Decision Support Tool to unlock the potential of large-scale agent-based transport demand simulation for planning practice

Alex Erath, Michael van Eggermond, Pieter Fourie, Artem Chakirov

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Principles of agent-based transport modeling
Example of an agent’s daily activities and travel
Agent-based transport simulation for planning

Agent-based transport simulation for planning

Advantages

Full temporal dynamics
- Bunching phenomena
- Overcrowding of individual vehicles
- Time-dependent demand management

Agent-based paradigm
- Individuals
- Parcel or building (or unit) as base unit
- Interdependency of trips and activities, e.g. tour based mode choice

Challenges

How to deal with the wealth of data?
- Who?
- With how much time?
- What skills?
- New questions?
Current situation I

Network and moving vehicles

Highlight transport lines

Follow individual agents

Public transport demand analysis
Decision support system for transportation

Transport planners
• Effects of new bus services/network
• Impact of travel demand management schemes

Urban planners:
• Temporal patterns of buildings and neighbourhood
• Flow between public transport stops to surrounding buildings

Policy-makers
• Costs and benefits of a infrastructure measures?
• Who and where are the winners and losers?

Public transport operators
• Who profitable will a new line be?

Service industry
• Which customers are in catchment areas, separated by mode?
Requirements for DSS in transport planning

**Functional:**
- Appraisal
  - Cost-benefit
  - Winners and losers
- Scope
  - Journeys
  - Stages
  - Activities
- Temporal analysis
  - Full temporal resolution for filtering and aggregation

**Technical:**
- Database
  - Open source with open interface
  - Spatial queries
  - Flexible permission setting
- Front-end
  - Business analytics software for customisable and interactive analysis
  - GIS
General Framework
Case study: decision support tool for Singapore

Travel survey
- Re-coded into households, persons, trips, stages
- Survey database
  - Households
    - household_id
    - facility_id
    - income, car availability, etc.
  - Persons
    - person_id
    - household_id
    - income, tenure, etc.
  - Journeys
    - person_id
    - journey_id
    - mode, distance, duration, etc.
  - Stages
    - journey_id
    - stage_id
    - mode, distance, duration, etc.
  - Transfers
    - journey_id
    - transfer_id
    - waiting time, walk time, etc.
  - Activities
    - person_id
    - journey_id
    - activity_id
    - type, duration, timing, etc.

Spatial data
- Re-coded and deleted, retained
- Spatial database
  - Zones/aggregations
    - zone_id
    - area, name, other attributes.
  - Parcels
    - parcel_id
    - land use, area, etc.
  - Buildings/facilities
    - building_id
    - facility_id
    - mode id
    - activity capacity, dwelling types, number of units, etc.
  - Network links
    - link_id
    - land use, area, etc.
  - Transit stops
    - stop_id
    - travel, arrival, etc.
    - bus and rail stops

MATSim
- Converted into SQL records
- MATSim database
  - Households
    - household_id
    - facility_id
    - income, car availability, etc.
  - Persons
    - person_id
    - household_id
    - income, tenure, etc.
  - Journeys
    - person_id
    - journey_id
    - mode, distance, duration, etc.
  - Stages
    - journey_id
    - stage_id
    - mode, distance, duration, etc.
  - Transfers
    - journey_id
    - transfer_id
    - waiting time, walk time, etc.
  - Activities
    - person_id
    - journey_id
    - activity_id
    - type, duration, timing, etc.

Smart card
- Summarized as journeys, trips and transfers
- Transit smart card database
  - Persons
    - card_id
    - age, gender, home and work location
  - Journeys
    - journey_id
    - journey_id
    - mode, distance, duration, etc.
  - Stages
    - stage_id
    - activity_stop_id (bus & rail)
    - mode, distance, duration, etc.
  - Transfers
    - transfer_id
    - waiting time, walk time, etc.
  - Transit stops
    - card_id
    - transit_stop_id
    - total transfer time

SQL cross-joins and aggregations

Tableau visualization
Two case study applications

Comparison between modeled and actual travel demand patterns
- Data available from same data platform
- Public transport smart card transactions replicate level of disaggregation provided by agent-based transport simulation

Travel demand explorer
- Spatial selection
- Special focus
  - Mode share
  - Commuting trips
- Socio-demographics
Public transport trips data explorer
Travel demand explorer
Vision, Mission and Strategy

Vision
- Continuously updated data input
- Living (3d) city model to be maintain and shared data across stakeholders
- Automatic generation of MATSim ‘live’ scenarios

Mission:
- Developing the necessary tools to make MATSim more accessible for practitioners
- Engaging with practitioners in workshops to overlap of pressing needs with abilities new modelling technology offers

Strategy / Next steps
- Calibration and validation of MATSim Singapore with DSS
Connect and edit spatial database with Quantum GIS
Travel survey: reported vs MATSim routed

Travel Time

Travel Distance by Car

Main mode of travel
- Car Passenger
- Car Driver

Main mode of travel
- LRT
- Bus
- MRT

Invehicle distance by Public Transport

Distance under equilibrium conditions [m]

Distance for unloaded network [m]
Connect and edit spatial database with Quantum GIS
How do other disciplines deal with the problem?

1960: First Management Information Systems
   • Interactive analysis
   • Single decision maker

1970: Computer Based Systems to aid decision making
   • Databases and models
   • Financial planning

1980: Decision Support Systems (DSS)
   • Data -> Model -> management software for end user
   • Cognitive psychology and operations research join the club
How do other disciplines deal with the problem?

1990: Group decision support system
• Various stakeholders with different agendas

2000: Business intelligence
• Procter&Gamble links retail scanner data to DSS
• On-Line Analytical Processing (OLAP) for interactive analysis
• Linkage of various data sources, e.g. from different departments

2010: Visualisation
• Analyst circumvents data warehouse specialists
• External, interactive visualisation tools
• State-of-the–Arte visualisation principles