Efficient methods to synthetically create and calibrate MATSim scenarios

Dominik Ziemke
Workshop Modéliser les transports d’aujourd’hui et de demain
Paris, 26 September 2019
MATSim scenarios

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Slide 2
MATSim scenarios

Network

Transport Supply

Daily Plans

Home (dep: 06:43)
trip (car)

Work (dep: 16:04)
trip (car)

Shopping (dep: 18:04)
trip (car)

Home

Home (dep: 12:42)
trip (bike)

Shopping (dep: 14:05)
trip (bike)

Home

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MATSim scenarios

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Slide 4
Generation of daily plans

- Trip diaries
  - often not openly available

- Big data
  - cell-phone data
  - Twitter

- Transport demand models (activity scheduling models)
  - Some model activity sequences of individuals
MATSim: The beginning or the end of a transport model?

• “Typical” approach to microscopic transport modeling
  • Activity-based demand generation (ABDG)
    • Model demand for transport
  • Dynamic Traffic Assignment (DTA)
    • Assign traffic to network
MATSim: The beginning or the end of a transport model?

- “Typical” approach to microscopic transport modeling
  - Activity-based demand generation (ABDG)
    - Model demand for transport
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    - Assign traffic to network

- MATSim contains
  - Activity-based demand adaptation
  - Dynamic Traffic Assignment
  - …
Demand adaptation

Recall/Compare: **Macroscopic case**

- Trip Generation
- Trip Distribution
- Mode Choice
- Route Assignment
Demand adaptation

Recall/Compare: Macroscopic case

Behaviorally: “Choice dimensions”

- Who? / How many?
- Where to?
- By what mode?
- When?
- Which route?

Trip Generation

Trip Distribution

Mode Choice

Route Assignment

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Demand adaptation

Recall/Compare: Macroscopic case

Behaviorally: “Choice dimensions”

- Who? / How many?
  - Agents
- Where to?
  - Activities + locations
- By what mode?
  - Mode choice
- When?
  - Departure time choice
- Which route?
  - Routing

Traditional Four Step Process

1. Trip Generation
2. Trip Distribution
3. Mode Choice
4. Route Assignment
Demand adaptation

Responsible component

“Typical” micro setup

Behaviorally:

“Choice dimensions”

• Who? / How many?
  • Agents

• Where to?
  • Activities + locations

• By what mode?
  • Mode choice

• When?
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• Which route?
  • Routing

ABDM

ABDM

ABDM

DTA
Demand adaptation in MATSim

- **Home** (dep: 06:43) trip (car, route x)
- **Work** (dep: 16:04) trip (car, route y)
- **Shopping** (dep: 18:04) trip (car, route y)
- **Home**
Demand adaptation in MATSim: Route choice

Home (dep: 06:43) trip (car, route a)
Work (dep: 16:04) trip (car, route b)
Shopping (dep: 18:04) trip (car, route c)
Home
Demand adaptation in MATSim: Departure time choice

Home (dep: **06:38**) trip (car, route x)
Work (dep: **16:15**) trip (car, route y)
Shopping (dep: **18:20**) trip (car, route y)
Home
Demand adaptation in MATSim: Mode choice

- Home (dep: 06:43)
  - trip (bike, route x)
- Work (dep: 16:04)
  - trip (bike, route y)
- Shopping (dep: 18:04)
  - trip (bike, route y)
- Home
Demand adaptation in MATSim: Destination choice

Home (dep: 06:43) trip (car, route x)
Work (dep: 16:04) trip (car, route y)
Shopping (dep: 18:04) trip (car, route y)
Home
### Demand adaptation

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### Demand adaptation

**Responsible component**  
MATSim setup | “Typical” micro setup  
--- | ---  
? | ABDM  
MATSIm | ABDM  
MATSIm | ABDM  
MATSIm | DTA

**Behaviorally:**  
“Choice dimensions”

- Who? / How many?  
  - Agents  
- Where to?  
  - Activities + locations  
- By what mode?  
  - Mode choice  
- When?  
  - Departure time choice  
- Which route?  
  - Routing
Intermediate summary

• MATSim models much more than a pure DTA model
  • “more” = more choice dimension

• MATSim does not cover ALL choice dimensions of an ABDM
  • “Demand adaptation model”

• Innovative strategy modules (in “replanning” step)
  • Update agents’ choice concerning specific choice dimension during the iterations
EXAMPLE 1

OPEN BERLIN SCENARIO
ABDM in Open Berlin Scenario: CEMDAP

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

**Input**
- Disaggregate Demographics
- Model Specification

**Output**
- Daily Activity-Travel Patterns for each individual
ABDM in Open Berlin Scenario: CEMDAP

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

**Input**

- Disaggregate Demographics
- Model Specification

**Output**

- Daily Activity-Travel Patterns for each individual

Available for Dallas/Fort Worth, TX and Los Angeles, CA
Demand adaptation in Open Berlin Scenario

Responsible component

MATSim setup

Census + commuter stat.

CEMDAP / ?

CEMDAP / MATSim

CEMDAP / MATSim

MATSim

Behaviorally:
“Choice dimensions”

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Demand adaptation in Open Berlin Scenario

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CEMDAP / ?

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Demand adaptation in MATSim: Mode choice

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Home (dep: 06:43)
trip (bike, route x)

Work (dep: 16:04)
trip (bike, route y)

Shopping (dep: 18:04)
trip (bike, route y)

Home
CaDyTS

- calibration integrated into MATSim’s genetic algorithm

“Extended” Plan Scoring

- Agents score their executed activities and trips
  - behaviorally
  - in terms of match with real-world observations
**MATSim: Simulation and calibration**

**CaDyTS**
- calibration integrated into MATSim’s genetic algorithm

**“Extended” Plan Scoring**
- Agents score their executed activities and trips
  - behaviorally
  - in terms of match with real-world observations

Set of multiple initial plans

... with different work locations
MATSim: Simulation and calibration

- Cadyts as additional component of MATSim‘s scoring
- „Rewards“ plans which contribute to reproduction of reality
Relation to other methods

• Macroscopic models
  • use initial rough OD matrix
  • use traffic counts
  • make OD matrix more appropriate for a region
  → “OD matrix estimation”

• Microscopic models (here: MATSim)
  • set of initial daily plans
  • use traffic counts
  • select most appropriate plans
Summary of method

1. Create synthetic population (in CEMDAP format) 5x
   • Demographic according to census
   • Residential and work locations based on commuter matrix
   • Different refined work location in different syn. pop. versions
2. Run CEMDAP for each synthetic population 5x
   • Result: 5 potential daily activity-travel pattern for each agent
3. Convert and combine into MATSim plans
   • Results: Plans for all agents with 5 daily plans
4. Run MATSim incl. Cadyts
   • Agents choose plans based on
     • assumptions of activity participation and travel behavior
     • reproduction of real-world observations
5. Plans at end of simulation = travel demand of study region
   • Perform validation
Some results

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Results / Public transport statistics

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EXAMPLE 2

SNF BIG DATA PROJECT
SNF Big Data Project

- **Efficiently** create transport simulation scenario (Switzerland)

- Based on mobile-phone-data-based OD trip matrices

- Other data must be almost *universally available*

- Set up an efficient and transferable toolchain
Proposed toolchain

1. Synthetic population

2. Workplaces (SwissCom mobile phone OD matrix)

3. Generation of activity chains

4. Location Choice

5. Scenario Calibration (SwissCom)
SwissCom OD Matrix

- 12 monthly x 24 hourly trip matrices
- Numbers of trips
- Municipality-municipality relation
- For workdays

![Trip Matrix Diagram]
SwissCom OD Matrix

- 12 monthly x 24 hourly trip matrices
- Numbers of trips
- Municipality-municipality relation
- For workdays

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<tr>
<th>00:00-01:00</th>
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<th>Munic. 2</th>
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- Time slices of morning peak (e.g. 6:00 to 10:00)
  - Inform commutes, i.e. work municipalities
- Other time slices
  - Calibration
## Demand adaptation

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**ABDM**

MATSim ABDM

MATSim ABDM

MATSim ABDM

MATSim DTA

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*Slide 38*
A more **efficient** way to create a scenario

**Responsible component**
- MATSim
- “Typical” micro setup

**Behaviorally:**
- “Choice dimensions”
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**Activity sequences + locations**
### ABDMs

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Other models: ALBATROSS, TASHA, TAPAS, …

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Slide 41
ActiTopp

- models activity chains*
- based on basic demographic information
- estimated on German mobility panel (MOP)
- developed at KIT (Karlsruhe)
- part of the mobiTopp suite
- written in Java
- open source
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*Activity chains = pure activity chains
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ActiTopp: Person specification

- Id
- Age
- Gender
- Locality type
- Children aged 0-10 in the hh
- Children aged <18 in the hh
- Occupation type
- Number of cars in the hh
- Commuting distance
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Synthetic population

OD matrix
Thank you!

Description of methods

• Ziemke, D., Nagel, K. & Bhat, C.; Integrating CEMDAP and MATSim to increase the transferability of transport demand models; Transportation Research Record, 2015, 2493, 117-125.


• Ziemke, D., Kaddoura, I. & Nagel, K. The MATSim Open Berlin Scenario: A multimodal agent-based transport simulation scenario based on synthetic demand modeling and Open Data, ABMTrans 2019

Find the Open Berlin Scenario

• https://github.com/matsim-vsp/matsim-berlin