Optimisation-based ActBM

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Outline

- Framework
- State of research
- Current investigations
- Applications
- Further work, ideas…
Framework

- Optimisation-based simulation framework for activity-based models

- Joint estimation
  - Activity participation
  - Activity scheduling
  - Mode choice
  - Location choice

- Three modelling elements:
  1. Schedule simulation
  2. Choice set generation
  3. Parameter estimation
State of research

Data

Estimation

Literature

Parameters $\beta_n$

Synthetic individual $n$

Disturbances $\varepsilon$

Optimisation $\Omega$

Schedule $S^n_\varepsilon$

Indicators
State of research

Simulation framework

Data

Estimation

Parameters $\beta_n$

Disturbances $\varepsilon$

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Schedule $S^n_\varepsilon$

Indicators

Literature

Synthetic individual $n$
State of research

Simulation framework

From an activity... 

...to a utility function... 

... to a maximisation problem

\[ \Omega_n = \max \sum w_i U_i \]

\[ U_i (x_i, \tau_i, \delta_{xin}, \delta_{tin}, t_i, \omega_{in}) \]
State of research

- **Simulation framework**
  - Successfully implemented in practice (Innosuisse project with SBB)
  - Publication available

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State of research

Parameter estimation

Data \rightarrow \text{Estimation} \rightarrow \text{Parameters } \beta_n \rightarrow \text{Synthetic individual } n \rightarrow \text{Optimisation } \Omega \rightarrow \text{Schedule } S^n_\varepsilon \rightarrow \text{Indicators}

\text{Disturbances } \varepsilon \rightarrow \text{Estimation} \rightarrow \text{Literature}
State of research

- Choice set generation

Feasible schedules

- Considered schedules

Unobserved and possibly infinite

Estimation choice set: sample of feasible schedules generated for estimation purposes

Actual choice set: Unobserved

Realized schedule

Based on Shocker (1991)
State of research

- Choice set generation
  - Metropolis-Hastings sampling of feasible schedules
  - STRC 2021

- Initial state
- Swap
- Inflate/Deflate
- Assign
Parameter estimation

- Calibration of DCMs using Biogeme and sampled choice sets
- Case study: Lausanne population in MZMV 2015
- Estimating:
  - Activity specific constants
  - Penalties for schedule deviation
  - Desired times*

- STRC 2022
Current investigations

- Simulation framework
  - Formulation of the problem using Constraint Programming
  - So far 2.5x faster than MILP
  - Fully open-source (Google OR-Tools instead of CPLEX)
Current investigations

- **Choice set generation**
  - Generation of choice sets for location and mode
  - **ICMC 2022:**
    - N. Salvadé, “Representing mode and location choice within activity-based models”

Salvadé (2022)
Applications

Data → Estimation → Parameters $\beta_n$ → Optimisation $\Omega$ → Schedule $S^n_\varepsilon$ → Indicators

Literature → Estimation → Synthetic individual $n$ → Disturbances $\varepsilon$
Applications

- **OPTIMS (OPTimisation of Individual Mobility Schedules)**
  - Sept 2020 – March 2022

- Integration of optimisation model into SIMBA MOBi (SBB’s forecasting framework)

Manser et al (2021)
Applications
**What’s next?**

- **Other applications**
  - Sociological applications (e.g. mobility motifs)
  - Shared mobility
  - Energy demand
  - ...

- **Output**
  - Open-source code for the simulator to be released

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Schultheiss (2021)
Thank you!

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References

- Schultheiss M., Spatial familiarity and mobility motifs, Bridging Transportation Researchers, August 2021