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Transport Demand Modeling with Limited Data: Transfer and Calibration of a Model from another Geographical Region

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Motivation

- Goal: Create Transport Demand Representation for a given region
  - Activity-based
  - Policy-sensitive
- Problem: Data Availability
  - Trip diaries with geo-coding increasingly difficult to procure because of privacy concerns (DE, US, …)
  - No information about trip destinations
- Approach: Generate locations in activity plans somewhat randomly and remove plans/locations not consistent with measurements.
  1. For home-work-home plans
  2. For full daily plans.

MATSIM

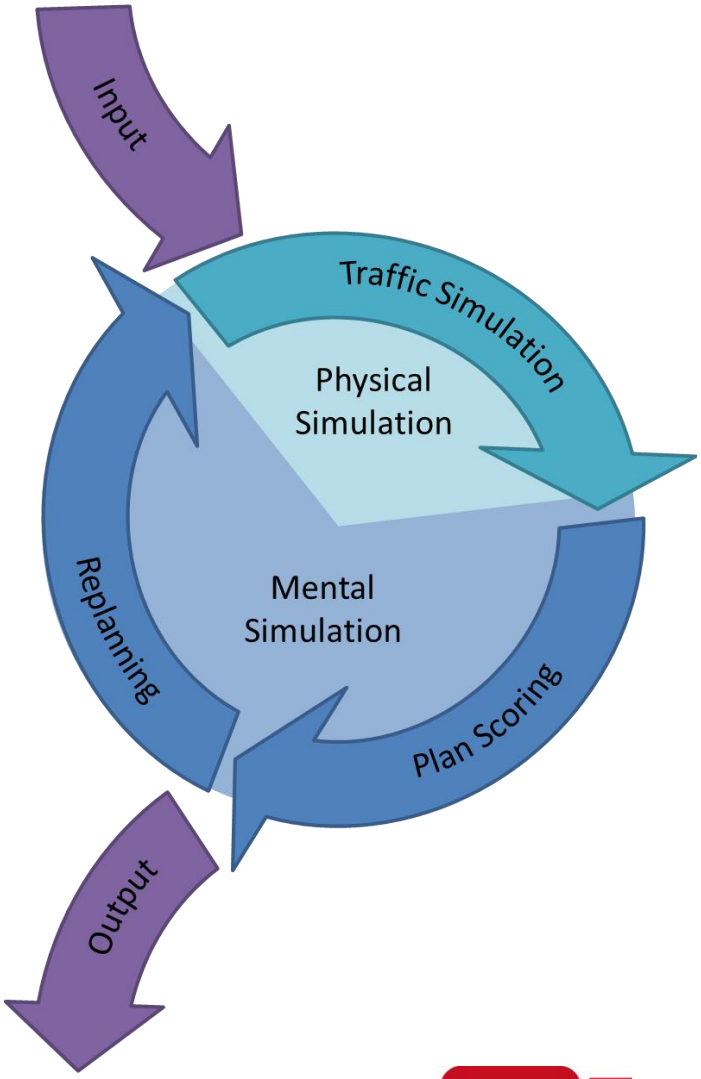
Multi-Agent Transport Simulation (MATSim)

- Agent-based
- Activity-based
- Iterative Demand-Supply Adaption
  - Dynamic Traffic Assignment
  - Microscopic Demand
    - Plan Scoring

$$V(i) = \sum_{act \in m} V_{perf,m} + \sum_{trav \in n} V_{trav,n}$$

    - Replanning
      (Prob. Selection or Mutation)

$$P(i) = \frac{e^{V(i)}}{\sum_j e^{V(j)}}$$



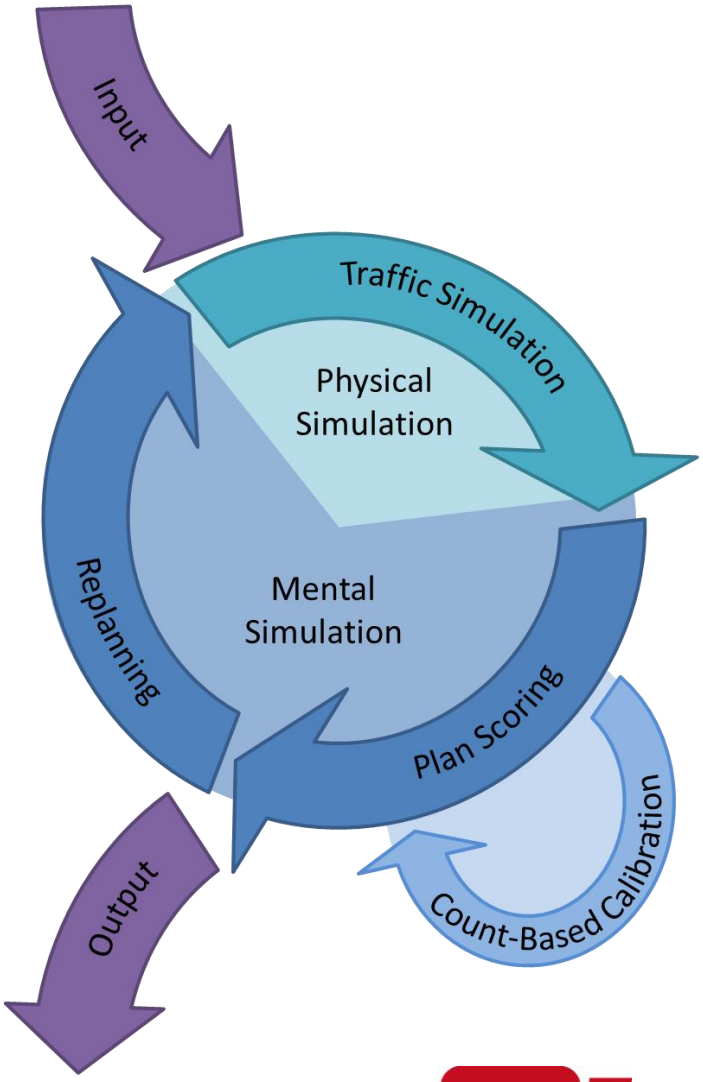
CADYTS

Calibration of Dynamic Traffic Simulations (Cadyts)

- Developed by Flötteröd [2010]
- Can interact with any stochastic, dynamic, and iterative transport simulation framework, e.g. MATSim
- Calibrates in a Bayesian setting
- Treats simulation as a black box
- Correction term: $\Delta V_a(k) = \frac{y_a(k) - q_a(k)}{\sigma_a^2(k)}$
- Calibration via scoring function [Moyo Oliveros & Nagel, 2012, 2013]:

$$V(i) = \sum_{act \in m} V_{perf,m} + \sum_{trav \in n} V_{trav,n} + w \cdot \sum_{ak \in i} \Delta V_a(k)$$

- Performance evaluation in terms of behavior and real-world measurement reproduction at the same time



HOME-WORK-HOME PLANS

Home-Work-Home Plans

Idea

- Create several HWH plans per agent, each with another work location
- Use Cadyts to sort out those HWH plans which are not consistent with measurements (traffic counts)

Setup

- Population with home and work locations based on Commuter Statistics
- Only people going by car (car share by region)
- Work activity starts at 8:00 +/- 1.5h
- Work activity ends at 16:30 +/- 1.5h
- 7+1 plans per agent

Settings and Results

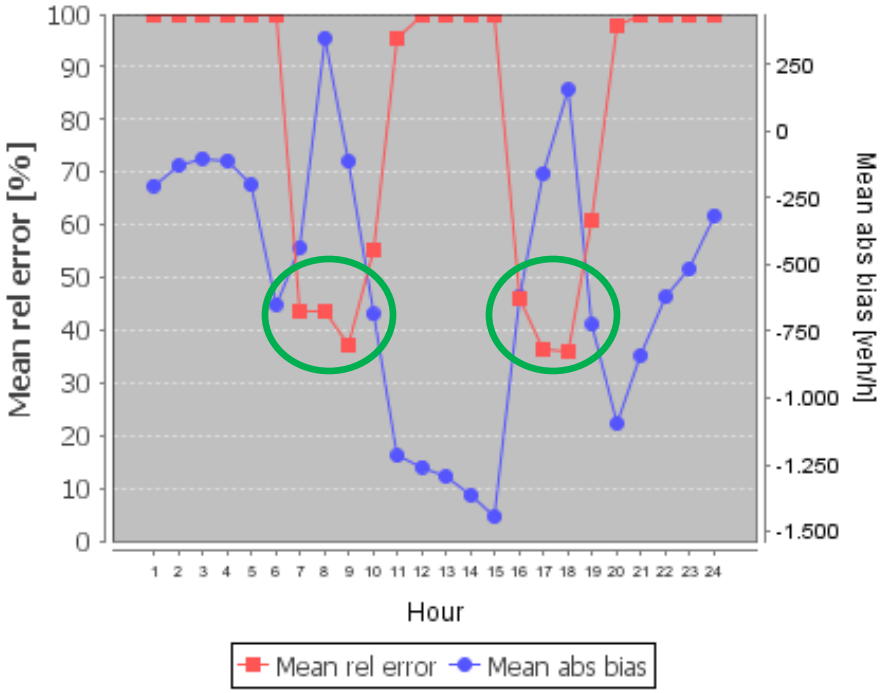
Parameter	W/o Cadyts	W/ Cadyts	Reference
Demand Elasticity	Yes	Yes	n/a
Number of Plans	10	10	n/a
Number of initial Plans	8	8	n/a
Flow Capacity Factor	0.02	0.02	n/a
Cadyts Scoring Weight	n/a	15	n/a
Calibration Time	n/a	0h - 24h	n/a
Norm. Log Likelihood	n/a	-213	-10*
Car Trips	1.35m	1.29m	n/a
Car Trips / Person	2.0	2.0	n/a
Avg. Trip Distane [km]	**12.7**	**14.9**	**14.7****
Avg. Trip Duration [km]	**25.8**	**34.4**	**31.1****

* Flötteröd et al. 2009, p.10

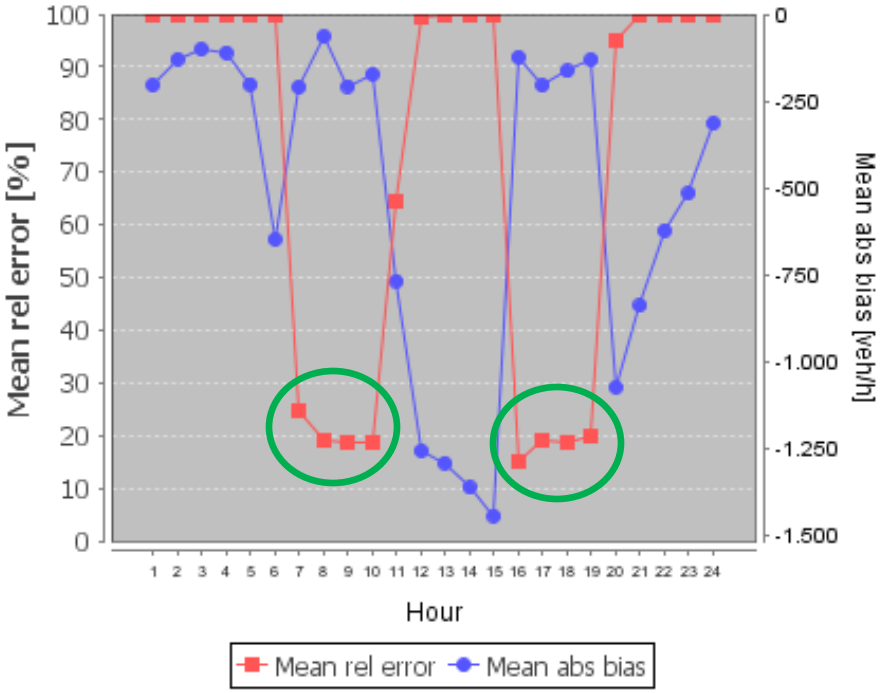
** Own calculations based on SrV Berlin 2008

HWH Plans without Cadyts vs. with Cadyts

Without Cadyts



With Cadyts



- HWH Plans (alone) generate morning/afternoon peak traffic, but is far away from counts
- HWH Plans + Cadyts generate morning/afternoon traffic which is much closer to counts

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CEMDAP

CEMDAP

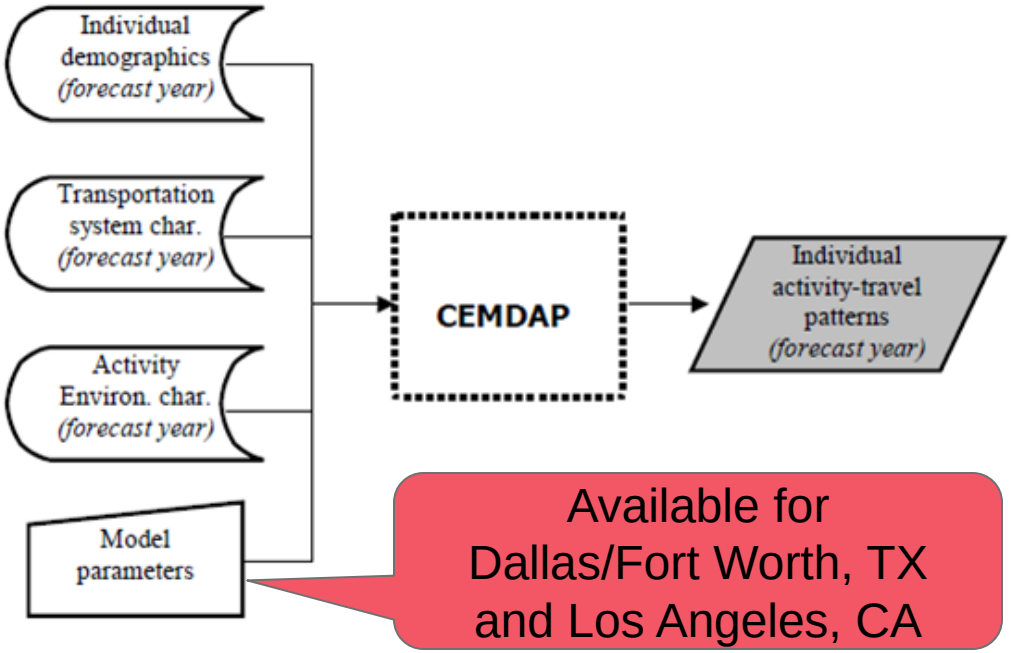
- Comprehensive Econometric Microsimulator for **Daily Activity-Travel Patterns**
- C. Bhat et al., University of Texas

Input

- Disaggregate Demographics (Preprocess: SPG)
- Model Specification (taken from Dallas/Fort Worth, TX)

Output

- Daily Activity-Travel Patterns for each Indiv.



Used Data

Input

- Commuter Statistics by Federal Employment Agency
- Basic Demographics
- Settlement Patterns
- Traffic Counts

Validation

- SrV 2008 Scientific Use File for Berlin

Premise

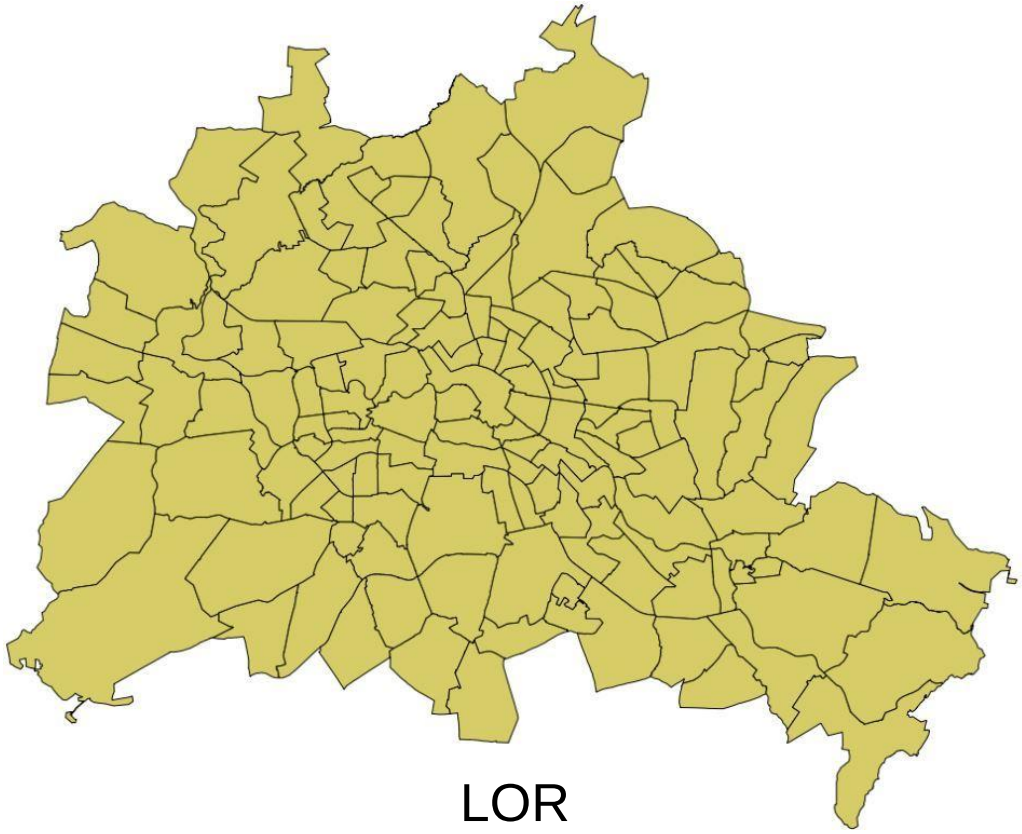
- “Do not use data that are not readily accessible.”

Synthetic Population

- Problem: „Big Municipalities“

Properties

- Home-Work Relations
- Settlement Patterns
- Car Share
- Age
- Gender
- Employment Status
- Retired people
- Students



LOR
(“Lebensweltlich orientierte Räume”)

FULL DAILY PLANS

CEMDAP Output -> MATSim Input

CEMDAP

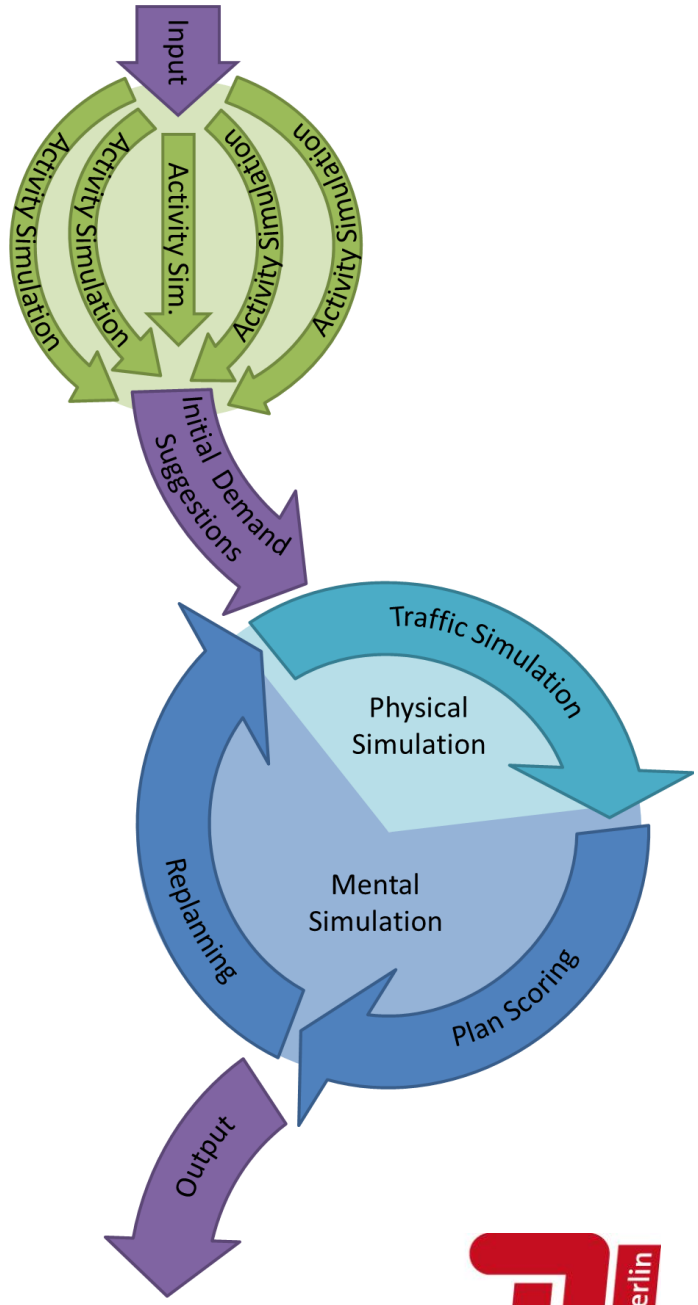
- yields daily activity-travel patterns of individuals

Are we done yet?

- No context-specific estimation of model parameters
- No interaction of supply and demand („feedback“)

MATSim

- expects daily plans as input
- ≈ CEMDAP output



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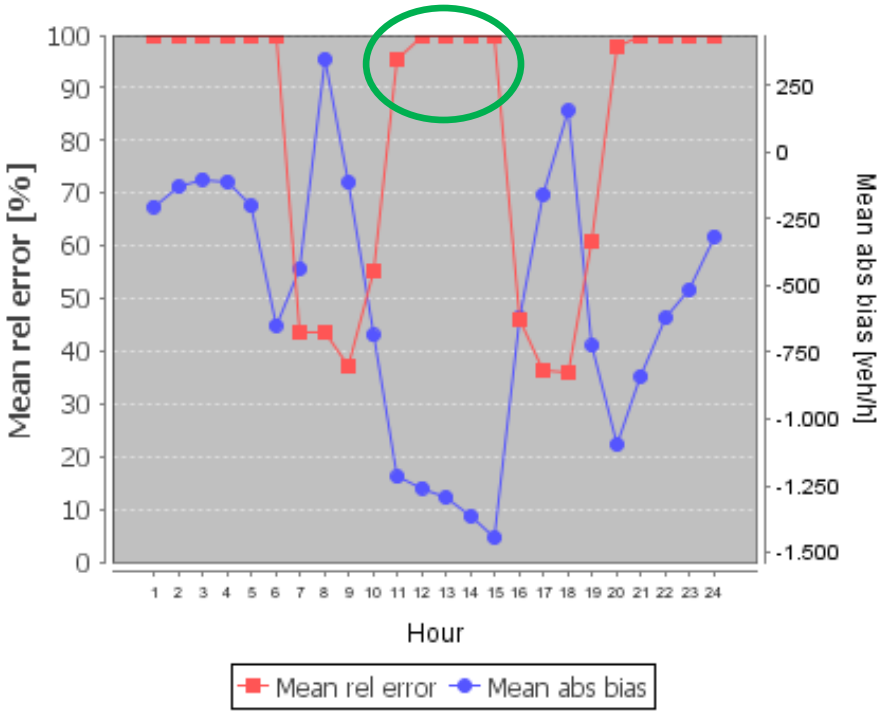
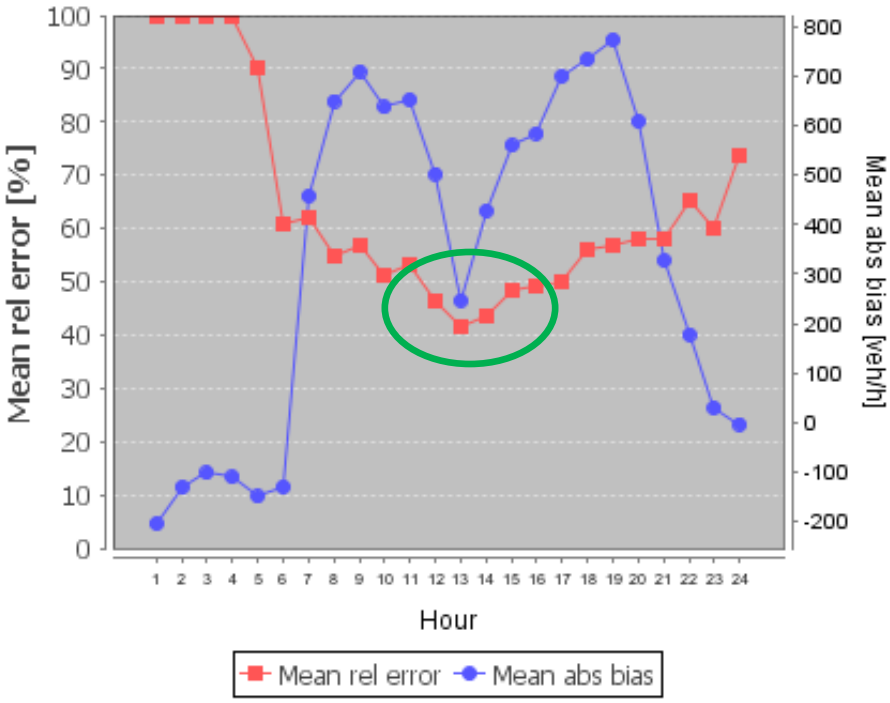
HWH Plans vs. CEMDAP Full Daily Plans (w/o Cadyts)

HWH Plans (as earlier)



CEMDAP Plans



- CEMDAP plans generate travel for whole day where HWH plans only reproduce morning and afternoon peaks

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FINAL SETUP

CEMDAP -> MATSIM+CADYTS

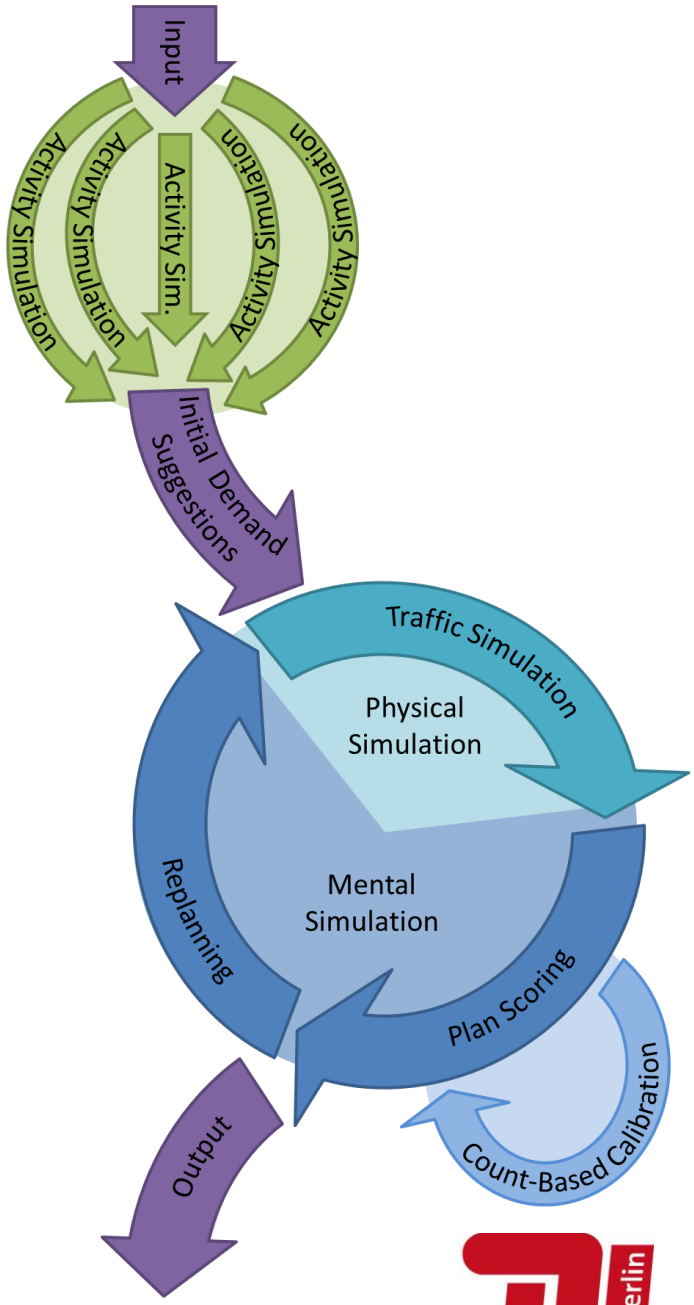
Full Daily Plans + Cadyts

Idea

- Create several full daily plans per agent with CEMDAP, each with another work location
- Use Cadyts to sort out those full daily plans which are not consistent with measurements (traffic counts)

Setup

- As before (CEMDAP)
- 7+1 plans per agent



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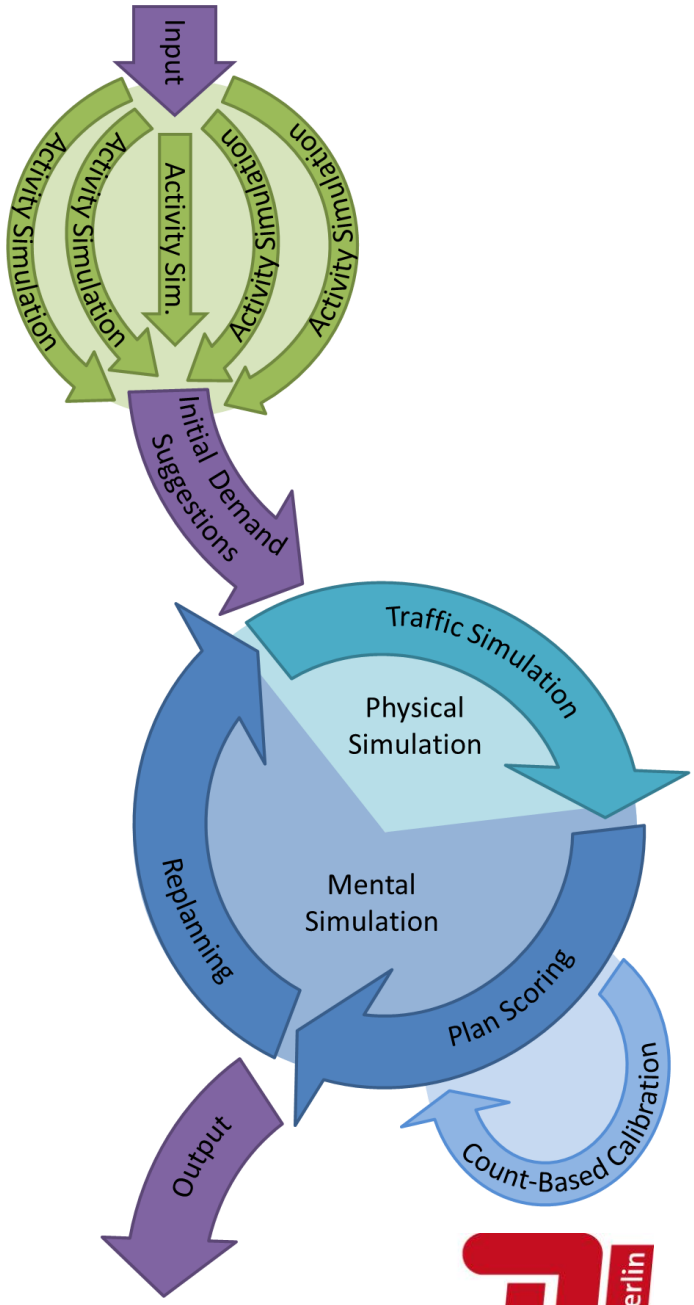
Summary of Procedure

- Run CEMDAP multiple times
- Get multiple activity patterns for each agent with different locations
- Consider output plans as Initial Suggestions for a Demand Representation
- MATSim evaluates the performance of these *suggestions* in terms of
  - Behavioral soundness
  - Relation to reality (via Cadyts)



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Settings and Results

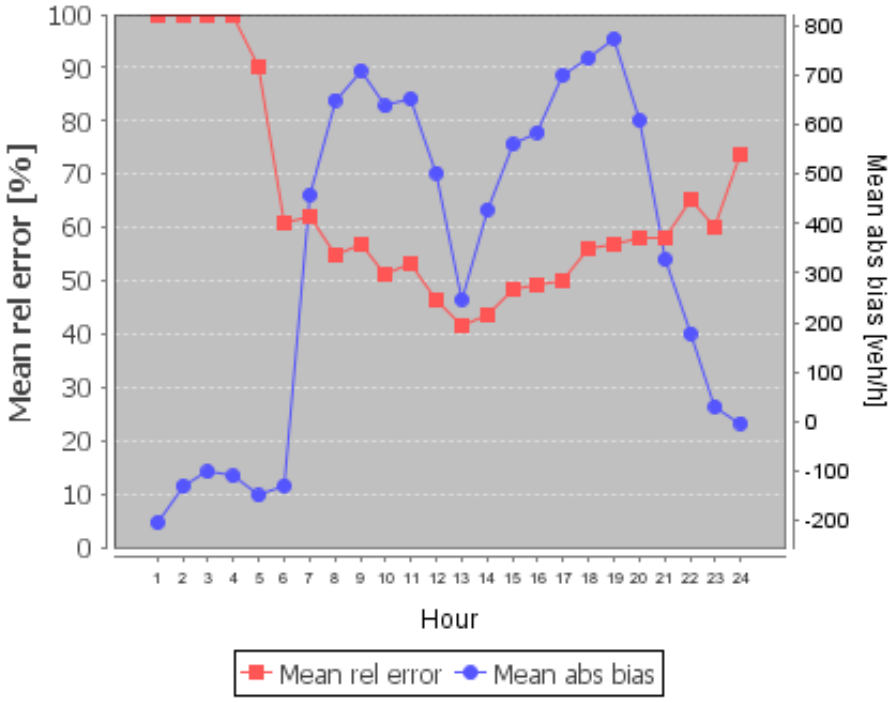
Parameter	W/o Cadyts	W/ Cadyts	Reference
Demand Elasticity	Yes	Yes	n/a
Number of Plans	10	10	n/a
Number of initial Plans	4	4	n/a
Flow Capacity Factor	0.02	0.02	n/a
Cadyts Scoring Weight	n/a	15	n/a
Calibration Time	n/a	0h - 24h	n/a
Norm. Log Likelihood	**-219**	**-23**	**-10***
Car Trips	**3.89m**	**2.92m**	**3.20m****
Car Trips / Person	**3.9**	**3.4**	**3.4****
Avg. Trip Distane [km]	**12.0**	**11.0**	**9.5****
Avg. Trip Duration [km]	**27.0**	**22.0**	**22.3****

* Flötteröd et al. 2009, p.10

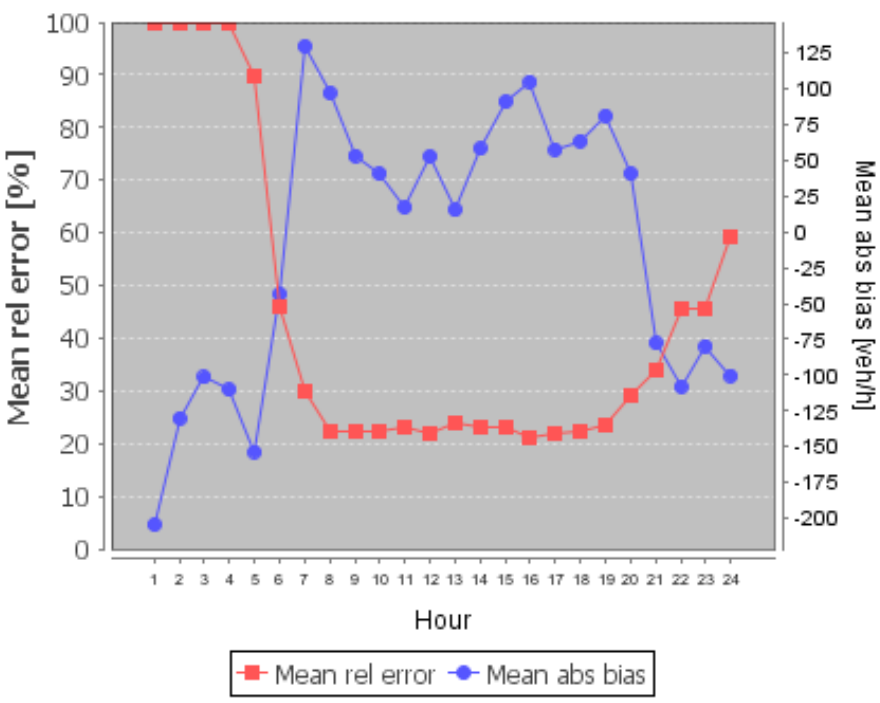
** Ziemke 2013, pp.59, based on SrV Berlin 2008

CEMDAP Full Daily Plans (without Cadyts vs. with Cadyts)

Without Cadyts (as earlier)



With Cadyts



- CEMDAP full daily plans calibrated by Cadyts generate travel for whole day

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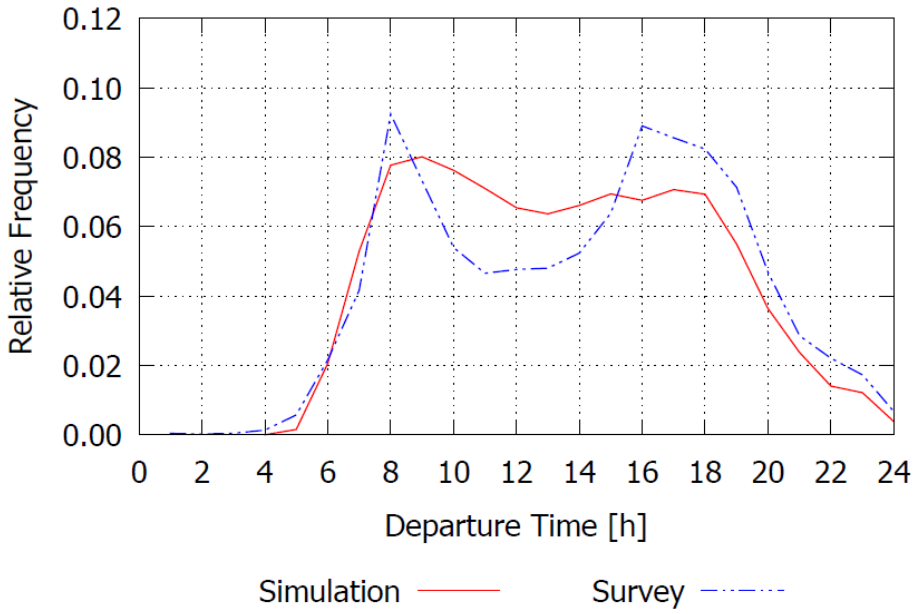
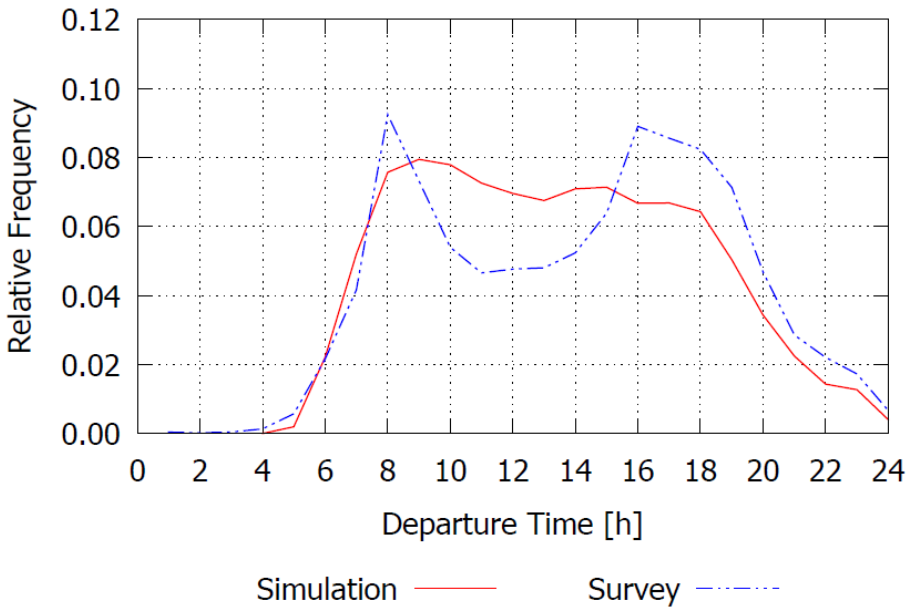
VALIDATION

Departure Times

Without Cadyts



With Cadyts



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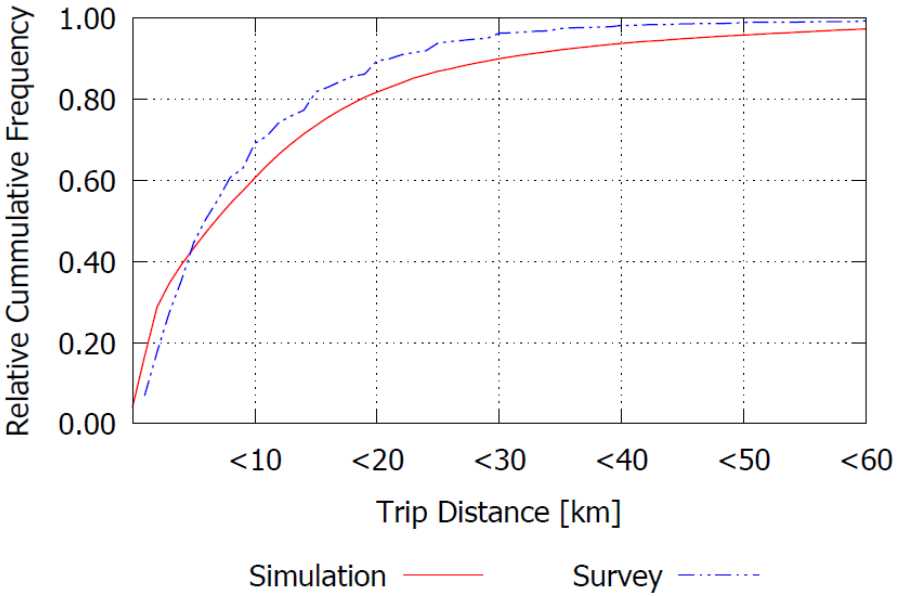
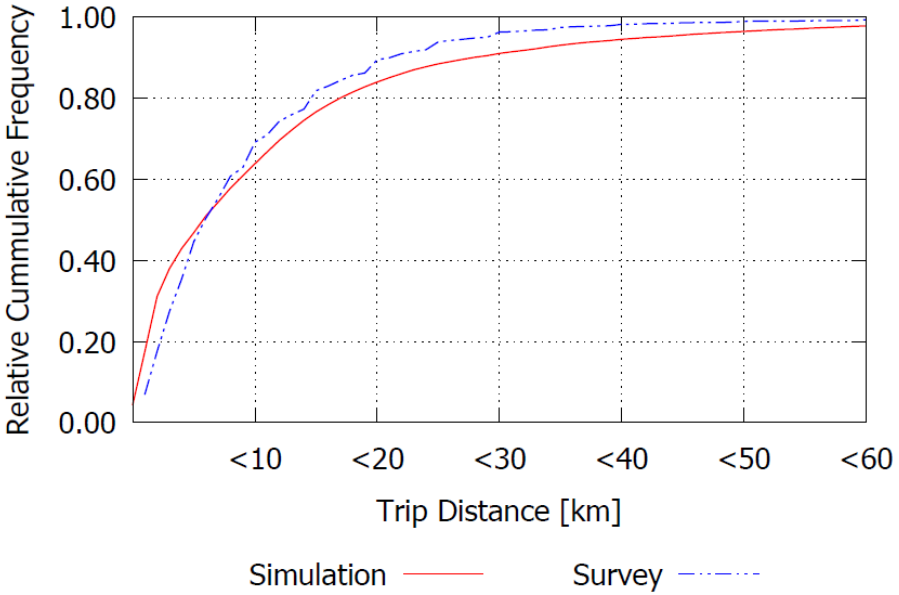
Trip Distance (Beeline)

Without Cadyts



With Cadyts



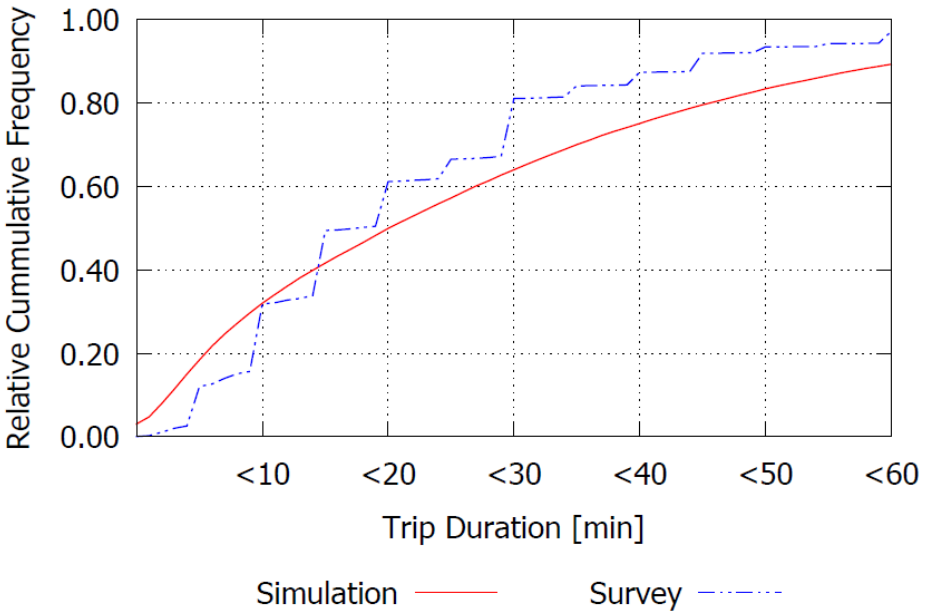
Average = 12.0km

Average = 11.0km

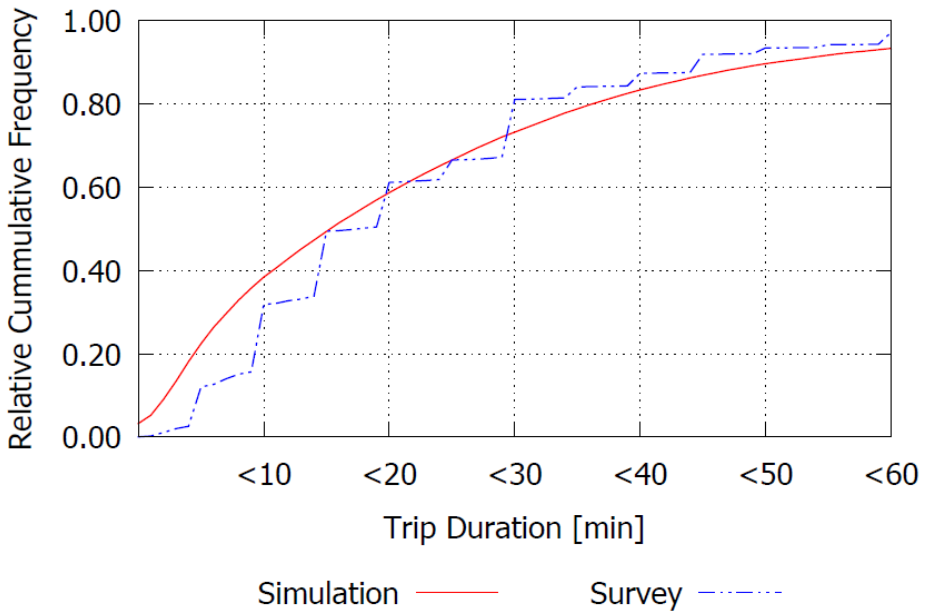
Reference = 9.5km

Trip Duration

Without Cadyts



With Cadyts

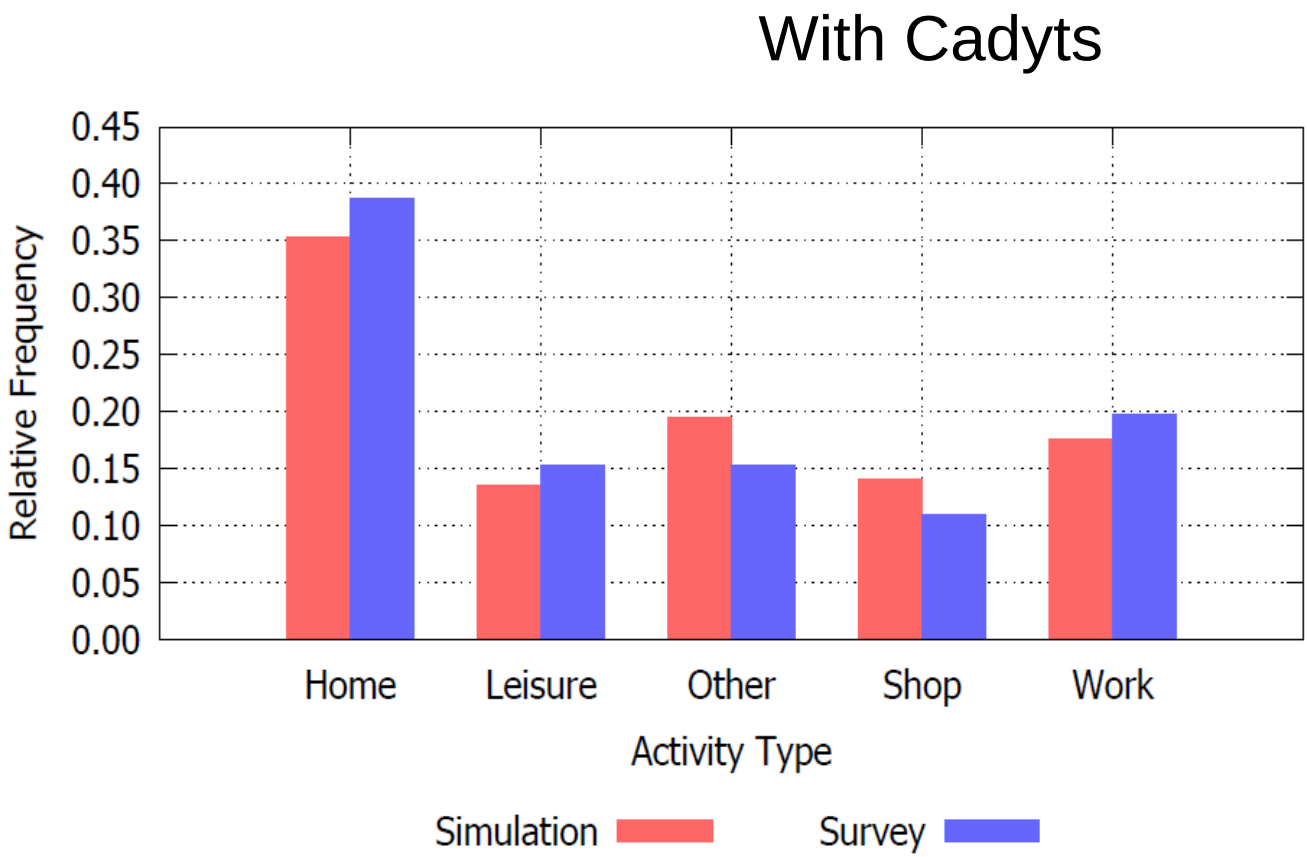


Average = 27.0min

Average = 22.0min

Reference = 22.3min

Activity Type at Trip End



Conclusion

- Generate a transport demand representation for Berlin
  - Microscopic – individuals with full daily plans
  - Based on readily accessible input data
  - A activity-travel plan generator estimated for another region (CEMDAP)
  - Updating procedure based on traffic counts (Cadyts)
- Good fit towards measurements
- Good validation results

- Individual travelers maintained over whole process

- Contribution to dealing with data without geo-coding
- Contribution to transferability of models