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Modelling Parking Search Behaviour with an Agent-Based Approach

Rashid A. Waraich

IVT
ETH
Zurich

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Outline

• Motivation
• Example agent-based parking search model
• Challenges
• Proposed parking choice and search framework
• Current status of the work
• Conclusions
Motivation

- Parking supply and price have impact on e.g. mode and destination choice
- Can't model parking policy changes without it
- Search traffic can be substantial (average 30%, 16 cities, D. Shoup, 2007)
- Necessary for modelling the parking/charging demand by electric and plug-in hybrid electric vehicles
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 resort
  - limited notion of agent's taste heterogeneity
  - over-estimation of parking search time
- No impact of parking shortage on mode or destination choice
MATSim
Simulation
MATSim

initial demand → simulation → scoring → relaxed demand

replanning
Current MATSim parking model

original MATSim plan

adding parking acts + walk legs

car

walk

P

car

walk
Multiple parking choices/strategies available

User defines, which agent can use which strategies at which activity. Example:

**home**: search for street parking (non-metered) - as agent has residence parking card for area close to home.

**work**: drive to parking provided by company - no parking search needed

**shop**: 4 parking strategies available:
- search for street parking only (free + metered)
- garage parking
- combined street parking search with last resort garage parking
- illegal parking
Utility Function

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

\[ U_{plan,i} = \sum U_{travelTime,i} + U_{travelCost,i} + U_{performActivity,i} \cdots + \sum U_{parking,i} \] (2)
Requirements for parking strategy optimization

• At end of simulation with high probability (>90%) optimal parking strategy selected
• Allow system to «relax» (similar condition to MATSim replanning).
• Periodic re-evaluation of parking strategy with «fresh/updated» environment
Parking strategy optimization algorithm

parking strategies available for activity: s₁, ..., sₙ;
initial score of each strategy is ←∞;
for first iteration, select strategy at random

execute traffic simulation
(including selected parking strategies)

assign parking score to strategy
and overall MATSim score

select strategy with
highest score

if t mod k is zero

no

select parking strategy which has not been executed for the longest time

yes

next iteration (t+1)
Policy change example

AT WORK

just one parking strategy: use company provided parking

new policy: no free parking for employees any more

three parking strategies:
- rent parking from company
- search free and metered on-street parking
- search off-street parking

(mode change, arrival time change, etc.)
Current implementation status

- Framework implemented
  - optimal parking choice (all parking)
  - (private parking)
  - optimal garage parking
  - random parking search
  - in development: real parking strategies as reported

- Calibrating Zurich scenario
Zurich scenario

- Street parking tariff zones
- Parking garage prices
- Price structure
- Occupancy counts data
Parking infrastructure supply model

Public Parking
- street parking (49'409)
- garage parking (16'277)

Private Parking
- Indoor (118'531)
- Outdoor (82'781)

[Source: Parking counts from «Statistisches Jahrbuch der Stadt Zürich 2011»]
In C. Weiss et al. (2012) a stated choice survey was conducted and a model estimated for the influence of parking on location and mode choice:

Model estimated with following depends on:
- income
- age
- gender
- activity duration
Conclusions

• Optimization of multiple parking choices/strategies
  • avoiding systematic overestimation of parking search time
• Taking taste heterogeneity into account
• Parking model has impact on mode and destination choice (and other MATSim replanning modules)

Future work:
• Implementing parking strategies
• Running on Zurich scenario
Questions?