# Modelling mobility tool availability at a household and individual level:

## A case study of Switzerland


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Angebotsplanung

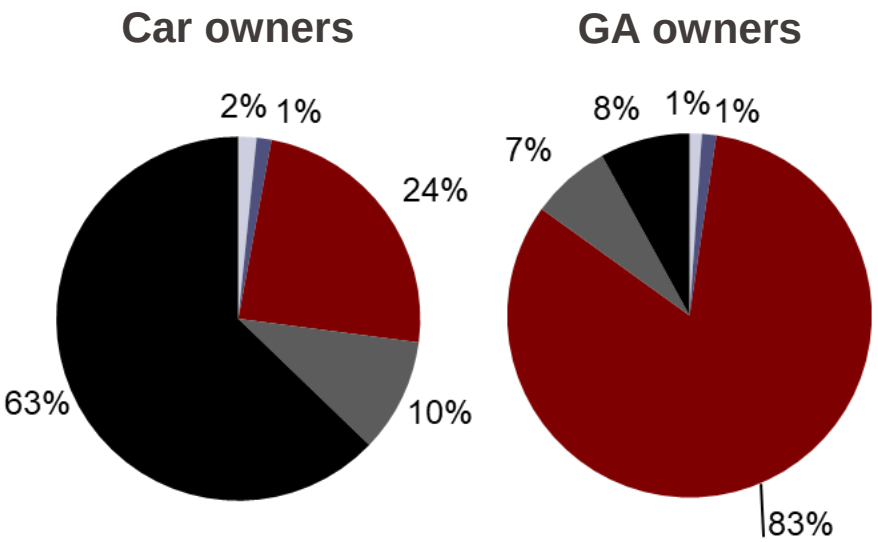
Schweizerische Bundesbahnen SBB AG

SBB CFF FFS

EPFL

# Ownership of mobility tools

Person-kilometers by transport mode:




- trips with origin and destination inside CH
- Mon through Fri («DWV»)
- Demand of CH residents

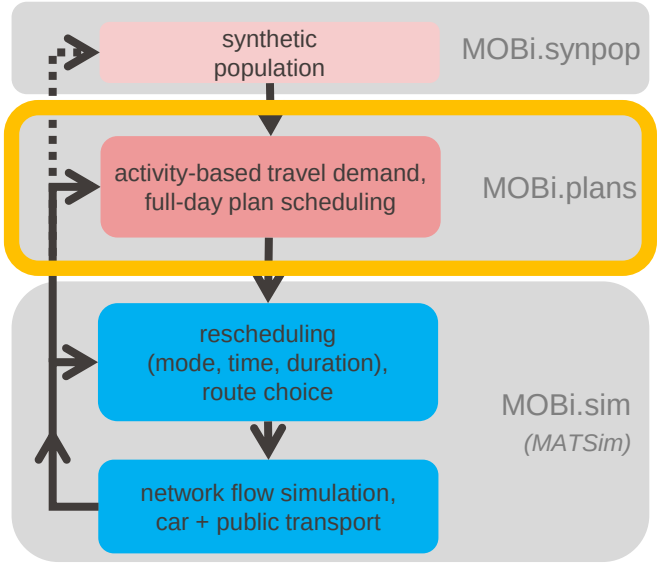
- Ownership of mobility tools determines individual scheduling and travel behaviour
- Combination of decisions made both at **household** level and at **individual** level
- Understanding shared mobility resources key to modelling complex household interactions

# Travel demand forecasting at SBB

- Swiss Federal Railways (SBB) is continuously developing an operational **multimodal** and **microscopic** nationwide transport model as an extension of the existing rail model
- Model requirements:
  - ability to simulate long-term forecasting scenarios (2040+)
  - representation of transport modes that are **competing with the railway**
  - **door-to-door** simulation of travel (e.g. access to train stations)
  - **future transport modes** (e.g. autonomous vehicles and ridesharing services for *first and last-mile*)
  - detailed representation of **demographic shifts** and **disruptive policies**
- Pioneers in this field, need for more research on various topics

# SIMBA MOBi: microscopic travel simulation of Switzerland

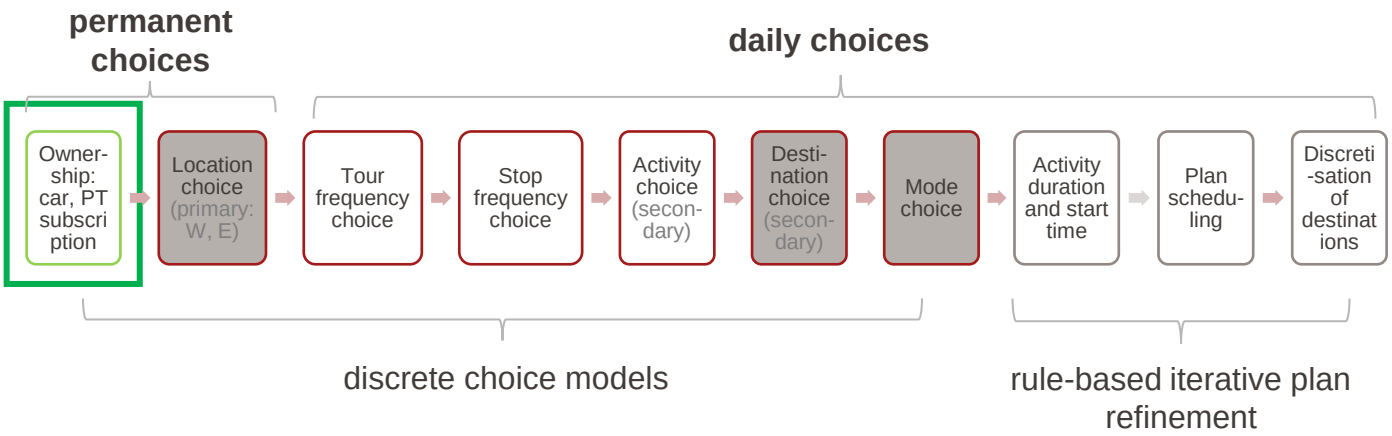
- Full nationwide agent-based simulation model for Switzerland




Scherr W., Joshi C., Manser P., Frischknecht N., and Métrailler D. (2019). “An Activity-based Travel Demand Model of Switzerland Based on Choices and Constraints,” in *8th Symposium of the European Association for Research in Transportation, Budapest*.

# MOBi.Plans: microscopic travel devand

- A sequence of 10 steps to construct individual day plans




Scherr W., Joshi C., Manser P., Frischknecht N., and Métrailler D. (2019). “An Activity-based Travel Demand Model of Switzerland Based on Choices and Constraints,” in *8th Symposium of the European Association for Research in Transportation, Budapest*.

# Ownership of mobility tools model – previous approaches

- Individual-level DCM (MNL) with 10 alternatives:

| | GA | Regional ticket | Half fare | RT + HF | None |
|---|---|---|---|---|---|
| **Car** | 1 | 2 | 3 | 4 | 5 |
| **No-car** | 6 | 7 | 8 | 9 | 10 |

- **Individual-level** input features from travel survey data
- Jointly models PT subscriptions with ***car availability*** at individual level
- **Manual specification**

Danalet A., and Mathys N. (2018). “Mobility Resources in Switzerland in 2015,” in *18th Swiss Transport Research Conference, Ascona, Switzerland*.

# Ownership of mobility tools model – previous approaches

- Individual-level joint probit model of mobility tool ownership **and** number of trips by each mode
- Mobility tool ownership (*effectively*) represented by four alternatives:

| | Season ticket | No season ticket |
|---|---|---|
| Car | 1 | 2 |
| No-car | 3 | 4 |

- **Individual-level** input features from travel survey data **and** household/zonal level accessibility metrics (~3000 zones)

Loder A., and Axhausen K. (2018). “Mobility tools and use: Accessibility’s role in Switzerland” in *Journal of Transport and Land Use* 11.1 (2018): 367-385.

# New model

## 1. Data

- Augment travel survey with network-level data - individual, household, zonal, and canton level input features

## 2. Structure

- Explicitly model interactions between household-level and individual-level decisions

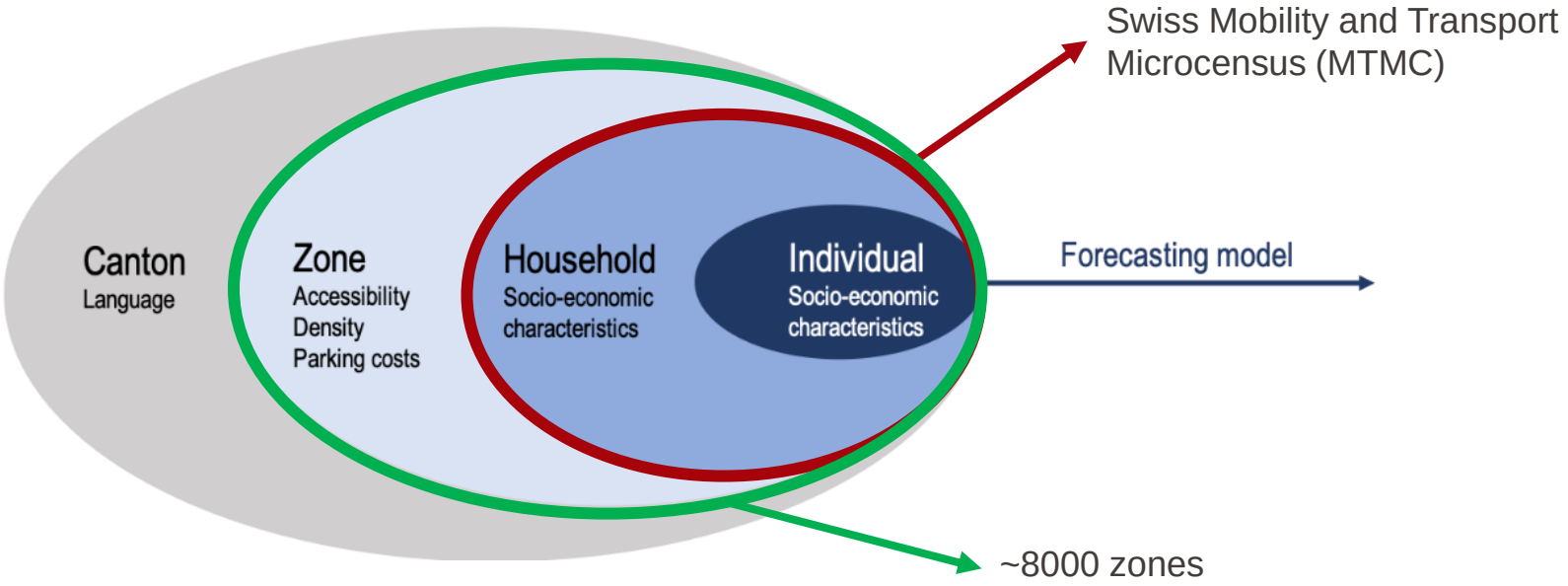
## 3. Machine learning

- Assisted specification of choice models using Ensemble Learning (EL)

## 4. Validation

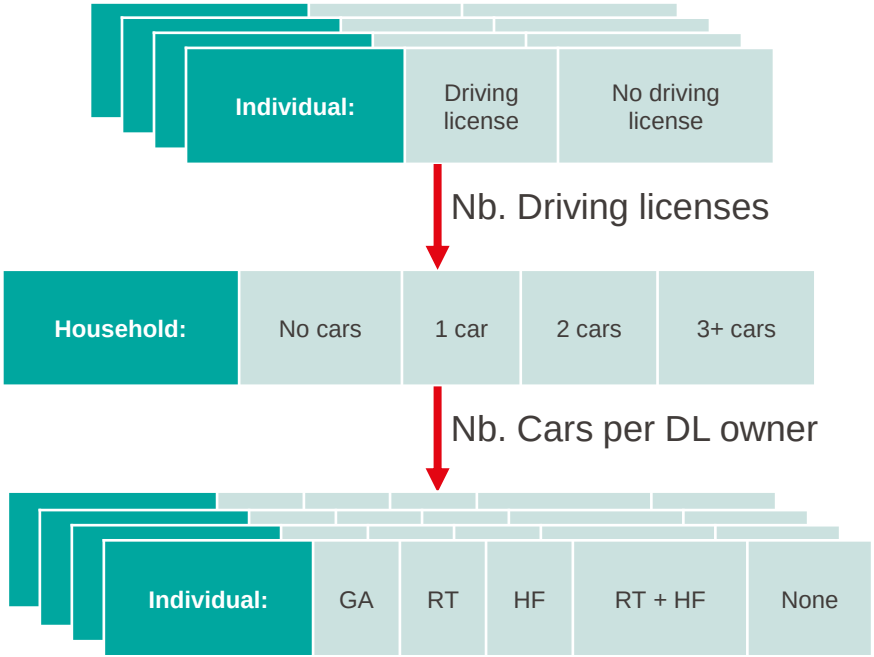
- Prediction results compared with control totals for different spatial aggregation levels

# Data

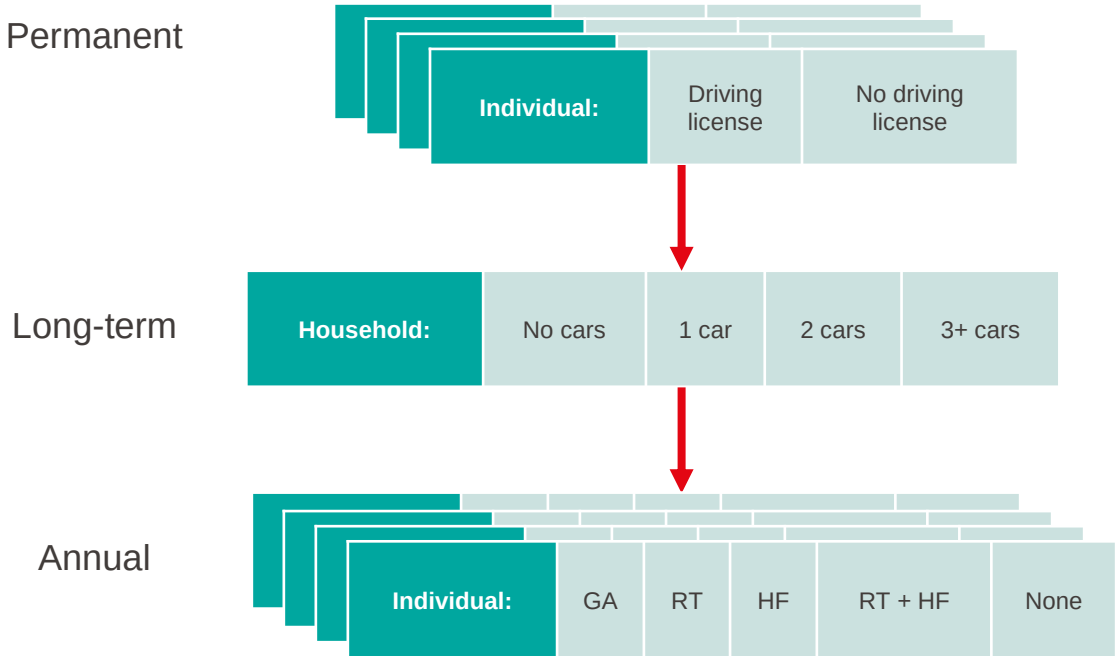



Federal Statistical Office (FSO)/Federal Office for Spatial Development (ARE) (2017). *Mobility and Transport Microcensus 2015*. Neuchâtel and Bern, Switzerland.

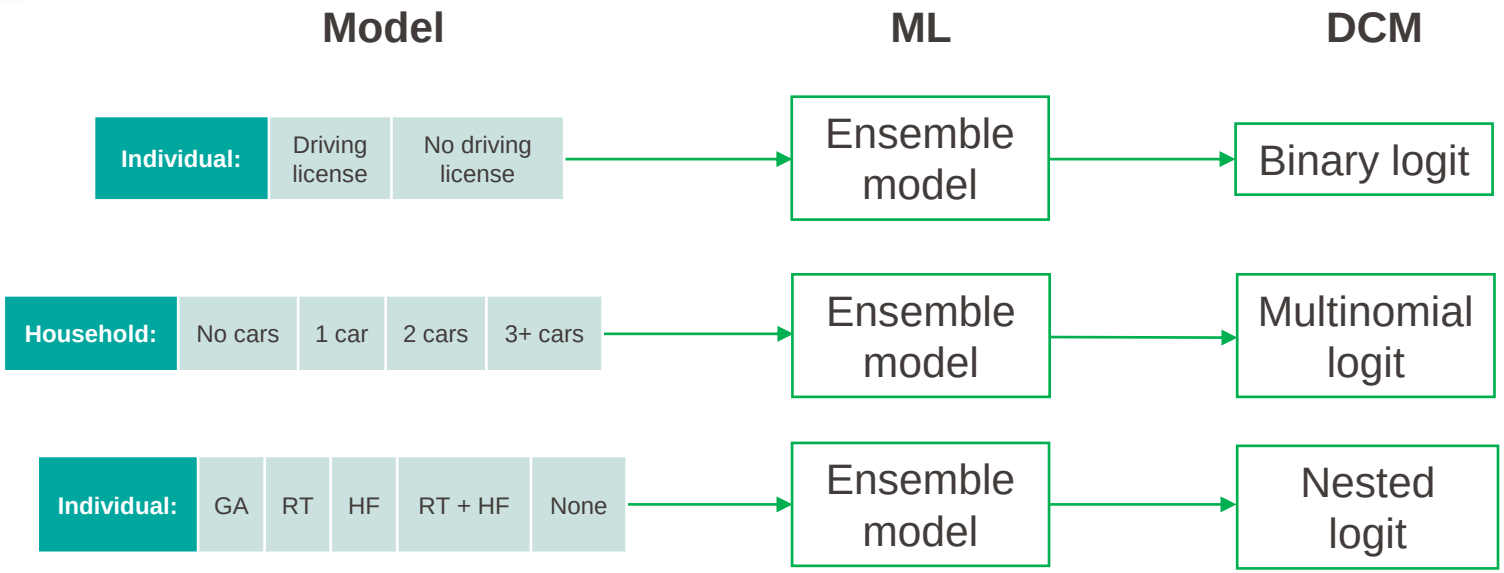
# Structure


Individual:
Driving license
No driving license
Nb. Driving licenses
Household:
No cars
1 car
2 cars
3+ cars
Nb. Cars per DL owner
Individual:
GA
RT
HF
RT + HF
None

# Structure

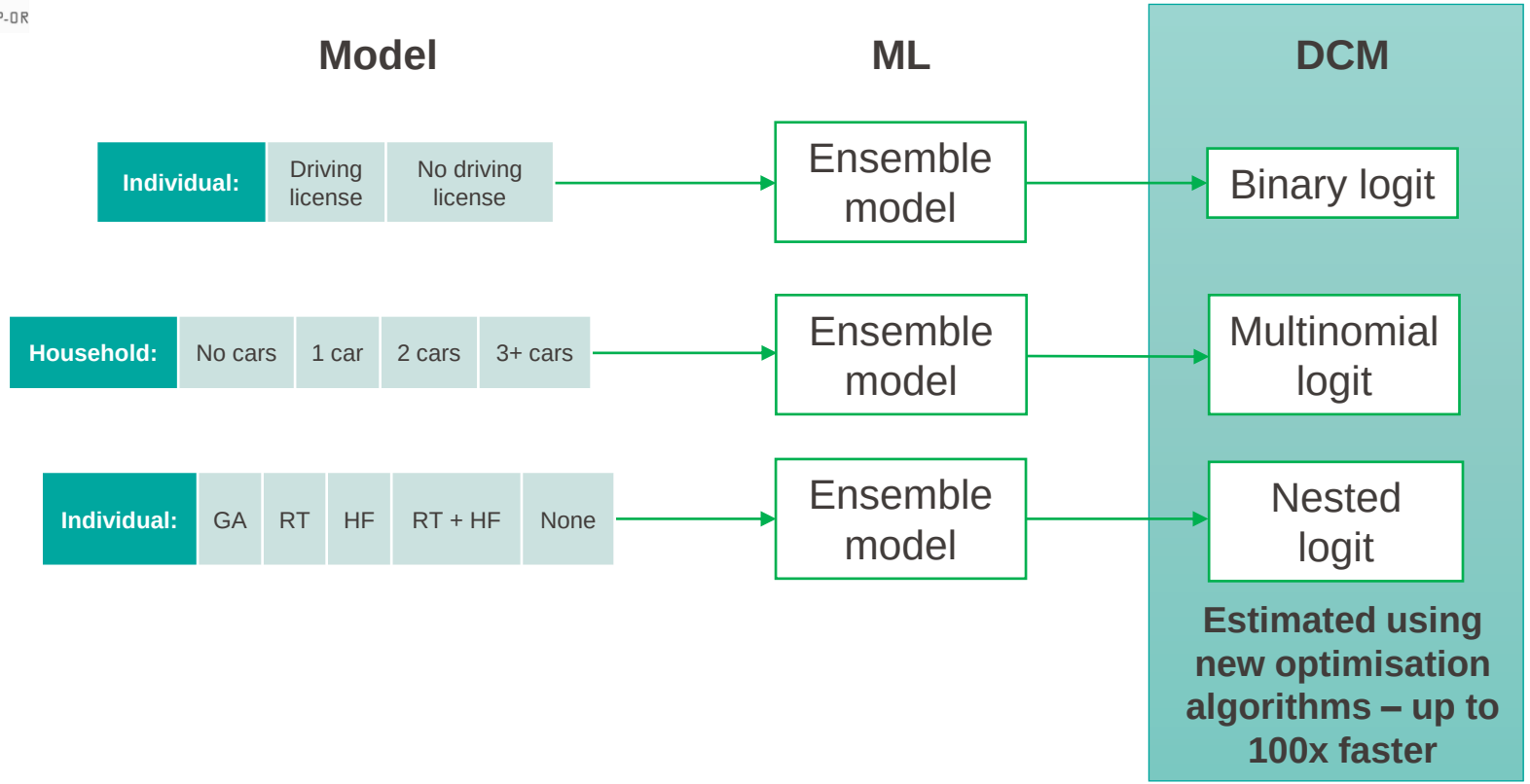

Permanent
Individual:
Driving license
No driving license
Long-term
Household:
No cars
1 car
2 cars
3+ cars
Annual
Individual:
GA
RT
HF
RT + HF
None

# Machine learning: Assisted specification approach




Hillel T., Bierlaire M., Elshafie M., & Jin Y. (2019). Weak teachers: Assisted specification of discrete choice models using ensemble learning. In *8th Symposium of the European Association for Research in Transportation, Budapest*.

# Machine learning: Assisted specification approach

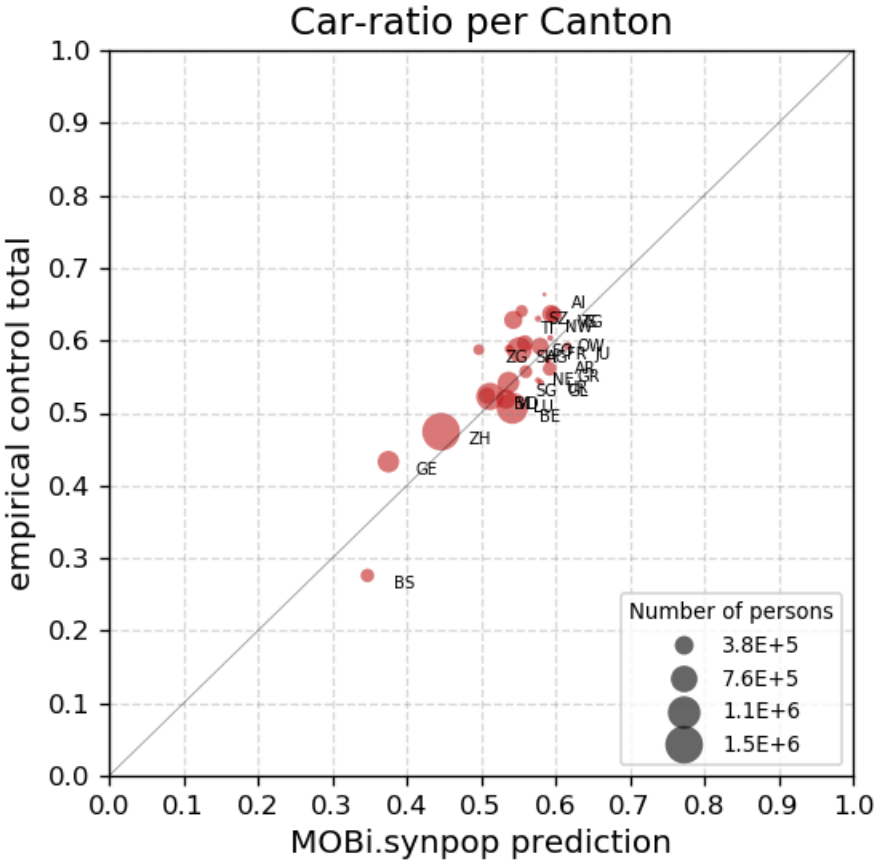


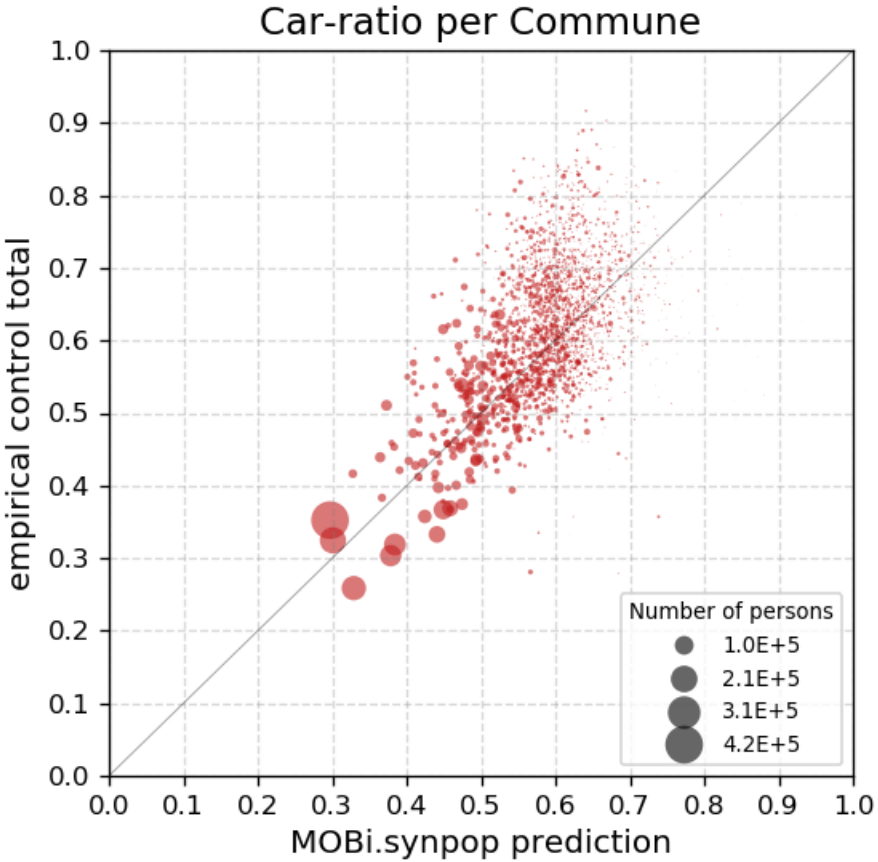

Lederrey G., Lurkin V., Hillel T., & Bierlaire M. (2021). Estimation of discrete choice models with hybrid stochastic adaptive batch size algorithms. *Journal of Choice Modelling*, *38*, 100226.

# Model application and validation

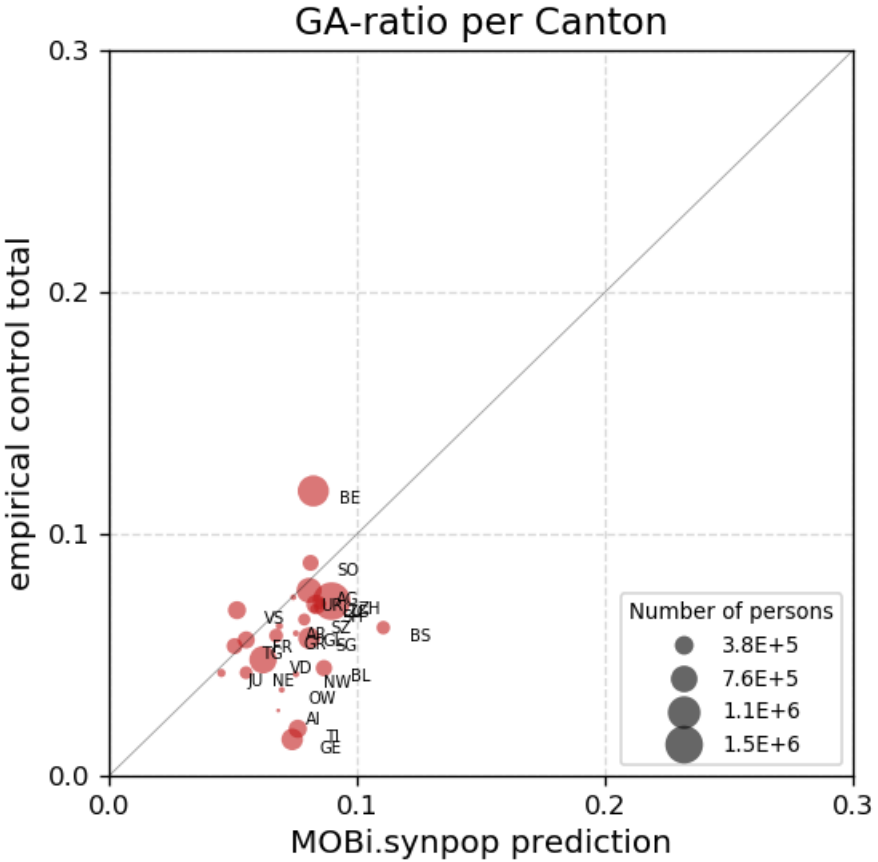
- Model applied to nationwide synthetic population to simulate:
  - Individual level driving license ownership
  - Household level car ownership
  - Individual level public transport subscription
- Predictions validated against control totals at multiple levels of aggregation:
  - Accessibility level (high/medium/low) – 3 groups
  - Cantonal level – 32 groups
  - Municipality level – 2,212 groups
- Recalibration with *shadow constants* at labour market regions (101 groups)

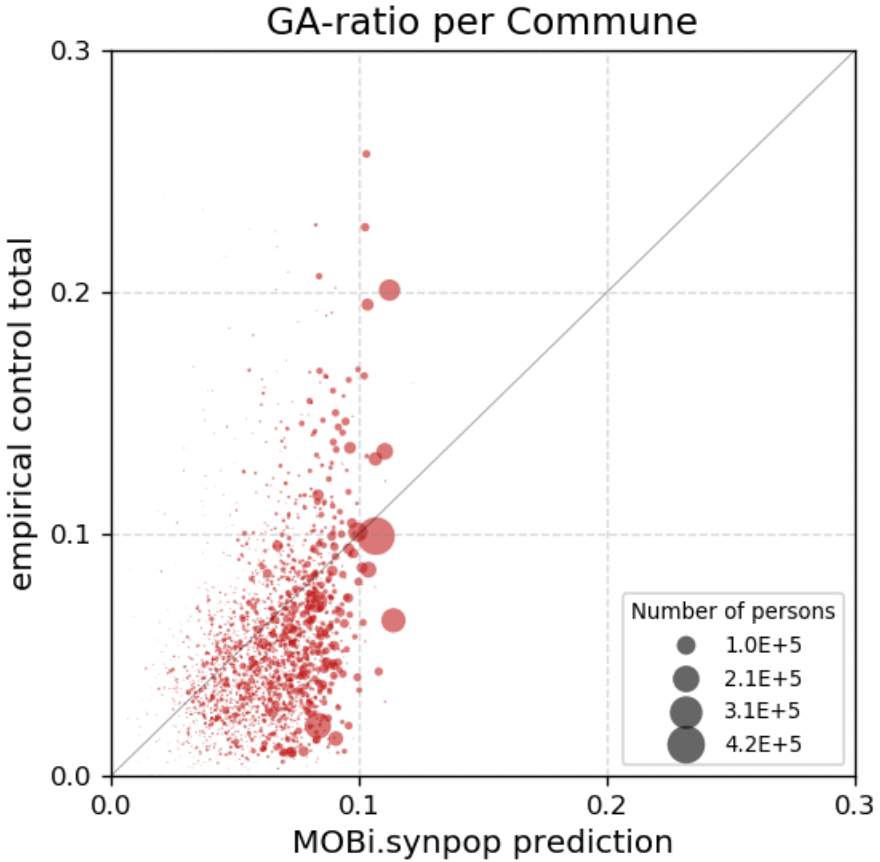
# Private vehicle ownership



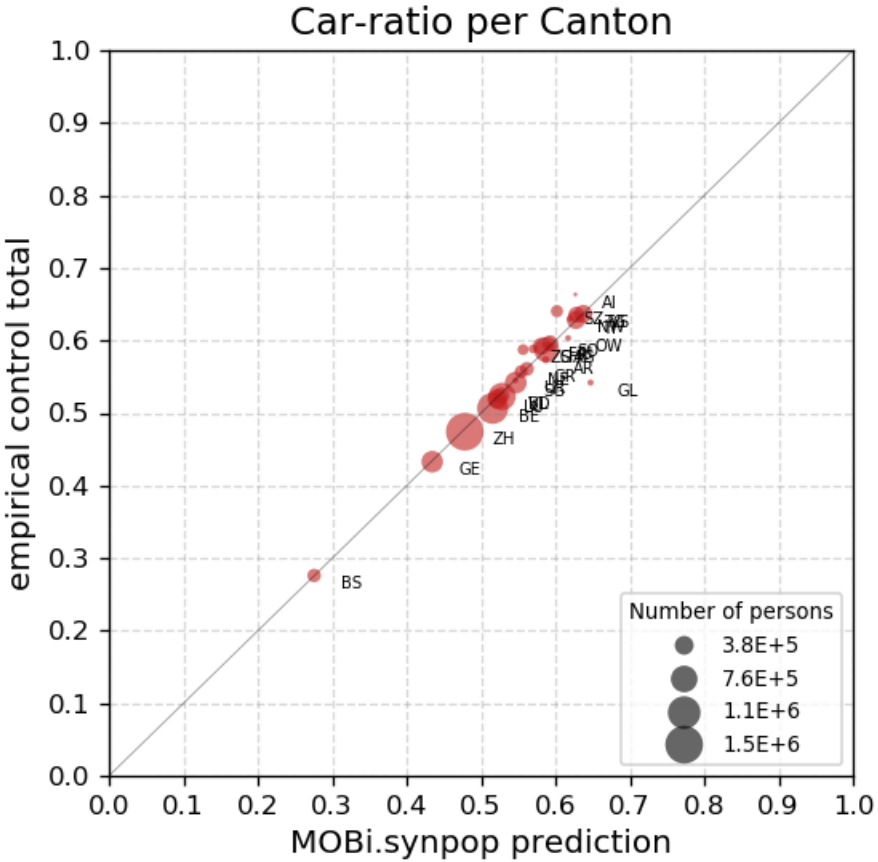



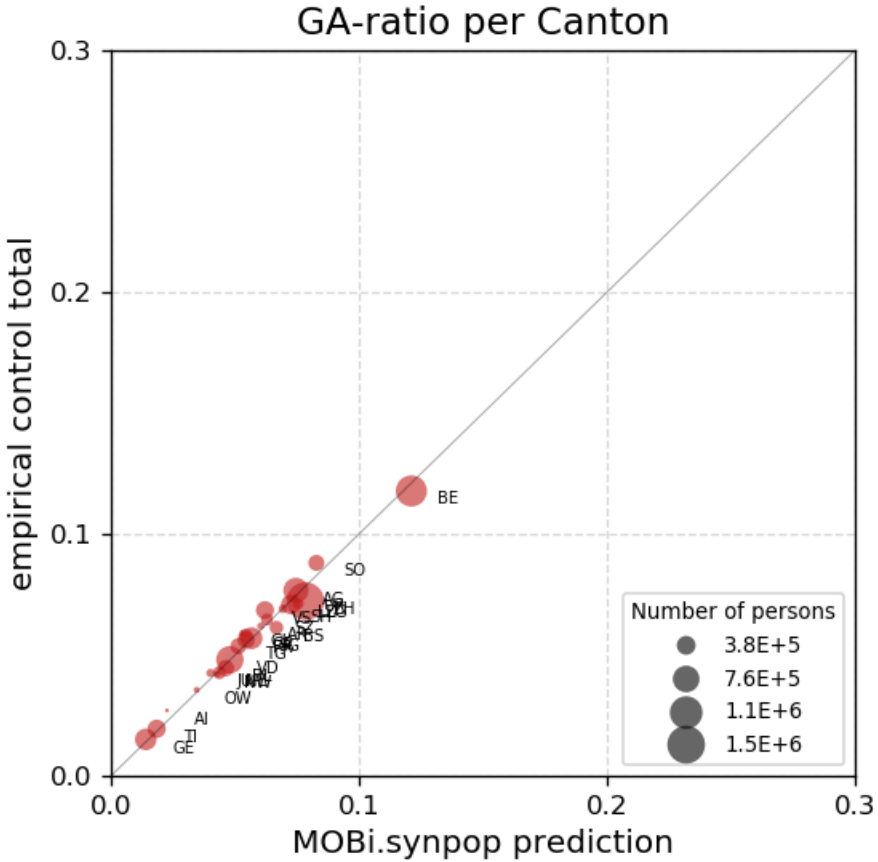
# PT subscription



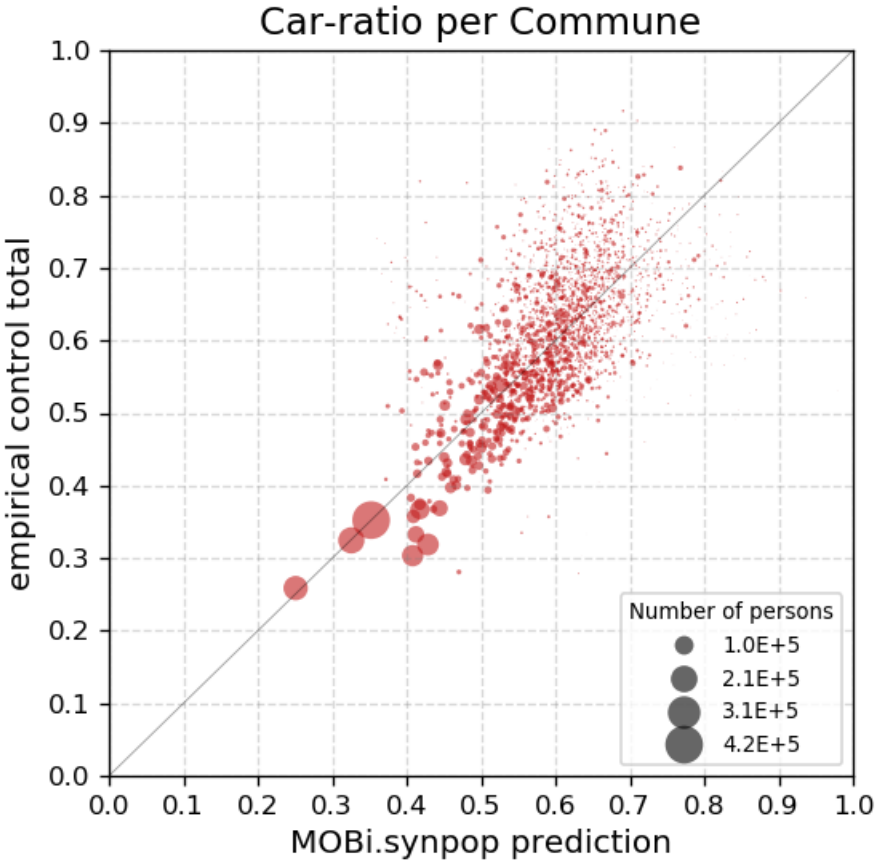



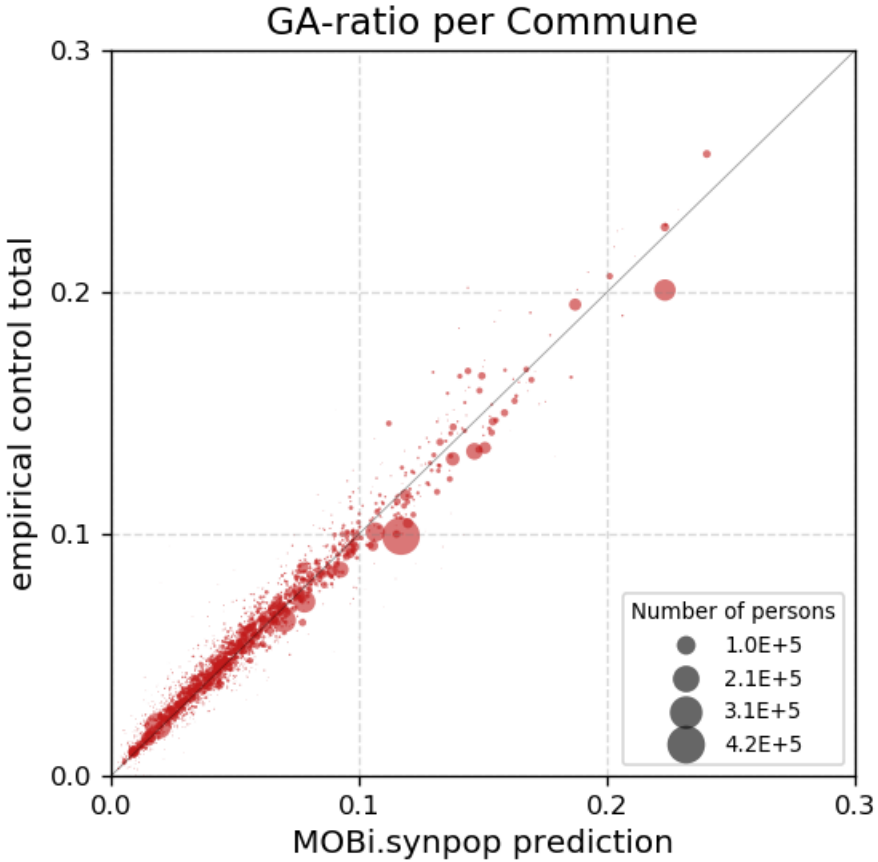
# Recalibrated - cantonal level



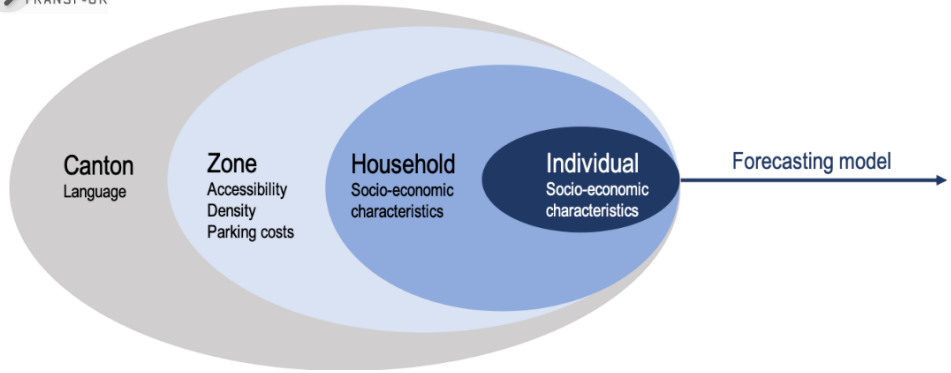



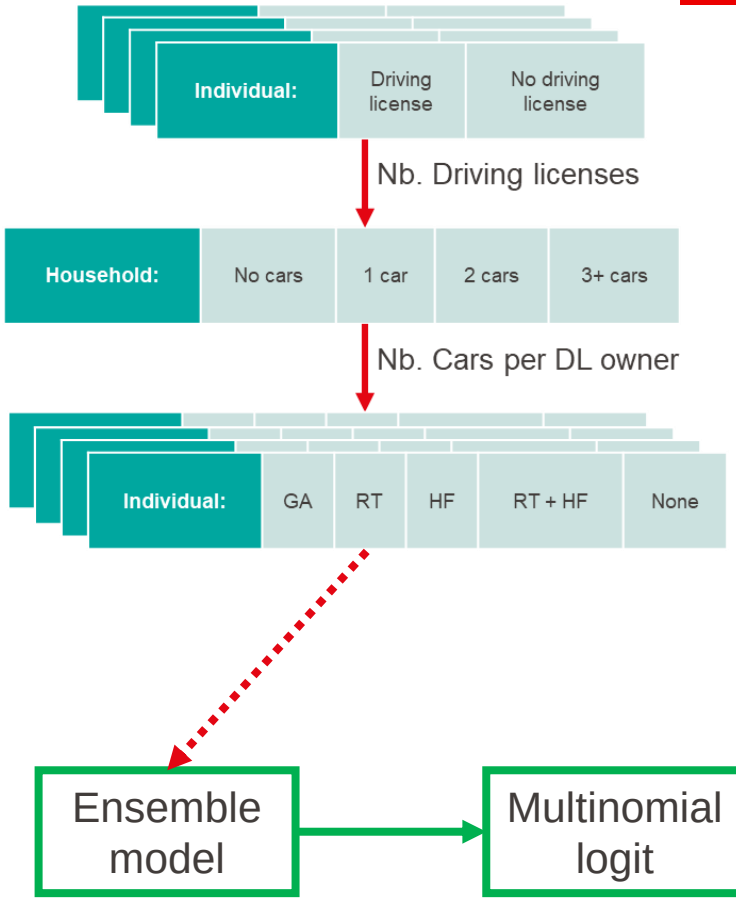
# Recalibrated - municipality level



# Summary


Canton
Language
Zone
Accessibility
Density
Parking costs
Household
Socio-economic characteristics
Individual
Socio-economic characteristics
Forecasting model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Nb. Cars per DL owner
Individual:
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RT + HF
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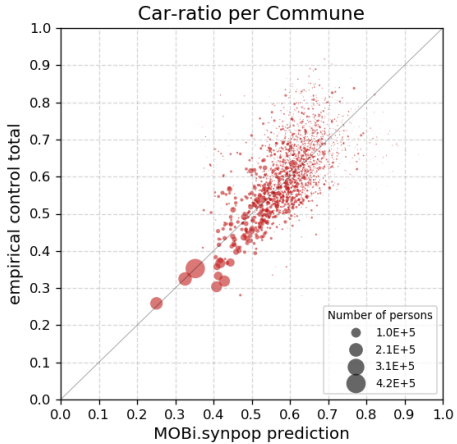
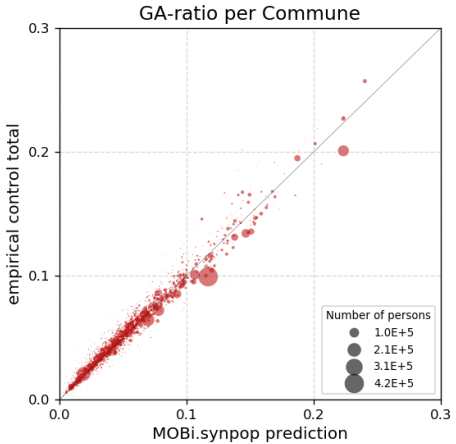
Ensemble model
Multinomial logit


Car-ratio per Commune
empirical control total
MOBi.synpop prediction
Number of persons
1.0E+5
2.1E+5
3.1E+5
4.2E+5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# Thank you!

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