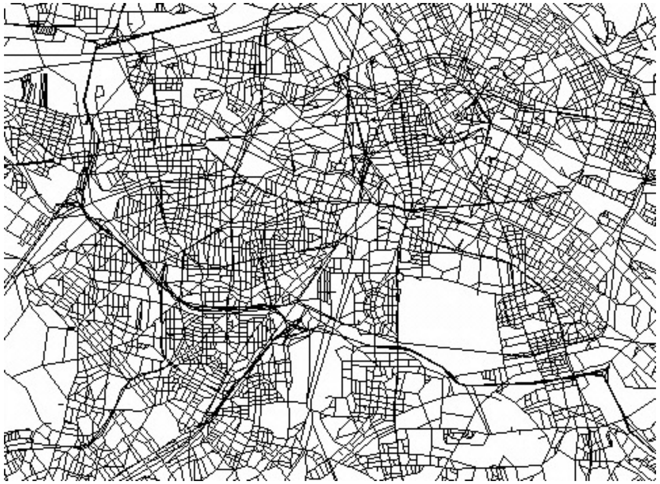
Efficient methods to synthetically create and calibrate MATSim scenarios

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

MATSim scenarios



Network

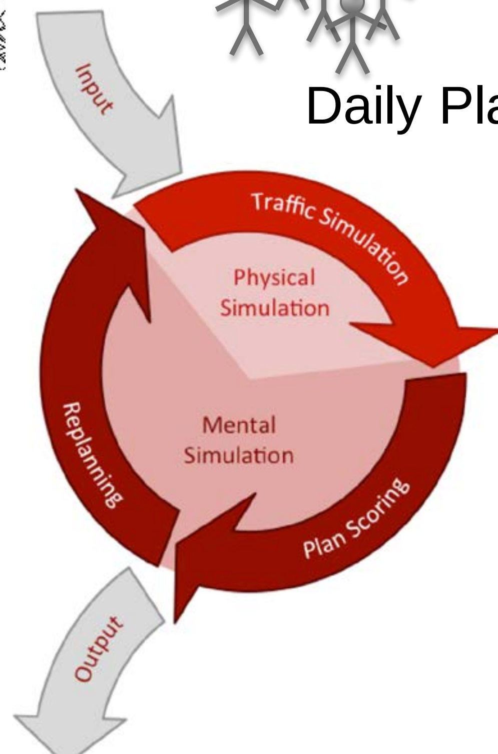
Home (dep: 06:43)
trip (car)
Work (dep: 16:04)
trip (car)
Shopping (dep: 18:04)
trip (car)
Home

Home (dep: 12:42)
trip (bike)
Shopping (dep: 14:05)
trip (bike)
Home

Daily Plans

Transport Supply

Transport Demand



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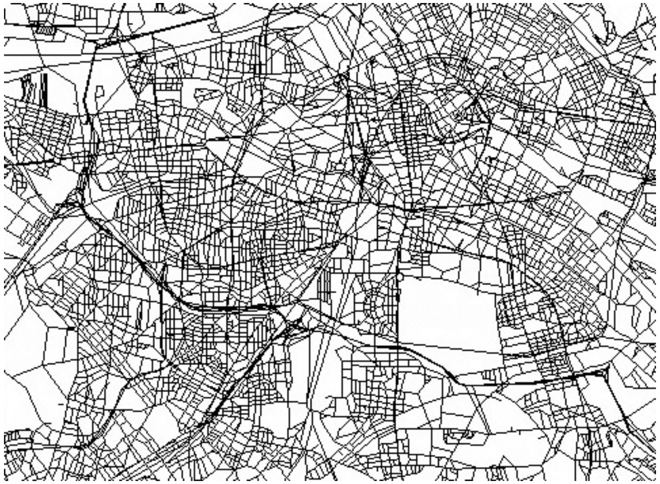
MATSim scenarios



Network

Transport Supply

GTFS

...

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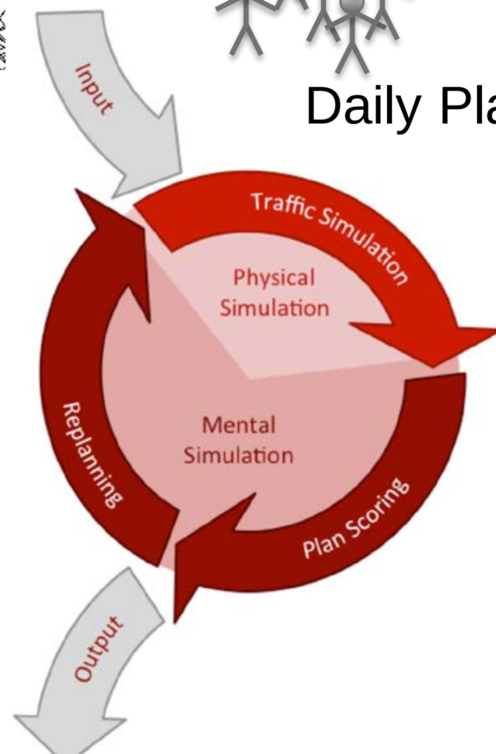
Daily Plans

Transport Demand



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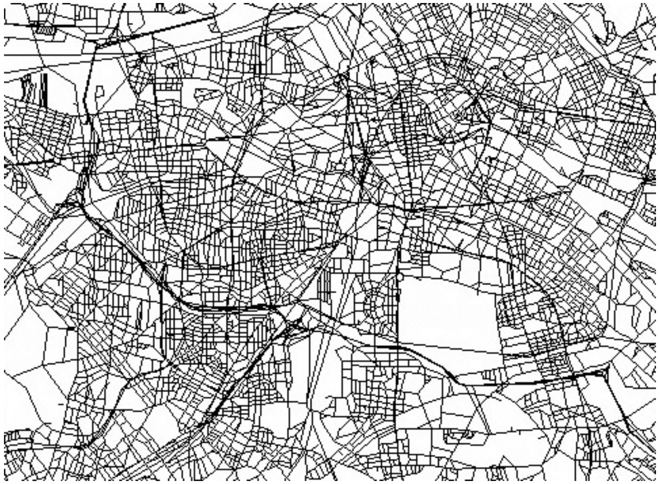
MATSim scenarios



Network

Transport Supply

OpenStreetMap

GTFS

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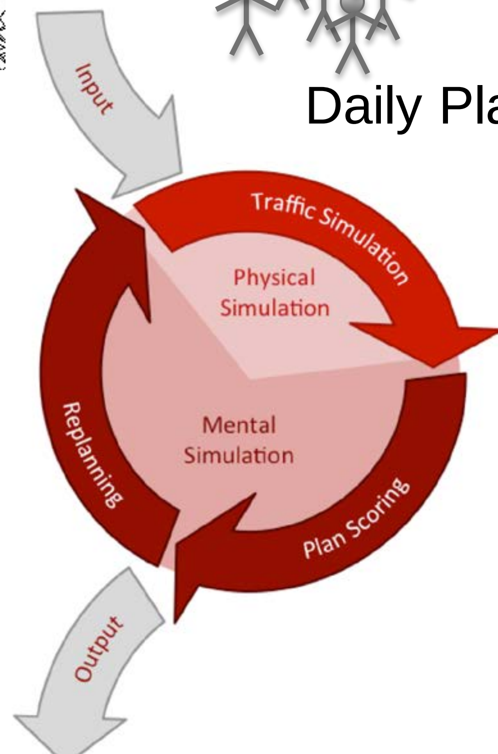
?

Daily Plans

Transport Demand



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

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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 contains
  - Activity-based demand <u>adaptation</u>
  - Dynamic Traffic Assignment
  - …

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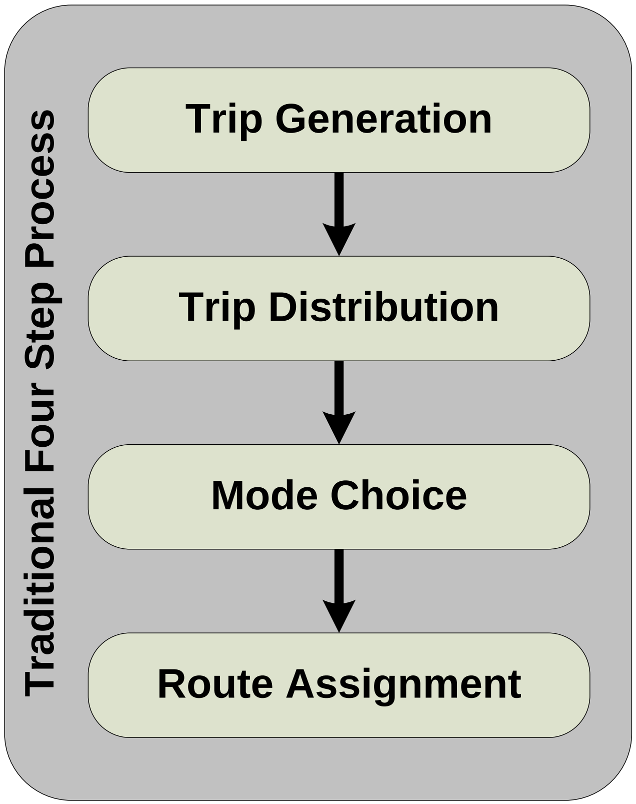
Demand adaptation

Recall/Compare:
M**a**croscopic case



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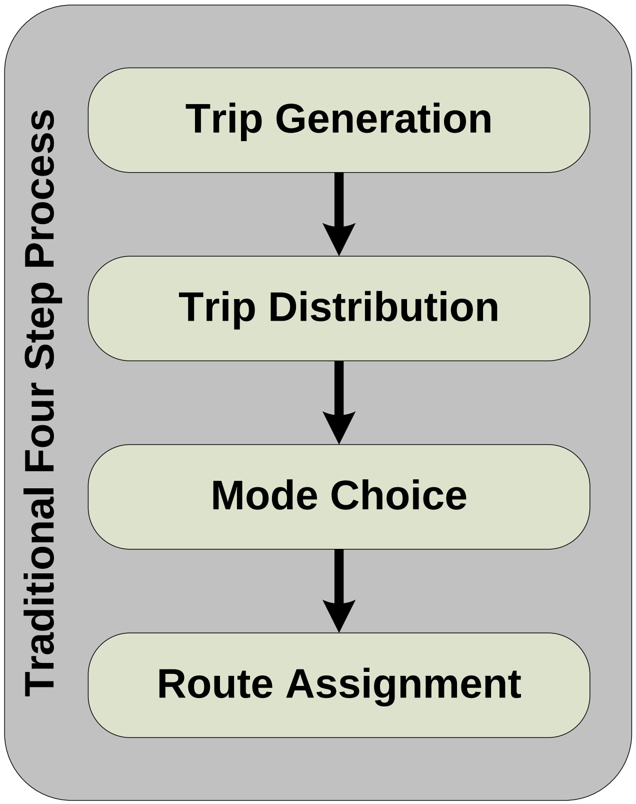
Demand adaptation

Recall/Compare: M<u>a</u>croscopic case



Behaviorally: "Choice dimensions"

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

Demand adaptation

Recall/Compare:
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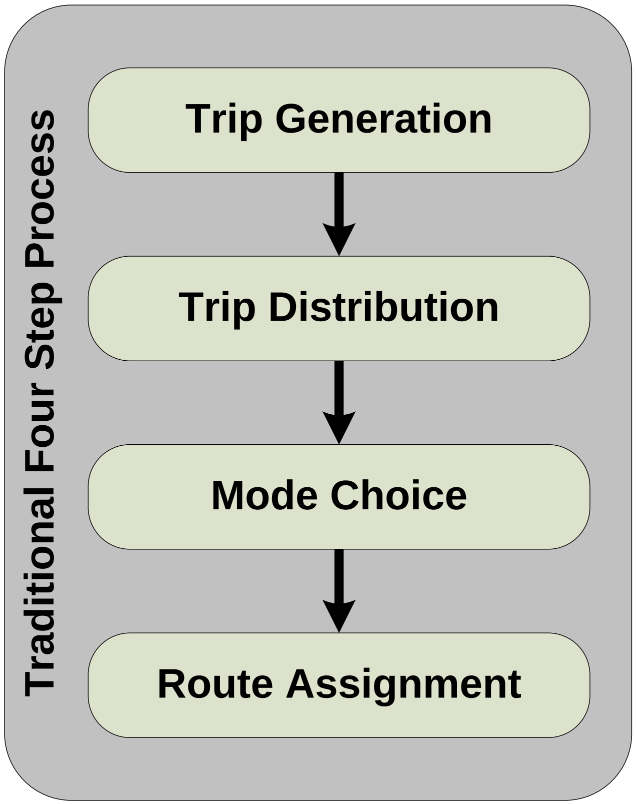

Behaviorally:
"Choice dimensions"

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

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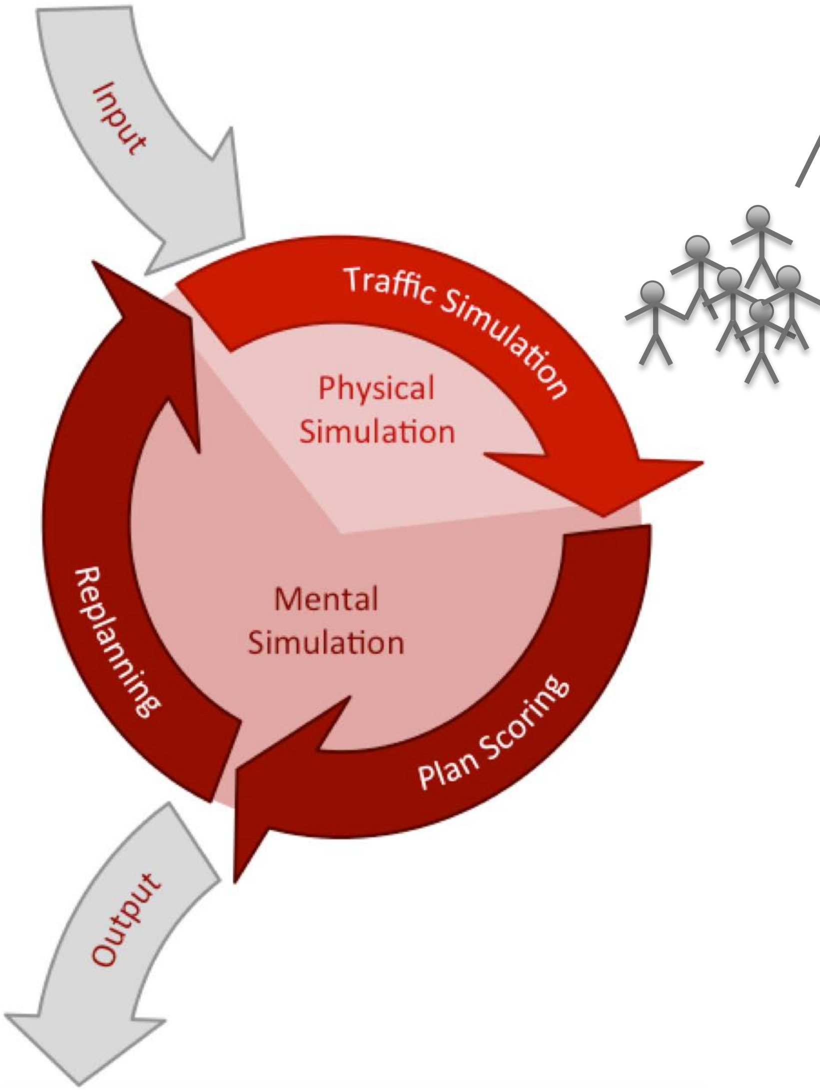
Demand adaptation

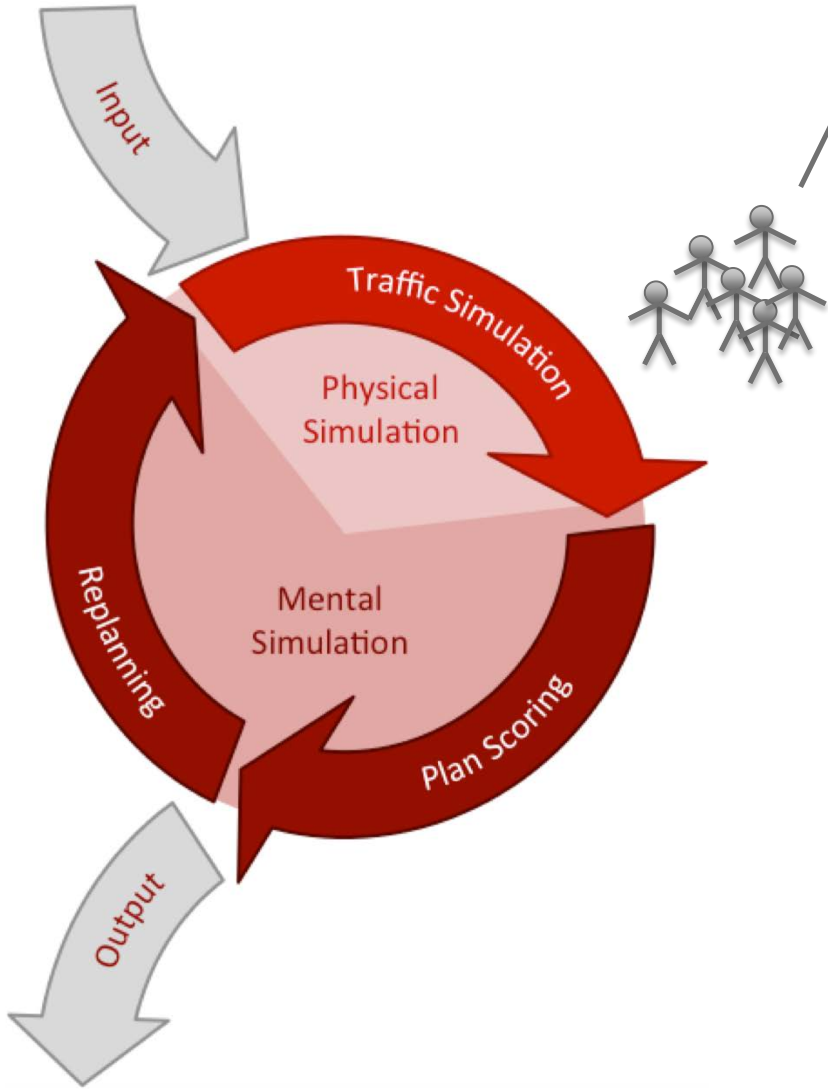
Responsible component "Typical" micro setup	Behaviorally: "Choice dimensions"
	• Who? / How many?
ABDM	• Agents
	• Where to?
ABDM	• Activities + locations
	• By what mode?
ABDM	• Mode choice
	• When?
ABDM	• Departure time choice
	• Which route?
DTA	• Routing

Demand adaptation in MATSim



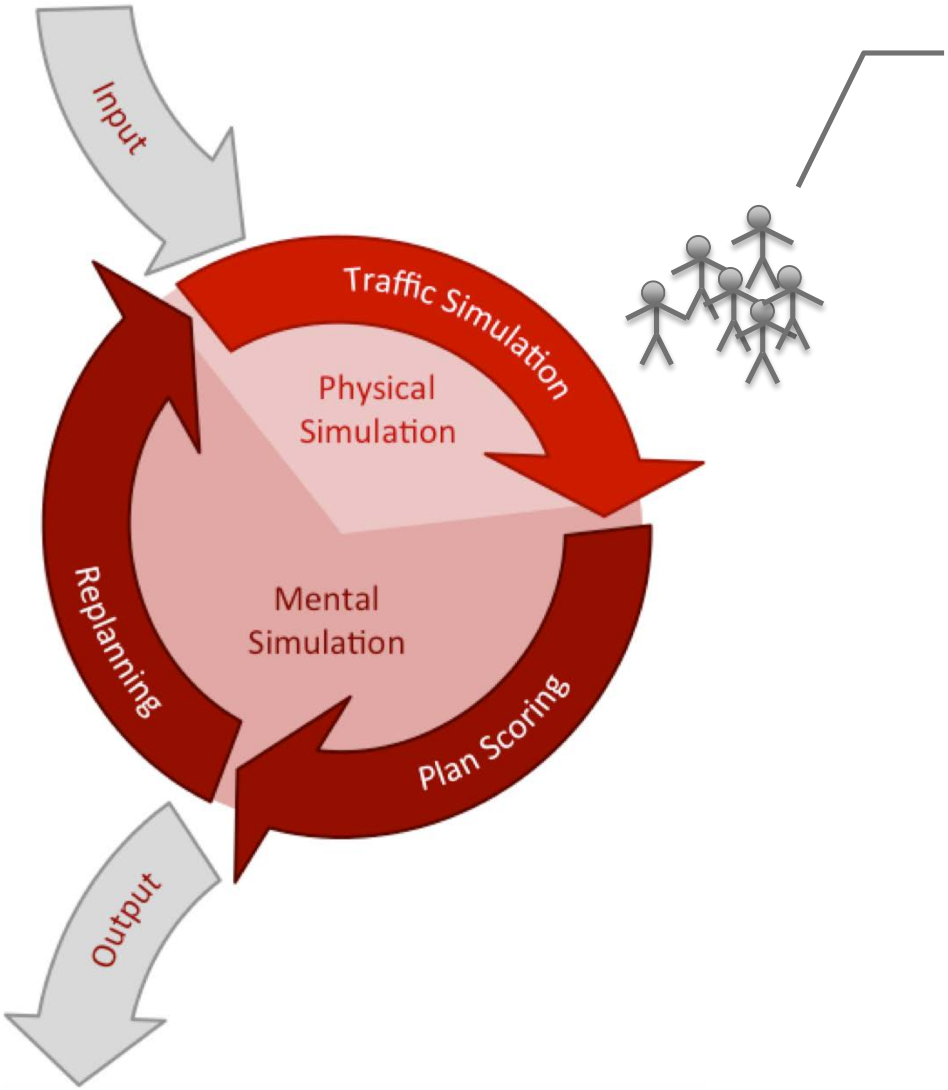
Home (dep: 06:43)
trip (car, route x)
Work (dep: 16:04)
trip (car, route y)
Shopping (dep: 18:04)
trip (car, route y)
Home

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

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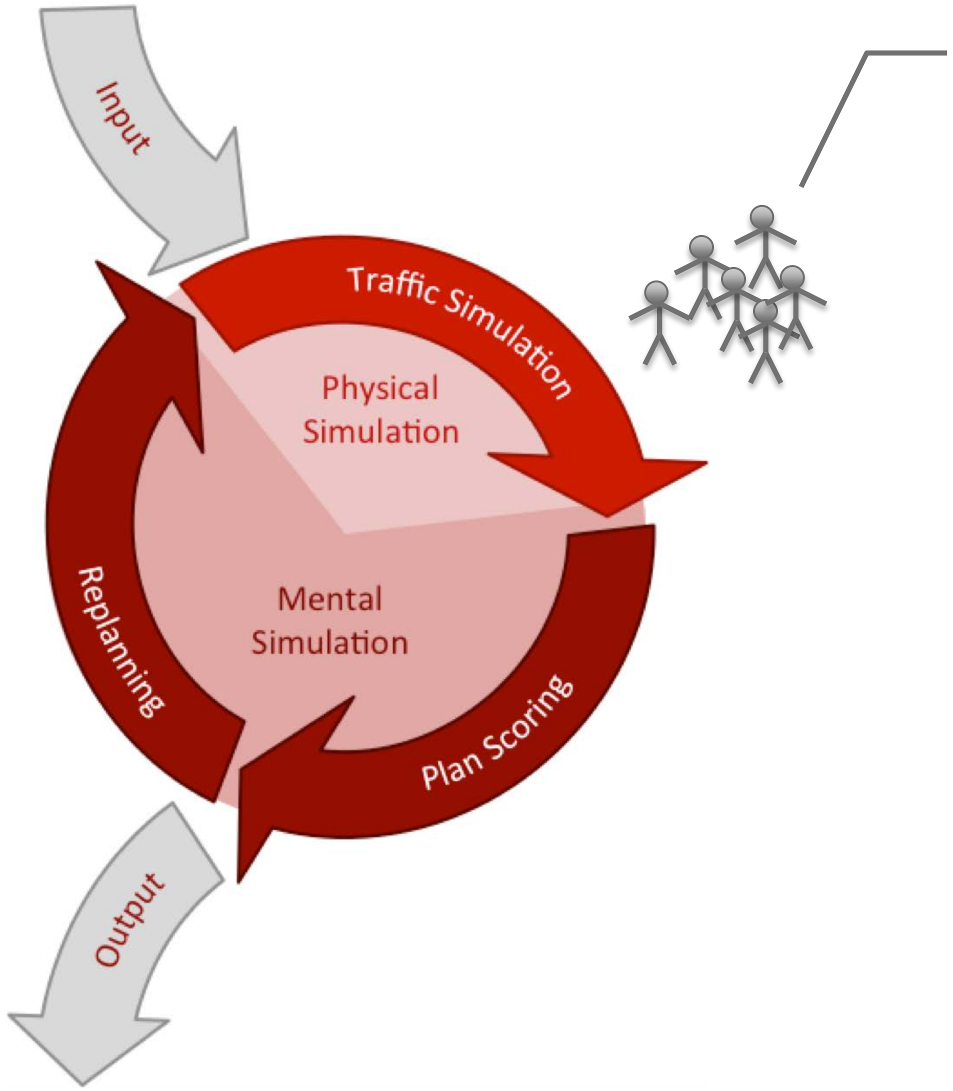
Demand adaptation in MATSim: Mode choice



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trip (**bike**, route x)
Work (dep: 16:04)
trip (**bike**, route y)
Shopping (dep: 18:04)
trip (**bike**, route y)
Home

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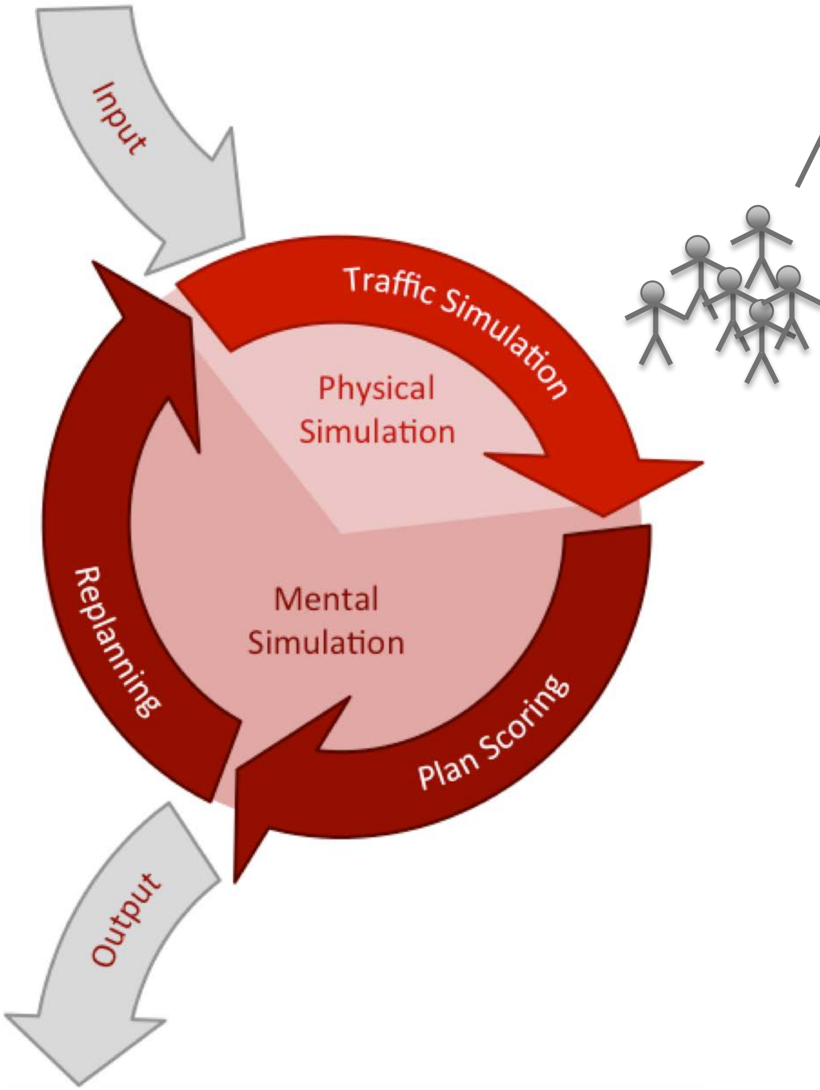
Demand adaptation in MATSim: Destination choice



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trip (car, route y)
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Demand adaptation

Responsible component "Typical" micro setup	Behaviorally: "Choice dimensions"
	Who? / How many?
ABDM	Agents
	Where to?
ABDM	Activities + locations
	By what mode?
ABDM	Mode choice
	When?
ABDM	Departure time choice
	Which route?
DTA	Routing

Demand adaptation

Responsible component

MATSim setup	“Typical” micro setup
?	ABDM
MATSim	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

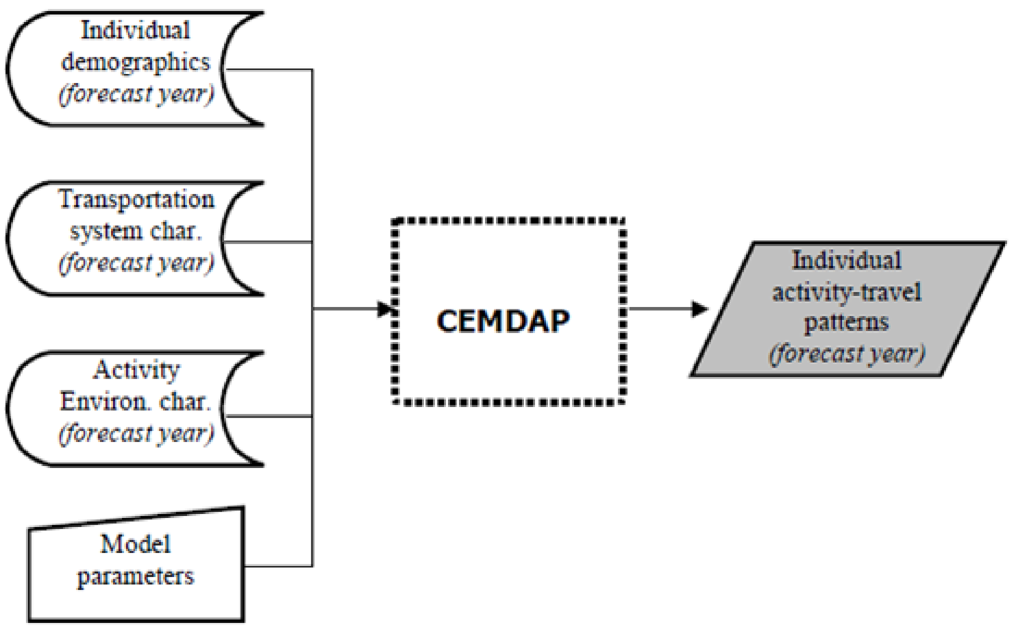
- Comprehensive Econometric Microsimulator for **Daily Activity-Travel Patterns**
- C. Bhat et al., University of Texas

Input

- Disaggregate Demographics
- Model Specification

Output

- Daily Activity-Travel Patterns for each individual



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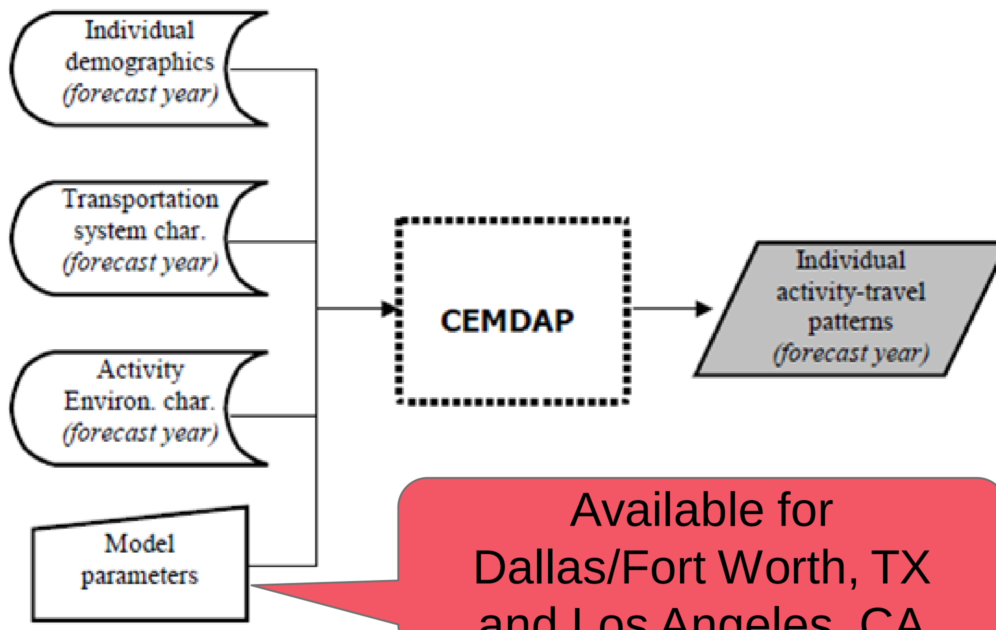

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Demand adaptation in Open Berlin Scenario

Responsible component	Behaviorally: "Choice dimensions"
MATSim setup	
Census + commuter stat.	• Who? / How many? • Agents
CEMDAP / ?	• Where to? • Activities + locations
CEMDAP / MATSim	• By what mode? • Mode choice
CEMDAP / MATSim	• When? • Departure time choice
MATSim	• Which route? • Routing

Demand adaptation in Open Berlin Scenario

Responsible component	Behaviorally: "Choice dimensions"
MATSim setup	
Census + commuter stat.	• Who? / How many? • Agents
CEMDAP / ? (Work Locations?)	• Where to? • Activities + locations
CEMDAP / MATSim	• By what mode? • Mode choice
CEMDAP / MATSim	• When? • Departure time choice
MATSim	• Which route? • Routing

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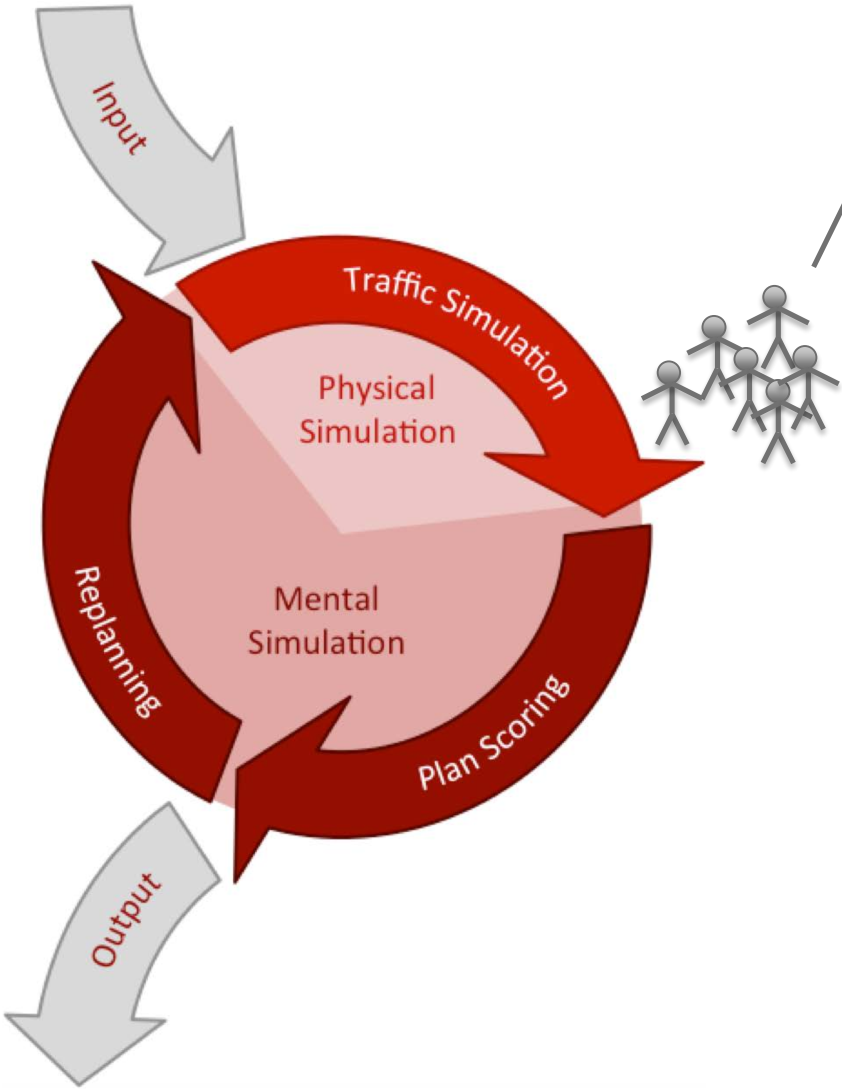
Demand adaptation in MATSim: Mode choice

Repetition



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trip (**bike**, route y)
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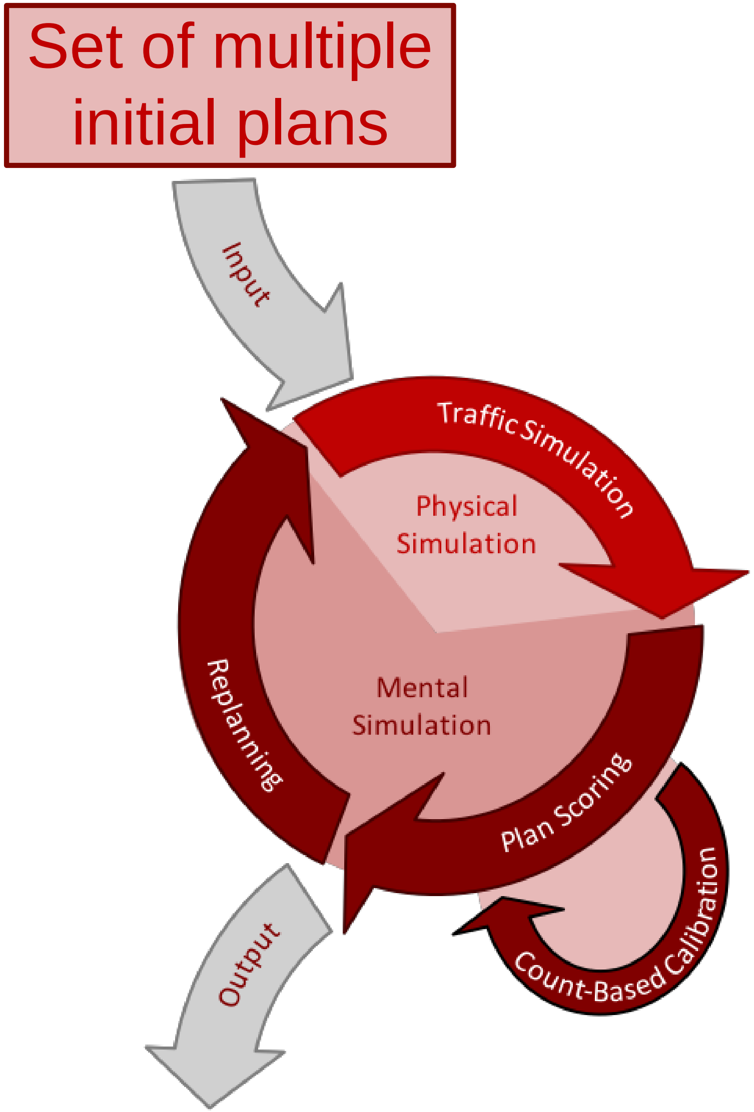
MATSim: Simulation and calibration



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

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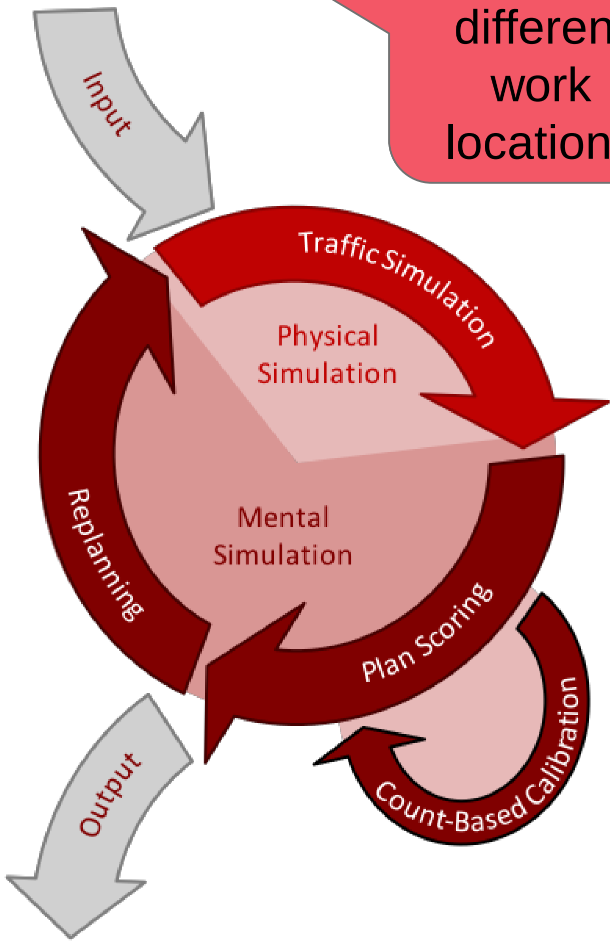
MATSim: Simulation and calibration

Set of multiple initial plans

… with different work locations



CaDyTS

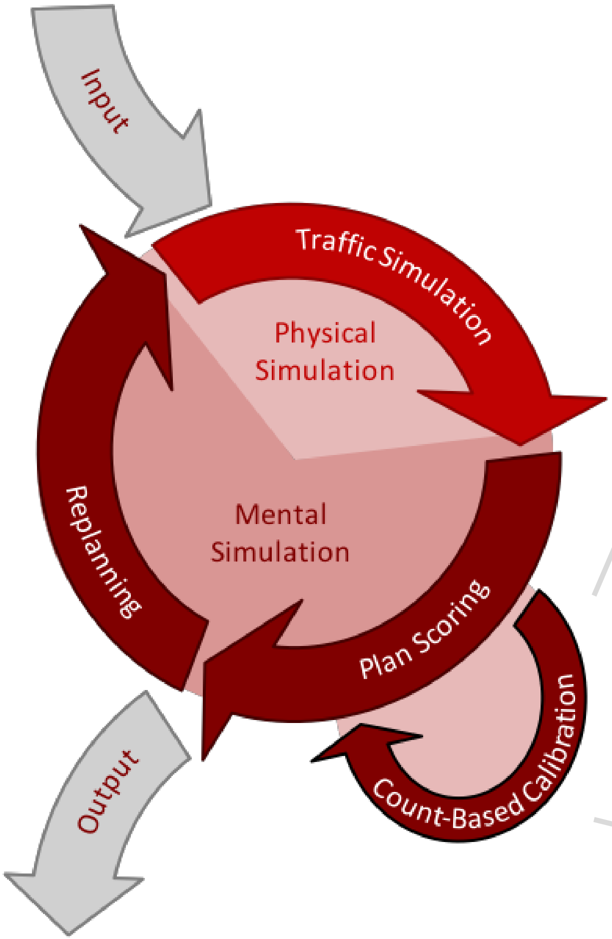
- calibration integrated into MATSim’s genetic algorithm

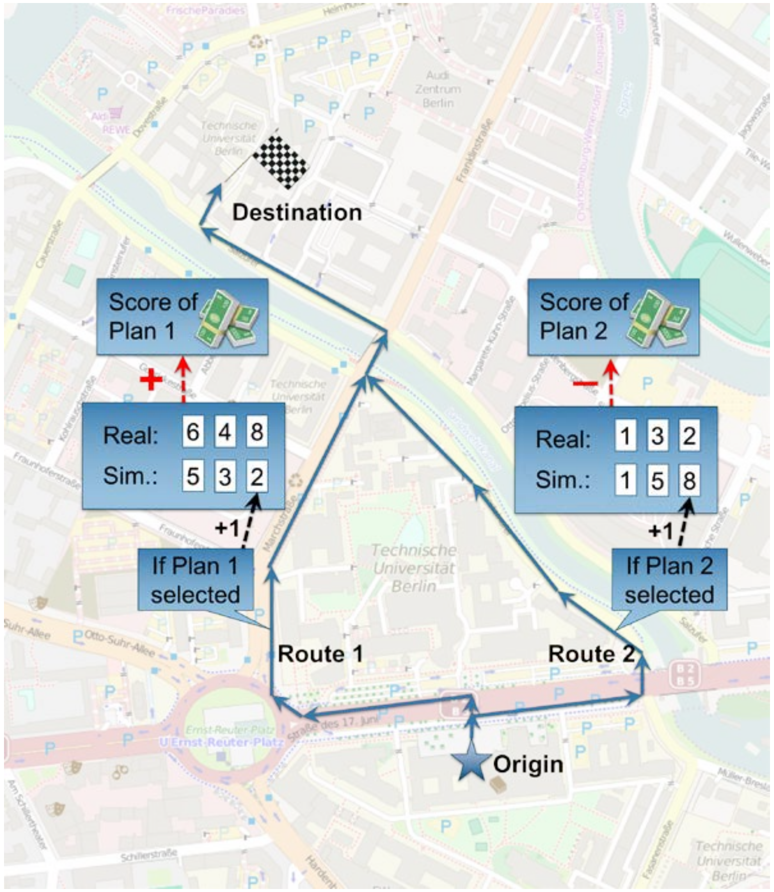
“Extended” Plan Scoring

- Agents score their executed activities and trips
  - behaviorally
  - in terms of match with real-world observations

MATSim: Simulation and calibration

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





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Relation to other methods

- Macroscopic models
  - use initial rough OD matrix
  - use traffic counts
  - make OD matrix more appropriate for a region

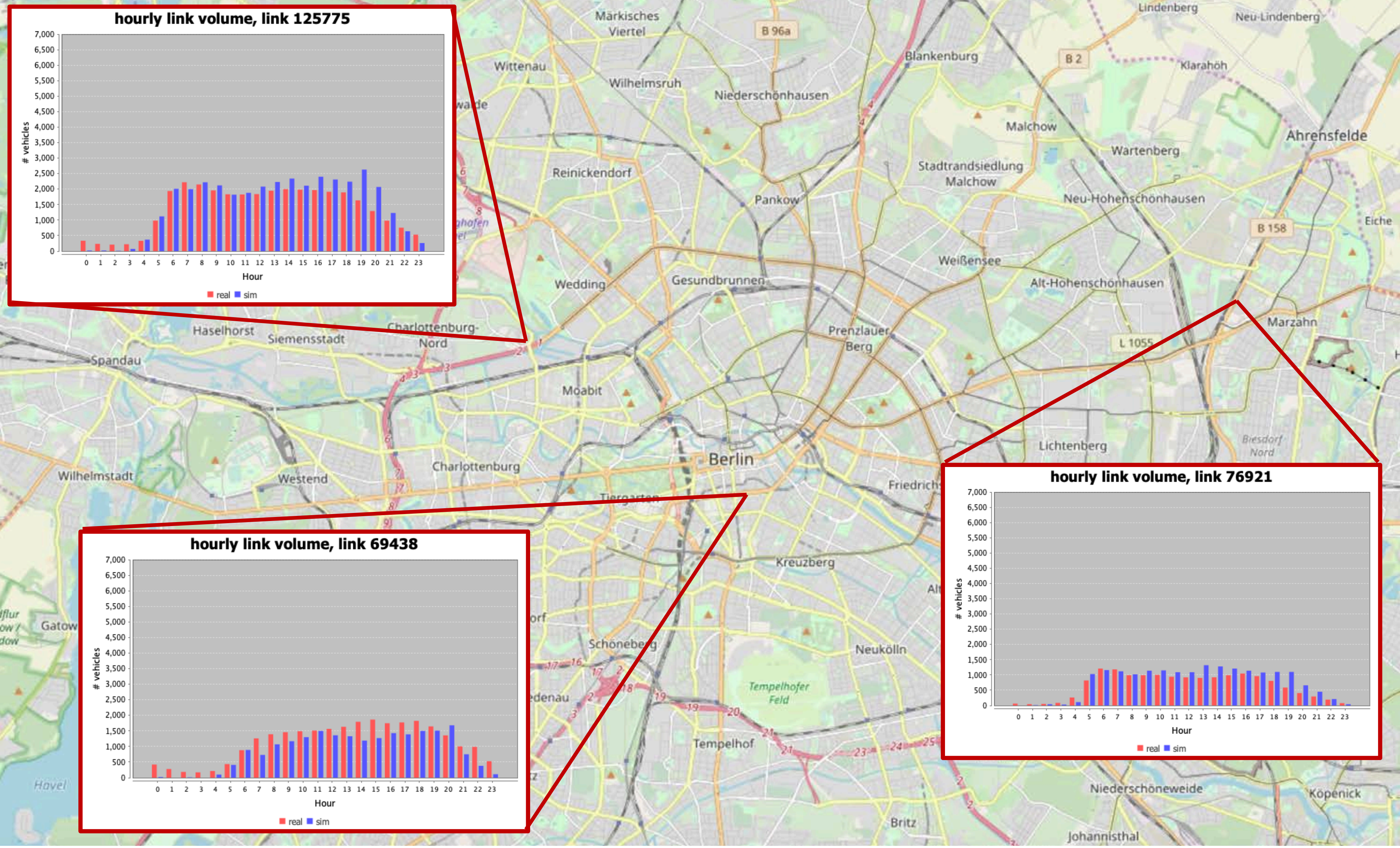
  → "OD matrix estimation"

- 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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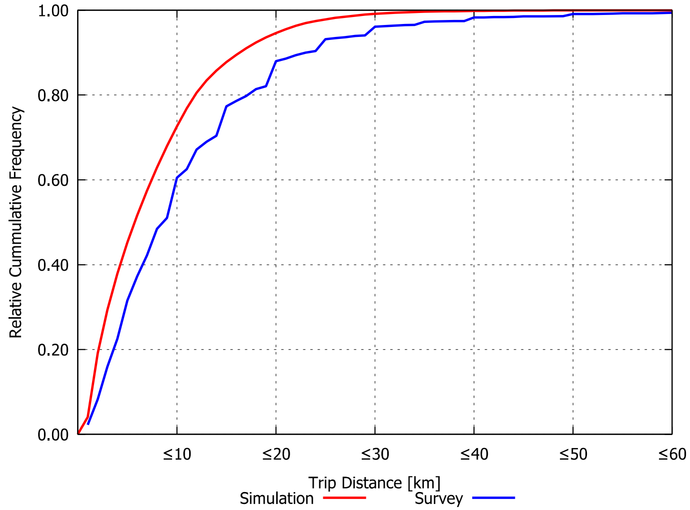
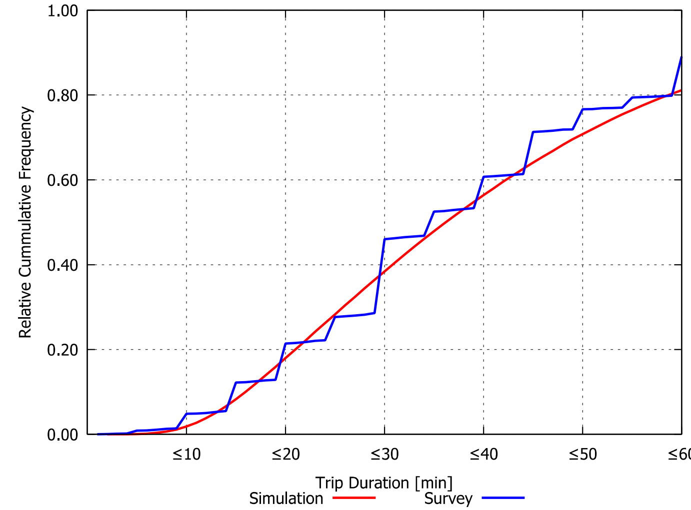
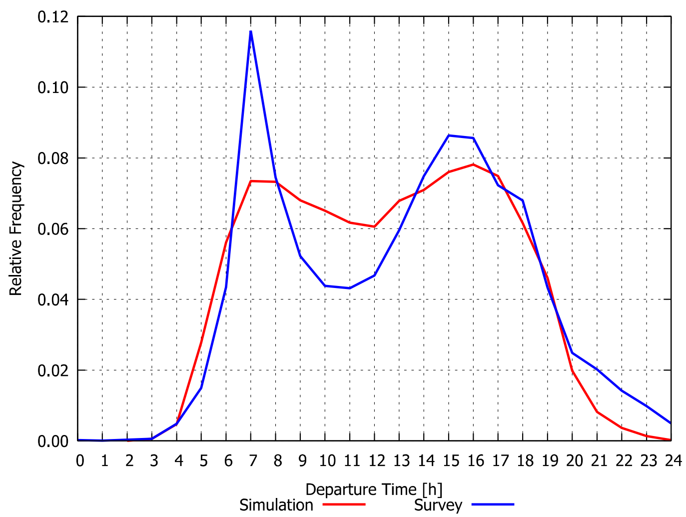
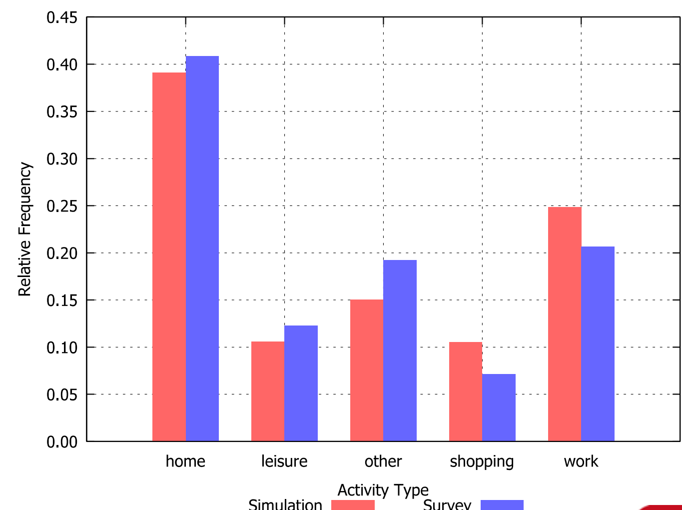
Results / Public transport statistics









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EXAMPLE 2

SNF BIG DATA PROJECT

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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**

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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

00:00-01:00	Munic. 1	Munic. 2	…	Munic. n
Munic. 1	#trips	#trips	…	#trips
Munic. 2	#trips	#trips	…	#trips
…	…	…	…	…
Munic. n	#trips	#trips	…	#trips

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SwissCom OD Matrix

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...	...	...	...	...
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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

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Demand adaptation

Responsible component		Behaviorally:
MATSim setup	"Typical" micro setup	"Choice dimensions"
		• Who? / How many?
?	ABDM	• Agents
		• Where to?
MATSim	ABDM	• Activities + locations
		• By what mode?
MATSim	ABDM	• Mode choice
		• When?
MATSim	ABDM	• Departure time choice
		• Which route?
MATSim	DTA	• Routing

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

Responsible component

MATSim setup	"Typical" micro setup
?	ABDM
MATSim	ABDM

Activity sequences + locations

Behaviorally:
"Choice dimensions"

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

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ABDMs

	CEMDAP	FEATHERS	ActiTopp
Developer	University of Texas	Universiteit Hasselt	Karlsruhe Inst. of Technology
Language	C++	C++	Java
Code	.exe (one version can be inspected)	.exe	Open source (GitHub)
Interaction with MATSim	File-based + database (man.)	File-based (with integration test)	Code-based
Estimation cont.	Los Angeles	Flanders	Germany (MOP)
Input	Many variables	Various variables	A few variables
Output	Full activity-travel patterns for each individual	Full activity-travel patterns for each individual	Activity sequence with dummy trips; no locations, but commute dist.
Spatial transfer and application	Count-based cali-bration for Berlin	Use in est. con-text (Flanders)	Use in est. con-text (Germany)

Other models: ALBATROSS, TASHA, TAPAS, …

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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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  - No information on intervening trips

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***Activity chains** = pure activity chains

- No information on location ➔ Destination choice
- No information on intervening trips

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

ActiTopp: Person specification

- Id
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- Commuting distance

Synthetic population (Id – Number of cars in the hh)

OD matrix (Commuting distance)

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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. and K. Nagel. Development of a fully synthetic and open scenario for agent-based transport simulations – The MATSim Open Berlin Scenario. VSP Working Paper 17-12, TU Berlin, Transport Systems Planning and Transport Telematics, 2017. URL: http://www.vsp.tu-berlin.de/publications.

- 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

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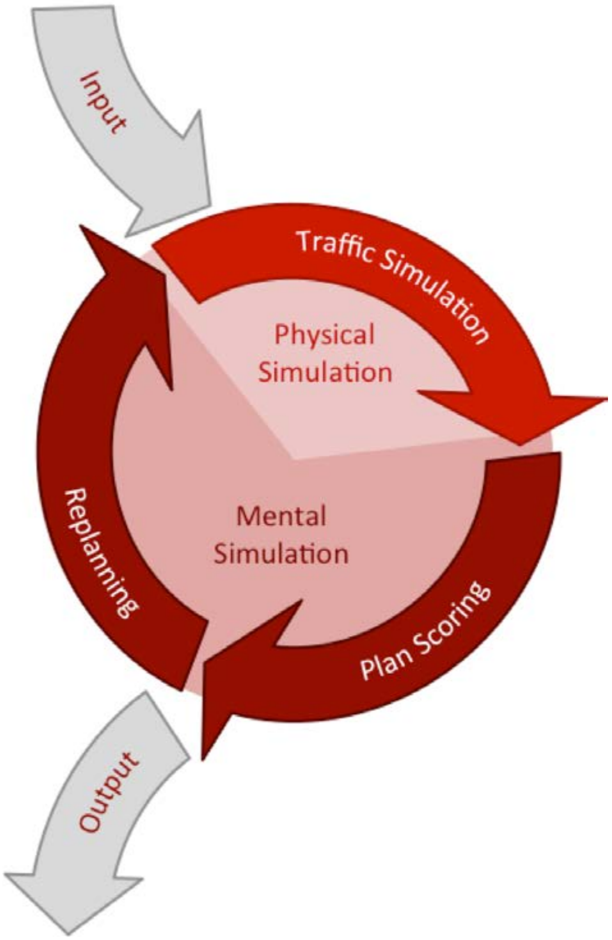
BACKUP (BERLIN)

MATSim simulation



Traffic Simulation

- Agents travel on the network

Plan Scoring

- Agents score their executed activities and trips

Replanning

- Agents modify their plans along various possible choice dimensions
- Agents select a plan based on a multinomial logit model

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Activity Scheduling Models

- Output: Full activity-travel patterns of a day = “daily plan”

- Activity participation
  = *f* (properties of person/household,
  model specification (behavior),
  transport/land-use environment)

- Activity participation → Transport demand (derived demand)

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Activity Scheduling Models

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- Transferable?

Activity Scheduling Models

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  model specification (behavior),
  transport/land-use environment)

- Activity participation → Transport demand (derived demand)

- Transferable?
- One thought further: *Universal* model?

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Model Transferability

- Cambridge Systematics et al., 2012
  - “transferability improves with a better variable specification and with a disaggregate level model”
  - “some level of model updating should be undertaken using local data collected in the application context”
- Arentze et al., 2002
  - good performance for a regionally transferred model in regard to activity participation and time-of-day distributions, but weaker results for mode choice (model parameters updated)
- Sikder and Pinjari, 2013
  - update on ASC
  - better results when transferred with updating

- Open Berlin Scenario (This study)
  - Other models: Updating on specific model parameters
  - Here: Updating on initial full daily activity plans

Generalization of calibration approach

- Berlin Scenario
  - with calibration based on traffic counts

- Ruhr Scenario
  - with calibration based on
    - traffic counts
    - numbers of trips by distance class and mode

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Open Berlin Scenario Literature

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. and K. Nagel. Development of a fully synthetic and open scenario for agent-based transport simulations – The MATSim Open Berlin Scenario. VSP Working Paper 17-12, TU Berlin, Transport Systems Planning and Transport Telematics, 2017. URL: http://www.vsp.tu-berlin.de/publications.

- 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

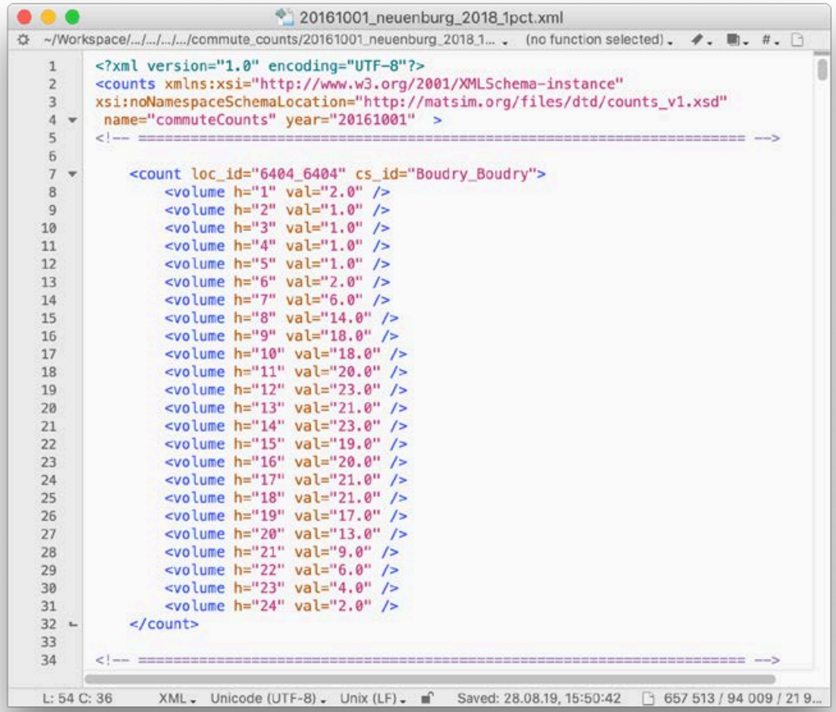
BACKUP (SNF)

Next steps

- Run a full 1% Switzerland scenario
- Speed/timing tests: dest choice is slow.
- Write regression and integration tests
- Calibration / validation of MATSim outputs

MunicipalityCommutesParser

- Reads in SwissCom matrices
- Creates “MATSim counts”
  - 1 count = 1 mun-mun relation
  - Each count has 24 hourly trip obs.
- Spatial scope of included counts
  - Adjustable by canton level
- Includes conversion of municipalities
  - needed because:
  - SwissCom matrix is based on the 2012 Swiss municipality layout (2.5k municipalities)
  - IVT population is based on some 2018 Swiss municipality layout (2.2k municipalities)
- Output
  - MATSim counts of number of trips by mun-mun relation with 24 hourly values based on 2018 Swiss mun layout




```xml
<?xml version="1.0" encoding="UTF-8"?>
<counts xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="http://matsim.org/files/dtd/counts_v1.xsd"
 name="commuteCounts" year="20161001"  >
<!-- ===================================================================== -->

    <count loc_id="6404_6404" cs_id="Boudry_Boudry">
        <volume h="1" val="2.0" />
        <volume h="2" val="1.0" />
        <volume h="3" val="1.0" />
        <volume h="4" val="1.0" />
        <volume h="5" val="1.0" />
        <volume h="6" val="2.0" />
        <volume h="7" val="6.0" />
        <volume h="8" val="14.0" />
        <volume h="9" val="18.0" />
        <volume h="10" val="18.0" />
        <volume h="11" val="20.0" />
        <volume h="12" val="23.0" />
        <volume h="13" val="21.0" />
        <volume h="14" val="23.0" />
        <volume h="15" val="19.0" />
        <volume h="16" val="20.0" />
        <volume h="17" val="21.0" />
        <volume h="18" val="21.0" />
        <volume h="19" val="17.0" />
        <volume h="20" val="13.0" />
        <volume h="21" val="9.0" />
        <volume h="22" val="6.0" />
        <volume h="23" val="4.0" />
        <volume h="24" val="2.0" />
    </count>

<!-- ===================================================================== -->
```

IvtPopulationParser

- Reads in IVT Population (based on STATPOP)
- Re-computes and categorizes attributes as needed by actiTopp
- Output: Population, households, and facilities

population_1pct.xml

~/Workspace/shared-svn/projects/snf-big-data/data/scenario/neuenburg_1pct/population_1pct.xml

```xml
<?xml version="1.0" encoding="utf-8"?>
<!DOCTYPE population SYSTEM "http://www.matsim.org/files/dtd/population_v6.dtd">

<population>



<!-- ====================================================================== -->

	<person id="4865627">
		<attributes>
			<attribute name="age" class="java.lang.Integer" >45</attribute>
			<attribute name="canton_id" class="java.lang.Integer" >24</attribute>
			<attribute name="children_0_10" class="java.lang.Boolean" >false</attribute>
			<attribute name="children_0_18" class="java.lang.Boolean" >true</attribute>
			<attribute name="employed" class="java.lang.Boolean" >true</attribute>
			<attribute name="facility_id" class="java.lang.String" >2156844</attribute>
			<attribute name="gender" class="java.lang.String" >male</attribute>
			<attribute name="household_id" class="java.lang.String" >2156844</attribute>
			<attribute name="municipality_id" class="java.lang.Integer" >6416</attribute>
			<attribute name="municipality_type" class="java.lang.String" >suburban</attribute>
			<attribute name="number_of_cars" class="java.lang.Integer" >0</attribute>
		</attributes>
	</person>

<!-- ====================================================================== -->

	<person id="4865628">
```

L: 1 C: 1 XML Unicode (UTF-8) Unix (LF) Saved: 28.08.19, 15:58:33 1 750 885 / 146 013 / 31 673 100%

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RunActitoppForIvtPopulation

- Prepare counts
  - All counts from 6 to 10 o'clock are regarded "morning peak"
  - Set up *commute trips lists* for each origin containing corresponding number of destinations (based on these morning peak observations)
- For each person from (MATSim) population
  - Create ActiTopp ("alter ego") person
  - Transfer basic demographic attributes from MATSim person and households
  - For employed people (full time, half time, vocational program, …)
    - Select destination from *commute trips lists*
    - Determine distance by shortest path
  - Run actiTopp
    - Attributes: children <=10, children <18, age, employment, gender, areaType, # cars, commuting distance to work or education
    - Result: **Activity chain -> convert into MATSim plan**
- Output: Population with daily plans for each agent

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```xml
<!-- ===================================================================== -->

<person id="4865627">
    <attributes>¿
        <attribute name="actitopp_area_type" class="java.lang.Integer" >3</attribute>¿
        <attribute name="actitopp_employment_class" class="java.lang.Integer" >2</attribute>¿
        <attribute name="actitopp_gender" class="java.lang.Integer" >1</attribute>¿
        <attribute name="age" class="java.lang.Integer" >45</attribute>¿
        <attribute name="canton_id" class="java.lang.Integer" >24</attribute>¿
        <attribute name="children_0_10" class="java.lang.Boolean" >false</attribute>¿
        <attribute name="children_0_18" class="java.lang.Boolean" >true</attribute>¿
        <attribute name="employed" class="java.lang.Boolean" >true</attribute>¿
        <attribute name="facility_id" class="java.lang.String" >2156844</attribute>¿
        <attribute name="gender" class="java.lang.String" >male</attribute>¿
        <attribute name="household_id" class="java.lang.String" >2156844</attribute>¿
        <attribute name="municipality_id" class="java.lang.Integer" >2</attribute>¿
        <attribute name="municipality_type" class="java.lang.String" >suburban</attribute>¿
        <attribute name="number_of_cars" class="java.lang.Integer" >0</attribute>¿
        <attribute name="work_edu_municipality_id" class="java.lang.Integer" >6458</attribute>¿
    </attributes>¿
    <plan selected="yes">
        <activity type="home" x="2557157.0" y="1203106.0" end_time="06:37:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="work" x="2561300.0" y="1204700.0" end_time="13:26:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="leisure" x="2557157.0" y="1203106.0" end_time="14:17:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="home" x="2557157.0" y="1203106.0" end_time="16:05:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="other" x="2557157.0" y="1203106.0" end_time="16:37:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="home" x="2557157.0" y="1203106.0" end_time="30:04:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="work" x="2561300.0" y="1204700.0" end_time="12:20:00" >
        </activity>
        <leg mode="car">
        </leg>
        <activity type="home" x="2557157.0" y="1203106.0" end_time="15:10:00" >
        </activity>
        <leg mode="car">
        </leg>
    </plan>

</person>
```

Destination choice: options

We need to perform destination choice to assign locations for the secondary ActiTopp tours (we already have home and work locations)

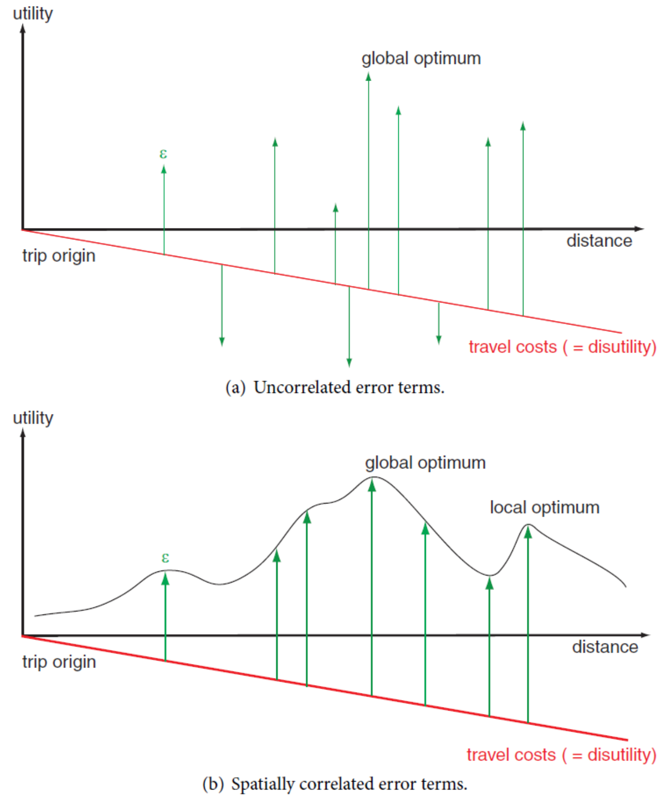
We are exploring three approaches:

- **Location assignment (Hörl)**
- **Location choice (Horni)**
- **CaDyTS-based**

Destination choice (A. Horni)

- An existing, published Location Choice contrib in the MATSim repository

- **“Frozen Epsilons”** -- Optimizes the otherwise intractable choice set by assigning consistent epsilons to each person and to each facility choice.



Destination Choice – initial tests

- Neuenburg chosen as small test area

- Run Actitopp -> less than one minute ☺
- Run Destination Choice -> about 3 minutes

ActiTopp

```
public class ActitoppExample {

    private static ModelFileBase fileBase = new ModelFileBase();
    private static RNGHelper randomgenerator = new RNGHelper(1234);

    public static void main(String[] args) {

        ActitoppPerson testperson = new ActitoppPerson(
                99,     // PersIndex
                0,      // Kinder 0-10
                1,      // Kinder unter 18
                55,     // Alter
                1,      // Beruf
                1,      // Geschlecht
                2,      // Raumtyp
                2       // Pkw im HH
                );
        System.out.println(testperson);

        try {
            testperson.generateSchedule(fileBase, randomgenerator);
        } catch (InvalidPatternException e) {
            e.printStackTrace();
        }

//      testperson.getWeekPattern().printOutofHomeActivitiesList();
        testperson.getWeekPattern().printAllActivitiesList();

        HWeekPattern pattern = testperson.getWeekPattern();

        List<HActivity> activities = pattern.getAllActivities();
        for (HActivity activity : activities) {
            if (activity.getDay().getWeekday() == 1) {
                System.out.println("Start time = " + activity.getStartTime());
                System.out.println("End time = " + activity.getEndTime());
                System.out.println("Type = " + activity.getType());
            }
        }
    }
}
```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ActiTopp: Activity chains

```
0 Akt : Start 0 Ende 435 Dauer: 435 Typ: H (7)
1 Weg : Start 435 Ende 454 Dauer 19
1 Akt : Start 454 Ende 724 Dauer: 270 Typ: W (1)
1 Weg (letzter in Tour) : Start 724 Ende 743 Dauer 19
2 Akt : Start 743 Ende 785 Dauer: 42 Typ: H (7)
3 Weg : Start 785 Ende 804 Dauer 19
3 Akt : Start 804 Ende 1044 Dauer: 240 Typ: W (1)
3 Weg (letzter in Tour) : Start 1044 Ende 1063 Dauer 19
4 Akt : Start 1063 Ende 2160 Dauer: 1097 Typ: H (7)
5 Weg : Start 2160 Ende 2179 Dauer 19
5 Akt : Start 2179 Ende 2679 Dauer: 500 Typ: W (1)
5 Weg (letzter in Tour) : Start 2679 Ende 2698 Dauer 19
6 Akt : Start 2698 Ende 3580 Dauer: 882 Typ: H (7)
7 Weg : Start 3580 Ende 3599 Dauer 19
7 Akt : Start 3599 Ende 4134 Dauer: 535 Typ: W (1)
7 Weg (letzter in Tour) : Start 4134 Ende 4153 Dauer 19
8 Akt : Start 4153 Ende 4703 Dauer: 550 Typ: H (7)
9 Weg : Start 4703 Ende 4722 Dauer 19
9 Akt : Start 4722 Ende 5279 Dauer: 557 Typ: W (1)
9 Weg (letzter in Tour) : Start 5279 Ende 5298 Dauer 19
10 Akt : Start 5298 Ende 6220 Dauer: 922 Typ: H (7)
11 Weg : Start 6220 Ende 6239 Dauer 19
11 Akt : Start 6239 Ende 6796 Dauer: 557 Typ: W (1)
11 Weg (letzter in Tour) : Start 6796 Ende 6815 Dauer 19
12 Akt : Start 6815 Ende 7550 Dauer: 735 Typ: H (7)
13 Weg : Start 7550 Ende 7569 Dauer 19
13 Akt : Start 7569 Ende 8230 Dauer: 661 Typ: W (2)
13 Weg (letzter in Tour) : Start 8230 Ende 8249 Dauer 19
14 Akt : Start 8249 Ende 8325 Dauer: 76 Typ: H (7)
15 Weg : Start 8325 Ende 8345 Dauer 20
15 Akt : Start 8345 Ende 8374 Dauer: 29 Typ: S (41)
15 Weg (letzter in Tour) : Start 8374 Ende 8394 Dauer 20
16 Akt : Start 8394 Ende 9420 Dauer: 1026 Typ: H (7)
17 Weg : Start 9420 Ende 9440 Dauer 20
17 Akt : Start 9440 Ende 9610 Dauer: 170 Typ: L (51)
17 Weg (letzter in Tour) : Start 9610 Ende 9630 Dauer 20
18 Akt : Start 9630 Ende 10080 Dauer: 450 Typ: H (7)
```


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ActiTopp: Activity chains

```
0 Akt : Start 0 Ende 435 Dauer: 435 Typ: H (7)
1 Weg : Start 435 Ende 454 Dauer 19
1 Akt : Start 454 Ende 724 Dauer: 270 Typ: W (1)
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17 Weg : Start 9420 Ende 9440 Dauer 20
17 Akt : Start 9440 Ende 9610 Dauer: 170 Typ: L (51)
17 Weg (letzter in Tour) : Start 9610 Ende 9630 Dauer 20
18 Akt : Start 9630 Ende 10080 Dauer: 450 Typ: H (7)
```

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ActiTopp: Unknown properties

- Unknown properties
  - Number of cars
  - Occupations type

- Multiple draws and selection of plans
  - 2 or 3 draws per variable
  - Create multiple initial plans
  - Selection of plans supported by CaDyTS
    - (Calibration of dynamic transport simulations)
  - Validate if marginal distributions fit

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