The Activity-based Incremental Model (ABIT)

Modeling 24 hours, 7 days per week

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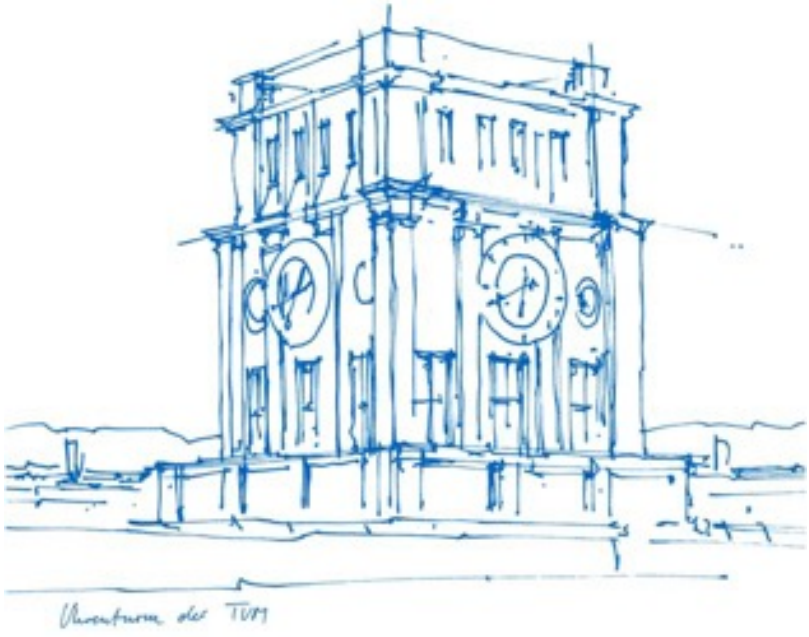

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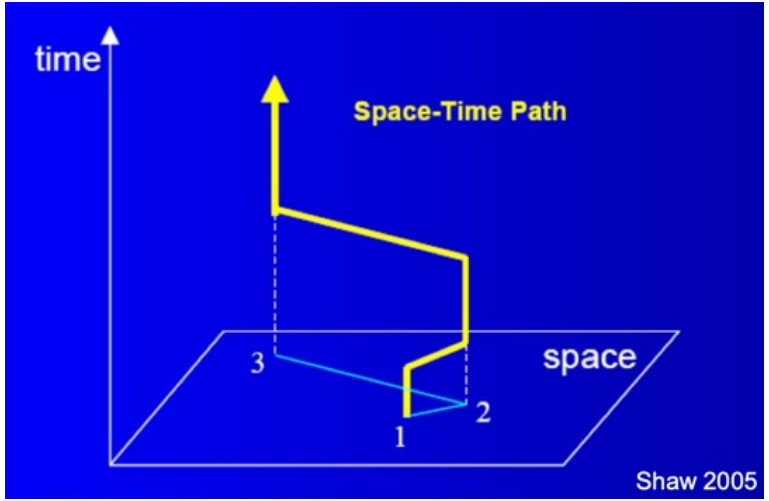
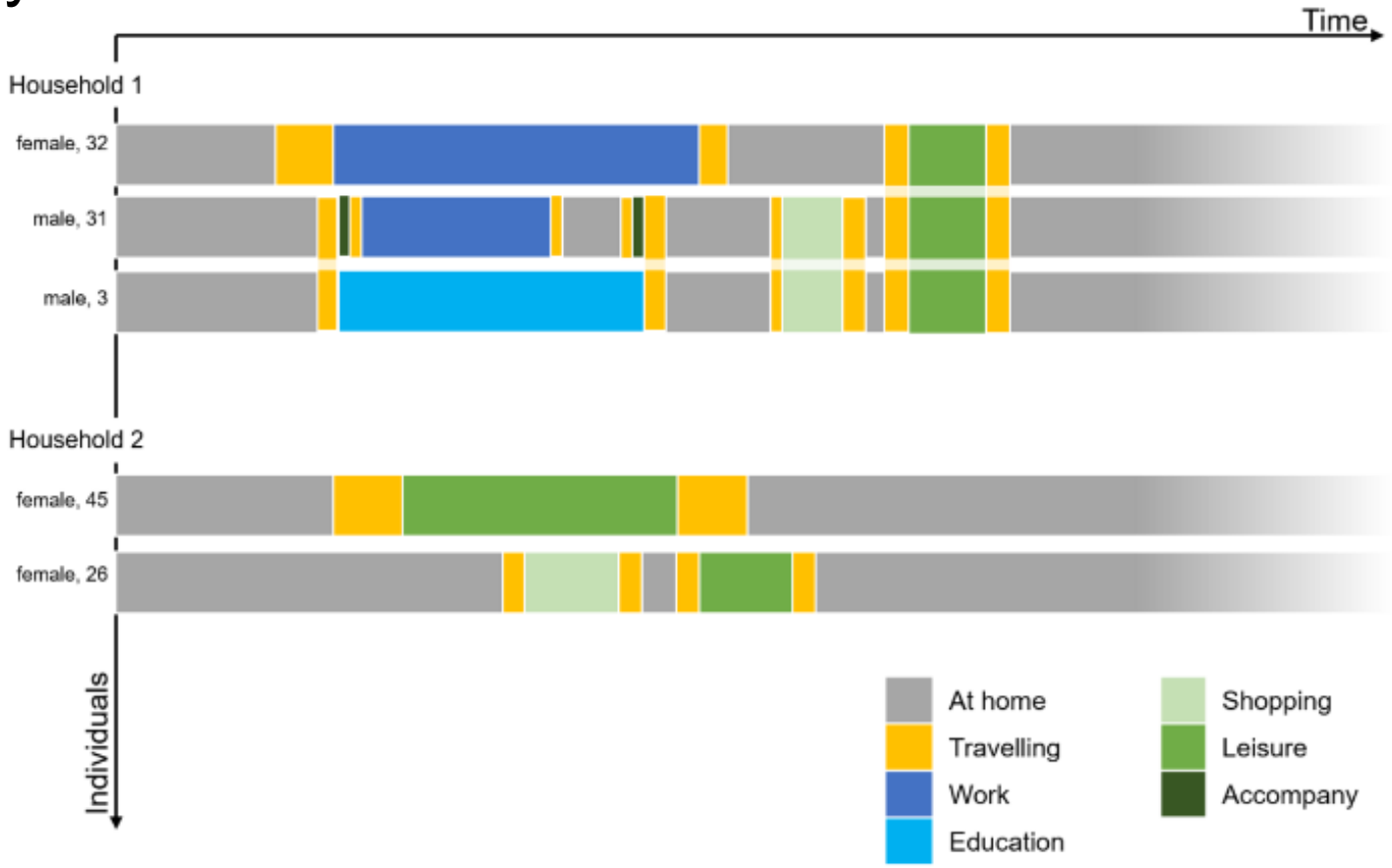
2. Simulating Weekly Demand
3. Simulating Year-to-year Incremental Updates

Activity-based Modelling

- Travel represented **the need to change location between activities**
- People (and their vehicle) can only be in one place at a time
- More behaviorally realistic
- Easier to explain to policymakers and stakeholders
- Expands modelling possibilities & potential scenarios, e.g.,:
  - EV charging infrastructure
  - Impacts of telework on other activities
  - Pricing studies
  - Autonomous vehicles
  - Ride-hailing
  - Health

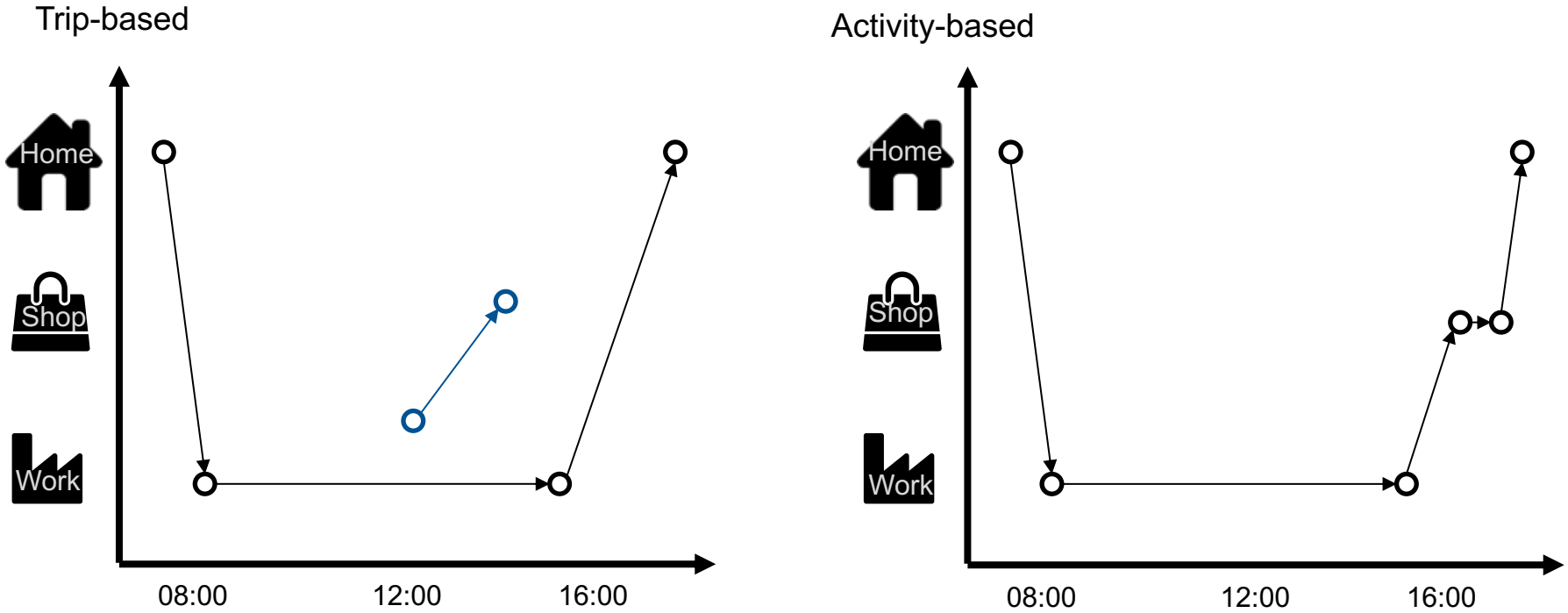


Activity schedule

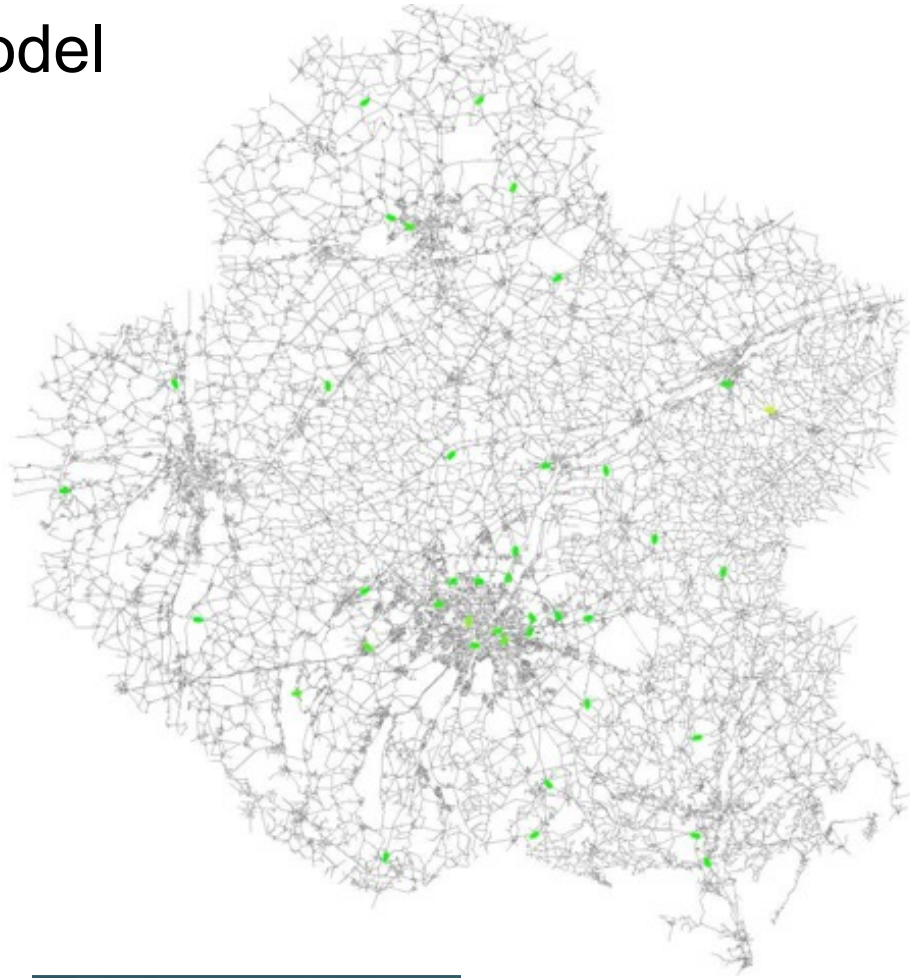


Trip based vs. Activity-based consistency

Temporal and spatial representations in TDM: Home->Work->Shopping->Home



The MATSim Transport Model



- “Multi-agent Transport Simulation”
- Open source
- https://www.matsim.org
- Activity-based simulation framework

Habits and Day-to-day Stability

Travel demand is typically modelled for a typical “hour” or “day”

Not always sufficient to to model a peak “hour” or “day”, e.g.,

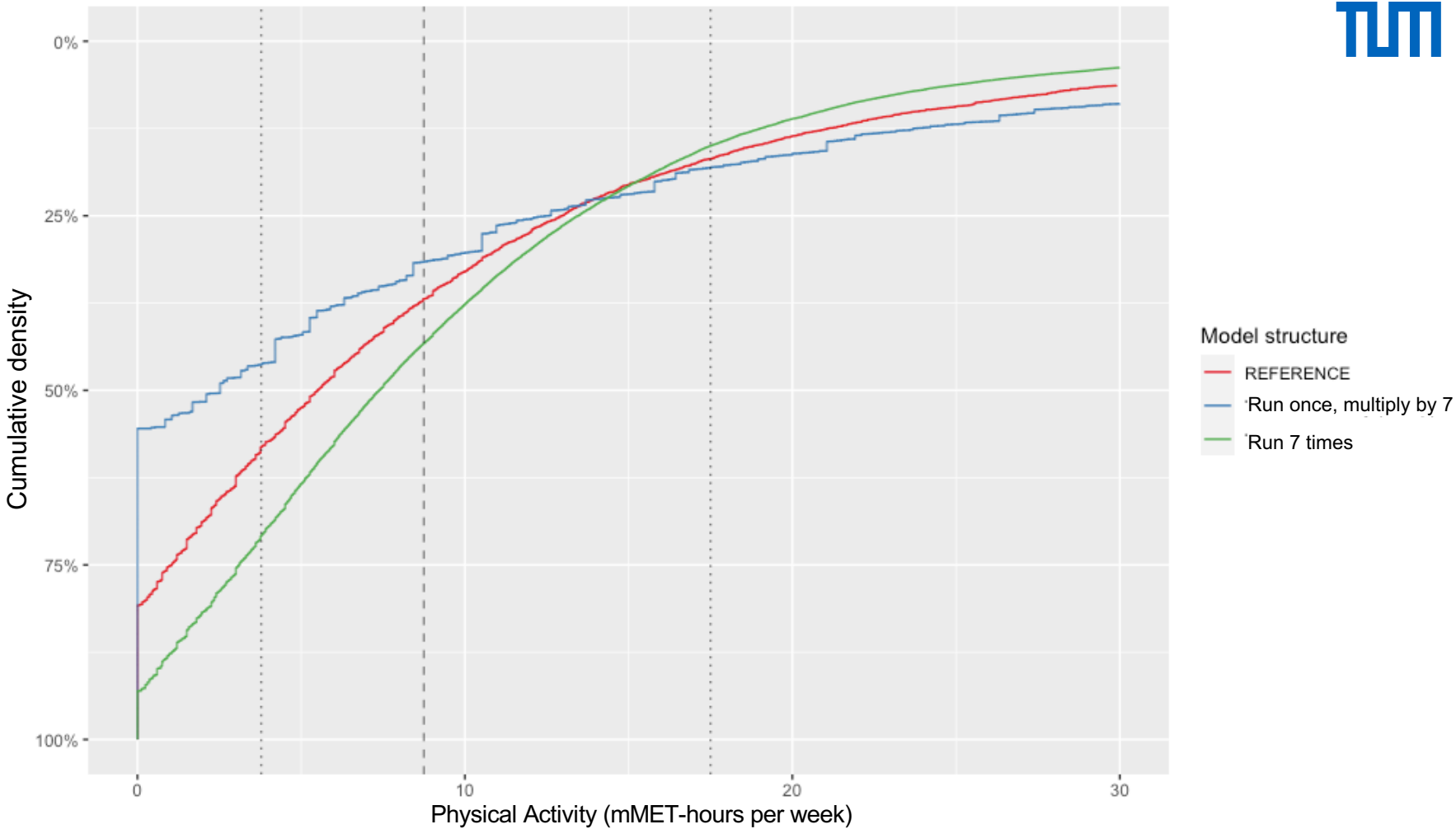
- Person-centric policy assessments *(Jones and Clarke, 1988)*
- Environmental exposures
- Health *(Staves, 2020)*

Longer-term models create challenges in capturing **stability** and **variability** in people’s behavior.

Example: You have a 1-day model, but needed a 7-day result (e.g., weekly physical activity)

- Run the 1-day simulation, multiply outputs by 7 → Too much ***stability***
- Run the 1-day simulation 7 separate times → Too much ***variation***

Simulating Weekly Physical Activity with a 1-day Model



Beyond 7 Days: Longer-term stability

- Travel behaviour differs from day to day (Raux et al. 2016) but 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 behaviour fundamentally.
- But for most people, such changes are rare, and travel behaviour 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.

Key Aims

The Activity-based incremental model (ABIT) aims to:

- **Integrate** within a land-use and transport model
- Simulate a **full week** of activity-travel behavior for each agent
- Simulate **incremental updates each year** with changes to life events

Development of the Activity-based Incremental Model (ABIT)

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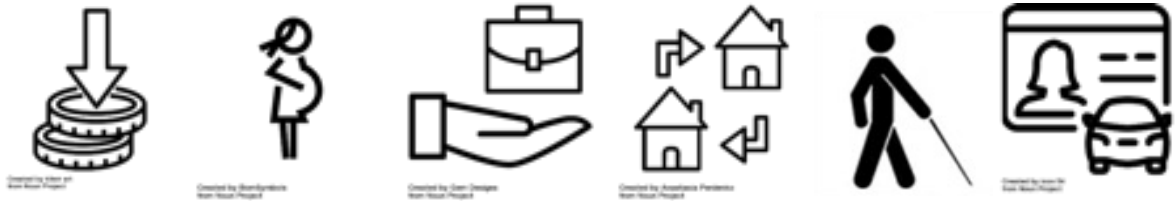
Data

- **German Mobility Panel** data (2010 - 2019):
  - Respondents were asked to participate in **3 consecutive years**
  - Each year, participants provide:
    - A **7-day trip diary**
    - Socio-demographic attributes
    - Mobility resources
  - Raw data: 589,357 trips of **25,449 individuals**

- Data were reduced to obtain:
  - **Active days by purpose**
  - **Life events**



Final sample: **9645 individuals, 220440 activities**

Munich metropolitan region

- Municipalities where at least 25% of workers commute to Munich, Augsburg, Ingolstadt, Rosenheim or Landshut

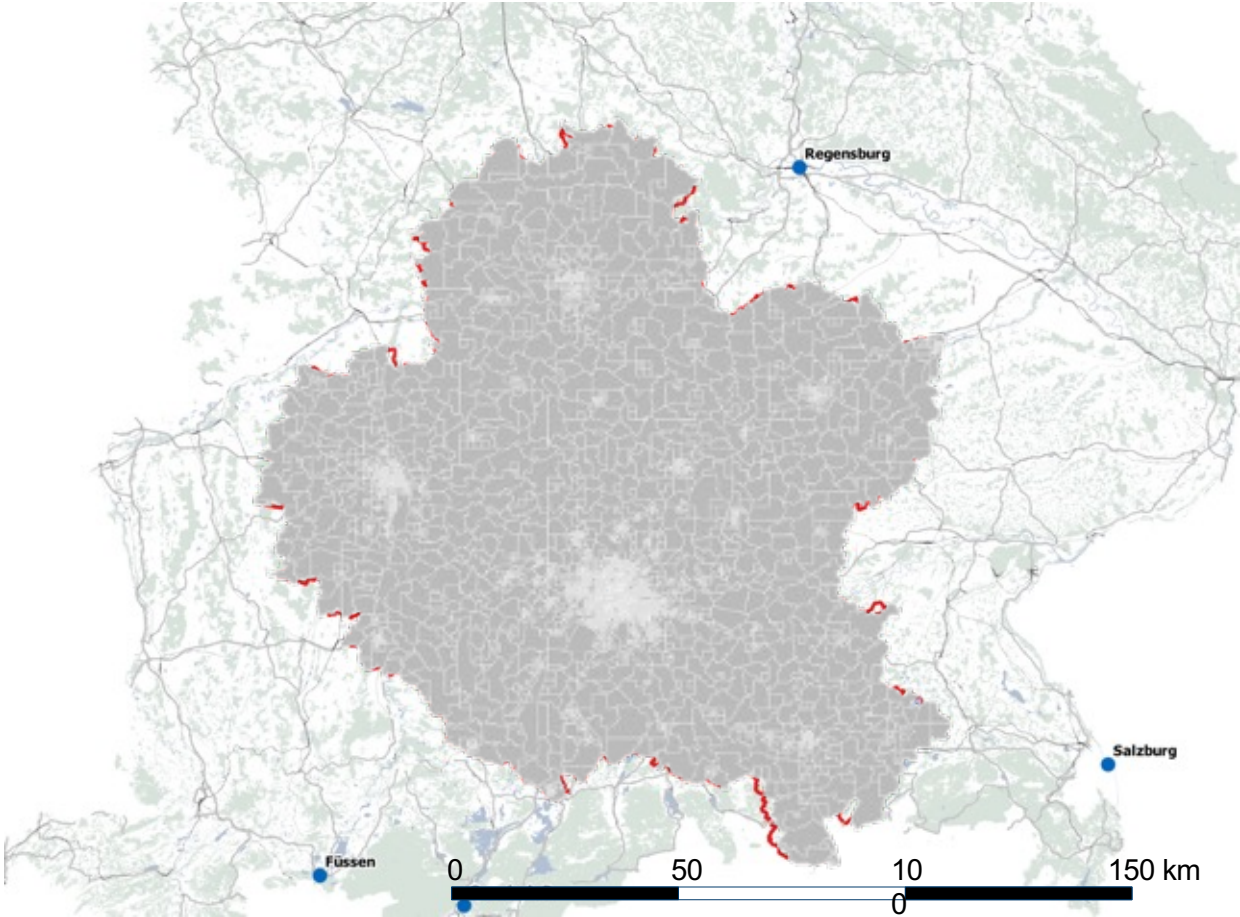
4,4 million inhabitants

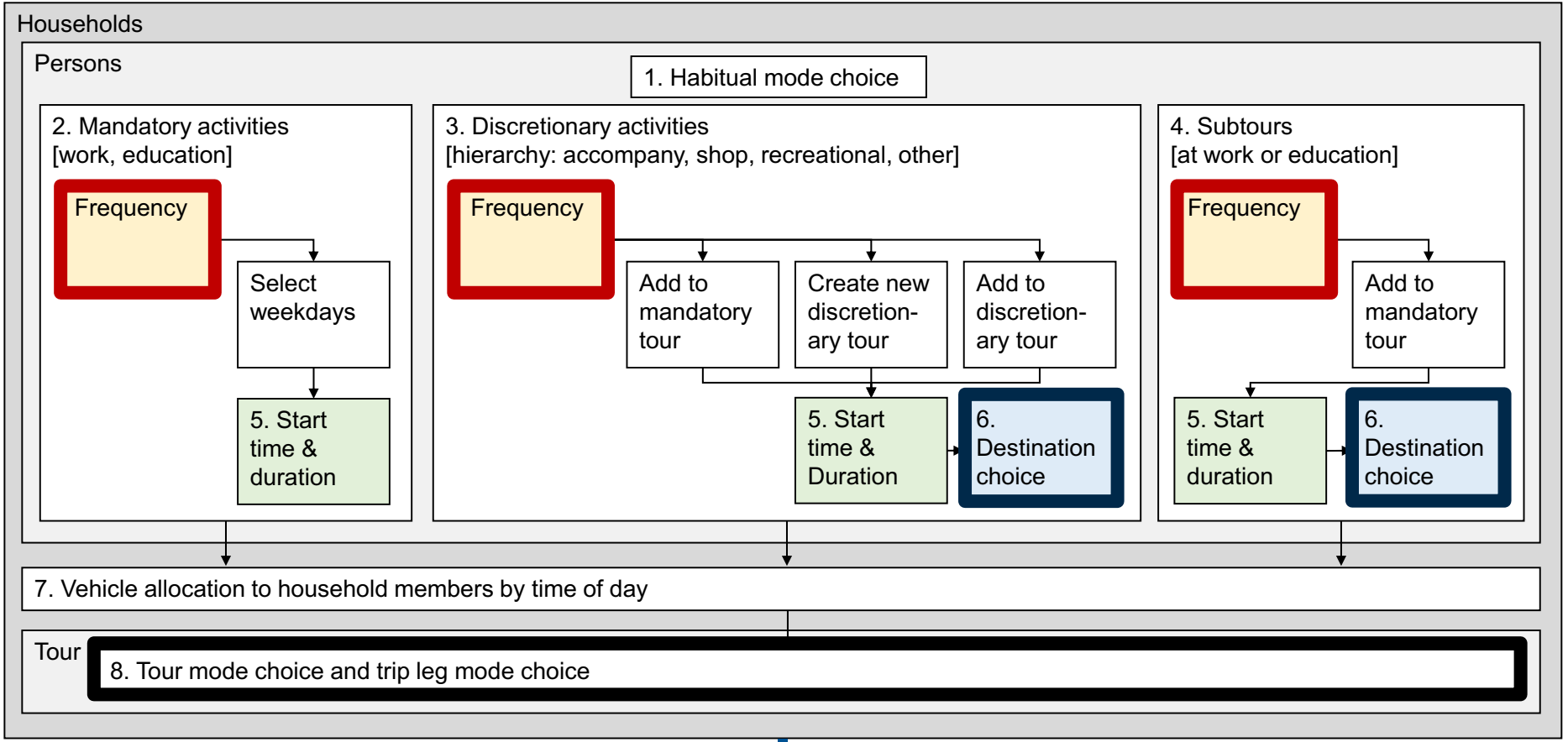
444 municipalities

1,7 million jobs

14 million trips/day

~ 5,000 Zones




Households
Persons
1. Habitual mode choice
2. Mandatory activities
[work, education]
Frequency
Select weekdays
5. Start time & duration
3. Discretionary activities
[hierarchy: accompany, shop, recreational, other]
Frequency
Add to mandatory tour
Create new discretion-ary tour
Add to discretion-ary tour
5. Start time & Duration
6. Destination choice
4. Subtours
[at work or education]
Frequency
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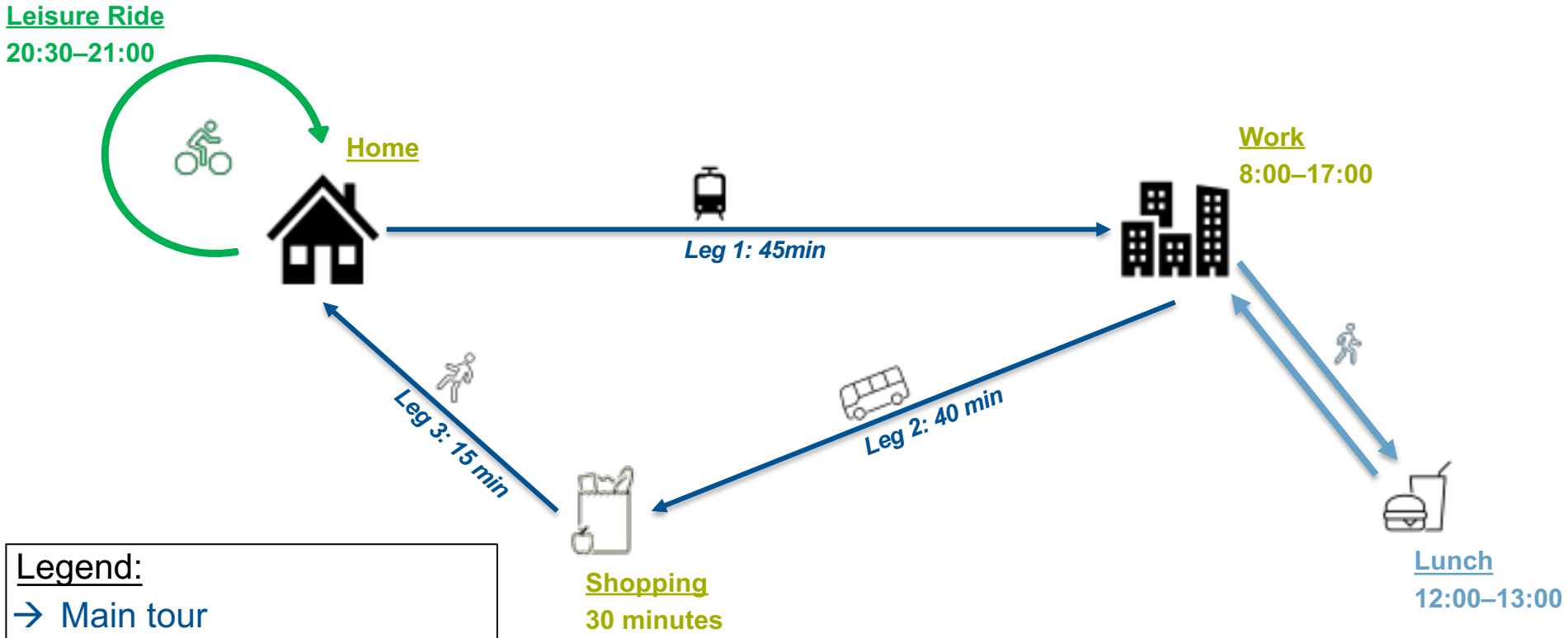
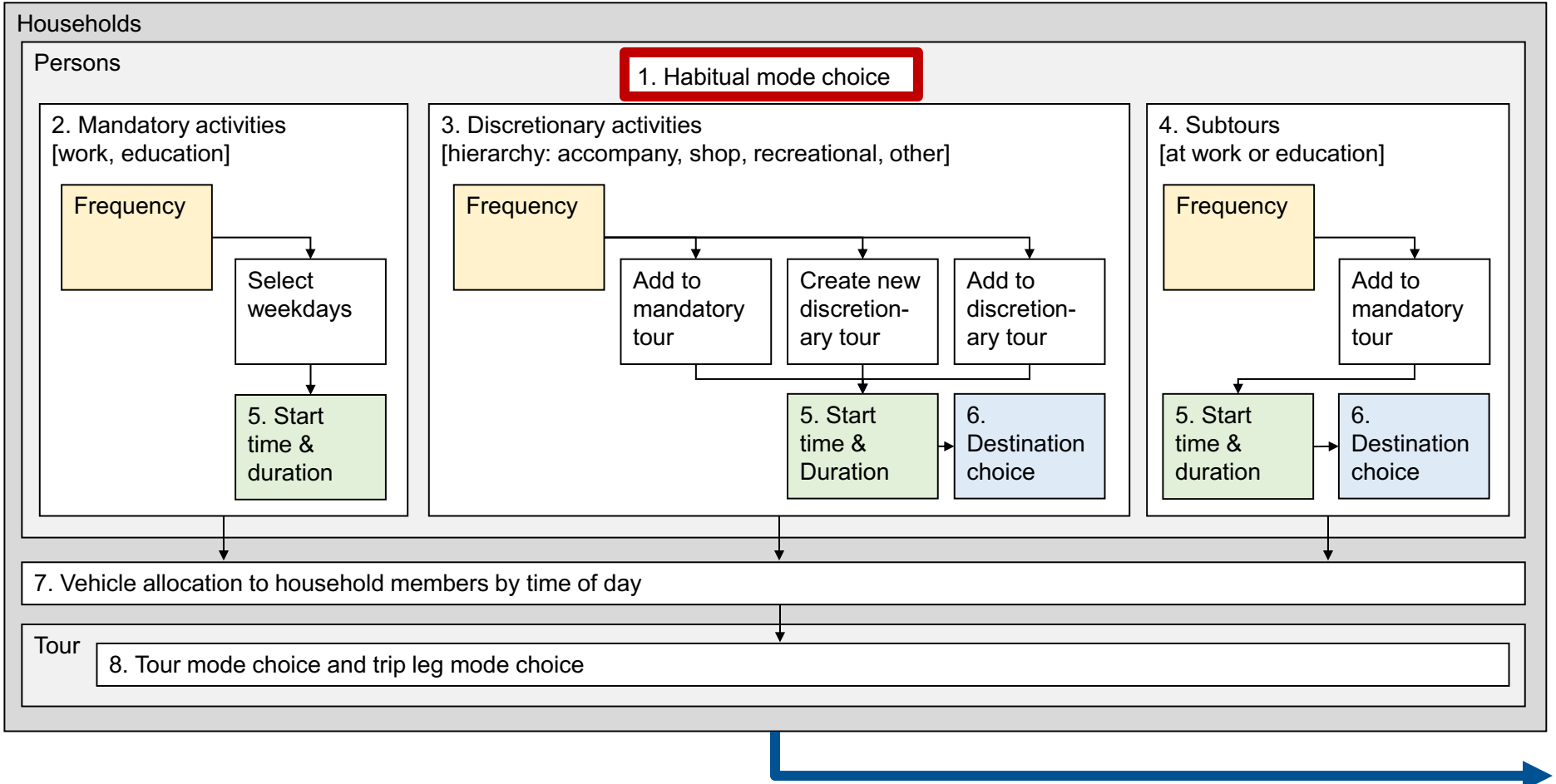
7. Vehicle allocation to household members by time of day
Tour
8. Tour mode choice and trip leg mode choice
To assignment in MATSim…

Example output (1 day)

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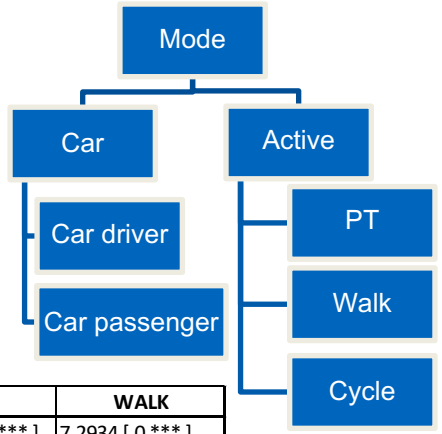
Habitual mode: maintaining day-to-day stability

Nested-logit model estimated using 5601 records

- **Output:** mode used **the most often** for work tours
- **Input:** sociodemographic attributes, household & workplace location

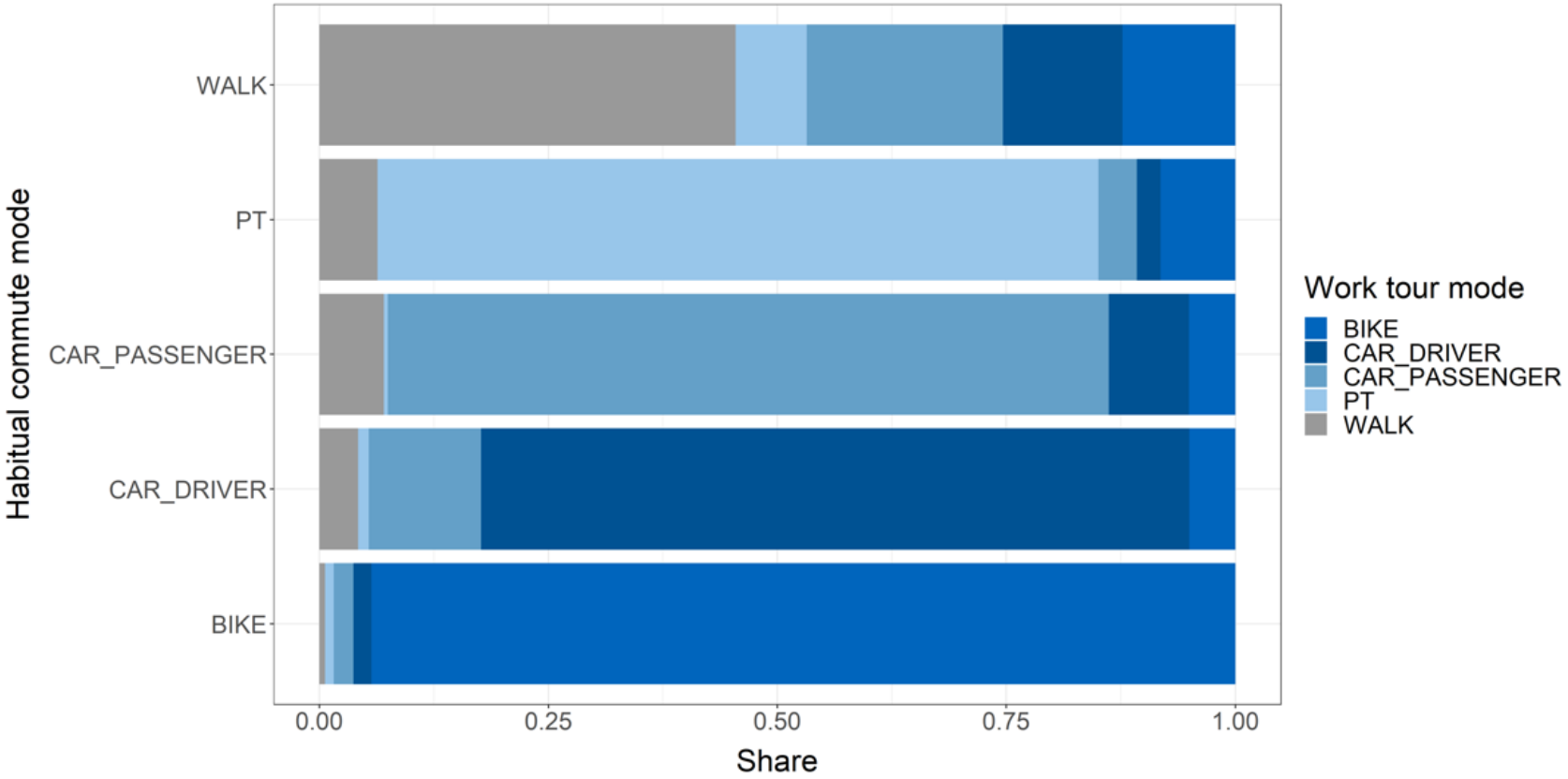
Influences other decision-making, including:

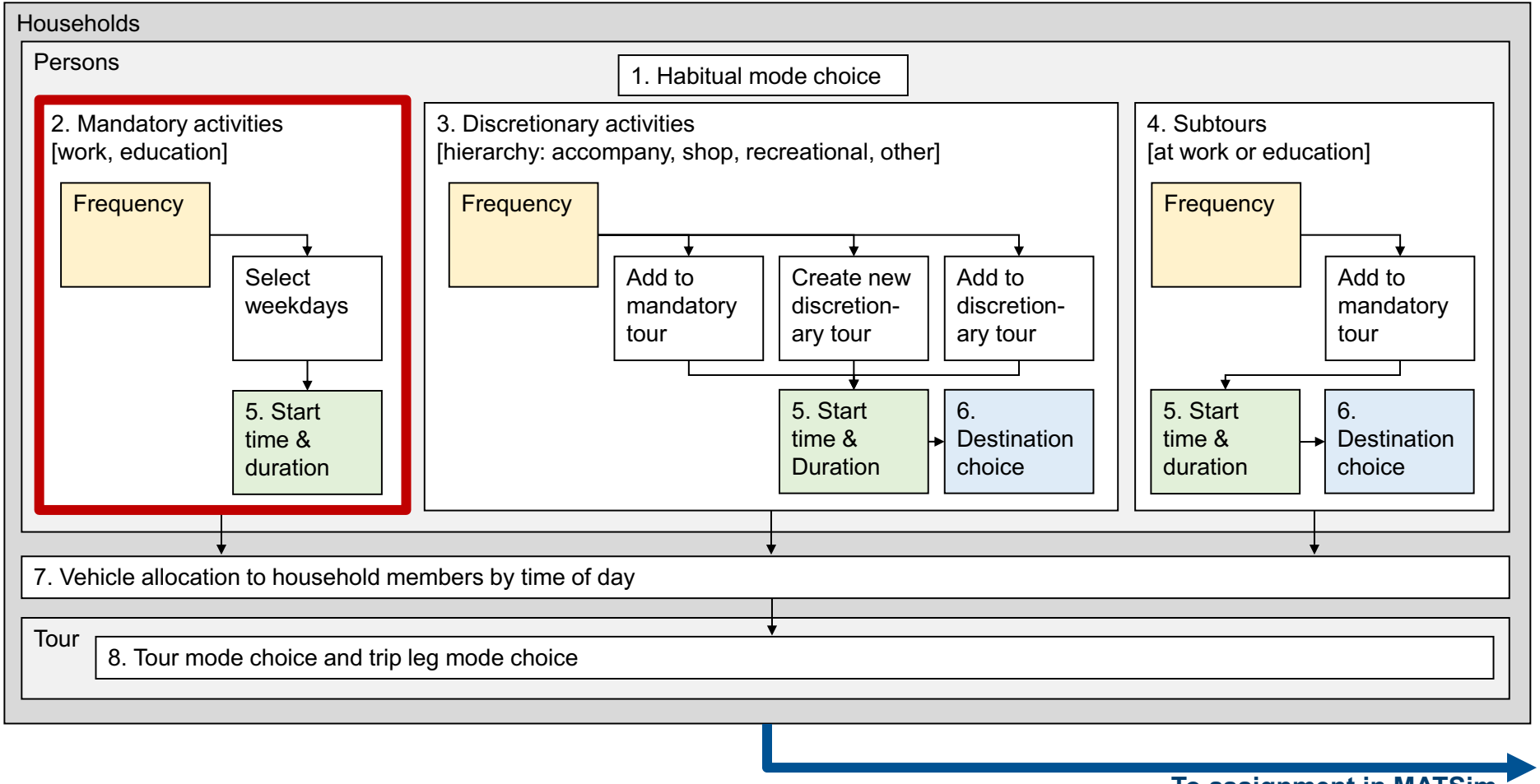
- **Mode choice** for individual tours and legs
- **Trip chaining** of discretionary activities



Attribute	Value	CAR_DRIVER	CAR_PASSENGER	PT(train, tram, metro, bus)	BIKE	WALK
Intercept		0	3.4247 [0 ***]	4.1495 [0 ***]	3.8822 [0 ***]	7.2934 [0 ***]
Household region type	Urban	0	-0.3942 [0.004 **]	1.1804 [0 ***]	0.4984 [0 ***]	0.2806 [0.065 .]
	Not urban					
Household size	1 - 5	0		-0.1377 [0 ***]		-0.2772 [0 ***]
Cars per adult in household	Ratio from 0 - 1	0	-2.2089 [0 ***]	-3.8021 [0 ***]	-3.699 [0 ***]	-2.9195 [0 ***]
Sex	Female	0		-0.111 [0.153]	-0.3697 [0 ***]	-0.3215 [0.022 *]
	Male					
Drivers license	Yes	0	-3.7583 [0 ***]	-3.8433 [0 ***]	-2.9566 [0 ***]	-3.4793 [0 ***]
	No					
Bicycle ownership	Yes	0	-0.3597 [0.029 *]	0.337 [0.001 **]	2.2101 [0 ***]	0.449 [0.021 *]
	No					
Occupation status	Student	0	0.218 [0.271]	1.2644 [0 ***]	0.6519 [0 ***]	0.9966 [0 ***]
	Employed, half-time, unemployed					
Travel time		-0.8577 [0.01 *]	-1.2337 [0.001 **]	-0.35 [0.133]	-2.117 [0 ***]	-2.6837 [0 ***]
Nesting coefficient		0.8343		0.8955		
McFadden's R2	**0.54**					

Results: Differentiated by habitual commute mode

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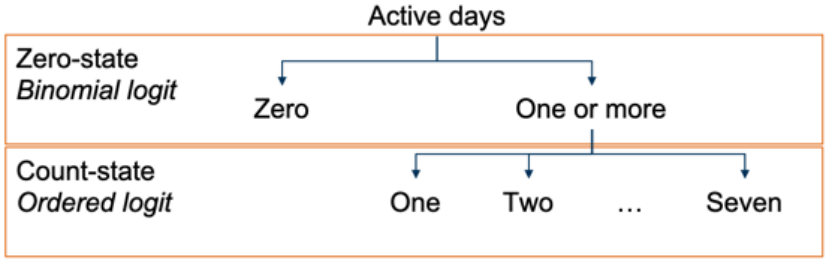
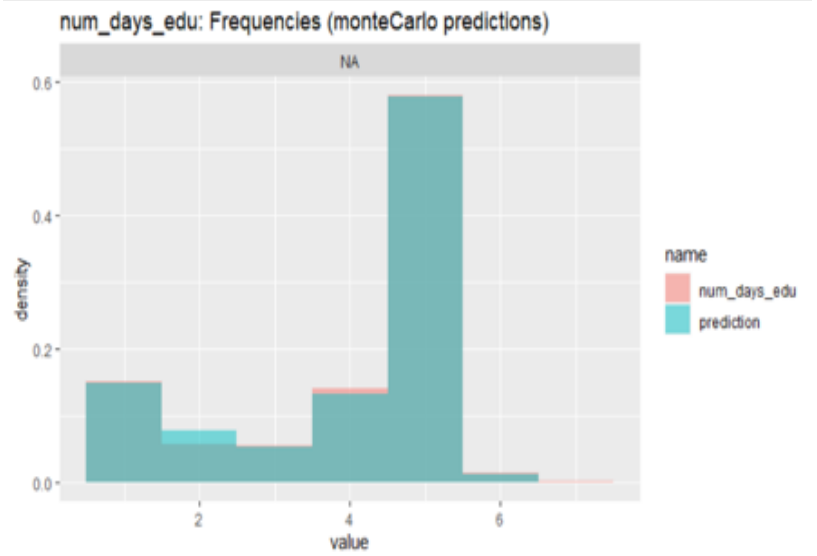
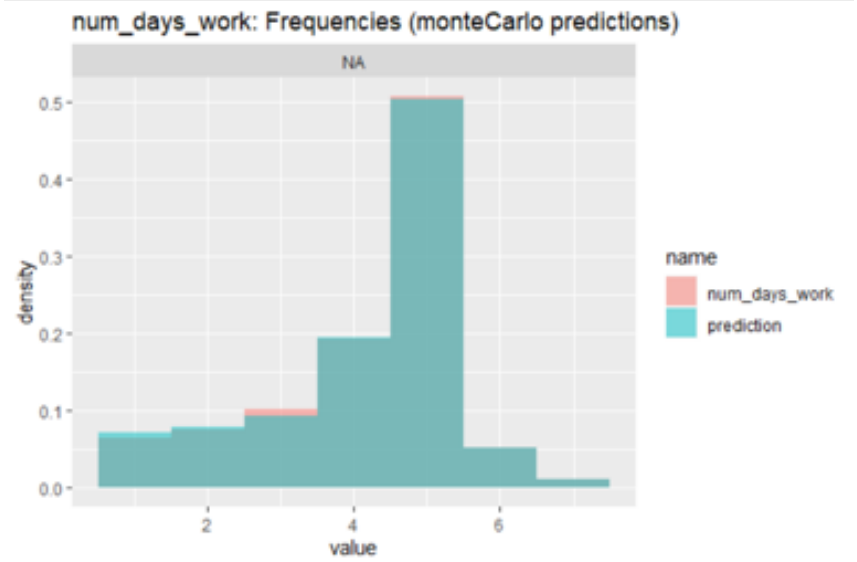
Commute tour frequency

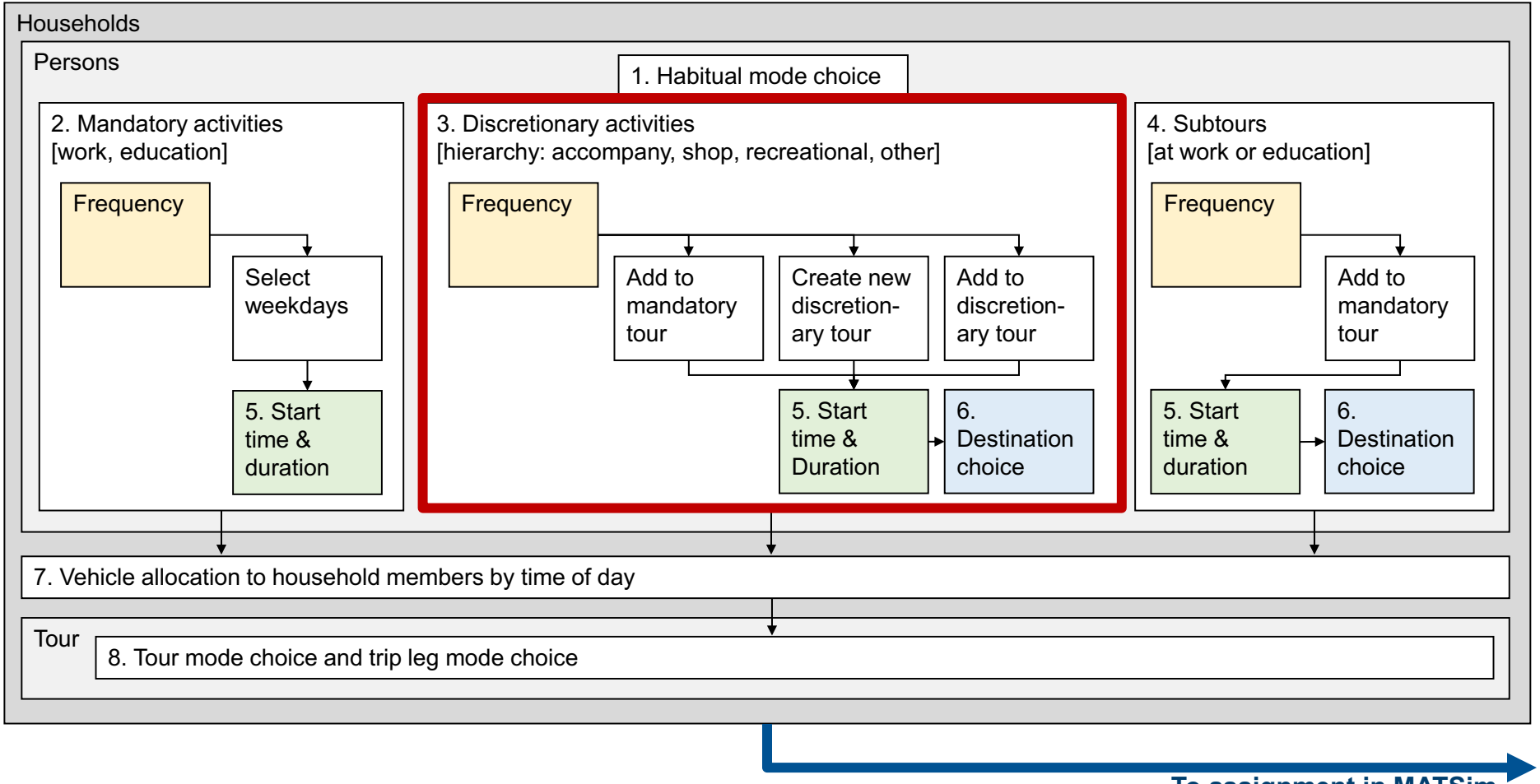
Zero-inflated ordered logit

- Estimates frequency of commute tours
- Every tour starts/ends at home





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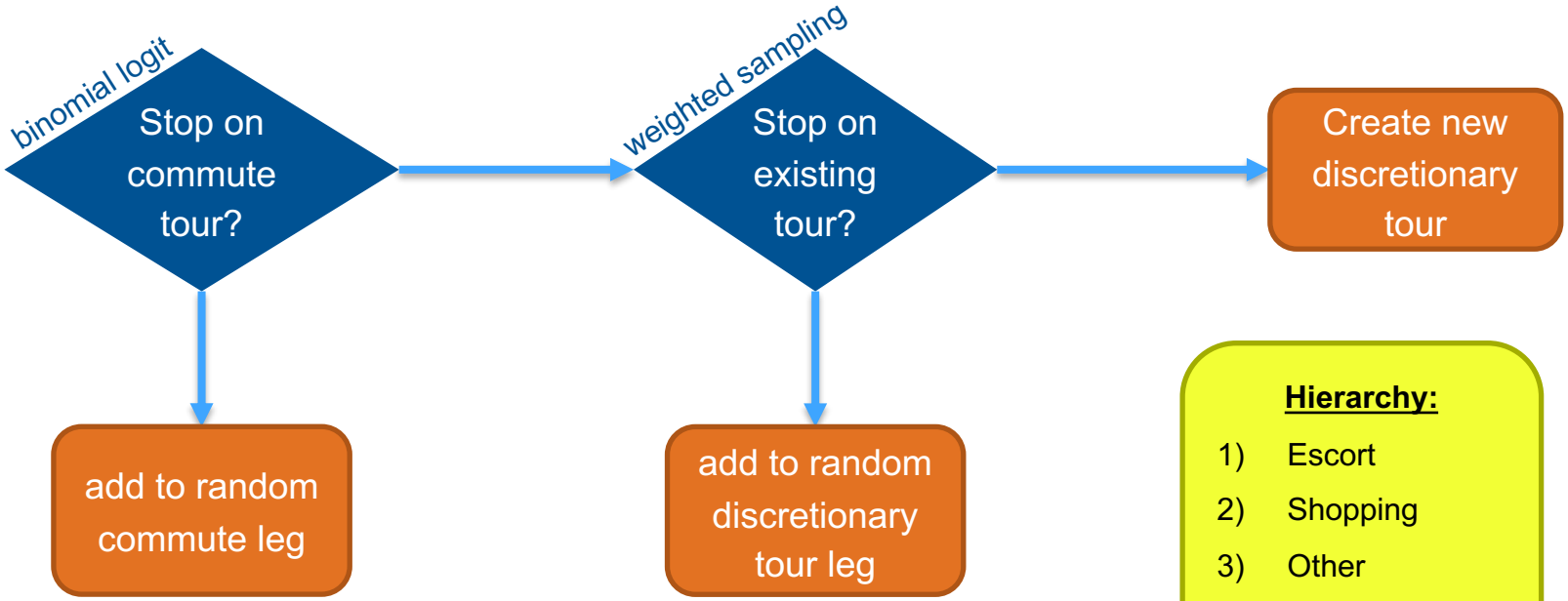
Discretionary Activities

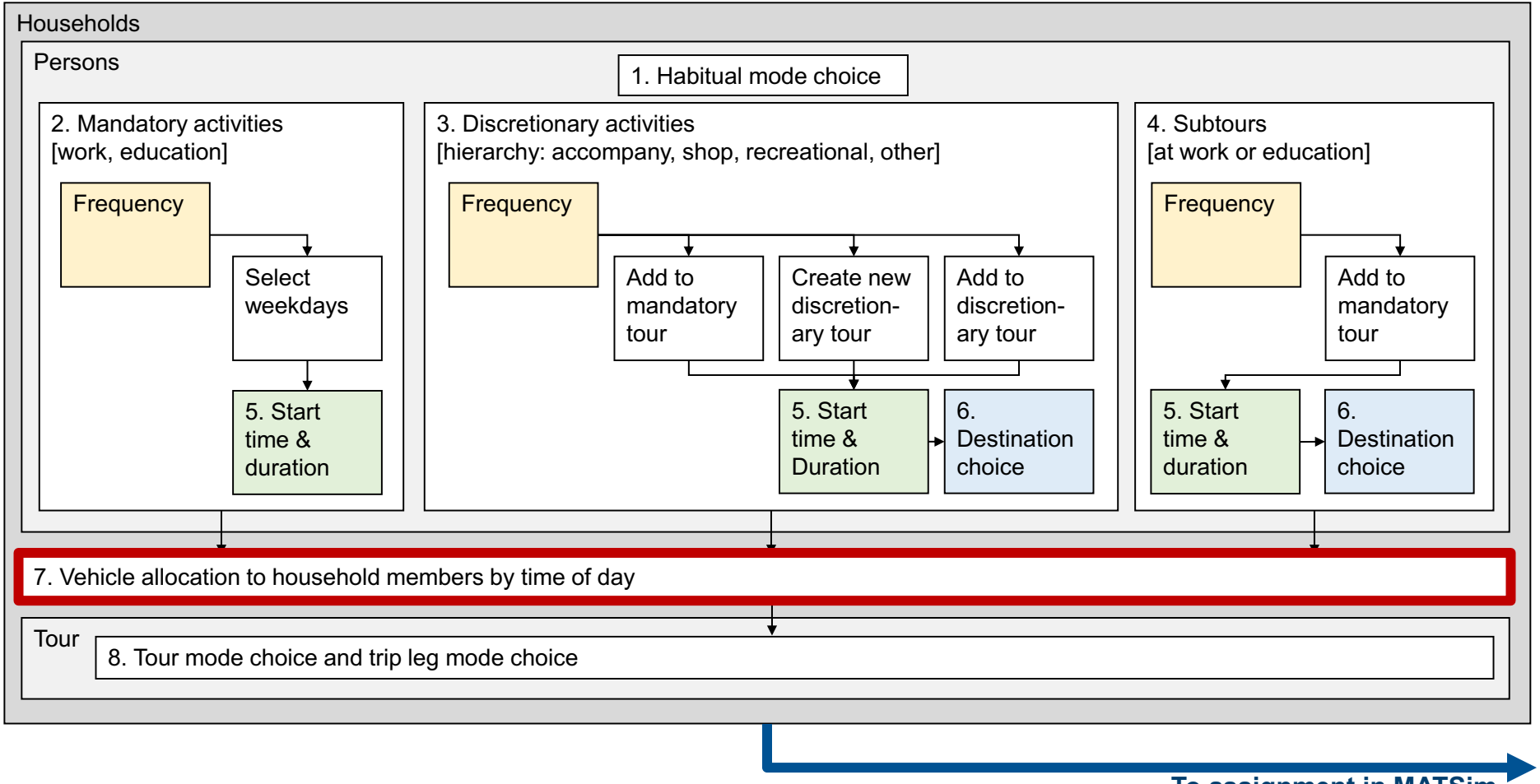
Steps:

1. Frequency for each purpose (method: **zero-inflated negative binomial** models)
2. Decide where to put them:



Subtours

- **Definition:** a tour that starts and ends at the **school** or **workplace**
- **Method:** Binary logit, for every commute tour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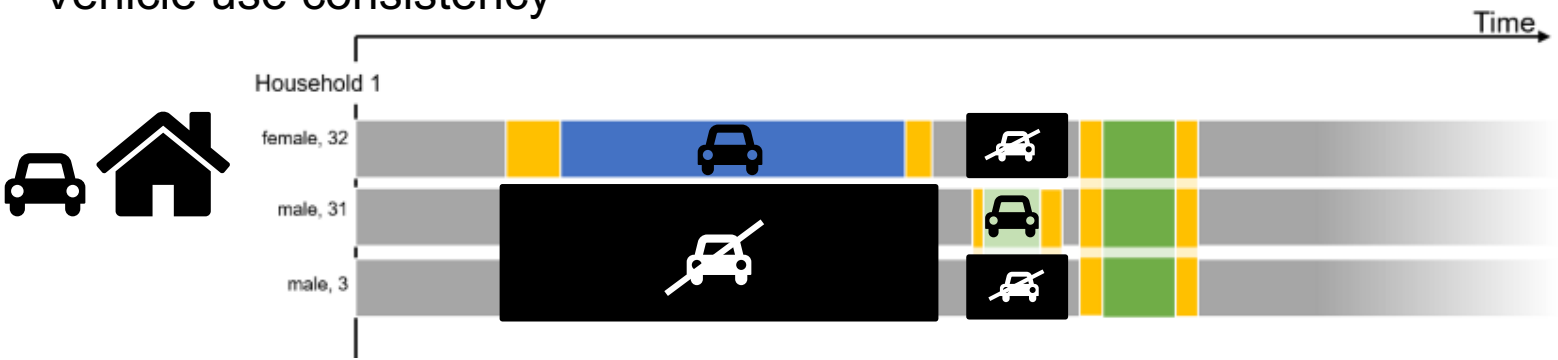
Activity-based travel demand model overview

Vehicle use consistency



Priority given to the user with **greatest benefit** of using car, considering

- Trip purpose
- Travel times
- Driver's license

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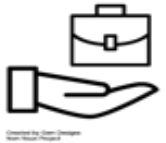
Simulating Year-to-year Incremental Changes

Empirical analyses have shown for a long time that travel behavior tends to be rather stable from year to year *(Kitamura and Hoorn, 1987, Jones, 1988)*, unless some life event occurs

Strong association between changes commute mode and life events *(Clark et al., 2014)*

Patterns of time use before and after key events differ by gender *(Schneider, 2016)*

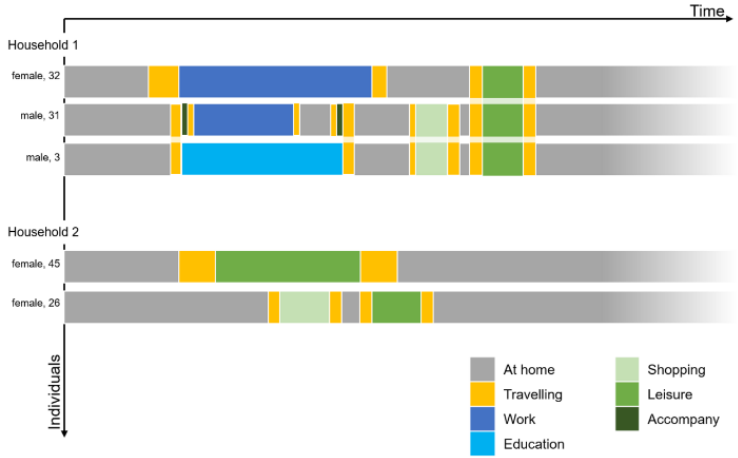
Changes in **employment status** triggers the largest difference in commute frequency *(Moreno et al., 2023)*



Discussed further in "*Understanding the Impact of Life Events on Travel Behaviour Change via Machine Learning*" (Moreno et al, Session 16)

ABIT: Activity-based travel demand model overview

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)



Graphical representation of sample tour plans for households

- See further descriptions at : https://wiki.tum.de/display/msmmodels/abit
- Code: https://github.com/msmobility/abit (under development)

Thank you!