Modelling Shared Autonomous On-Demand (Transit) Services

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Modeling AV Demand

[Graph showing the relationship between wait time and fleet size on the left, and demand on the right.]
Modeling AV Demand

How can we model the dynamic demand?
Modeling AV Demand

1) Behavioral model

2) Cost of using the service

3) Simulation framework
Behavioral model - AV Survey

- Fleet introduced: Two weeks ago
- Weather: 20°C
- Mobility tools: Priv. aut. car, car, Half-fare card
- Provided trip: Work

<table>
<thead>
<tr>
<th>Currently chosen</th>
<th>Automated</th>
<th>Automated</th>
<th>Automated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>Automation car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Pooled Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi Service</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Main transport mode</th>
<th>Feeder</th>
<th>Total travel time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>Car</td>
<td>00:30 h</td>
</tr>
<tr>
<td>Private automated car</td>
<td></td>
<td>00:30 h</td>
</tr>
<tr>
<td>Bus / tram</td>
<td></td>
<td>01:36 h</td>
</tr>
</tbody>
</table>

| Time in main transport mode | 00:06 h | 00:40 h | 00:20 h |
| Time in feeder           | 00:20 h |
| Time waiting / transferring | 00:12 h | 00:04 h | 00:05 h |
| Access and egress time   | 00:30 h |
| Transfers                | 1       |
| Frequency                | 00:16 h |

Variable costs:
- 7 CHF, 7 CHF, 3 CHF, 7 CHF, 12 CHF

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AV Cost Estimation

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Regional</th>
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<tbody>
<tr>
<td>Rail</td>
<td>0.53</td>
<td>0.47</td>
<td>0.44</td>
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<tr>
<td>Bus</td>
<td>0.24</td>
<td>0.4</td>
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<tr>
<td>Ind. Taxi</td>
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<td>1.92</td>
<td>0.32</td>
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<tr>
<td>Pooled Taxi</td>
<td>1.61</td>
<td>1.13</td>
<td>0.21</td>
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<tr>
<td>Private Car</td>
<td>0.48</td>
<td>0.48</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Steering
- Autonomous
- Not autonomous

CHF per passenger kilometer

Simulation Framework

**Cost calculator**
- Price

**Plan modification**
- Discrete Mode Choice Extension
- Mobility simulation

**Prediction**
- Utilization
- Empty distance, ...
- Travel times
- Wait times, ...

**MATSim**
Multi-Agent Transport Simulation
Single-occupancy AV Taxi Demand in Paris

Setup:
• 2.4Mil trips
• Mode-choice
• Cost estimate

Single-occupancy AV Taxi Demand in Paris

Results:
Results:
• Maximum demand of 2.3 Mil is never reached

• Optimal price of 0.3 EUR/km is very close to the marginal cost of car ownership

• Currently, mode-share of car trips in the city of Paris is around 10%, which means that AMoD service brings a substantial shift to car travel, causing undesirable effects
Automated Transit on-demand Service

Service characteristics:
• PUDO locations
• No detours
• Defined frequency

Modelling characteristics:
• No mode-choice
• No cost
• Replacement of all car trips
• Optimization of fleet size and VKT
Results:

- Without pooling the fleet to serve the demand is 11-18 times smaller (VKT increases between 3 and 24%)

- With max 2-person pooling, fleet can be reduced by a factor of 20 (VKT is slightly reduced as well)

- Finally with a mixed fleet, the fleet can be reduced by a factor of 27 (VKT drops as well by up to 10%)
Automated Transit on-demand Service

Service characteristics:
- PUDO locations
- No detours
- Defined frequency

Modelling characteristics:
- Mode-choice (wait time, travel time, cost)
- Optimization of fleet size and VKT
- Two scenarios
Results:

- Scenario I: with pooling and mixed fleet, we have a **vehicle replacement rate of 4:1** (VKT increases by 6%), with total fleet reduction of 16% (with AToD mode share of 24%)

- Scenario II: if we protect areas with high PT accessibility, we can achieve a **vehicle replacement rate of 10:3** (VKT increases by 5%), with total fleet reduction of 6.4%

- Charging users more in the urban core the possibilities for pooling all but vanishes
Conclusion

- We urgently need to think about policies in the world of AVs

- The proposed framework can help us to better understand the impacts of those policies
Questions?