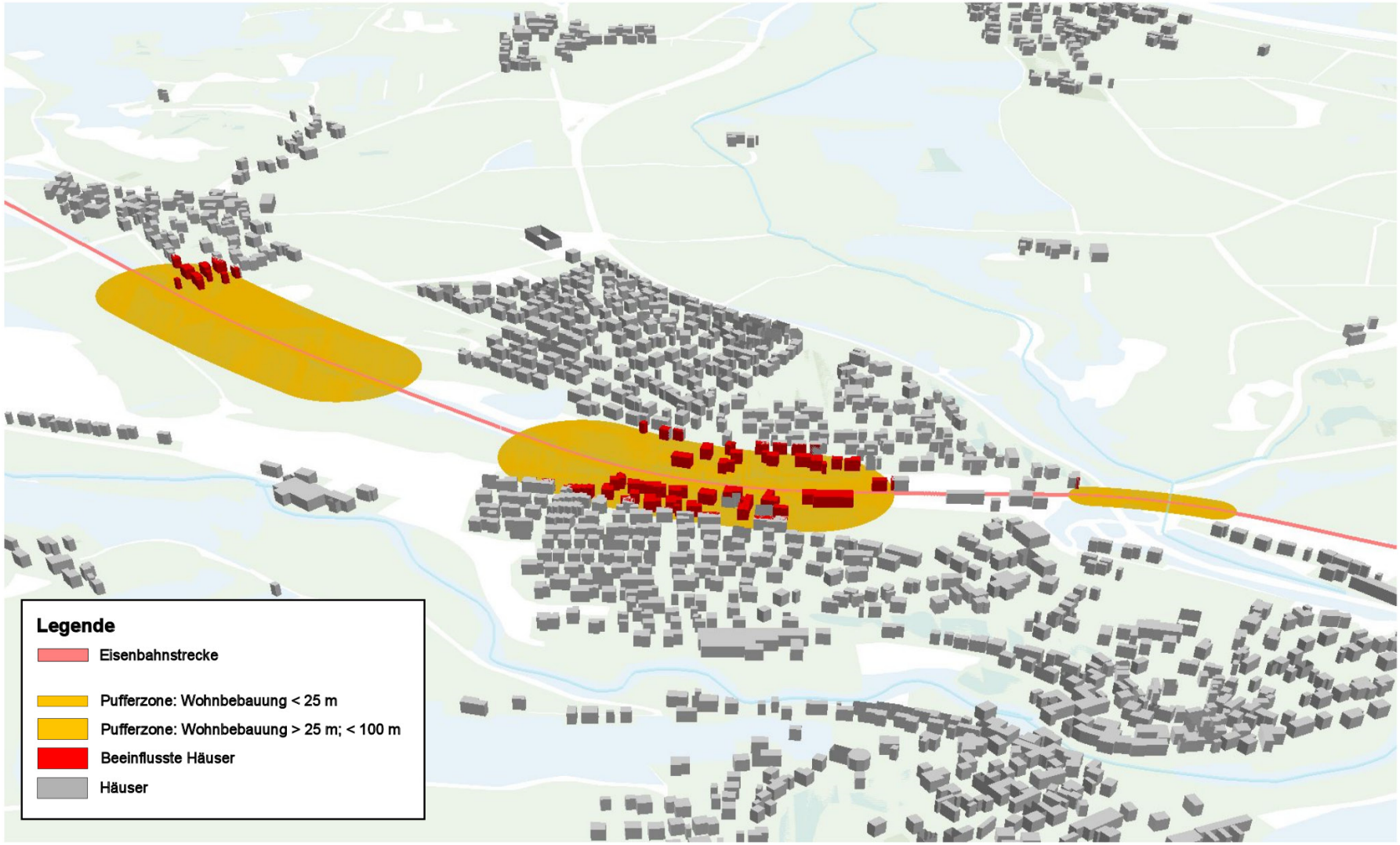



Nürnberg – Neumarkt - Regensburg 1869

Is it possible to save 5 min travel time along the track?



Two options: heighten the banking or straighten the curve




Theresa Coduro, 01.07.2014

Quellen: Basiskarte aus OpenStreetMap, Sachdaten aus Projekt ProZeit

# Buffer zones of noise along the curve elements

| max Δu | Fahrzeit-verkürzung | | max. +ΔV [km/h] inh0 | max. +ΔV [km/h] inh1 | Anzahl Elemente anzupassen | Gleislänge anzupassen | Kosten |
|---|---|---|---|---|---|---|---|
| 20 mm (1x stopfen) | 3 Min | | 0 | 20 | 29 | 2 x 20.700 m | 685.000 € |
| | | | 10 | 30 | 23 | 2 x 17.100 m | 571.000 € |
| | | | 50 | 50 | 20 | 2 x 14.000 m | 460.000 € |
| | 5 Min | | 0 | 20 | --- | --- | --- |
| | | | 10 | 30 | 50 | 2 x 38.300 m | 1.288.000 € |
| | | | 50 | 50 | 40 | 2 x 28.800 m | 955.000 € |
| | 6 Min | | 0 | 20 | --- | --- | --- |
| | | | 10 | 30 | --- | --- | --- |
| | | | 50 | 50 | 54 | 2 x 40.400 m | 1.353.000 € |
| | max | 4,7 Min | 0 | 20 | 66 | 2 x 46.500 m | 1.533.000 € |
| | | 5,9 Min | 10 | 30 | 67 | 2 x 46.900 m | 1.544.000 € |
| | | 6,7 Min | 50 | 50 | 67 | 2 x 46.900 m | 1.544.000 € |

| max Δu | Fahrzeit-verkürzung | | max. +ΔV [km/h] inh0 | max. +ΔV [km/h] inh1 | Anzahl Elemente anzupassen | Gleislänge anzupassen | Kosten |
|---|---|---|---|---|---|---|---|
| 40 mm (2x stopfen) | 3 Min | | 0 | 20 | 28 | 2 x 20.100 m | 739.000 € |
| | | | 10 | 30 | 20 | 2 x 14.900 m | 518.000 € |
| | | | 50 | 50 | 20 | 2 x 14.700 m | 516.000 € |
| | 5 Min | | 0 | 20 | --- | --- | --- |
| | | | 10 | 30 | 47 | 2 x 35.300 m | 1.349.000 € |
| | | | 50 | 50 | 37 | 2 x 28.200 m | 1.071.000 € |
| | 6 Min | | 0 | 20 | --- | --- | --- |
| | | | 10 | 30 | 66 | 2 x 46.500 m | 1.849.000 € |
| | | | 50 | 50 | 51 | 2 x 37.400 m | 1.452.000 € |
| | max | 4,8 Min | 0 | 20 | 67 | 2 x 46.500 m | 1.866.000 € |
| | | 6,0 Min | 10 | 30 | 67 | 2 x 46.500 m | 1.866.000 € |
| | | 6,8 Min | 50 | 50 | 67 | 2 x 46.500 m | 1.866.000 € |

Solution suggestions

# II. Multimodal routing and navigation services

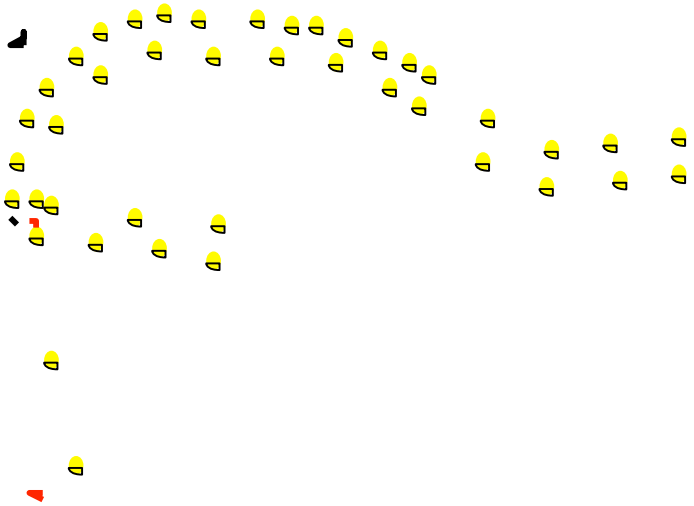
A case study of value-adding chain
from data integration to navigation
at the Department of Cartography (LfK), TUM

## Task

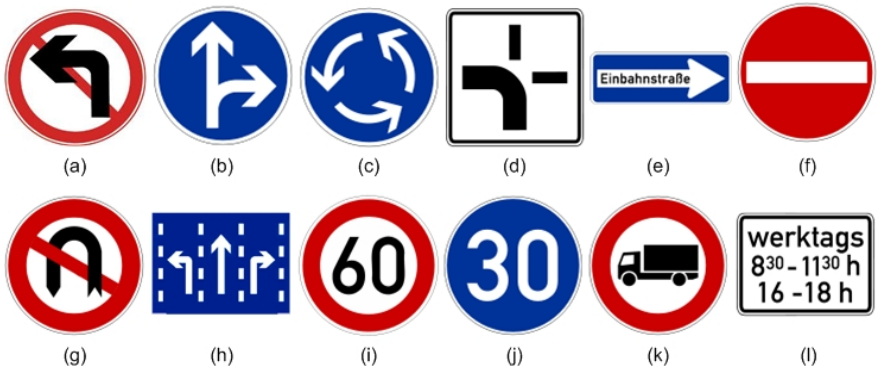
Enrichment of DLM-De with house numbers and navigation information

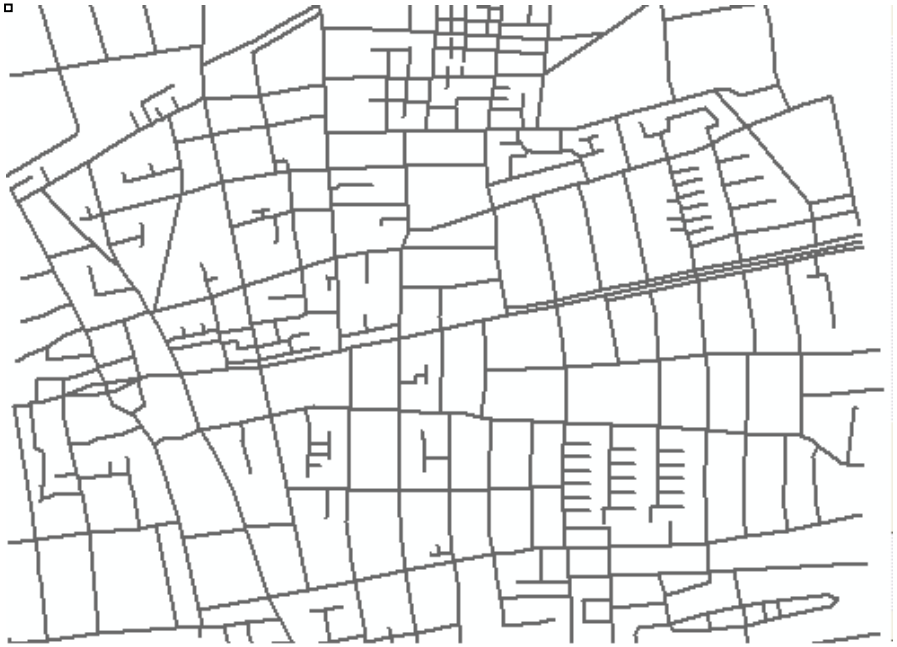
## Challenge

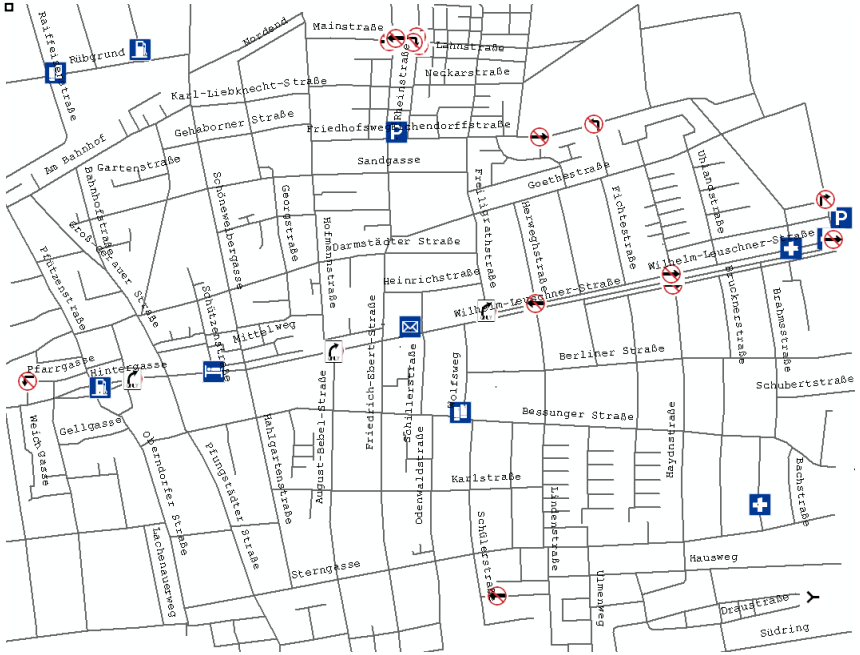
House numbers captured on the basis of TeleAtlas or GPS-equipped crowdsourcing of OSM

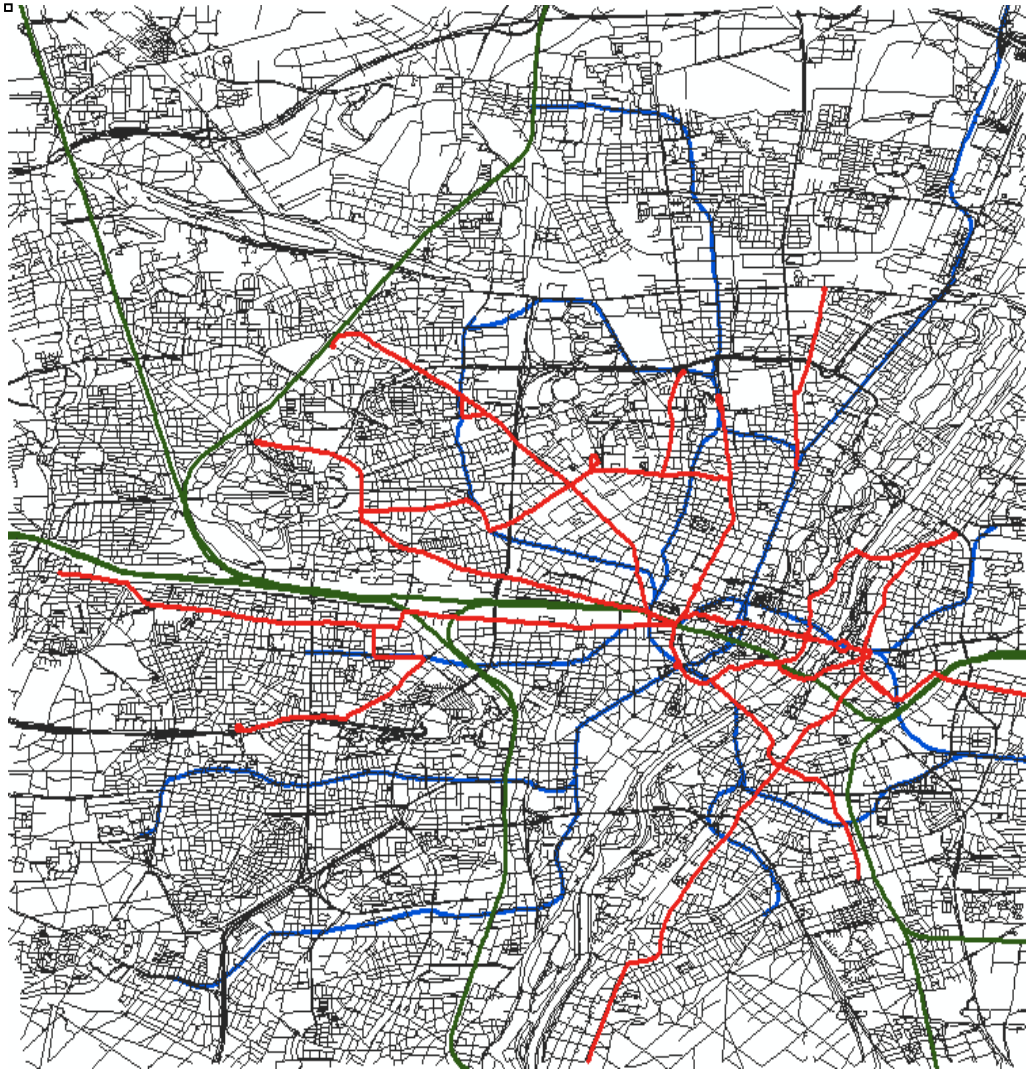


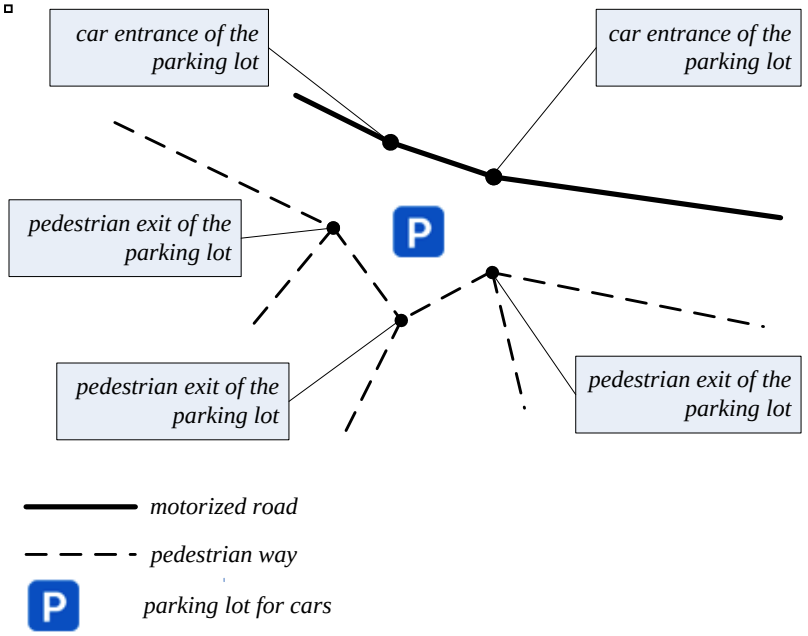
# Integration of navigation information





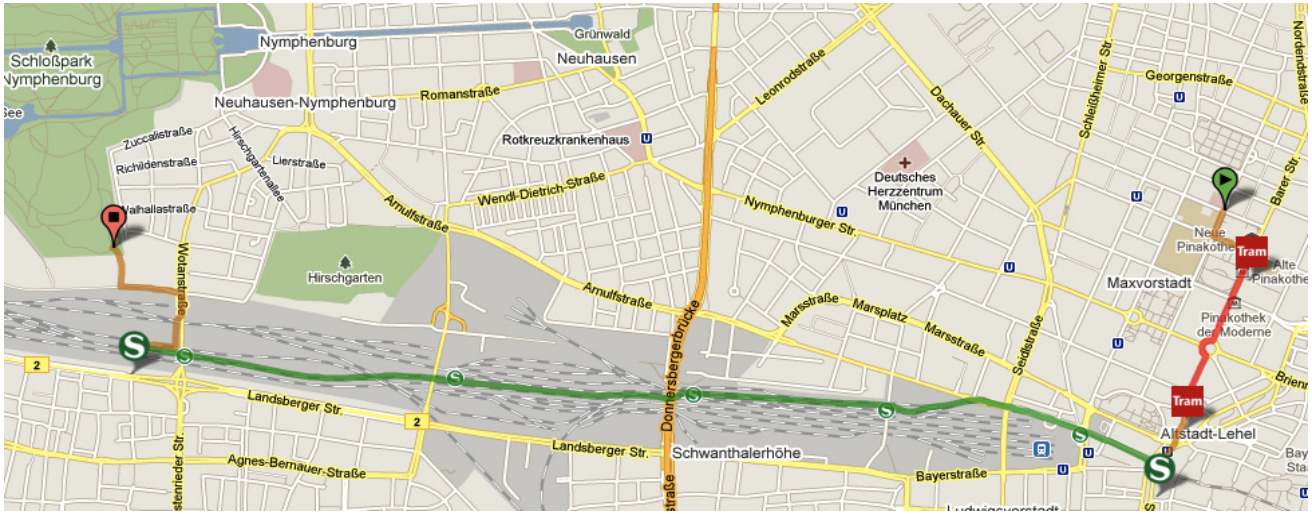


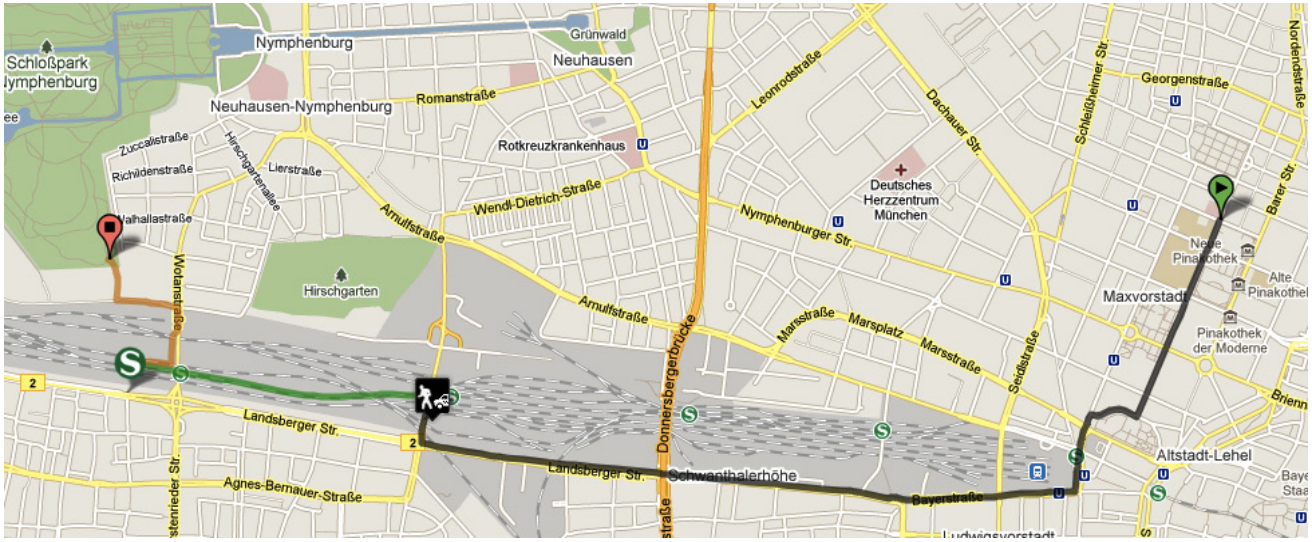



Conflation with public transport network in Munich

(Tram - red, Express track – green, Subway – blue)

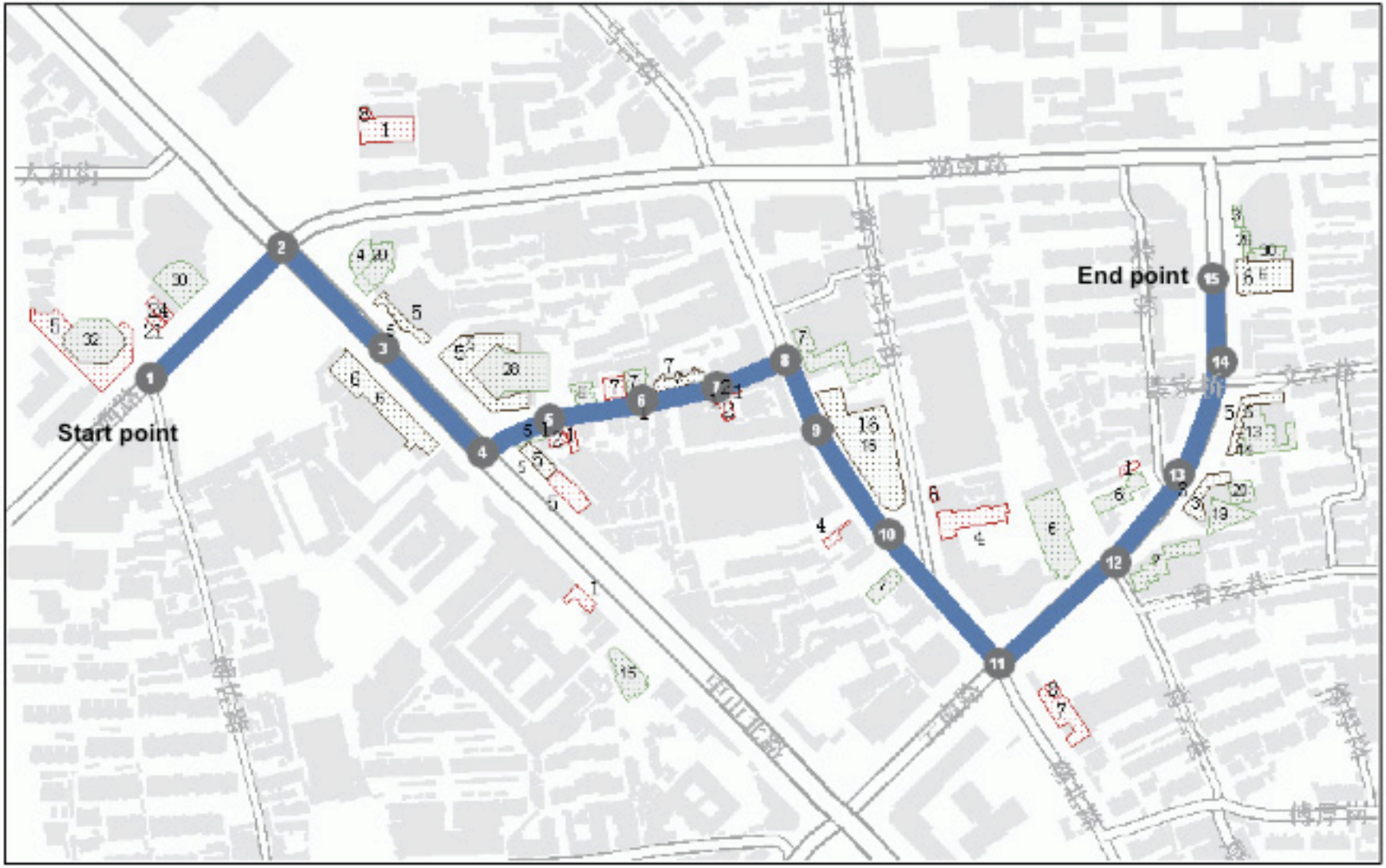
# Multimodal routing services




Car driving – black, Walking - brown, Tram - red, Express track – green

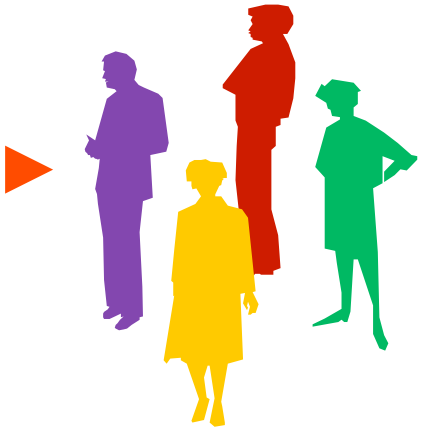
# Navigation guided by landmarks



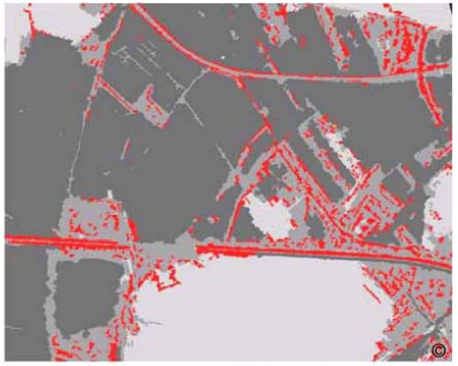
# III. Geovisualization services

Visual story telling

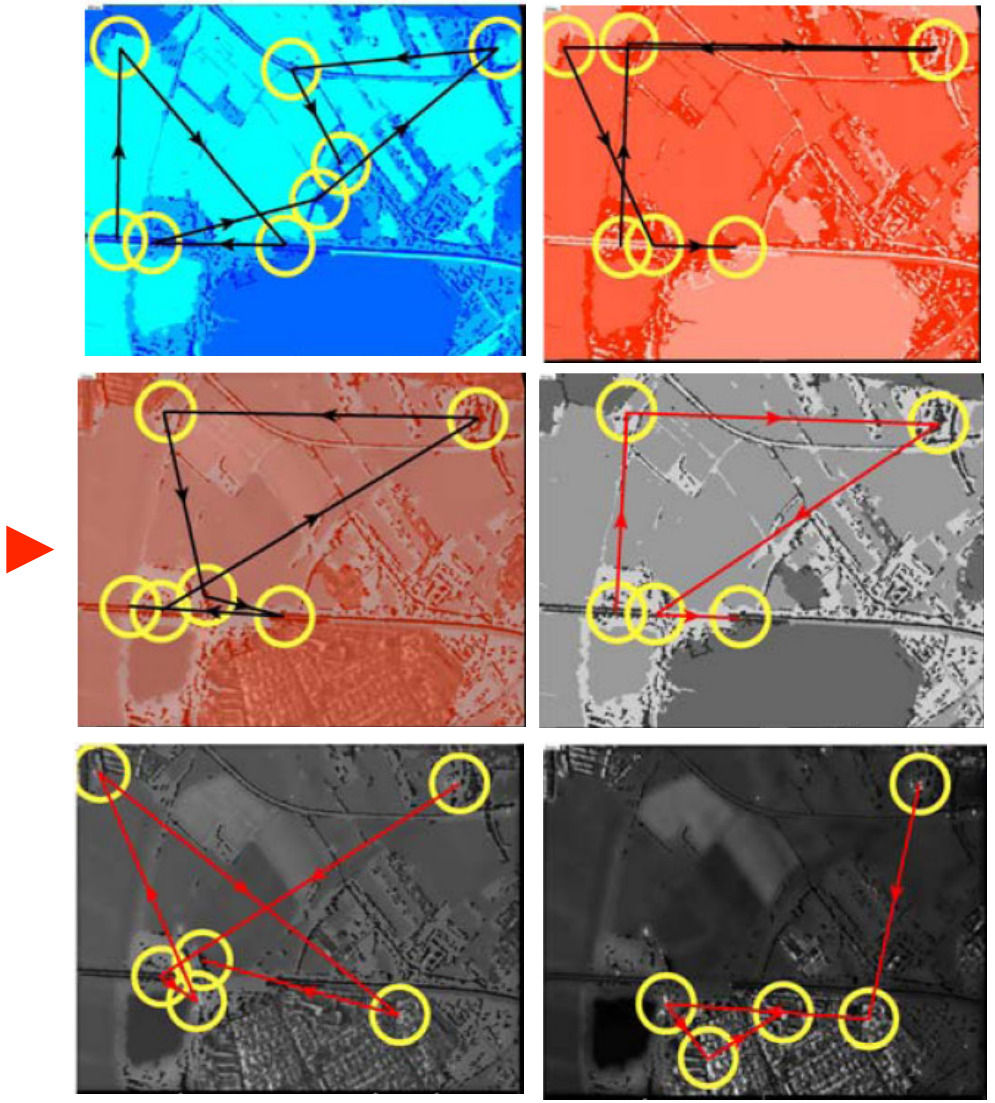
- where and when
- what and (who)
- how much
- how



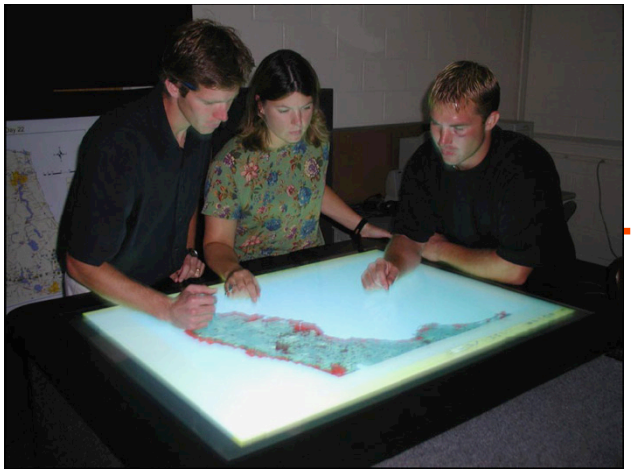
## Attention-Guiding design



(Swienty, 2008)



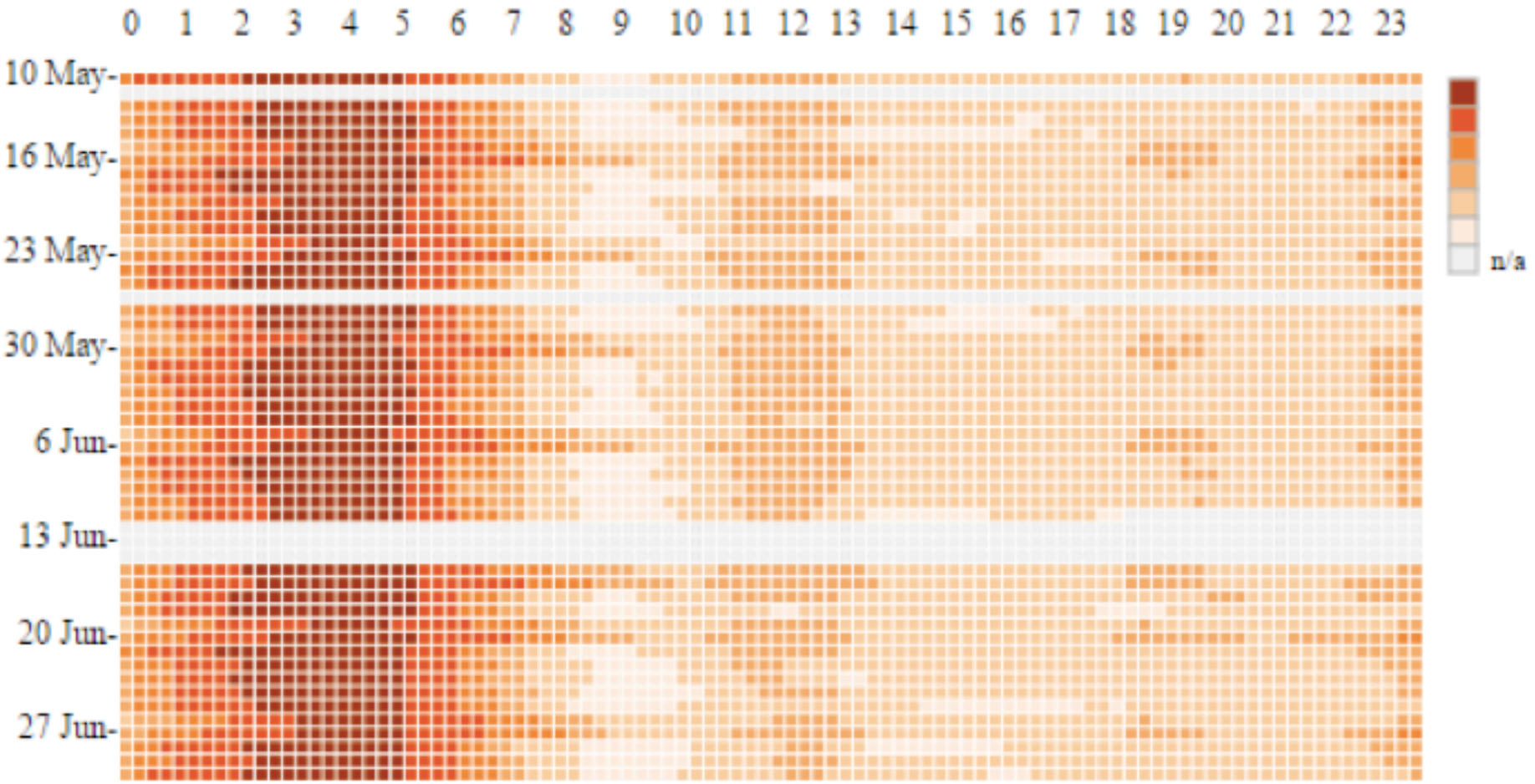

(Murphy 2014)



## Visual story discovery

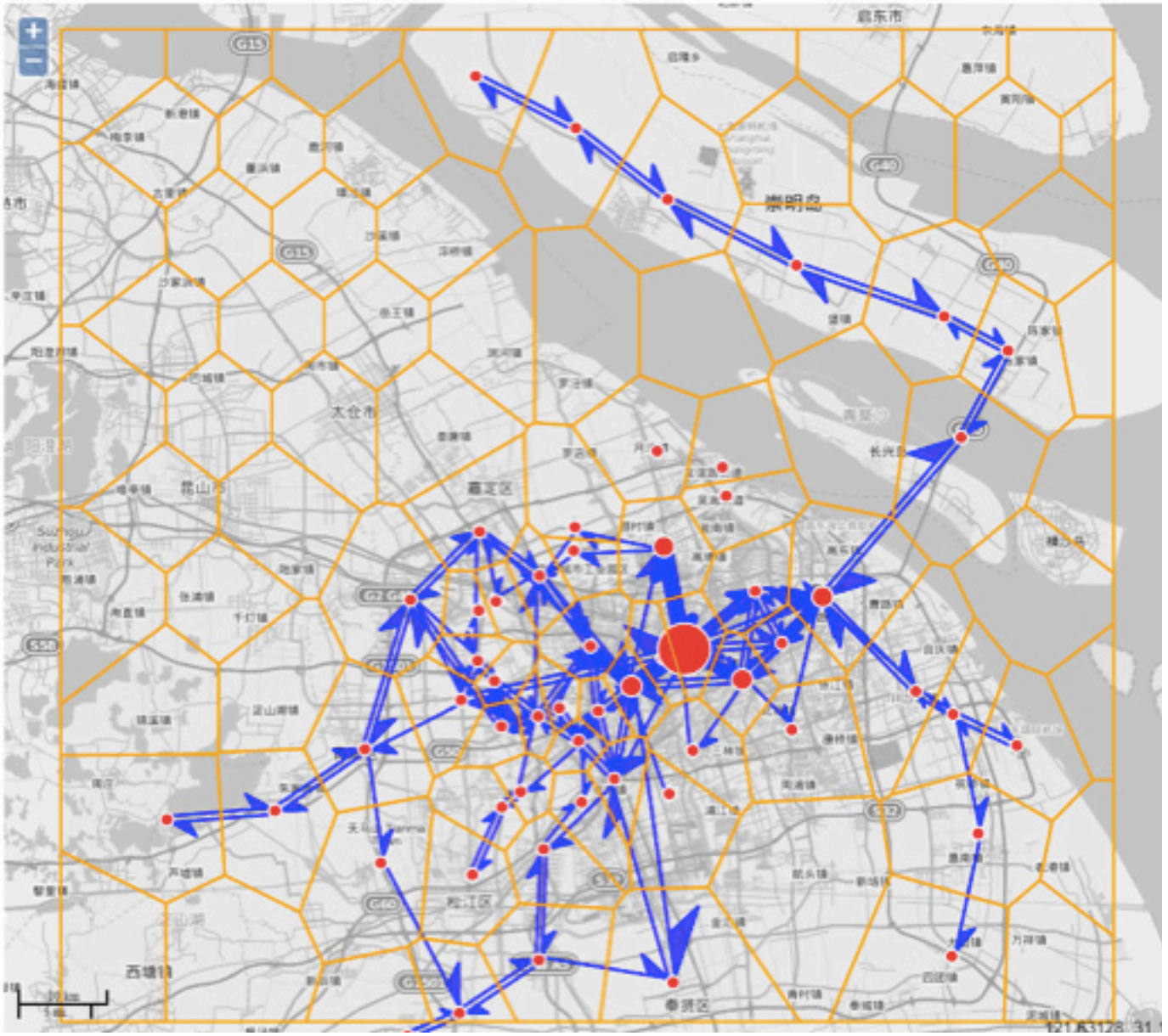
- where and when
- how
- why

# Case 1: Visual exploration of floating car behavior




Peak times for pick up and drop off

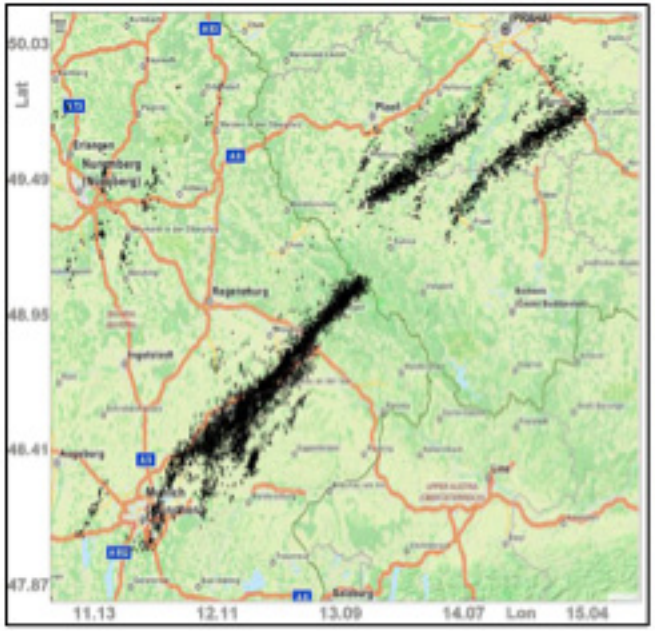
(Ding, L. 2014)

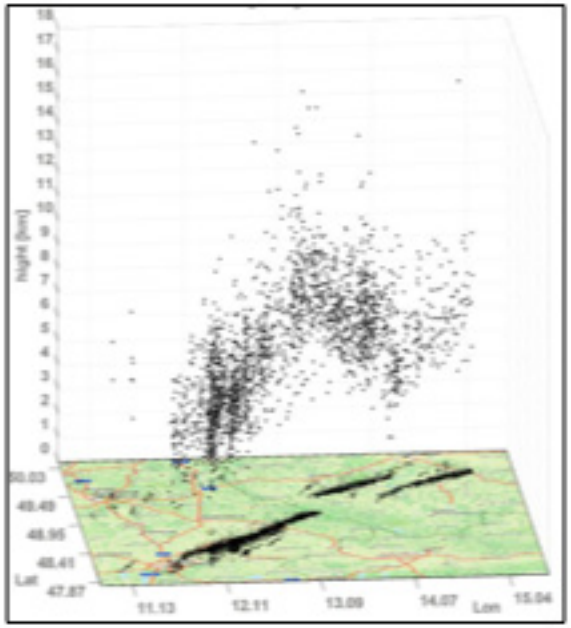


Major routes taken by floating cars

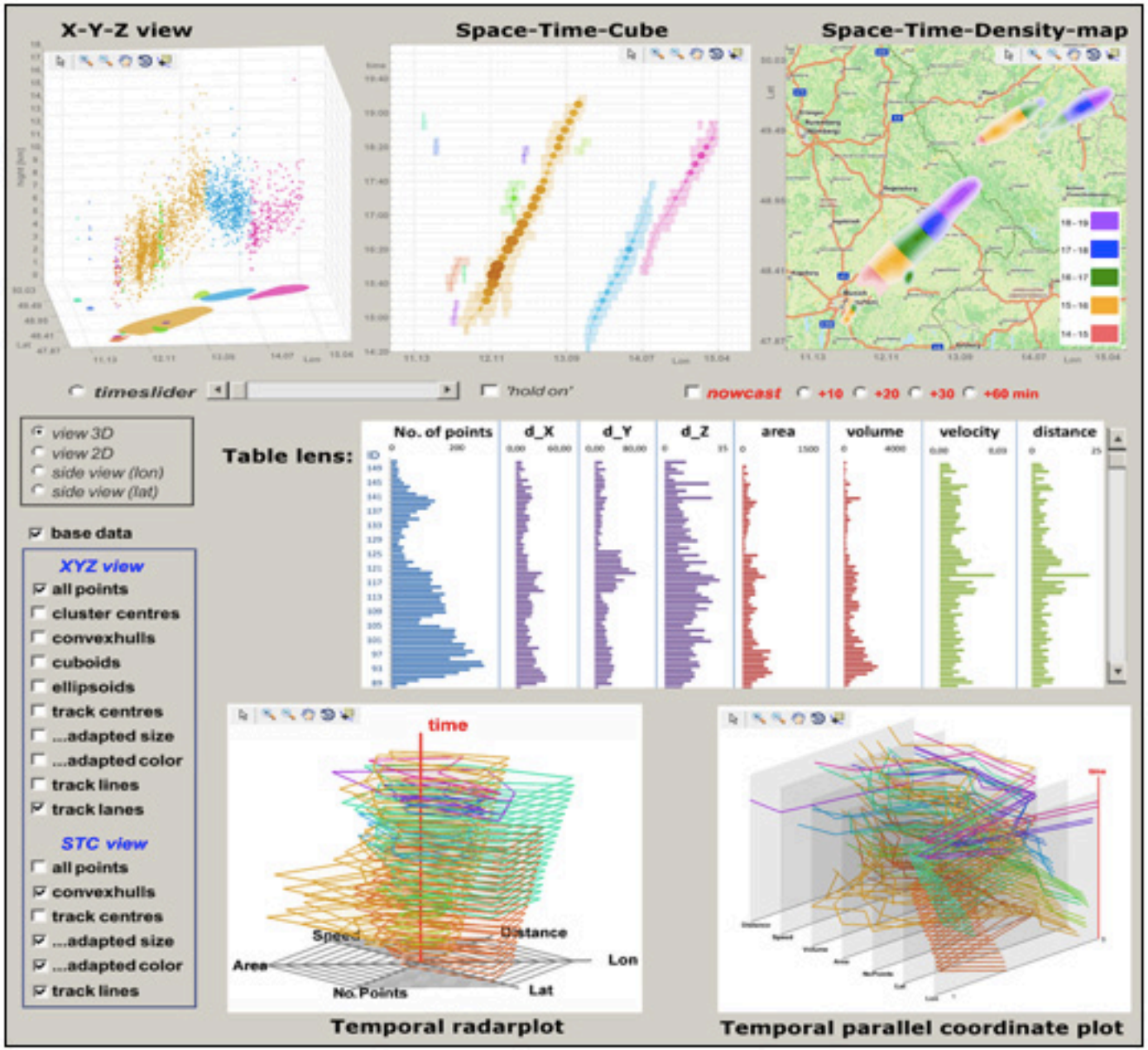
(Ding, L. 2014)

# Case 2: Nowcast of lightning behavior




Test dataset from April 26, 2013, between Munich and Prague (2919 IC, 5565 GC)


X-Y-Z view
Space-Time-Cube
Space-Time-Density-map
timeslider
'hold on'
nowcast
+10
+20
+30
+60 min
view 3D
view 2D
side view (lon)
side view (lat)
base data
XYZ view
all points
cluster centres
convexhulls
cuboids
ellipsoids
track centres
...adapted size
...adapted color
track lines
track lanes
STC view
all points
convexhulls
track centres
...adapted size
...adapted color
track lines
Table lens:
No. of points
d_X
d_Y
d_Z
area
volume
velocity
distance
time
Speed
Distance
Area
Lon
No. Points
Lat
Temporal radarplot
Temporal parallel coordinate plot

(Peters, 2014)

# To summarize