Verkehrsingenieurtag – 6. March 2014

Carsharing: Why to model carsharing demand and how

F. Ciari

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

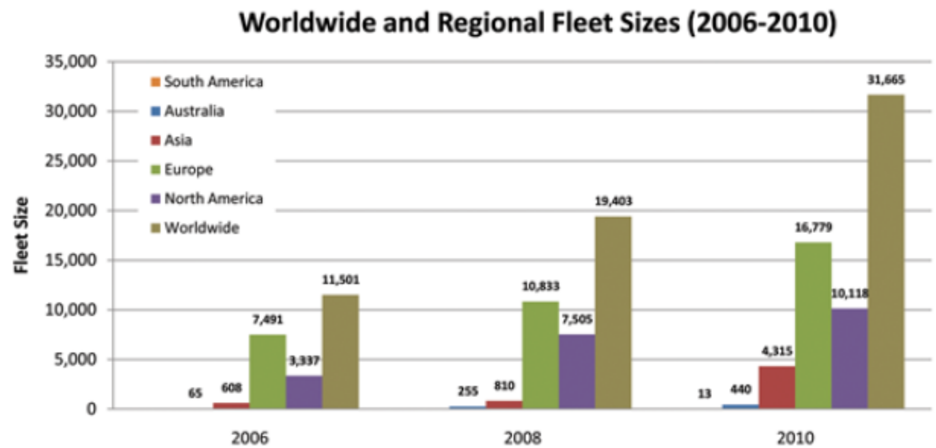
Outline

1. Introduction: What's going on in the carsharing world?
2. Why to model carsharing demand?
3. Modeling carsharing with MATSim
4. Summary and future work

1. Introduction: What’s going on in the carsharing world?
2. Why to model carsharing demand?
3. Modeling carsharing with MATSim
4. Summary and future work

Worldwide growth of carsharing

Carsharing in terms of members / vehicles is growing fast



Source: Shaheen and Cohen, 2012

Actors

- The **actors** involved are increasingly **large**
  - Car manufacturers → Daimler, BMW, Pegeout
  - Traditional car rental companies → Avis, Sixth
  - Public transport operators → DB

Competition

- The level of **competition** on the market is increasing
    - At the start of modern carsharing operations (90's Switzerland and Germany) and until recently, operators mostly were "local monopolists"
    - Now many cities boast several carsharing operators

Services

- The world of shared mobility is **evolving fast** and **new services** are coming to the market to **challenge/complement** the **old ones**

  - Round trip-based carsharing (Mobility)
  - One-way (station based) carsharing (Autolib)
  - Free-floating carsharing (Car2go, DriveNow)
  - Peer-to-peer carsharing (RelayRides)

  - Bike-sharing
  - Carpooling
  - Dynamic ride sharing
  - Slugging
  - …

1. Introduction: What's going on in the carsharing world?
2. Why to model carsharing demand?
3. Modeling carsharing with MATSim
4. Summary and future work

Why do we need to model carsharing demand?

Models are used to **get insight** on the **behavior of a transportation system** under given circumstances

but

Is **carsharing** relevant?

Because...

- Still small but conceptually “**mainstream**” (“Shared economy”)
- Fits well with some **societal developments** (“Peak car”)
- Is often mentioned when it comes to make transport more **sustainable** (but the mechanisms aren’t clear)

…and also because…

- The **actors** involved are increasingly **large** → Able to have a "big bang" approach, implies **large investments**
- The level of **competition** on the market is increasing → **Higher** investment **risk**
- The world of shared mobility is **evolving fast** → Incertitude about **integration/competition** among different modes/systems

Research Goal

- Build a **predictive** and **policy sensitive model** that can be used by **practitioners (operators)** and **policy makers**

Methodology: Observations

- Inherent **limitations** of **traditional models** representing carsharing – the importance of CS **availability** at **precise points** in **time** and **space** is not fitting with vehicles per hour flows

- **Travel** is the result of the **individual need** performing out-of-home **activities** at different locations – this matters for carsharing even more than for other modes! (according to the length / location of the activities)

1. Introduction: What's going on in the carsharing world?
2. Why to model carsharing demand?
3. Modeling carsharing with MATSim
4. Summary and future work

MATSim

It sketches **individuals' daily life** using the agent paradigm.

Agents have **personal attributes** (age, gender, employment, etc.) which influence their behavior

Agents **autonomously** try to **carry out a daily plan** being able to **modify** some dimensions of their **travel** (time, mode, route, activity location)

High **temporal** and **spatial resolution**

MATSim = Multi-agent transport simulation (www.matsim.org)

Carsharing model in MATSim – Current status

- **Traditional carsharing** + **Free-floating** (by senozon)

  - Agents always **walk** from the starting facility to the **closest car**
  - **Time** and **distance** dependent **fare**
  - Stations are located at the **actual carsharing locations** in the modeled area
  - Carsharing is available **only to members**
  - Actual **vehicle availability** is **accounted** for

Test Case 1 - Berlin

Part of a German project called "**Berlin elektroMobil**" → **Berlin**, **Germany** as a test case

Goals:

- Understand the **behavior** of the whole **transportation system** under different **carsharing scenarios**
- Finding **strategies** to **extend** the **carsharing supply** in Berlin and get hints on how to **combine free-floating** (FF) and **station-based** (SB) carsharing

Scenarios

- Scenario I: SBCS (Basis, station based only, reflecting actual supply)
- Scenario II: Expanded SBCS (Station based only, additional stations and members)
- Scenario III: Scenario II + Free-floating

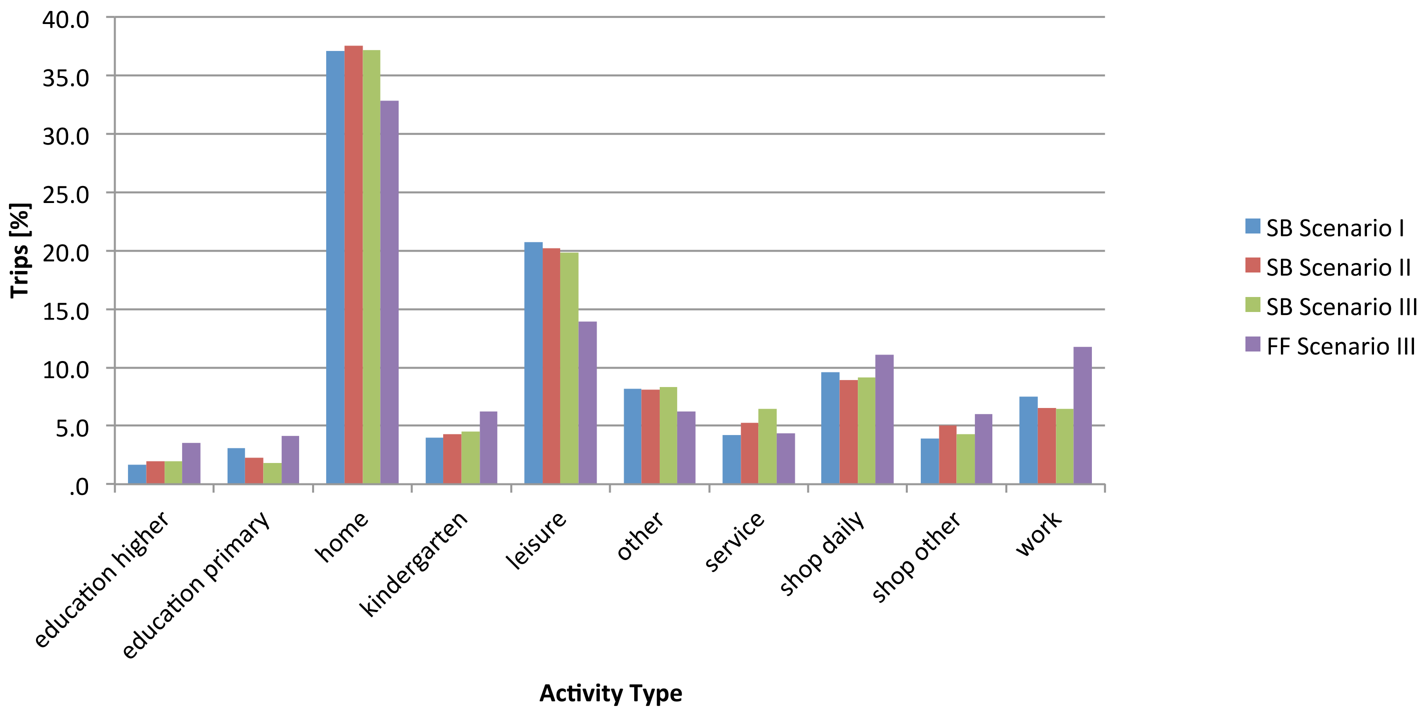
	Scenario I	Scenario II	Scenario III
Population	4‘422‘012	4‘506‘058	4‘506‘058
# Members CS SB & FF	20‘000	38‘000	38‘000
# Members CSFF	-	-	194‘000
# CS Stations	82	152	152
# Vehicles (Station based)	175	329	329
# Vehicles Free-floating	-	-	2‘500
# Members traveling (any mode)	16‘489	31‘358	191‘819

Statistics overview

	CS SB (Scenario I)	CS SB (Scenario II)	CS SB (Scenario III)	CS FF (Scenario III)
# Trips	496	1‘298	1‘379	10‘708
Avg. Trip Duration [min]	22.9	23.5	27.5	20.1
Avg. OD-Distance [km]	5.8	5.3	5.3	5.7
Total travel time [Days]	7.9	21.2	26.5	149.8
Total distance [km]	2‘900	6‘900	7‘300	60‘600

- **Over-proportional increase** of **SB** rentals (increasing stations / cars)
- **Trips** (distance and travel time) essentially **unchanged**
- Adding FFCS (2'500 cars) →
  ~ 10'000 additional trips and SBCS grows
- **SB** (S III) **shorter** trips (distance), **FF** slightly **longer but faster** trips.

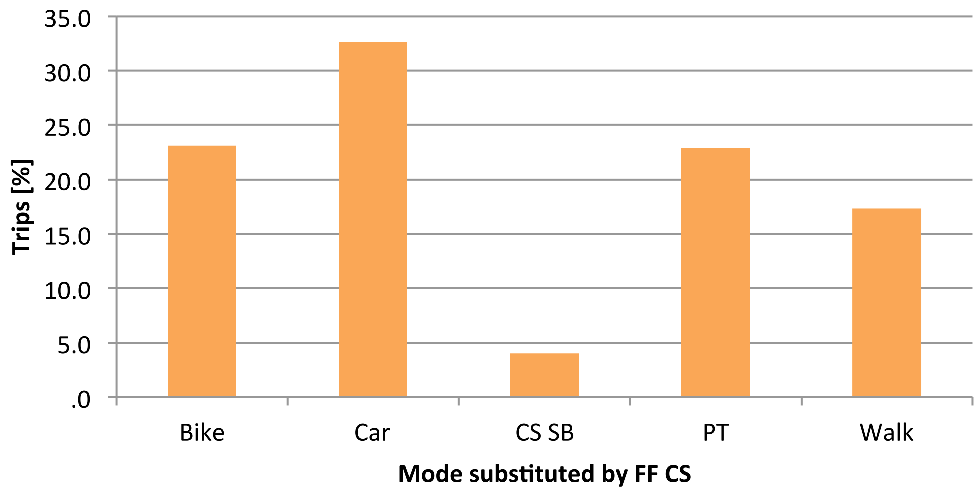
Purpose



FF CS has **more Work** and **less Leisure** travel compared to SB CS

Modal substitution

Mode substituted by free-floating carsharing



- **Car travel** is the mode which is **reduced the most** (> 30%) of the free-floating trips were car trips before its introduction

- Overall **car travel** (VMT) **grows** with FF compared to SB only → **modal substitution** patterns for free-floating carsharing might be problematic

- Relatively **few agents changed from SB to FF** carsharing

Conclusions

- **Untapped potential for SBCS** in Berlin – **Over-proportional growth** of SB doubling # carsharing cars
- **SB** carsharing is **used more intensively** after **FF** carsharing is introduced
- Some **differences** in the **use** of the two CS modes (**purpose, time, distance**)
- **Substitution patterns** are a possible **concern** for **FF**
- Apparently **FF** and **SB** are rather **complementary**

Test Case 2 - Zürich

Goals:

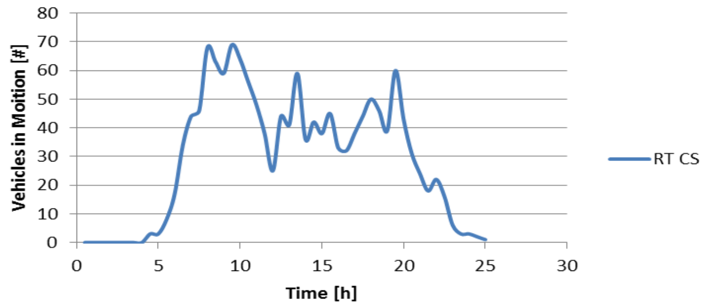
- Understand the **behavior** of the whole **carsharing system** under different (carsharing) **pricing scenarios**
- Get hints on the **interactions** between traditional **station based** carsharing and **free-floating carsharing** under such **scenarios**

Scenarios

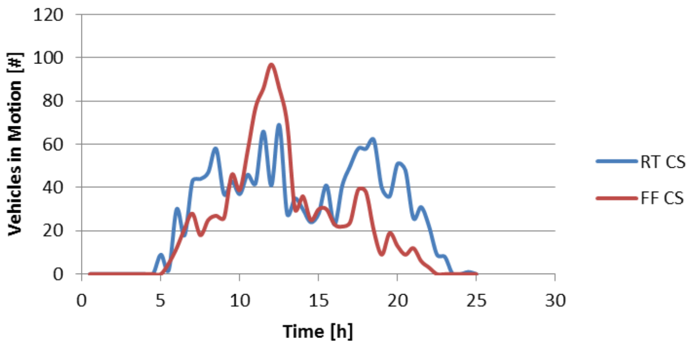
	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
SB Time Fee	4.52 SFr./h	4.52 SFr./h	4.52 SFr./h	4.52 SFr./h	4.52 SFr./h
SB Distance Fee	0.18 SFr./Km	0.18 SFr./Km	0.18 SFr./Km	0.18 SFr./Km	0.18 SFr./Km
FF Time Fee	-	0.237 SFr./min	0.118 SFr./min	0.118 SFr/min (10-16) 0.237 SFr/min (rest of day)	0.237 SFr./min
FF Distance Fee	-	0.29 SFr./Km	0.29 SFr./Km	0.29 SFr./Km	0.29 SFr./Km
FF Free Distance	-	20 Km	20 Km	20 Km	0 Km

Vehicles in Motion

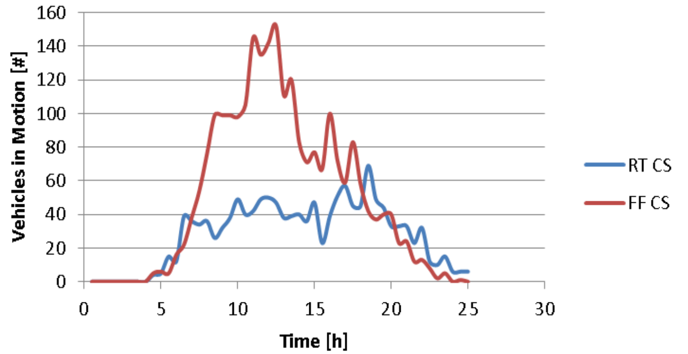
Scenario I



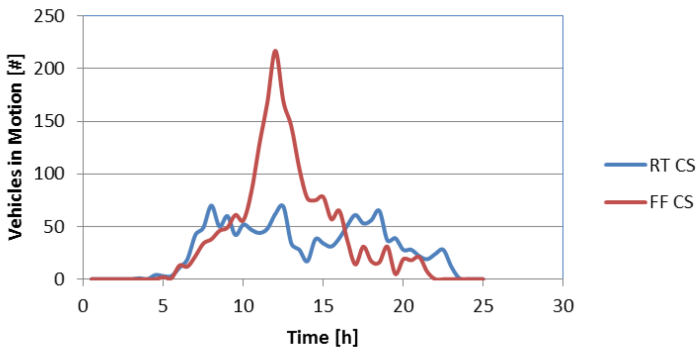
Scenario II



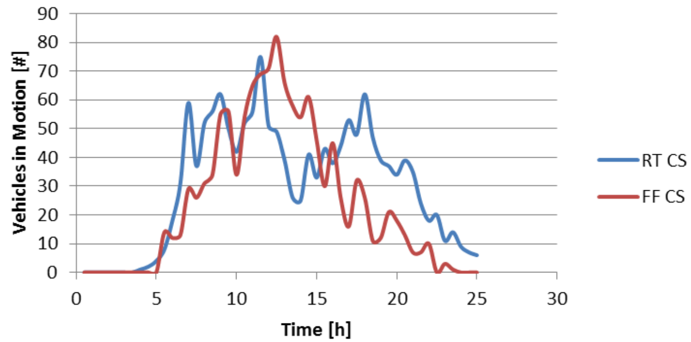
Scenario III



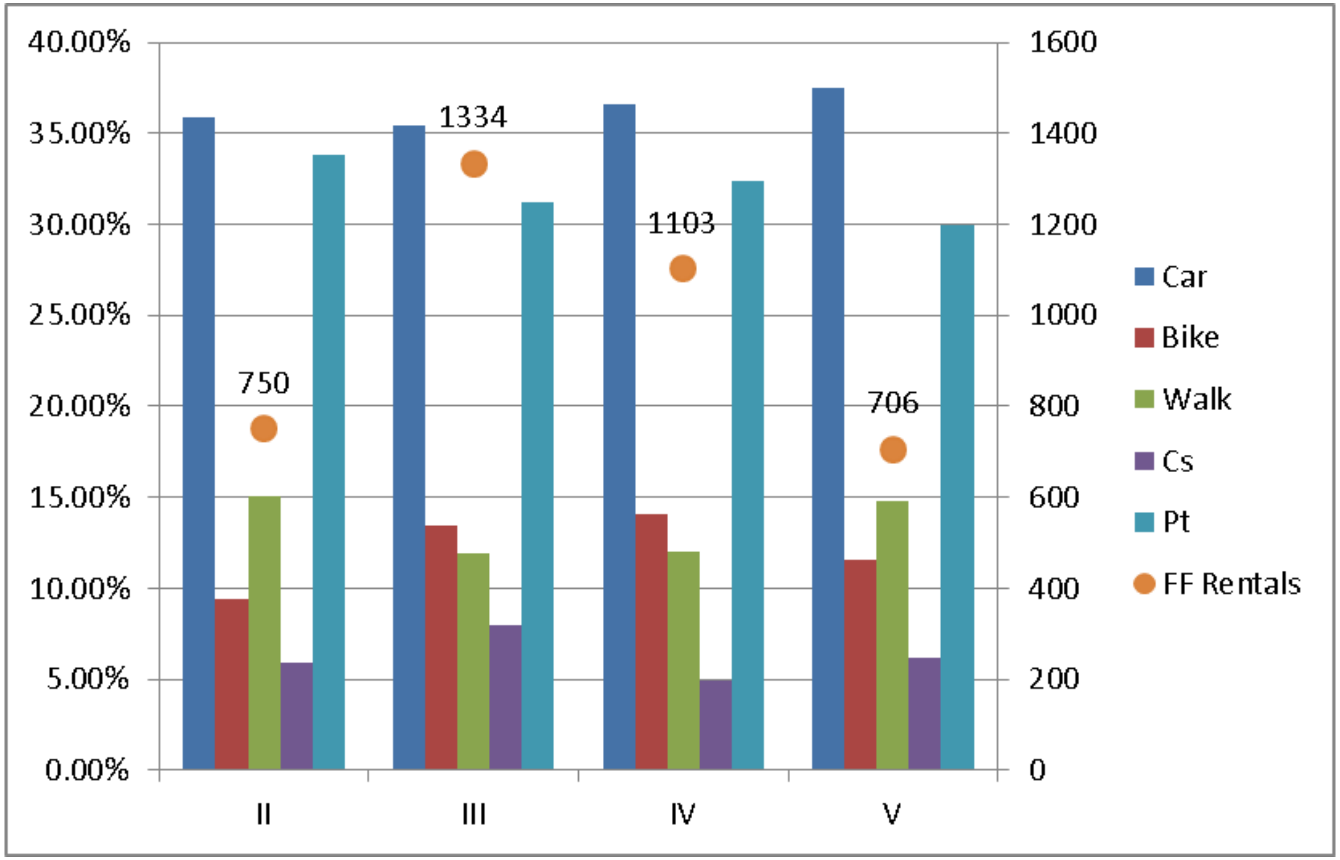
Scenario IV



Scenario V



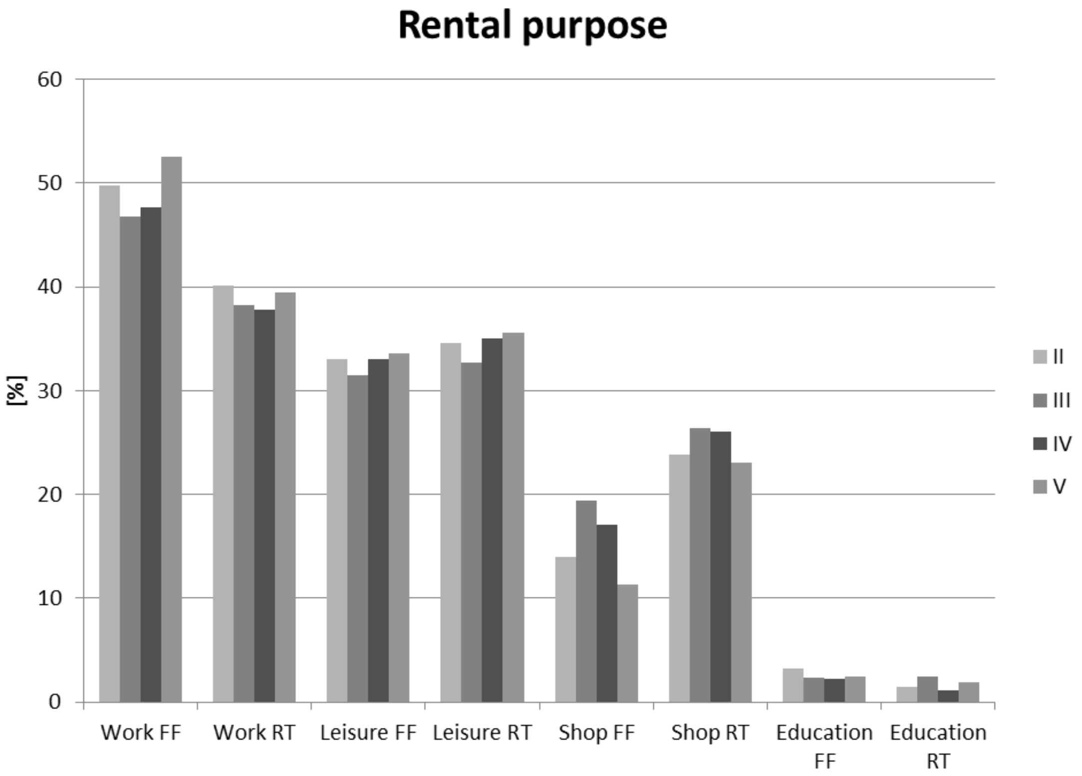
Modal substitution



Modes substituted by free-floating carsharing in scenarios II to V as compared to scenario I. The secondary axis shows the number of free-floating rentals for the scenario

Rentals spatial patterns

Purpose of the rental



	Scenario I	Scenario II	Scenario III	Scenario IV	Scenario V
RT CS	1h23’9’’	1h39’7’’	1h44’7’’	1h24’28’’	1h26’29’’
FF CS	-	2h45’58’’	2h16’56’’	2h34’38’’	2h12’45’’
Car	3h58’2’’	3h58’14’’	3h58’	3h57’53’’	3h57’47’’

Conclusions

- The **impact** of different **pricing schemes** is **not limited to** increasing or reducing the **aggregate level of usage**

- **Pricing** strategy **structurally affects** the **interactions** between the two carsharing types

- **Complex interactions** between **spatiotemporal availability** of carsharing vehicles and users are observed

- The **realism** of some aspects (i.e. **purpose, modal substitution**) is still **unclear**

1. Introduction: What’s going on in the carsharing world?
2. Why to model carsharing demand?
3. Modeling carsharing with MATSim
4. Summary and future work

Summary

- **Carsharing** is **growing fast** and is becoming «**mainstream**»
- Instruments for the **modeling of carsharing** are becoming **necessary**
- **Traditional models** are **not** well **suited** to model carsharing
- **MATSim** is already able to **simulate carsharing** and to evaluate **complex scenarios**…

…but there are still **many limitations**

Ongoing work

- **Improving** the existing **membership model**
- **Testing** our implementations of **free-floating** and **one-way carsharing**

Future work

- **Further validation** of the existing results with **empirical data**
- Applying the tool for analysis on **new scenarios**, possibly relying on **new empirical data**
- Improve the simulation with **better behavioral models**
- New case studies where different **shared mobility options** (**Autonomous Vehicles, Ride Sharing**) are **combined**

Thank you for your attention!

www.matsim.org