Investigation of the effect of AVs on the capacity of an urban transport network

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Introduction

- Autonomous vehicles (AV) entering an operational stage
- Intensive testing of driving functions etc., partly on public roads
- Numerous research and demonstration projects, e.g.

KoMo:D next

funded by

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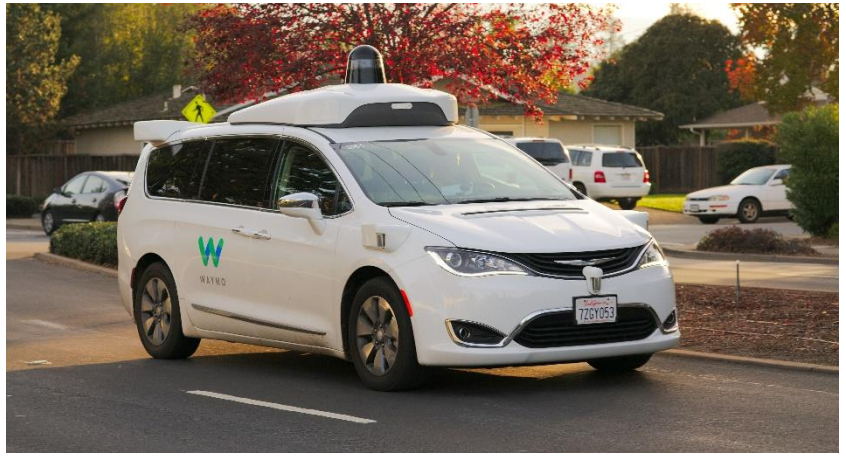
- Sensing systems (and communication) → expected increase in traffic safety *and* efficiency



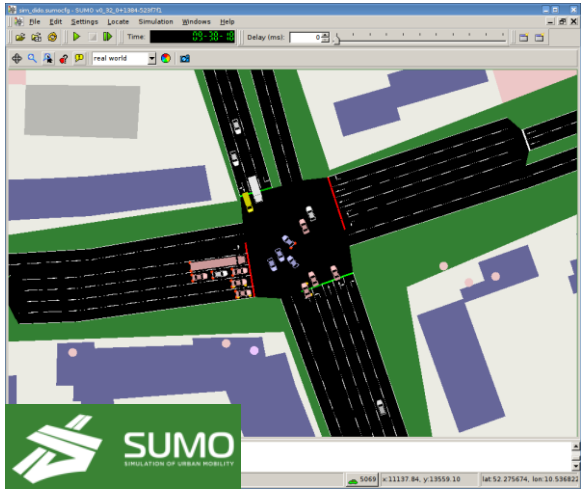
Source: Wikipedia.org (CC BY-SA 4.0)

Aim and Motivation

- Data exchange between meso- and microscopic simulation → “semantic coupling”

Dynamic traffic volumes, vehicle mix, ...

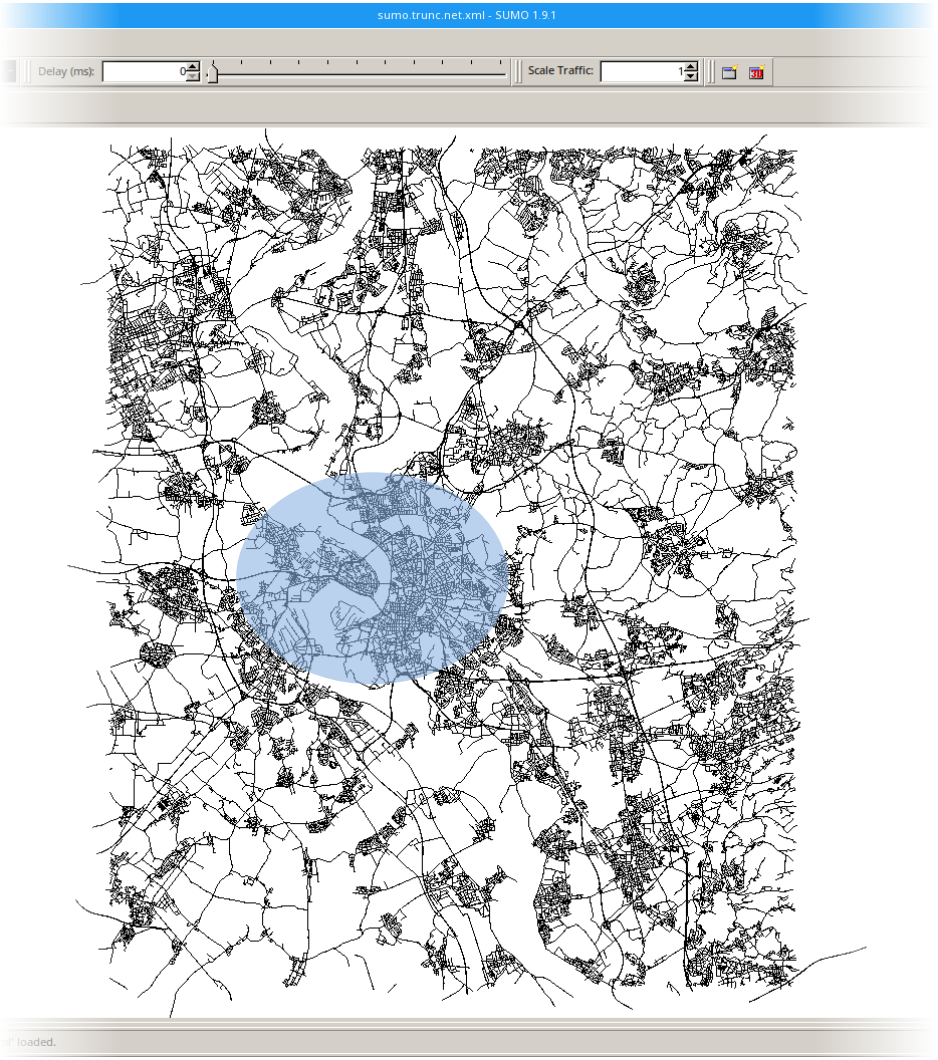
Traffic flow parameters for modified vehicles/ infrastructure

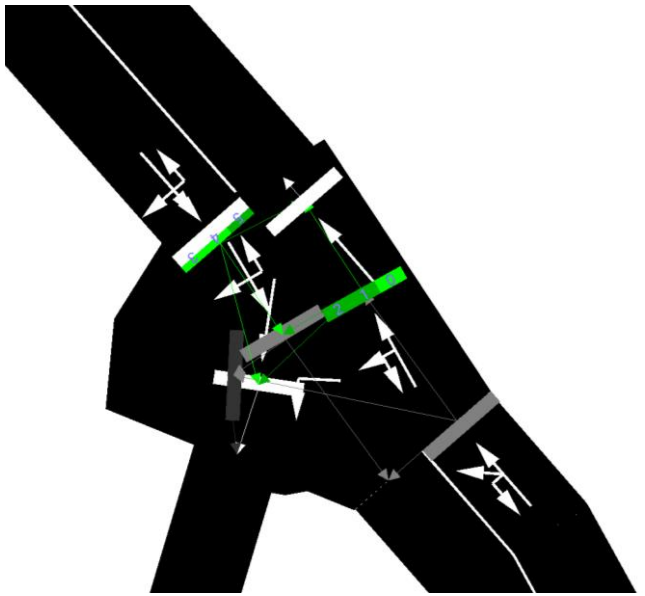


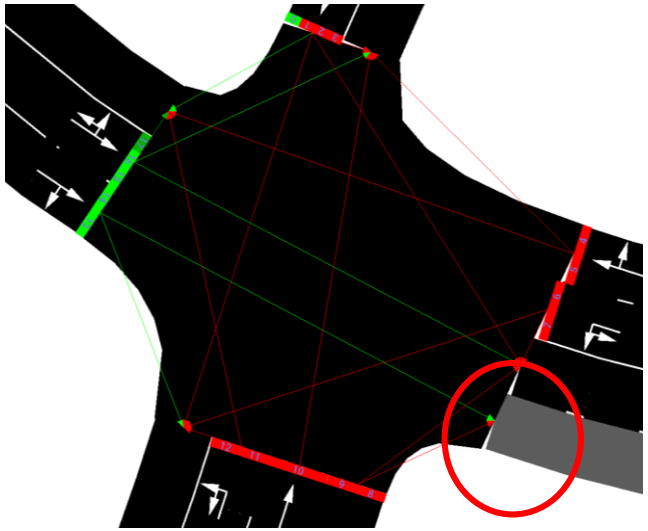
- Extrapolation of locally observed effects of A(C)V on the overall traffic system (entire road network, public transport, combined use of different modes of transport)
- Consideration of both route, mode and departure time choices of demand
- Calculation of the traffic impacts and resulting environmental impacts

Scenario

- First question: capacities at traffic signal controlled intersections
- Area around the city of Düsseldorf, 900 km²
- Total length of all edges: about 13700 km
- Number of signal-controlled intersections: 1637
- Network based on raw OSM data, no post-processing → some network defects







Scenario – cont.

- Current set-up of the test site: no application of V2X communication technologies
- Approximate representation of AV by adapting the SUMO standard model of car-following for passenger cars → ref. table
- Analysis of all shares/combinations of CV and AV in 10% steps (0...100%)
- Parameters:
  - *b*: technical limitation to 3 m/s²
  - τ: rather conservative, missing regulations
  - σ: latencies in signal processing

Source: DLR (CC-BY 3.0)

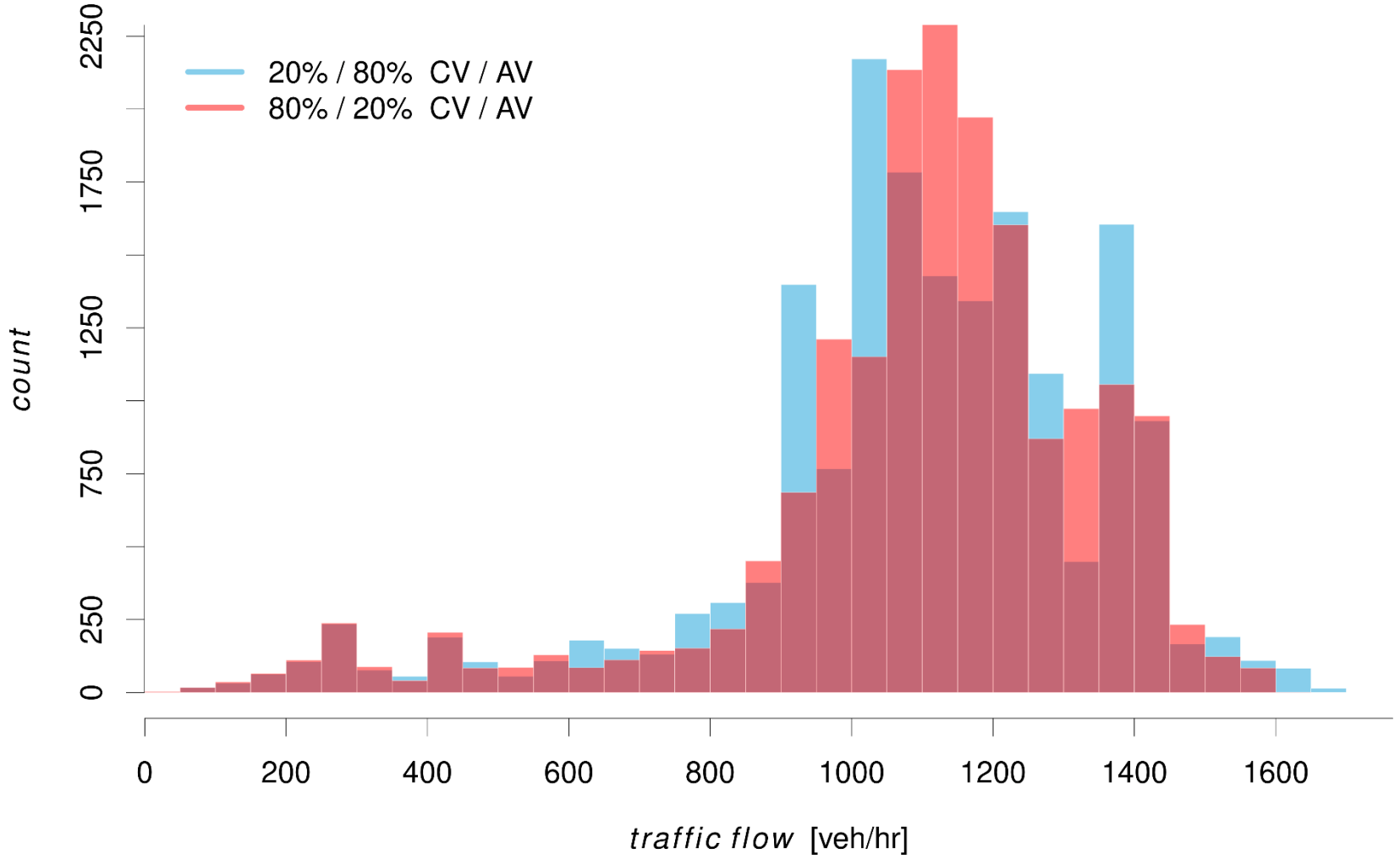
Parameter	CV (default)	AV (adapted)
decel	7.5	3.0
tau	1	1.5
sigma	0.5	0.1
speedFactor	1	1
speedDev	0.1	0

Computation

- 1637 signal-controlled nodes, all of type=“actuated”
- 17653 transit or turning lanes in total at these intersections
- 11 different shares of CV/ AV
- Procedure:
  - Network parsing using sumolib
  - Intersection identification and creation of subsets
  - For each subset (of intersections): Traffic flow creation for each lane with the respective share of AV/ CV using TraCI
  - (Parallel) simulation runs for 1 hour
  - Determination of resulting out flow with E1 detector
- Computation time: ~ 6 days creating 36 threads (on two different servers)

Results

- Typical histogram for resulting capacities at signal controlled intersections
- Comparison of 20%/ 80% CV resp. AV
- Very low flows → network defects
- Very high flows → network particularities, e.g. intersections with different road categories



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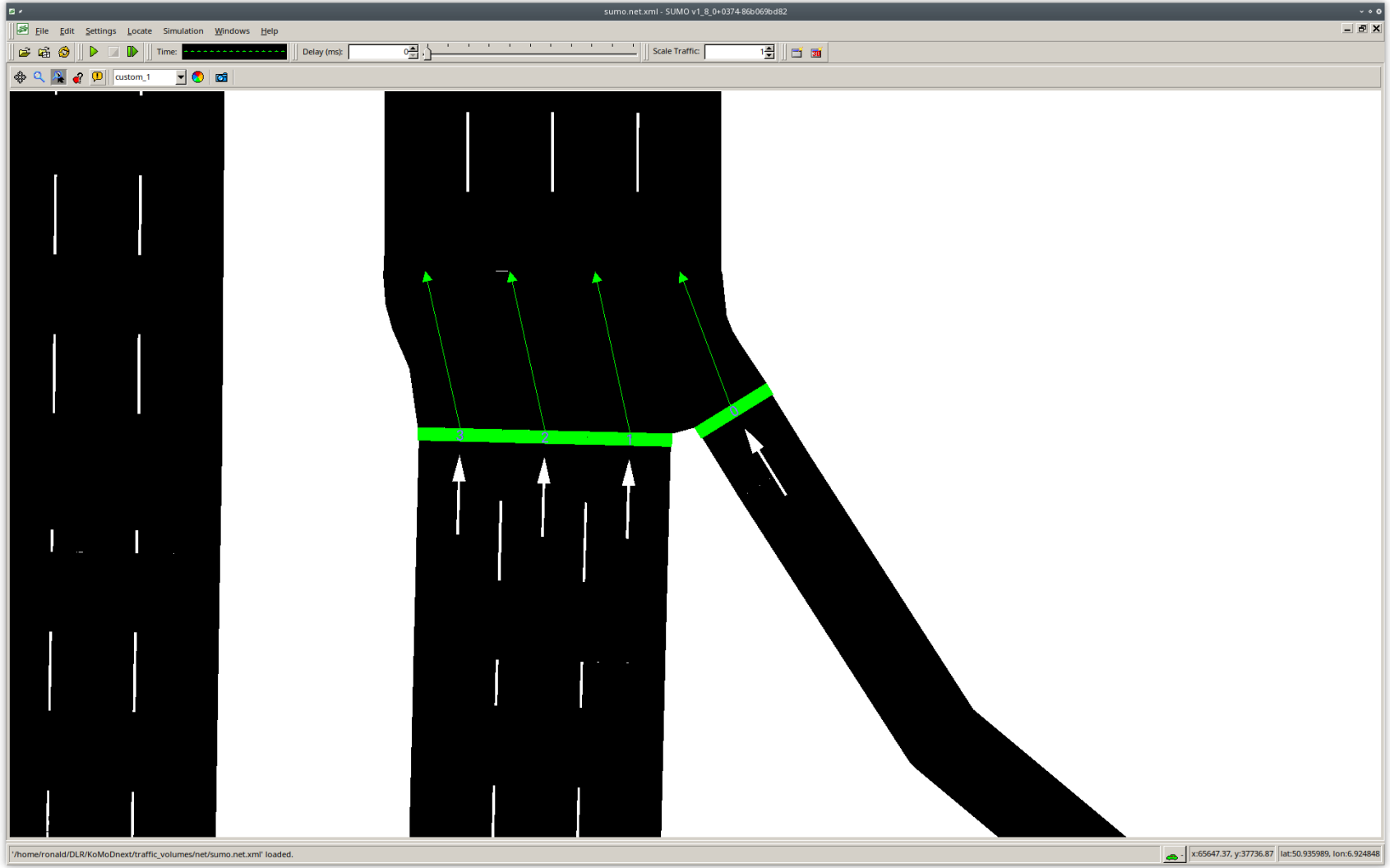
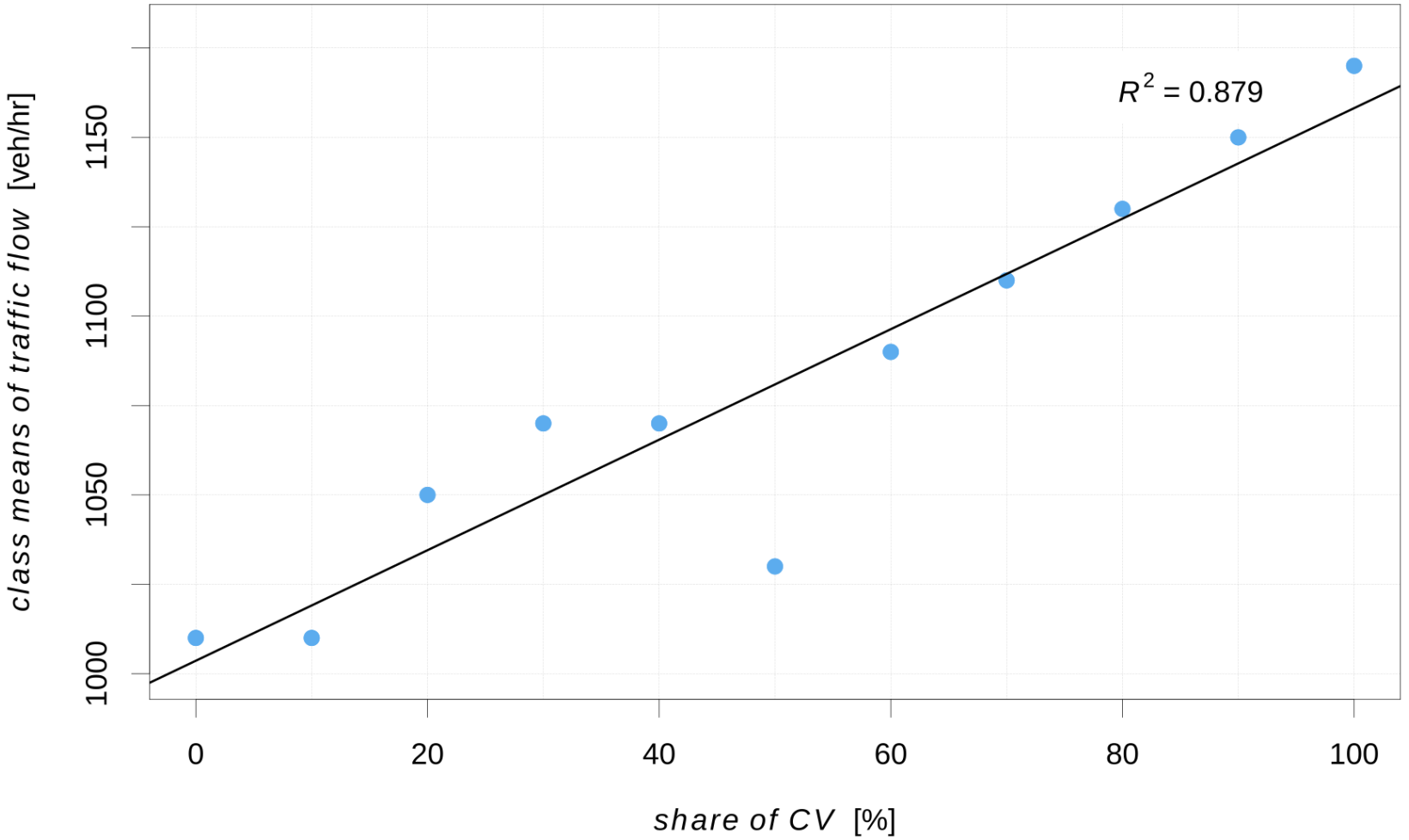


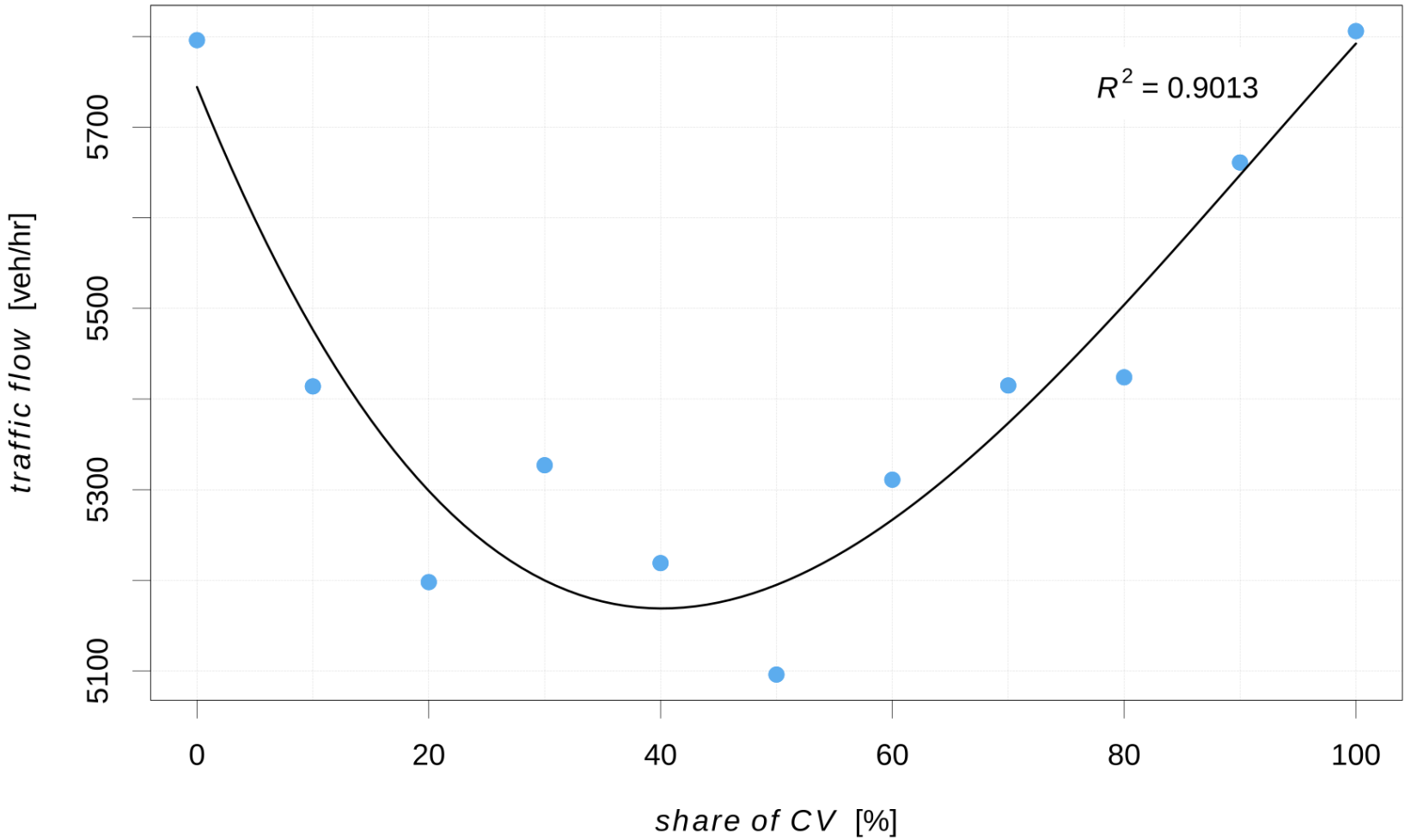
Results – cont.

- Plot of class means of peaks for all 11 shares of CV/ AV
- Almost linear increase of traffic flow with growing share of CV ($R^2 \approx 0.9$)
- 50%/ 50% CV resp. AV → max. disruption in traffic flow
- 0% and 100% AV differ noticeably by over 10% difference in traffic flow



Comparison with free flow on highways

- Plot of class means of peaks for all shares
- Three lanes per direction, road gradient < 1%, low amount of heavy duty traffic → q_{max} ≈ 5700 veh/h
- Best fit by 3rd order polynomial (not symmetric)



Future research

- Modeling of effects of intelligent traffic infrastructure concepts directly in SUMO and transfer to the MATSim model
- Matching congestion patterns from simulation and data

Thanks for listening!