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

Clean-up of worst plans until N are left

Almost purely random proposition of new plans

Score-based selection of plan from memory

Simulation

Scoring

Initial execution is necessary before selection makes sense
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: $|C_f \subset C| = M^N - q$
Selection procedure

Three + one (-imperfect) approaches:

Best response selection:

\[ k = \text{argmax}\{\tilde{u}_1, \ldots, \tilde{u}_K\} \]

Total chain utility sampling:

\[ k = \text{argmax}\{\tilde{z}_1, \ldots, \tilde{z}_K\} \quad \text{with} \quad \tilde{z}_k = \sum_i u_{k,i} + \epsilon_{k,i} \quad \text{and} \quad \epsilon_{k,i} \sim \text{Gumbel} \]

Naïve chain sampling:

\[ k = \text{Cat}(\tilde{\pi}_1, \ldots, \tilde{\pi}_K) \quad \tilde{\pi}_k = \frac{\tilde{w}_k}{\sum_{k'} \tilde{w}_{k'}} \quad \tilde{w}_k = \prod_i \pi_{k,i} \]
First simulation results

Teleportation-based simulation
Best-response is upper bound
Fast convergence for tested approaches vs SMC

![Graphs showing simulation results](image-url)
First simulation results

Network-based simulation
Best-response is not upper bound
That one approach missing

Multinomial chain sampling:

\[ k = \text{Cat}(\pi_1, \ldots, \pi_k) \quad \pi_k = \frac{e^{U_k}}{\sum_m e^{U_m}} \quad U_k = \sum_n U_{k,i} \]
Results for Zurich, Switzerland
Results for Zurich, Switzerland
Results for Zurich, Switzerland

Private Car

Public Transport

Cycling

Walking
The best of both worlds?

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

- Maintains stability
- Compensates for estimation bias
Questions?
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?