CITY-SCALE TRAFFIC SIMULATION

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CITY-SCALE TRAFFIC SIMULATION THE DUBLIN SCENARIO

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Overview

Building the Dublin Traffic Scenario

Multi-Agent Simulation
Input Data
Travel Demand
- Population Data, Car Ownership, Commuting, Daily Trips, Selection Choice, Social Network, Road Network

Results

Motivation

- Long Term
    - Building Projects
    - Infrastructure
    - Road Pricing

- Short Term
    - Emergency Response
    - Dynamic Road Pricing
    - Dynamic Speed Limits

Traffic Simulation

- Simulate Dublin Traffic
- Agent-Based Micro-Simulation
  - A population of agents performing a sequence of activities
- Large-scale (millions of vehicles/agents)
- Handles interactions between vehicles, junction crossing, congestion, etc.
- A single day simulation

MATSim

Traffic Simulation

Qsim
- Routing
- Queue Based
- Links in the Network have capacity (roads)

Adaptation strategies
- Route selection, Departure time, Location choice
- Agents have memory (a score)
- Competing for resources
  - Slot on the road network to complete journey at a given time

Equilibrium
- Average score of agents stabilises
  - Utility score – travel time

Traffic Simulation

Traffic Simulation

Initial Demand

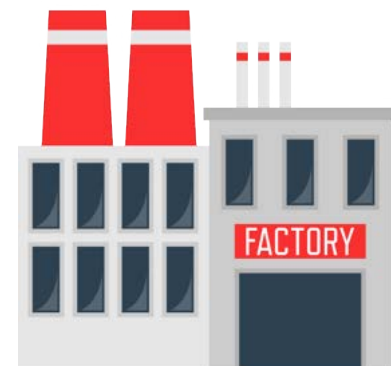Where/When do people:
  Live
  Work
  Learn/School
  Shop
  Eat
  Entertain
  Socialise
  GO?

Initial Demand

Where/When do people:
- Live
- Work
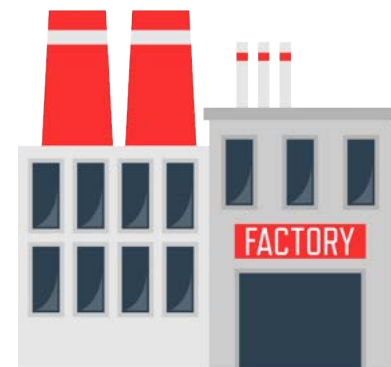- Learn/School
- Shop
- Eat
- Entertain
- Socialise
- GO?

Spatial Data

Census

Conducted at small area level
  80 – 100 households (18488 small areas)
  Each individual's home is anonymised to a small area
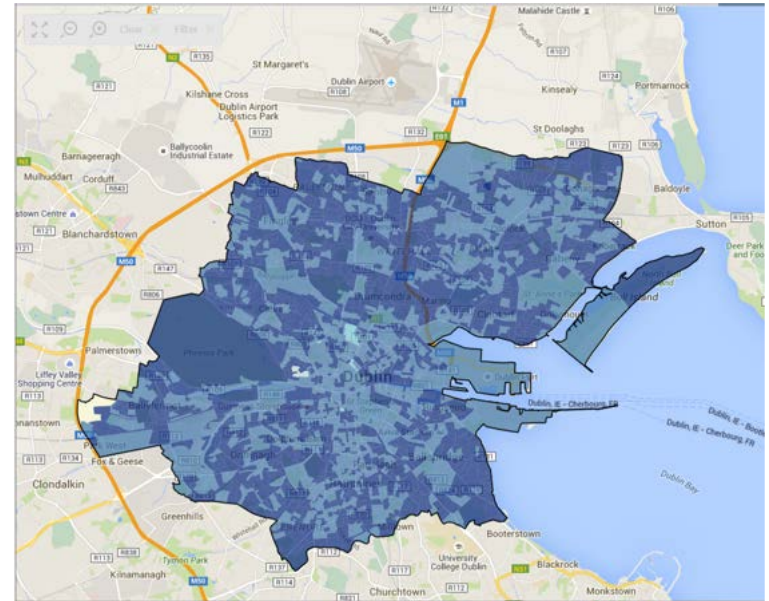
Requested Full Address of Work, School or College
  Geo-coded using GeoDirectory for Rep. of Ireland and Pointer for N. Ireland
  Students

- Aged 5-14 or over 15 and indicated they were students in census question

Census Small Areas

POWSCAR Census

	Students	Workers	Total	%
Persons in private households or establishments enumerated and resident in Ireland	1,013,292	1,770,644	2,783,936	100.0
Place of work, school or college address (Q34) was matched to a GeoDirectory address point	929,003	1,360,800	2,289,803	82.3
Place of work, school or college address (Q34) blank or uncodeable	78,956	147,250	226,206	8.1
No fixed place of work indicated at Q34	-	148,177	148,177	5.3
Works from home indicated in Q34	-	106,055	106,055	3.8
Place of work, school or college address (Q34) was matched to a NI Pointer database address point	3,117	6,419	9,536	0.3
Place of work, school or college address (Q34) overseas	1,598	1,943	3,541	0.1
Home school indicated at Q34	618	-	618	0.0

POWSCAR Structure and Content

Tab delimited file micro data text file
- First row contains variable names
- Each subsequent row represents and individual (person)

Additional excel file with a description of the variable labels and codes (e.g. OSI codes)

42 POWSCAR Variables
- Spatial data
- House data(building)
- Household data
- Individual data
- Some variables are relevant to students and vice-versa

POWSCAR Variables

Spatial Variables

Residence

- NUTS3, County, CSO Electoral Division, OSI Electoral Division
- Area Type (town v rural)
- Town Name
- **Small Area**

POWSC

- Location (IE, At home, NI, Abroad, Mobile)
- NUTS3, County, CSO Electoral Division, OSI Electoral Division
- Area Type (town v rural)
- Town Name
- Small Area
- **Fuzz East, Fuzz North**

POWSCAR Variables

Household Variables
    Number Residents
    Number Workers
    Number Students

Home/House Variables
    Year Built
    Nature of Occupancy
    One-Off House
    Number of Cars or Vans
    Household Composition
    Highest Education of parents (students)
    Unemployed parents (students)

POWSCAR Variables

Individual Variables
   Sex
   5 Year Age Group (not students)
   School Level (students)
   Religion (students)
   Ability to Speak English (students)
   Nationality (student)
   Marital Status (not students)
   Usual Residence
   Highest Level of Education (not students)
   Socioeconomic Group
   Industry Group (not students)

POWSCAR Variables

Travel to Work, School or College
- Means of Travel
- Time of Departure
- Journey Time

Experience of Using POWSCAR

POWSCAR added to Spatially enabled database – PostGIS.

Individuals who live **OR** work **OR** study in Dublin (GDR)

- Fixed place of work
- Means of Travel
    - limited to cars and vans
- Time of departure
- Residential Small Area
- Fuzzy East and Fuzzy North Anomalies
- Travel time
- No School/College

GDR Counties
Dublin Metropolitan Area
Electoral Divisions (ED)

0   25 km

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Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community. GDR Counties: OSI (Permit N. MP009006)

Input Sources – Initial Demand

Population

  Home Location

  Work Location

Network

  Road Network

  Public Transit Network

MATSim routes agents from their home location to their work location via the *road network*. Recursive iterations reduce travel time by avoiding congested routes.

Input Sources

Traditional Sources

    Population Census

- POWSCAR
  - Home Location
  - Work Location
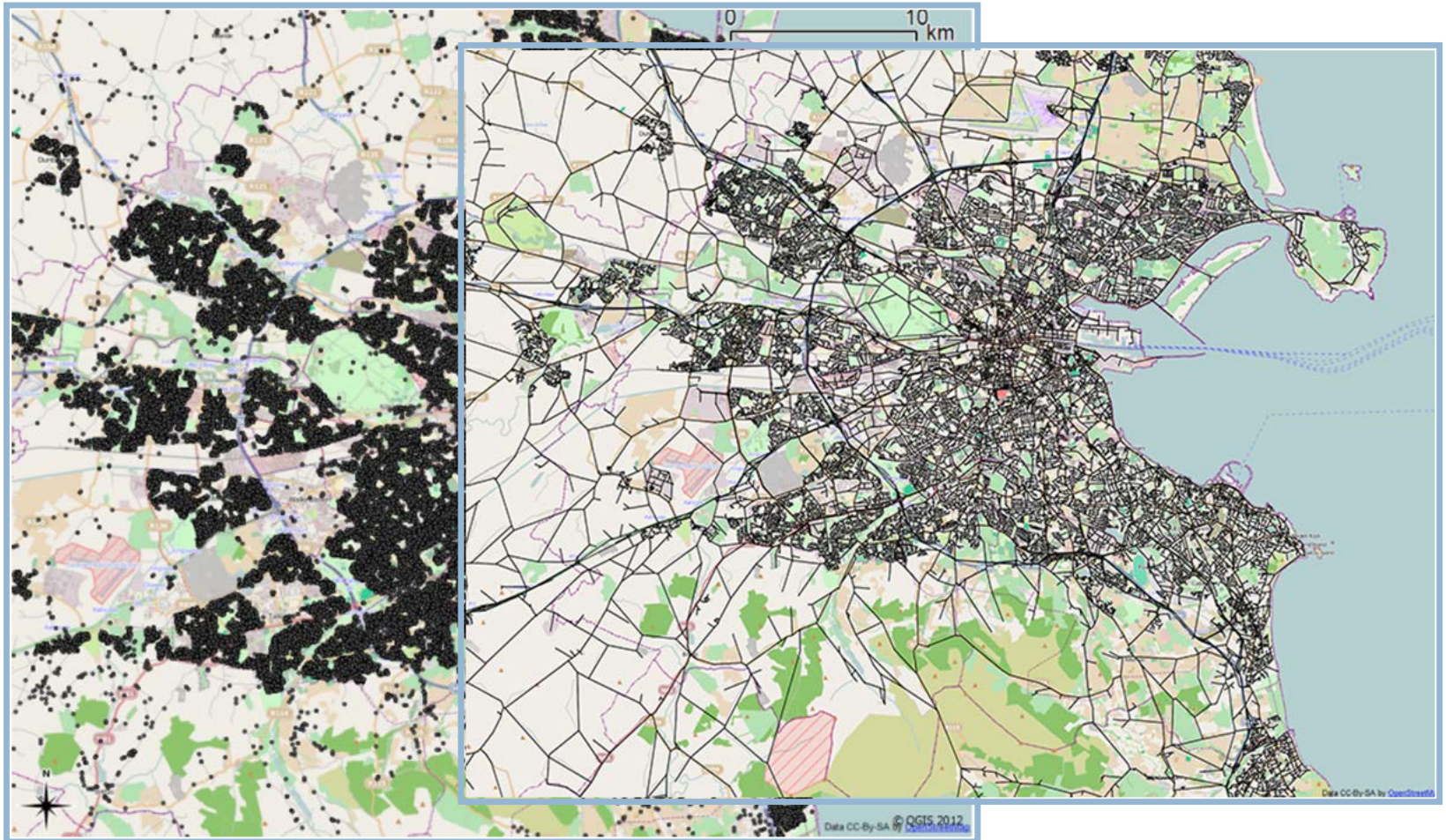 - Morning departure time
  - School/College Location

    Road Network- Open Street Map

- Links and nodes
- Speed Limits
- No. of Lanes
- Class of Road

Input Sources
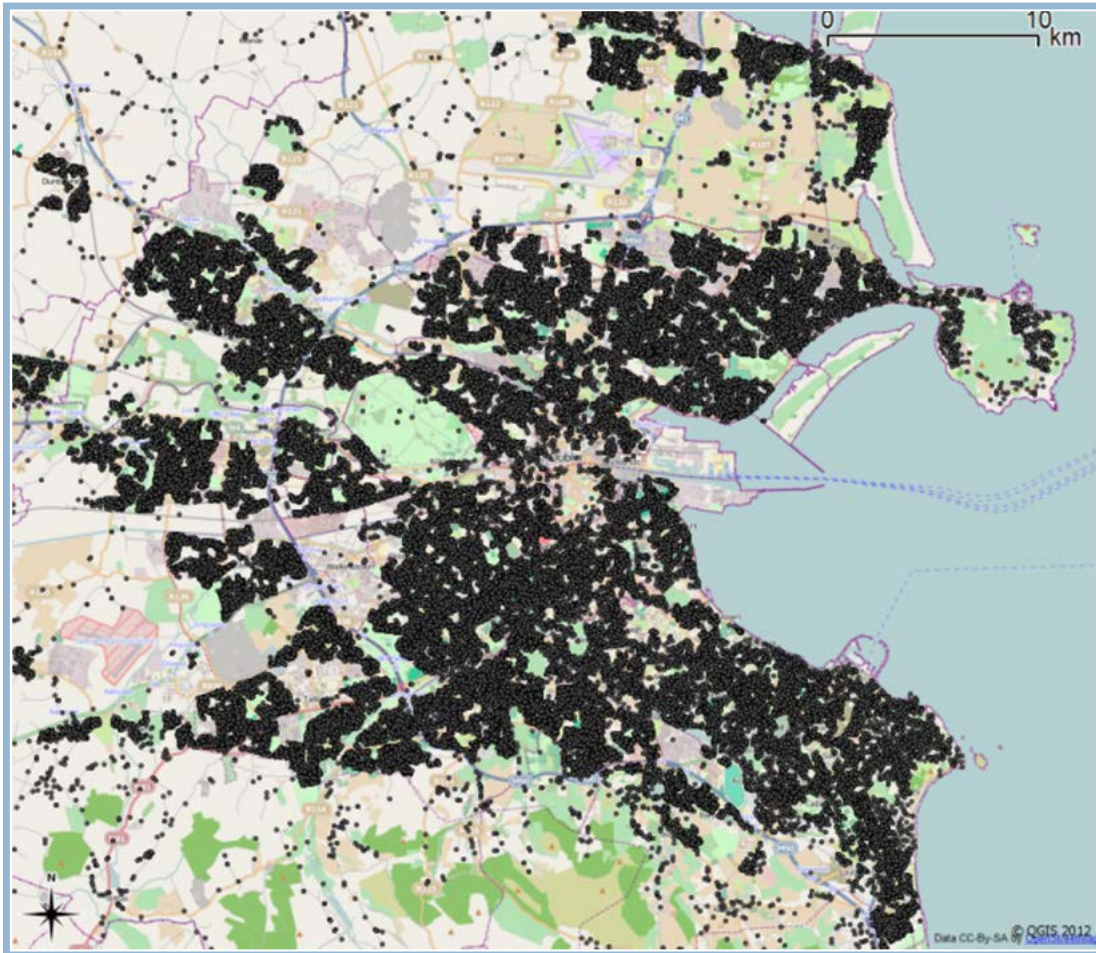
Input Sources

Input Sources

Anonymous Data

Required data fusion

Electoral districts/small areas for home locations

Merge with GeoDirectory to produce coordinates for buildings were people live/work

GEO DIRECTORY
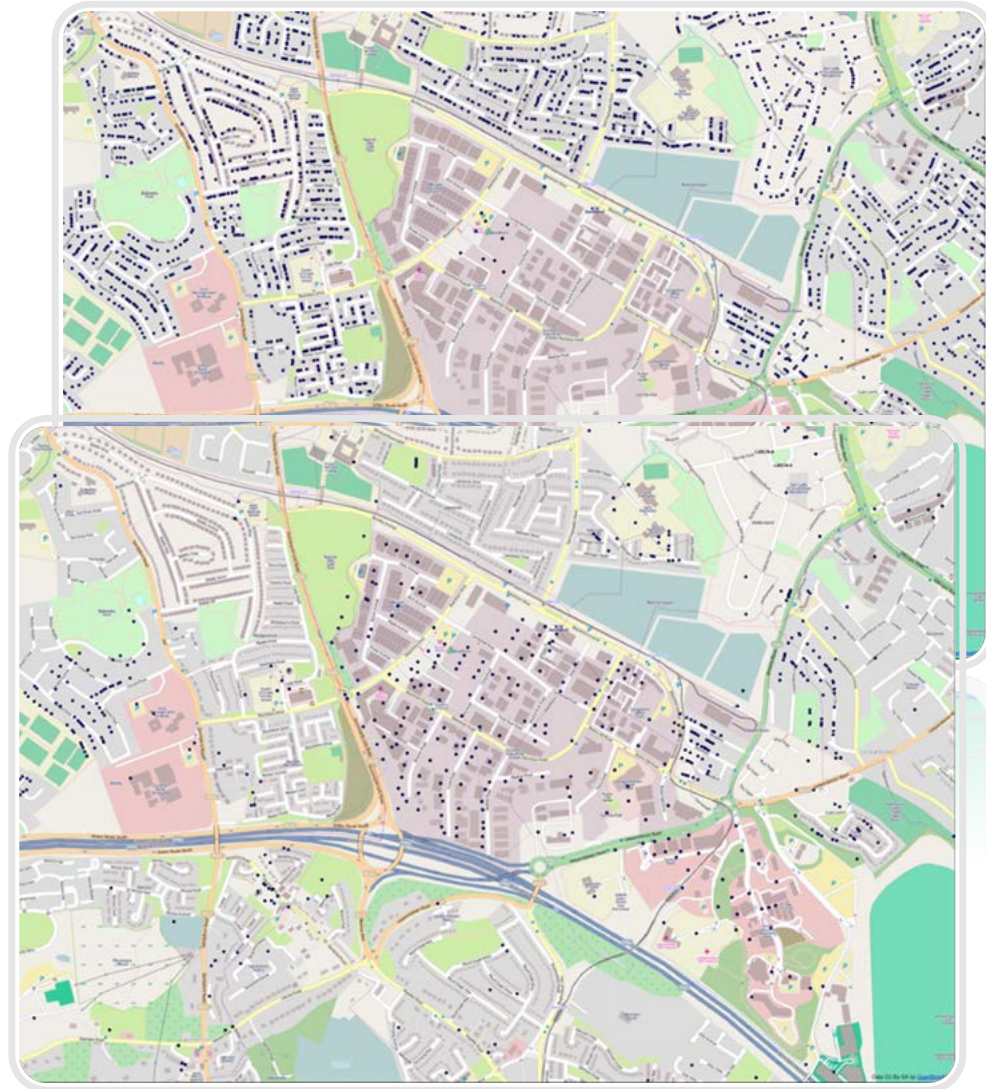
Input Sources

Irish National Travel Survey
   16000 people kept a travel diary

- School/Education
- Shopping
- Sport/Leisure
- Doctor/Medical/Personal business
- Visiting Family/Friends
- Social/Entertainment

| Home | Work | Home |

| Home | School | Work | Shopping | Friends | Home |

Where?
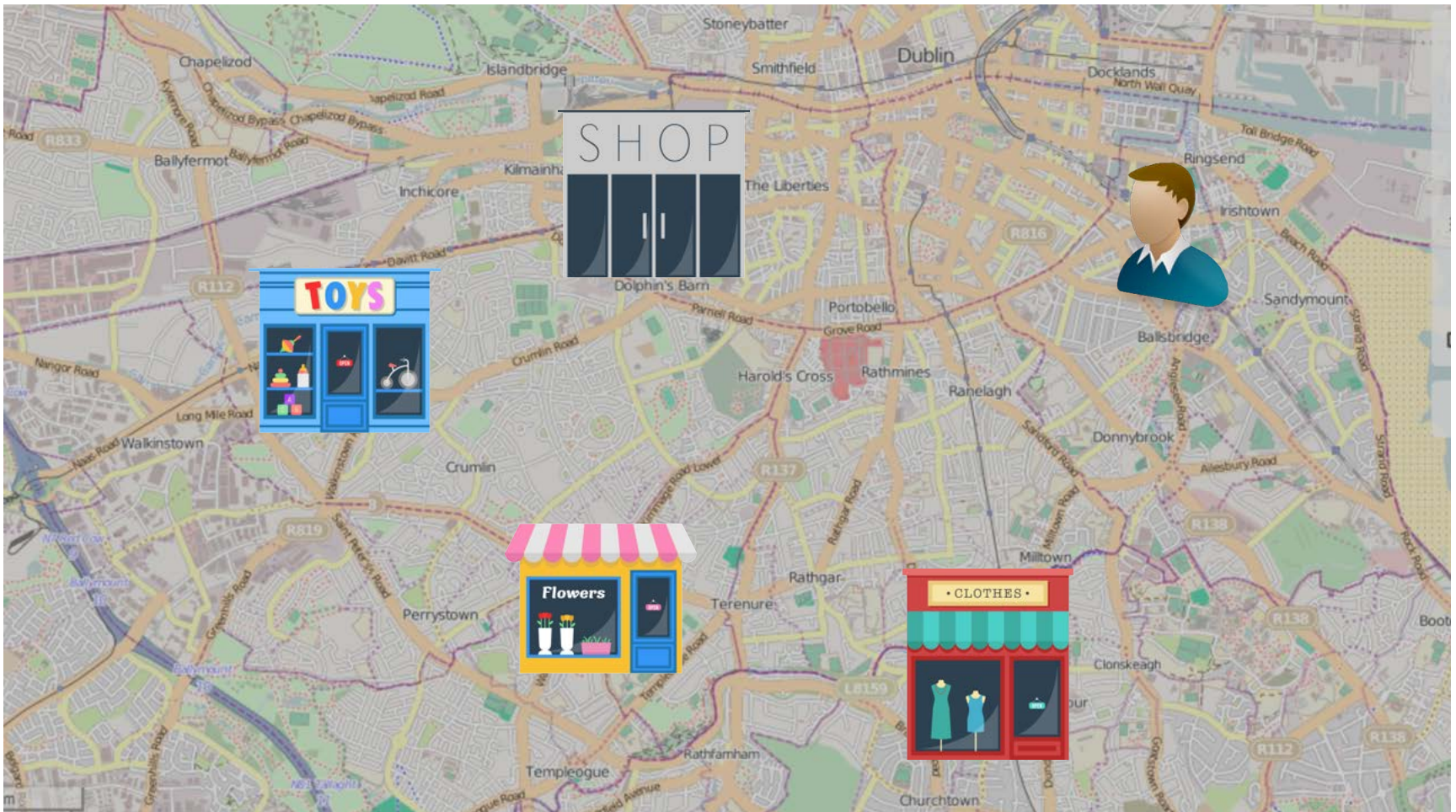
Input Sources

Facility Locations

    Shopping

    Entertainment

    Sport

Facility Capacities

    Attractiveness Score

    Size of Facility

    No. Parking Spaces
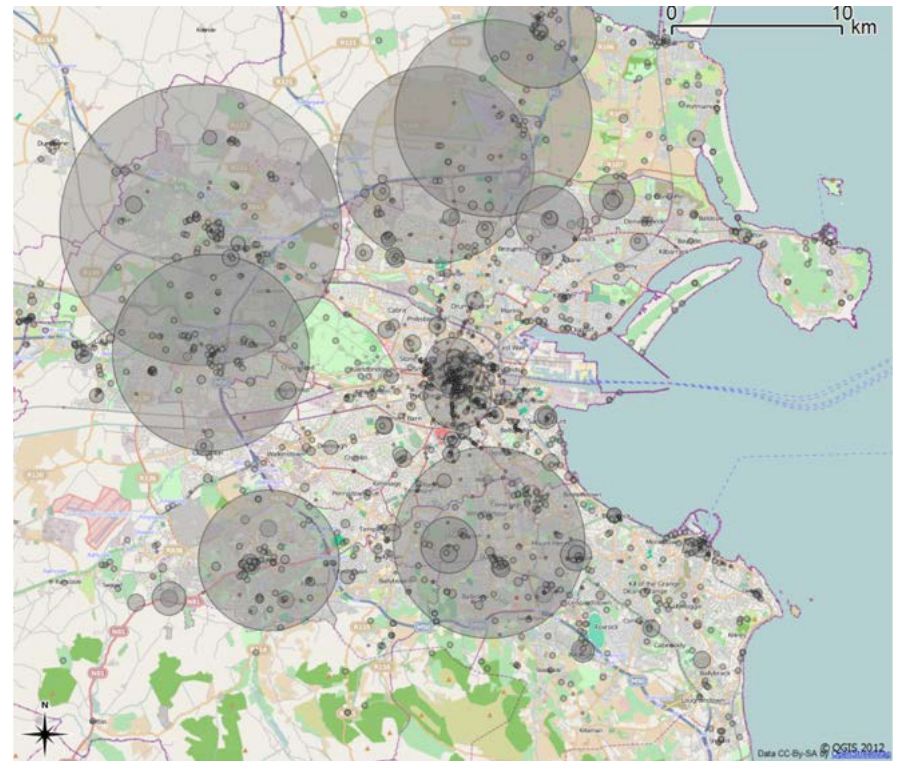
Spatial Choice Models

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.).

- Typical distances travelled for such activities

Where?

Social Network

Geography of the Social Network is important

Probability of friendship decays with distance

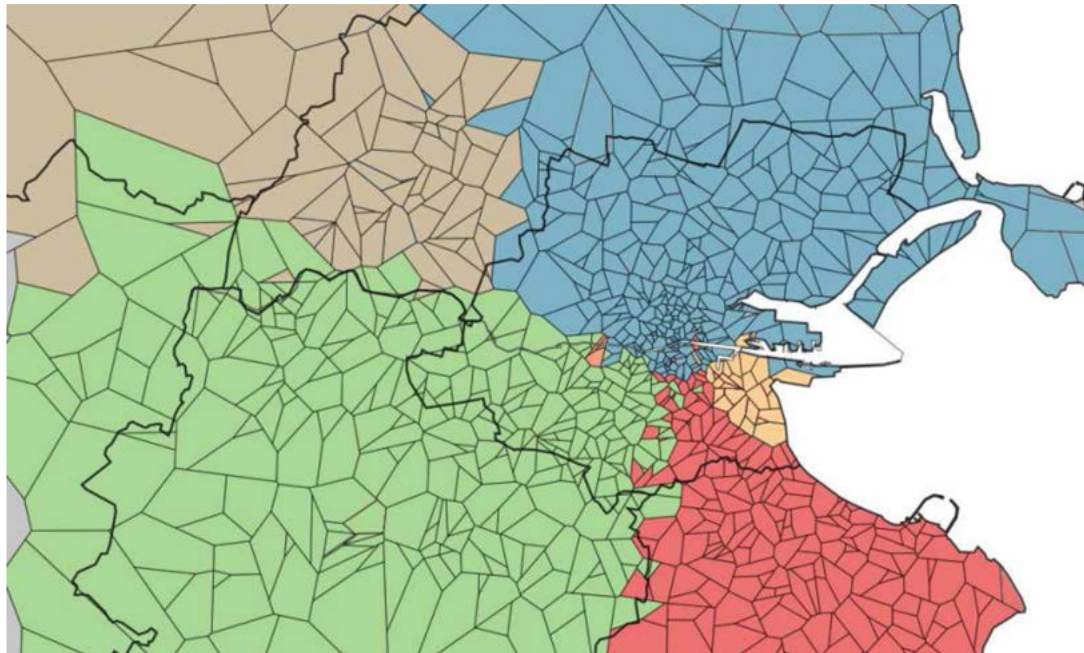Communities are spatially structured into enclosed contiguous regions

Utilised the social network built using CDR data

- Call detail records for cell/mobile phones
- Identify home locations
- Show how individuals are connected

Social Network

Reconstructed Social Network for the simulation population

Community structure

Simulation

Road Network

Facility Locations

Home Location

   Drivers

- Workers
- Non Workers

Work Location

Activity Chains

   Schedule

Social Network

Location Choice

MATSim

Output & Validation

Hourly traffic volumes and travel times for all road segments in the road network (Open Street Map)

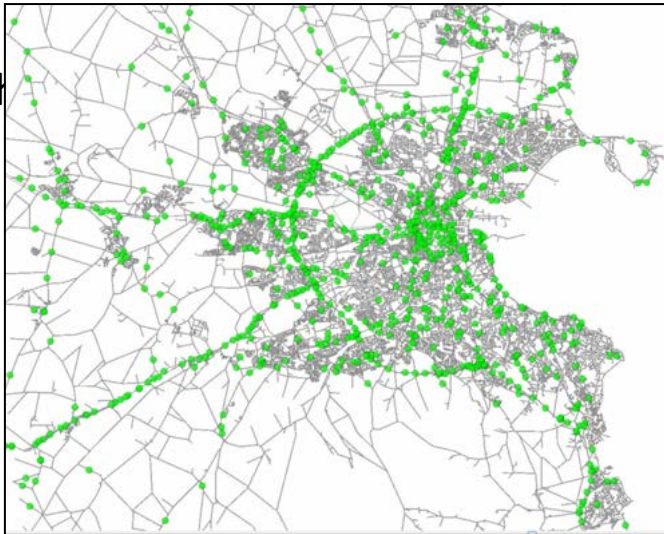Validate against ground truth from the National Roads Authority count stations

   M50/M4 Count Stations Midweek (motors)

   SCATS(Sydney Coordinated Active Transport System)

Compare *Radiation Model* for location choice with a *Nearest Neighbour* approach

NRA
An tÚdarás um Bóithre Náisiúnta
National Roads Authority

Output

6AM
Pre 'Rush
Hour'

8AM
'Rush-
Hour'

8PM
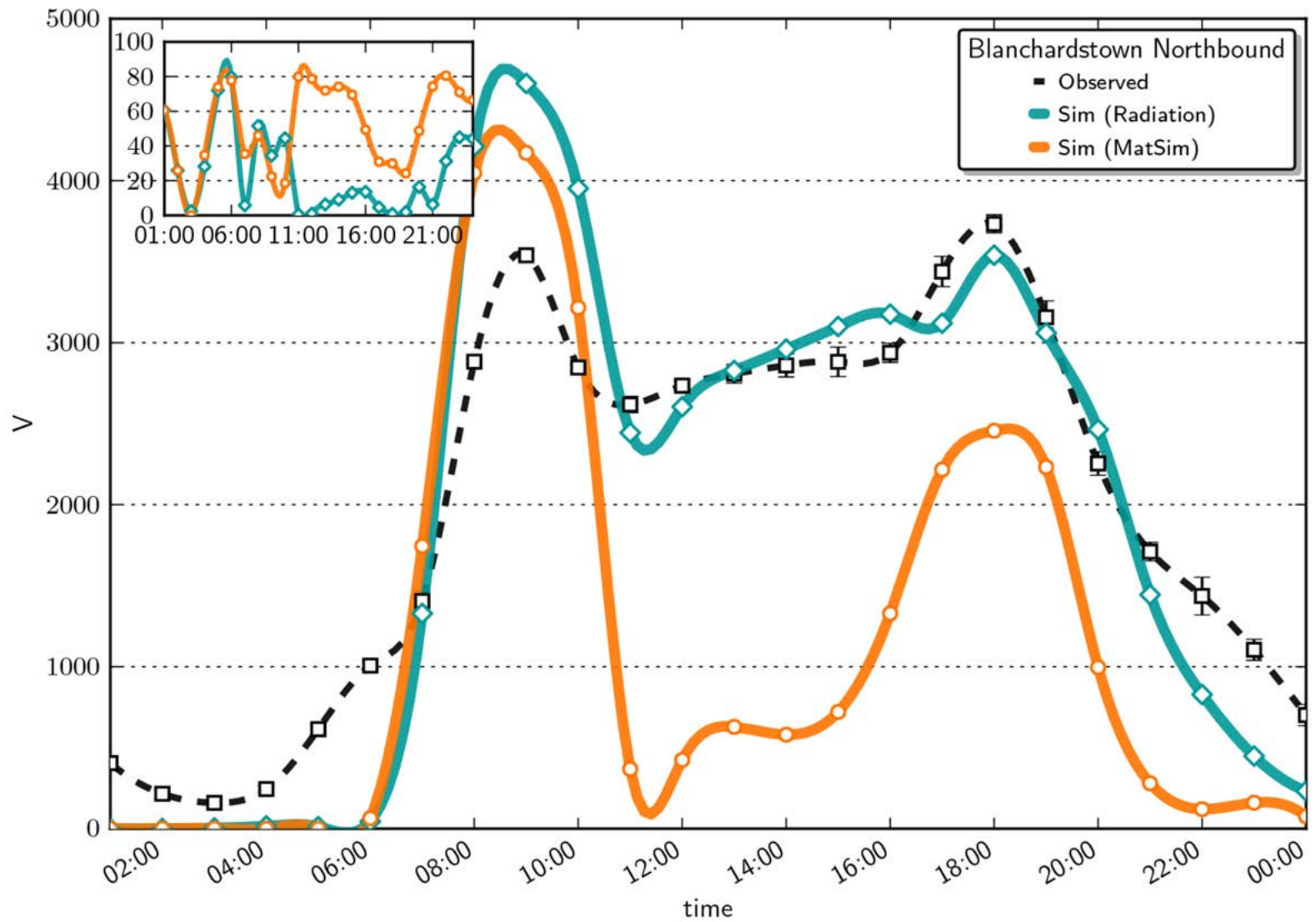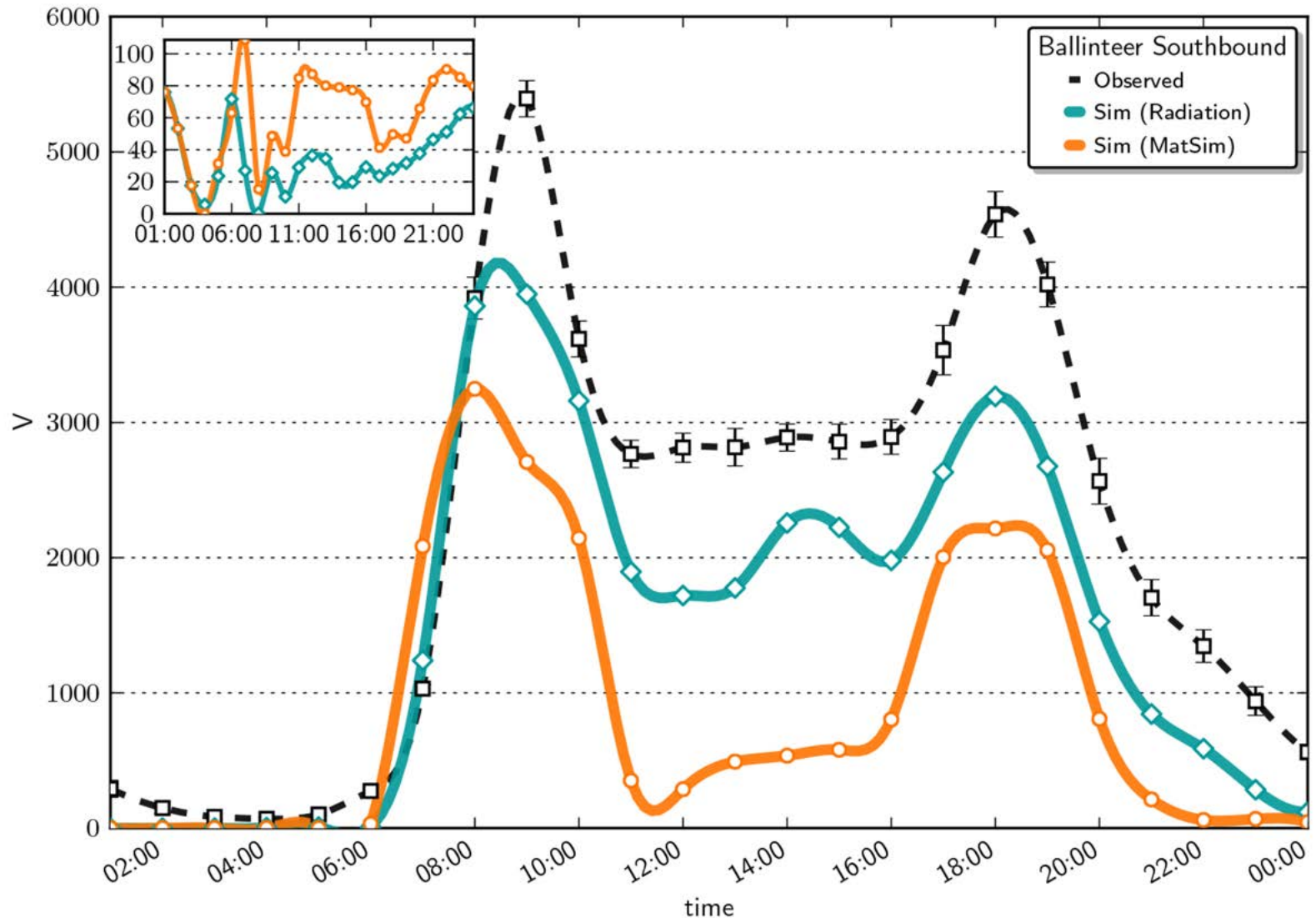Post 'Rush-
Hour'

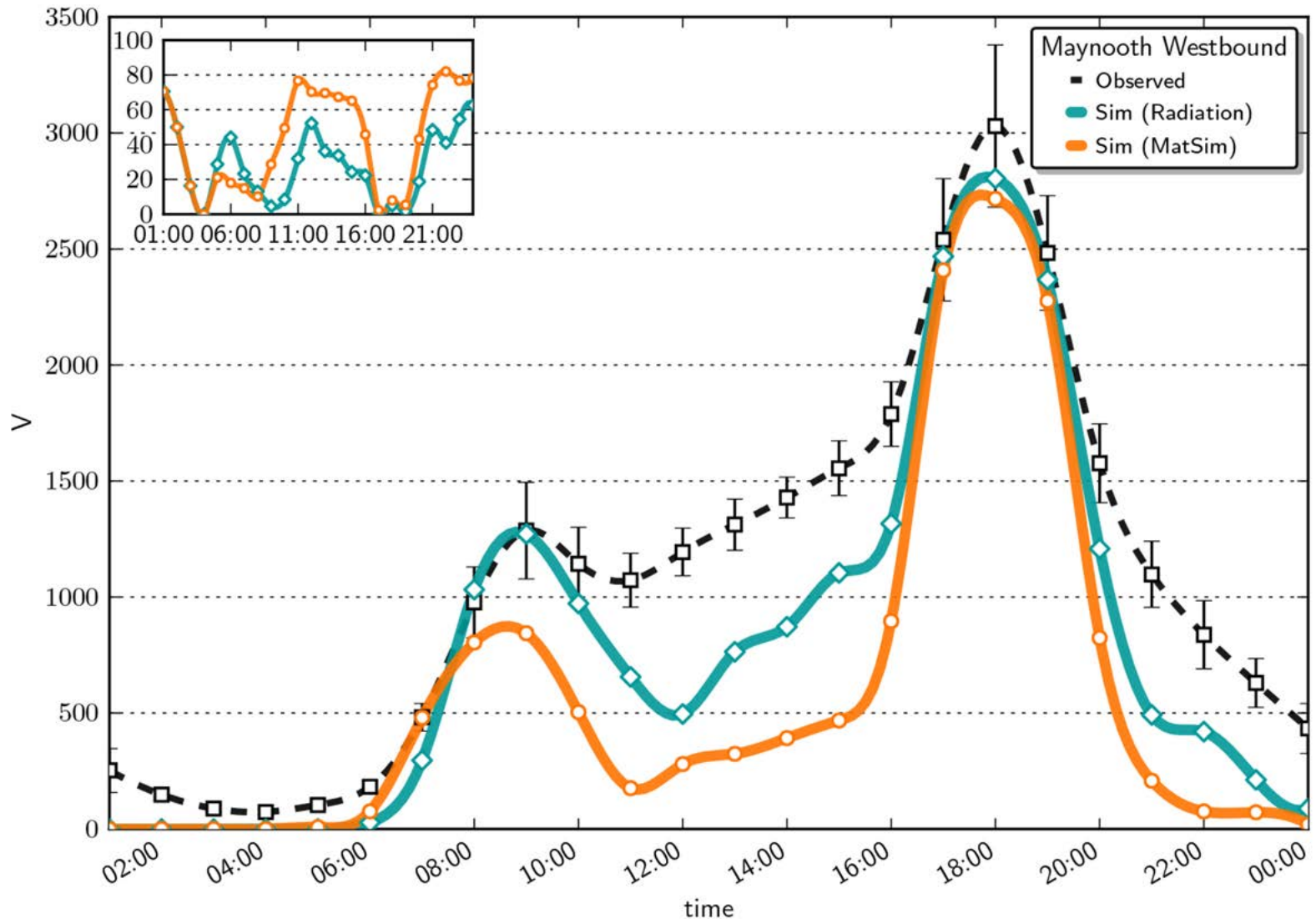# Output & Validation

Aggregated Counts over a 24 Hours

Blanchardstown Northbound

Ballinteer Southbound

Maynooth Westbound

Dublin Scenario Summary

Realistic large-scale traffic micro-simulation account for work, social and leisure related trips

- ? 500k individuals (~50% sample)
- ? Commute patterns from census data
- ? Social network from mobile phone logs
- ? Leisure and Shopping trips using radiation type model

Future work involves increasing the number of individuals

- ? Integrating new datasets
  - Public transport
- ? Handling weekend traffic and large events
- ? Investigating the role of habit
- ? Investigating the influence of social network on location choice
- ? Integration of EVs
  - Charing stations
  - Variable Road pricing
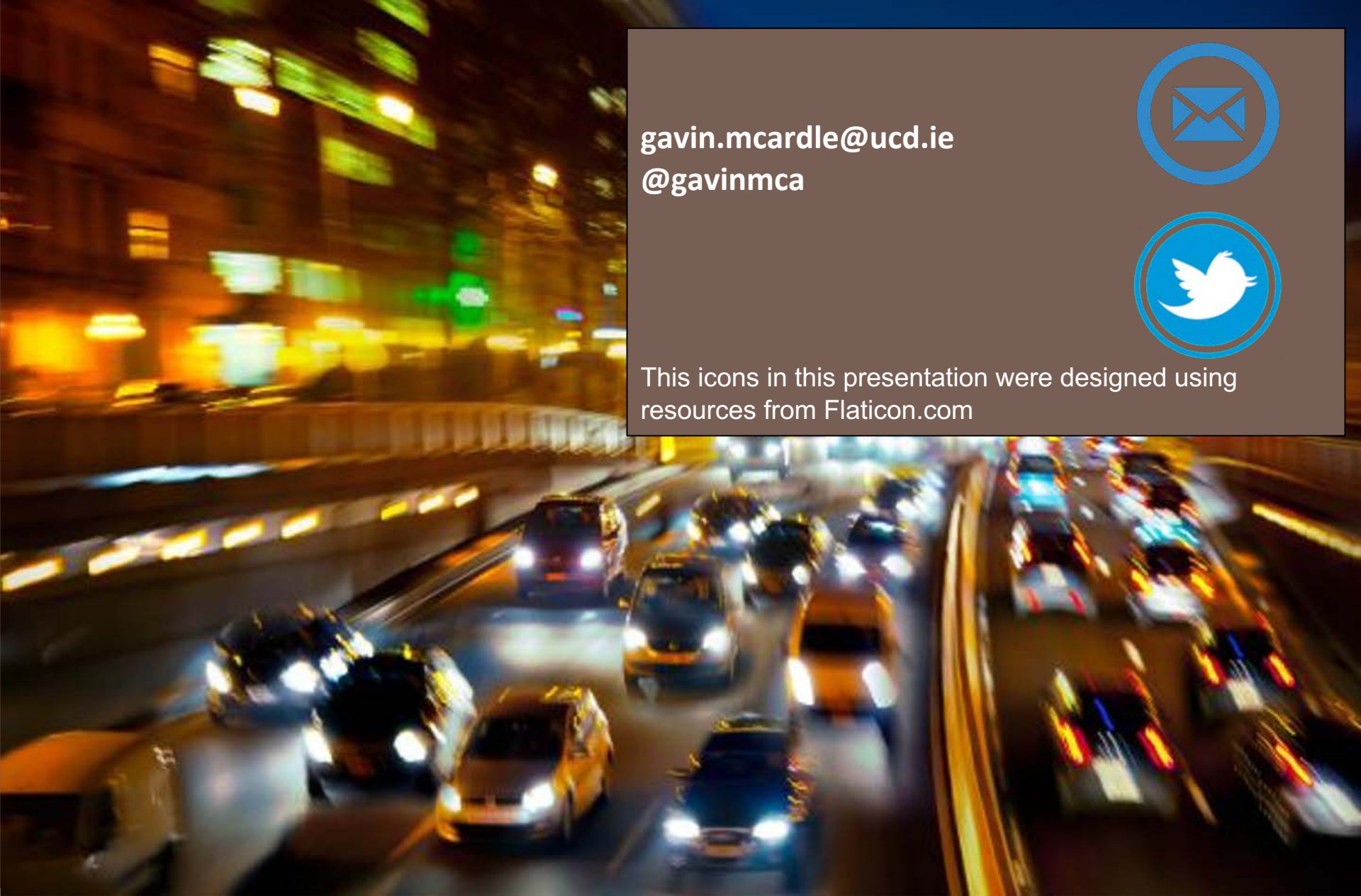
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@gavinmca

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