

Can you „sniff“ what type of car is passing by?

Jens Borcken-Kleefeld
based on the MSc thesis by Lukas Unterschütz and
with contributions from Pascal Kerschke

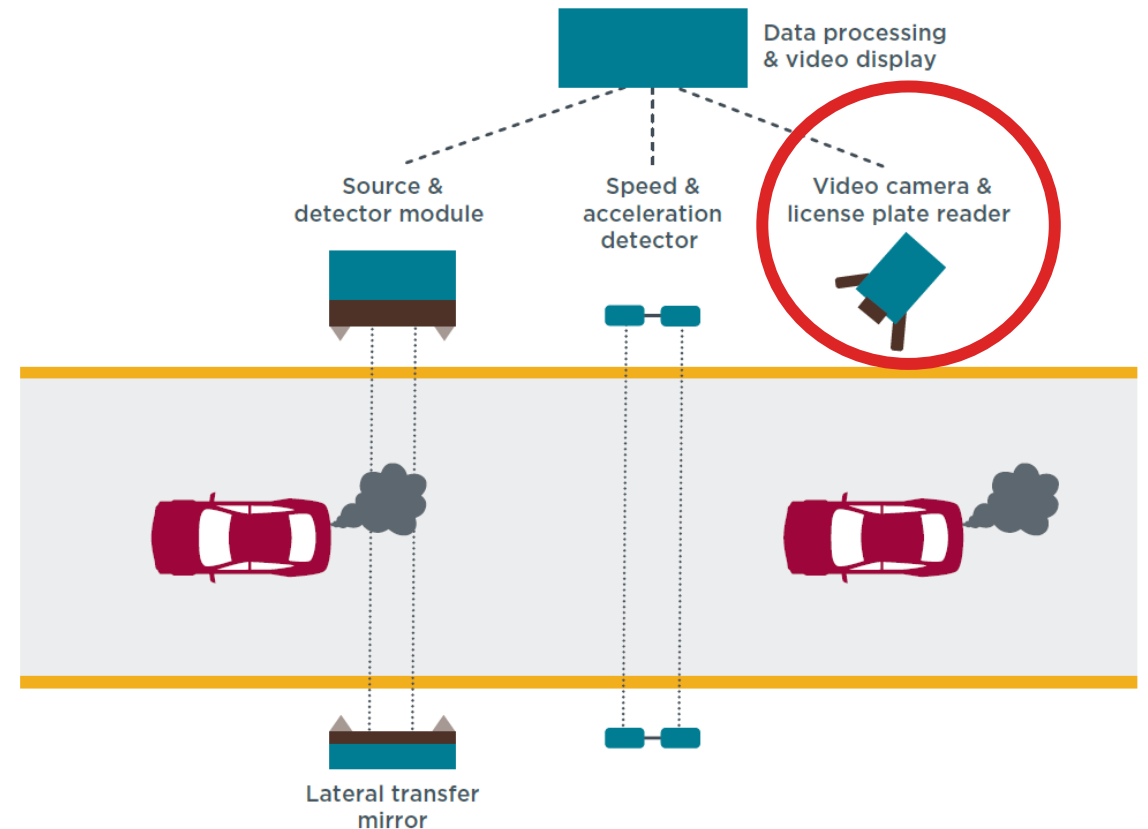
Professor für Verkehrsökologie - TU Dresden/Germany

28.11.2023 - ERMES plenary meeting (online)

Remote sensing measurements are great tools e.g. for fleet monitoring -

but... mass photographing of vehicle
number plates may infringe personal
data (GDPR)

=> No routine use of remote sensing
for fleet monitoring to date 😞

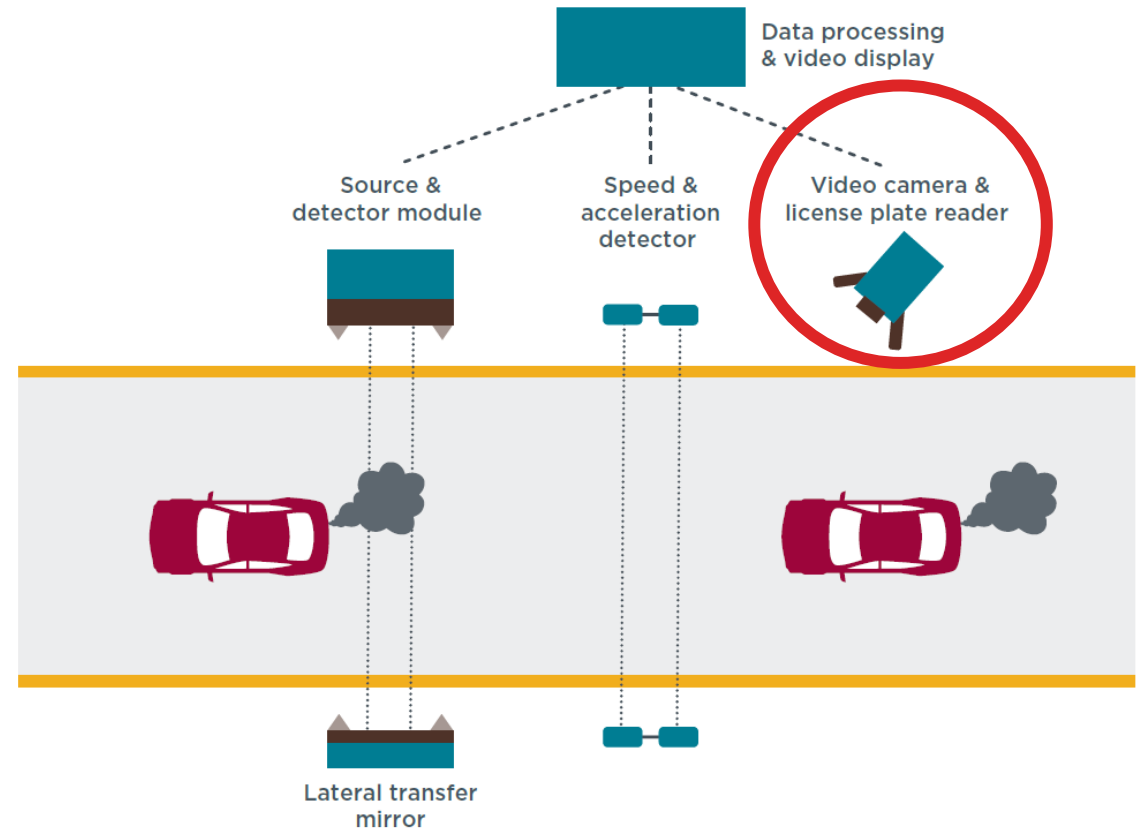


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Can fuel type and emission class be „sniffed“ from emission records only?



„Sniff“ fuel type & emission standard of a car

Approach: Use chassis and PEMS data for cars

Train two machine learning algorithms

Transfer to remote sensing data

Aim: Identify fuel type (petrol or diesel) and emission standard (Euro 5, 6b, 6d-TEMP, 6d) from pollutant measurement

When successful, we can also sniff high-emitters!!!

Data sources and treatment

„Reference data“ (ERMES/ARTEMIS db):

Emissions, fuel flow, driving parameters from chassis dynamometer (hot ARTEMIS cycles) and PEMS RDE trips second-by-second [g/sec].

- Take moving 3-sec averages to improve time alignment and calculate ratio pollutant/fuel flow => 22'000 records [g/kg fuel]_{sec}
- Filter for v-a/driving situations & temperature comparable to RS values

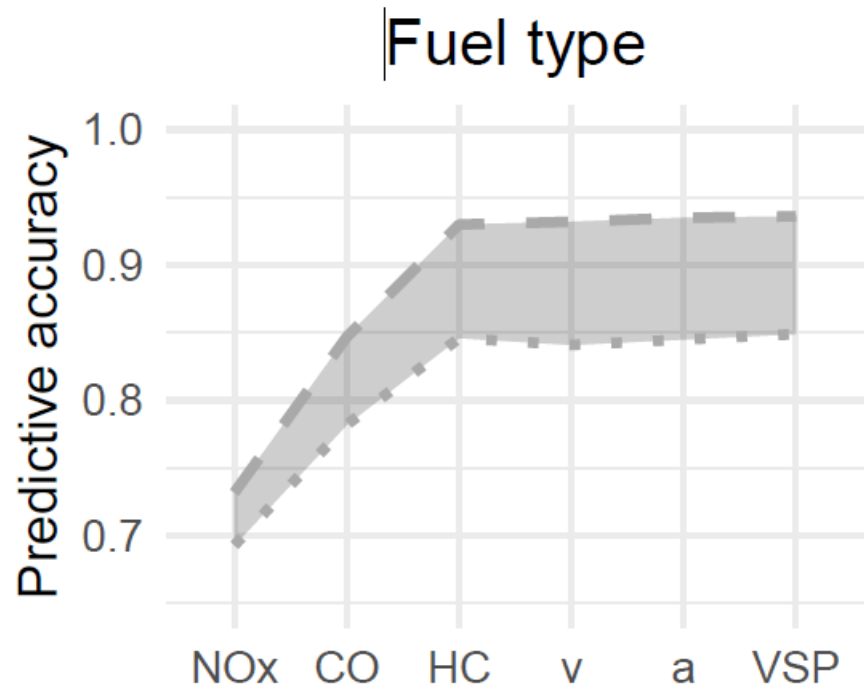
„Field data“ (CONOx/CARES remote sensing db):

Instantaneous remote sensing records from campaigns across Europe, mostly urban driving conditions: 63'000 records [g/kg fuel]_{sec}

Identification of fuel type on reference data

Given: Instantaneous pollutant ratios from reference data.

=> **Train algorithms on reference data, then make blind test.**



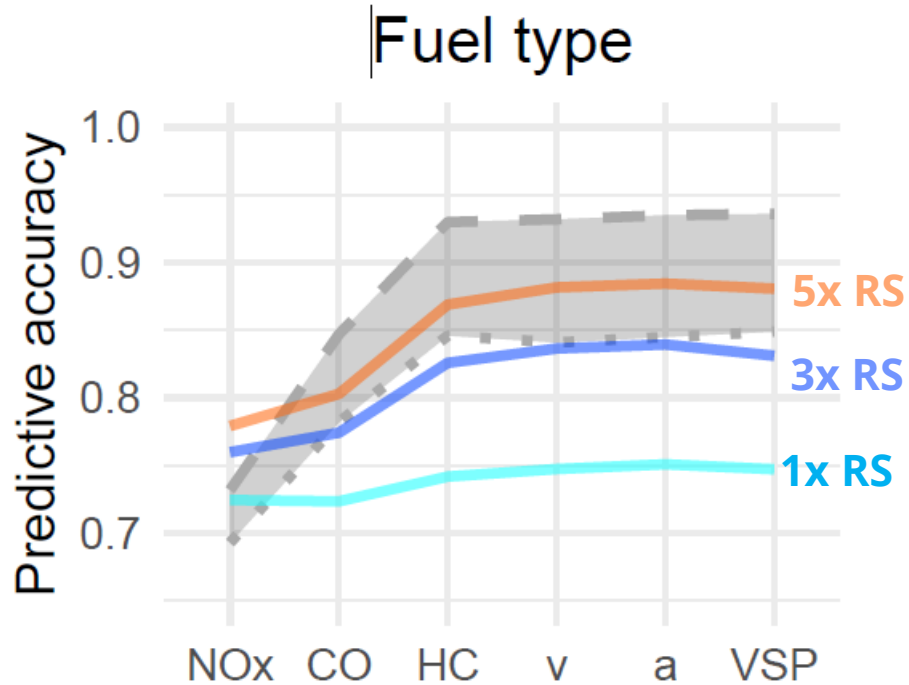
With reference data:

- Estimate of petrol or diesel type possible,
- based on NO_x, CO and HC as measured,
- no gain from v, a, VSP
- Up to 90+% accuracy of detection

Identification of fuel type on field data

Given: Instantaneous RS records drawn from field data.

=> **Apply algorithms on RS data** (where fuel type is known).



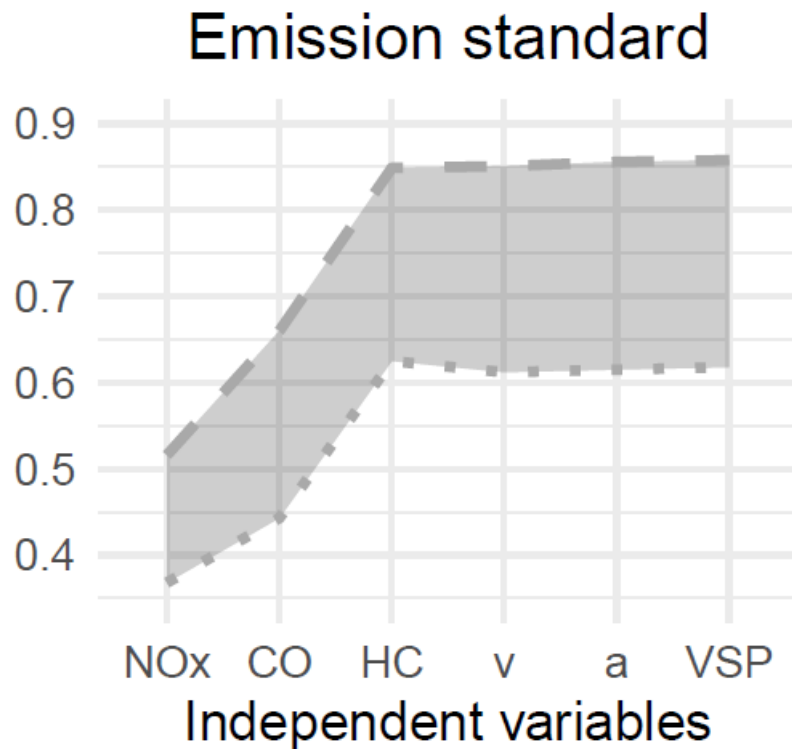
With RS field data:

- Estimate of petrol or diesel type possible,
- based on NO_x, CO and HC as measured,
- no gain from v, a, VSP
- using 5 RS records per vehicle up to 90% accuracy of detection

Identification of emission class on reference data

Given: Instantaneous pollutant ratios from reference data.

=> **Train algorithms on reference data, then make blind test.**



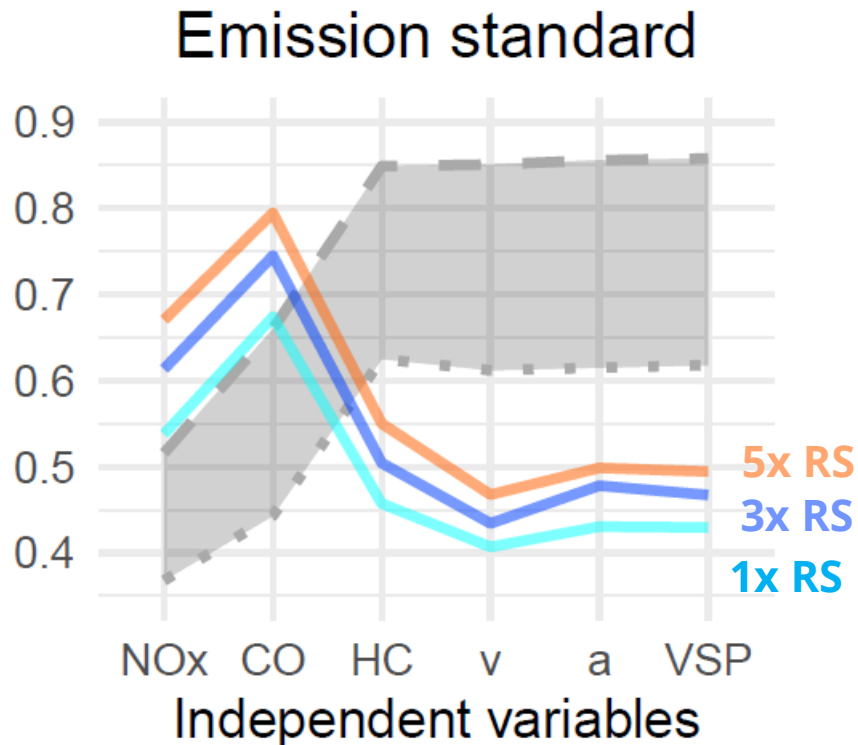
With reference data:

- Estimate of Euro 5, 6b, 6d-TEMP, 6d emission standard possible,
- based on NOx, CO and HC as measured,
- no gain from v, a, VSP
- Up to 85% accuracy of detection

Identification of emission class on field data

Given: Instantaneous RS records drawn from field data.

=> **Apply algorithms on RS data** (whose emission class is known).



With RS field data:

- Estimate of Euro 5, 6b, 6d-TEMP, 6d emission standard possible,
- based on NO_x, CO as measured,
- no gain from v, a, VSP
- gets bad, when also HC included 😞
- Up to 80% accuracy of detection

Results – and open questions / your input needed!

Proof of concept: Estimate 80%+ accurate of fuel type and emission class possible based on a few emission records.

=> Apply to identify vehicles with suspiciously high emissions!

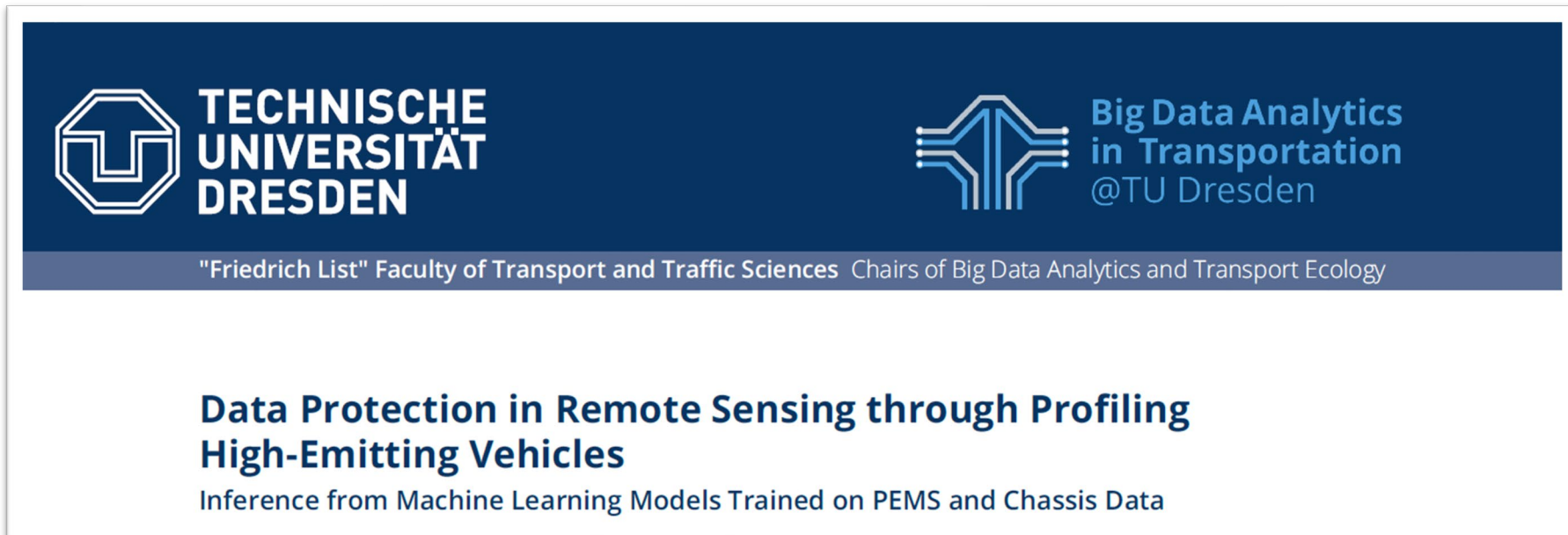
↔ **For enforcement no need to photograph ALL number plates, but only those 10%+, where emissions are suspiciously high.**
(technical data though important for other detailed analyses)

Open questions:

- Mismatch or accuracy issue for HC measurements!?
- More reference data (PEMS) needed!
- Test other algorithms and vehicle classes

Further reading / information

- MSc thesis (2023, in English) by Lukas Unterschütz (TU Dresden)
- Poster by Unterschütz et al. at TAP 2023 Conference:
„Data Protection in Remote Sensing through Profiling High-Emitting Vehicles”
- Jens.Borken-Kleefeld@TU-Dresden.de
www.verkehrsoekologie.de



The poster features a dark blue header with the TU Dresden logo and name on the left, and a stylized circuit icon with the text 'Big Data Analytics in Transportation @TU Dresden' on the right. Below the header, a lighter blue bar contains the text '"Friedrich List" Faculty of Transport and Traffic Sciences Chairs of Big Data Analytics and Transport Ecology'. The main title 'Data Protection in Remote Sensing through Profiling High-Emitting Vehicles' is centered in bold, with the subtitle 'Inference from Machine Learning Models Trained on PEMS and Chassis Data' below it.

TECHNISCHE UNIVERSITÄT DRESDEN

Big Data Analytics in Transportation @TU Dresden

"Friedrich List" Faculty of Transport and Traffic Sciences Chairs of Big Data Analytics and Transport Ecology

Data Protection in Remote Sensing through Profiling High-Emitting Vehicles

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