# Analysis of mobility patterns in different neighborhoods, integrating GPS tracks with OpenStreetMap data


**P5 Presentation - Matilde Oliveti (4323564)**

**MSc Geomatics 25-06-2015**

**Graduation Professor:** ***Stefan van der Spek***

**Daily Supervisor:** ***Wilko Quak***


TU Delft

# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

# Introduction

- Mobility patterns are complex
- Current trend: more and longer trips mostly by private car
- Policy makers and spatial planners: need of accurate information

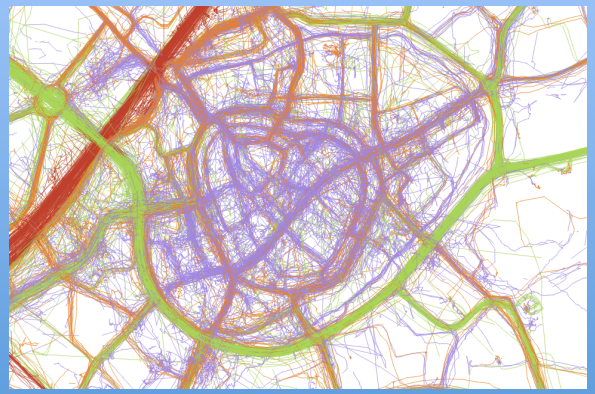
# Introduction

- Open data
- Volunteer Geographic Information (VGI)
- New technologies and tools

Facilities and built environment characteristics

*Theoretical Performances*

Actual people travel behaviour



*Actual Performances*

# Objectives

- Validate theoretical performances (built environment characteristics) with actual performances (actual people travel behaviour)
- Develop a standard procedure to assess mobility patterns in the different neighborhoods

**Main Research Question**

*"How do different neighbourhoods perform in terms of mobility patterns based on proximity, density, and accessibility?"*

# Relevance

- Add a new layer of knowledge to previous studies (maps and real data)
- Help policy makers to assess actual mobility patterns
- SDSS (Spatial Decision Support System)
- Neighbourhood renovation and future neighbourhood design

# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

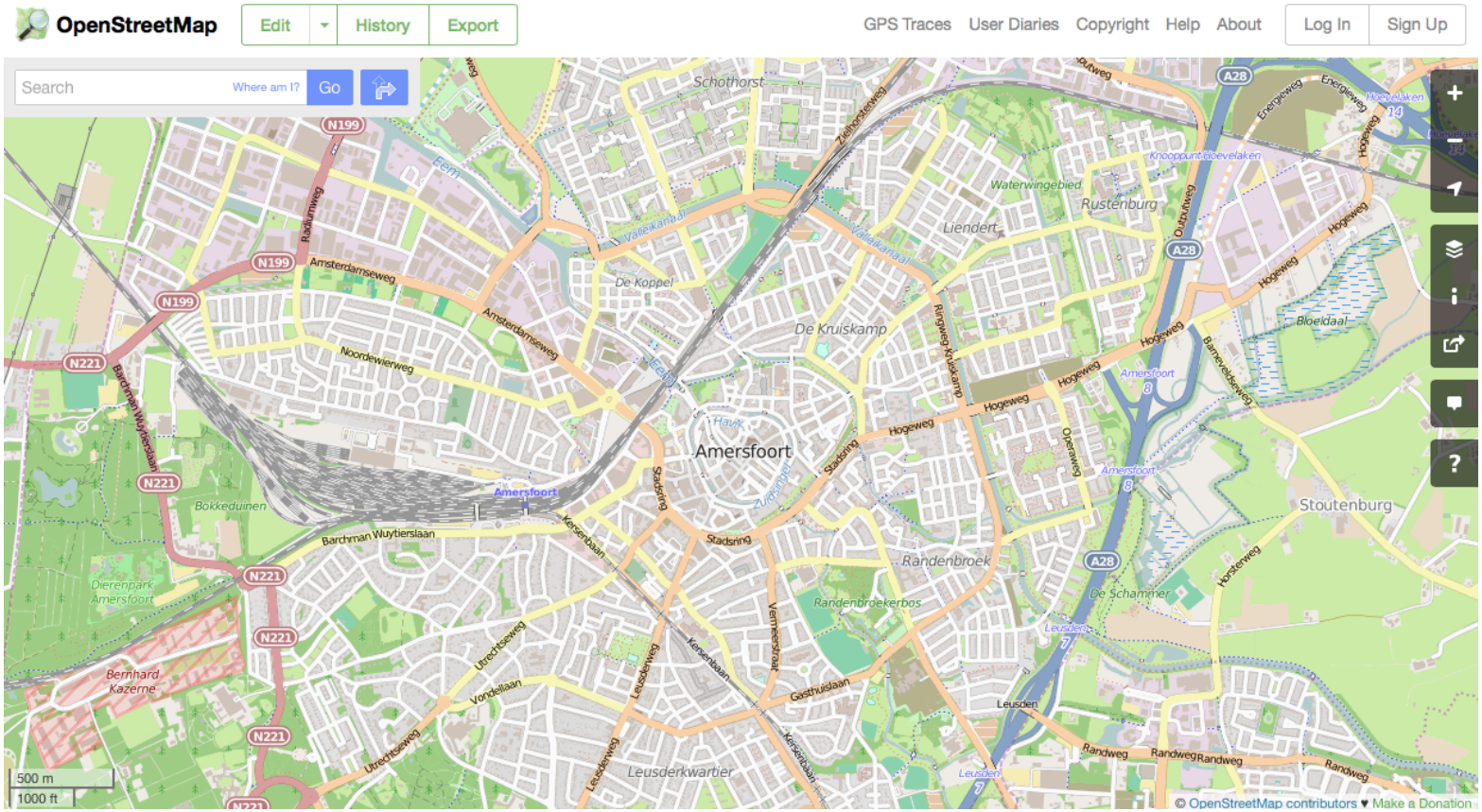
# Tools

- **PostgreSQL/PostGIS:** DBMS (Database Management Systems)
- **QGIS:** GIS (Geographical Information Systems)
- **IBM SPSS:** Statistical analysis
- **PgRouting:** PostgreSQL extension for routing functionalities



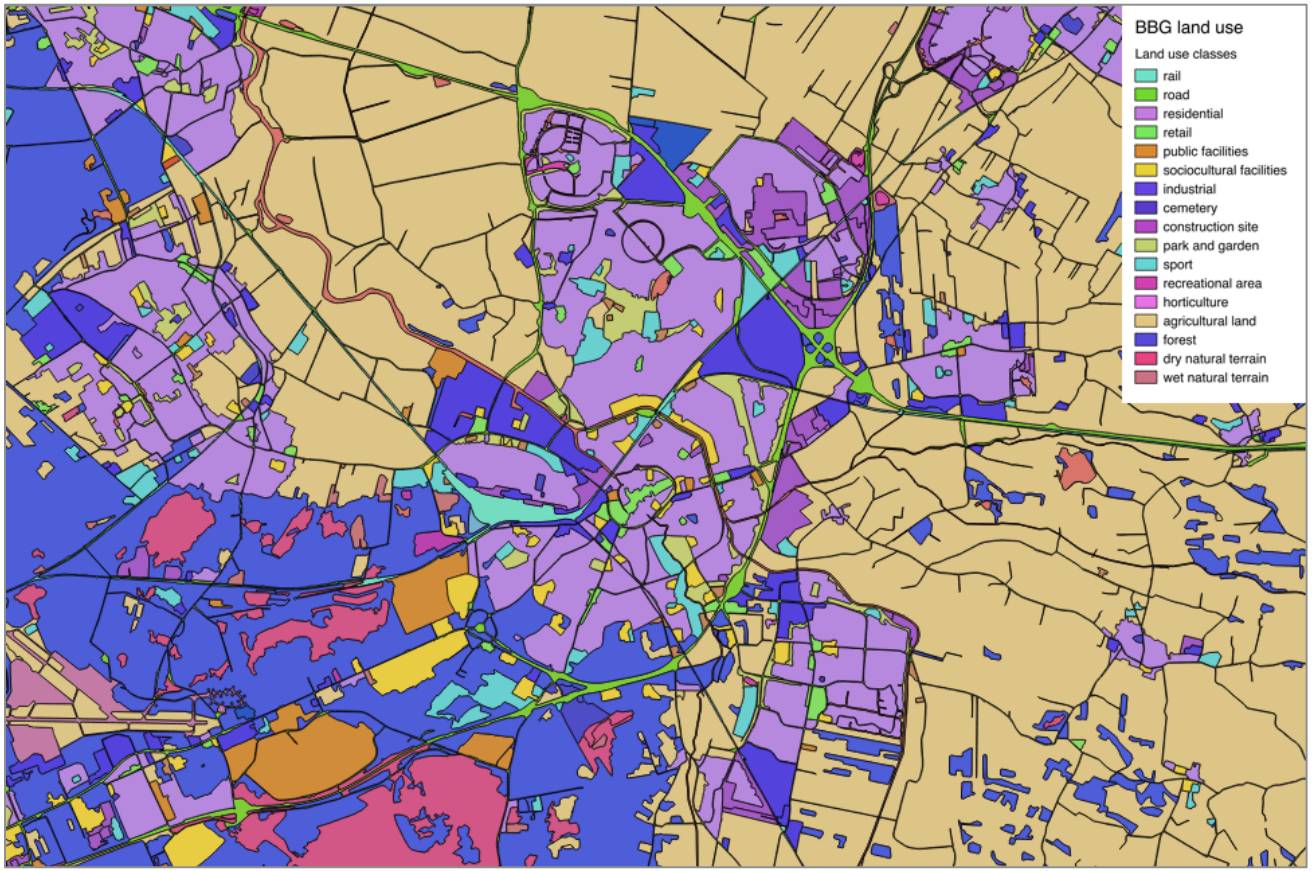

# Datasets

**OpenStreetMap:** infrastructure network and theoretical performances



# Datasets

**BBG (Bestand Bodemgebruik):** land use

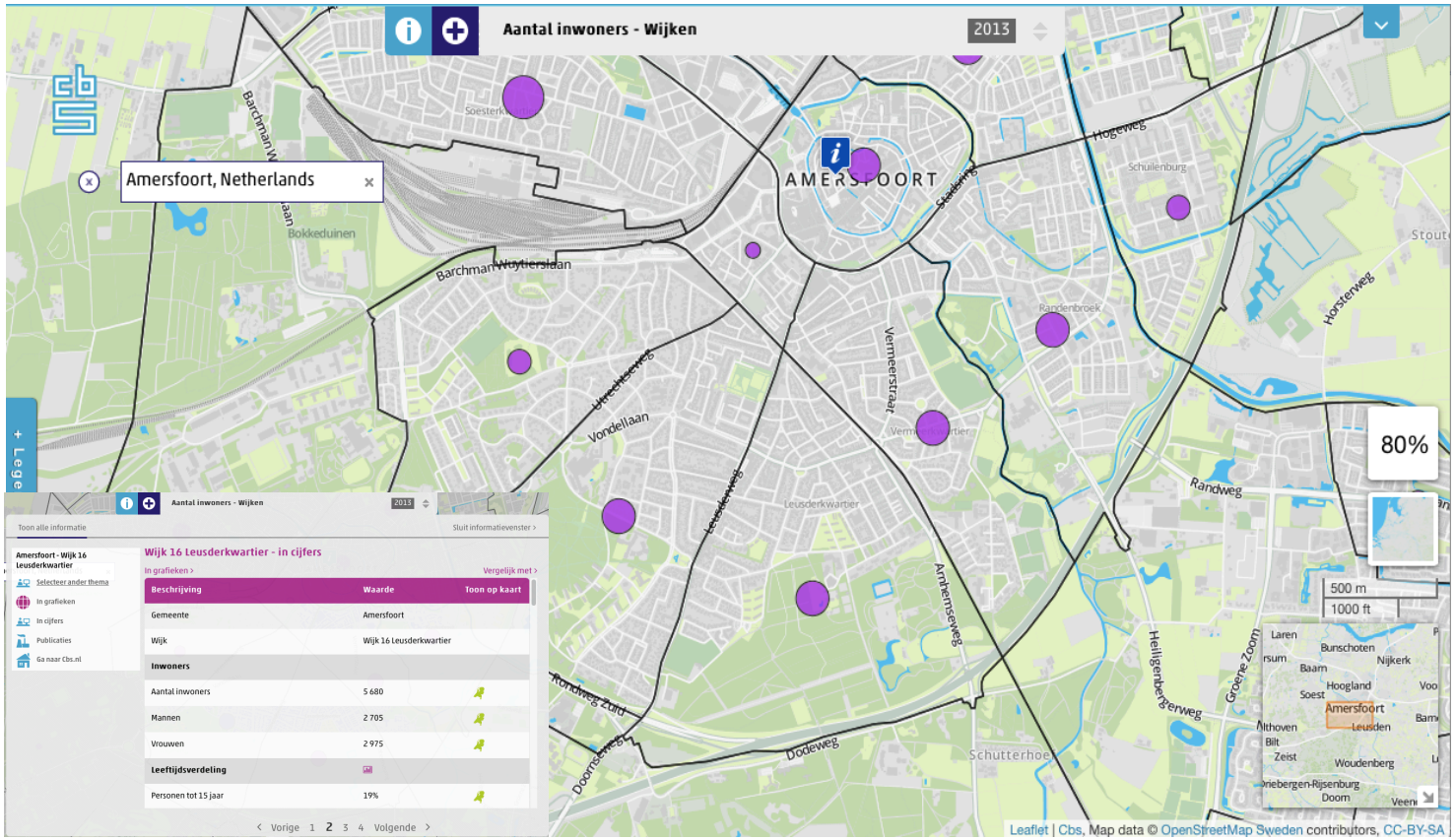


# Datasets

**BAG (Basisregister Adressen en Gebouwen):** buildings

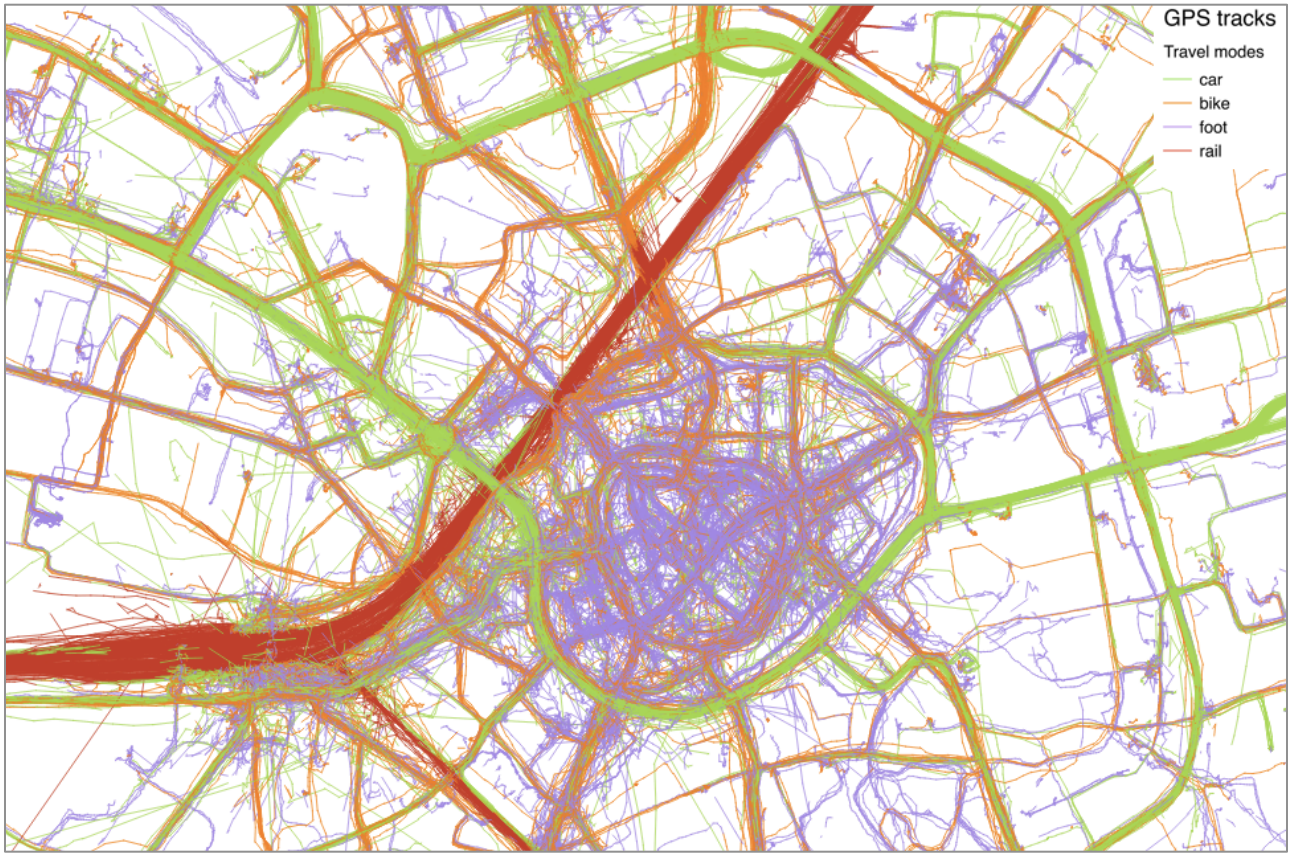
# Datasets

**CBS (Central Bureau of Statistics):** population, neighbourhoods boundaries



# Datasets

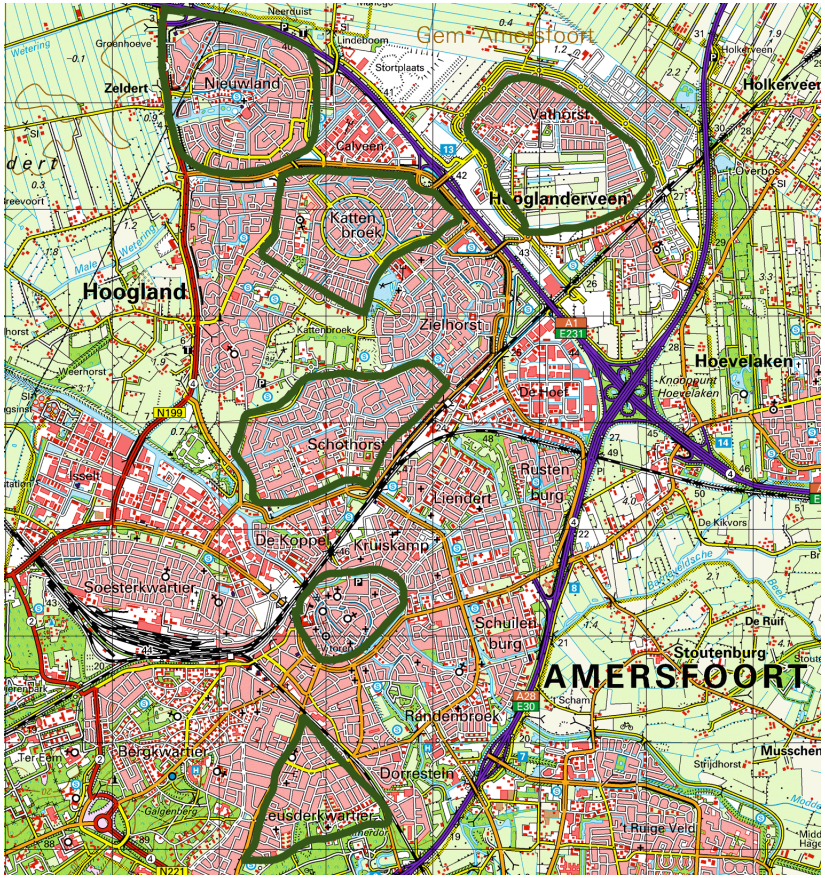
**GPS real data**: actual performances

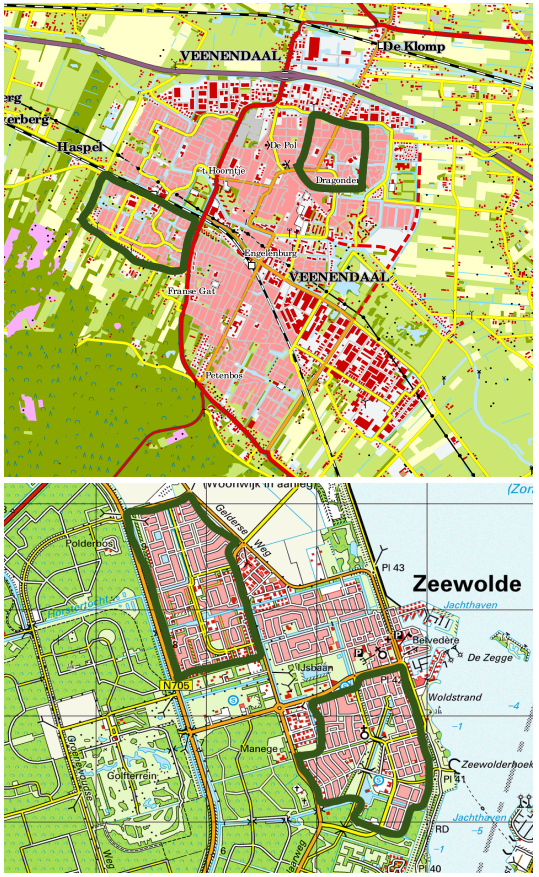


# Case study

10 neighborhoods in 3 different cities
GPS survey in 2012

**Amersfoort**: Nieuwland, Vathorst, Kattenbroek, Schothorst, city center, Leusderkwartier
**Veenendaal:** Dragonder-Noord and Dichtersbuurt & Schepenbuurt
**Zeewolde:** Horsterveld, Zeewolde-Zuid



# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

# Theoretical performances

**17 Indicators**

**Literature review: 25 papers**

**Criteria:**

- GIS-based
- Neighbourhood scale
- Available datasets
- Aim of the research

| Measure | Indicator description |
|---|---|
| Proximity | Distance (shortest path) to closest railway station (km) |
| | Distance (shortest path) to the closest bus stop (m) |
| | Distance (shortest path) to closest motorway exit (km) |
| | Distance (shortest path) to several daily facilities (supermarket, school, etc.) (m) |
| | Distance (shortest path) to city centre (km) |
| Density | Population density (residents/ $km^2$) |
| | Road, public transport, cycle and walk network density ($km/km^2$) |
| | Parks and green areas density (parks/ $km^2$) |
| | Buildings density (buildings/ $km^2$) |
| | Land use mix per neighbourhood (% land use type/total area) |
| | Buildings function density (office, residential, industrial, etc.) (building function type/total n° buildings) |
| Accessibility | City centre accessibility (travel distance/travel time) |
| | Ratio n° buildings with railway station within 1 km (Network/Euclidean distance) |
| | % Buildings with railway station within 10 min travel time by car, bike and walking |
| | Ratio n° buildings with bus stop within 500 m (Network/Euclidean distance) |
| | N° shops within 10 min travel time by car, bike and walking |
| | N° schools within 2 and 5 km (Euclidean distance) |

# Theoretical performance indicators

**Proximity:** distance from an origin to a destination

Closest railway station, bus stop, motorway exit, school, supermarket and city centre

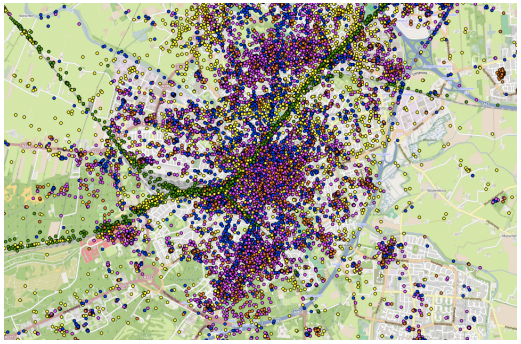
**Density:** land use or activities intensity

Population, network, land use, parks, open area, and building function types

**Accessibility:** importance of a location based on distance/opportunities

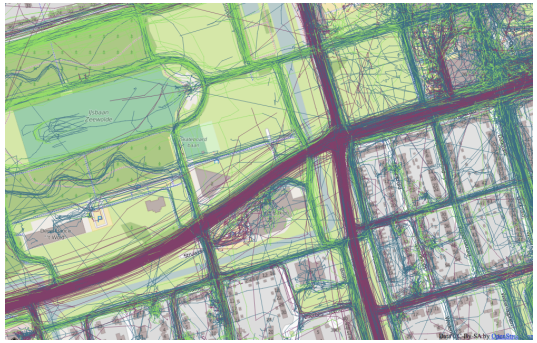
Railway station, % buildings, shops, bus stops, shops, and school

# Actual performances



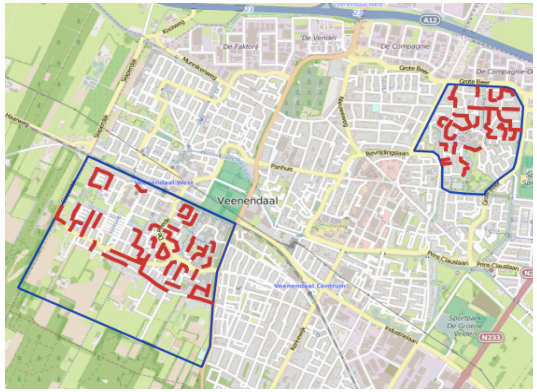
Original GPS dataset: 40 millions of track points

1. GPS data filtering: 400 households selected



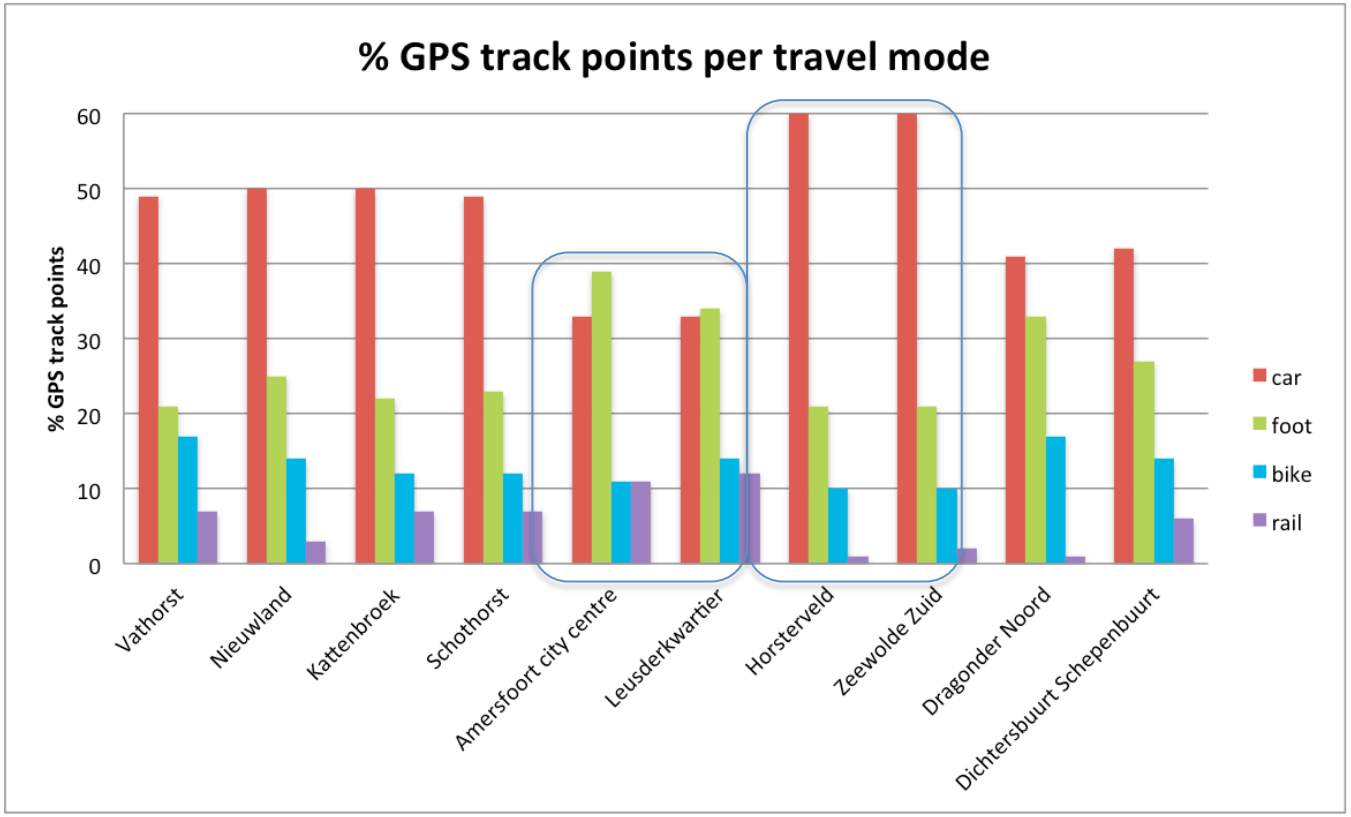
2. Households geolocation by postal codes

3. Actual performances implementation
   - Travel modes
   - Main destinations
   - Walking modal share



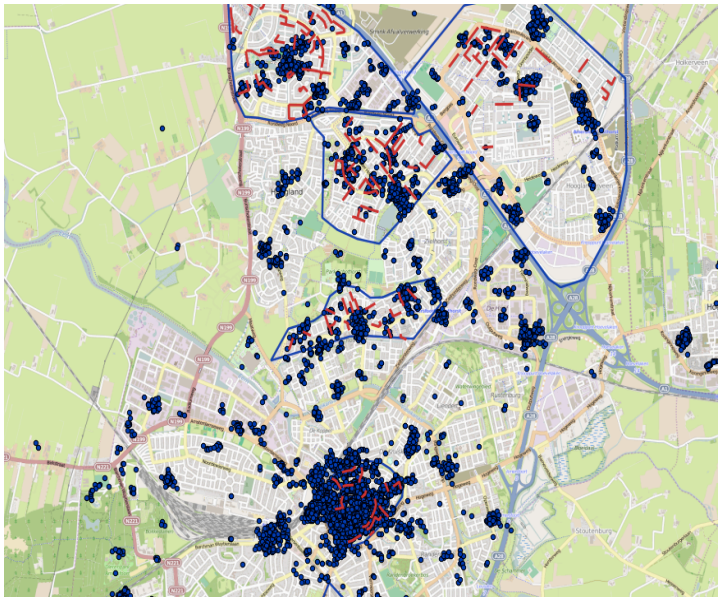
# Actual performances

- **Modal share:** car, foot, bicycle and rail

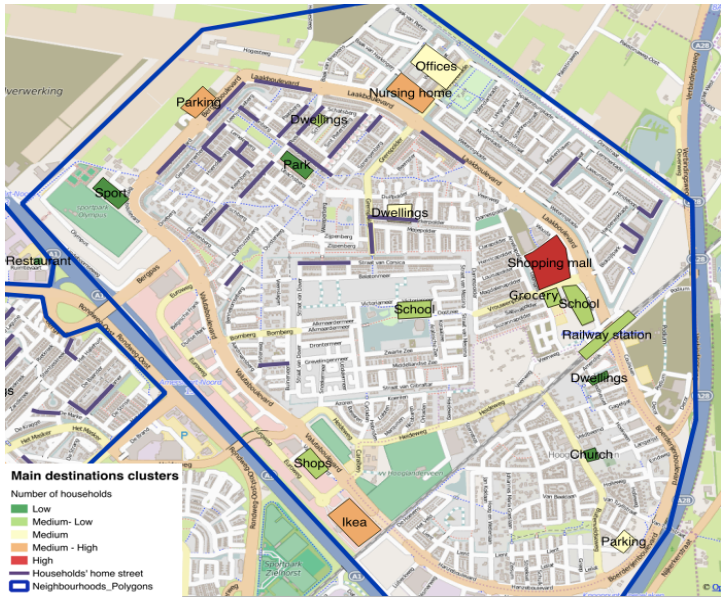


# Actual performances

- **Main destinations**



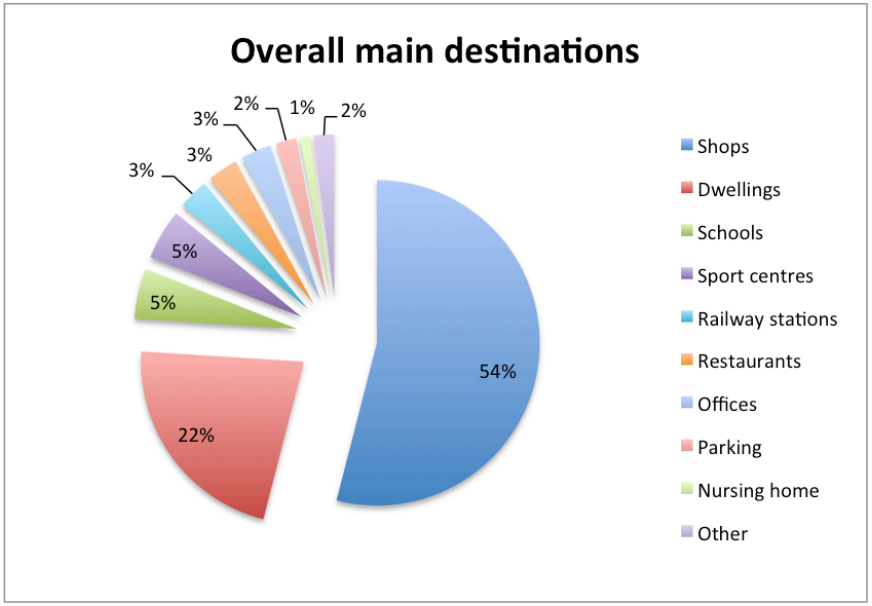
GPS track points




Cluster main destinations according to number of visiting households

# Actual performances

- **Main destinations**



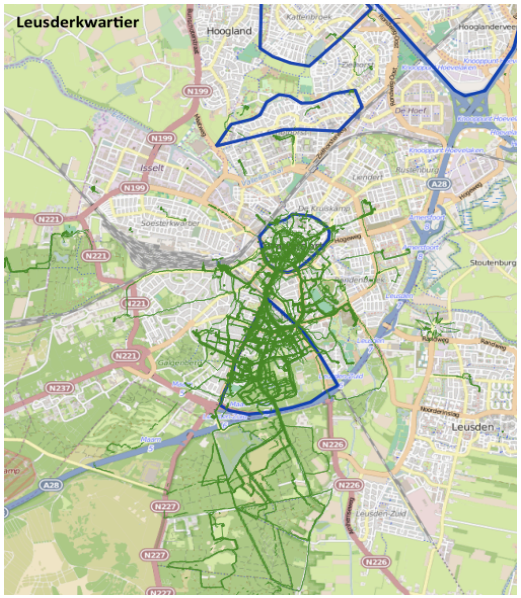

- Shops in Amersfoort city centre visited only by 30% of local households
- Ikea in Vathorst visited only by 25% of local households
- Amersfoort central station visited only by 20% of local households

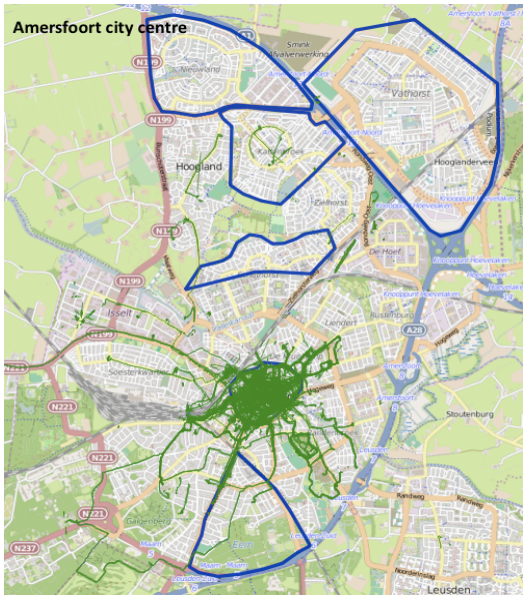
# Actual performances

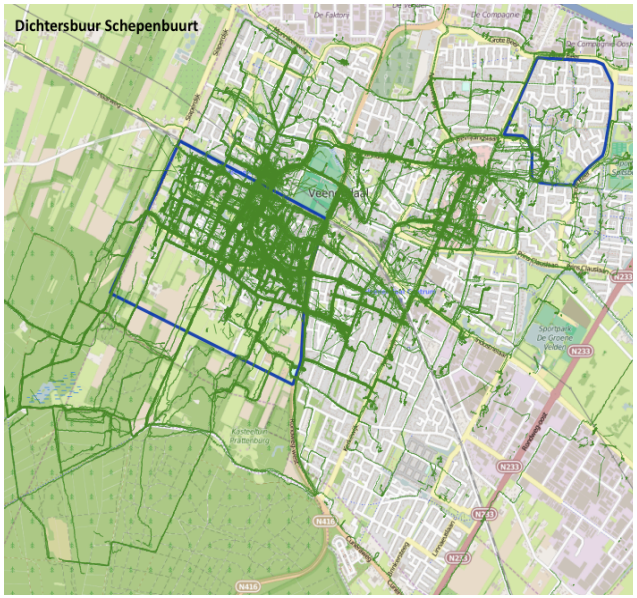
- **Walking modal share**

  Where do people actually walk?

  - City centre and within their own neighbourhood
  - Parks and green areas



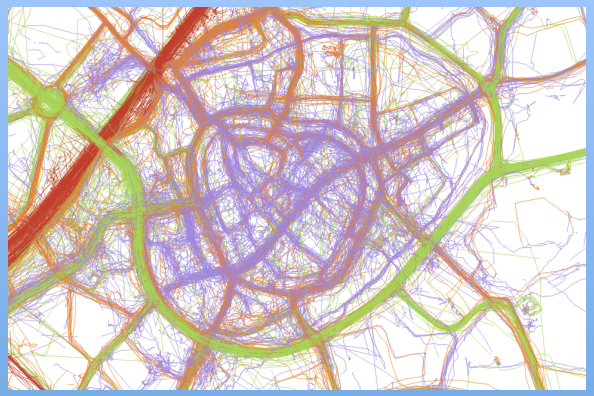
# Validation

***Theoretical Performances***

- Proximity
- Density
- Accessibility

?

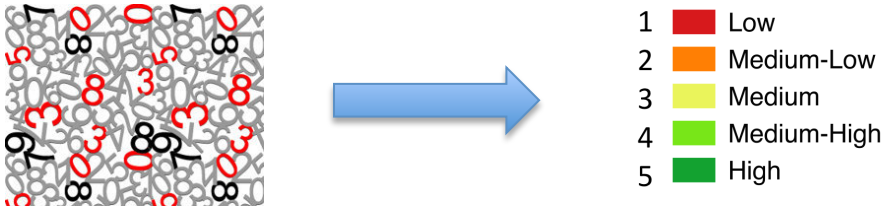
***Actual Performances***



- Modal share
- Main destinations
- Walking travel mode

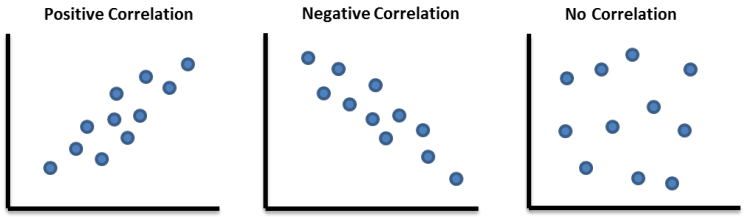
# Validation

1. **Normalization:** z-scores
2. **Classification:**
   - Natural Breaks (Jenks) with 5 classes
   - Likert scale: Low, Medium-Low, Medium, Medium-High and High




3. **Correlation Test:** Spearman coefficients (between 1 and -1)

**+1:** positive correlation
**0:** no correlation
**-1:** negative correlation



# Validation

| | | |
|---|---|---|
| GPS tracks by walking | Positive correlation | wider building function type mix<br>higher population density |
| GPS tracks by train | Positive correlation | closeness to the railway station |
| GPS tracks by car | Negative correlation | closeness to the railway station |
| GPS tracks by walking | No correlation | wider land use mix |

# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

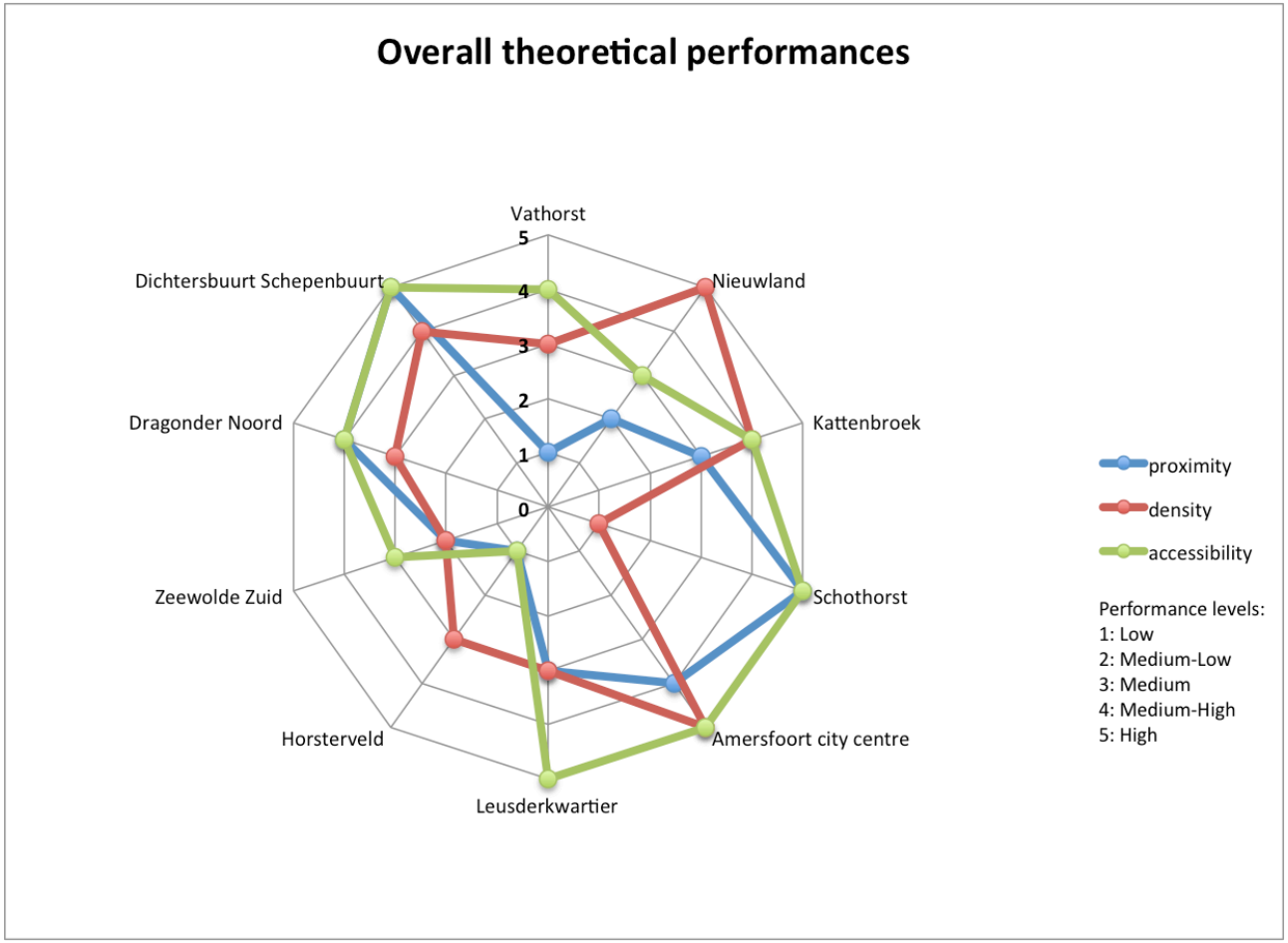
Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

# Theoretical performances: overall results



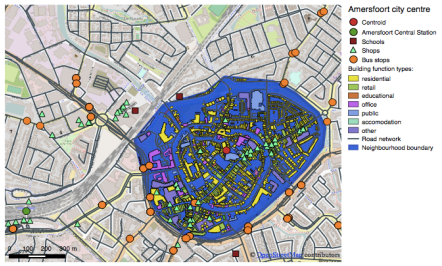
# Theoretical performances: overall results

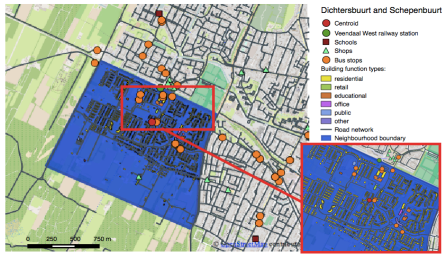
**The most efficient neighbourhoods:**

*Amersfoort city centre and*

*Dichtersbuurt and Schepenbuurt*

- Wide building function types mix
- Closeness to railway station
- Great accessibility to shops by walking/cycling



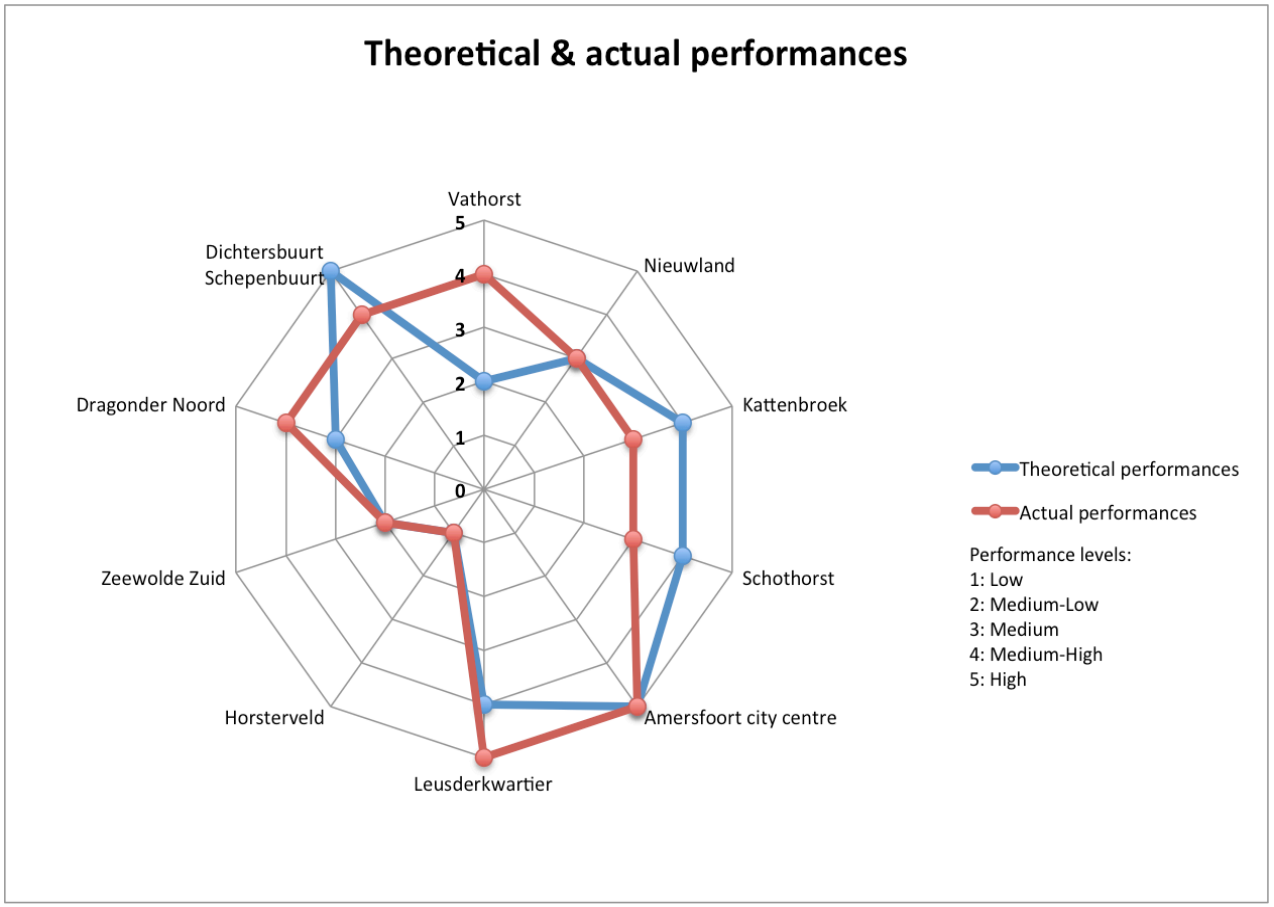




**The least efficient neighbourhoods:**

*Horsterveld*

- Bad accessibility and closeness to railway station and motorway exit
- Low building density

# Theoretical performances: overall results



# Contents


Introduction

- Objectives
- Relevance

Methodology

- Tools
- Datasets

Implementation

- Theoretical performances
- Actual performances

Results

Conclusions & Future Research

# Conclusions

**Key aspects and points of innovation:**

- **Real data (GPS tracks)** instead of traditional methods
  - Sample data but still reliable
- **Open data** and open source tools
  - OpenStreetMap
- **GIS-based indicators** rather than pure statistical indexes
- **Network distance** instead of Euclidean distance
- **PgRouting:** shortest path and accessibility maps

# Conclusions

- **Neighbourhoods' theoretical performances:** different scores
- **Match theoretical and actual performances:**
  - Perfect match 4/10 Neighbourhoods
  - In general assigned to neighbouring classes
- **Proximity, density and accessibility have impact on the way people travel**
- **Key factors for promoting sustainable mobility:**
  - Closeness to the city centre
  - Diverse building function types
  - Great accessibility to railway station

# Future Research

- **Use** a **broader range of indicators**: traffic information, accidents information, job accessibility, income, parking density, sidewalks, public transport timetables
- **Use additional datasets** (e.g. Dutch Travel Survey, CBS, OpenOV)
- **Improve routing**: turns, traffic lights
- **Improve GPS data analysis**: modality algorithm, trip algorithm, travel diaries
- **Classification:** use thresholds and apply weights

# Thank you!