Agent Based Modeling in Transportation: the example of MATSim

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MATSim at a glance

- Implementation of a fully agent-based approach as part of a transport modeling tool
- Open source framework written in Java (GNU License)
- Started ~10 years ago, community is growing
- Developed by Teams at ETH Zurich, TU Berlin and Senozon AG
- [www.matsim.org](http://www.matsim.org)
MATSim applications around the world
• **MATSim Singapore 60FPS NEW TITLES.mkv**

(author: Pieter Fourie)
Case Study 1 – Road Pricing

Evaluation of a road pricing policy in Zurich:

- How would a toll to enter the city center between 3 and 7 pm affect daily traffic inside and outside the area?
Toll links
Traffic over the day

(author: Kai Nagel)
• Car Travel: base case

• Car Travel: city toll
Toll vs. no-toll
Case Study 2 – A new bypass

Evaluation of a new bypass in Zurich’s west side:

• Who would win and lose with the new infrastructure?
Current network

Colours: Allowed Speed; Thickness: # of Lanes
New network with bypass

Colours: Allowed Speed; Thickness: # of Lanes
New network with bypass and additional measures

Colours: Allowed Speed; Thickness: # of Lanes
Simulation results bypass

Daily Volumes: Difference with current situation

Bypass *without* additional measures

Bypass *with* additional measures

**Planned additional measures are impactful**

*Blue: Traffic reduction*

*Orange: Traffic increase on the Bypass*
Simulation results bypass

Daily Volumes: Difference with current situation

Bypass **without** additional measures

Traffic Lights
Strengthen the impact of the infrastructural additional measures

Bypass **with** additional measures
Winners and Losers: Travel Time
Winners and Losers: MATSim Score (Utility)
Evaluation of a new free-floating carsharing service:

- How would different pricing strategies affect demand for a newly introduced free-floating carsharing?
<table>
<thead>
<tr>
<th></th>
<th>Scenario I</th>
<th>Scenario II</th>
<th>Scenario III</th>
<th>Scenario IV</th>
<th>Scenario V</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB Time Fee</td>
<td>2.80 SFr./h</td>
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</tr>
<tr>
<td>SB Distance Fee</td>
<td>0.60 SFr./Km</td>
<td>0.60 SFr./Km</td>
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<td>0.60 SFr./Km</td>
<td>0.60 SFr./Km</td>
</tr>
<tr>
<td>FF Time Fee</td>
<td>-</td>
<td>0.37 SFr./min</td>
<td>0.185 SFr./min</td>
<td>0.185 SFr/min (10-16)</td>
<td>0.185 SFr/min (16-10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.37 SFr/min (rest of day)</td>
<td>0.37 SFr/min (rest of day)</td>
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</tbody>
</table>
Carsharing Vehicles in Motion

Scenario II - FF Full Price

Scenario III - FF Half Price

Scenario IV - Half Price 10am to 4pm

Scenario V - Half Price 4pm to 10am
Rentals spatial patterns
## Purpose of the rental

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</thead>
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<tr>
<td>RT Work</td>
<td>3h14'57&quot;</td>
<td>3h29'36&quot;</td>
<td>3h07'49&quot;</td>
<td>3h37'12&quot;</td>
<td>3h21'22&quot;</td>
</tr>
<tr>
<td>RT Shop</td>
<td>-</td>
<td>6h21'10&quot;</td>
<td>6h40'43&quot;</td>
<td>6h09'14&quot;</td>
<td>6h52'02&quot;</td>
</tr>
<tr>
<td>RT Leisure</td>
<td>3h37'16&quot;</td>
<td>5h37'24&quot;</td>
<td>5h37'32&quot;</td>
<td>5h37'59&quot;</td>
<td>5h37'25&quot;</td>
</tr>
<tr>
<td>RT Education</td>
<td>3h57'16&quot;</td>
<td>5h37'24&quot;</td>
<td>5h37'32&quot;</td>
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**Legend:**
- I
- II
- III
- IV
- V

**Note:**
- RT: Retail Trade
- FF: First Floor
- CS: Car Sharing
- Car: Private Car
Questions?

MATSim @ ETHZ, TU Berlin, FCL, Senozon (present)

Prof. Kay Axhausen
Milos Balac
Dr. Michael Balmer
Henrik Becker
Patrick Bösch
Artem Chakirov
Dr. Francesco Ciari
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Thibaut Dubernet
Dr. Alexander Erath
Dr. Gunnar Flötteröd
Pieter Fourie
Prof. Kai Nagel
Kirill Müller
Dr. Andreas Neumann
Benjamin Kickhöfer
Sergio Ordonez
Dr. Marcel
Rieser
Lijun Sun
Michael Van Eggermond
Dominik Ziemke
Michael Zilske
Macro-Simulation vs. Micro-Simulation

• Macro-Simulation
  – Based on aggregated data
  – Flows instead of individual movement
  – Often planning networks

• Micro-Simulation
  – Population is modeled as a set of individuals
  – Traffic flows are based on the movement of single vehicles (or agents) and their interactions
  – Various traffic flow models, e.g. cellular automata model, queue model or car following model
  – Often high resolution networks (e.g. in navigation quality)
• A MATSim scenario contains some mandatory as well as some supplementary data structures

• Mandatory
  – Network
  – Population

• Supplementary
  – Facilities
  – Transit (Schedule, Vehicles)
  – Counts
Performance - Scenario

• Transportation system in Switzerland
• 24 h of an average Work-day

• 5.99 Mio Agents
• 1.6 Mio Facilities for 1.7 Mio Activities (5 Types)
• Navigation network with 1.0 Mio Links
• 4 Modes (others optional → i.e. shared modes)
• 22.2 Mio Trips
• Routes-, Time-, (Subtour-)Mode- und „Location“-Choice

➔ One Iteration in ca. 4.5 hours