Leveraging GIS-data: The case of transport modeling

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What is the question for transport planning?
Which network? What grammars?

Ahmedabad

Source: Jacobs, 1993
Which network? What grammars?

Portland, OR

Source: Jacobs, 1993
Which network? What grammars?

Irvine

Source: Jacobs, 1993
What task does transport planning have as a science?
Who, were, when, why, and how?
and with an even higher spatial resolution
Starting point
Learning approach of the generic transport model

Competition for slots on networks and in facilities

Activity scheduling

Mental map

\[ q_i \equiv (t,r,j)_{i,n} \]

\[ k(t,r,j)_{i,n} \]
One approach: MATSim
MATSim evolutionary process

Read scenario
Generate initial demand (schedules)

Do until convergence

Select schedule to execute with a biased random approach
Execute schedules (traffic flow simulation)
Score all executed schedules
Add a new schedule to a random subset of the agents
Delete worst schedule, if necessary
MATSim in Switzerland: Initial demand

Population: Census-based (sample); Through traffic from surveys

Number, type, sequence and duration of activities:
• Conditional random draw from observed categorised MZ 2000-2005 distributions by person type

• Location of work/school activity:
  • Census commuter matrix

• Location of secondary activities:
  • Random constrained selection or
  • Capacity-constrained MNL within a time-space prism

• Mode choice:
  • MZ-based subtour MNL

• Route choice:
  • Improved A* shortest path
Capacity constrained MNL with time-space prism

Based on PPA-Algorithm Scott, 2006

„Implicit choice sets“
E.g.: Chains of consecutive shopping activities → recursion

\[ r = \frac{t_{budget}}{2} \ast V \]

Random choice
Check \( \sum t_{travel} \leq t_{budget} \)
Mode choice: Subtour

Subtour 1

Subtour 2

Subtour 3
MATSim in Switzerland: Iteration

Number and type of activities
Sequence of activities

- Start and duration of activity
  - Random mutation
  - Planomat: GA optimiser
- Composition of the group undertaking the activity
- Expenditure division
- Location of the activity

- Location of access and egress from the mean of transport
  - Parking type
- Vehicle/means of transport
- Route/service
- Group travelling together
- Expenditure division
MATSim in Switzerland: Traffic flow simulation

- Disaggregate simulation of car traffic
  - (Detailed signal control)
  - Detailed parking facilities
  - Detailed recharging facilities for electric vehicles

- Disaggregate simulation of public transport

- Disaggregate simulation of cyclists

- Disaggregate simulation of pedestrians
2009 MATSim Switzerland: $10^6$ agents, links and facilities
Quality of the results: Overall counts
Quality of the results: A1 at Winterthur (no transit traffic)
Next steps in Singapore for “Future Cities Laboratory”
Module VIII: Mobility and transport

• Implementing MATSim for Singapore
  • Networks
  • Facilities
  • Behaviour

• New methods
  • Optimal pricing
  • Longer term choices and supply responses
  • Social networks and their impacts
    • Based on a new survey in Singapore
Implementing MATSim: Access with 1/without transfer

Red: Direct from Treasury Auditorium; Green: 1 transfer
Implementing MATSim: HDB and private housing

Light brown: HDB; dark brown: Private
Implementing MATSim: Comparing the daily patterns

Data: travel diary 2008; public transport for one day in 2010

Trips involving bus and LRT or MRT
Implementing MATSim: Derived “waits” [min]; NS line

Waiting Times for North South MRT Line

<table>
<thead>
<tr>
<th>Station</th>
<th>Waiting Time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>STN Marina Bay</td>
<td>5.5</td>
</tr>
<tr>
<td>STN Raffles Place</td>
<td>5.0</td>
</tr>
<tr>
<td>STN City Hall</td>
<td>4.5</td>
</tr>
<tr>
<td>STN Dhoby Ghaut</td>
<td>4.0</td>
</tr>
<tr>
<td>STN Somerset</td>
<td>3.5</td>
</tr>
<tr>
<td>STN Orchard</td>
<td>3.0</td>
</tr>
<tr>
<td>STN Newton</td>
<td>2.5</td>
</tr>
<tr>
<td>STN Novena</td>
<td>2.0</td>
</tr>
<tr>
<td>STN Toa Payoh</td>
<td>1.5</td>
</tr>
<tr>
<td>STN Braddell</td>
<td>1.0</td>
</tr>
<tr>
<td>STN Bishan</td>
<td>0.5</td>
</tr>
<tr>
<td>STN Ang Mo Kio</td>
<td>0.0</td>
</tr>
<tr>
<td>STN Yio Chu Kang</td>
<td>0.0</td>
</tr>
<tr>
<td>STN Khatib</td>
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<tr>
<td>STN Yishun</td>
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<tr>
<td>STN Sembawang</td>
<td>0.0</td>
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<tr>
<td>STN Admiralty</td>
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<tr>
<td>STN Woodlands</td>
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<tr>
<td>STN Marsiling</td>
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<tr>
<td>STN Kranji</td>
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<tr>
<td>STN Yew Tee</td>
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<tr>
<td>STN Choa Chu Kang</td>
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<tr>
<td>STN Bukit Gombak</td>
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</tr>
<tr>
<td>STN Bukit Batok</td>
<td>0.0</td>
</tr>
<tr>
<td>STN Jurong East</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Data: Public transport usage data for one day in 2010,
Challenges for the Singapore implementation

• Further data enrichment, e.g.
  • Population distribution
  • School catchment areas
  • Fuller description of the destinations
  • Full day - diary
  • Freight traffic

• New capabilities, e.g.
  • Mode and destination choice under ERP
  • Longer term demographics of families (and firm)
  • Residential choice
  • Optimal pricing (ERP, public transport, parking)
Challenges for MATSim

- Content:
  - Integration of social networks
    - Their location
    - Their interaction
  - Supply side responses beyond pricing
  - Fully stage-based implementation

- Computation
  - Reduction of computation times
  - Parallel multi-modal flow simulation
  - Non-equilibrium updating
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