AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

DYNAMIC RIDE-SHARING FOR MATSIM

Presenting the DRS module

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MOTIVATION FOR A NEW MODULE

- Properly simulate **occupancy rates** of cars
- **Teleportation** of *ride* agents may be OK for trips with acquaintances, but:
  - No precise representation of matching
  - Definitely not precise enough for general ride-sharing

- Previous work by Wang et al (2017)
  - Only available as prototype
  - Uses *dvrp* with new agents
    - riders‘ requests are only emitted when they already want to start the trip

Wang, B., Liang, H., Hörl, S., Ciari, F., 2017. *Dynamic ride sharing implementation and analysis in matsim*. hEART 2017.

DEFINING DYNAMIC RIDE-SHARING

- **Driver**
  - uses **private car** for **personal trip**
- **Rider**
  - picked up and brought to destination by driver
- Drivers and riders
  - **not necessarily acquaintances**
- Matching
  - via **platform** (e.g. app) on **trip-by-trip-basis** (=dynamic)

image: flaticon.com

FACTORS INFLUENCING DRS USAGE

Sociodemographics	Mode related	Situational	Judgemental
gender*	organisation time	trip distance	awareness
age*	waiting time	time of trip	ease of use
income*	travel time	travel schedule	safety
household size*	parking time	alternative modes	comfort
car availability*	parking cost	population density	flexibility
native	travel cost	DRS platform*	privacy
	reliability		

person attribute drsAffinity & planCalcScore utility of travel time
(*) covered in Upper Austria model

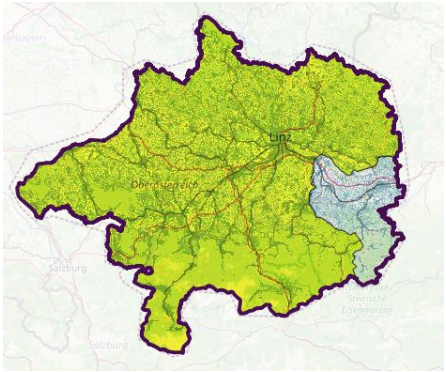
(configuration of) DRS module

mobsim

not covered

PREPARING A POPULATION

- Many factors influencing DRS are covered by
  - **Subpopulation assignment**
  - Mode choice model (**scoring parameters**)
  - Population attribute `drsAffinity`



Upper Austria Model

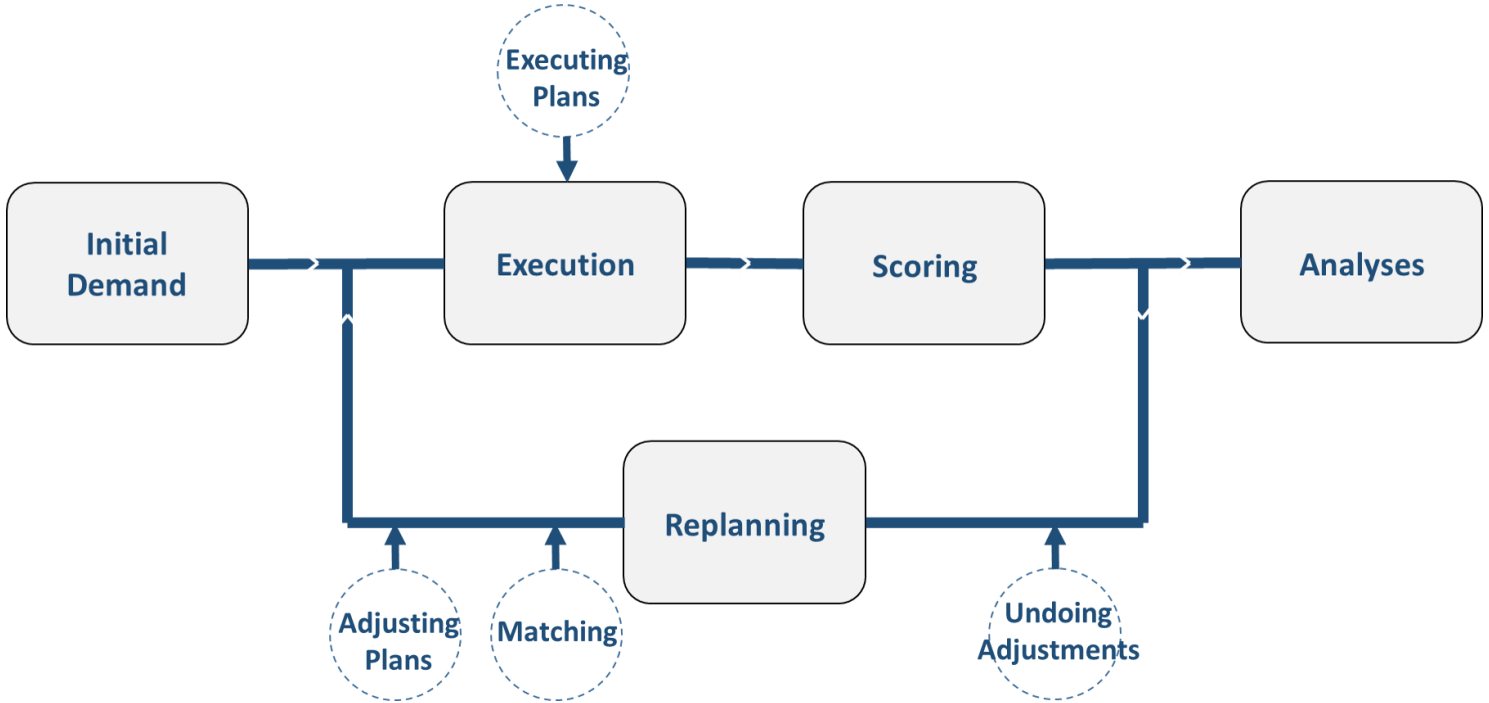
- Subpopulation / mode choice model
  - based on **travel survey** and socioeconomic parameters [1]
- `drsAffinity`
  - Based on **pro:motion typology** (information types) [2]

[1] Müller, J., M. Straub, A. Naqvi, G. Richter, S. Peer, and C. Rudloff, MATSim Model Vienna: Analyzing the Socioeconomic Impacts for Different Fleet Sizes and Pricing Schemes of Shared Autonomous Electric Vehicles. In Proceedings of the 100th TRB Annual Meeting, 2021.
[2] Markvica, K., A. Millonig, N. Haufe, and M. Leodolter, Promoting active mobility be- havior by addressing information target groups: The case of Austria. Journal of transport geography, Vol. 83, 2020, p. 102664.

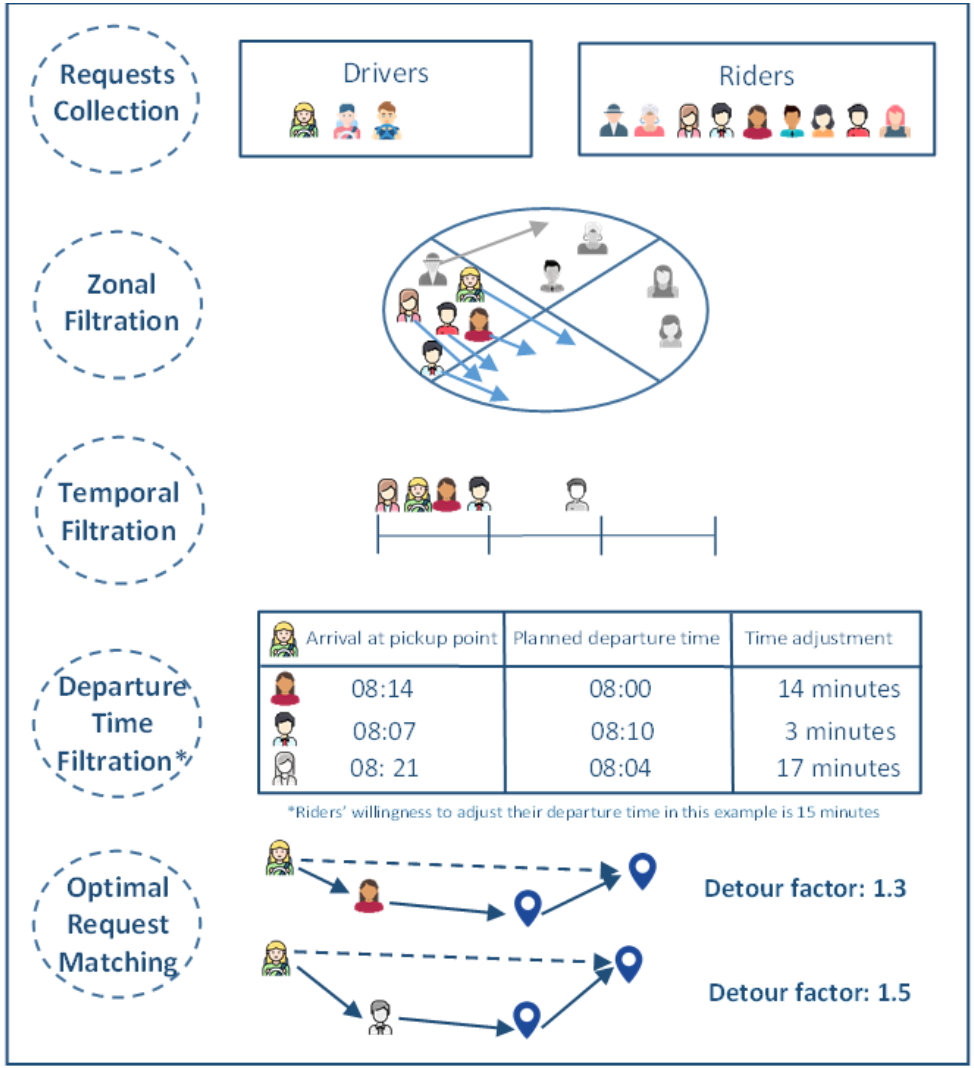
THE IMPLEMENTED DRS FLAVOUR

- Maximum of **one rider per trip**
- **Door-to-door service** for riders
- **Matching** of drivers and riders **before the start of each day**
  - no spontaneous requests during the day or during the trip
- **Mobility guarantee** for riders that could not find a match

PLUGGING INTO THE MATSIM LOOP



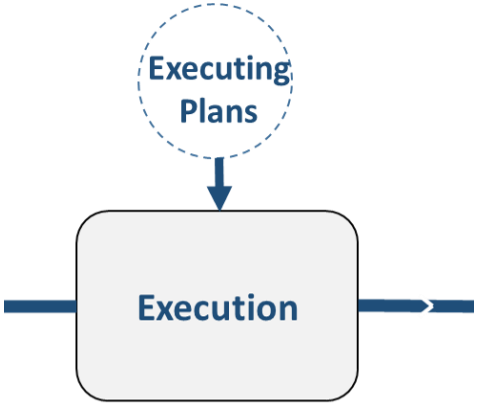
MATCHING


Requests Collection
Drivers
Riders
Zonal Filtration
Temporal Filtration
Departure Time Filtration*
Arrival at pickup point
Planned departure time
Time adjustment
08:14
08:00
14 minutes
08:07
08:10
3 minutes
08: 21
08:04
17 minutes
*Riders' willingness to adjust their departure time in this example is 15 minutes
Optimal Request Matching
Detour factor: 1.3
Detour factor: 1.5

EXECUTING PLANS

Matched agents

- Rider shows up at pickup point and waits
- Driver goes to pickup point and
  - Picks up rider if already there *or*
  - Waits for **`pickupWaitingSeconds`** to pick up rider
- Driver continues to rider's destination and drops him off
- Finally the driver drives to his own destination



Unmatched agents

- Riders get a **mobility guarantee** and are teleported
  - **`riderMobilityGuaranteeMonetaryConstant`**
- Drivers take trip like a **regular car trip**

DRS PARAMETERS: FULL LIST

Costs	Matching Algorithm	Simulation / Plan Adjustment	Plan Innovation
carAndDrsDaily-MonetaryConstant	cellSize	pickupWaitingSeconds	subtourModeChoice-ChainBasedModes
driverProfitPerKm	maxPossible-Candidates	riderDepartureTime-AdjustmentSeconds	subtourModeChoice-Modes
riderMobilityGuarantee-MonetaryConstant	minDriverLegMeters		drsAffinity (person attribute)
rider costs (set in planCalcScore*)	minRiderLegMeters		
	timeSegmentLength-Seconds		

(*) planCalcScore.modeParams.monetaryDistanceRate

Colored parameters are not set in the module's config section

UPPER AUSTRIA MODEL
DRS PARAMETER VALUES

Parameter	Default Scenario	Maximum Scenario
drsAffinity*	**50%**	**100%**
driverProfitPerKm	**0.05€**	**0.5€**
rider costs per km*	0.05€	0.05€
cellSize	4000m	4000m
timeSegmentLengthSeconds	1 hour	2 hours
minDriverLegMeters & minRiderLegMeters	20m	20m
pickupWaitingSeconds	**3 minutes**	**1 minute**
riderMobilityGuaranteeMonetaryConstant	10€	10€
riderDepartureTimeAdjustmentSeconds	**15 minutes**	**2 hours**

(*) parameters influencing results but not directly set in DRS config

UPPER AUSTRIA MODEL

DRS PARAMETER SENSITIVITY ANALYSIS

Scenario	Modal split DRS rider
Default DRS parameters, **`drsAffinity`** 50%	0.21%
Best single parameter variation (**`drsAffinity`** 100%, **`driverProfitPerKm`** 0.5€)	0.55%
Maximum (combination of best parameter values)	1.8%

LIMITATIONS AND FUTURE WORK

- Maximum of **one rider per driver's trip**
  - Increase limit
- **Detour of driver** to rider's destination even if rider does not show up
  - Re-route drivers during mobsim
- **`pickupWaitingSeconds` unnecessarily prolongs some pickups**
  - Regularly check for rider arrival during mobsim
- Matching algorithm
  - Option for predefined pickup points (instead of door-to-door)
  - Use sociodemographic attributes
  - Avoid local optimums
- Still many trips of **unmatched drivers** after reaching equilibrium
  - Reduce to 0

DIY!

- Source code available as open source!
  - https://github.com/ait-energy/matsim-drs
- Start exploring
  - **`RunSimpleDrsExample.java`**
  - **`config_drs.xml`**

Maven repo & dependency

```
<repositories>
  <repository>
    <id>matsim</id>
    <url>https://repo.matsim.org/repository/matsim/</url>
  </repository>
</repositories>

<dependencies>
  <dependency>
    <groupId>at.ac.ait.matsim</groupId>
    <artifactId>matsim-drs</artifactId>
    <version>14.1-SNAPSHOT</version>
  </dependency>
</dependencies>
```