Patterns of daily movement: An agent-based model of Switzerland

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Why transport planning/traffic engineering?

• Provide forecasts of the changes in use and impact of transport system change (short term to long term)

• Assess the economic viability of those changes (social benefit or individual/firm benefit)

• Provide input into the political assessment of projects and service changes

• Optimise the operation of the systems (social costs)
A peak hour
Conceptual understanding

- Personal worlds of others
- Social capital: stock of joint abilities, shared histories and commitments
- Biography
- Personal world
- Projects
- Learning
- Household locations
- Social network geography
- Mobility tools
## Time horizons of transport planning

<table>
<thead>
<tr>
<th>Time horizon</th>
<th>System</th>
<th>Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term</td>
<td>Slots</td>
<td>Home/work location</td>
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<tr>
<td></td>
<td>Regulation</td>
<td>Car ownership</td>
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<td></td>
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<td>Social networks</td>
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<tr>
<td>Medium term</td>
<td>Services offered</td>
<td>Season tickets</td>
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<td></td>
<td>Prices</td>
<td>Projects</td>
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<tr>
<td></td>
<td>Awareness</td>
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</tr>
<tr>
<td>Short term</td>
<td>Operation</td>
<td>Daily schedule</td>
</tr>
</tbody>
</table>
Generalized cost function of the schedule

Risk and comfort-adjusted weighted sum of times, expenditures and social content of activities and travel:

\[ U_{plan} = \sum_{i=1}^{n} U_{act,i} + \sum_{i=2}^{n} U_{trav,i-1,i} \]

\[ U_{act,i} = U_{dur,i} + U_{late.ar,i} \]
Choices currently modelled in MATSim-T

- Number and type of activities
- Sequence of activities

- Start and duration of activity
- Composition of the group undertaking the activity
- Expenditure division
- Location of the activity

- Connection between sequential locations

- Location of access and egress from the mean of transport
- Vehicle/means of transport
- Route/service
- Group travelling together
- Expenditure division
What does MATSim-T do?

Demand $q$ are the $i^{th}$ movements of person $p$ from the current location at time $t$ on route (connection) $r$ to location $j$. The resulting generalised costs $k$ are used to adjust the schedules and to change the capacities $C$ and prices $P$ of facilities $f$. 
What does it return?

<person id="22018">
  <plan score="157.72" selected="yes">
    <act type="h" x="703600" y="236900" link="5757" end_time="07:35:04" />
    <leg num="0" mode="car" dep_time="07:35:04" trav_time="00:16:31">
      <route>1900 1899 1897</route>
    </leg>
    <act type="w" x="702500" y="236400" link="5749" dur="08:12:05" />
    <leg num="1" mode="car" dep_time="16:03:40" trav_time="01:10:22">
      <route>1899 1848 1925 1924 1923 1922 1068</route>
    </leg>
    <act type="l" x="681450" y="246550" link="2140" dur="01:20:00" />
    <leg num="2" mode="car" dep_time="" trav_time="00:34:35">
      <route>1067 1136 1137 1921 1922 1923 1925 1848 1899</route>
    </leg>
    <act type="h" x="703600" y="236900" link="5757" />
  </plan>
</person>
MATSIM-T: Steady-state version

- Scale:
  - 7.5 mio agents,
  - 2 mio homes
  - 1 mio facilities
  - 1 mio links and nodes

- Continuous time resolution: Seconds
- Spatial resolution: Address (individual facilities)
Example: 3% of Swiss population
Example: Computing times by step

<table>
<thead>
<tr>
<th>Operation</th>
<th>Unit</th>
<th>Units/sec</th>
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</thead>
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<tr>
<td>Initial demand</td>
<td></td>
<td>0.12h</td>
</tr>
<tr>
<td>Scheduling (fixed components)</td>
<td></td>
<td>14.40h</td>
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<tr>
<td>Scheduling (planomat)</td>
<td>Agent</td>
<td>100</td>
</tr>
<tr>
<td>Scheduling (routing)</td>
<td>Agent</td>
<td>1000</td>
</tr>
<tr>
<td>Time-step based traffic flow simulation</td>
<td>Agent</td>
<td>300</td>
</tr>
<tr>
<td>Learning</td>
<td>Agent</td>
<td>250’000</td>
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<tr>
<td>Total iteration (with I/O)</td>
<td></td>
<td>0.22h</td>
</tr>
<tr>
<td>Total run (with I/O) (100 iterations)</td>
<td></td>
<td>23h</td>
</tr>
</tbody>
</table>
Example: Score/generalised costs by iteration
Westumfahrung Zürich: Before
Validation of status-quo
Westumfahrung Zürich: After
Outlook: Exploit the existing (coming) data wealth

Adapted from Botte, 2003
Outlook: Integration of supply side actors

Adapted from Botte, 2003
Outlook: Joint choice and information flow
Outlook

- Stability of simulation with multiple actor types
- Path dependence
- Development of crisis
- Validation
- Computing times
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