UR:BAN

Increased Consumption in Oversaturated City Traffic Based on Empirical Vehicle Data

Gefördert durch:

Bundesministerium
für Wirtschaft
und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

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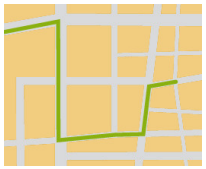
UR:BAN – Urbaner Raum: Benutzergerechte Assistenzsysteme und Netzmanagement
(Urban Space: User Oriented Assistance Systems and Network Management)

UR:BAN

Cooperative Infrastructure



Regional Network

- Optimal energy use by adaptive route guidance

Strategic Routing
> 5km

Urban Road

- Electronic horizon
  energy- and traffic optimised driving, avoiding stops at traffic lights

Adaptive driving
< 5km

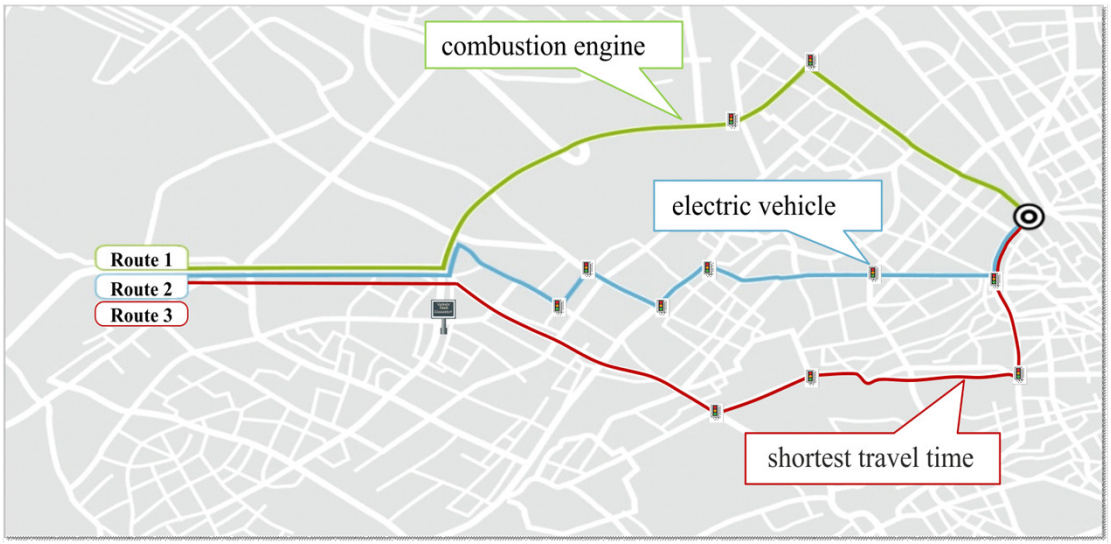
Smart Intersection

- energy- and traffic optimised stopping, waiting and deciding at traffic light

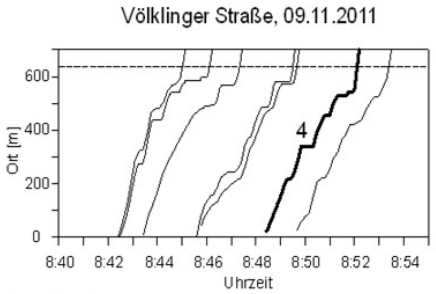
Tactical driving
< 1km

Goal:
Show energy efficient navigation based on precise traffic and infrastructure information

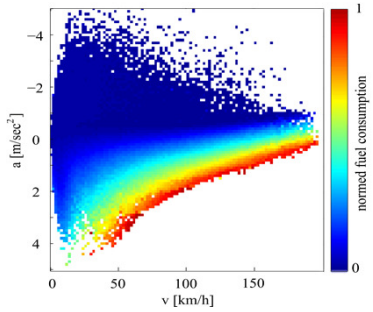
Basis:
- Precise traffic data
- Engine adaptive consumption simulation
- Analysis of traffic breakdown at network nodes
- Traffic control with minimized breakdown probability
- Urban traffic management

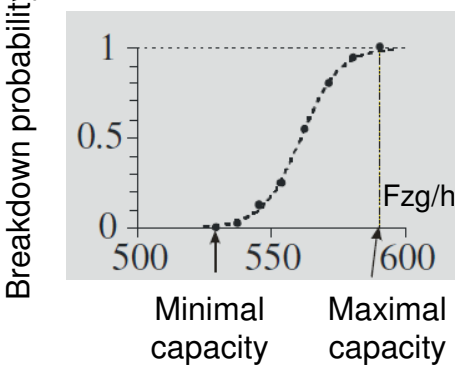


Precise data with mobile devices

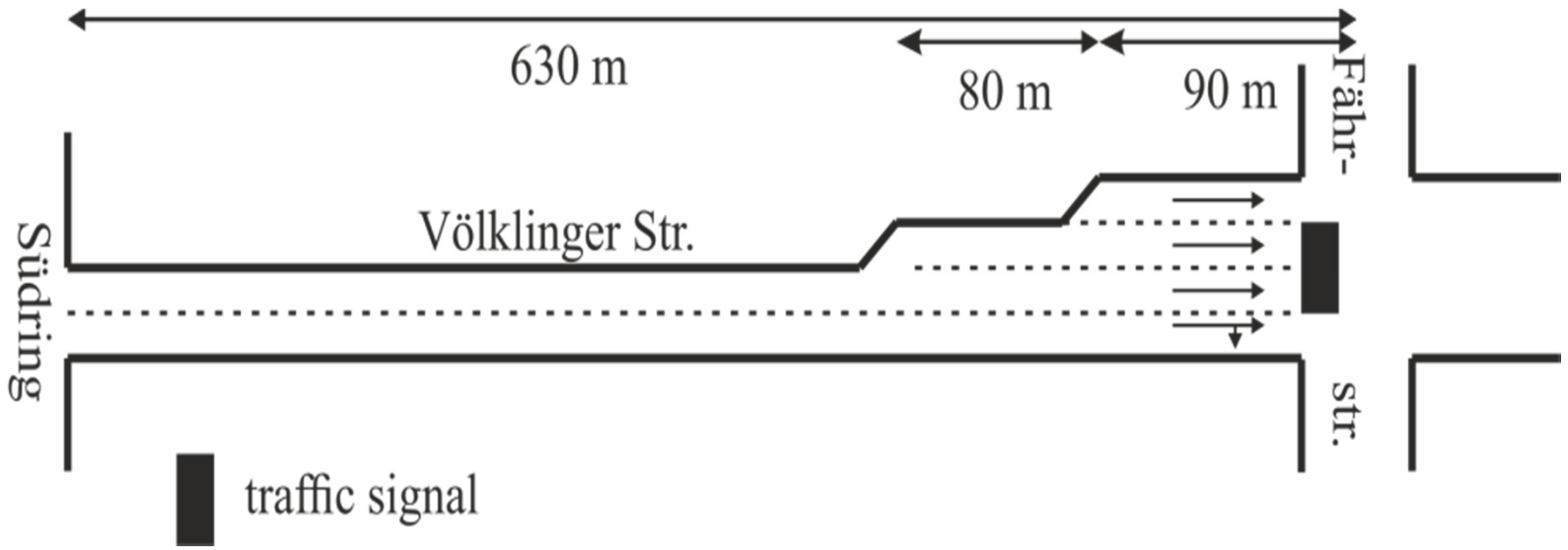


Consumption matrix





Road section of “Völklinger Straße” in Düsseldorf. The speed limit is 60 km/h.

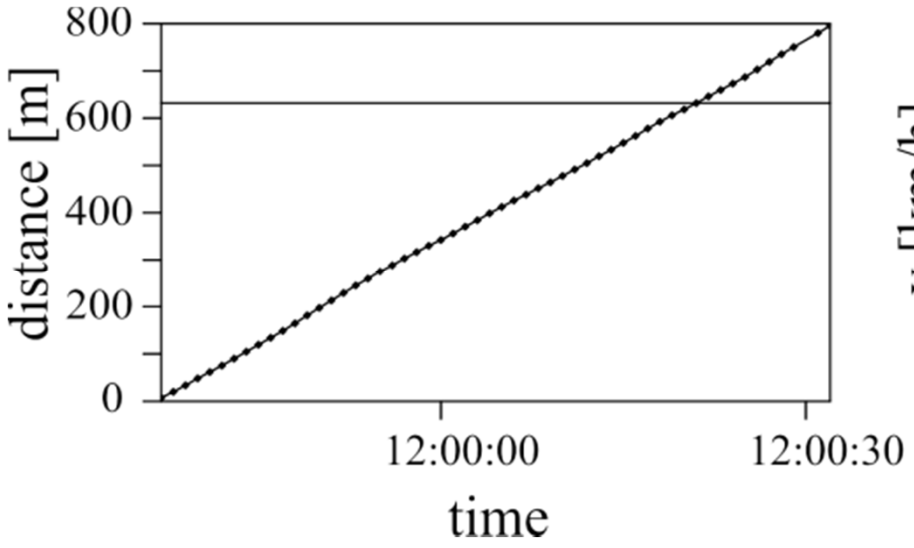


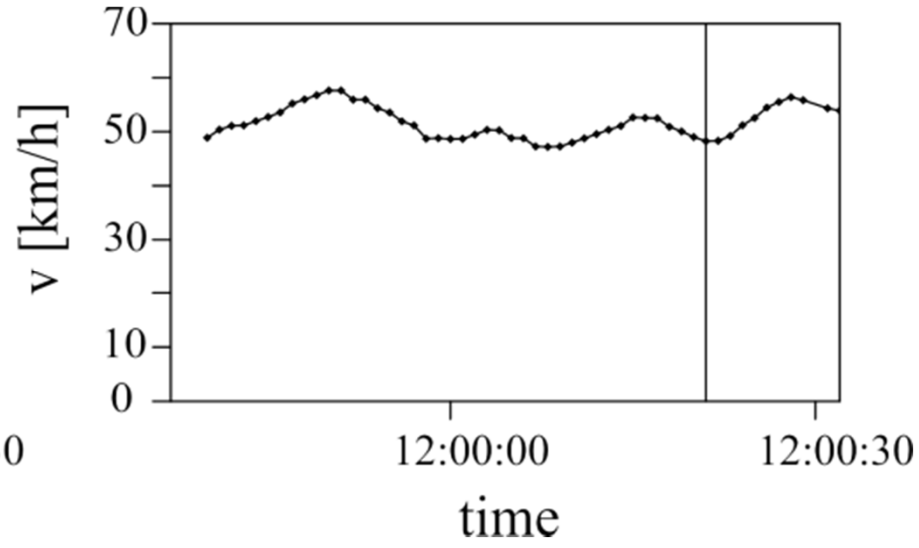
Overview of the 15 vehicle trajectory classes

	Average Speed [km/h]		Number of Stops	
Class	Minimum	Maximum	Minimum	Maximum
1	30	75	0	0
2	30	75	1	1
3	15	30	0	1
4	15	30	2	4
5	10	15	0	1
6	10	15	2	4
7	10	15	5	6
8	8	10	5	6
9	8	10	7	10
10	6	8	5	6
11	6	8	7	10
12	6	8	11	13
13	3.5	6	7	10
14	3.5	6	11	13
15	0	3.5	13	30

Definition of „stop“: speed lower than 5 km/h and a second stop can occur only 10seconds after the first one.

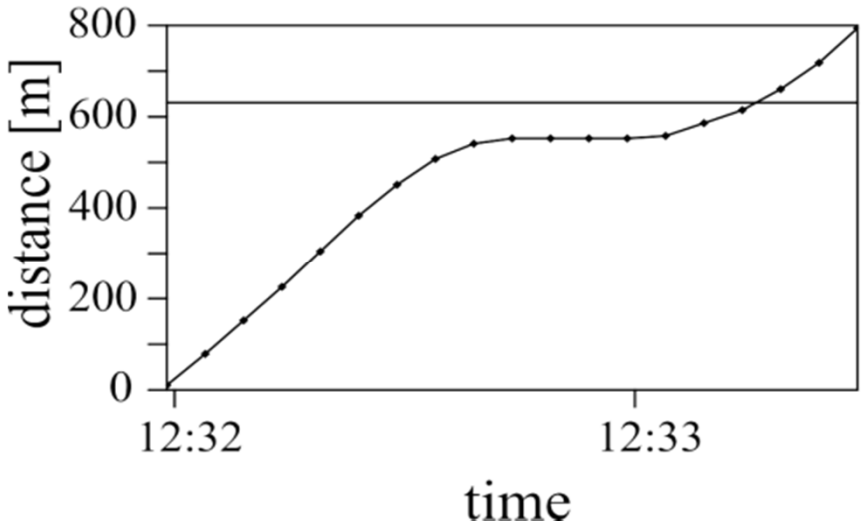
Representative of class 1 (undersaturated traffic, no stop); vehicle trajectory and speed profile from February 2013

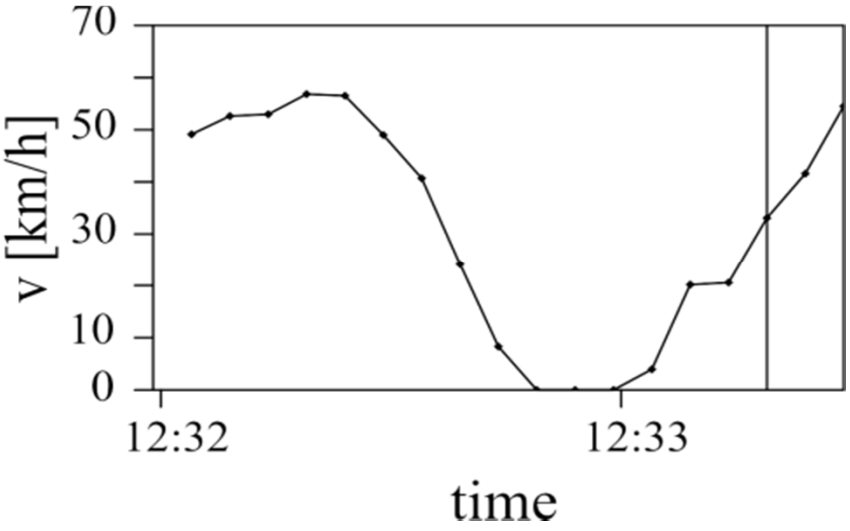




Free flow

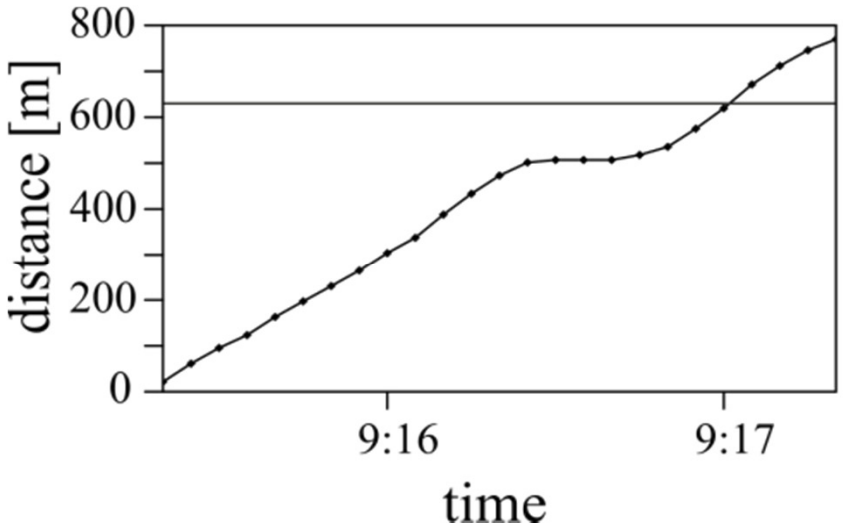
Representative of class 2 (undersaturated traffic, one stop); vehicle trajectory and speed profile from November 2011

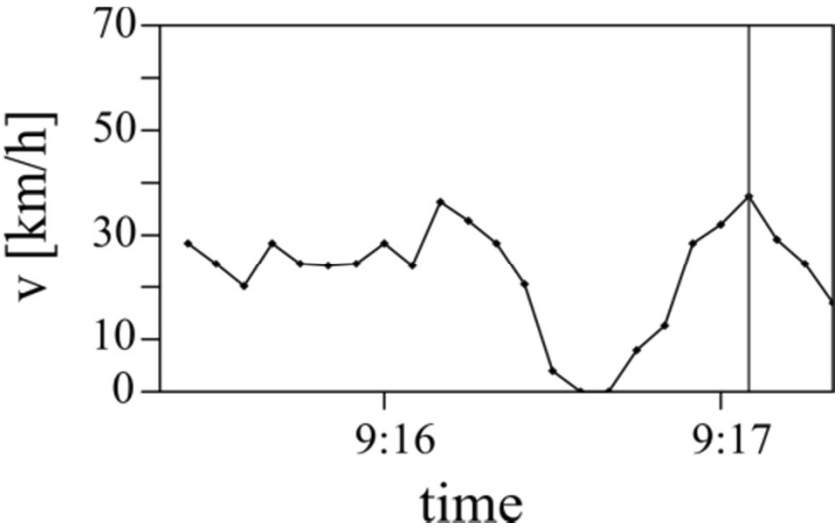




One stop at light signal

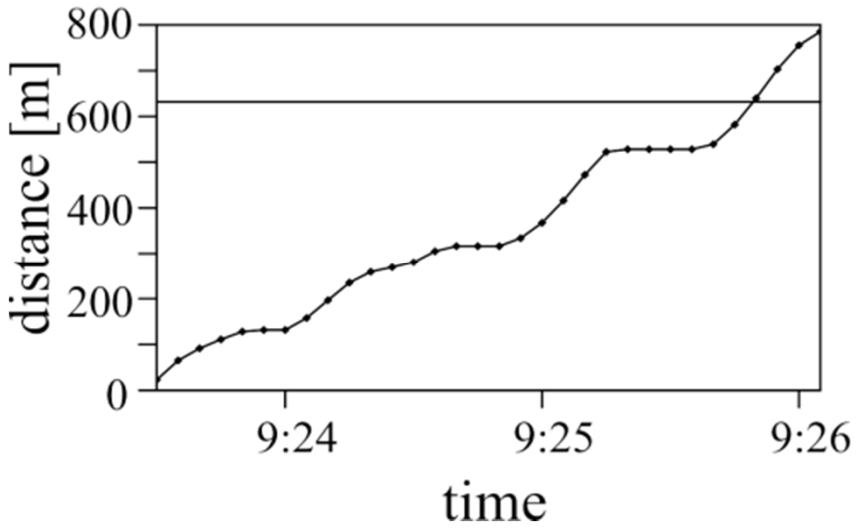
Representative of class 3; vehicle trajectory and speed profile from February 2013

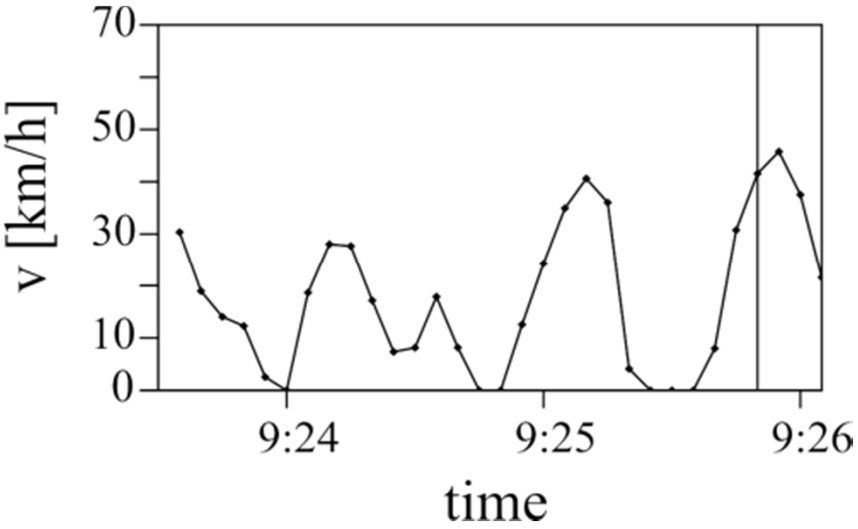




One stop at light signal and lower speed
(“synchronized traffic flow“):
oversaturation („congested“)

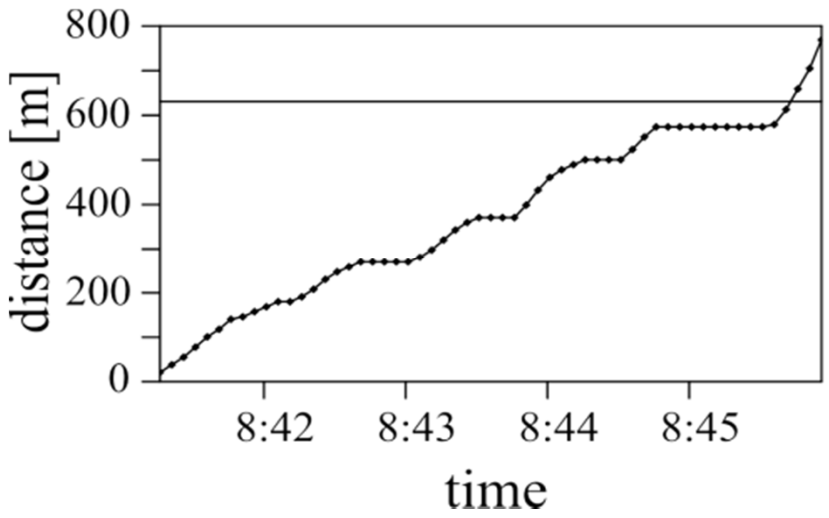
Representative of class 4; vehicle trajectory and speed profile from February 2013

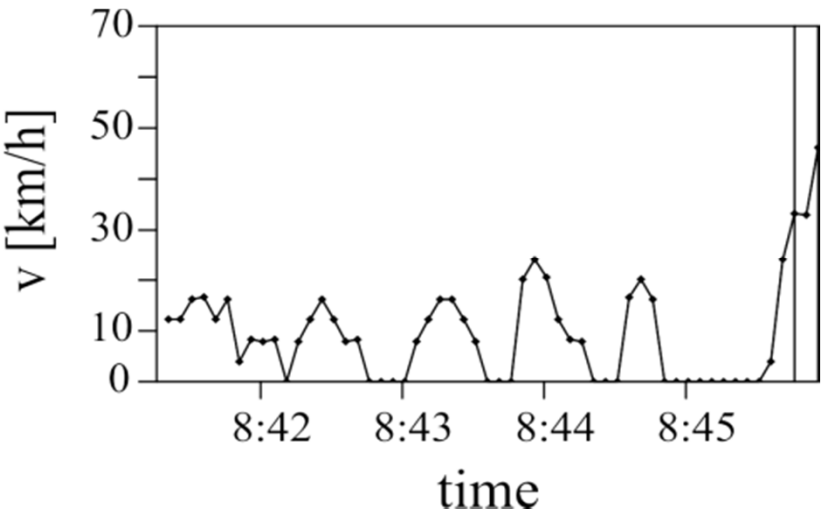




Three stops and lower speed:
oversaturation („congested“)

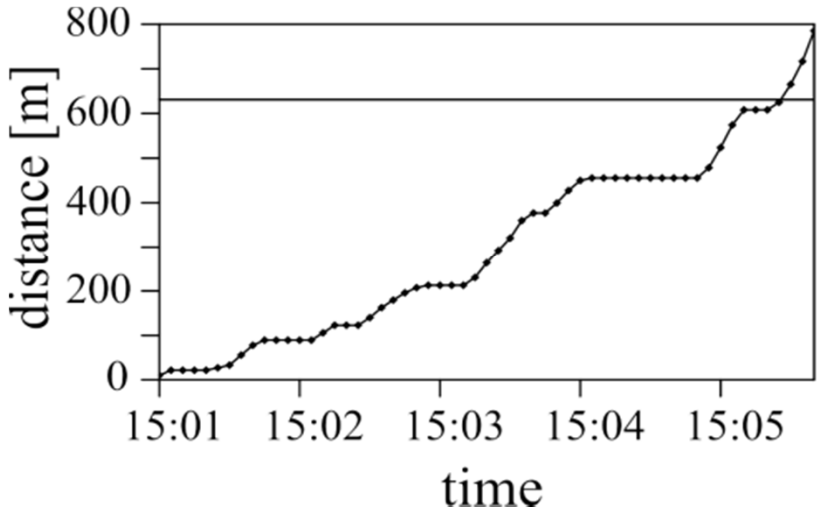
Representative of class 8; vehicle trajectory and speed profile from November 2011

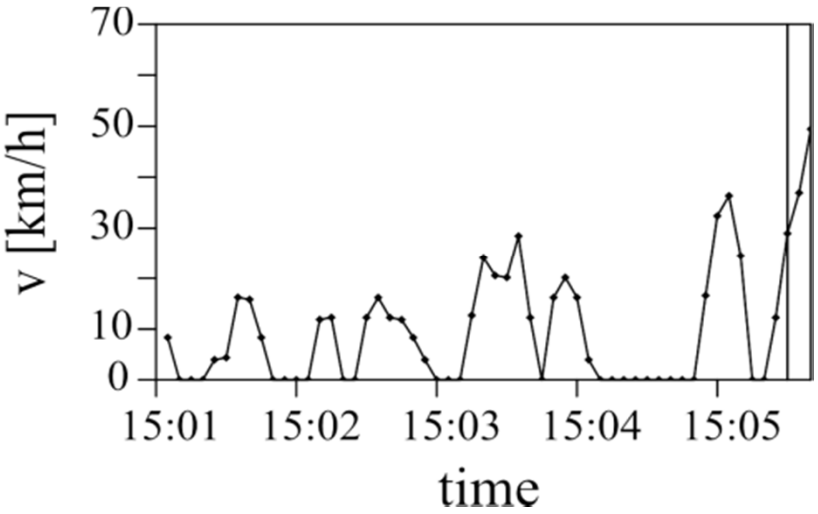




Five stops and lower speed:
oversaturation („congested“)

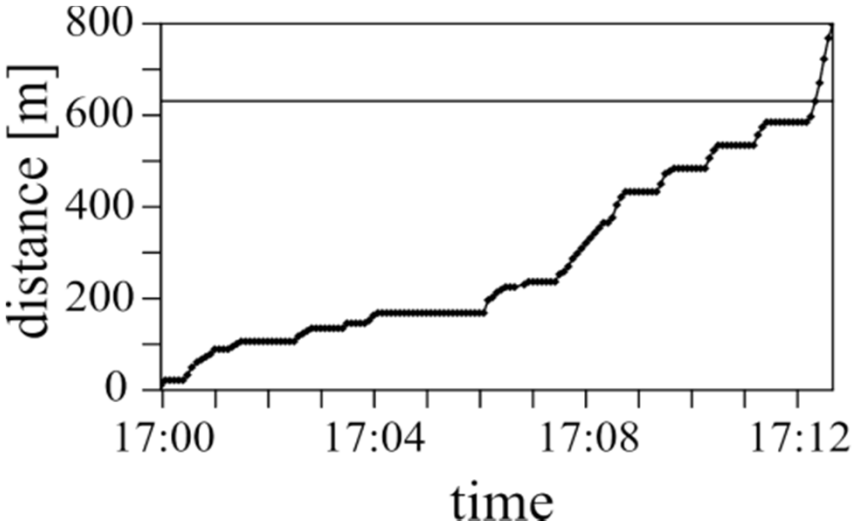
Representative of class 9; vehicle trajectory and speed profile from February 2013

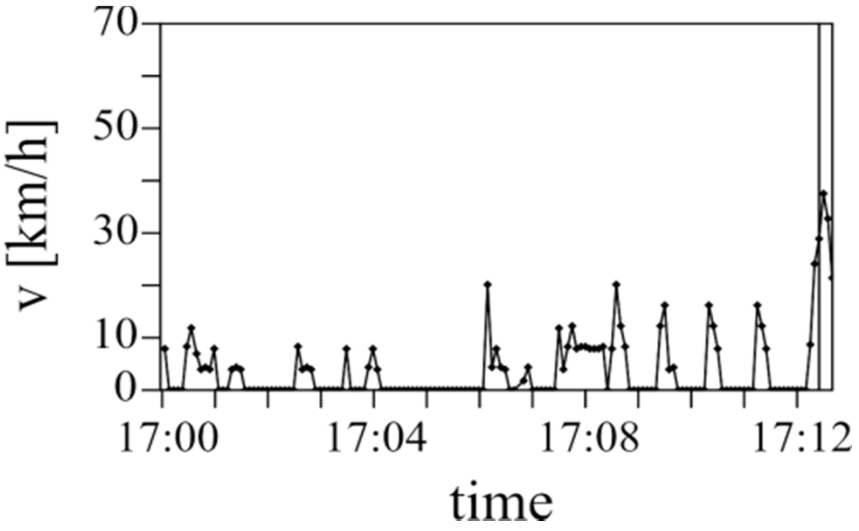




Seven stops and lower speed:
oversaturation („congested“)

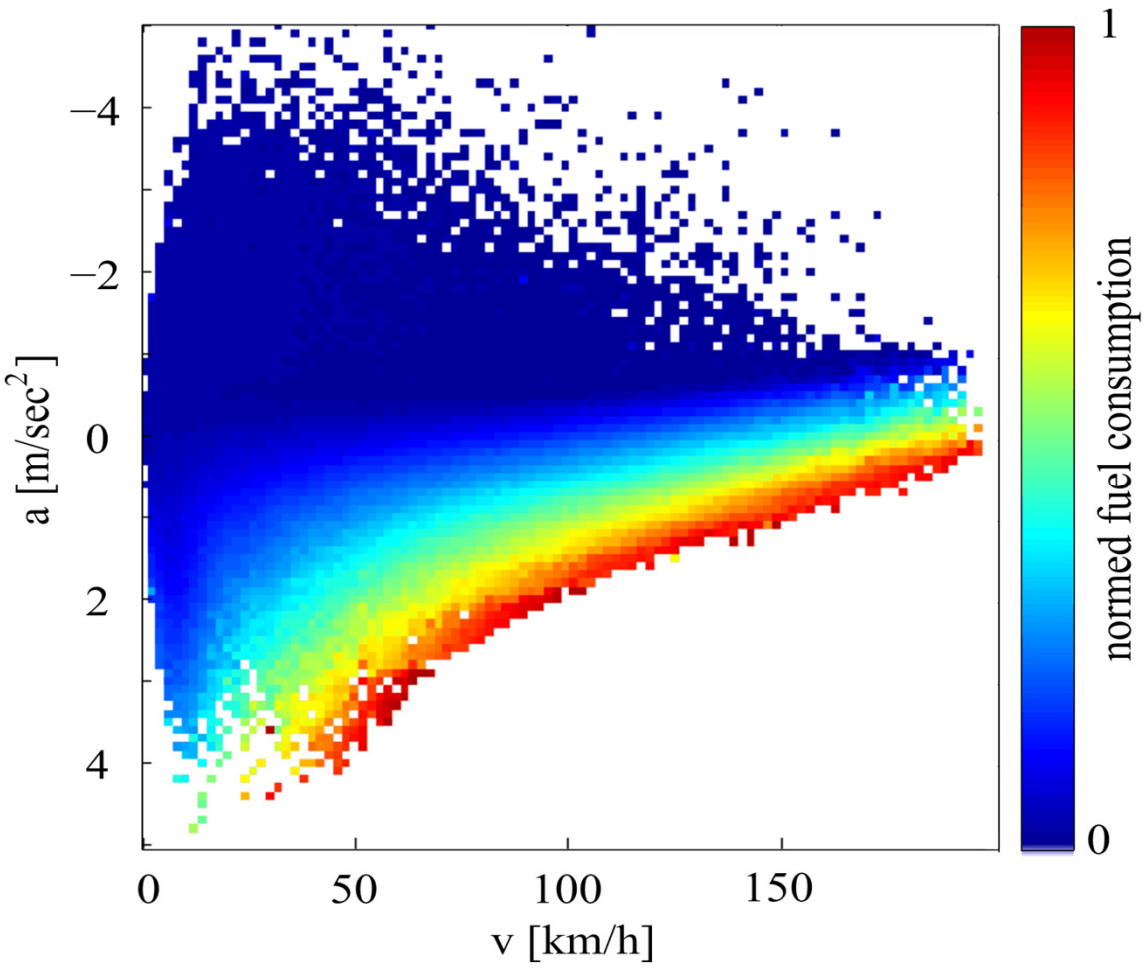
Representative of class 15; vehicle trajectory and speed profile from February 2013



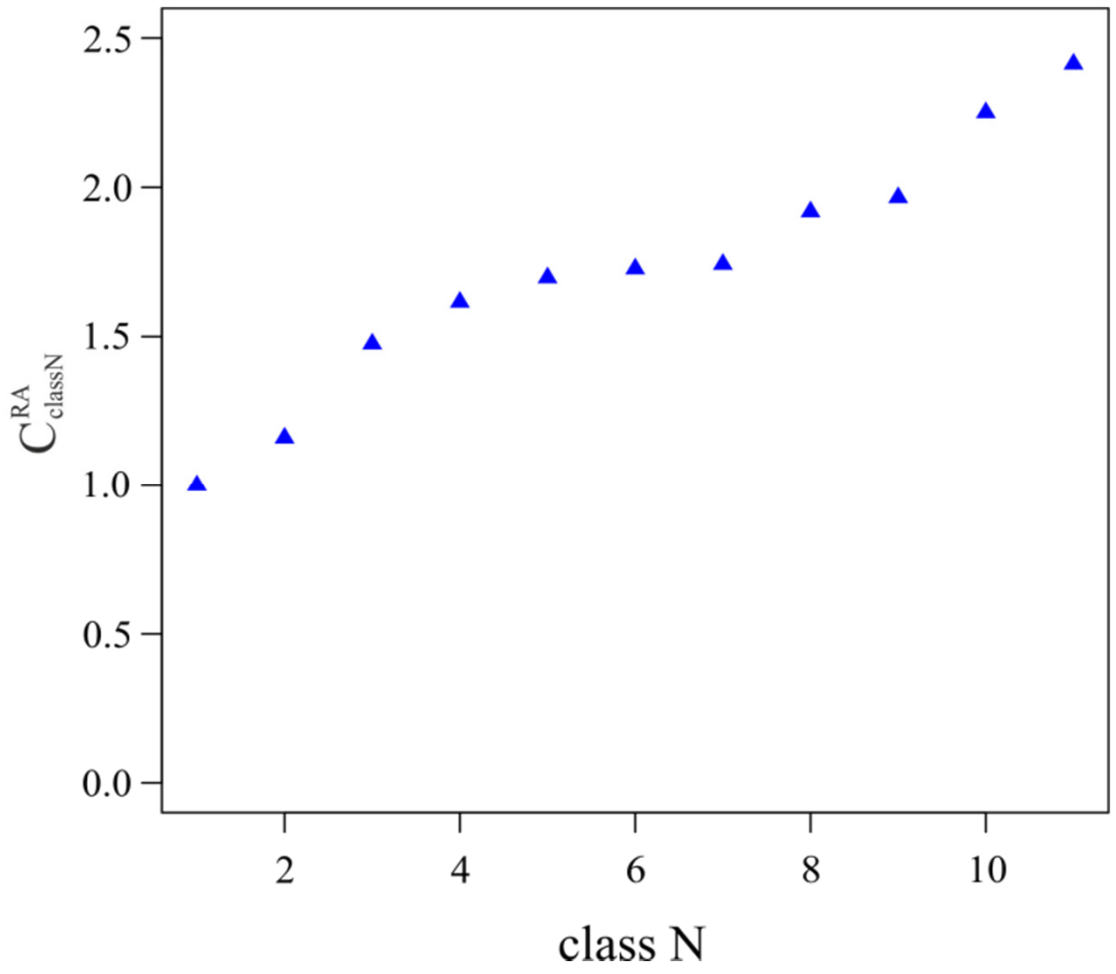


Thirteen stops and very low speed:
oversaturation („congested“)

Visualization of an empirical consumption matrix with the parameters acceleration *a* and velocity *v*

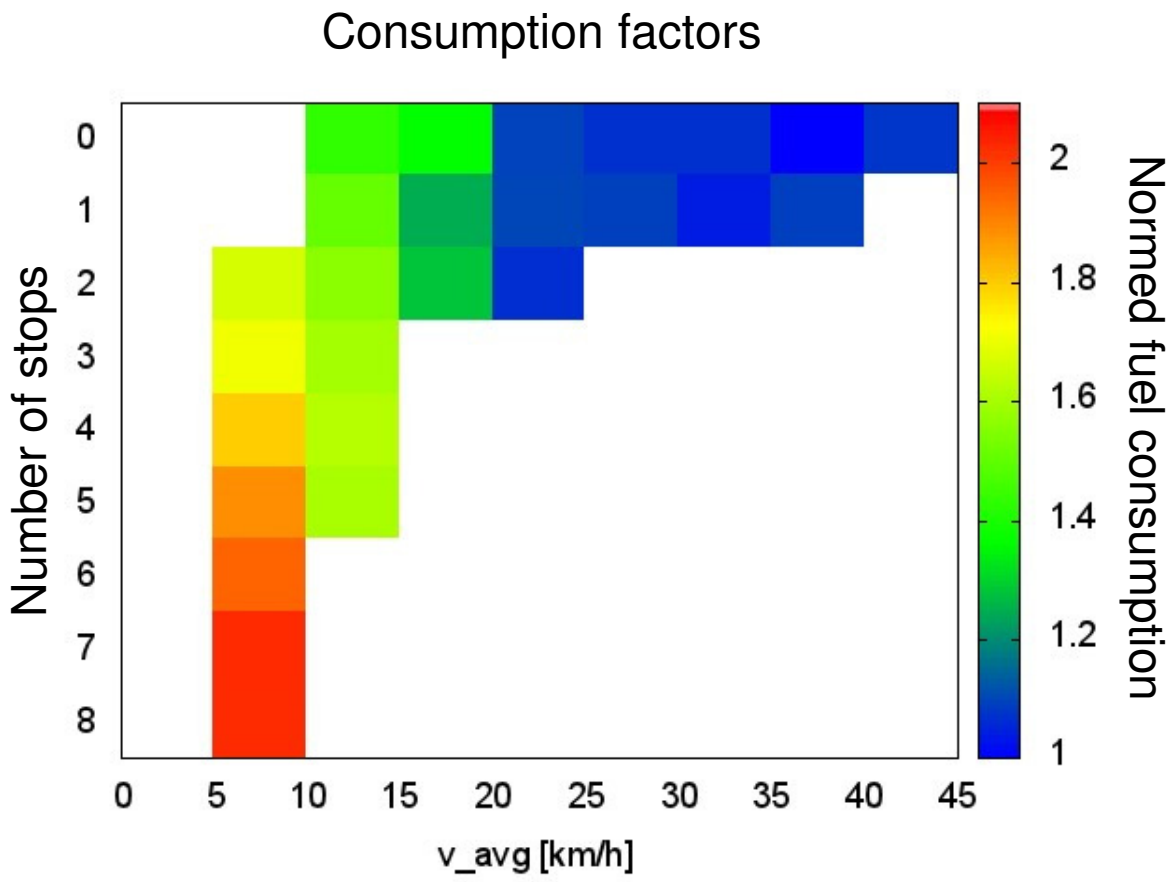


Average fuel consumption for the first 11 traffic pattern classes as a multiple of the average fuel consumption of class 1



$$C^{RA}_{classN} = \frac{C_{classN}}{C_{class1}},$$

Consumption factors based on average velocity and number of stops



Factors for additional fuel consumption based on average speed and number of stops: routing factor in energy efficient navigation

Conclusions

- Urban congestion situations have been classified with attributes „average speed“ and „number of stops“
- Recorded empirical consumption matrix shows additional fuel consumption as function of vehicle speed and acceleration
- Due to congested traffic in urban regions the additional fuel consumption could be twice as high as in free flow
- Consumption matrices for hybrid/electric vehicles will be developed next