Assistant Professorship for Travel Behavior
TUM School of Engineering and Design
Technical University of Munich

Activity-Based Incremental Travel Demand Model (ABIT)

Wei-Chieh Huang, Joanna Ji, Carlos Llorca, Rolf Moeckel, Corin Staves

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Model introduction

ABIT has two major components:

- Base year demand: generates travel plans for every person
- Incremental update: modifies previously generated plans

Development started November 2021

Properties of ABIT:

- Agent-based, activity-based
- 7-day model
- Open source, written in JAVA

Data source:

- German mobility panel (MOP)

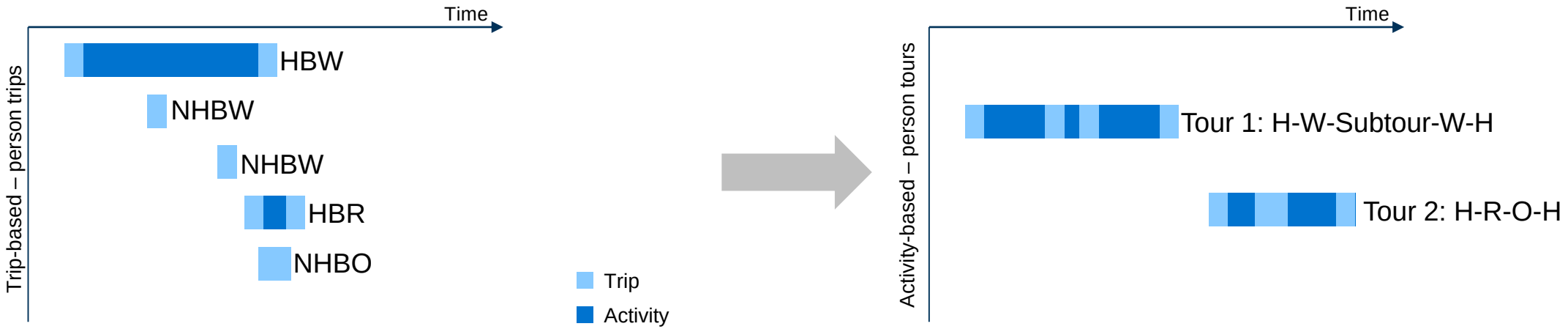
Base year travel demand

Motivation

From trip-based models to activity-based models: MITO → ABIT

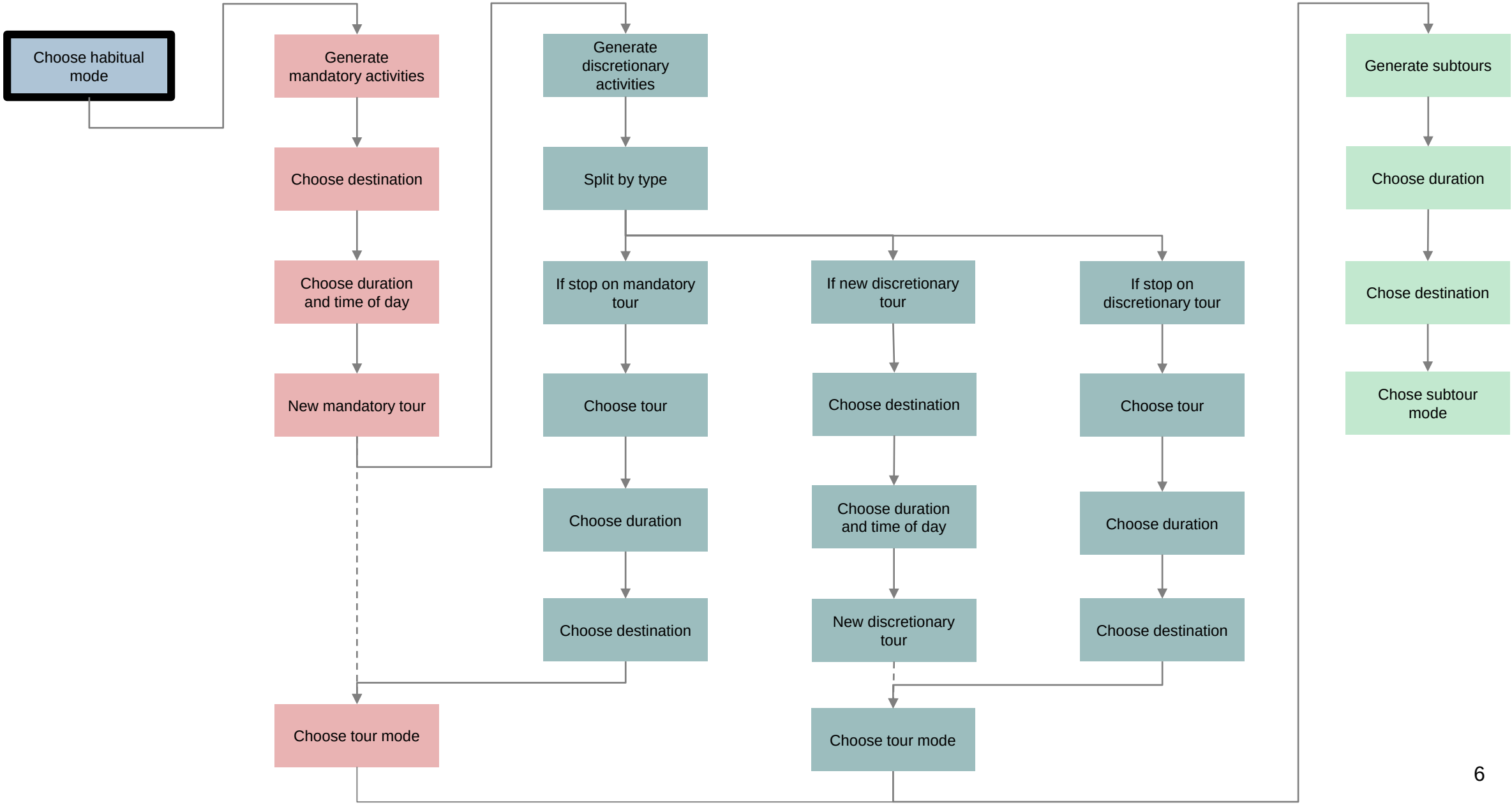
MITO: Microscopic Transport Orchestrator is a trip-based agent-based model

- JAVA open-source model developed in our group
- Four-step model at individual resolution
- Very fast (without traffic assignment): 2 minutes for 4,4 million persons and 12 million legs (Munich metropolitan area)
- Relatively simple, allowing for extensions, e.g. joint travel with partners of a social network
- Trip chains are not consistent in time and space



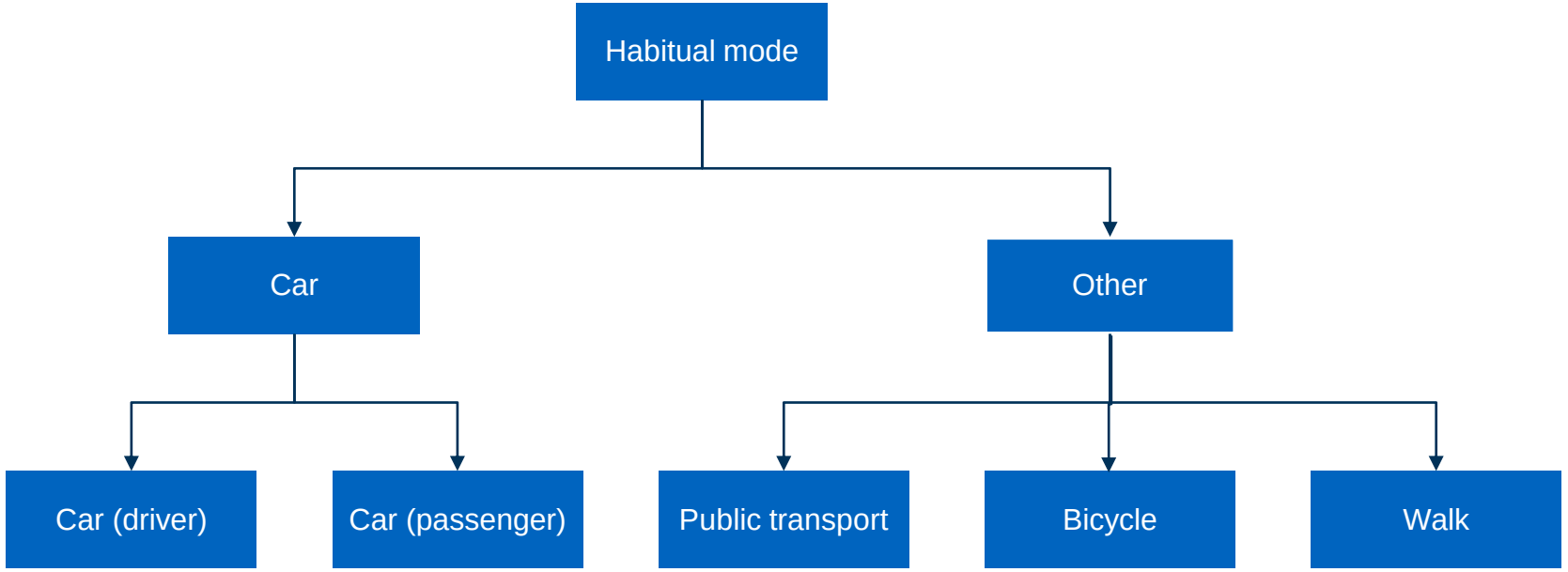
Base year demand generation workflow

Base year demand generation workflow



Habitual mode choice

- Mode that is used the most to travel to mandatory activities
  - Person attribute
  - Influences trip chaining behavior
  - Influences tour mode choice



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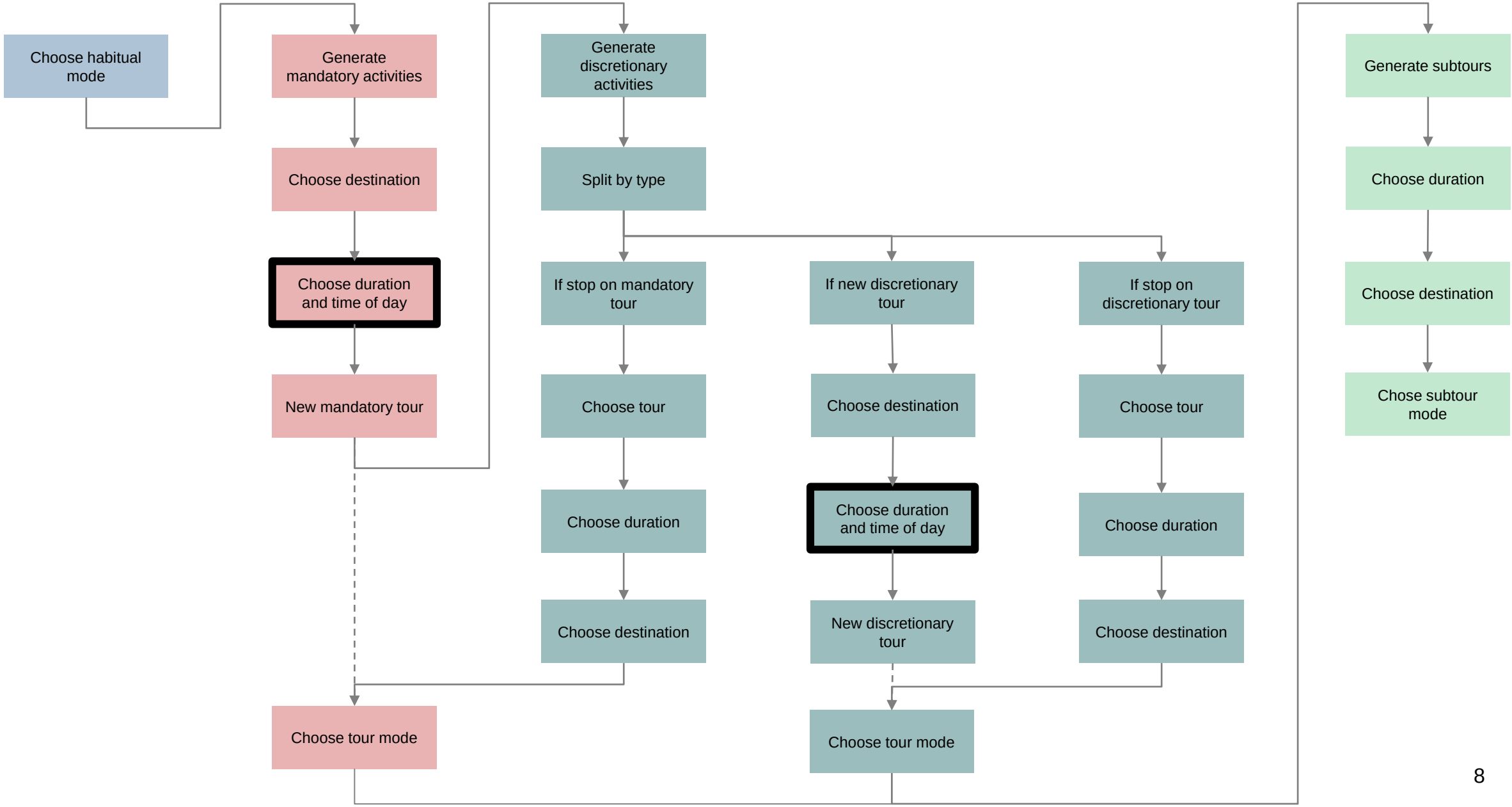
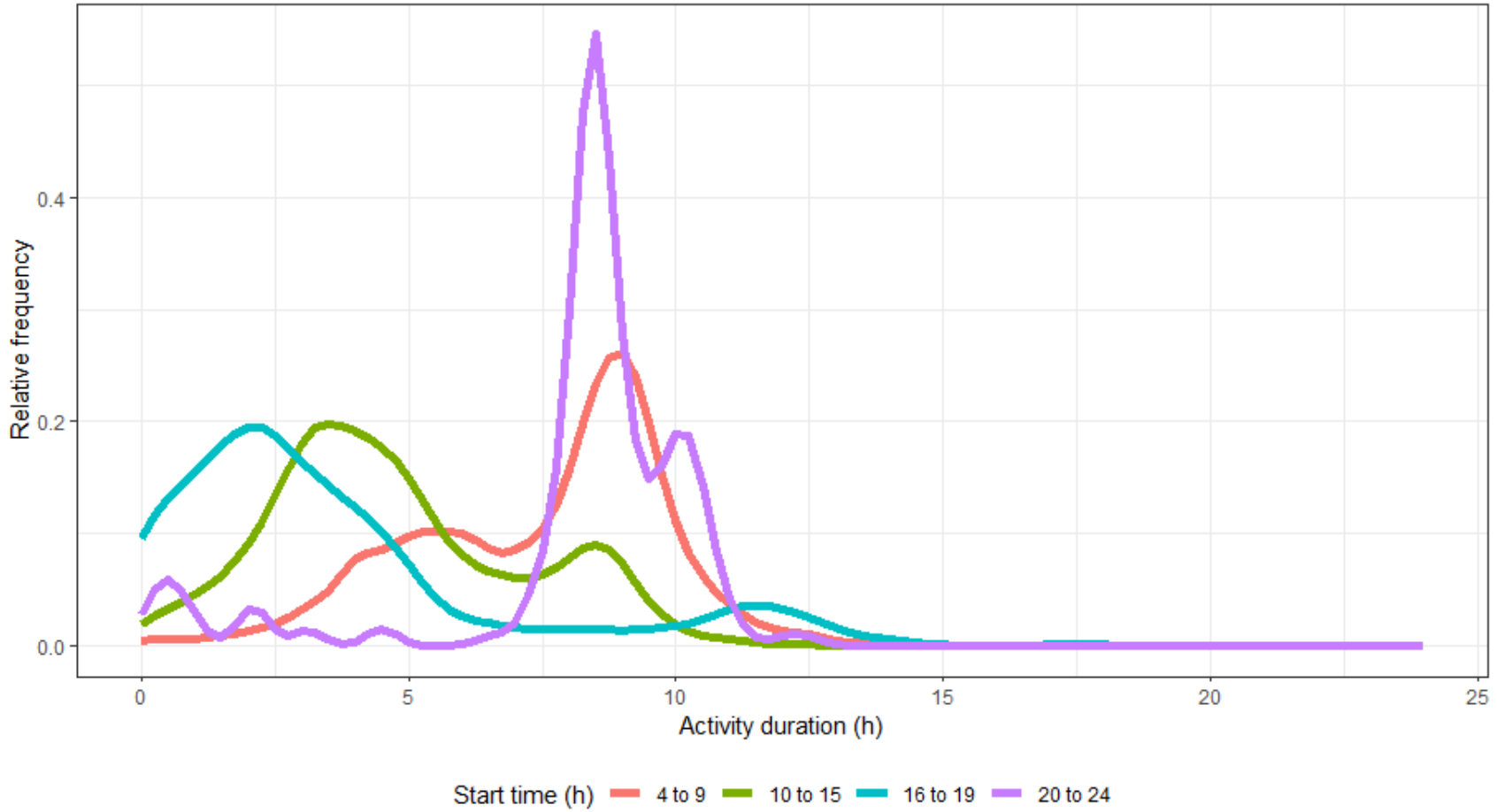


Scheduling

- Joint choice of activity start and activity duration
- Weighted sampling



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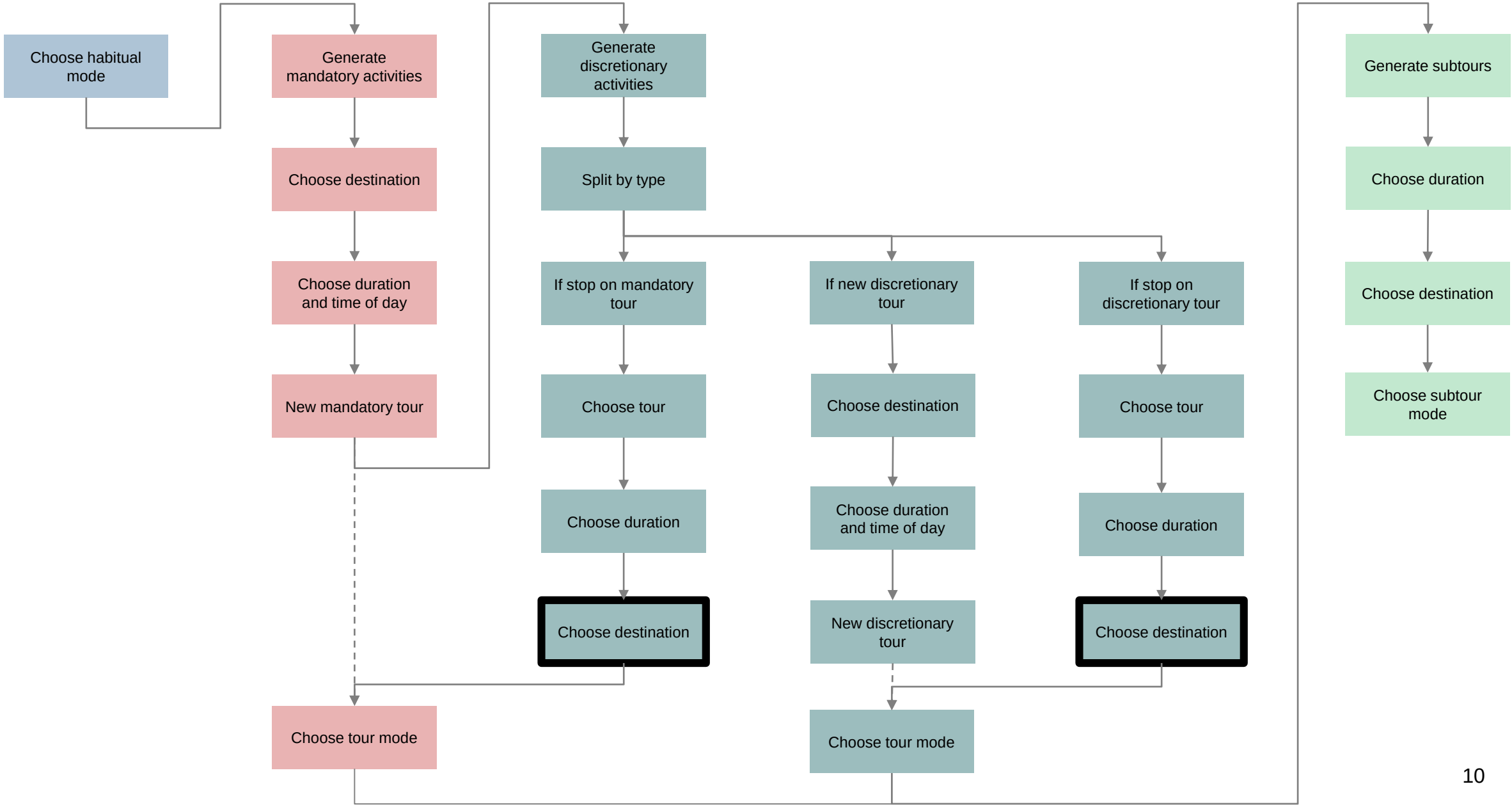
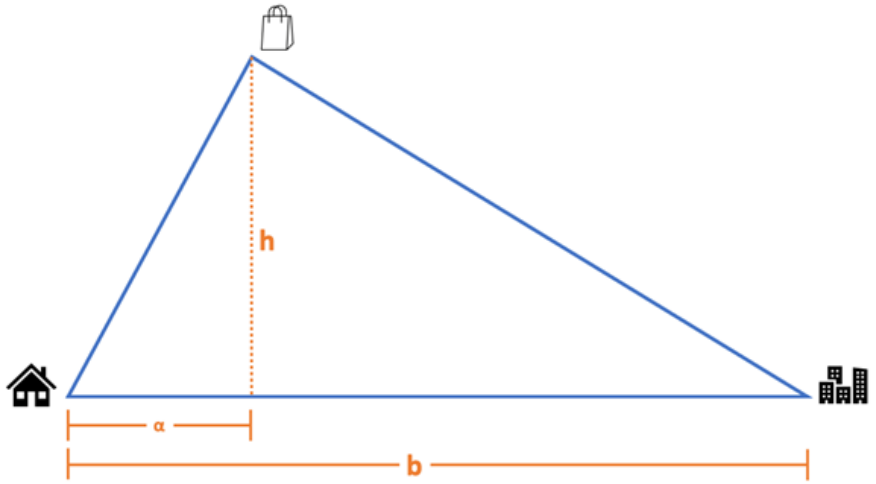
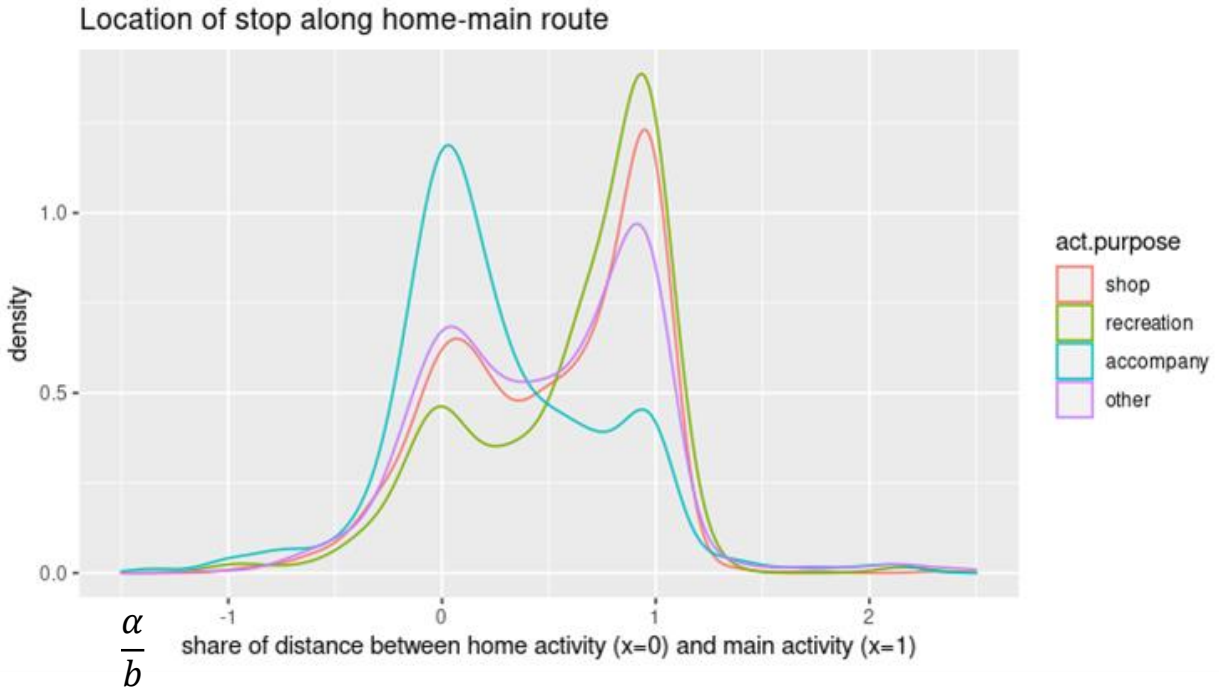


Destination choice models

Tour stop destinations based on a logit model:

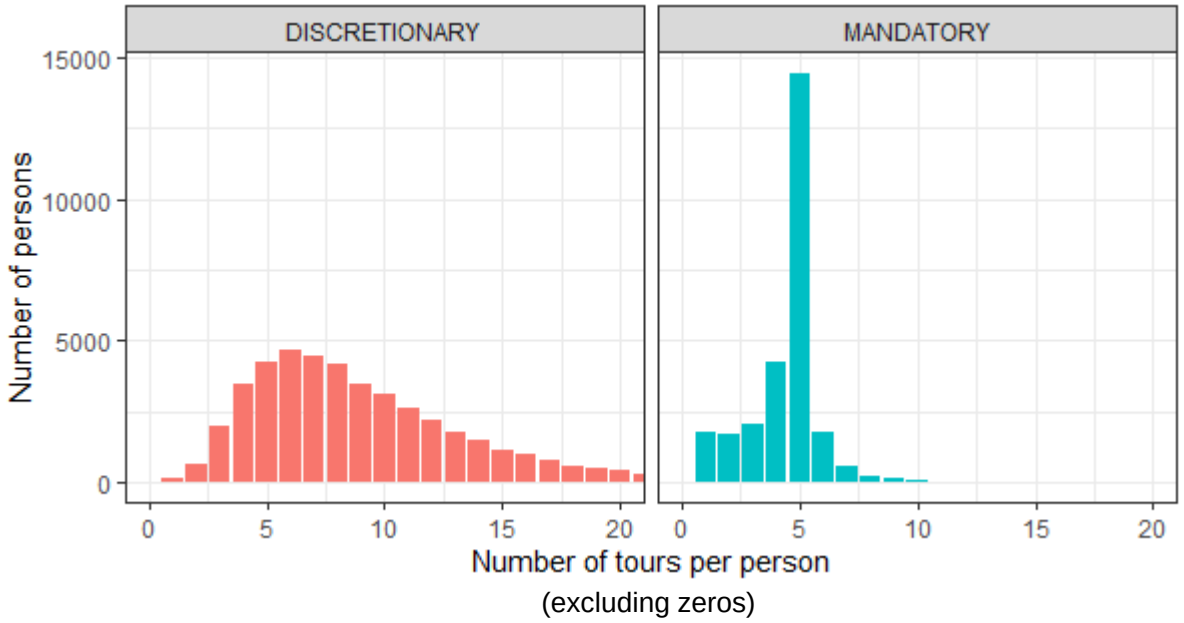
- Utility depends on cost from previous activity, cost to following activity and destination attractiveness
- Locations close to the origin or the main tour activity are more likely to be selected as stops

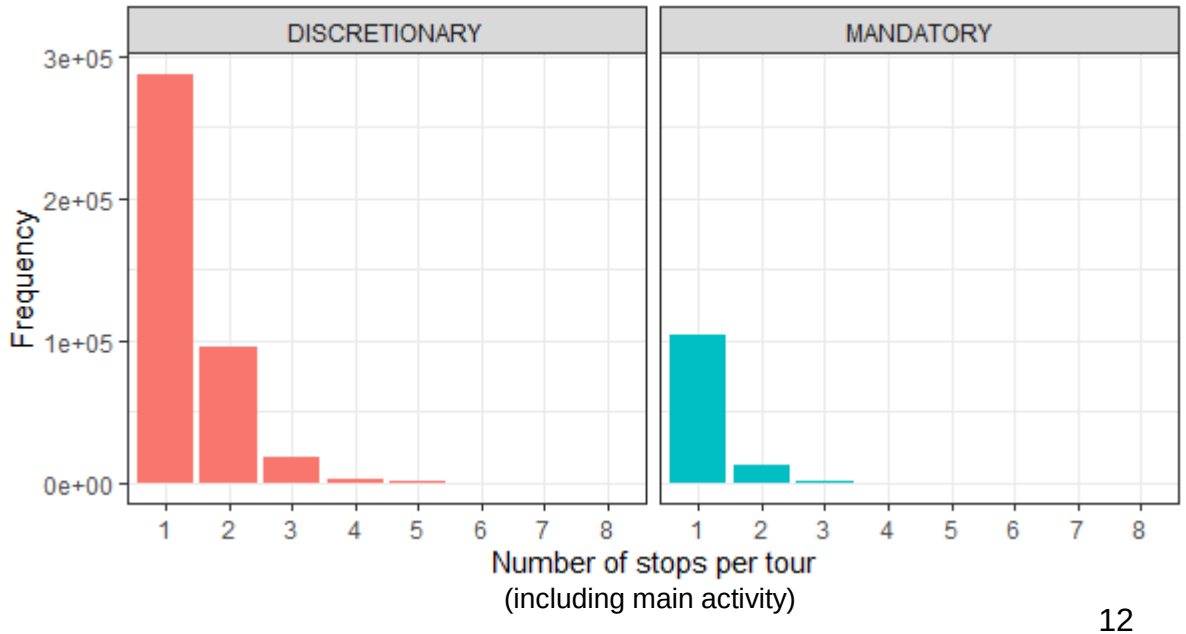




Preliminary results

- Operational, uncalibrated model is available now
- Runtime: 1 h 55 min with 4,4 million persons, without traffic assignment (0.0014 s/person)
  - 68 million activities (9,6 million activities per day – 2.2 per person)
  - 121 million legs (17 million legs per day – 3.9 per person)





Incremental update of travel demand

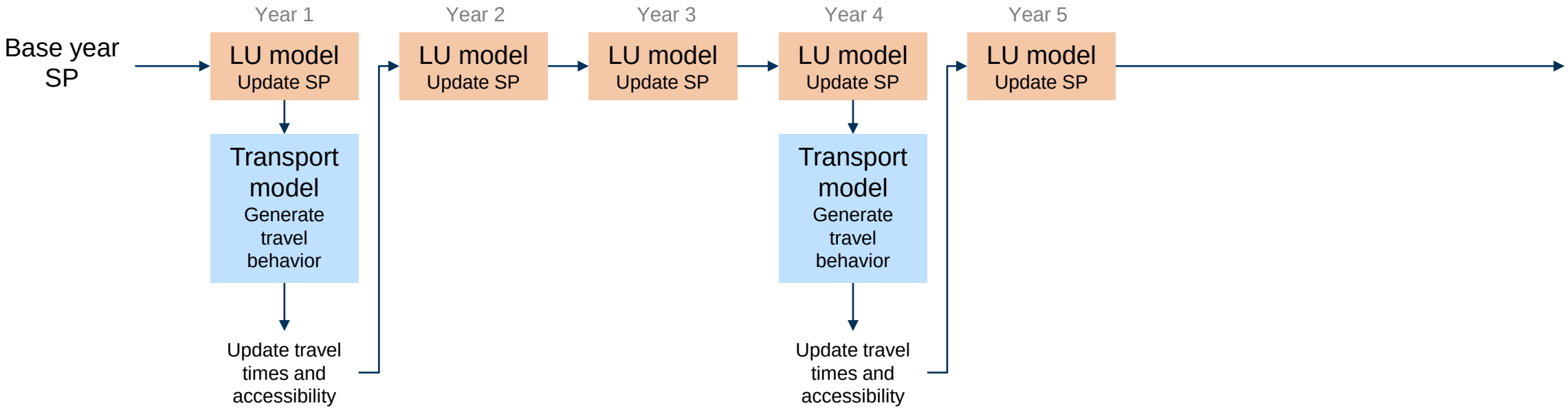
Motivation

- Travel behavior may differ a lot from day to day (Raux et al. 2016), but it does not change dramatically from year to year (McCarthy 1982, Kitamura 1987).
- Life events, such as household relocation, graduation from school, change of job, birth of a child, etc., may change travel behavior fundamentally.
- But for most agents, such changes are rare, and travel behavior changes marginally if at all.

By contrast, transport models tend to recreate travel behavior from scratch every time the model runs! Habitual behavior and attitudes are typically ignored in transport models.

Traditional model design

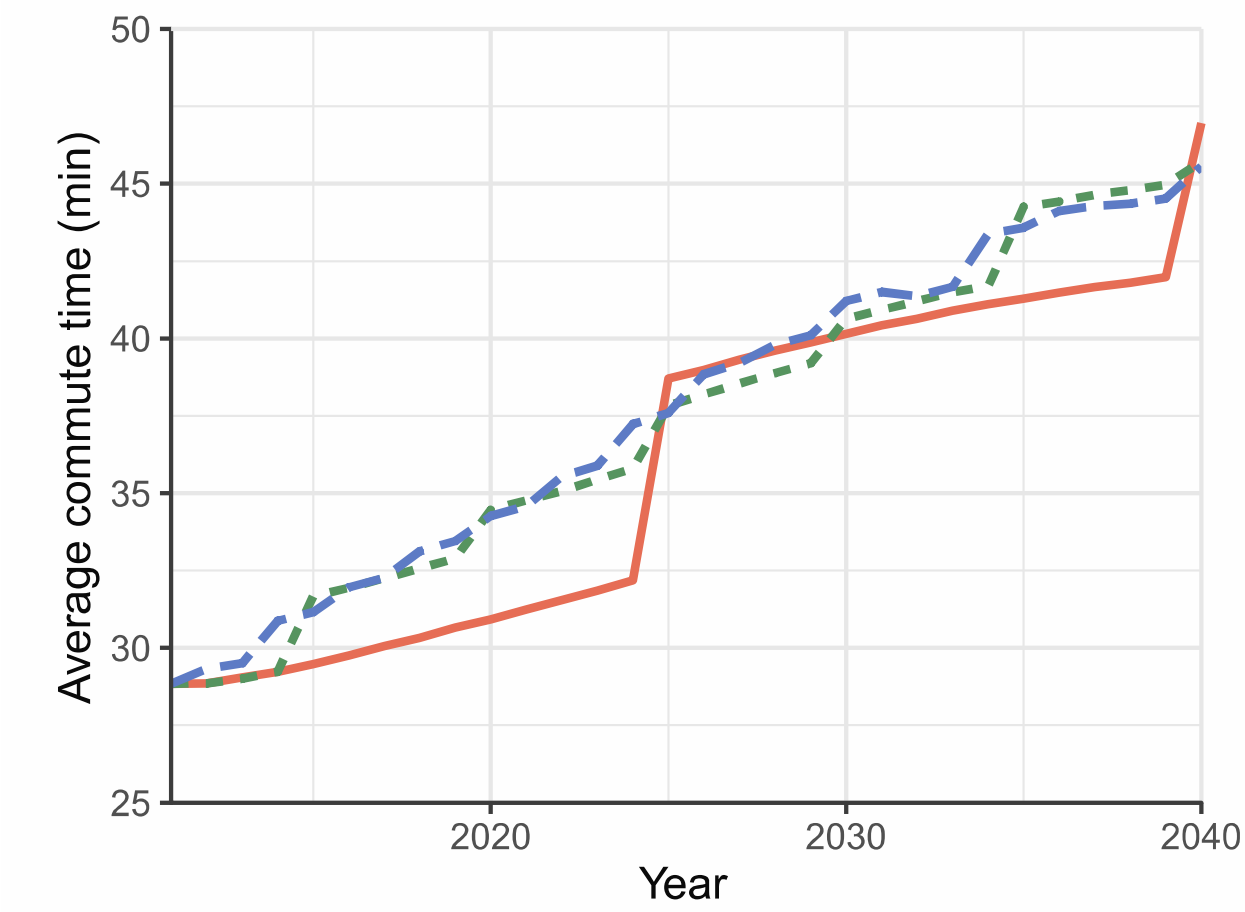
Transport and land use integration



Traditionally, successive transport model runs are independent:

- No memory, random variations that might be unrealistic

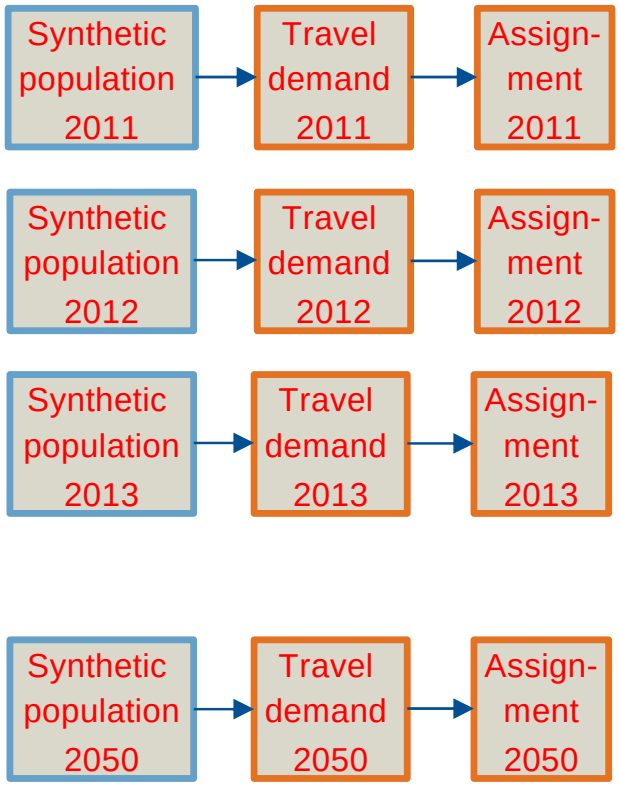
“Broken” travel times



- In this integrated LU/T model, the transport models is run every 15, 5 or 2 years
- Transport model should run every year to avoid jumps in travel time
- Long run times of transport models typically prohibit frequent runs

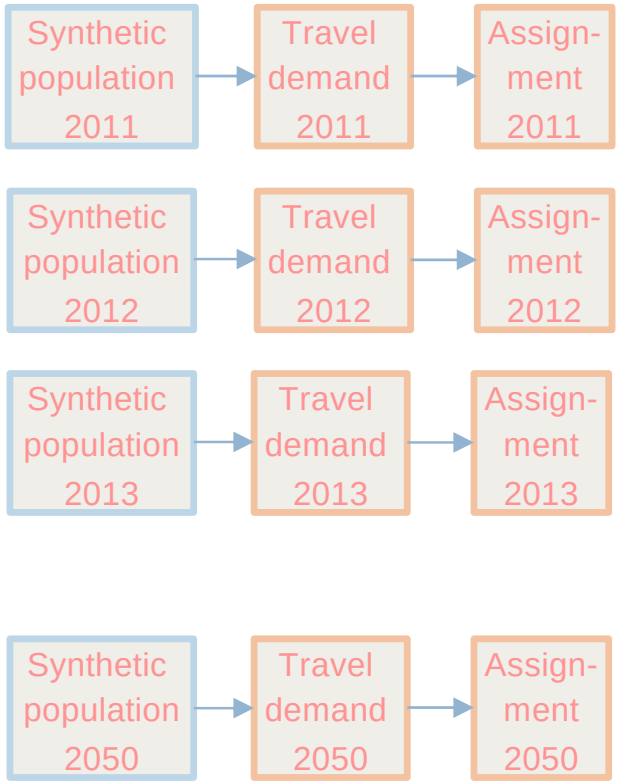
Idea

State of practice

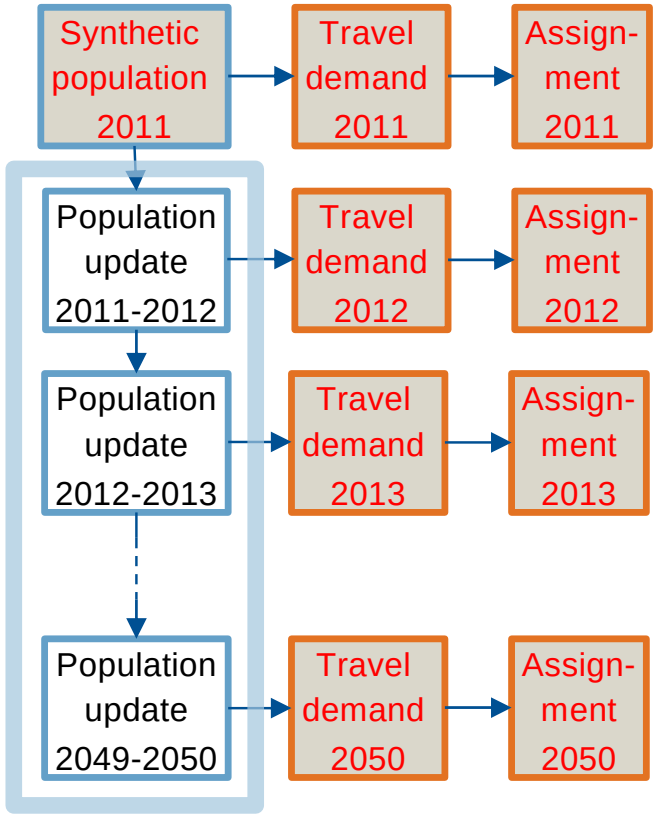


Idea

State of practice



Practice at TUM



Idea

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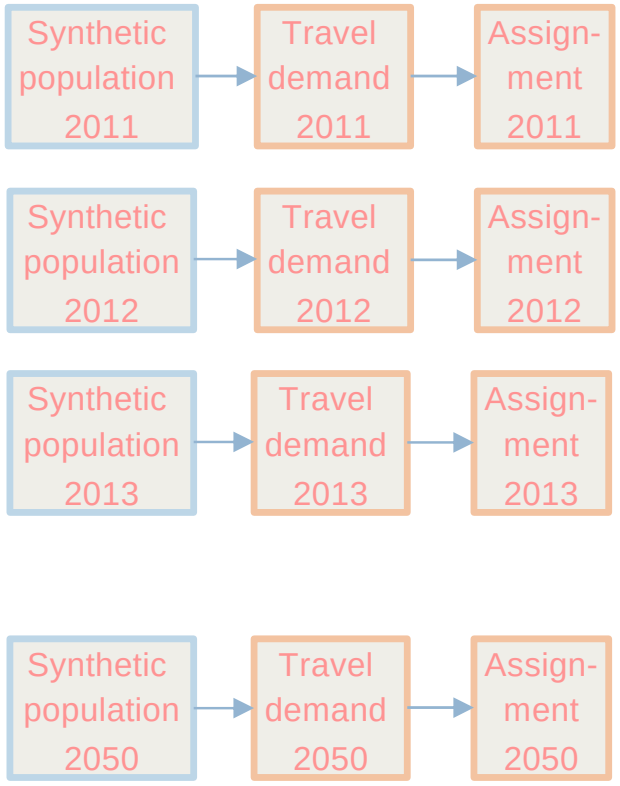

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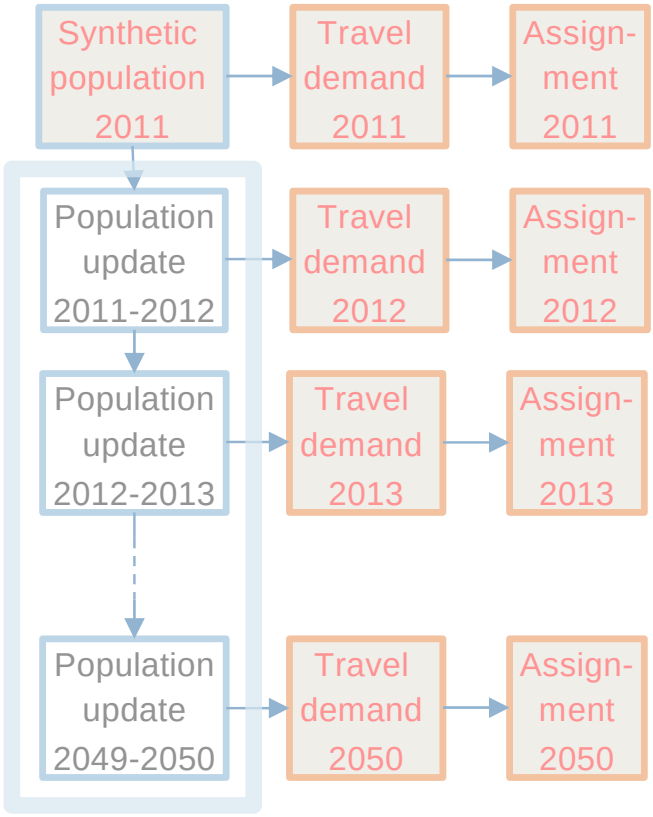
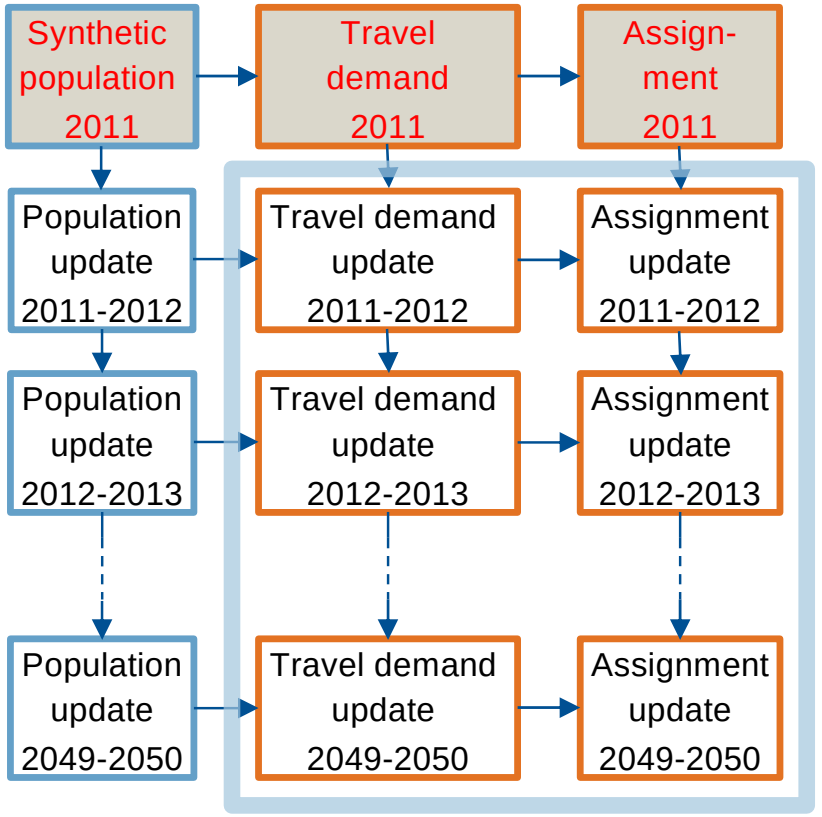


ABIT Model



Idea

- For most agents, copy weekly travel demand generated by ABIT from previous year
- For agents who experienced a major life event (birth of child, change of job, etc.), adjust travel behavior.
- Also, recalculate travel demand for agents where population, employment or travel times changed substantially within their common activity space.
- In the MATSim assignment, remove trips that were dropped, add new trips and keep everything else unchanged. Given the small changes, MATSim should reach an equilibrium again within a few iterations.

Dataset

German mobility panel

- weeklong travel diaries
- households asked to participate three years in a row
- Data of the last 9 years include 4,043 households and 6,508 persons
- Activities: work, education, shopping or errands, leisure or hobby, pick-up or drop-off, recreational round trips and other
- Modes: walk, bicycle, car driver, car passenger and public transport (city bus, long-distance bus, light rail, subway, regional and long-distance trains)

MOP-Wiederholraten											
Kohorte		*2016*		*2017*		*2018*		*2019*		*2020*	
		abs.	*%*	*abs.*	*%*	*abs.*	*%*	*abs.*	*%*	*abs.*	*%*
2016	*HH*	747	100%	577	77%	483	84%				
	P	1.273	100%	952	75%	793	83%				
2017	*HH*			806	100%	618	77%	539	87%		
	P			1.391	100%	1061	76%	911	86%		
2018	*HH*					744	100%	596	80%	544	91%
	P					1.264	100%	1009	80%	895	89%
2019	*HH*							718	100%	591	82%
	P							1.271	100%	1030	81%
2019	*HH*									828	100%
	P									1.536	100%
Gesamt	*HH*					1.845		1.853		1.963	
	P					3.118		3.191		3.461	

KIT Quelle: Deutsches Mobilitätspanel

Life events considered

1. Change in employment status of a person,
2. Change in household size,
3. Birth of a new child,
4. Change in household car ownership and
5. Household relocation.

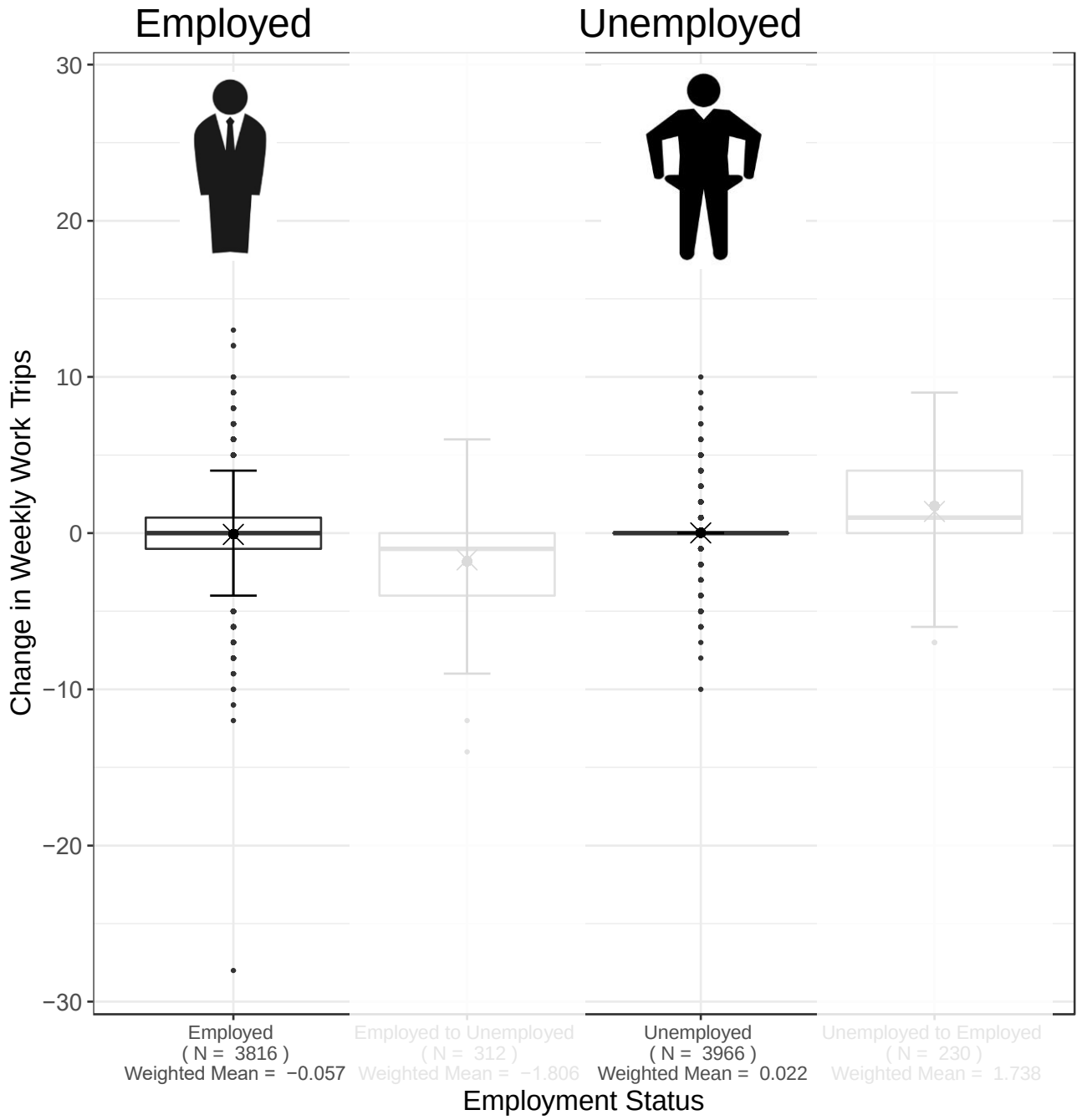
The number of weekly trips by purpose and mode were compared between people with and without such life events.

Number of Life Events	Persons	Proportion
0	7782	76.8%
1	1781	17.6%
2	464	4.6%
3	97	1.0%
4	13	0.1%
5	2	0.0%

Ignored so far due to uncertainty how multiple life events might interact

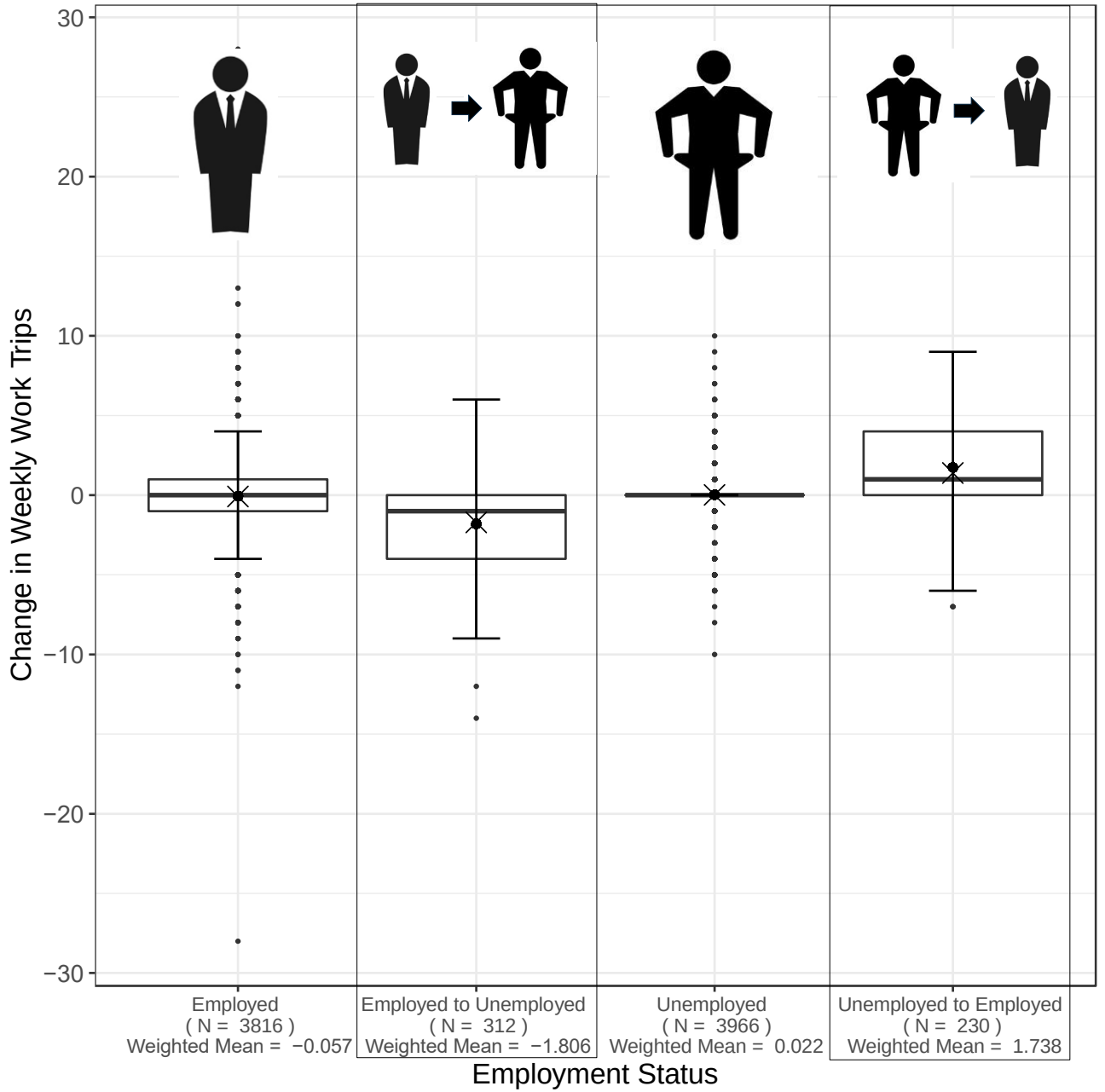
Change in employment status

Change in work trips



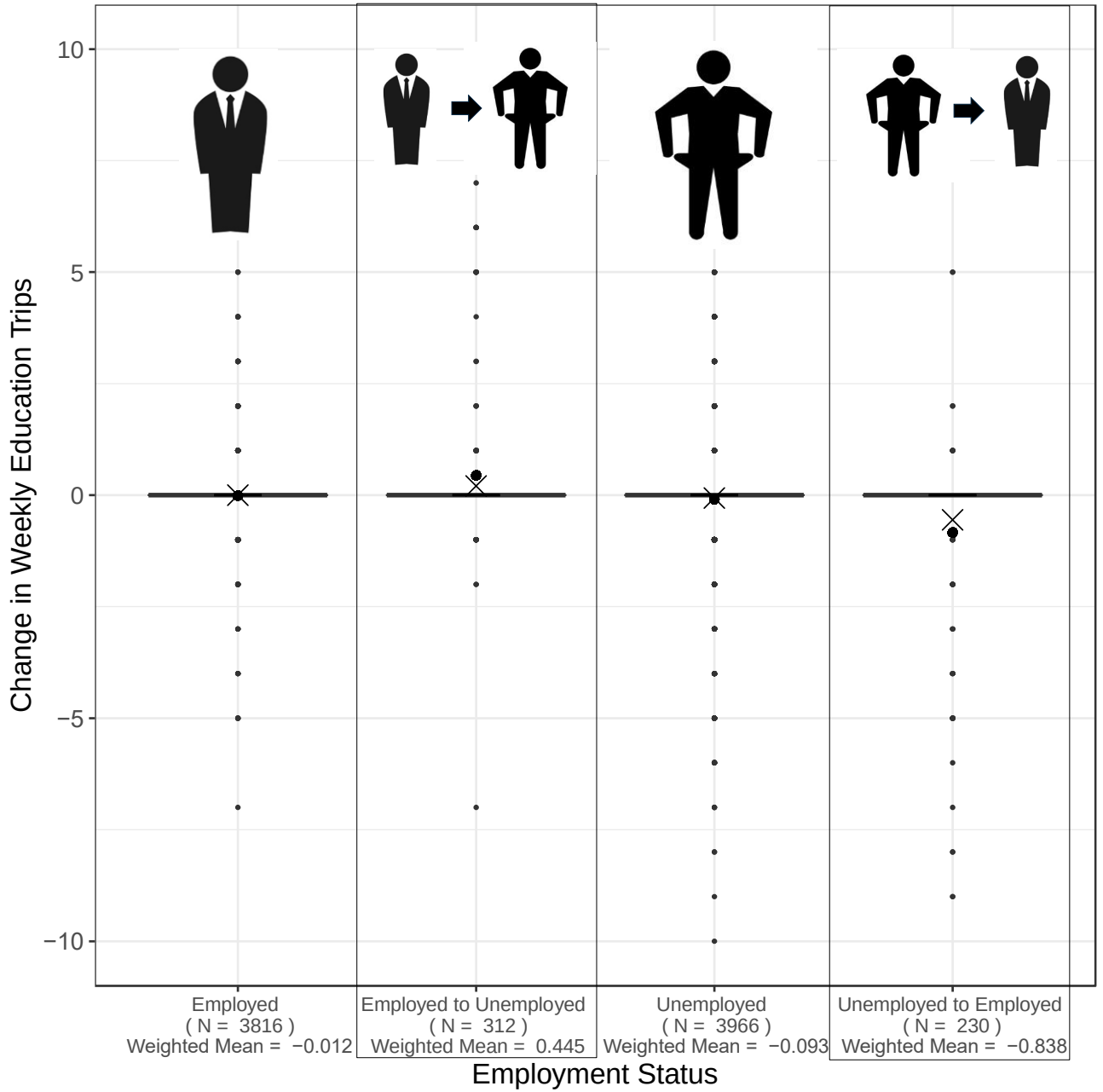
Change in employment status

Change in work trips



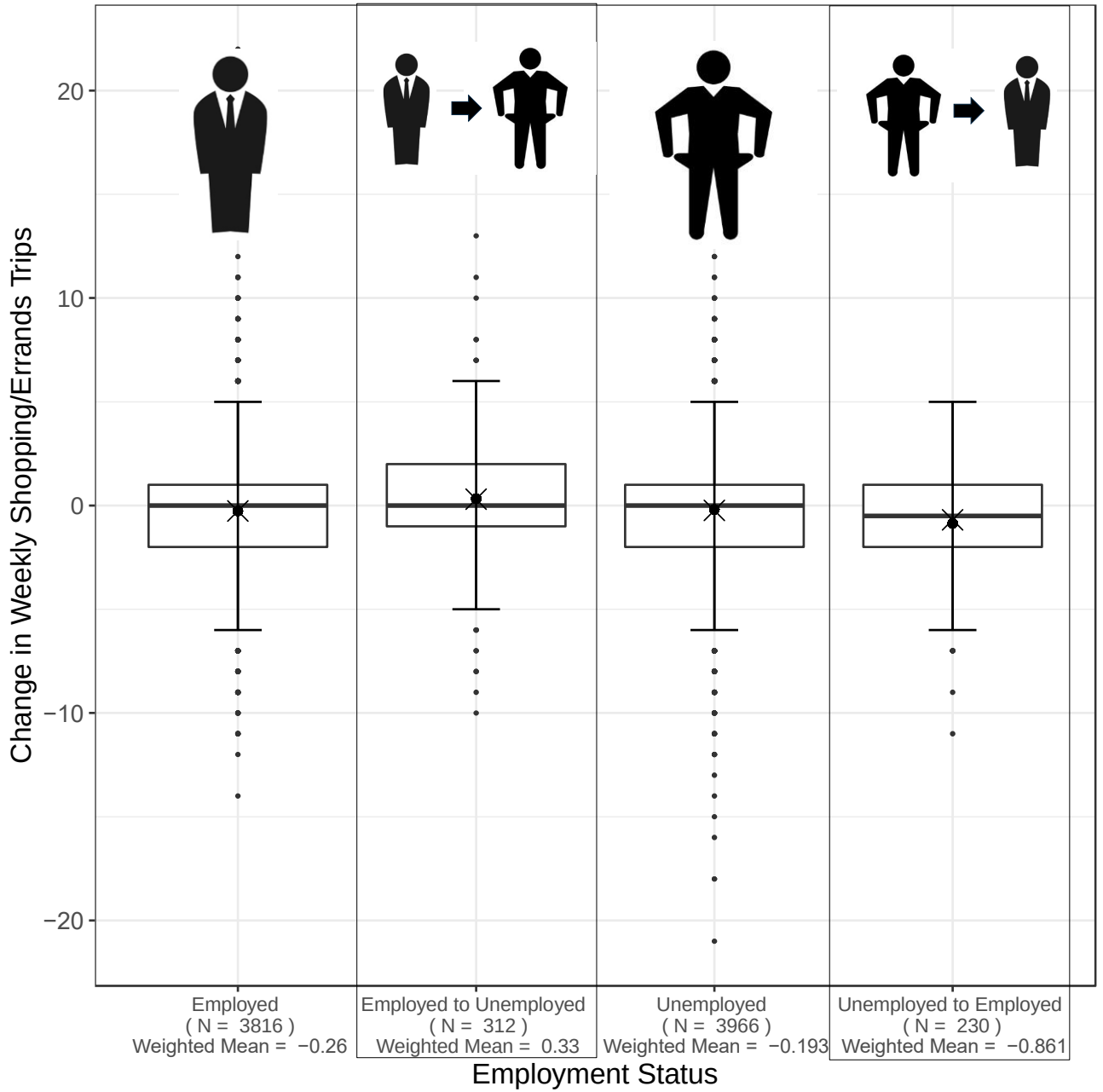
Change in employment status

Change in education trips



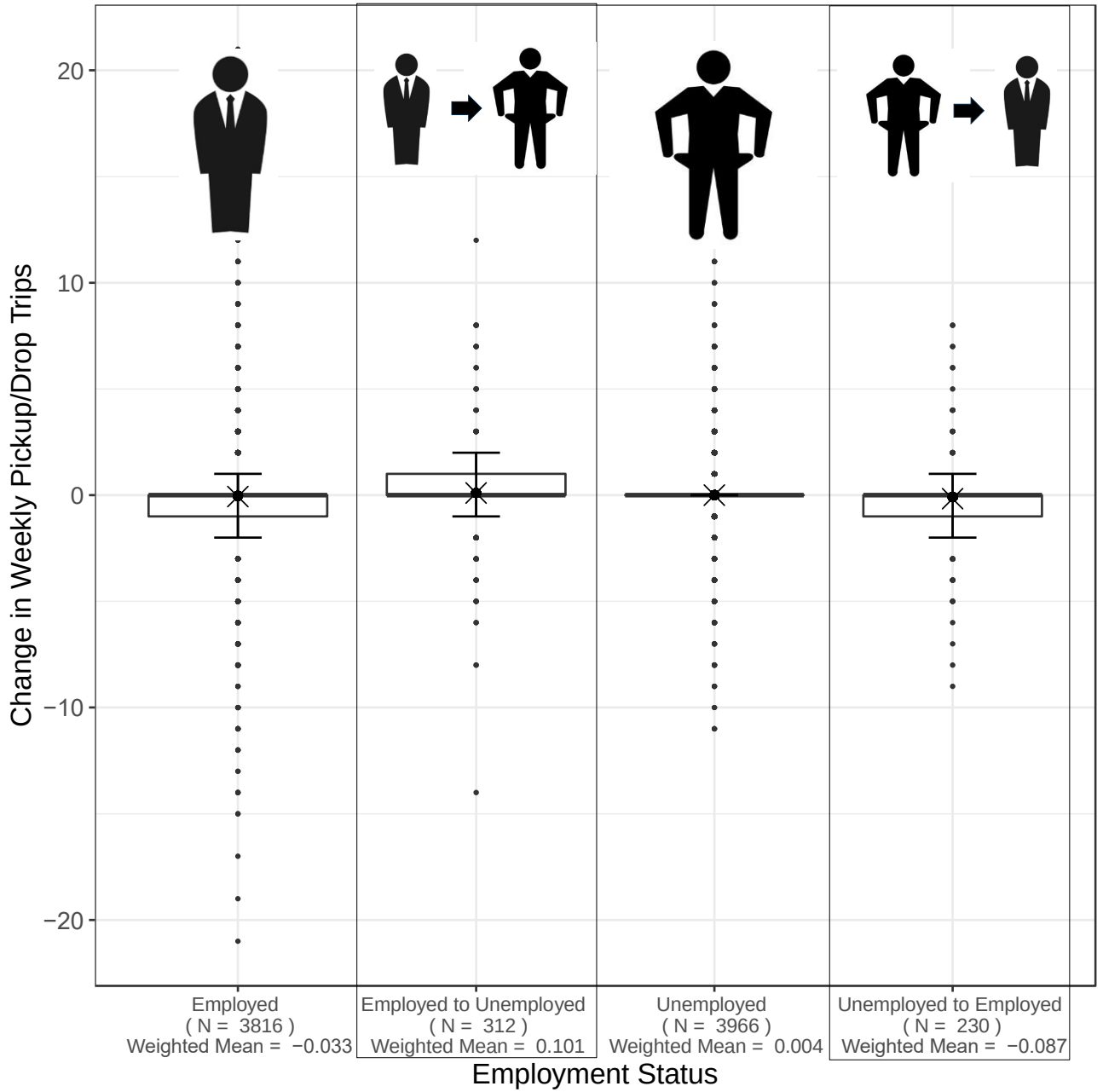
Change in employment status

Change in shopping trips



Change in employment status

Change in escort trips



Weighted average change in weekly number of trips by purpose and life event.

TABLE 2 Weighted average change in weekly number of trips by purpose and life event.

Car ownership	Work trips	Education trips	Shopping/ errand trips	Leisure/hobby trips	Pickup/ drop-off trips	Other trips	Recreational round trips
Zero	0.082	-0.108	-0.169	-0.175	0.026	0.265	0.014
Remained same	-0.035	-0.044	-0.236	-0.299	-0.022	0.175	0.011
Increased	-0.155	-0.063	0.011	0.072	-0.086	0.106	-0.216
Decreased	-0.329	-0.328	-0.734	-0.239	-0.21	0.092	0.052
Household size	Work trips	Education trips	Shopping/ errand trips	Leisure/hobby trips	Pickup/ drop-off trips	Other trips	Recreational round trips
No change	-0.015	-0.054	-0.225	-0.278	-0.014	0.19	0.012
Increased	-0.077	-0.062	-0.428	-0.146	0.702	0.12	-0.206
Decreased	-0.021	-0.052	-0.478	0.097	0.023	0.129	0.019
Child birth	Work trips	Education trips	Shopping/ errand trips	Leisure/hobby trips	Pickup/ drop-off trips	Other trips	Recreational round trips
Child born	-0.067	-0.191	-0.297	-0.437	-0.288	-0.146	-0.002
No child born	-0.015	-0.054	-0.225	-0.278	-0.014	0.19	0.012
Household move	Work trips	Education trips	Shopping/ errand trips	Leisure/hobby trips	Pickup/ drop-off trips	Other trips	Recreational round trips
Relocation	0.089	-0.122	-0.047	-0.356	-0.063	0.328	-0.47
No relocation	-0.015	-0.054	-0.225	-0.278	-0.014	0.19	0.012
Employment status	Work trips	Education trips	Shopping/ errand trips	Leisure/hobby trips	Pickup/ drop-off trips	Other trips	Recreational round trips
Employed	-0.057	-0.012	-0.26	-0.193	-0.033	0.161	0.005
Employed to unemployed	-1.806	0.445	0.33	0.003	0.101	0.524	-0.118
Unemployed	0.022	-0.093	-0.193	-0.354	0.004	0.216	0.018
Unemployed to employed	1.738	-0.838	-0.861	-0.554	-0.087	0.122	-0.02
Total*	-0.039	-0.083	-0.223	-0.29	-0.027	0.185	-0.001

* Includes total population with and without life event as shown in Table 1

Discussion

It is hypothesized that the incremental model requires smaller constants than traditional activity-based models that recreate travel behavior from scratch.

It is further hypothesized that the incremental runs much faster than traditional activity-based models, as most activities and travel choices are copied from the previous year.

There are still ‘unexplainable’ changes in travel behavior that would still require some random effect in agent-base models.
However, the more elements we are able to move from random effect to explainable effects with empirical evidence, the more meaningful the policy sensitivities in transport models will become.

Thank you

For more information, visit our ABIT wiki:

https://wiki.tum.de/display/msmmodels/abit

Download the code

https://github.com/msmobility/abit

Acknowledgment

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