Bridging discrete mode choice models and microsimulation in MATSim

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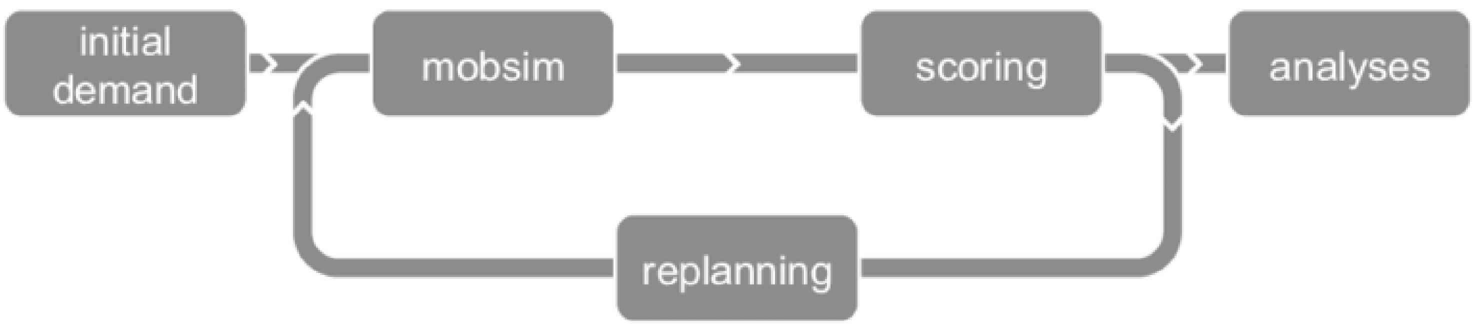
What is MATSim?

- Open-source transport simulation software
- Agent-based
- Uses a co-evolutionary approach
- Data driven
- Suitable for simulation of emerging mobility options and policies
- Jointly developed by TU Berlin and ETH Zurich

MATSim Loop



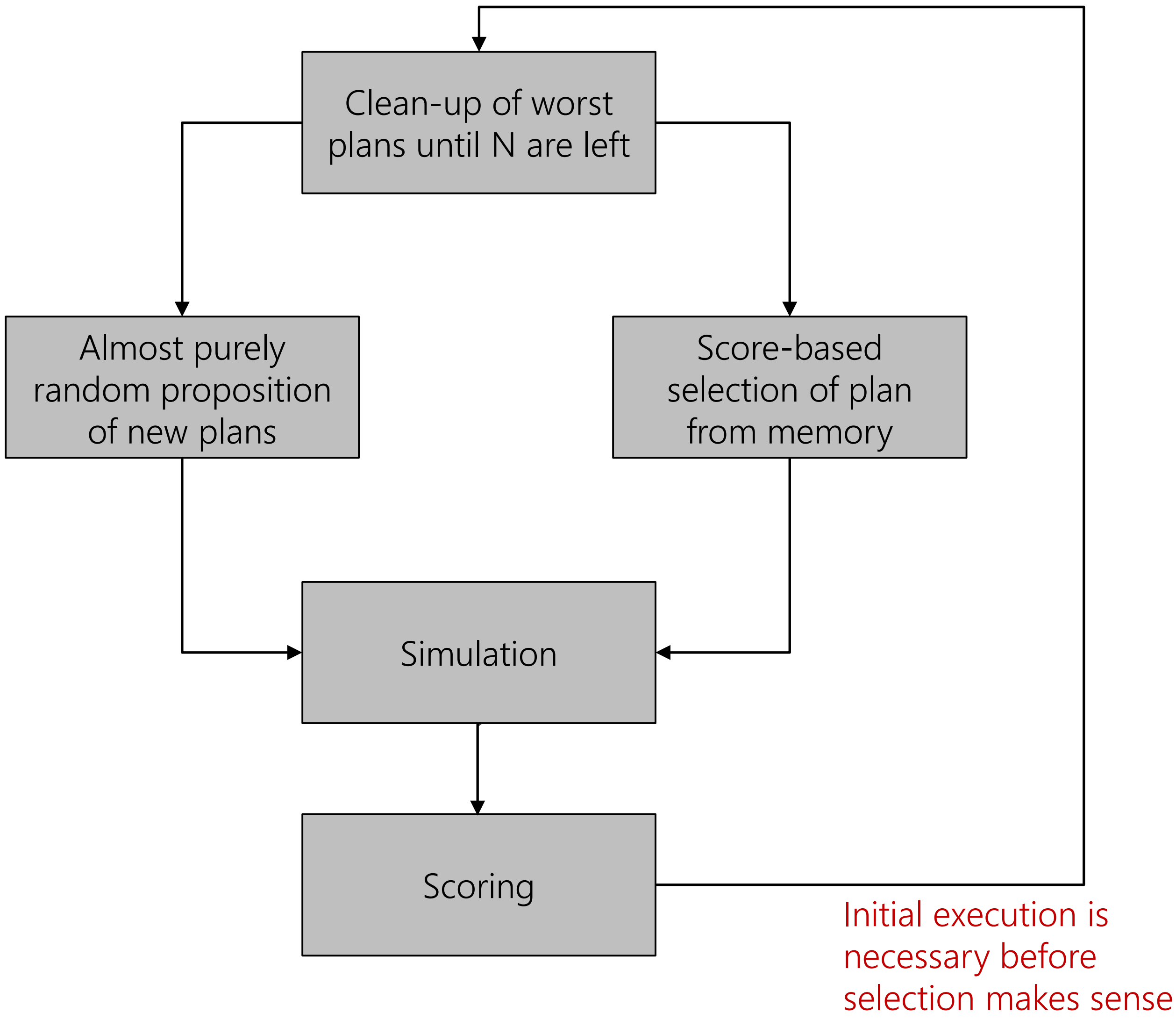
Motivation

- Much work and effort has been put into choice modeling at IVT

- Discrete choice models are readily available
  - National travel diaries – RP (SP)
  - Autonomous vehicles – SP
  - Post car world

- How to make use of them in MATSim?

Mode choice in MATSim



First idea of integration

- Selection between chains

- Two components:
  - Choice set generation
  - A priori mode choice based on estimated travel characteristics

Choice set generation

- Obtain the set of all possible chains of modes for a given chain of trips with origin and destination
  - Constrained by agent-level attributes (e.g. car availability)
  - Constrained by continuity constraints (e.g. vehicle location)

- Maximum set: $|C| = M^N$

- Feasible set: $\left|C_f \subset C\right| = M^N - q$

Selection procedure

Three + one (-imperfect) approaches:

Best response selection:

$$k = \text{argmax}\{\tilde{u}_1, \dots, \tilde{u}_K\}$$

Total chain utility sampling:

$k = \text{argmax}\{\tilde{z}_1, \dots, \tilde{z}_K\}$ with $\tilde{z}_k = \sum_i u_{k,i} + \varepsilon_{k,i}$ and $\varepsilon_{k,i} \sim \text{Gumbel}$

Naïve chain sampling:

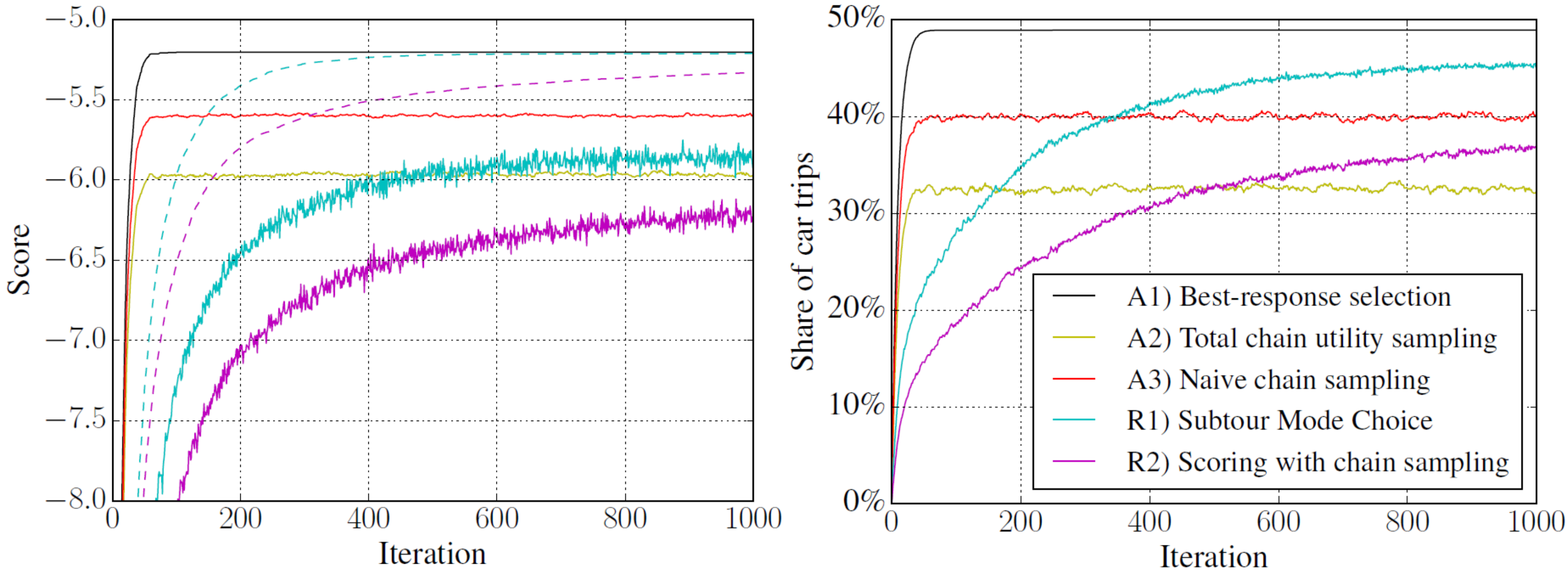
$$k = \text{Cat}(\tilde{\pi}_1, \dots, \tilde{\pi}_k) \qquad \tilde{\pi}_k = \tilde{w}_k / \textstyle\sum_{k'} \tilde{w}_{k'} \qquad \tilde{w}_k = \prod_i \pi_{k,i}$$

First simulation results

Teleportation-based simulation

Best-response is upper bound

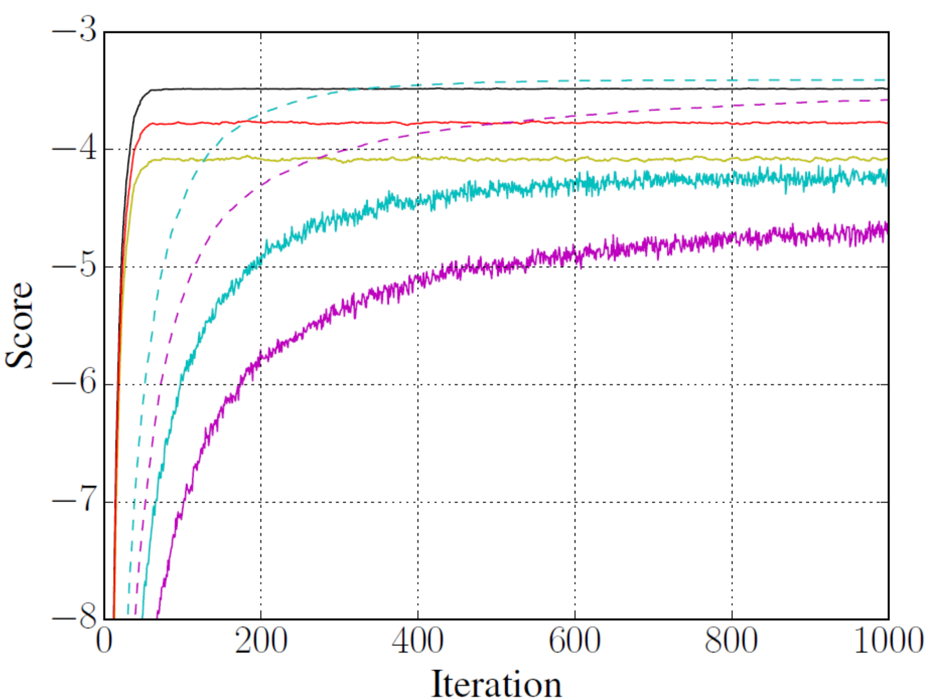
Fast convergence for tested approaches vs SMC

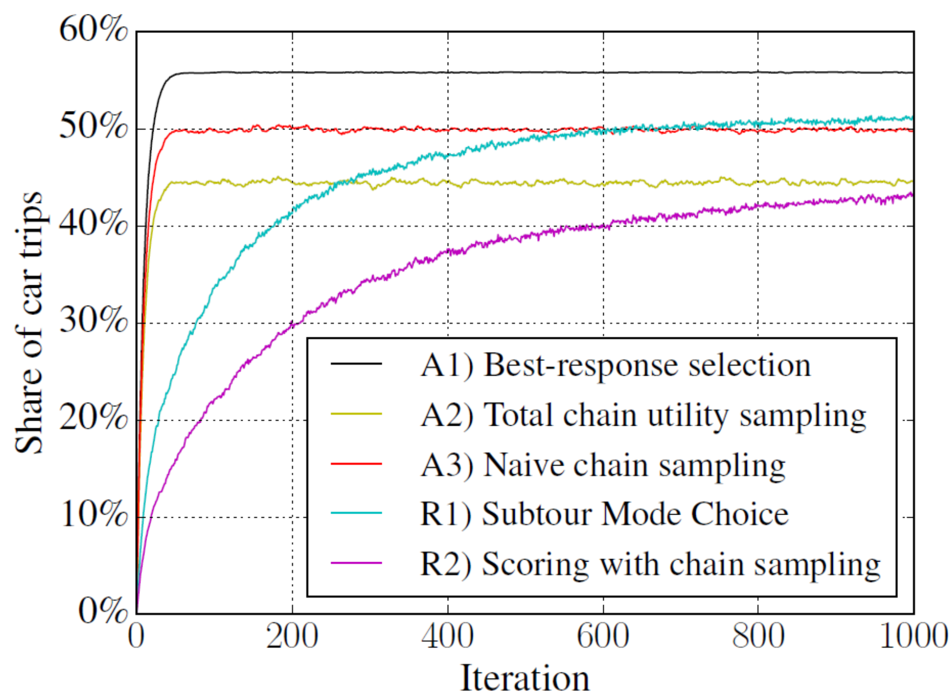


First simulation results

Network-based simulation

Best-response is **not** upper bound



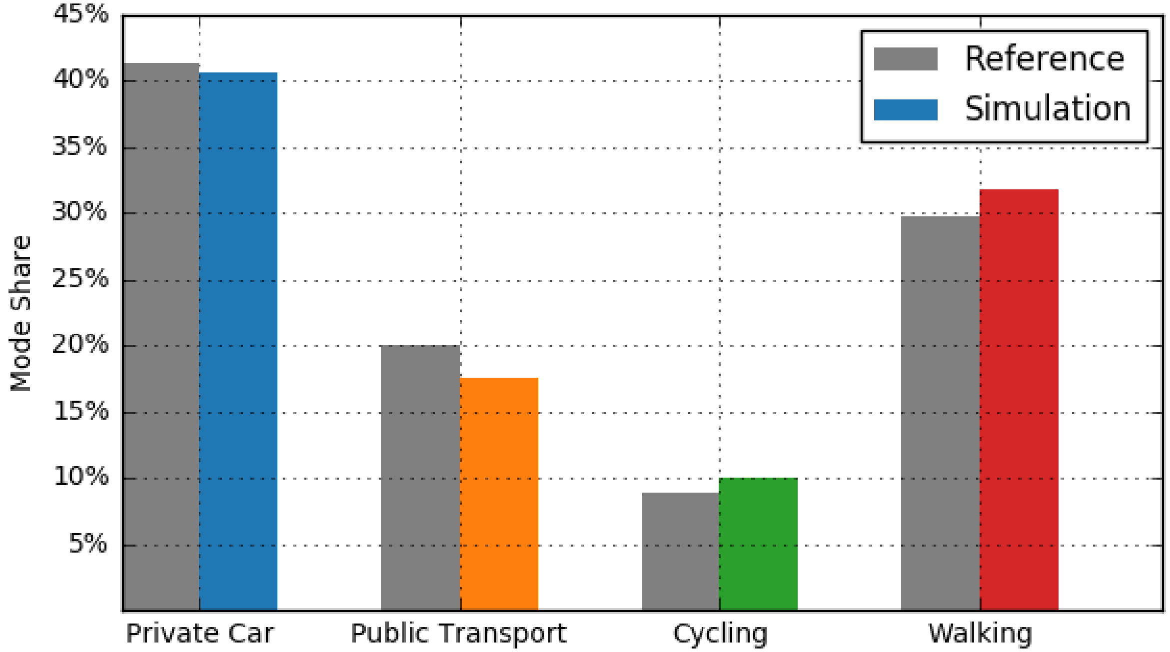


That one approach missing

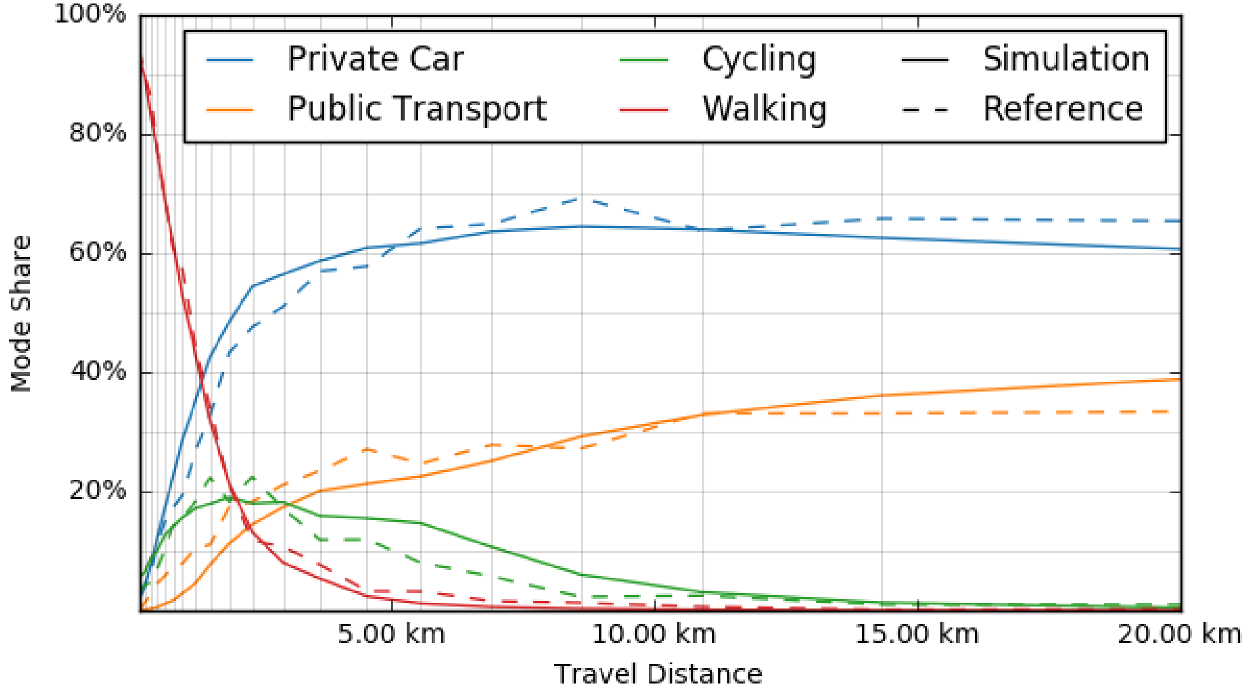
Multinomial chain sampling:

$$k = Cat(\pi_1, \dots, \pi_k) \qquad \pi_k = \frac{e^{U_k}}{\sum_m e^{U_m}} \qquad U_k = \sum_n U_{k,i}$$

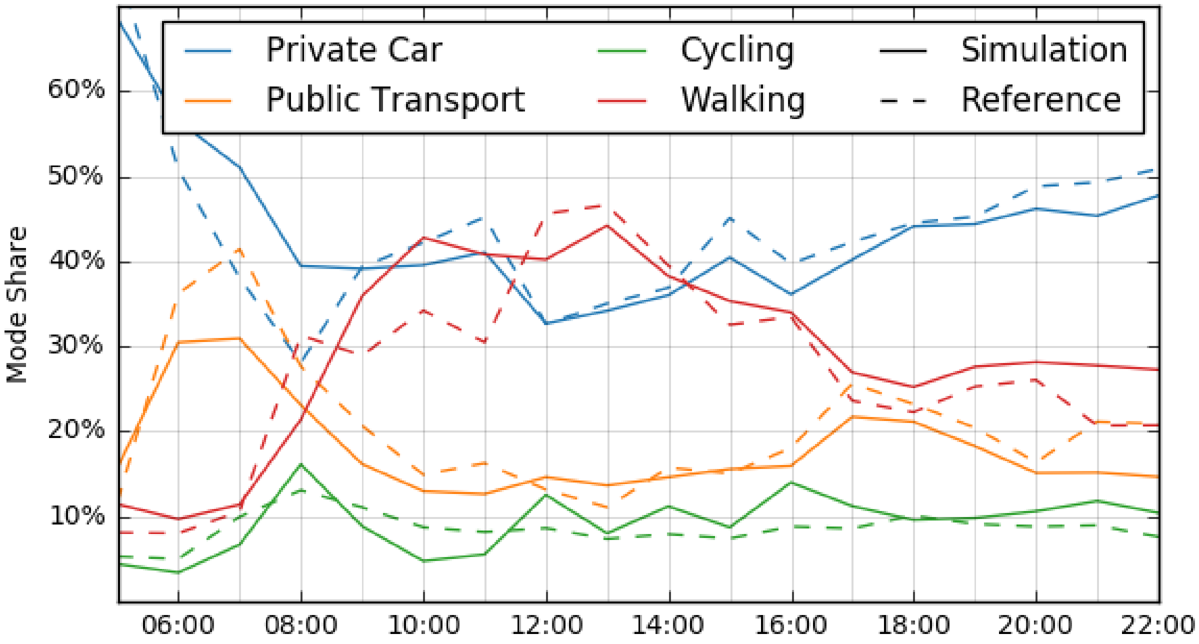
Results for Zurich, Switzerland



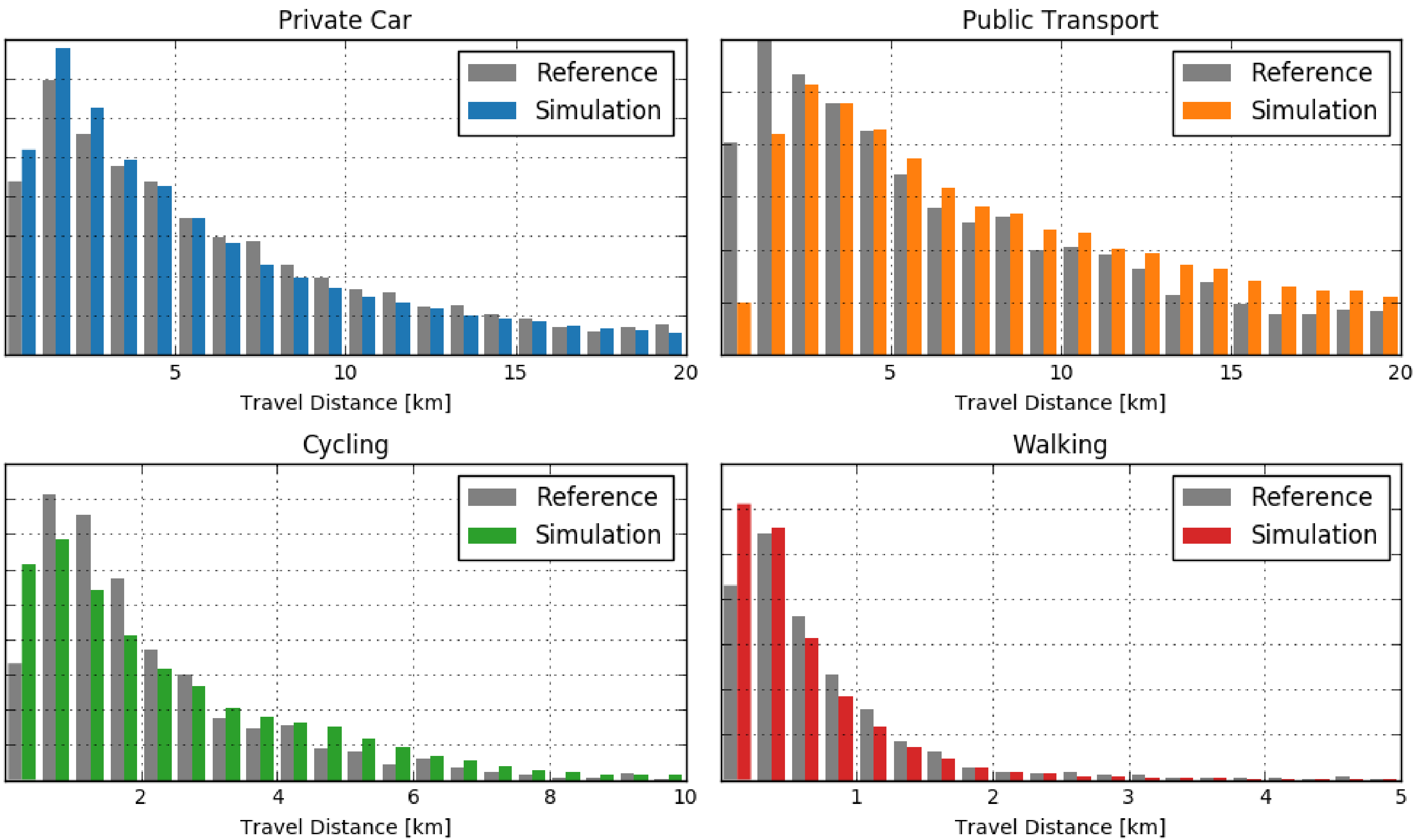
Results for Zurich, Switzerland



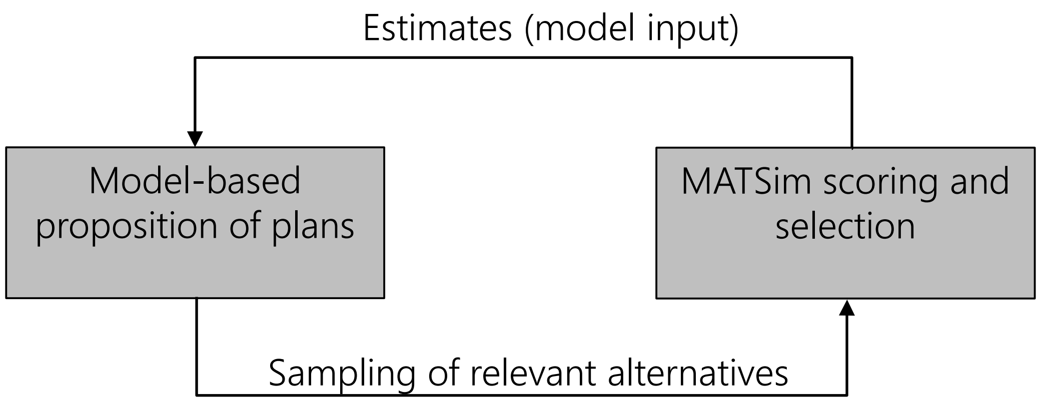
Results for Zurich, Switzerland



Results for Zurich, Switzerland



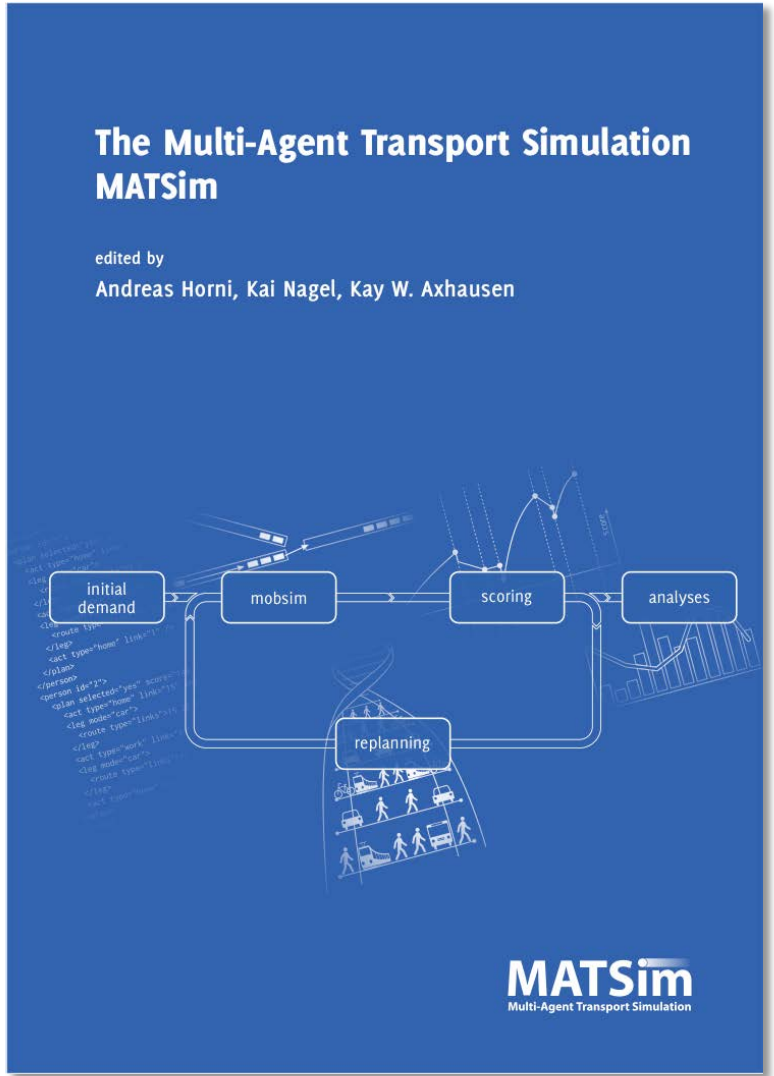
The best of both worlds?



- Improves convergence
- Avoids "innovation turn-off“
- May introduce bias through estimates

- Maintains stability
- Compensates for estimation bias

Questions?



The Multi-Agent Transport Simulation
MATSim
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scoring
analyses
replanning
MATSim
Multi-Agent Transport Simulation

Appendix

- Questionable to draw conclusions from trip-based model in chain-based environment (MATSim)

- Choice model makes life easier - we can argue to skip some **calibration** work, faster **convergence**

- Choice model makes life harder - we need to come up with good **estimates** for the trip characteristics

- *Which one is right?*