Preferred citation style for this presentation

Can Pseudo-Simulation be used for Modelling Parking Search?

Rashid A. Waraich

IVT
ETH
Zurich

April 2014
Motivation

• Parking search traffic can be substantial (average 30%, 16 cities, D. Shoup, 2007)
• Parking supply and price can have impact on e.g. mode and destination choice
• Parking model should be able to help design parking policies
How is agent-based parking search modelled till now?

- In Benenson et al. (2008) PARKAGENT is presented:
  - residential parking
  - agent’s enter simulation close to destination
  - decision in each time step (park or not)
  - take any parking, after destination link
  - max. search time 10min: drive to closest off-street parking
What are the challenges? What is missing?

- Treating off-street parking ALWAYS as a last option
  - over-estimation of parking search time
- Only look at residential parking search
- Just one single strategy for all people
- What is strategy based on?
Multiple Parking Strategies

Axhausen and Polak (1989):

- First comes parking strategy choice
- Group discussions/surveys: 7 search strategies
  - E.g. high probability parking set
  - Anchor: off-street parking and use on-street parking, if opportunity arises
  - Circle around destination
  - Illegal parking
  - Combinations
- Survey to find out which strategies used in Karlsruhe/Birmingham?
General Structure of Parking Search Strategies

approaching destination

proactive strategies start operation already before reaching destination

Backup strategy starts operation (mostly random or garage)
Instantiation of Parking Strategy
Utility Function

\[ U_{parking,i} = U_{P_{cost},i} + U_{P_{searchTime},i} + U_{P_{walk},i} + \epsilon_i \]  \hspace{1cm} (1)

\[ U_{plan,i} = \sum U_{travelTime,i} + U_{travelCost,i} + U_{performActivity,i} + \ldots + \sum U_{parking,i} \] \hspace{1cm} (2)

Utility function used: Weis et al. (2013)

- Sensitive to policy changes
  - Price change
  - Supply/capacity change
  - Restricting allowed parking time (e.g. max. parking)
  - Increased law enforcement
Optimization (similar to MATSim)

<table>
<thead>
<tr>
<th>iteration</th>
<th>executed</th>
<th>memory (max size=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>-5.1 A1</td>
</tr>
<tr>
<td>2</td>
<td>B1</td>
<td>-5.1 -2.7 A1 B1</td>
</tr>
<tr>
<td>3</td>
<td>C1</td>
<td>-5.1 -2.7 -6.3 A1 B1 C1</td>
</tr>
</tbody>
</table>

memory initialization completed; continue with 80% MNL; 20% new strategy

4  | MNL      | B1                      |
| 5  | new instance | D1                      |
| 6  | new instance | A2                      |

<table>
<thead>
<tr>
<th>memory</th>
<th>size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>B1</td>
</tr>
<tr>
<td>C1</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>B1</td>
</tr>
<tr>
<td>C1</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>B1</td>
</tr>
<tr>
<td>A2</td>
<td></td>
</tr>
</tbody>
</table>

worst instance dropped
First attempt

QSim + withinday + parking search

new physical simulation

Issues:
- Performance
- Parallelization/low resolution network/sampling not an option
Pseudosimulation (Psim)

(Fourie et al., 2013)
MATSim Simulation with Parking Search

Physical Simulation (e.g. Qsim or JDEQSim)

update link travel time matrix of PSim each n-th iteration

PSim + within day + parking search

physical simulation not directly connected to MATSim events anymore

new simulation
Performance Gains

• Scenario: ca. 10% scenario of area of interest around ZH city center; ca. 40’000 agents, high resolution network

• With Qsim + Withinday + parking search:
  ⇒ 33 min per iteration only simulation (mid. 2012)
  ⇒ estimated run-time for 100% run with 100 iterations: 3 weeks

• New Implementation (PSim + within day + JDEQSim):
  ⇒ ca. 80s per Iteration (only simulation)
  ⇒ estimated run-time for 100% run with 100 iterations: 1 day

⇒ 100% scenario possible
⇒ Qsim run, which is needed from time, to time not considered yet
⇒ There is potential left: Only those parts parallelized, which are easy to implement (E.g. re-routing) – simulation itself is not parallelized yet
Experiments

- We have implemented around 15 strategies – mostly based on ideas from Axhausen and Polak (1989) + Park Agent + other Heuristics
- Acknowledgment: Shyam Ranganathan (Uppsala, Sweden)
- Preliminary results: Not calibrated yet (especially private parking)
- Scenario: Zürich – replanning only for parking search strategies – other replanning fixed
Parking Strategy Shares

Parking Strategy Group Shares (without PrivateParking)
Typical Score Graph

![Parking Strategy Score Graph]

- Score vs Iteration
- Lines represent:
  - average best
  - average executed
  - average worst
  - average average
Strategy Quantity vs. Quality

• Only two strategies (scenario A):
  – Take closest garage parking at destination
  – Random parking search after reaching destination

• 10 strategies (scenario B):
  – All strategies represented from Axhausen and Polak (1989) + Park Agent + 2 others
Strategy Quantity vs. Quality (con’t)
Parking Search Traffic

(preliminary results: 10% scenario; not calibrated)
# Parking Activity Properties

<table>
<thead>
<tr>
<th>Parking Type</th>
<th>Walk Distance [m]</th>
<th>Search Time [s]</th>
<th>Cost [CHF]</th>
<th>Activity Duration [s]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>sd</td>
<td>mean</td>
<td>sd</td>
</tr>
<tr>
<td>Illegal</td>
<td>87.4</td>
<td>83.22</td>
<td>22.39</td>
<td>44.14</td>
</tr>
<tr>
<td>Street</td>
<td>162.77</td>
<td>182.40</td>
<td>120</td>
<td>1209.5</td>
</tr>
<tr>
<td>Private</td>
<td>87.6</td>
<td>69.54</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Garage</td>
<td>330.1</td>
<td>1087.2</td>
<td>80.97</td>
<td>161.52</td>
</tr>
<tr>
<td>Public Outside</td>
<td>115.2</td>
<td>116.21</td>
<td>24.7</td>
<td>44.48</td>
</tr>
<tr>
<td>Zurich</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Future Work: Toll Pricing & Parking Search

• Toll aware parking strategies => try to park vehicle outside toll area walk from there
• => see, how this strategy competes with other strategies
Future Work: Integration

Physical Simulation (e.g. Qsim or JDEQSim)

PSim + withinday + parking search

new simulation

update link travel time matrix of PSim each n-th iteration

only parking search strategy change
Conclusions / Future Work

• After long detour – some hope and progress
• Calibration – do experiments again
• Stepwise Integration in MATSim
  – replanning modules
  – calling physical simulation
  – integrate in existing contrib «parking»
Questions?
References


