Recent advances in the calibration of travel demand models from traffic counts

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Outline

Introduction and motivation

Microsimulation-based traffic monitoring

Real world case study – the city of Zurich

Summary

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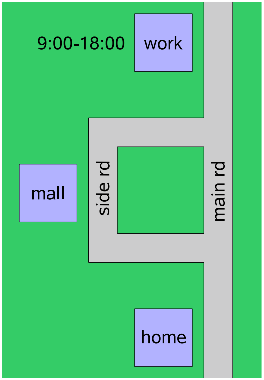
Aggregate demand calibration from traffic counts

- typical modeling approaches
  - demand = time-dependent origin/destination matrix + route assignment logic
  - supply = move flows/vehicles along routes, account for congestion
- typical demand calibration techniques
  - OD matrix calibration
  - path flow estimation

Why not calibrate the *causation* of traffic?



- plan A
  1. sleep late ☺
  2. 9:00 – 18:00 work
  3. shop afterwards
  4. late at home ☹
- plan B
  1. get up early ☹
  2. shop beforehand
  3. 9:00-18:00 work
  4. early at home ☺

Outline

Microsimulation-based DTA

travel behavior: plans

demand simulator

- individual travel behavior
  - route choice
  - dpt. time choice
  - act. (location) choice
- chooses **plan** for every single traveler

supply simulator

- interactions of vehicles
  - traffic flow dynamics
  - congestion
  - travel times
- joint plan execution yields **network conditions**

network conditions

Measurements provide additional information

- Bayes theorem combines prior demand model with traffic counts into posterior demand model:

$$\underbrace{P(\text{plans}|\text{counts})}_{(3)} \propto \underbrace{P(\text{plans})}_{(1)} \cdot \underbrace{P(\text{counts}|\text{plans})}_{(2)}$$

  1. **prior:** simulation system draws from this distribution
  2. **likelihood:** prob. of traffic counts given simulated plans
  3. **posterior:** revised distribution given the measurements

- Calibration objective is to make the the simulator draw from the posterior plan choice distribution.

Realization of calibrated behavior

- It is possible to approximately enforce the desired posterior plan choice – only by external manipulations of the individual choice behavior of (re)planning travelers.
- Two possible methods:

1. Accept the choice of a plan only with a certain probability. Otherwise, ask for another choice.
2. Add a correction term to the systematic utility of every plan a traveler considers before making a choice.

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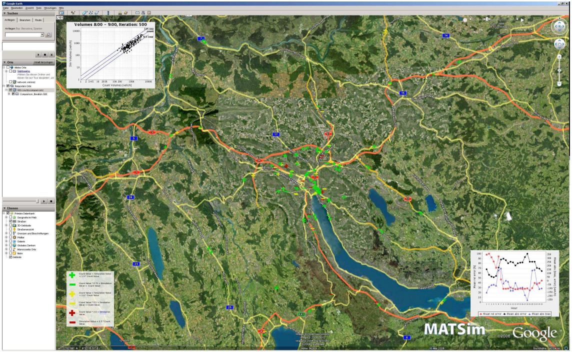
Real world case study – the city of Zurich

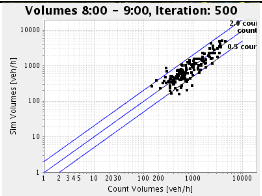
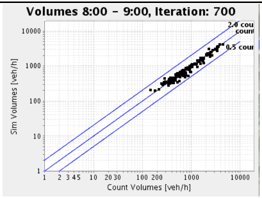


- network with 60 492 links, synthetic population of size 187 484
- calibrate all-day motorist behavior from 159 inductive loops

Settings

- modeling assumptions (Matsim)
  - fully disaggregate demand representation
  - combined choice of route, departure time, mode
  - disaggregate supply model (queuing simulation)
  - (some kind of) stochastic user equilibrium
- estimator setting
  - utilize 159 flow sensors
  - adjust all choice dimensions at once
  - influence driver behavior by accept/reject procedure
  - quality evaluation only at measurement locations

Results – scatterplots

<table>
<tr><th></th><th>plain simulation</th><th>with calibration</th></tr>
<tr><td>morning</td><td>
</td><td>
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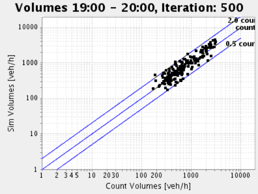
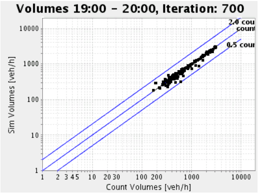
<tr><td>evening</td><td>
</td><td>
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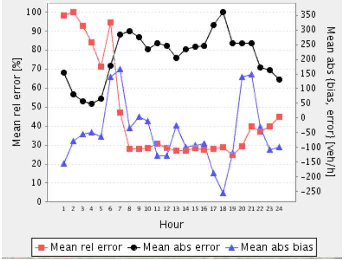
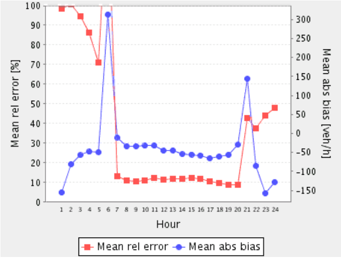
Results – all day

plain simulation	with calibration
	

- measurements available from 7:00 to 20:00
- red curve is mean relative flow error $\left|q^{\text{estim}} - q^{\text{true}}\right| / q^{\text{true}}$
- drastic improvement of results in real-world conditions

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  - flexible with respect to workings of DTA simulator
  - consistent with equilibrium and non-equilibrium models
- mathematically consistent
  - adopted formal view on microscopic modeling and simulation
  - Bayesian approach accounts for model and data uncertainties
- computationally efficient
  - is applicable to problems of practically relevant size
  - is applicable in real-time conditions

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Thank you for your attention.