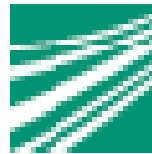
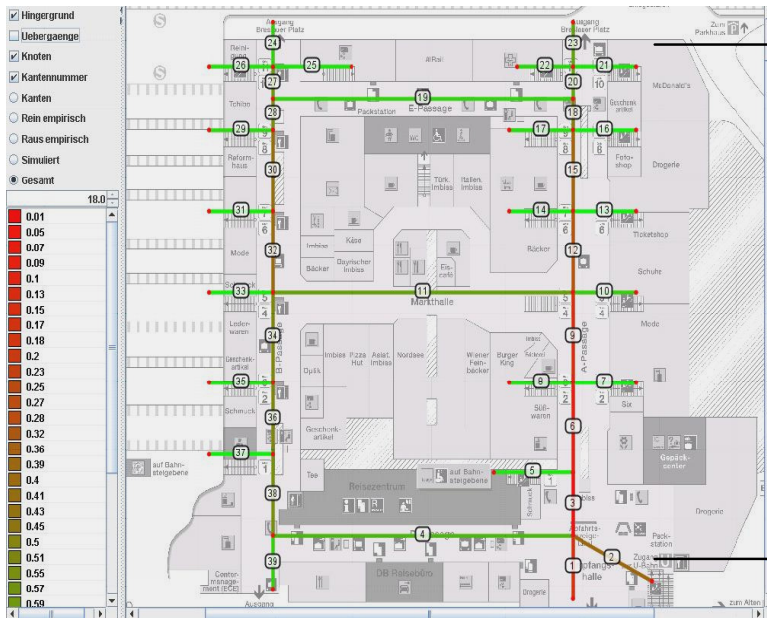


A Data Mining Approach on POI Based Traffic Flow Estimation - an Industrial Case Study



Fraunhofer
IAIS

Thomas Liebig

Outline

- Motivation
- Related work
- Algorithm with measurements
- Algorithm with POI
- Results
- Conclusion

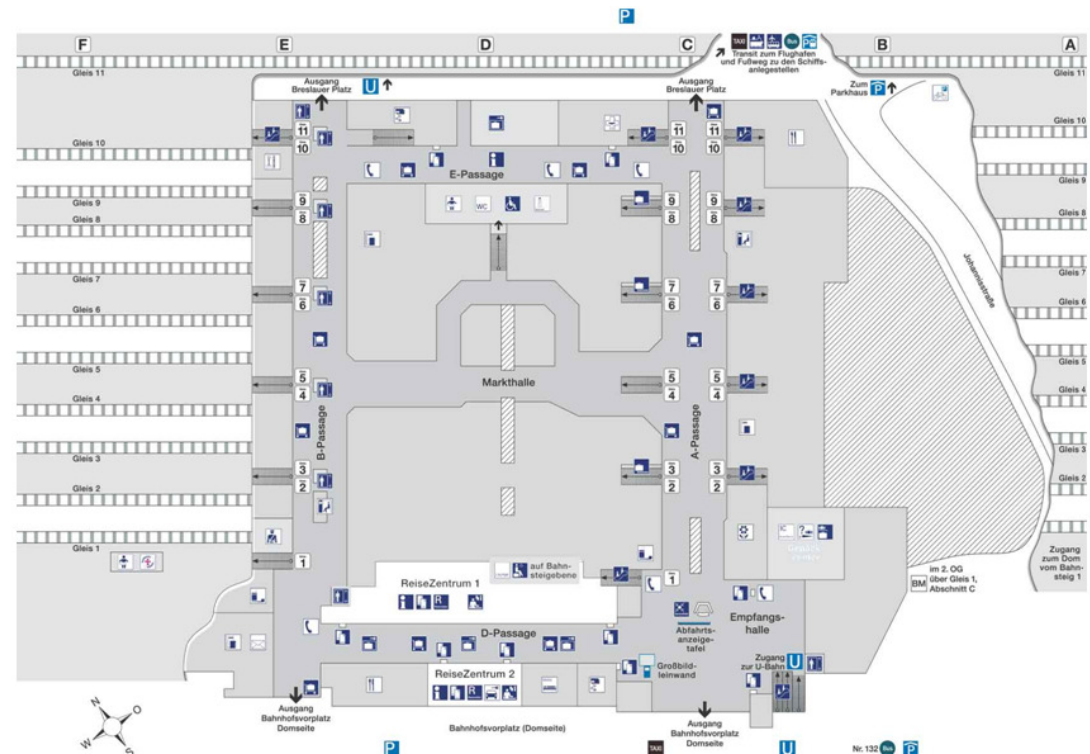
Frequency Map

Frequency Maps contain valuable information for

- Location planning
- Location evaluation
- Traffic monitoring
- Traffic prediction
- Emergency planning
- Environmental planning

Focus here on public buildings

- airports
- train stations
- shopping malls



Frequency Map – related work

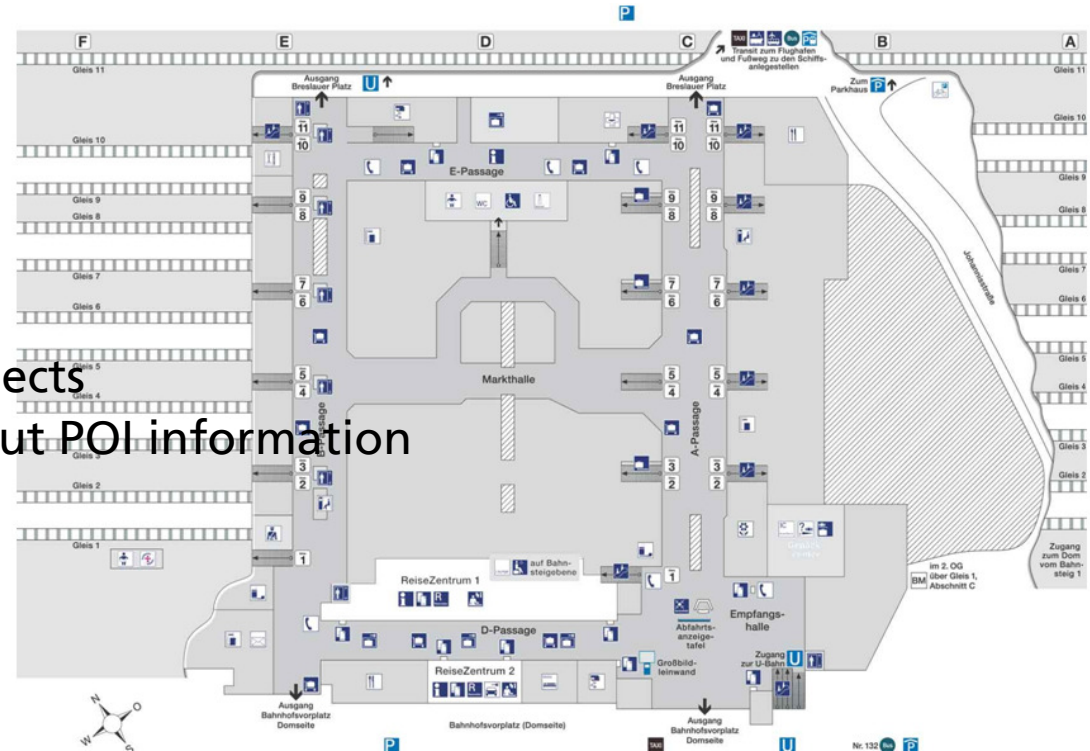
Methods for Traffic Flow Estimation

- Simulation
- s-kNN
- Markov Chain Model
- Regression

Challenge:

- Only measurements in few objects
- Generally, no measurements but POI information

→ Learn behaviour and transfer!



Frequency Map – Algorithm with measurements

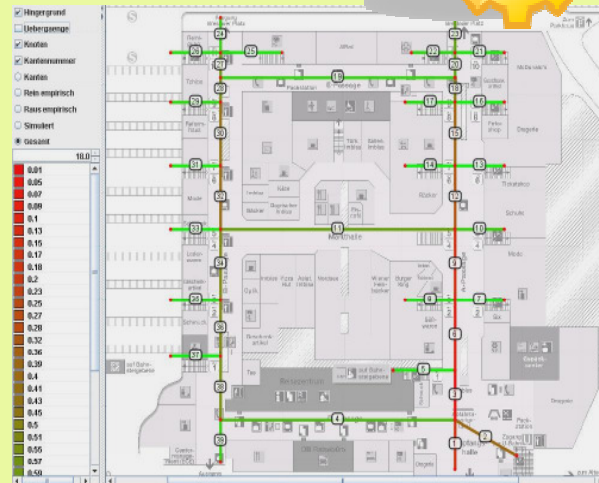
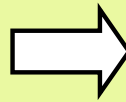
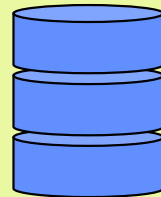
Case with measurement: (Tanyimboh '93)

1. Build traffic network (graph representing floors and junctions)
 2. Enumerate possible paths through the object (path-set)
requires: assumptions on the relevant pedestrian movement
 3. Regression at the measurement places (flow estimation)
- Frequency at all (unmeasured) edges: **Frequency Map'**
- Probability distribution for path-set denotes dependencies of locations

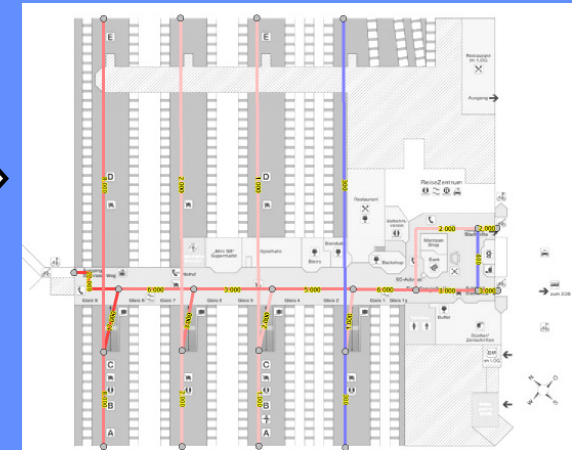
Data flow



170 object plans with
Traffic networks



Measured Frequency Map
for 15 public buildings (equal class)



Frequency Map
for 170 public buildings

Algorithm with POI

Given:

- overall frequency within a certain time-period
- Map depicting POI + additional POI sources (train schedules)

Can also create similar

- Traffic network and
- Path-set (by enumeration)

Problem description 1:

→ Predict edge frequency using POI data

Difficult! Can't distinguish people going there

- because of the POI or just
- because of its situation

Algorithm with POI

Problem description 2:

→ Predict probability distribution among path-set using POI data

Attributvector creation:

1. Label all edges of traffic network with POI attributes
2. Label edges with additional attributes from the map (path-width, stairway, ..)
3. Aggregate attributes along pathes to attributvector
4. Add additional attributes to attributvector (detour factor)

Manual Annotation

Derg

- ☒ Hingergrund
- ☒ Knoten
- ☒ Knotennummer
- ☒ Düsseldorf
- ☐ Mannheim
- ☐ Frankfurt
- ☐ Berlin Alexanderplatz
- ☐ Berlin Bornholmer Strasse
- ☐ Köln Deutz

Zoom: 77,0

Aachen Hbf

<Alle Ebenen>

Laden

Speichern

Löschen

Classification

--->

Frequenzzone Hoch

- Frequenzzone Hoch
- Frequenzzone Niedrig
- Frequenzzone Gleis
- Frequenzzone Hoch/Niedrig
- Eingang/Ausgang

Annotation :8

Edge Number : 8

WEGINFORMATION

Gangbreite

HauptWeg ☐ Ja ☒ Nein

Verstibueel ☐ Ja ☒ Nein

Zubringer ☐ Ja ☒ Nein

GLEIS INFORMATION

Bahnsteig ☒ Ja ☐ Nein

Fern ☐ Ja ☒ Nein

Nah ☐ Ja ☒ Nein

S-Bahn ☐ Ja ☒ Nein

U-Bahn ☐ Ja ☒ Nein

Bahnsteig ID

Gleisabschnitt

Gleis Nr am Bahnsteig

EIN-AUSGANG INFORMATION

Eingang ☐ Nebeneingang ☐ Haupteingang ☒ Nein

City Seite ☐ Ja ☒ Nein

Parkhaus ☐ Ja ☒ Nein

ÖPNV ☐ Ja ☒ Nein

Bus ☐ Ja ☒ Nein

S-Bahn ☐ Ja ☒ Nein

Tram/U-Bahn ☐ Ja ☒ Nein

Taxi Stand ☐ Ja ☒ Nein

Offene Seiteneingänge ☐ Ja ☒ Nein

Navteq

Auf-/Abgang ☐ Ja ☒ Nein

Treppe ☐ Ja ☒ Nein

RollTreppe ☐ Ja ☒ Nein

Fahstuhl/Behindertenrampe ☐ Ja ☒ Nein

FUNKTION INFORMATION

WC ☐ Ja ☒ Nein

Schließfach ☐ Ja ☒ Nein

Shop ☐ Ja ☒ Nein

Imbiss-To-Go ☐ Ja ☒ Nein

FF-Restaurant ☐ Ja ☒ Nein

Märkte ☐ Ja ☒ Nein

Zeitschriften/Bücher ☐ Ja ☒ Nein

Dienstleistung ☐ Ja ☒ Nein

Reisecenter ☐ Ja ☒ Nein

Fahrkarten ☐ Ja ☒ Nein

Automaten ☐ Ja ☒ Nein

Service Point ☐ Ja ☒ Nein

OK

Algorithm with POI

But: one path contains no information about its speciality:

→ Can not use attributvector to predict ratio in probability distribution for a single path ☹

Solution:

Z-transformation of aggregated attributes (per building)
(Mean and standard deviation get fixed)

Algorithm with POI - result

Prediction model:

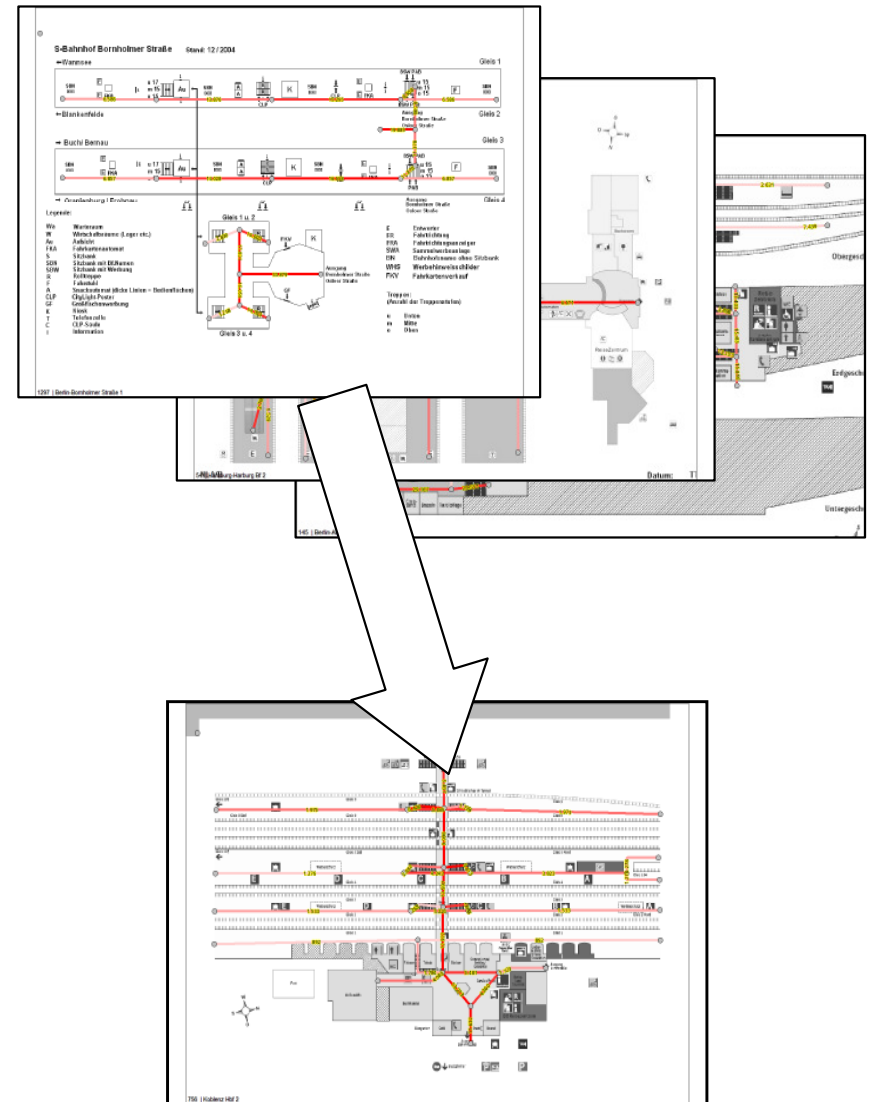
Decision tree

- can validate decisions
- Can communicate model to project partner

Result

cross-fold validation
correlation 83%
rank prediction accuracy 99%

170 Frequency Maps



Algorithm with POI - result

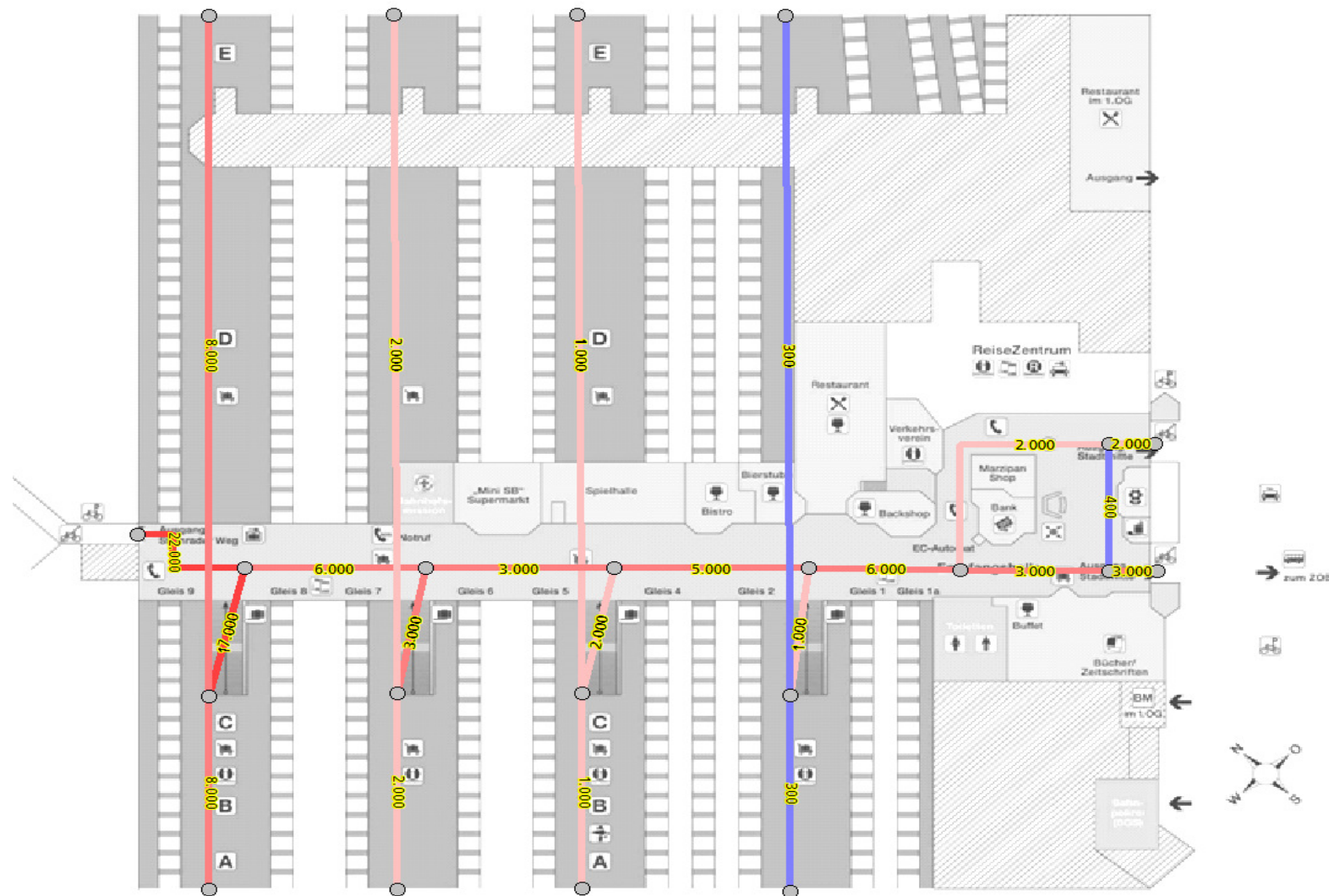
```
ANZAHL <= -0.64 :
|   MITTELWEG <= -1.399 :
|   |   Anteil3 <= 1.996 :
|   |   |   ANZAHL <= -2.054 :
|   |   |   |   TREPPE <= -0.098 :
|   |   |   |   |   VESTIBUEL <= -0.721 :
|   |   |   |   |   |   SHOPPING <= -1.828 :
|   |   |   |   |   |   |   Z_ZUG_1 <= -0.257 :
|   |   |   |   |   |   |   |   BREITWEG <= -0.38 :
|   |   |   |   |   |   |   |   |   Anteil3 <= -0.268 : LM1 (3/51.291%)
|   |   |   |   |   |   |   |   |   Anteil3 > -0.268 : LM2 (10/25.325%)
|   |   |   |   |   |   |   |   |   BREITWEG > -0.38 : LM3 (8/0%)
|   |   |   |   |   |   |   |   |   Z_ZUG_1 > -0.257 :
|   |   |   |   |   |   |   |   |   NEBENEINGANG <= -0.025 :
|   |   |   |   |   |   |   |   |   SBAHN <= 0.437 :
|   |   |   |   |   |   |   |   |   |   Z_ZUG_1 <= -0.013 : LM4 (9/36.041%)
|   |   |   |   |   |   |   |   |   |   Z_ZUG_1 > -0.013 : LM5 (13/34.662%)
|   |   |   |   |   |   |   |   |   |   SBAHN > 0.437 : LM6 (8/0%)
```

Algorithm with POI - result

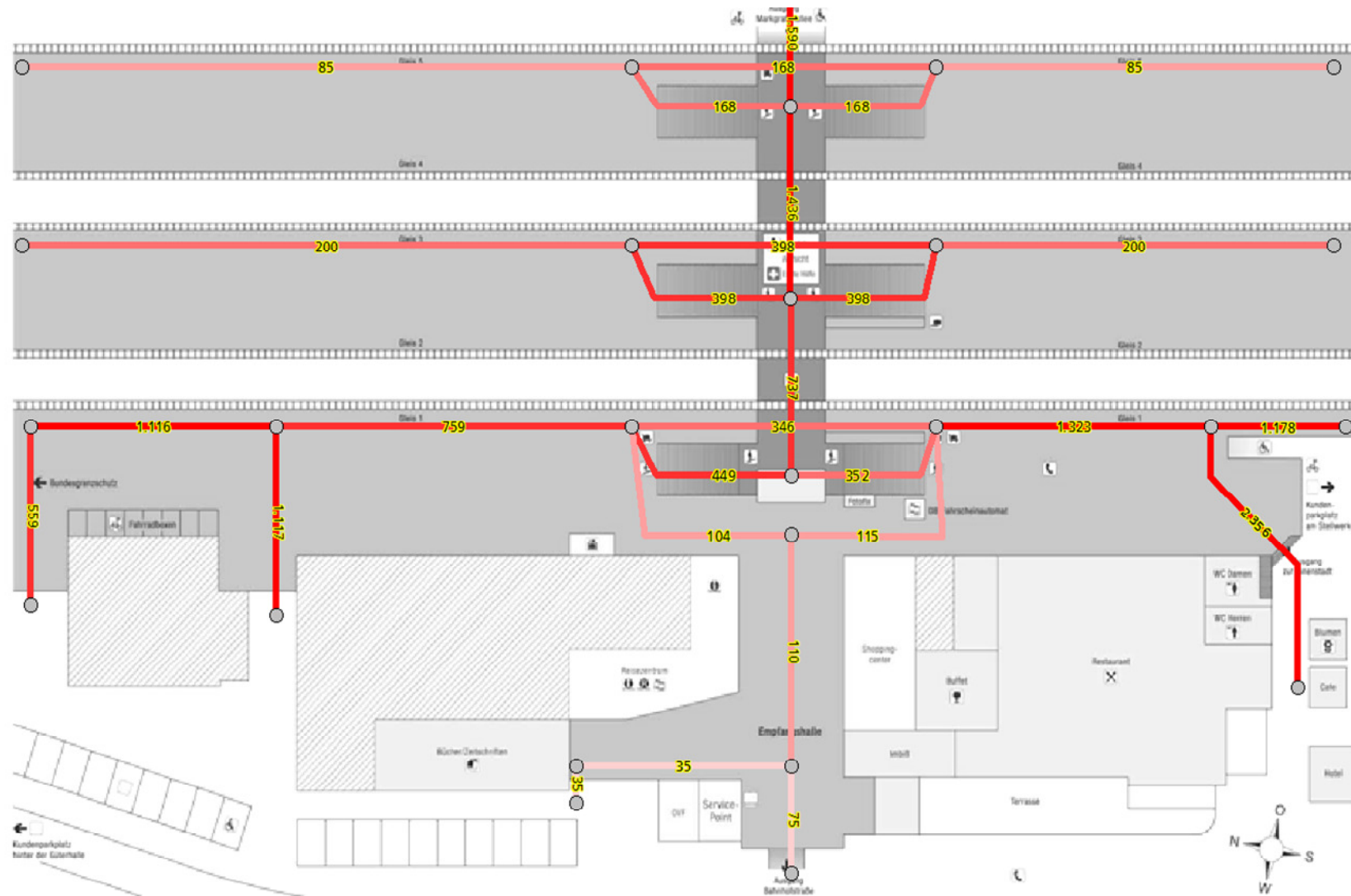
Most important attributes according to information gain

- path length
- path width
- detour factor
- stairs
- vestibül
- shops

Algorithm with POI - result



Algorithm with POI - result



Algo



Conclusion and Further Steps

Created meaningful frequency map based on emergency maps

- Empirical measurements in similar buildings
- Attribute annotation of network segments
- Model pedestrian behaviour within an object type depending on attributes
- Transfer to unknown building

Further steps:

- Correction Model for inclusion of expert knowledge
- Time dependent frequency maps
- Online traffic flow estimation and prediction