MATSim around the World

F.Ciari

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Future Cities Laboratory - Singapore ETH Centre (SEC)

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Technische Universität Berlin

MATSim
Multi-Agent Transport Simulation

Why this presentation?

- MATSim Monthly report
- MATSim book scenarios

Acknoledgements

- Gregor Lämmel – Julich, Germany
- Gavin McArdle - Maynooth University, Co. Kildare, Ireland
- Miguel Picornell – Nommon, Barcelona, Spain
- Sarra Belgacem – Polytechnique de Montréal, Canada

MATSim
Multi-Agent Transport Simulation

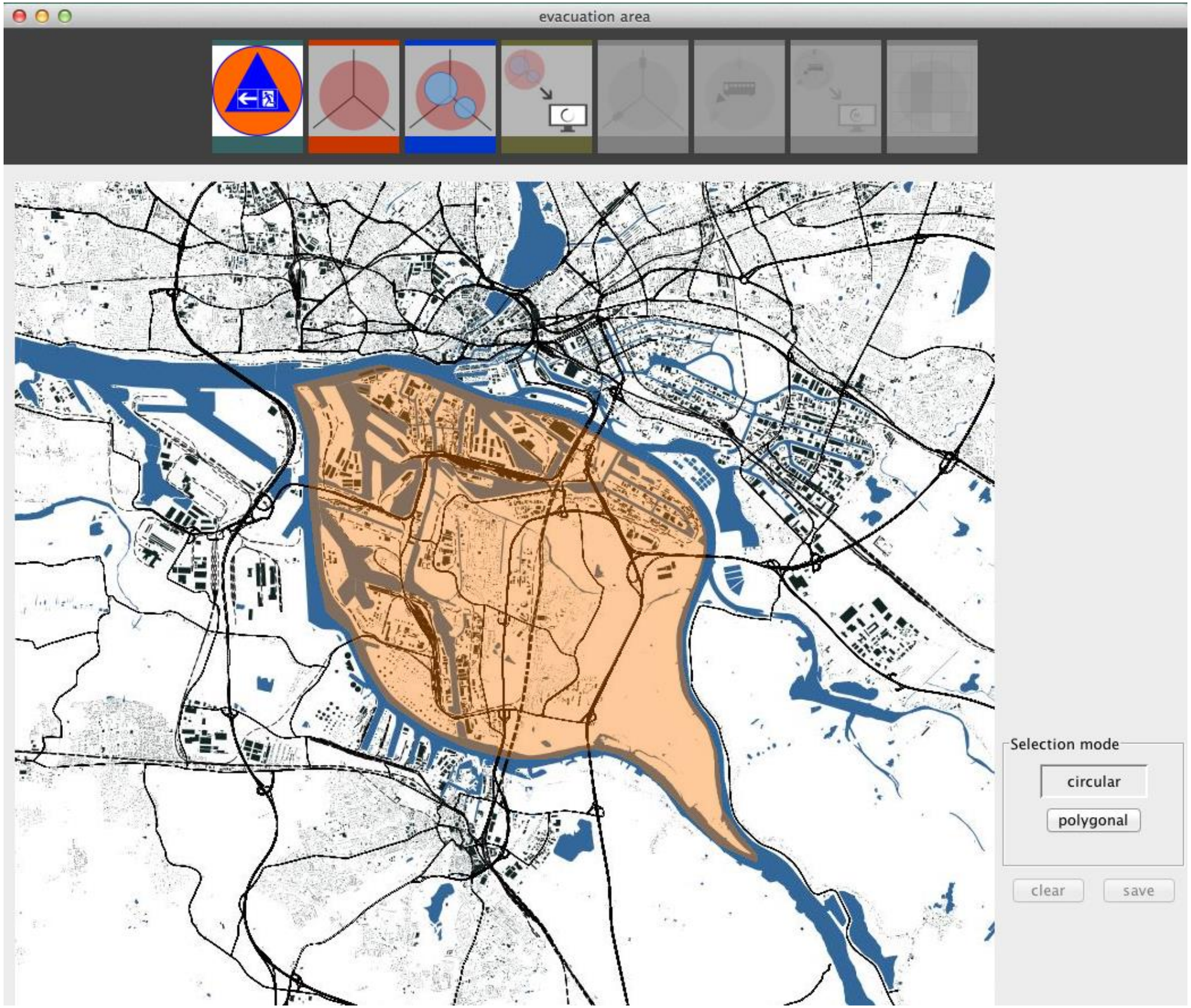
JÜLICH
FORSCHUNGSZENTRUM

GRIPS extension

March 27, 2015 | Gregor Lämmel | g.laemmel@fz-juelich.de

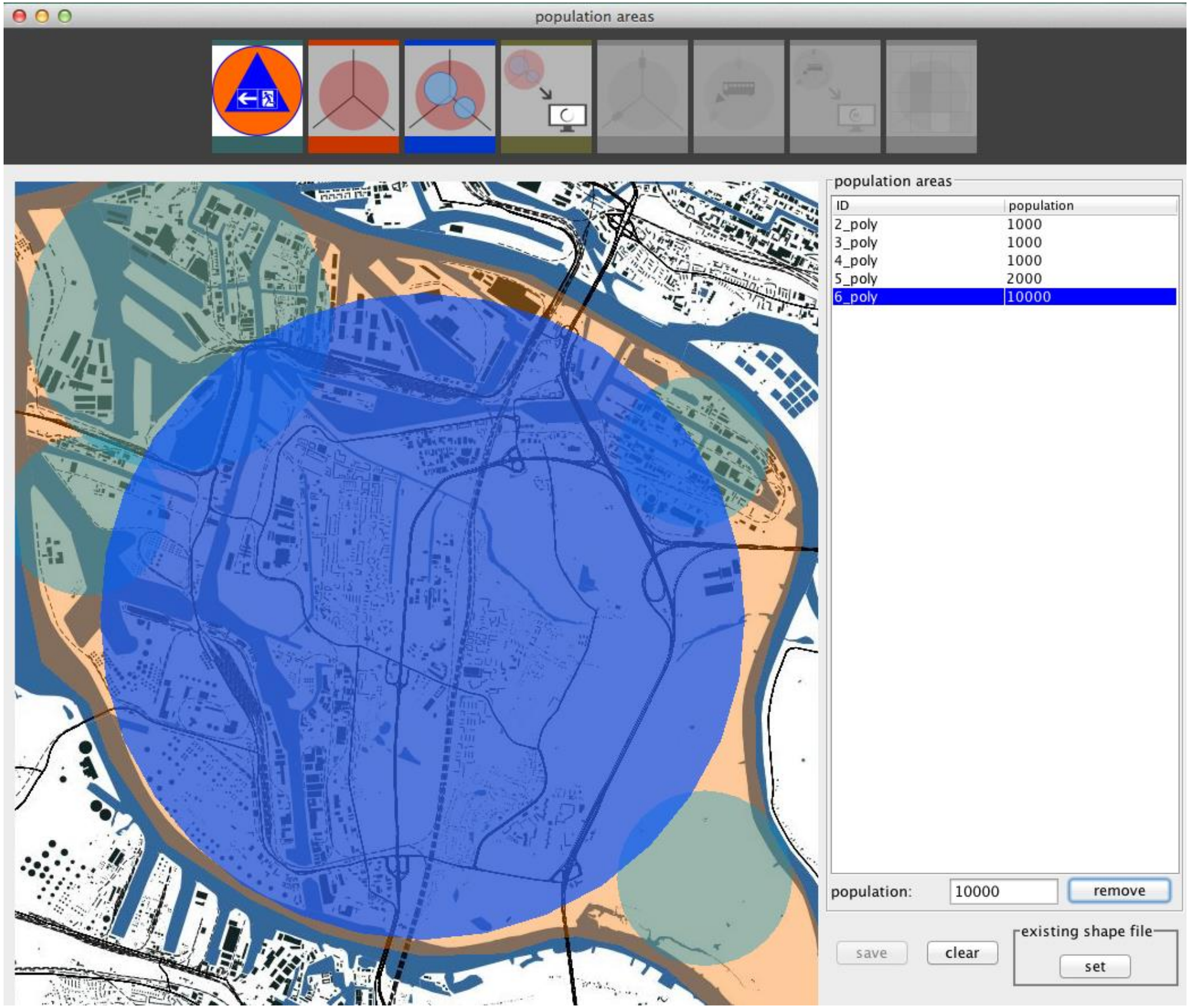
- GRIPS stands for “GIS base risk information and planning system for the evacuation of areas”.
- GRIPS offers an integrated solution for rapid evacuation planning (vehicular XOR pedestrian).
- No detailed population model is needed. For a rapid appraisal a rough approximation is sufficient.
- The only external input is an openstreetmap xml-file of the evacuation area.
- Besides the openstreetmap xml-file, all input data can be entered via an interactive GUI.
- Released as an open source MATSim extension (see https://matsim.atlassian.net/wiki/display/MATPUB/GRIPS)
- Supports Geoserver (www.geoserver.org) as background image provider

Evacuation area selection



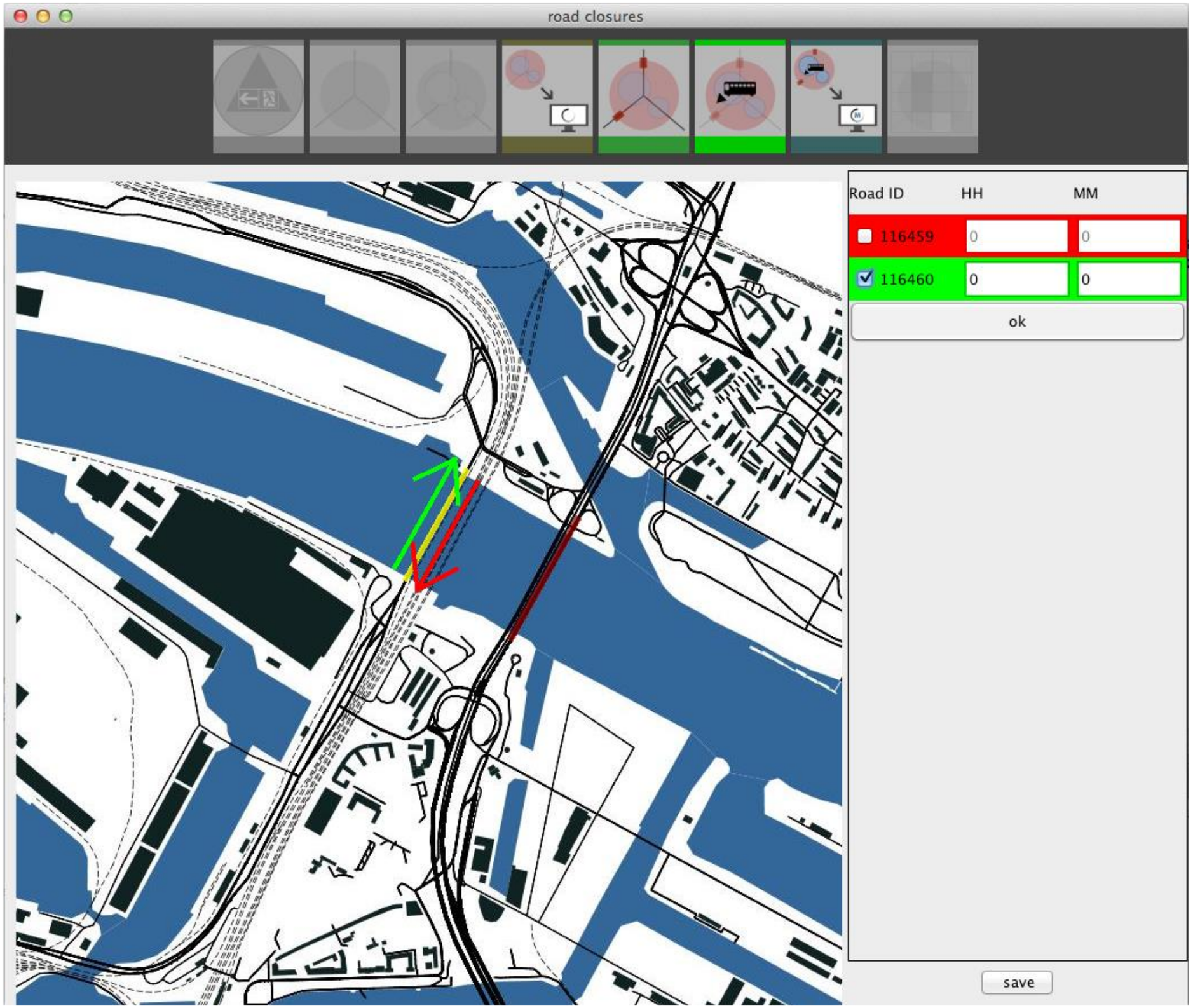
As a first step the user draws the evacuation area on a map.

Defining the evacuation population



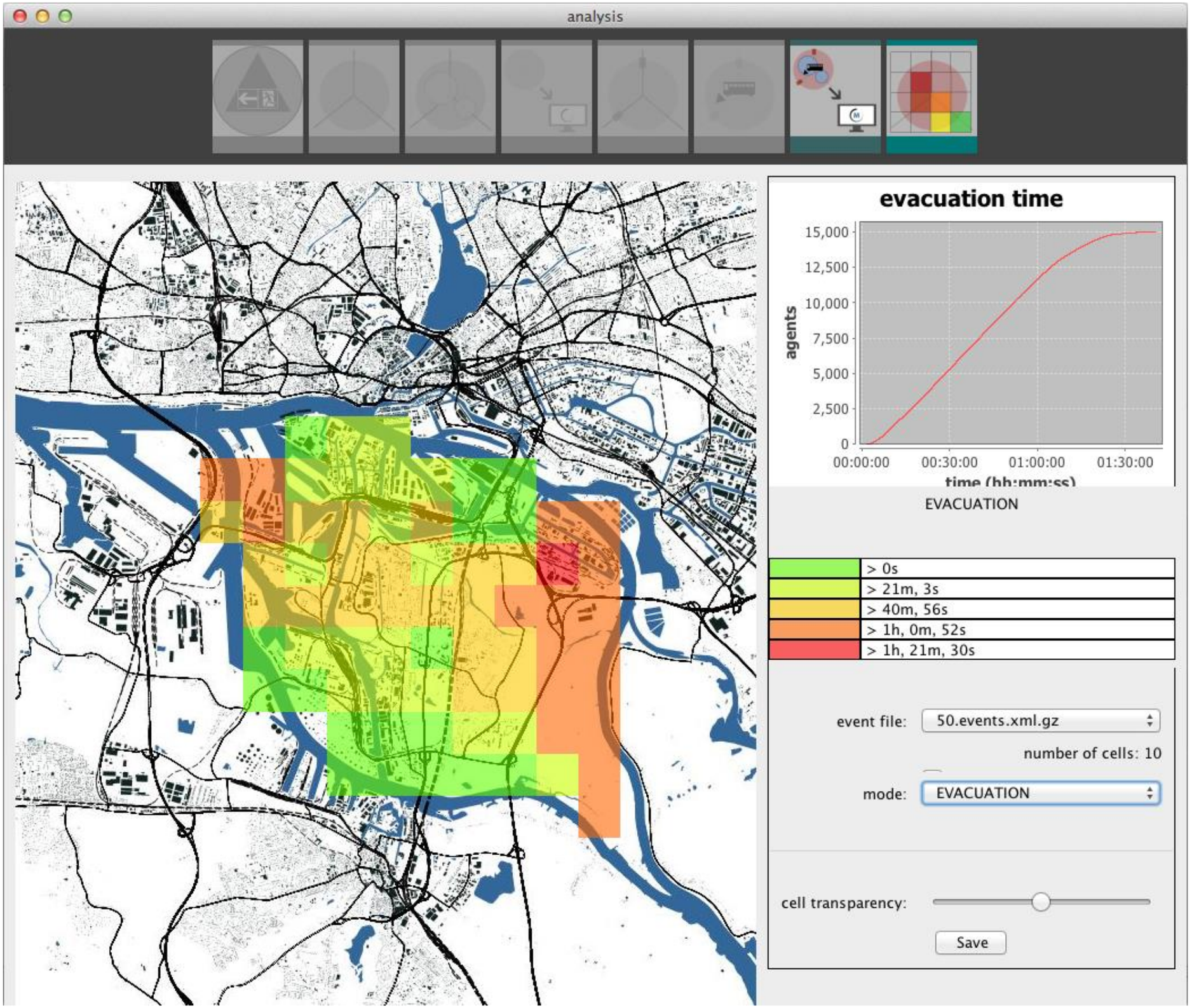
Population is equally distributed over user defined circles.

Road blockage editor



Optionally, time-dependent road blockages can be defined.

Analysis of the evacuation process



Simulation results are presented in an interactive GUI.

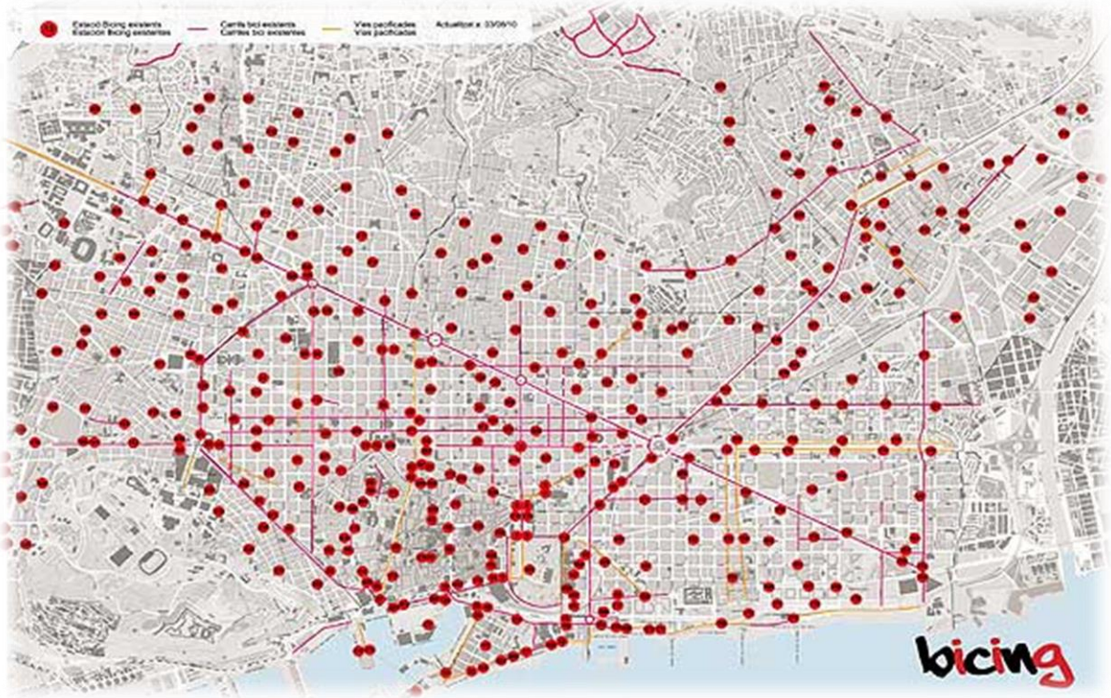
MATSim: Barcelona Case Study

Miguel Picornell, Maxime Lenormand

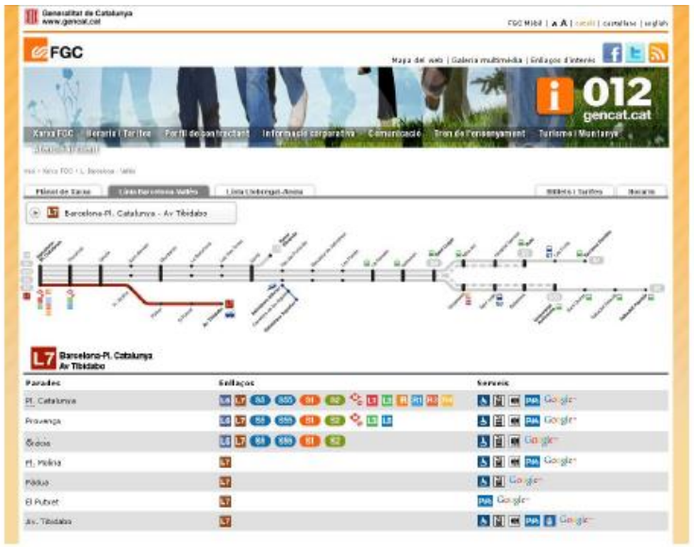
MATSim user meeting

Singapur 2015

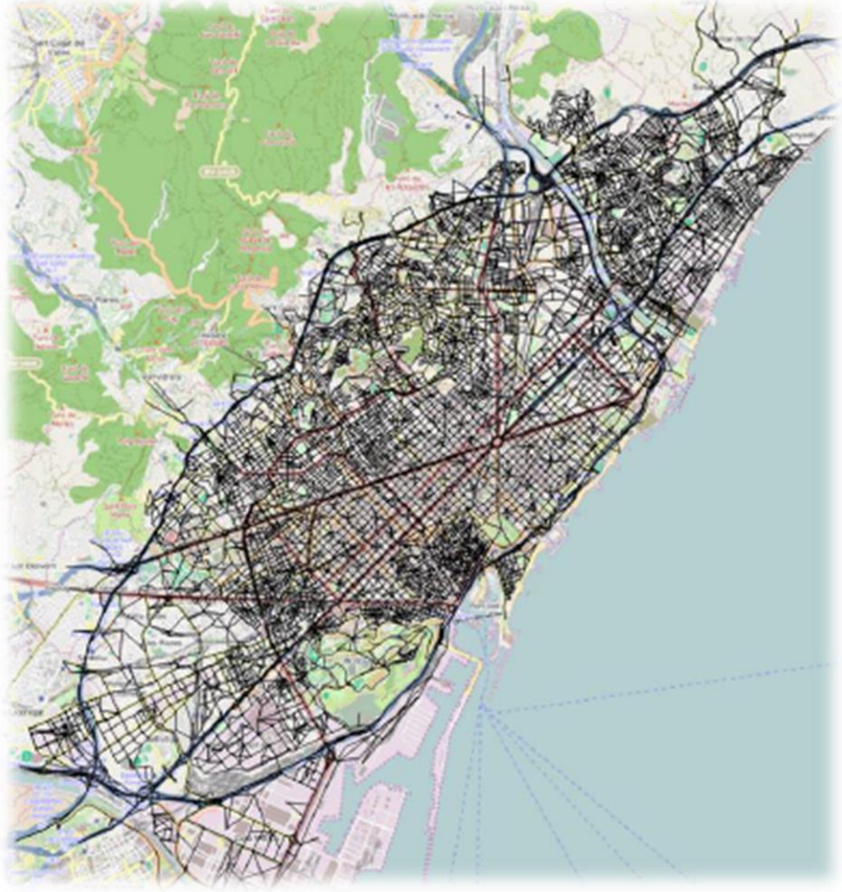
- **Project objective**:
  - Analyse the impact of different public bike-sharing schemes in the city of Barcelona. The current system (Bicing) provides 6000 bicycles and 420 docks distributed all over the city.



- **Data sources - Network**:
  - Road network adapted from Barcelona TRANSCAD network
  - Public transport network extracted from the public information available from the Transport Authority Website. Modes of transport considered:
    - Private vehicle, bus, underground, train, tram public bikes and walking

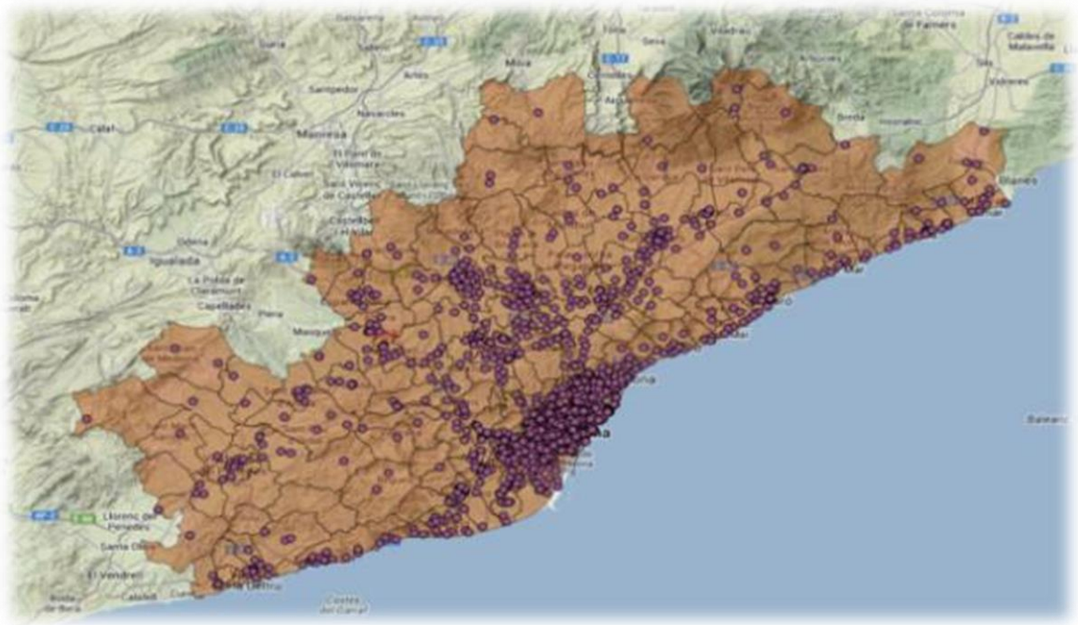


Train lines and schedules from the Website



TRANSCAD road network

- **Data sources – Travel Demand**:
  - Agents plans extracted from the analysis of mobile phone data (CDRs)
    - Sample of 55 days from September to November 2009 for Spain
    - Agent plans validated through the comparison with the annual Barcelona transport survey



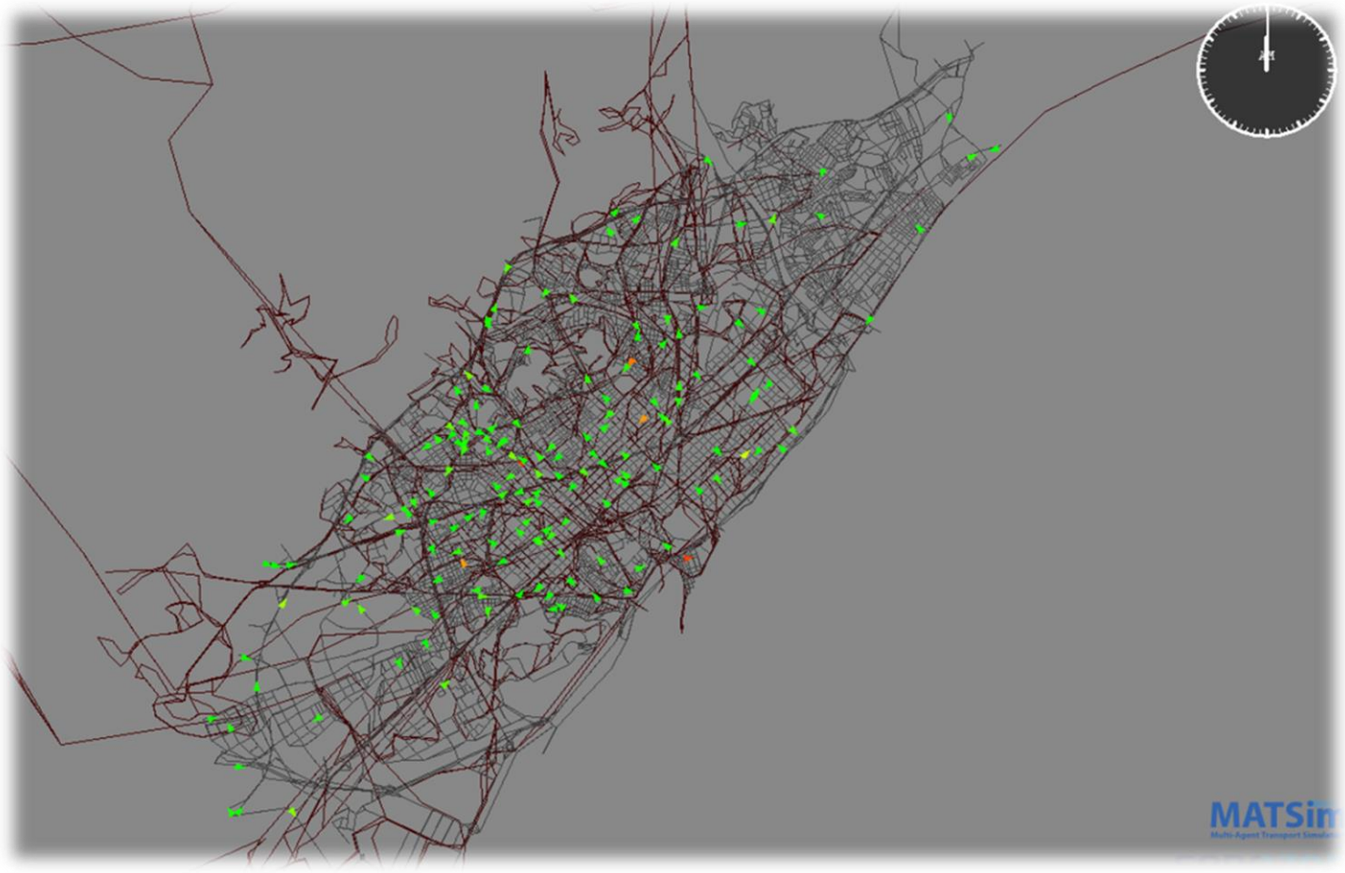
Mobile phone antennas coverage for the Metropolitan Area of Barcelona

- **Model calibration – Work in progress:**
  - Traffic counts for private vehicles
  - Transport surveys for modal split
  - Smart card for bike-sharing trips

Transport mode	Percentage from survey	MATSim results
Walking	44.2 %	37.8 %
Bicycle	1.0 %	6.19 %
Soft modes	**45.2 %**	**44%**
Bus	8.8 %	-
Metro	7.5 %	-
Train	4.9 %	-
Other public	1.0 %	-
Public transport	**22.2 %**	**19.89 %**
Car	24.4 %	36,10 %
Car-pooling	4.4 %	-
Motorbike	3.4 %	-
Other private	0.5 %	-
Private transport	**32.6 %**	**36.10%**

Preliminary calibration results

- **Simulation scenarios – Work in progress:**
  - Add new docks
  - Modify capacity of the current docks
  - Change current docks location
  - New payment schemes (stimulate uphill trips)
  - Introduce electric bikes



MatSim in Action: The Dublin Scenario

Gavin McArdle[1], Eoghan Furey[2],

Aonghus Lawlor[3], Alexei Pozdnoukhov[4]

[1]National Centre for Geocomputation, Maynooth University, Co. Kildare, Ireland

[2]Letterkenny Institute of Technology, Co. Donegal, Ireland

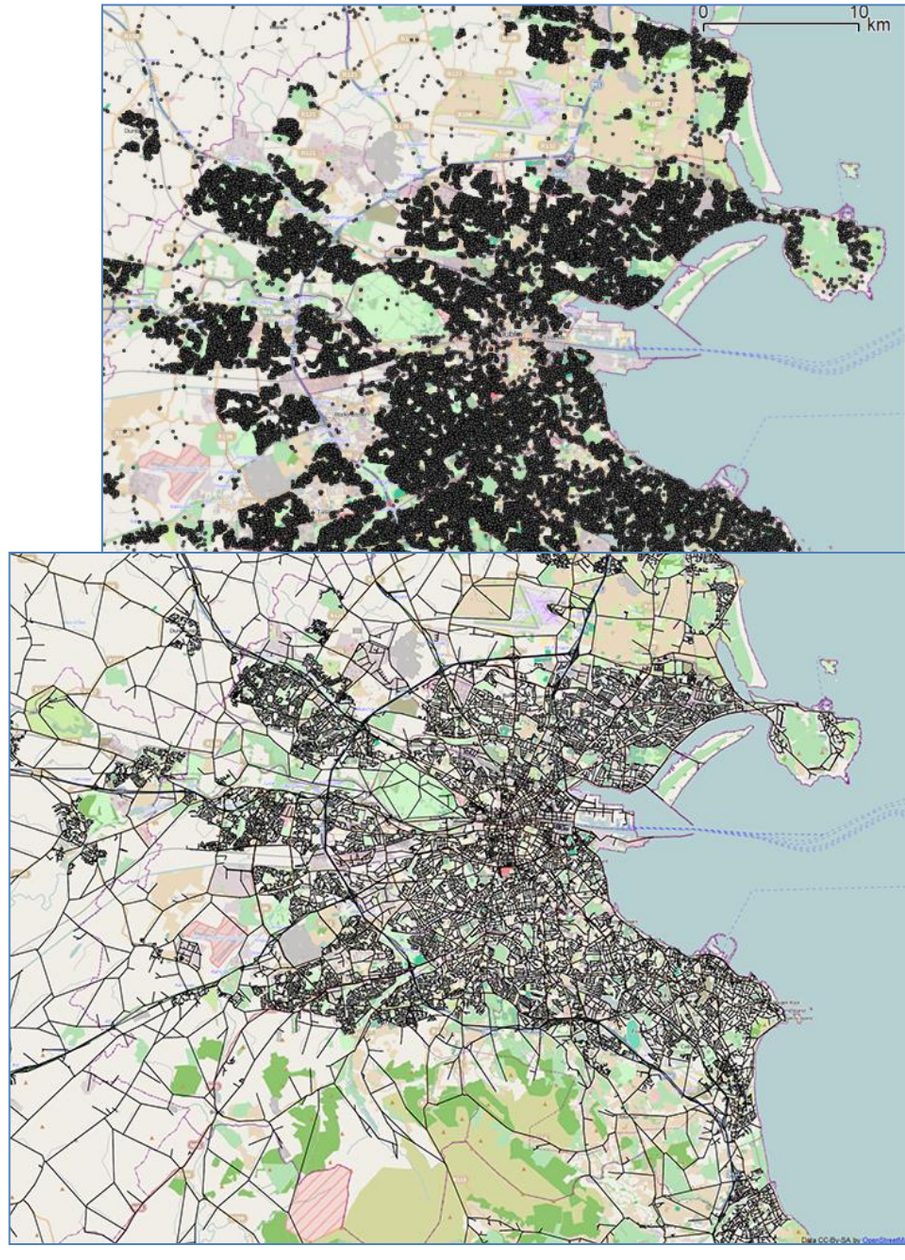
[3]Insight Centre for Data Analytics, University College Dublin, Dublin, Ireland

[4]Smart Cities Research Centre, University of California, Berkeley, California, USA

Email: gavin.mcardle@nuim.ie

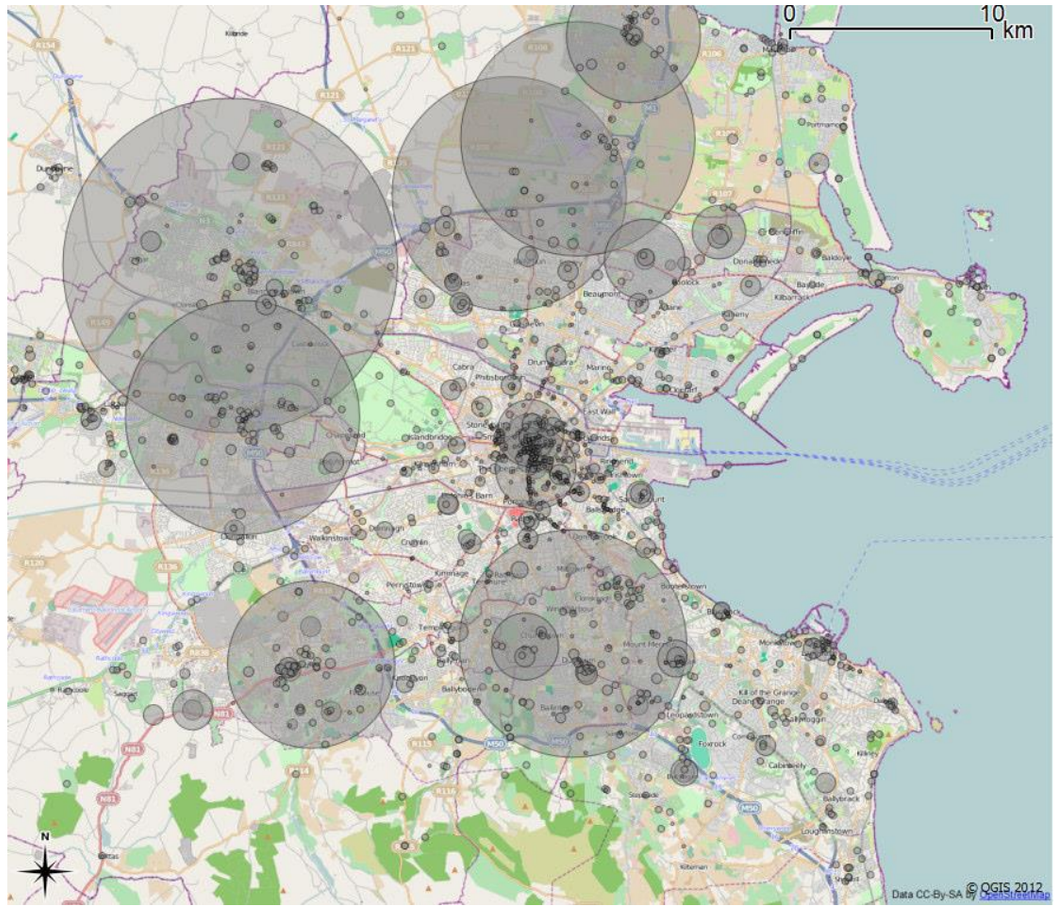
Input Sources - Initial Demand

- Traditional Sources
  - Population Census
    - Home Location (Administrative Area)
    - Work Location (250m Grid)
    - Translated administrative area and 250m grid data to **an individual home or work place** using GeoDirectory
    - Place of Work, School, College - Census of Anonymised Records (POWSCAR)
      - Morning departure time
      - Mode of Transport
  - Road Network- Open Street Map
    - Links and nodes, Speed Limits, Lanes, Class of Road



Input Sources - Secondary Trips

- Irish National Travel Survey
  - 16000 people kept a travel diary
    - School/Education
    - Shopping/Sport/Leisure
    - Doctor/Medical/Personal business
    - Visiting Family/Friends/Social/Entertainment
  - **No location information**
    - Facility Locations
      - Shopping
      - Entertainment
      - Sport
    - Facility Capacities
      - Attractiveness Score
      - Size of Facility
      - No. Parking Spaces



Home → School → Work → Shopping → Friends → Home

Spatial Choice Models

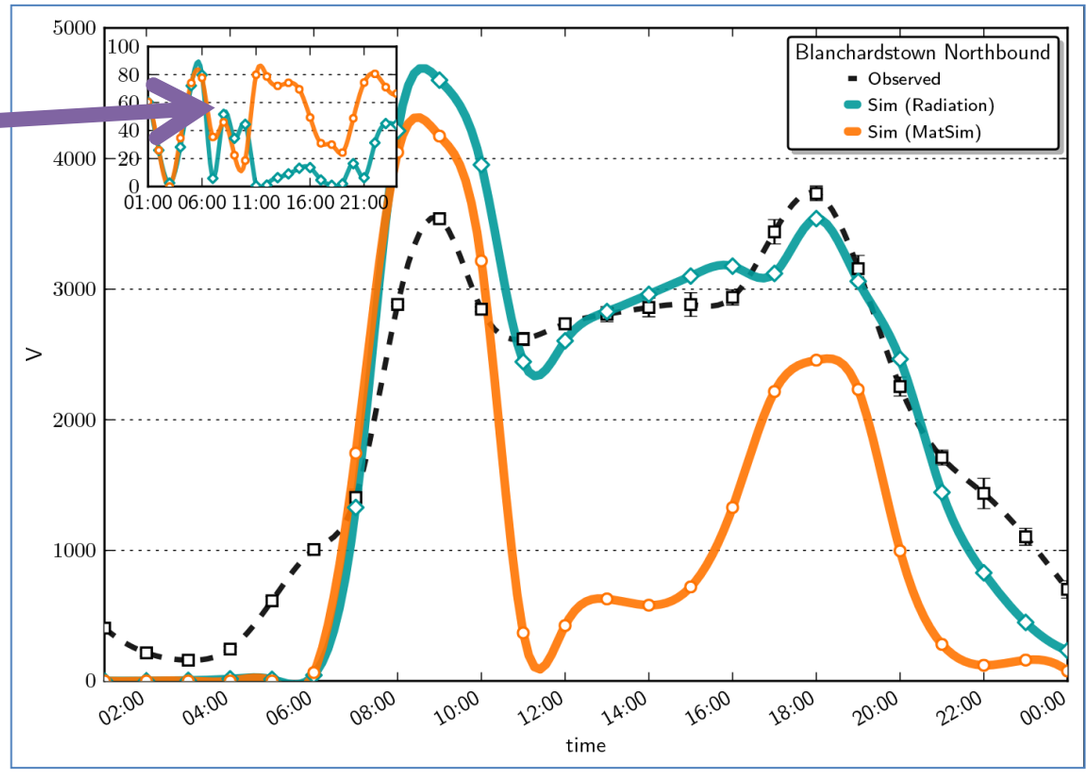
- Radiation Model for Individual Spatial Choice
  - Based on model of intervening opportunities
  - Individuals have a demand for activities which can be fulfilled at multiple locations/facilities
  - Produce a ranking of facilities based on distance and attractiveness/capacity scores
  - The parameters are tuned based on demand patterns identified in on Twitter and Foursquare check-ins (optimal travel distance, etc.).

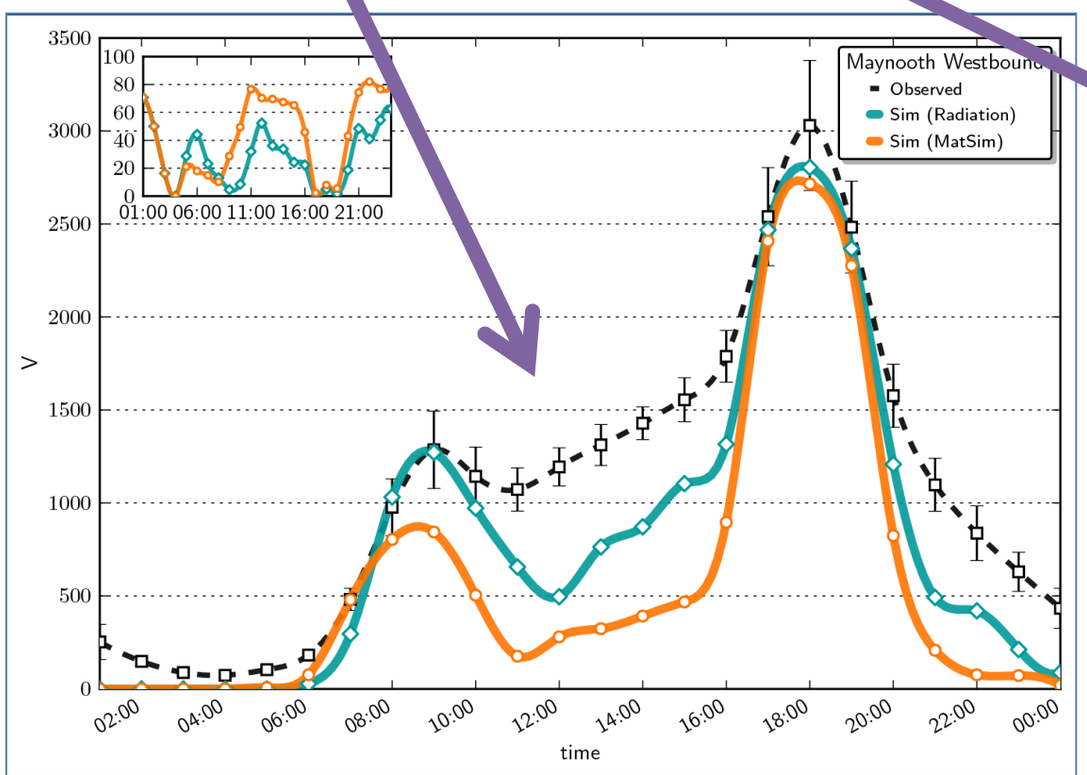
Output & Validation

- Hourly traffic volumes and travel times for all road segments in the road network (Open Street Map)
- Validate against ground truth from the National Roads Authority count stations on motorways
  - M50/M4 Count Stations Midweek
- Compare *Radiation Model* for location choice with a *Nearest Neighbour* approach

Results


1
2
3


Blanchardstown Northbound
Observed
Sim (Radiation)
Sim (MatSim)
V
time
01:00 06:00 11:00 16:00 21:00


Maynooth Westbound
Observed
Sim (Radiation)
Sim (MatSim)
V
time
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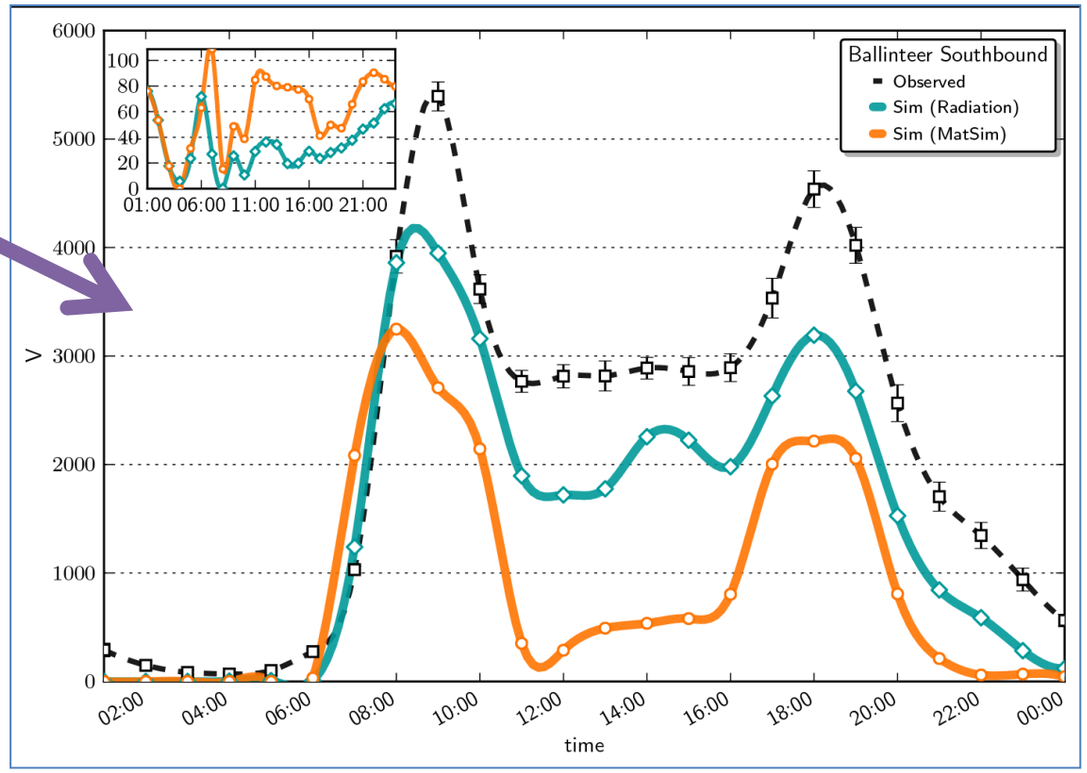

Ballinteer Southbound
Observed
Sim (Radiation)
Sim (MatSim)
V
time
01:00 06:00 11:00 16:00 21:00

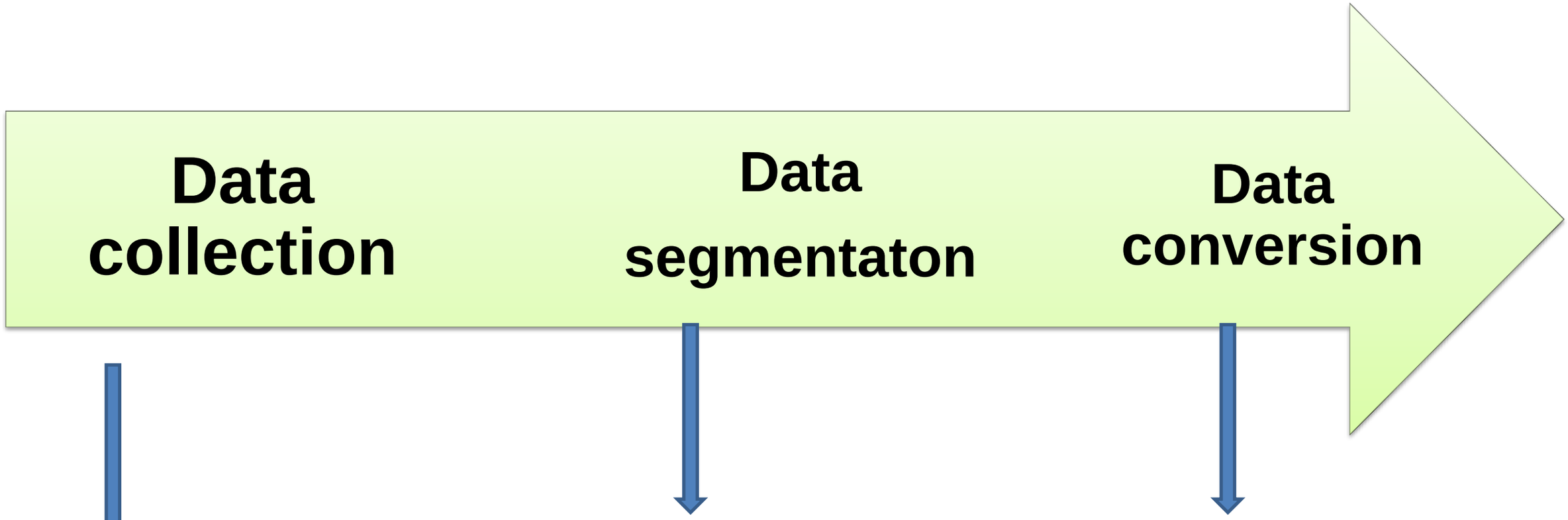
Use of MATSim for carsharing analysis in Montreal

Sarra Ben Belgacem, Ph.D. student[1]
Dr. Martin Trépanier, supervisor[1]
Dr. Francesco Ciari, cosupervisor[2]
1 – Polytechnique Montréal
2 – ETH Zurich

Objectives

- The first objective is to integrate carsharing data from Communauto (Montréal) into MATSim to compare the three types of carsharing services
- Communauto is a research partner
  - About 900 cars in station-based carsharing
  - About 120 cars in free-floating carsharing
- The long term goal is to develop a decision-support tool for carsharing planning

1. First steps with MATSim



Communauto provides all transaction data + members and cars attributes

Data has to be processed to fit MATSim format

(ie. plans, ids, etc.)

A data conversion program has been developed to convert to XML (MATSim format)

2. Road network conversion

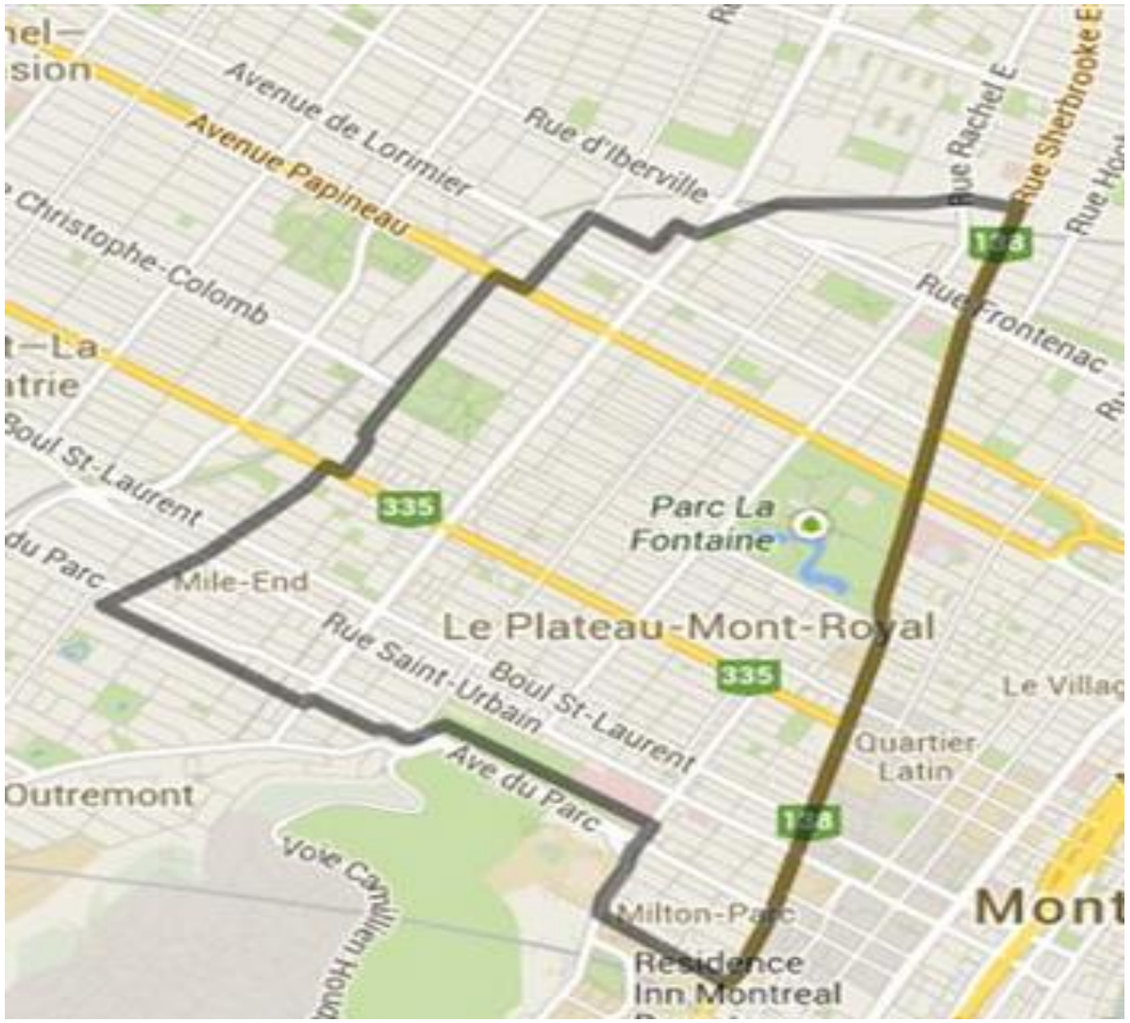
Test on Plateau district: dense populated district with a high level of carsharing use

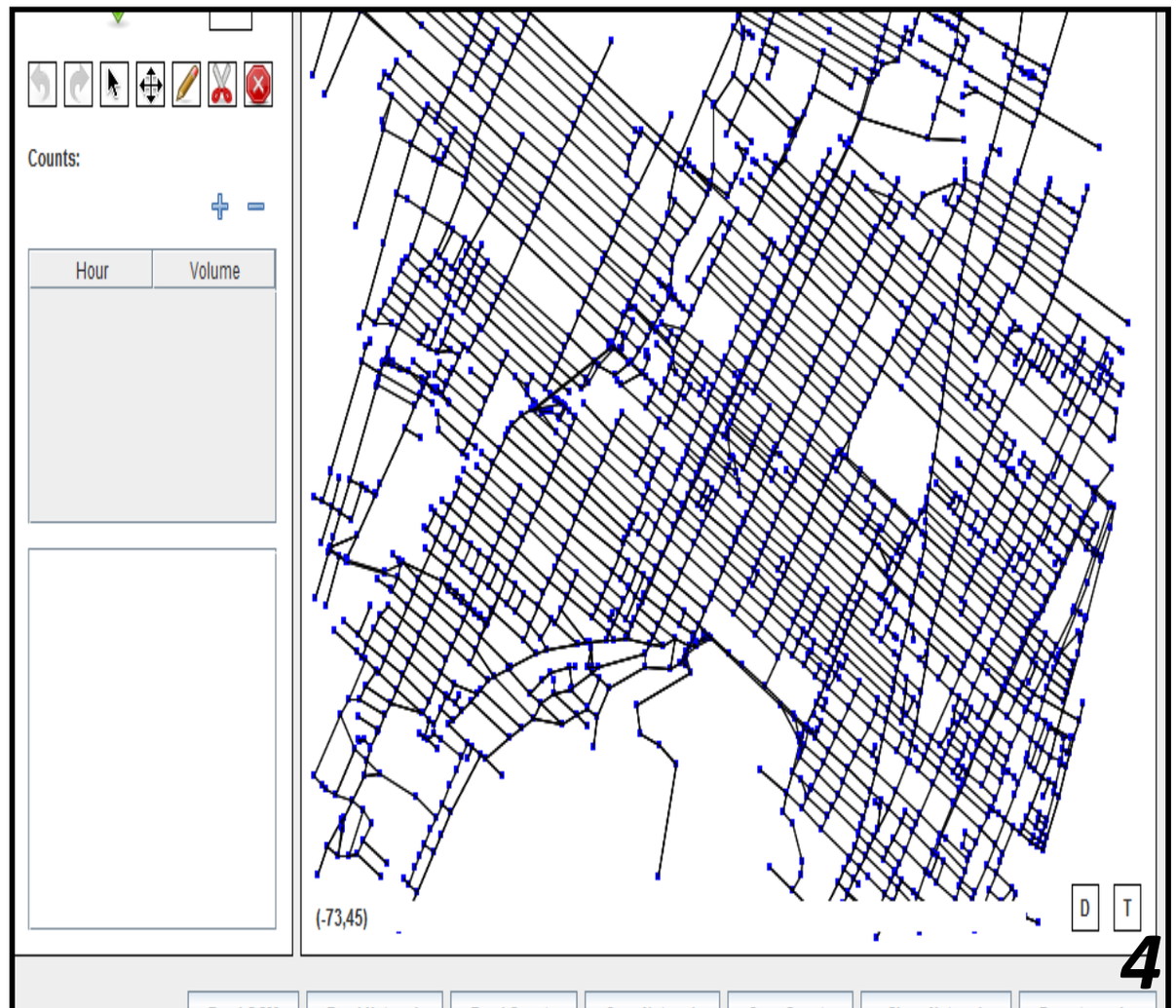
2196 nodes

5276 links

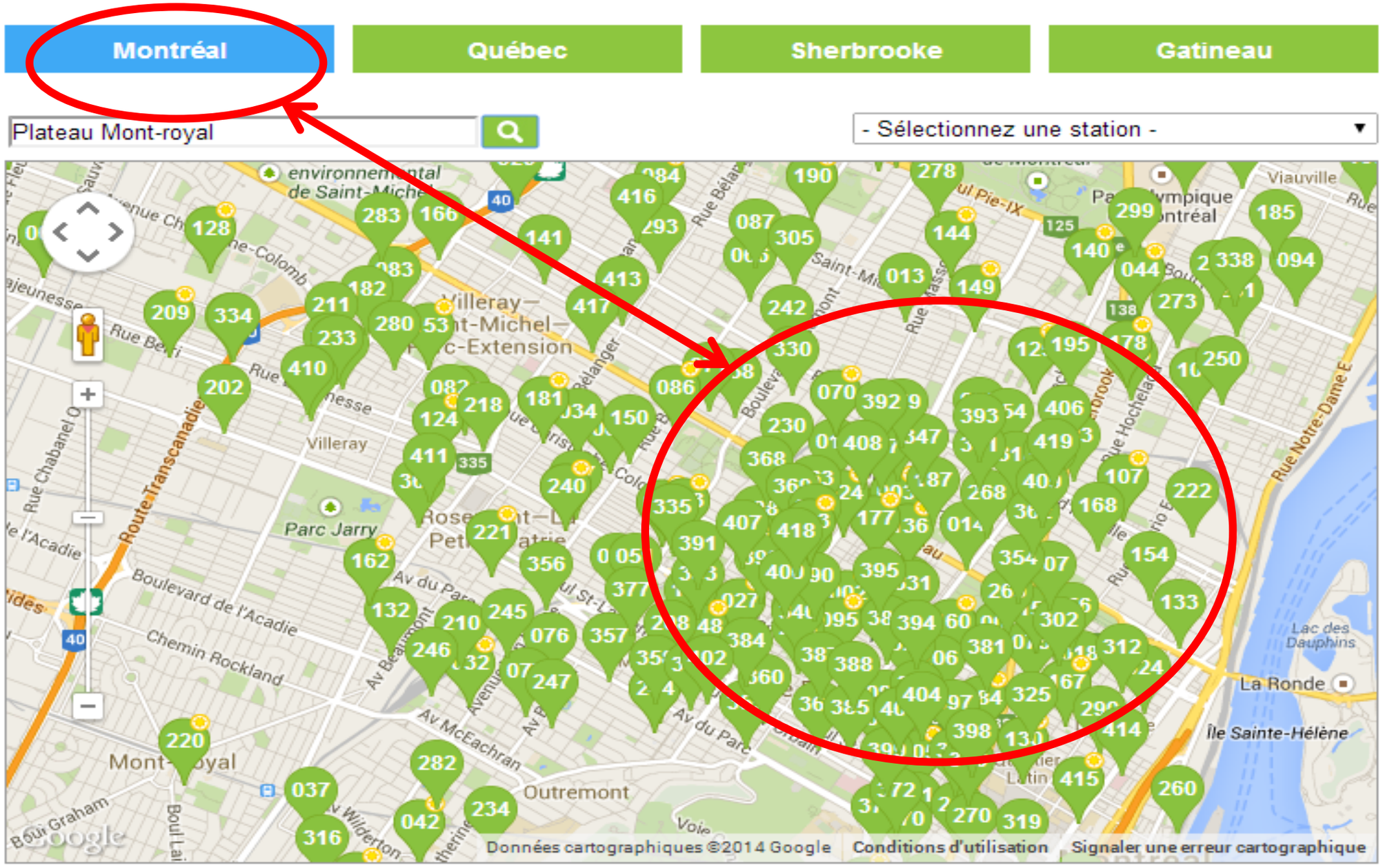
Open Street Map

MATSim XML network



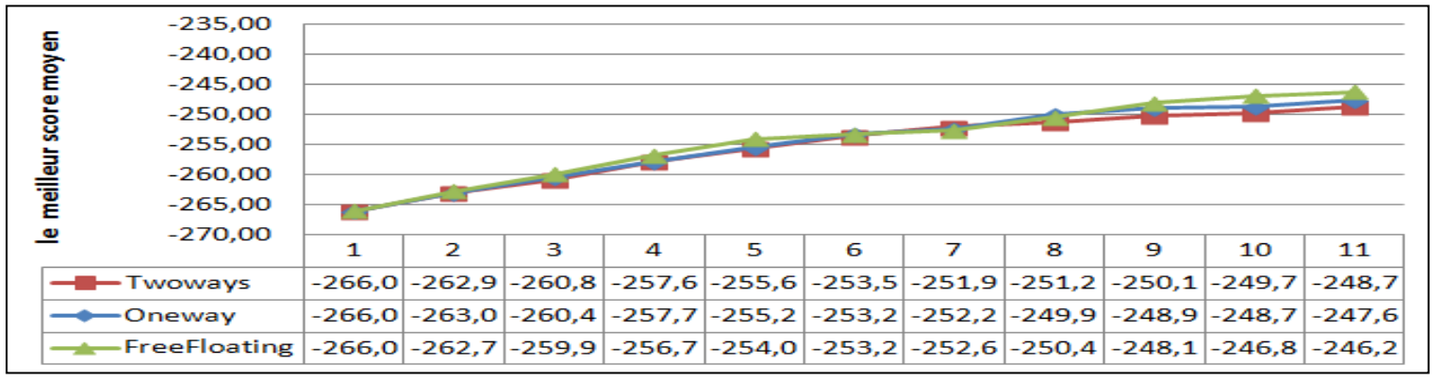


3. Carsharing stations location



4. Some results (based on gross assumptions, testing only)

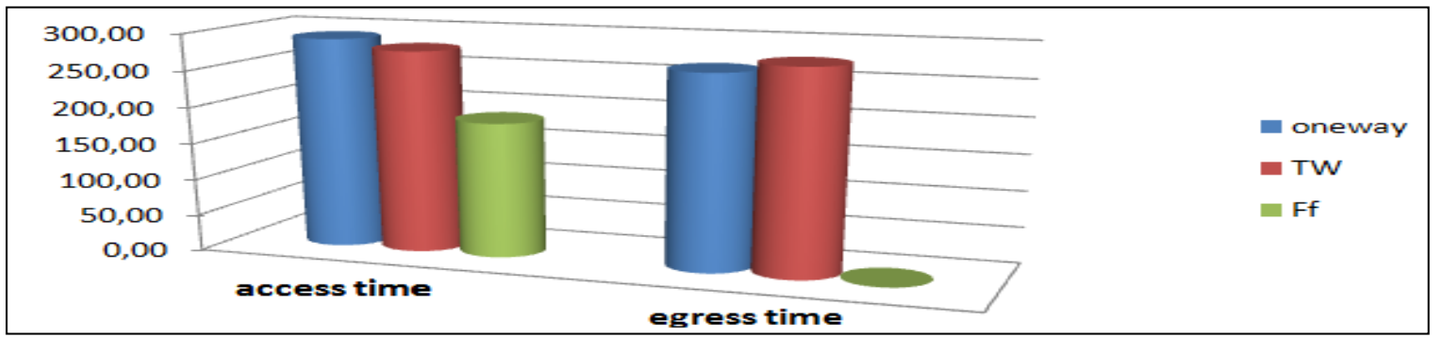
- **Score**



	1	2	3	4	5	6	7	8	9	10	11
Twoways	-266,0	-262,9	-260,8	-257,6	-255,6	-253,5	-251,9	-251,2	-250,1	-249,7	-248,7
Oneway	-266,0	-263,0	-260,4	-257,7	-255,2	-253,2	-252,2	-249,9	-248,9	-248,7	-247,6
FreeFloating	-266,0	-262,7	-259,9	-256,7	-254,0	-253,2	-252,6	-250,4	-248,1	-246,8	-246,2

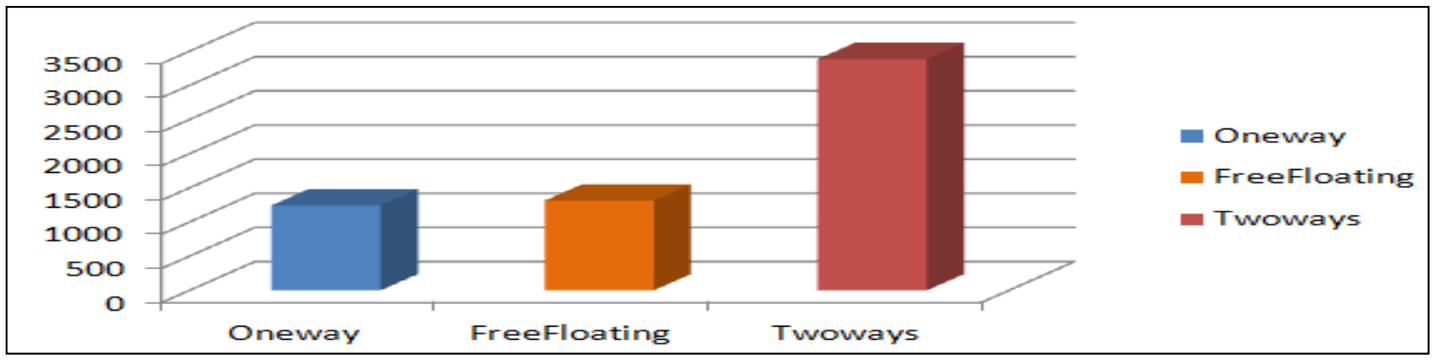
Free-floating carsharing gives the maximum score in MATSim simulation

- **« Access /egress » time**



Free-floating has a shorter access-egress time

- **Travael distance**



Shortest travel distance is for one-way service

Next steps

- Adapt MATSim to the Montreal case
- Integrate data from other modes into MATSim (from large household surveys available in Montreal)
- Develop a trip generation model for carsharing based on Montreal data
- Provide a DSS tool to Communauto for network design and service planning

Please your contribution to the MATSim Report!

MATSim
Multi-Agent Transport Simulation

Thank you!

MATSim
Multi-Agent Transport Simulation

Thank you!

MATSim Application in Seoul

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Seoul Initial MATSim Model 2012

The **MATSim model of Seoul Metropolitan** was developed in 2012. The brief statistics related to the demand (input) are summarized as follows:

Study Area: Seoul Metropolitan Area (SMA)

Population and Demand Generation: Total population of SMA is 21.5 million therefore, 10% sample was generated and simulated (2.15 million agents)

Network: 16,384 nodes and 32768 links

Transit Schedule & Vehicles: Total number of routes is 1317 (contains regional buses, inter-city buses, feeder line buses and metro lines etc.)

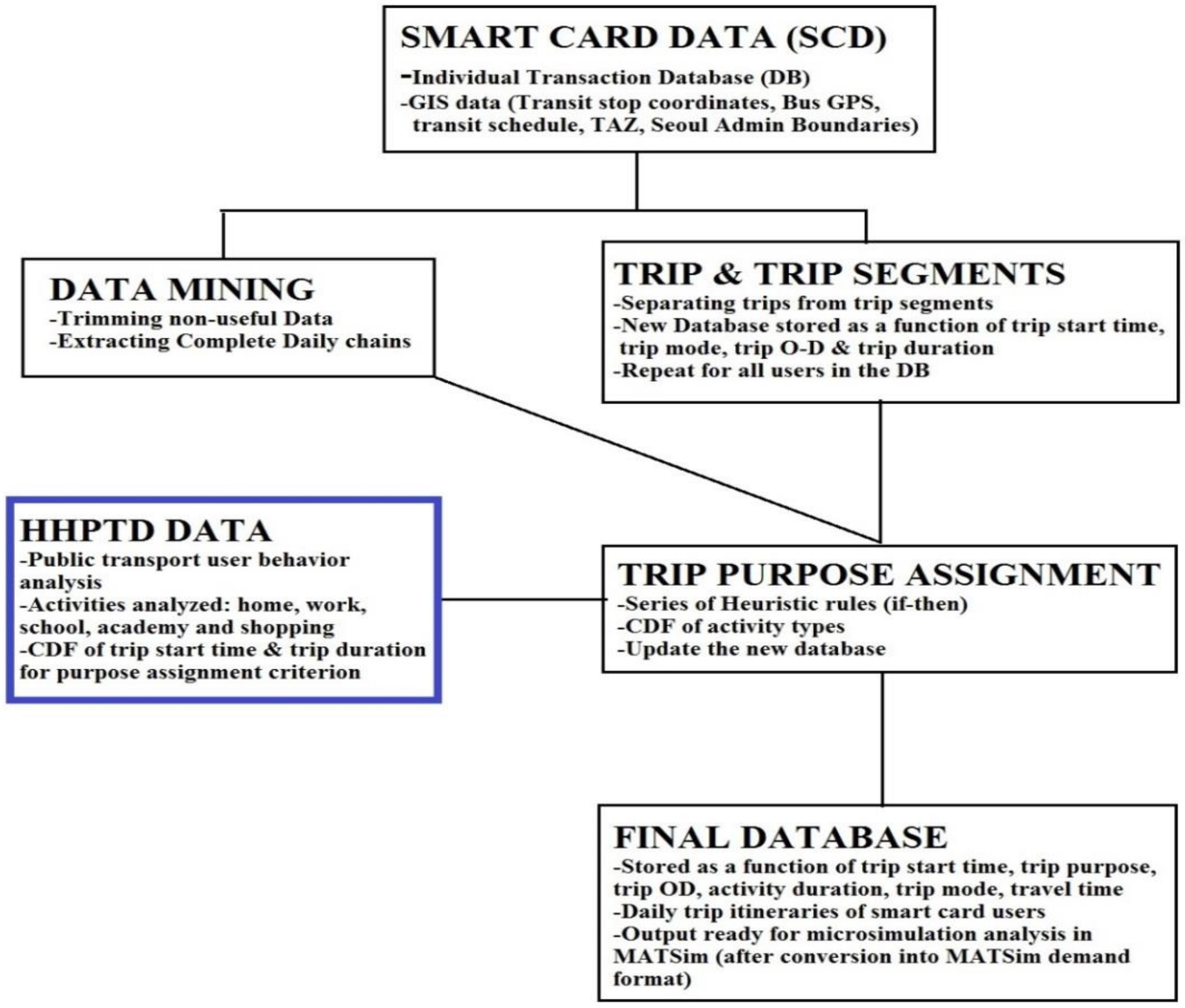
Facility Files: Door to door demand generation (July 2014). Data source is Korean GIS department.

ABM Using Smart Card Data

Thesis Topic: **Activity-based Modelling Using Smart Card Data**

(http://dcollection.uos.ac.kr/jsp/common/DcLoOrgPer.jsp?sItemId=000000023010)

Hierarchical Process of Generating Trip Purpose Assignment



Modelling Assumptions

For assigning activity purpose, following assumptions are made:

- The origin of the first trip is also the destination of last trip of the day (activity type is “home”)

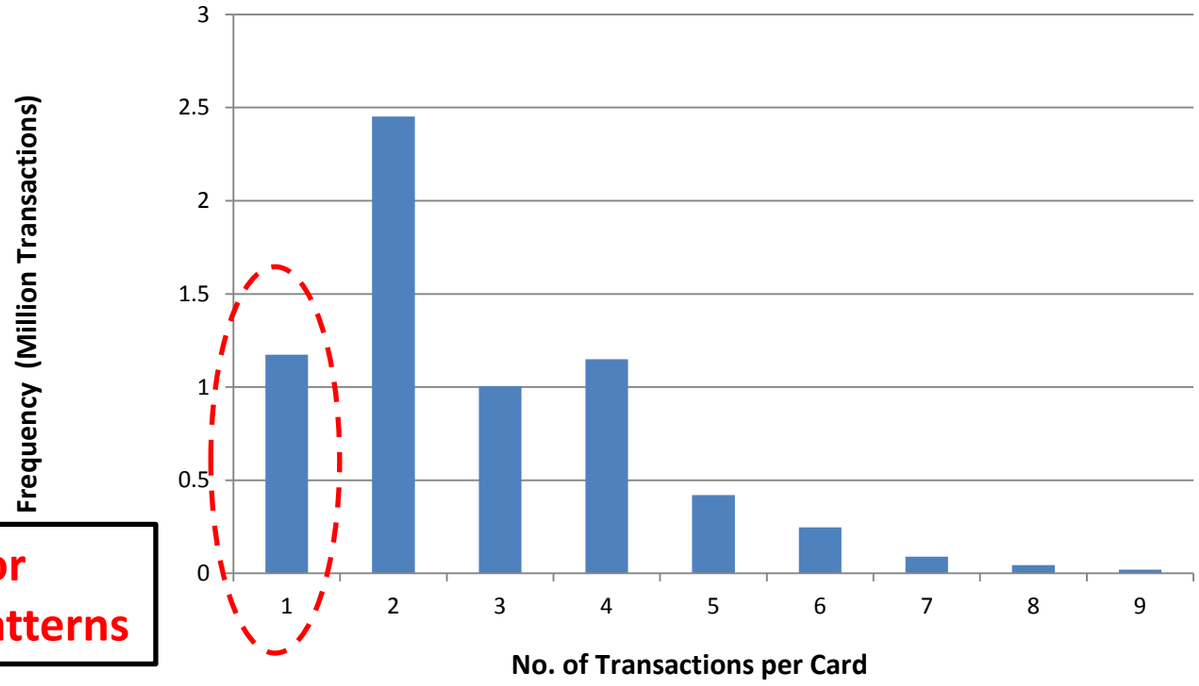
- The destination of the trip is also the origin of the succeeding trip (search radius of 500 meters)

- Transit users do not switch to other transport modes within their given sequence of daily transit trips

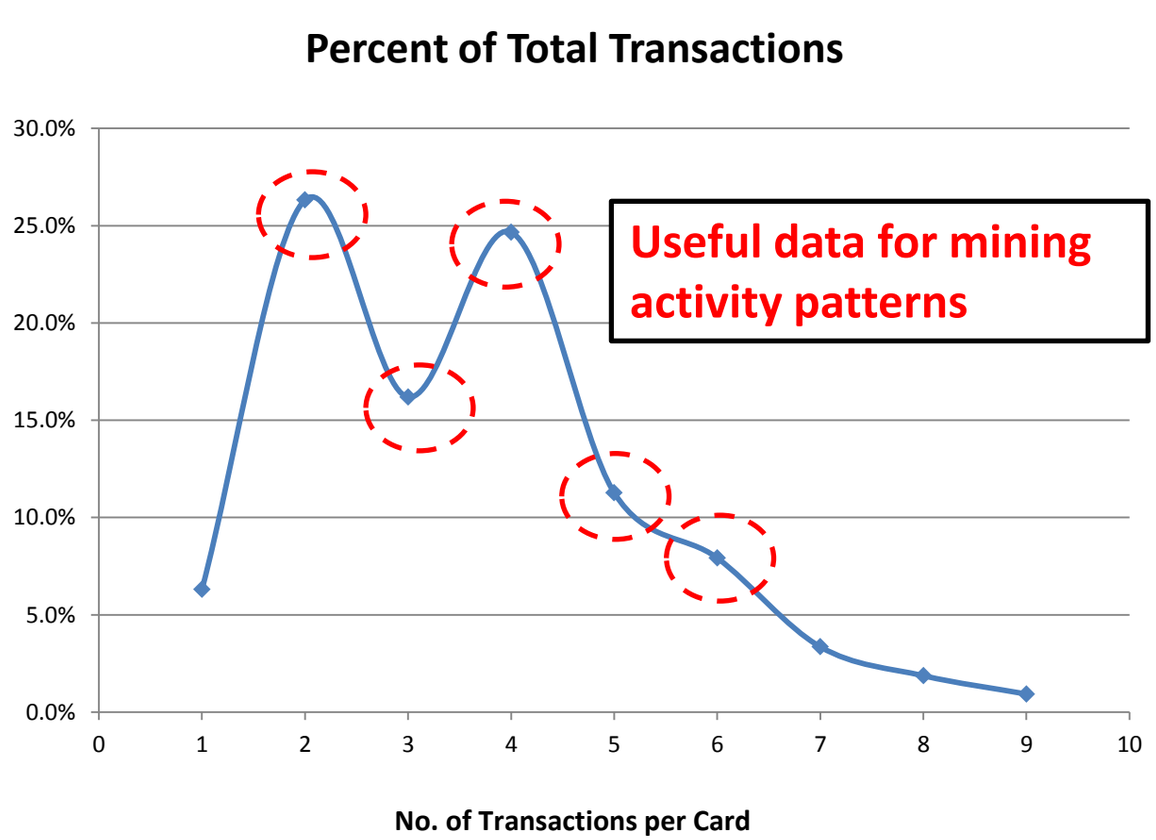
Data Trimming

Summary Stats (Working Day):

Total Transactions = **18.63** million
No. of Passengers = **6.6** million
No. of Transactions per person = **2.82**
No. of Trips per person = **2.11**



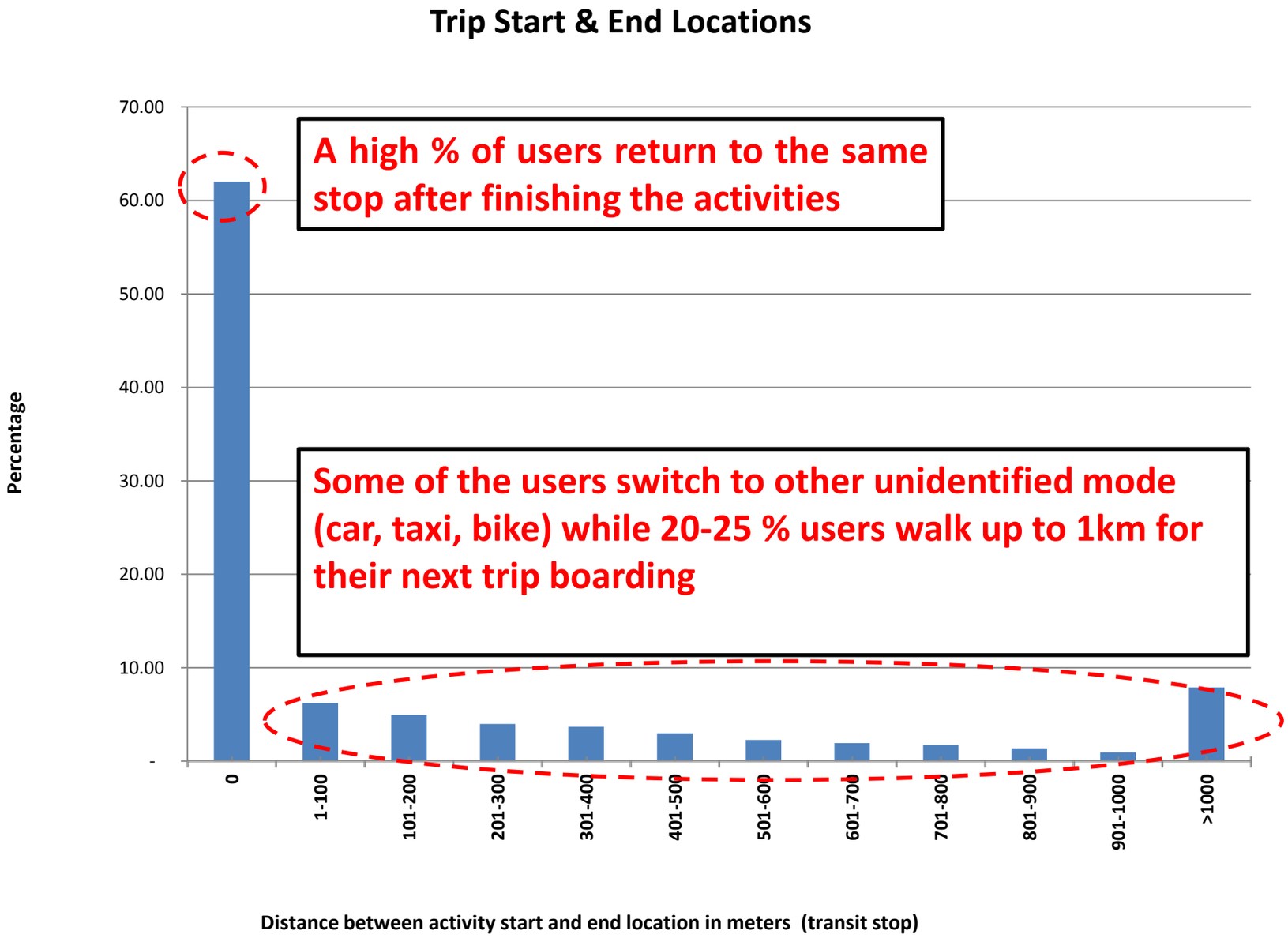
Data not useful for mining activity patterns



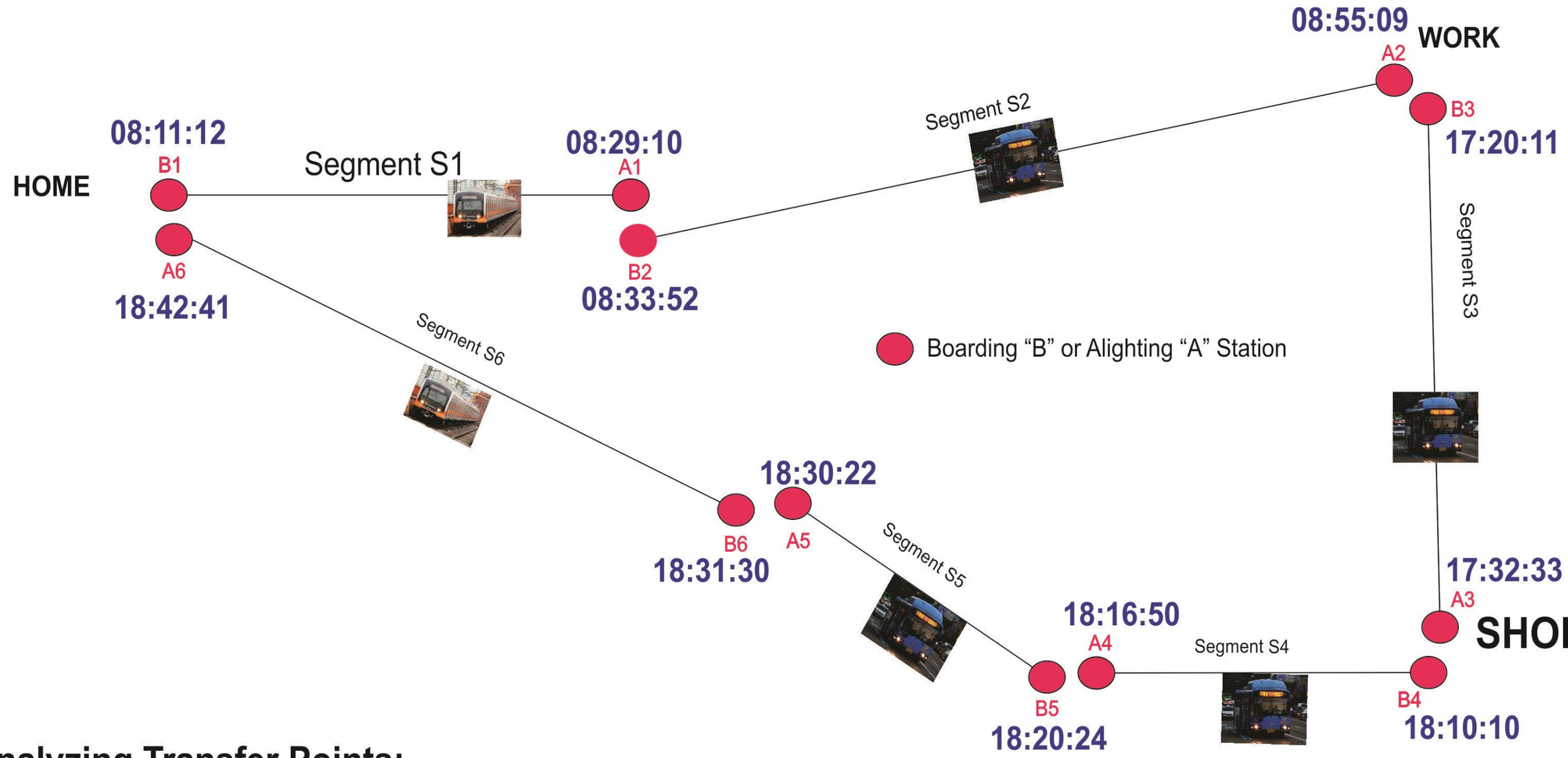
Useful data for mining activity patterns

Data Trimming

Activity locations (trips for the time being) and distance between the consecutive boarding & alighting play an important role in analyzing useful data



Segregating trips out of trip segments



Analyzing Transfer Points:

-For each Boarding Bi, if **Bi - Ai-1 > 30**, it is an Origin of a new trip, otherwise a transfer point
-For each Alighting Ai, if **Bi+1 - Ai > 30**, it is the Destination of that trip
-For each ID’s first and last segment, boarding of first segment is always origin and alighting of last segment is destination

Segregating trips out of trip segments

Trip Segments				Individual Trips		
Card ID	Boarding Time	Alight Time	Description	Card ID	Boarding Time	Alight Time
18558722	08:11:12	~~08:29:10~~	$O_1 = B_1$	18558722	08:11:12	08:55:09
18558722	~~08:33:52~~	08:55:09	$D_1 = A_2$	18558722	17:20:11	17:32:33
18558722	17:20:11	17:32:33	$O_2 = B_3$ $D_2 = A_3$	18558722	18:10:10	18:42:41
18558722	18:10:10	~~18:16:50~~	O3 = B4			
18558722	~~18:20:24~~	~~18:30:22~~				
18558722	~~18:31:30~~	18:42:41	D3 = A6			

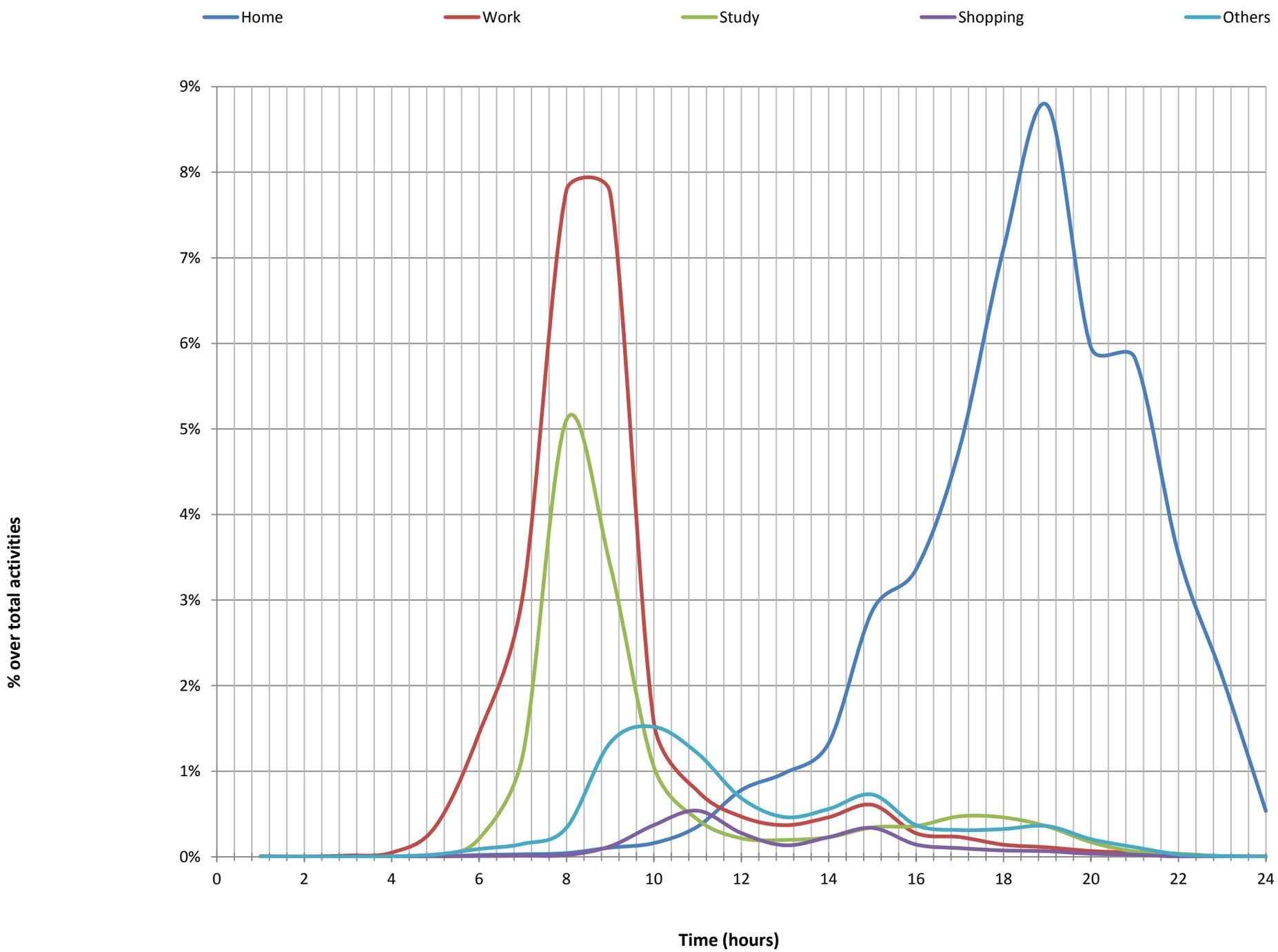
Incorporating Household Personal Travel Diary Survey (HHPTD)

- Conducted by Korean Transport Database in 2010
- 217,444 households surveyed
- 540,298 persons
- Average trip per person is 2.46 (Overall)
- Number of trips per person **2.07 (Transit users only)**
- Variables studied are: HH ID, Person ID, Trip Purpose, Trip Mode, Activity Start Time, Activity Duration and Activity Sequence
- Activities reported in the survey are: **“home”, “work”, “school”, “academy”, “work-based trip”, “shopping”, “leisure” and “other”**

ACTIVITY TYPE	PERCENTAGE
Home	45.7 % (trips)
Work	19.5 %
School	11.9 %
Academy	5.3 %
Shopping	2.3 %
Leisure	3.7 %
Work-based Trips	4 %

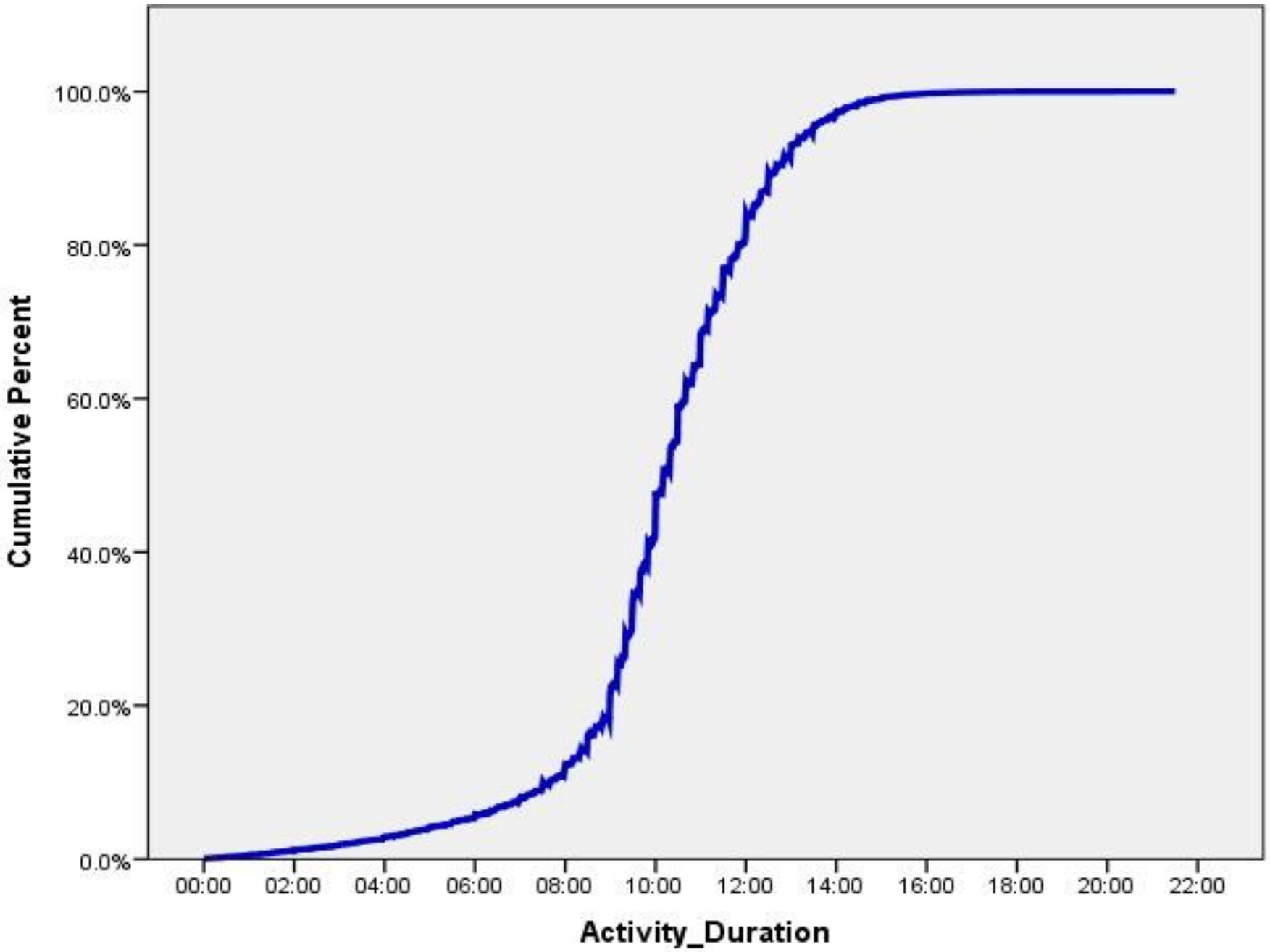
Incorporating Household Personal Travel Diary Survey (HHPTD)

Activity Start Time Regime



Incorporating Household Personal Travel Diary Survey (HHPTD)

Activity Duration: Work

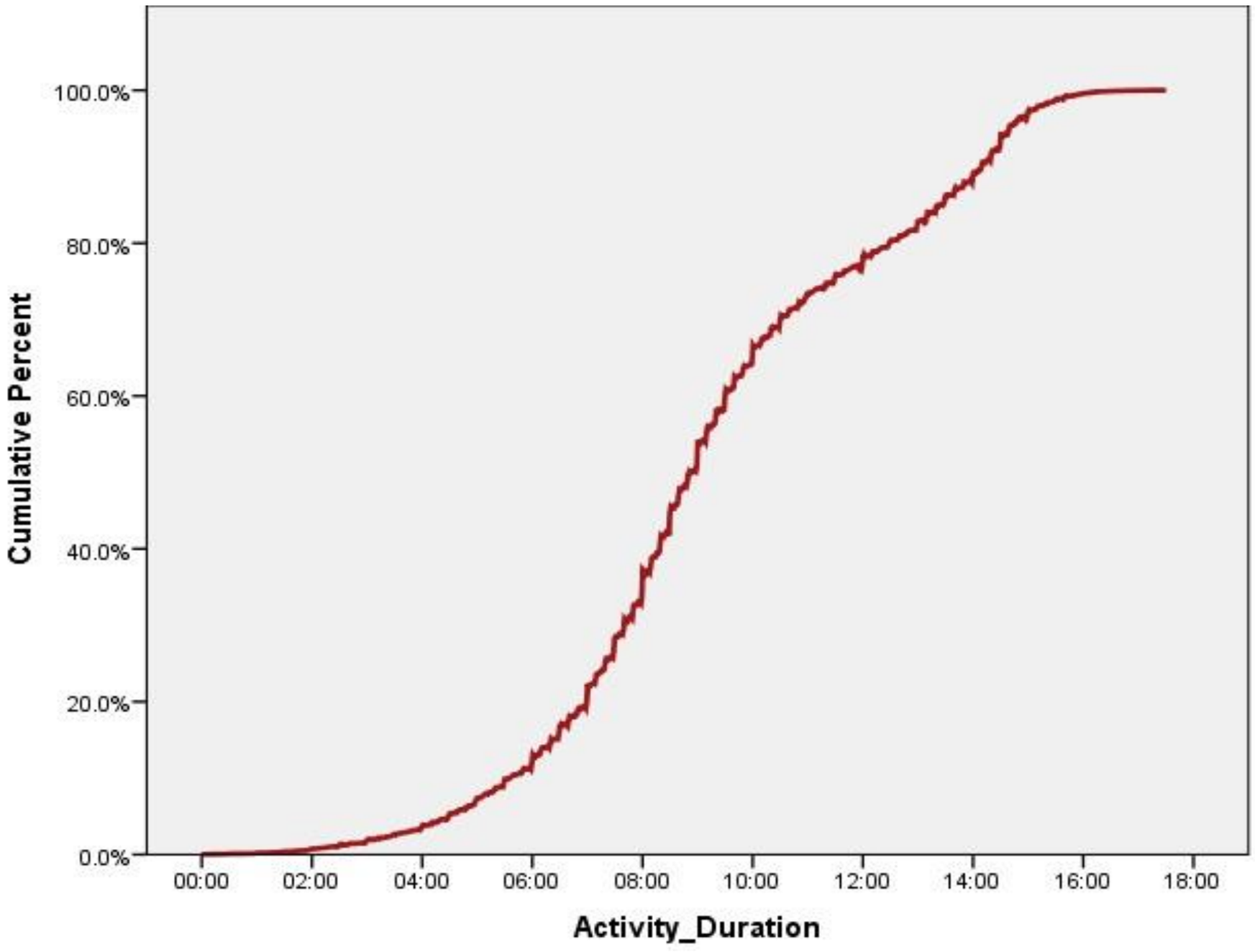


Mean Duration: 650 min (10:50 hours)

Standard Deviation: 2:18 hours

Incorporating Household Personal Travel Diary Survey (HHPTD)

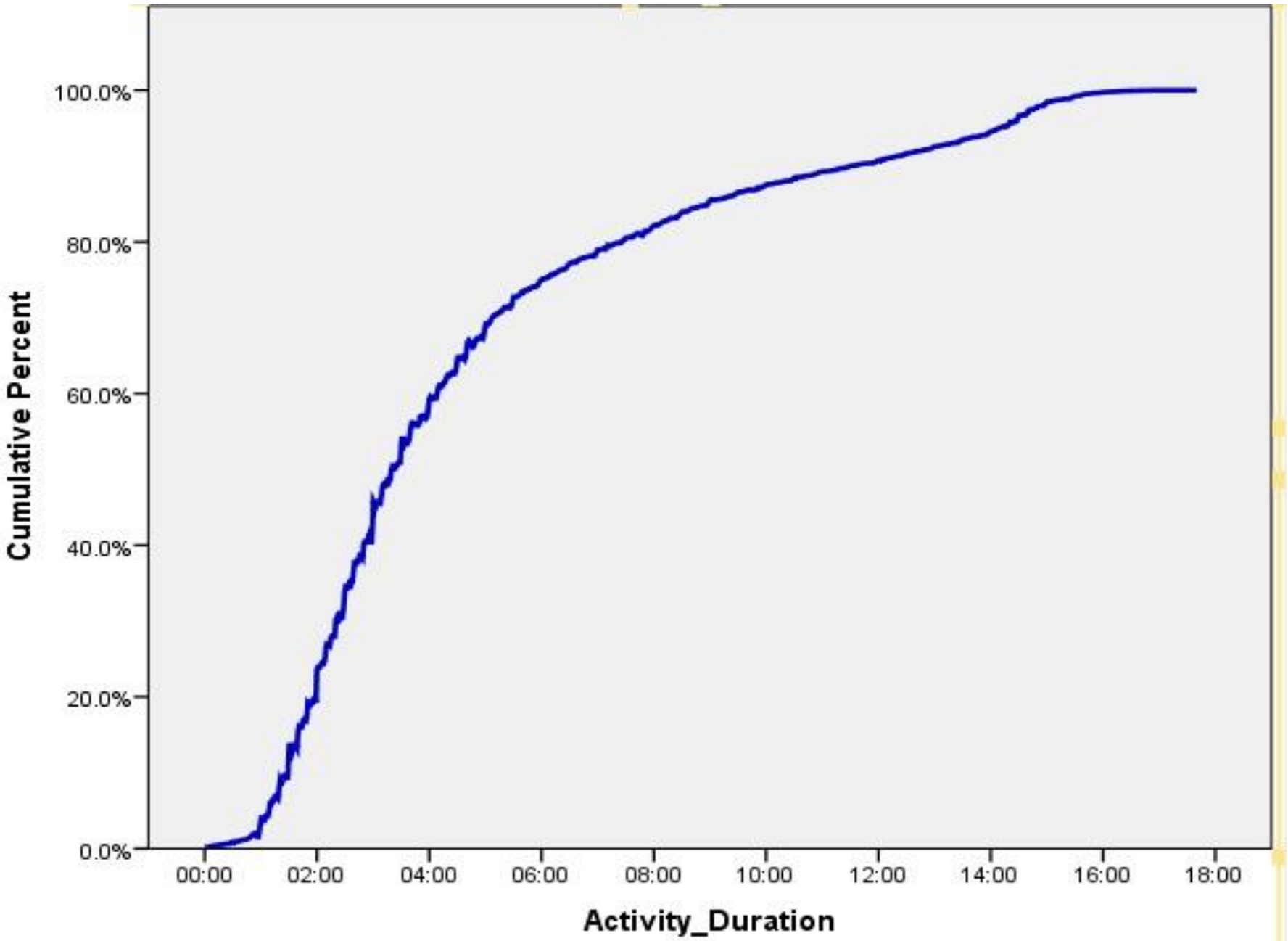
Activity Duration: School



Mean Duration: 500 min (08:20 hours)

Standard Deviation: 3:28 hours

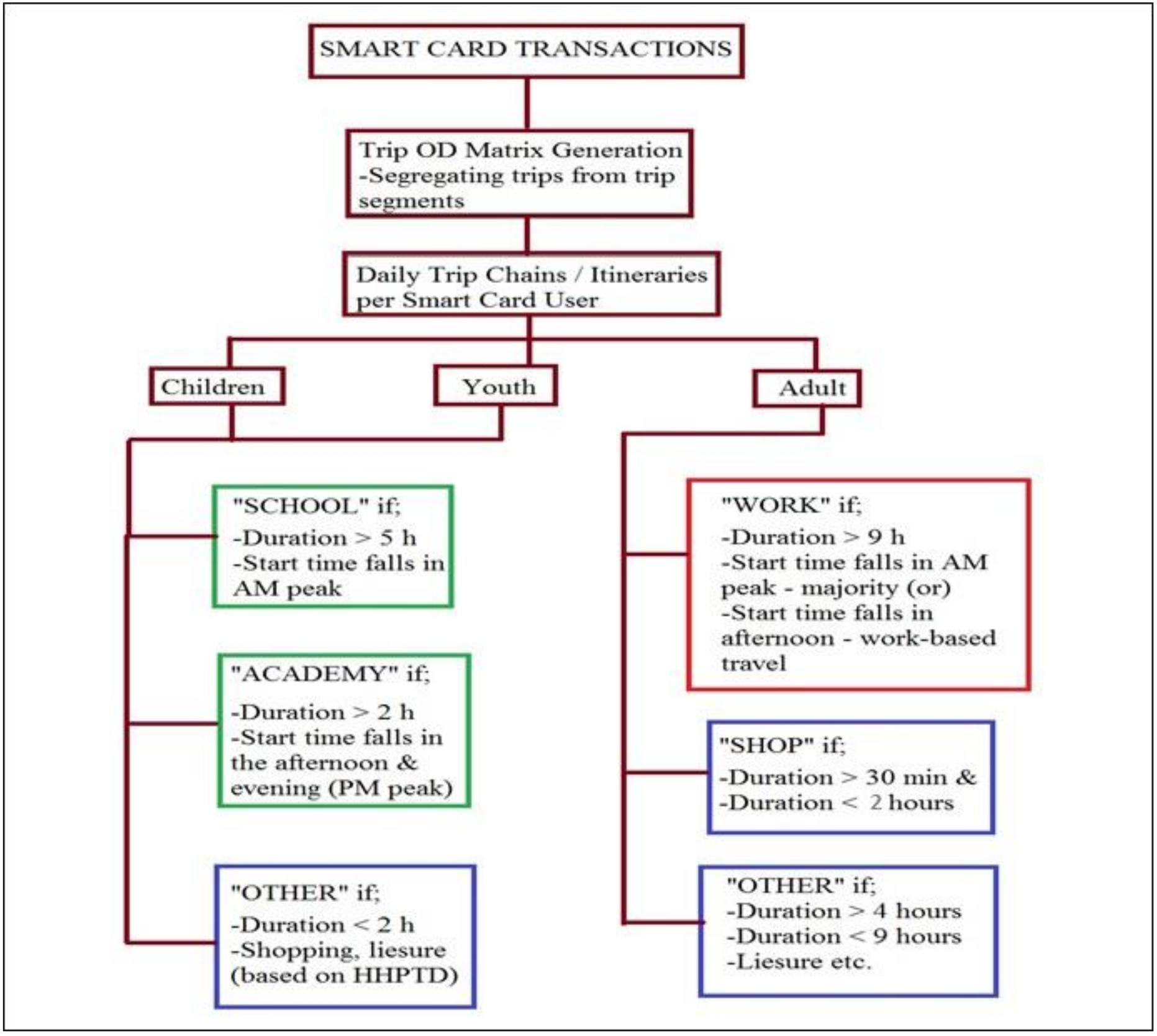
Activity Duration: Academy



Mean Duration: 263 min (4:23 hours)

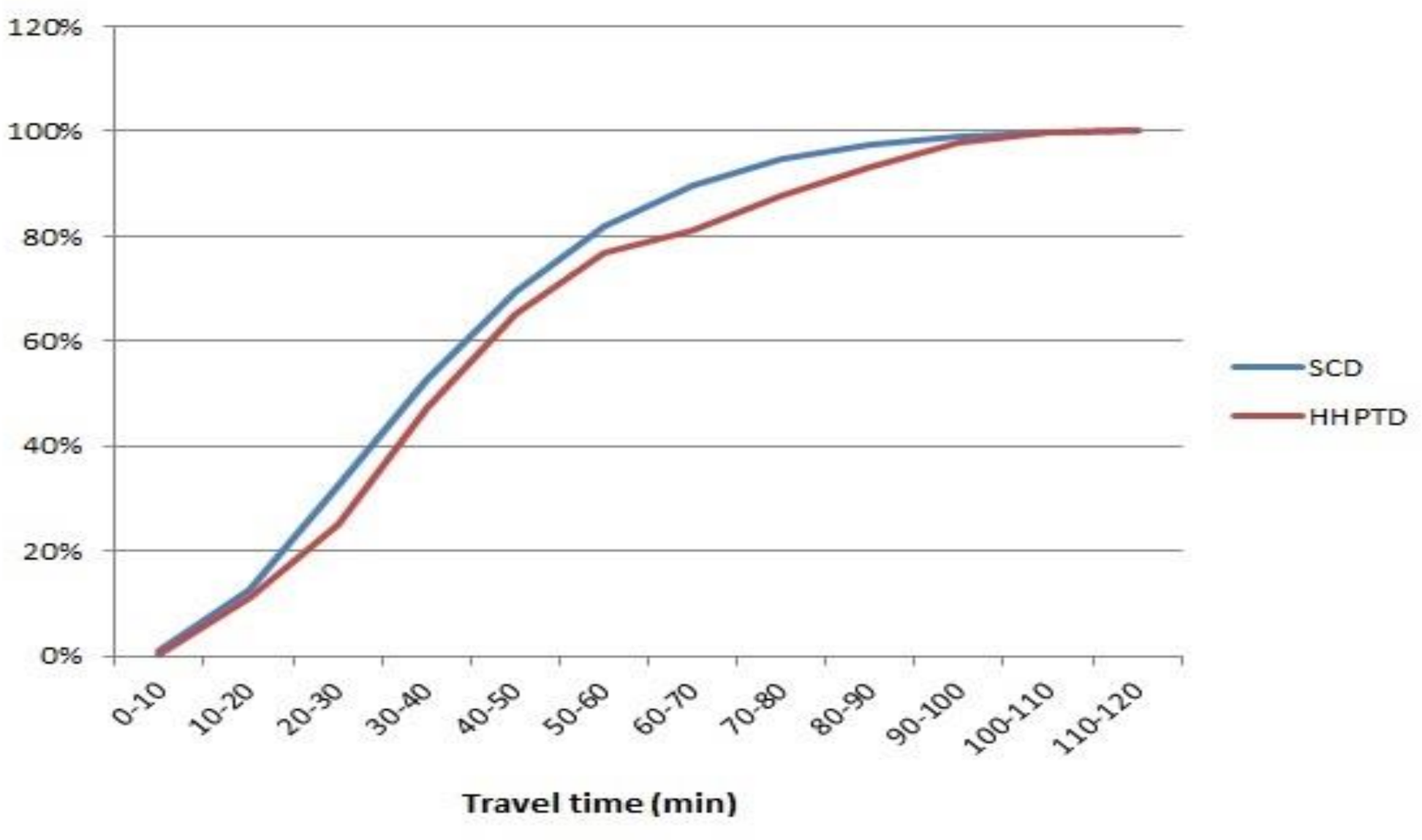
Standard Deviation: 2:29 hours

Trip Purpose Assignment

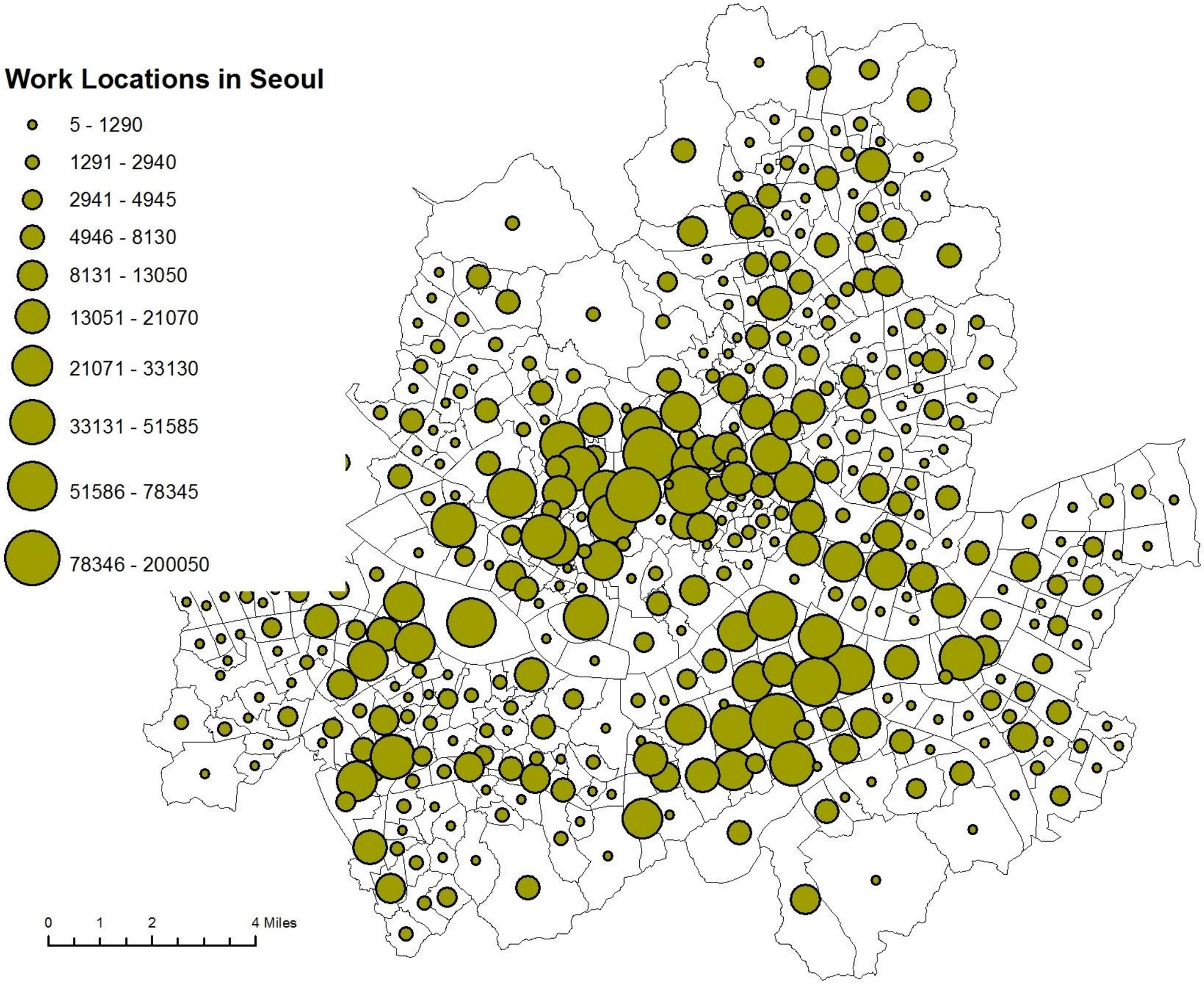


Results

Commuting Time for two Datasets - Validation



Results


Work Locations in Seoul
5 - 1290
1291 - 2940
2941 - 4945
4946 - 8130
8131 - 13050
13051 - 21070
21071 - 33130
33131 - 51585
51586 - 78345
78346 - 200050
0
1
2
4 Miles

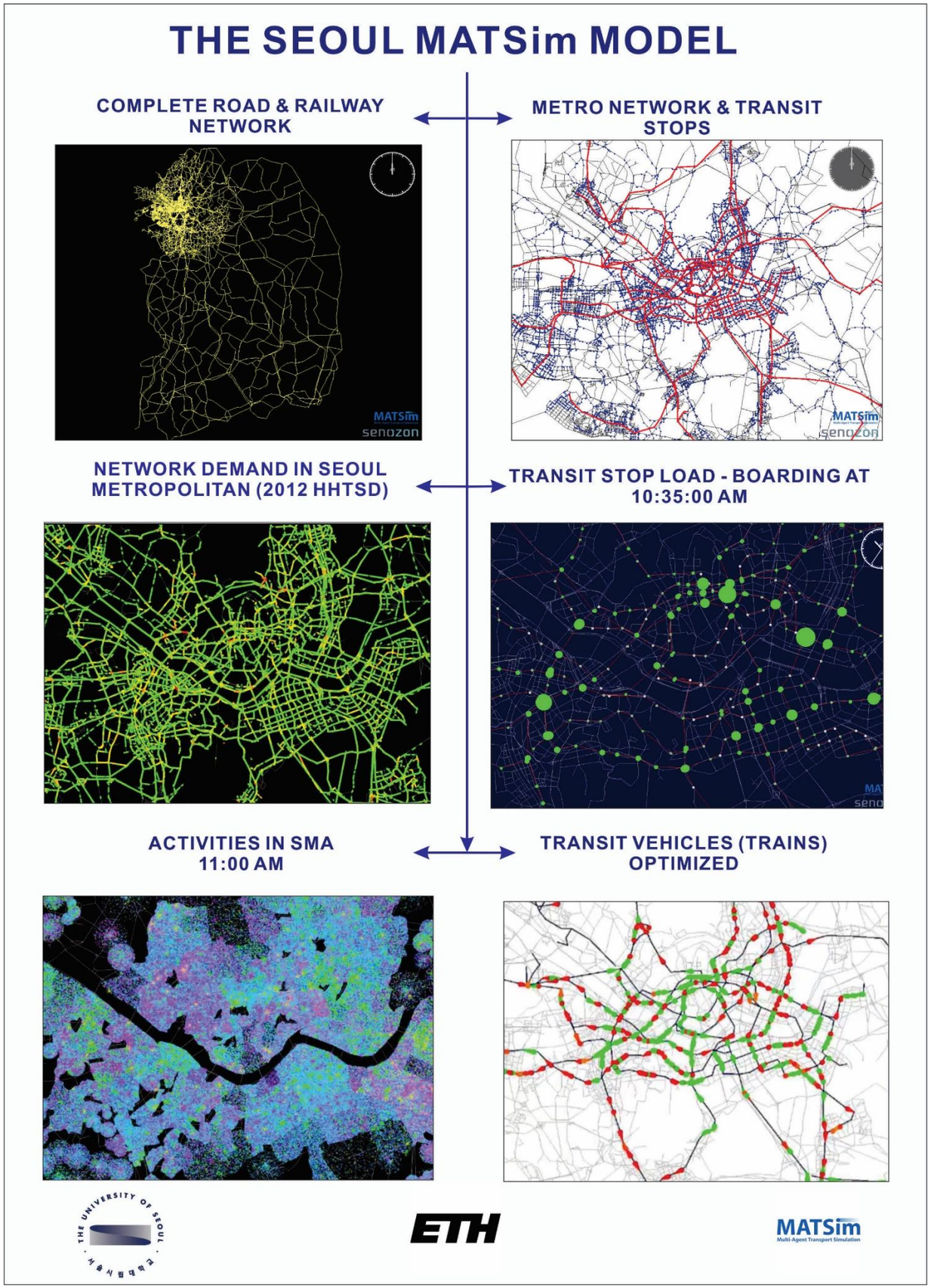
Results

The final **smart** database contains the following attributes
and
is ready for **MATSim input demand generation**

- **Card ID (user)**
- **Activity type**
- **Activity duration**
- **Activity start time**
- **Activity end time**
- **The consecutive trip boarding & alighting**

Once these attributes are available, they can be joined in database i.e. the **complete day itineraries** for all the agents!

Application in MATSim



Thank You!