

**CHALMERS**

# A method for extracting data for quantification of comfort zone boundaries for intersection negotiation from in-vehicle naturalistic data

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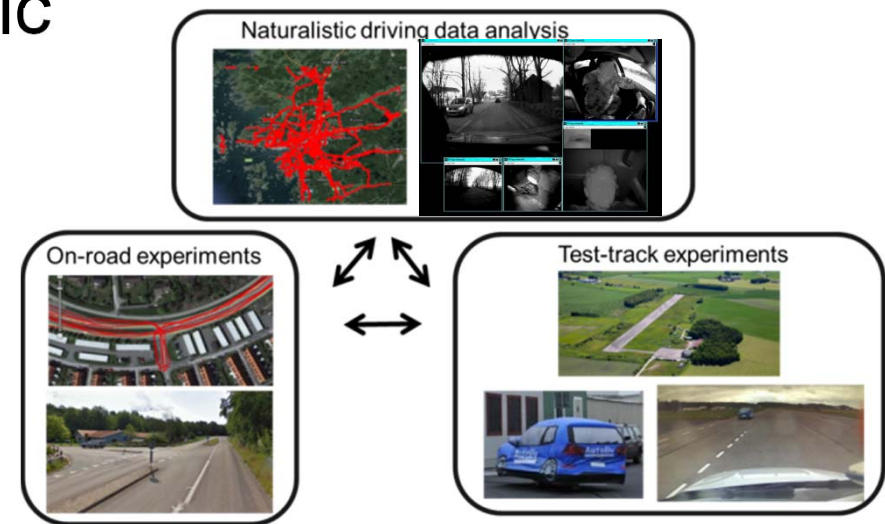
Driver Distraction and Inattention, Gothenburg, 18/09/2013

## Presentation outline

- This research in context
- Data source
- Data extraction and refinement process
- Proposal: Attention indicator
- Preliminary results
- Summary and next steps

## Research in context

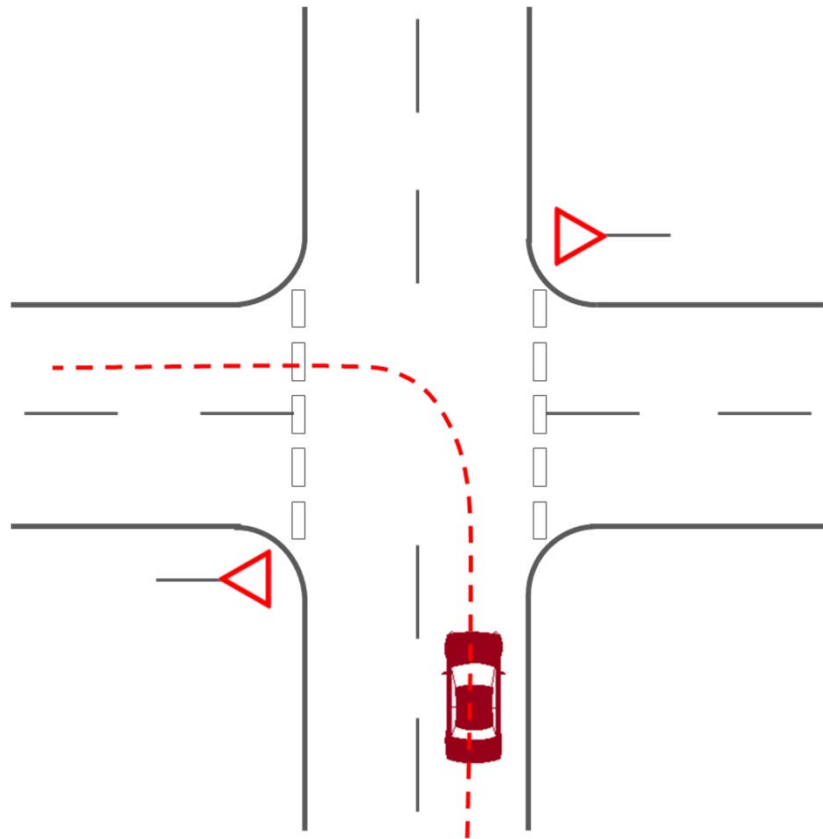
- General aim: To inform the development of ADAS for intersections with respect to driver comfort zone boundaries
- Analysis specific aim: Improve understanding of left-turning drivers attention allocation towards (potentially) oncoming traffic
- Part of a larger study



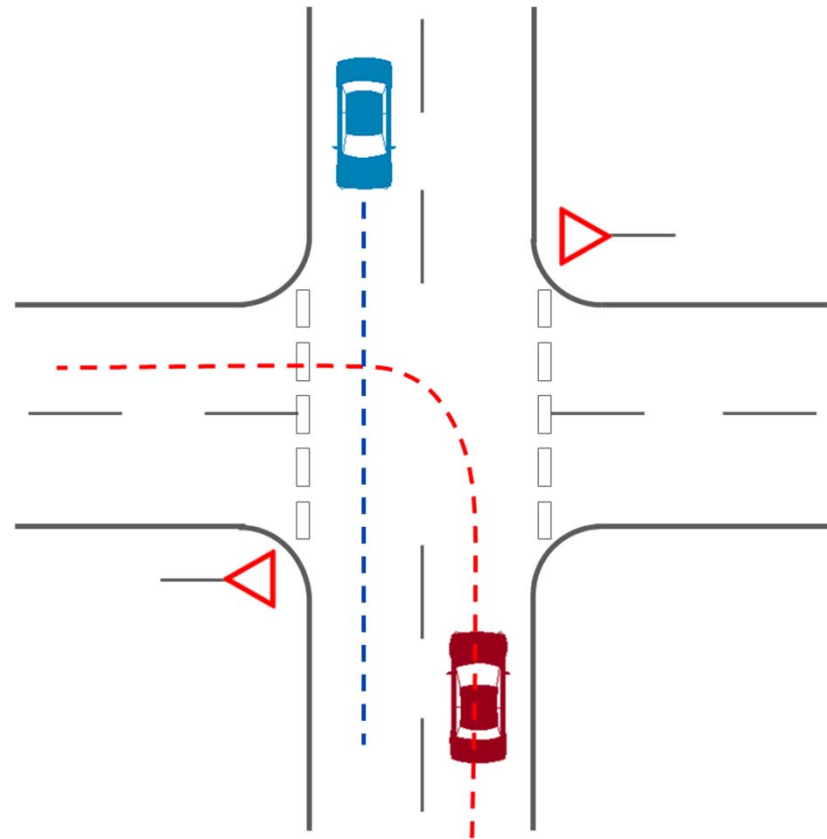
# Scenarios in focus

## Left Turn Across Path/Opposite Direction (LTAP/OD)

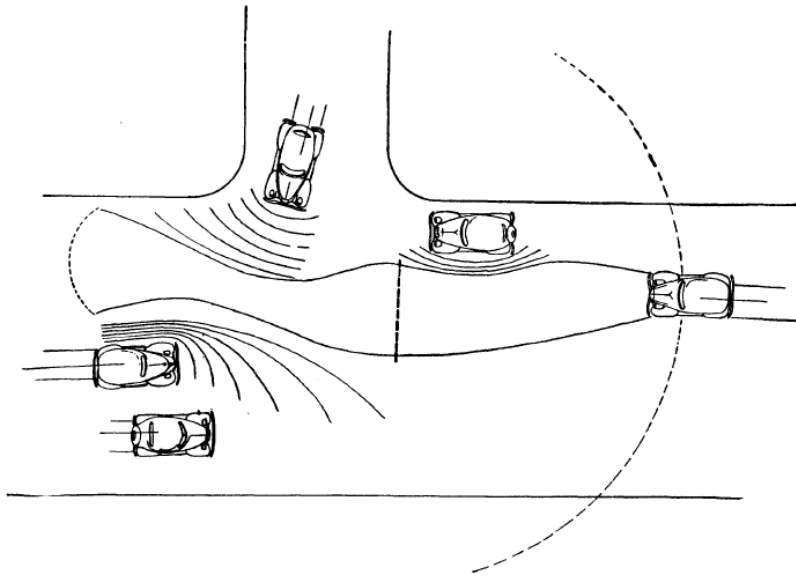
No-Other-Vehicles



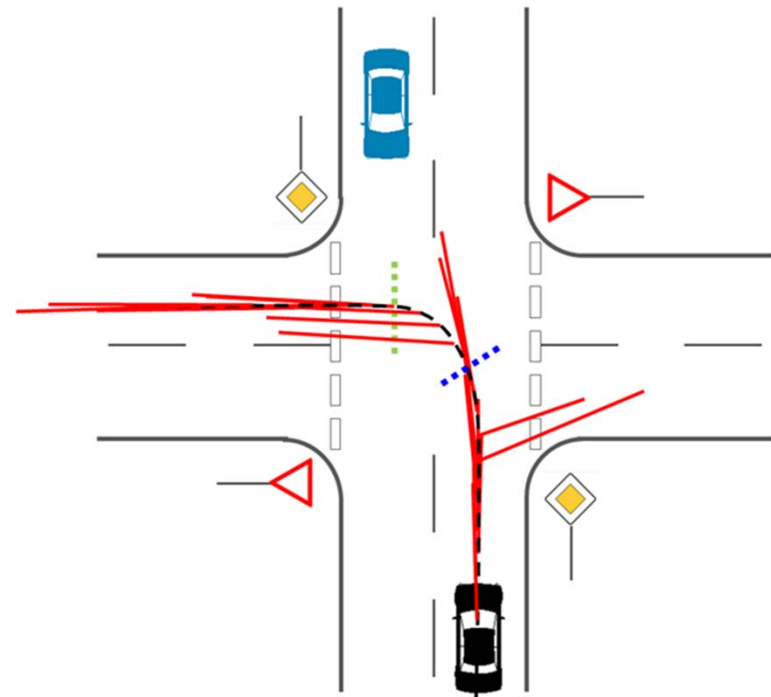
Only-One-Vehicle-Ahead



# Comfort zone boundaries

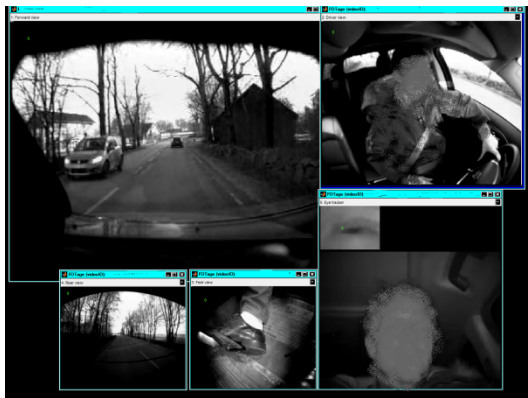


Gibson, J. J. & Crooks, L. E. (1938). A theoretical field-analysis of automobile driving. *The American Journal of Psychology*, 51, 453-471.



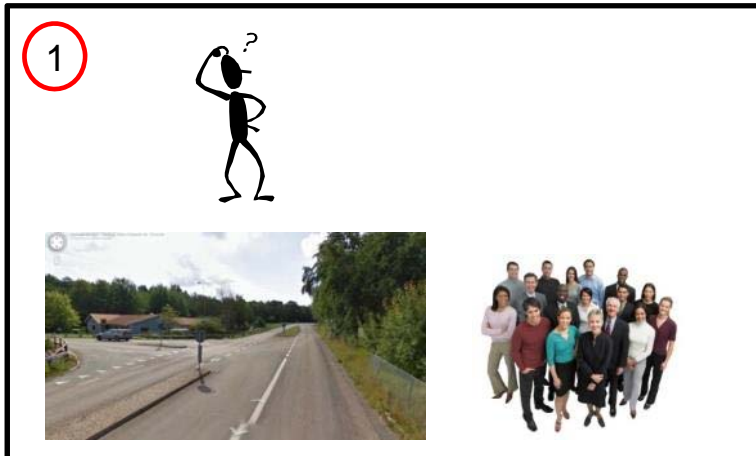
# Dataset used in analysis of naturalistic data

- EuroFOT
- 102 Volvo Cars vehicles
- Naturalistic data collection over 1 year
- Driven mainly in the Göteborg area
- Data include 5 x video, CAN, RADAR, GPS, etc

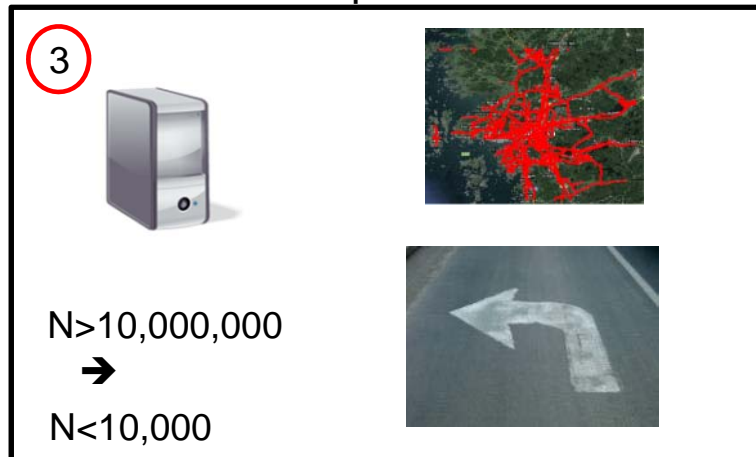


# Data extraction procedure 1-4 (of 8)

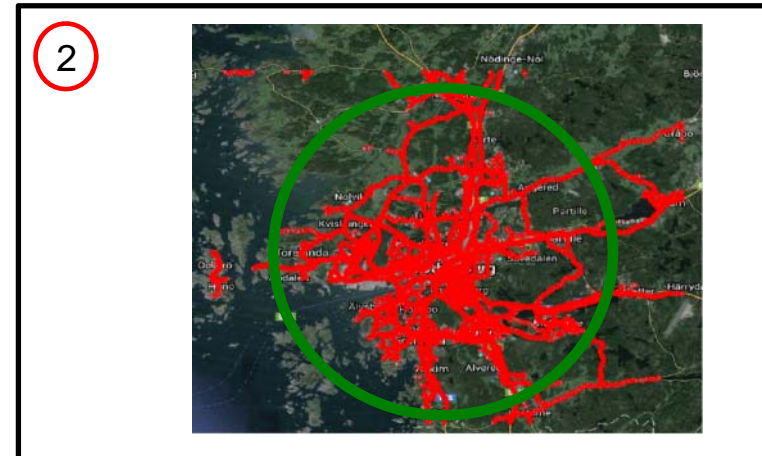
Intersection type & subject criteria



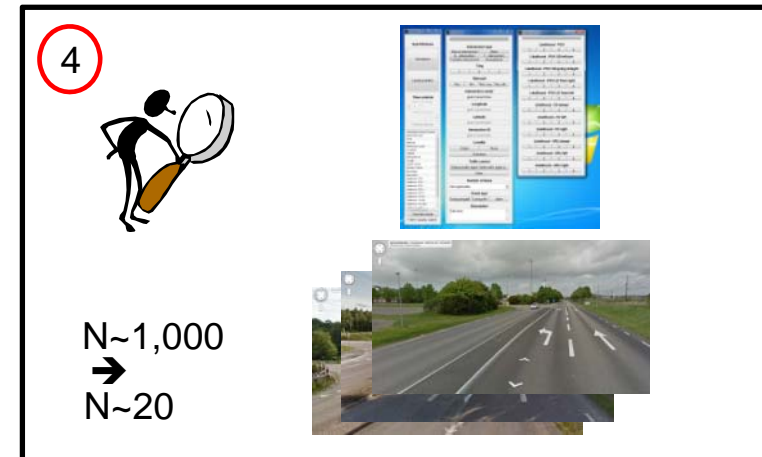
Extract all left turns. Group on unique locations and on pass count



Data source & region selection



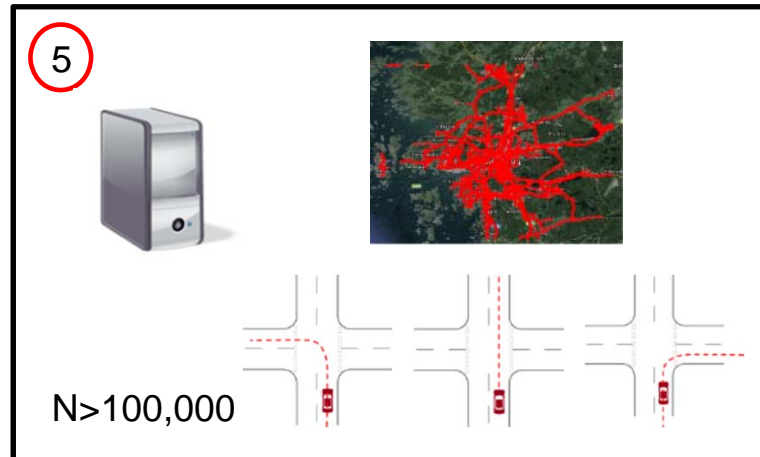
Manually check intersection type



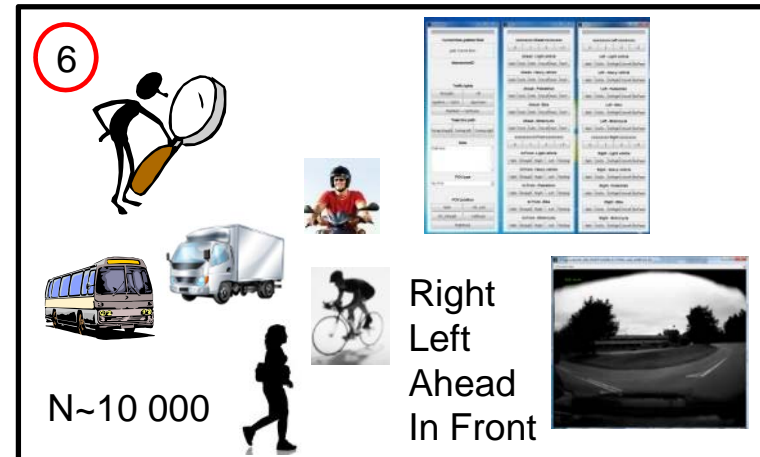


# Data extraction procedure 5-8 (of 8)

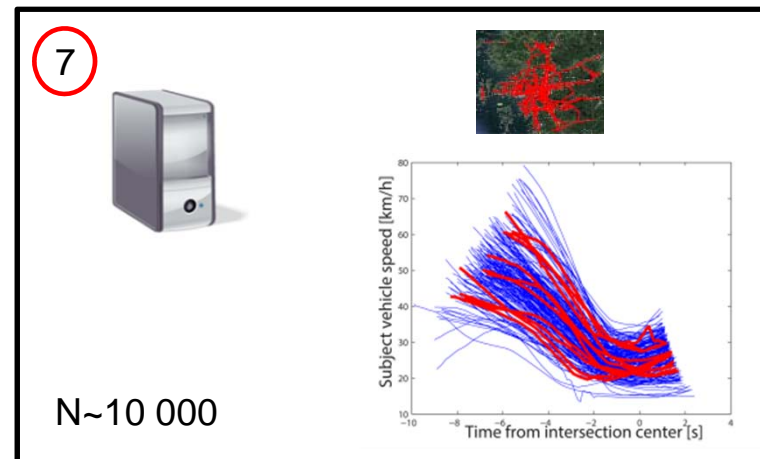
Find all passes through chosen intersections



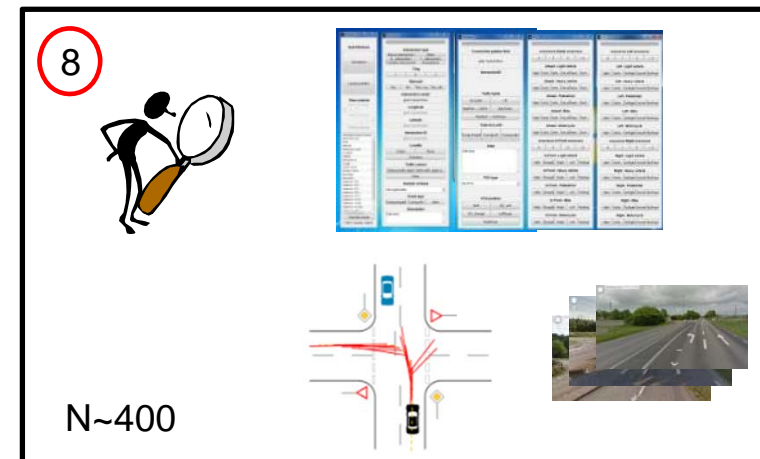
Manually annotate passes for context



Extract and process vehicle data for passes



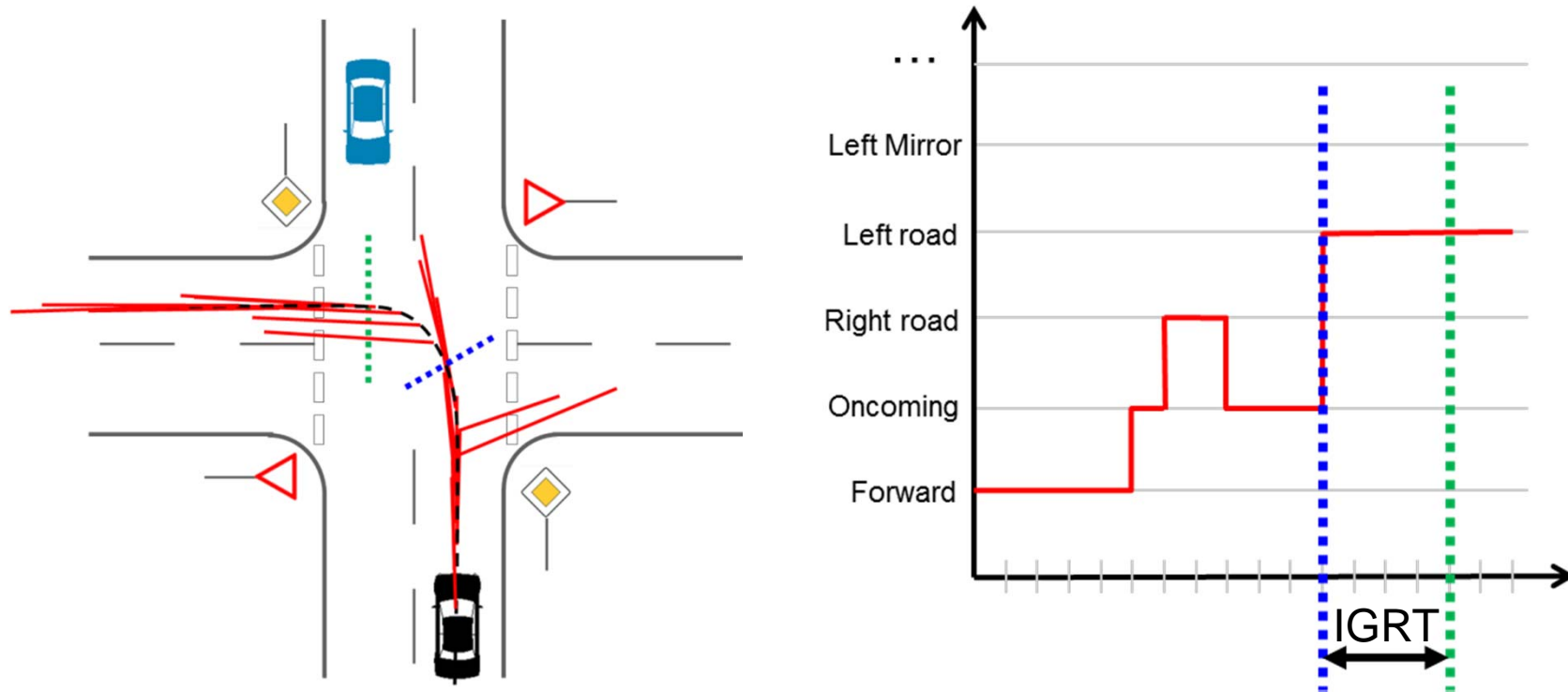
Manually annotate passes for gaze etc.





# Proposed attention indicator: Intersection Gaze Release Time (IGRT)

Definition: Time duration from last glance towards forward roadway until the own vehicle crosses the path of an (potentially) oncoming vehicle



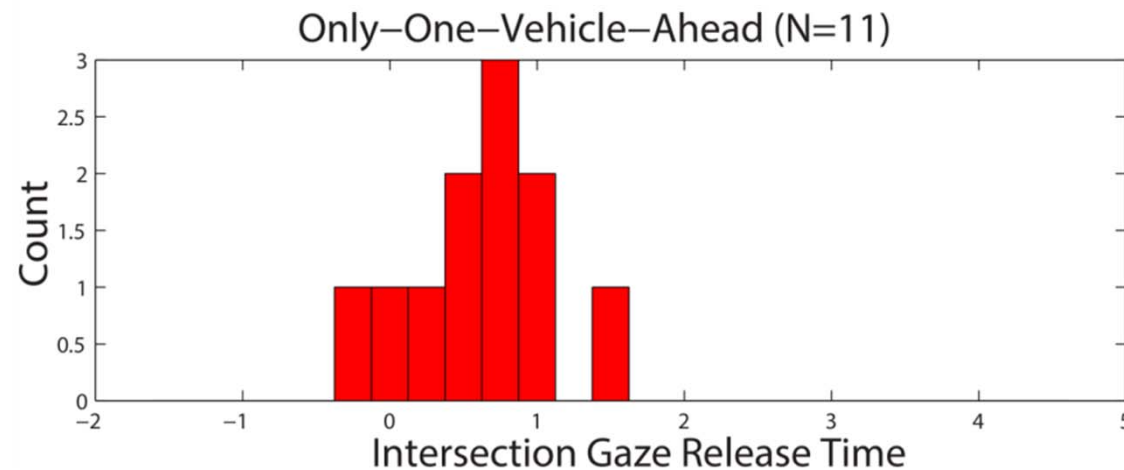
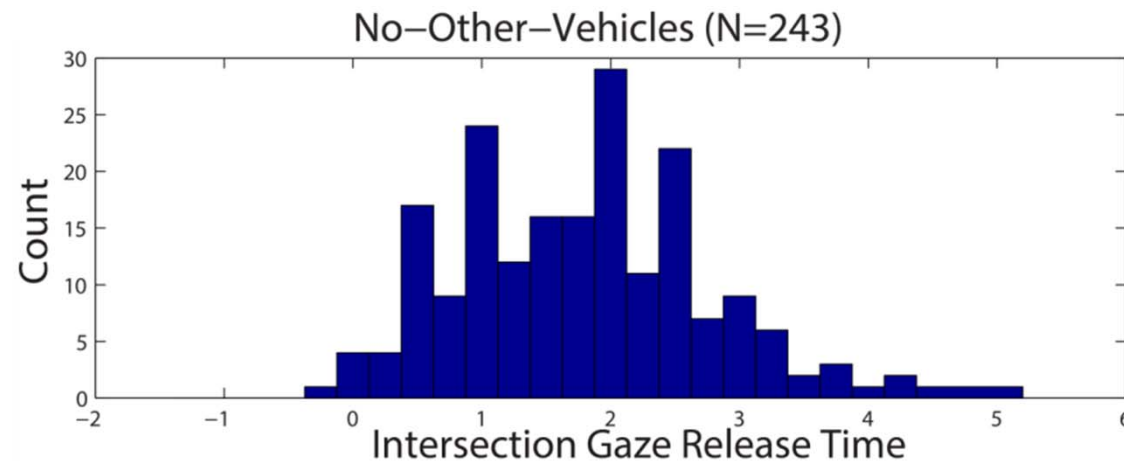
## Expectations of IGRT

- Short IGRT (for this scenario) should indicate more attention to possible threats ahead than long IGRT
- Speed may confound results → distance (IGRD)
- Can also be applied to other scenarios

## Results – Intersection Gaze Release Time

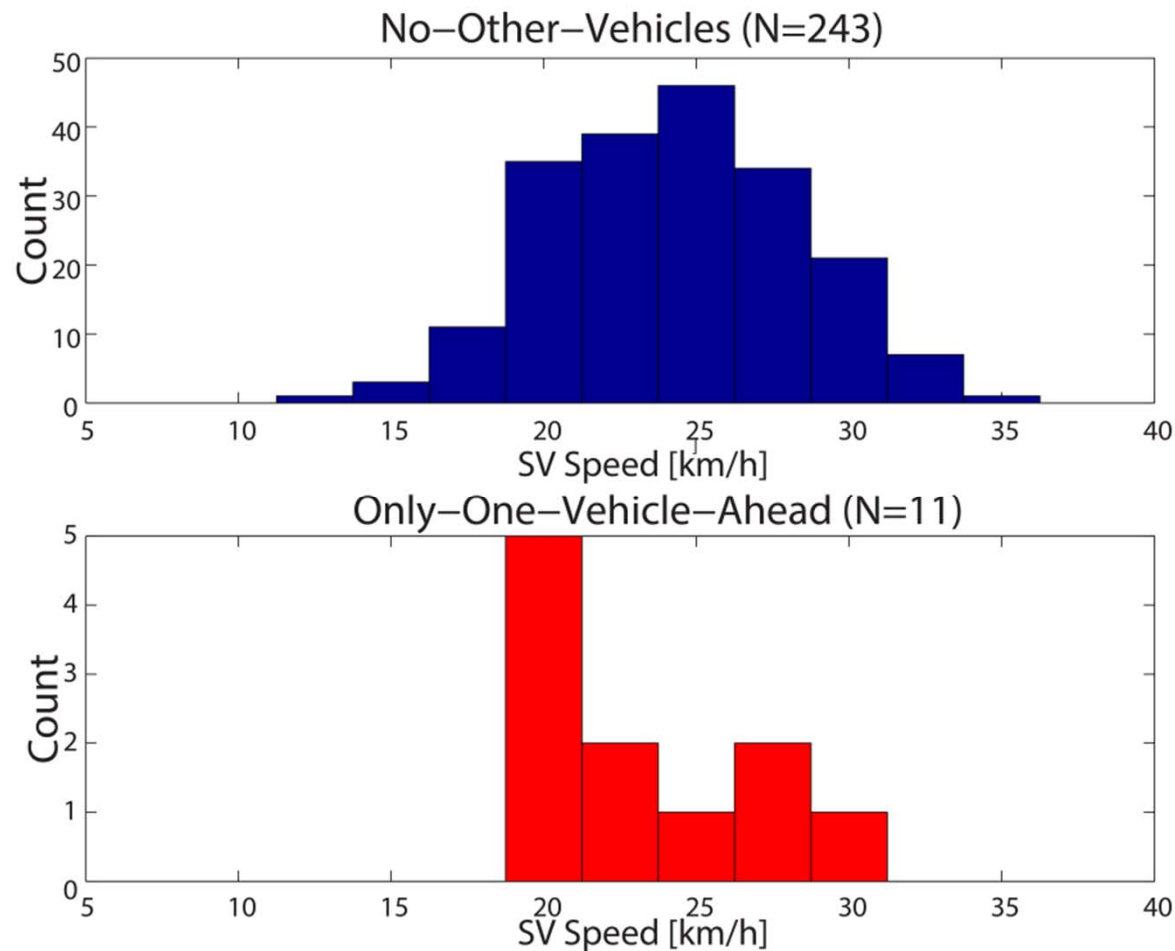
- Comparison of left-turns with:
  - No-Other-Vehicle
  - Subject vehicle “Go” case with Only-One-Vehicle-Ahead relatively close ( $PET < 4.5s$ )
- To date, we have only a few Only-one-vehicle-ahead cases

# Results – Intersection Gaze Release Time



- Few Only-One-Vehicle-Ahead cases so far
- Cases with *unknown* gaze directions removed (<10%)
- t-test  $p < 0.0001$  for IGRT

# Results – Minimum speed around intersection



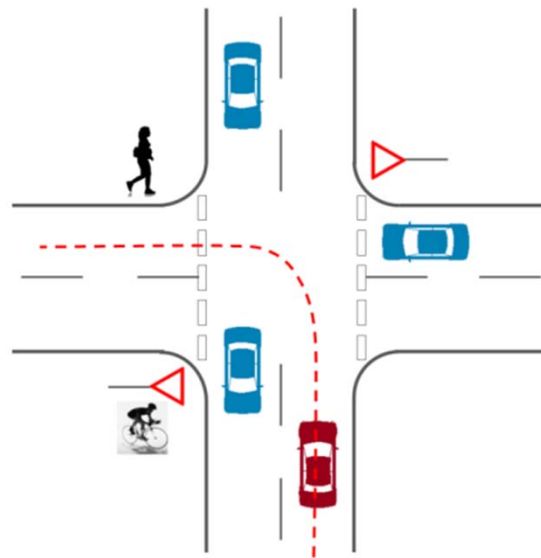
- Minimum speed from 20m before to 10m after the SV crosses the path of an (potentially) oncoming vehicle
- t-test  $p=0.42$  for *Minimum speed*

## Summary

- Naturalistic driving data promising source for location based attention research (e.g. intersections)
- Many steps and much annotation often needed
- Understanding drivers attention selection and comfort zones important for ADAS development

## Next steps

- Find and code more Only-One-Vehicle-Ahead cases for gazes
- Compare other contexts and different indicators
  - Issues with clean definitions of context





**Thank you!**

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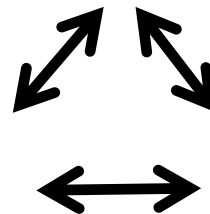
# Backup

# Part of larger project - DCBIN

## Naturalistic driving data analysis



## On-road experiments

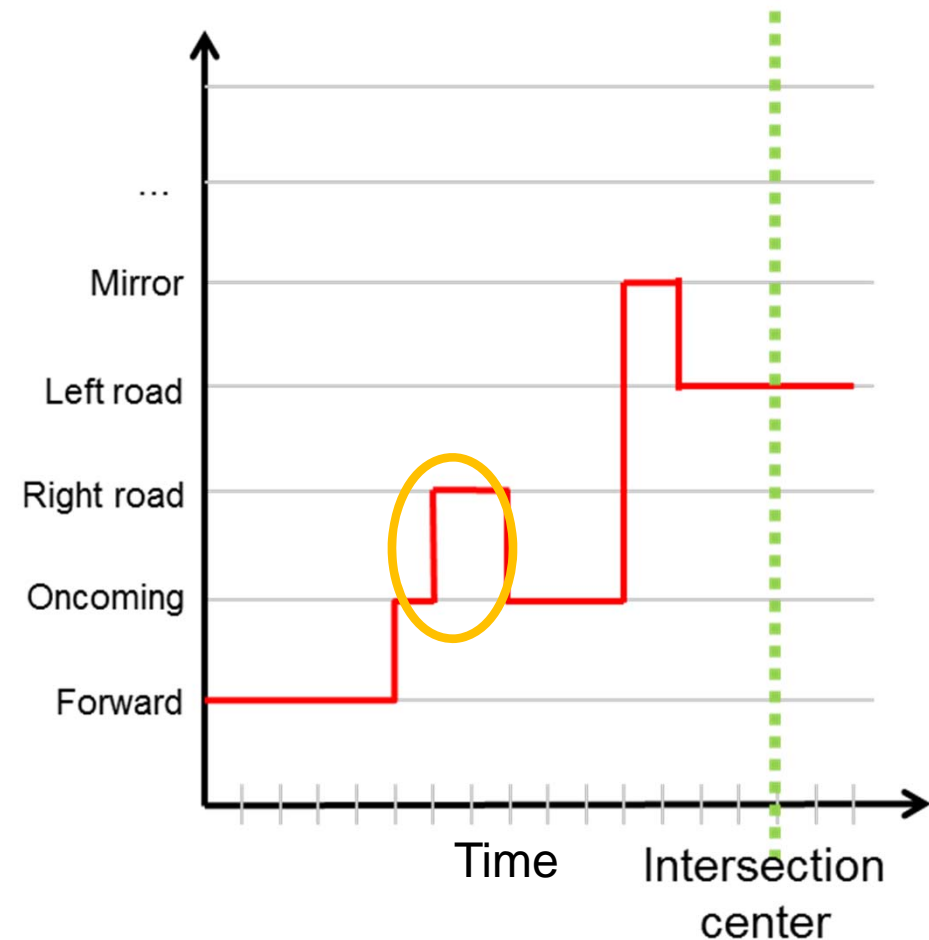


## Test-track experiments

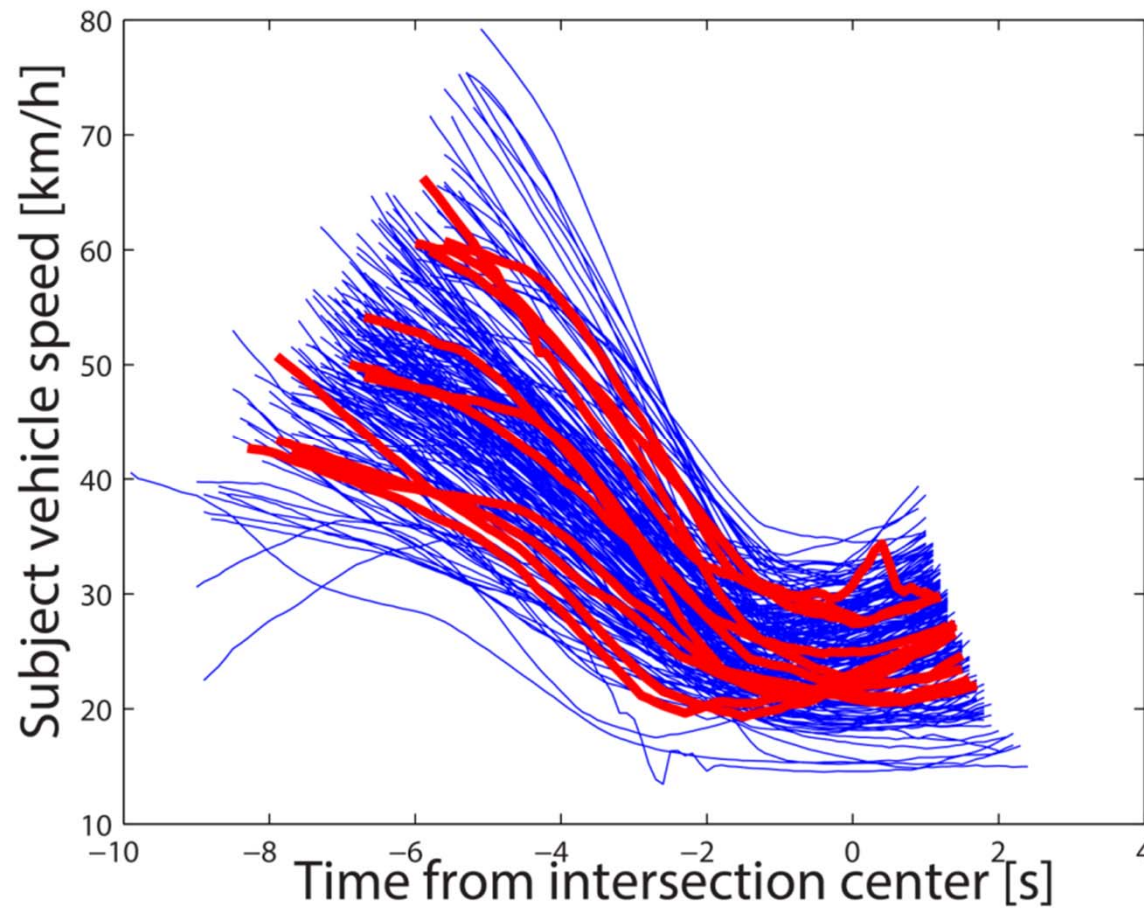


# Area-based gaze annotation

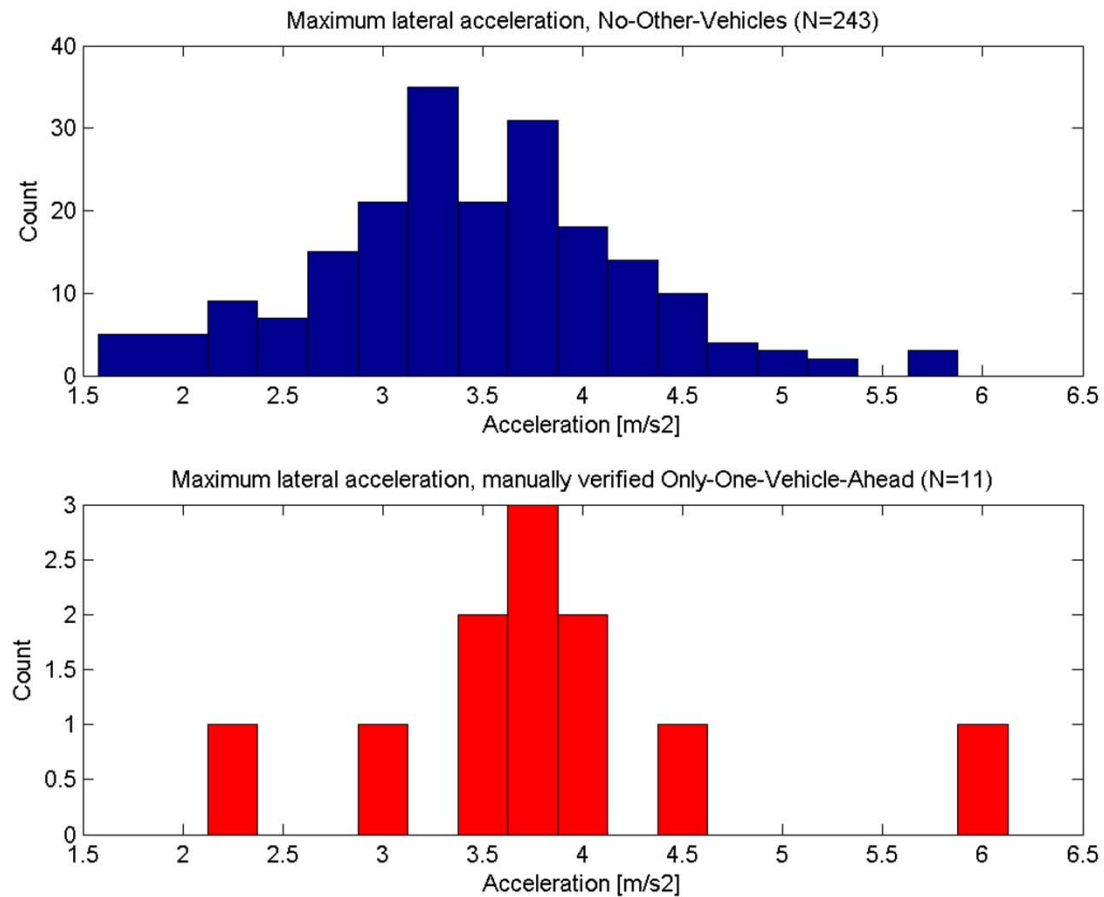
- Per frame (10Hz)
- ~5s before intersection until approx. turn completed
- *Unknown* coded when good estimate not possible



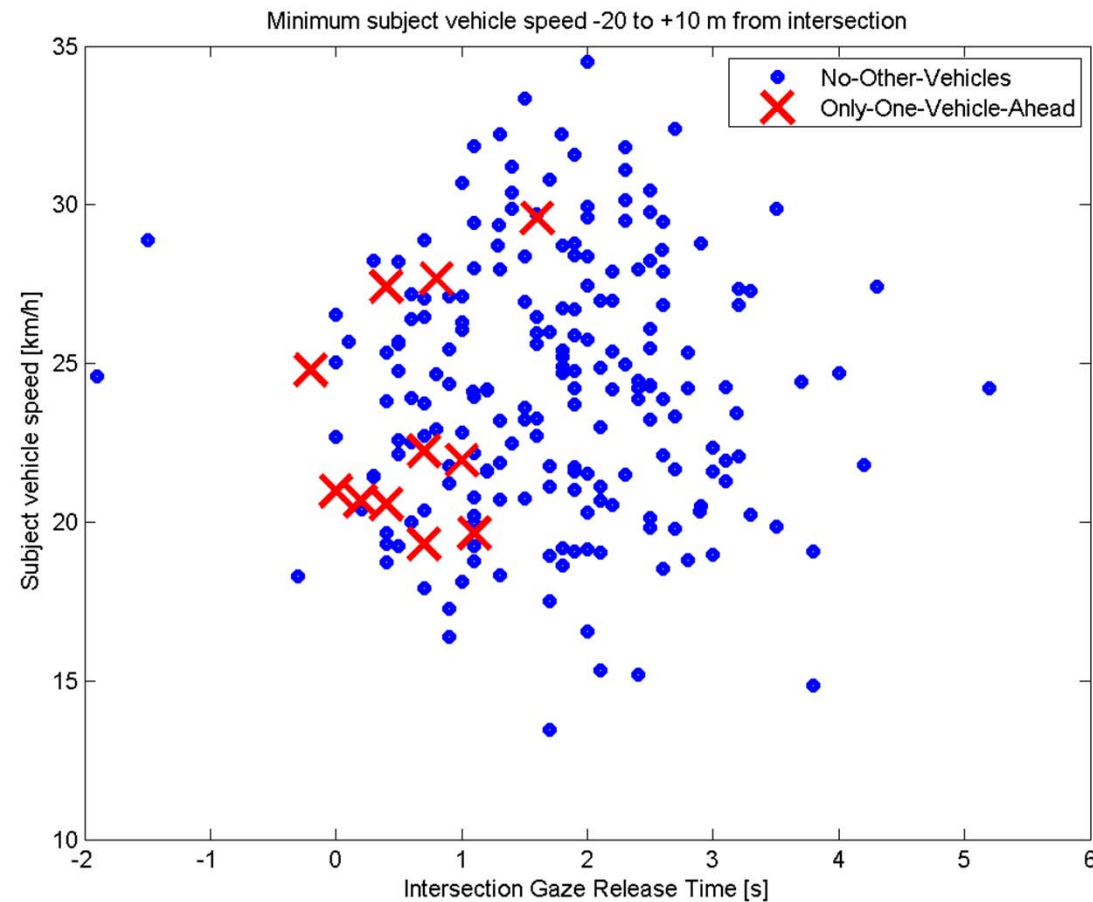
## Results – Velocity profiles



# Results – Maximum lateral acceleration

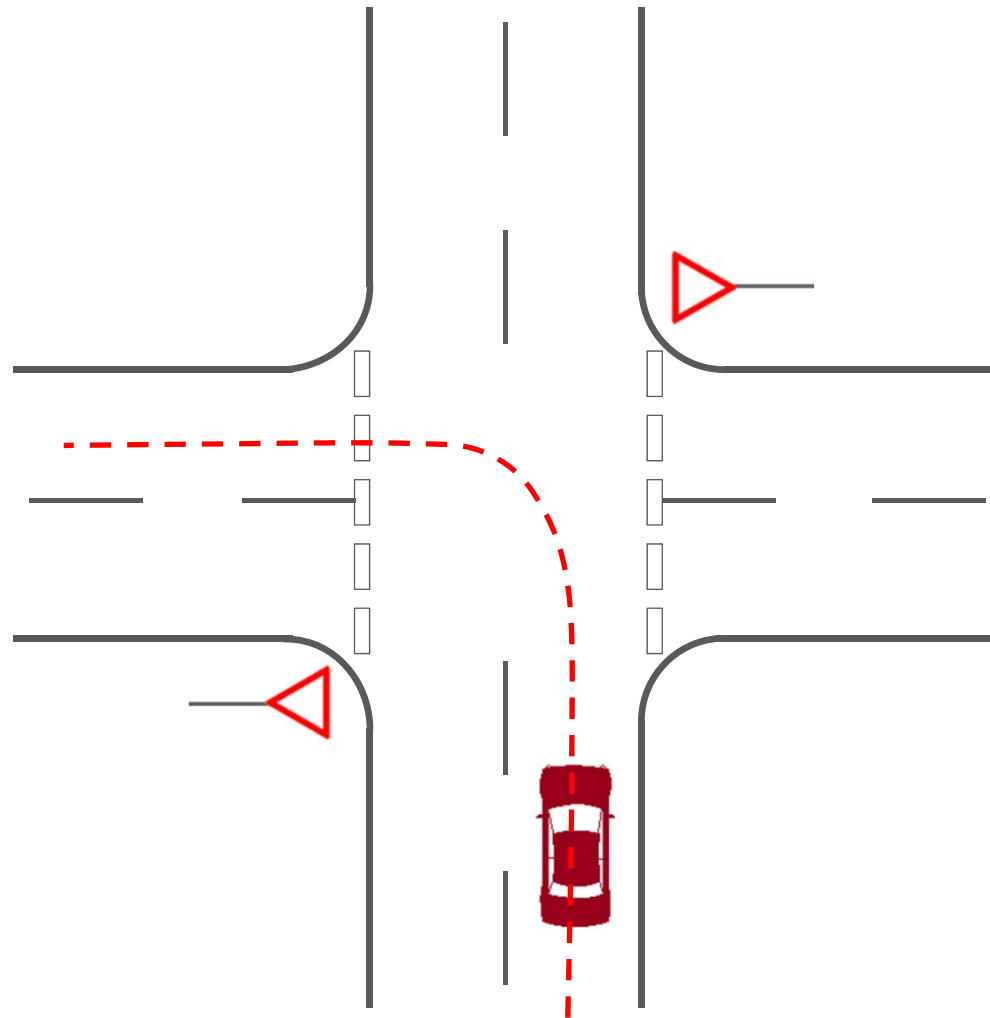


# Results – Minimum subject vehicle speed

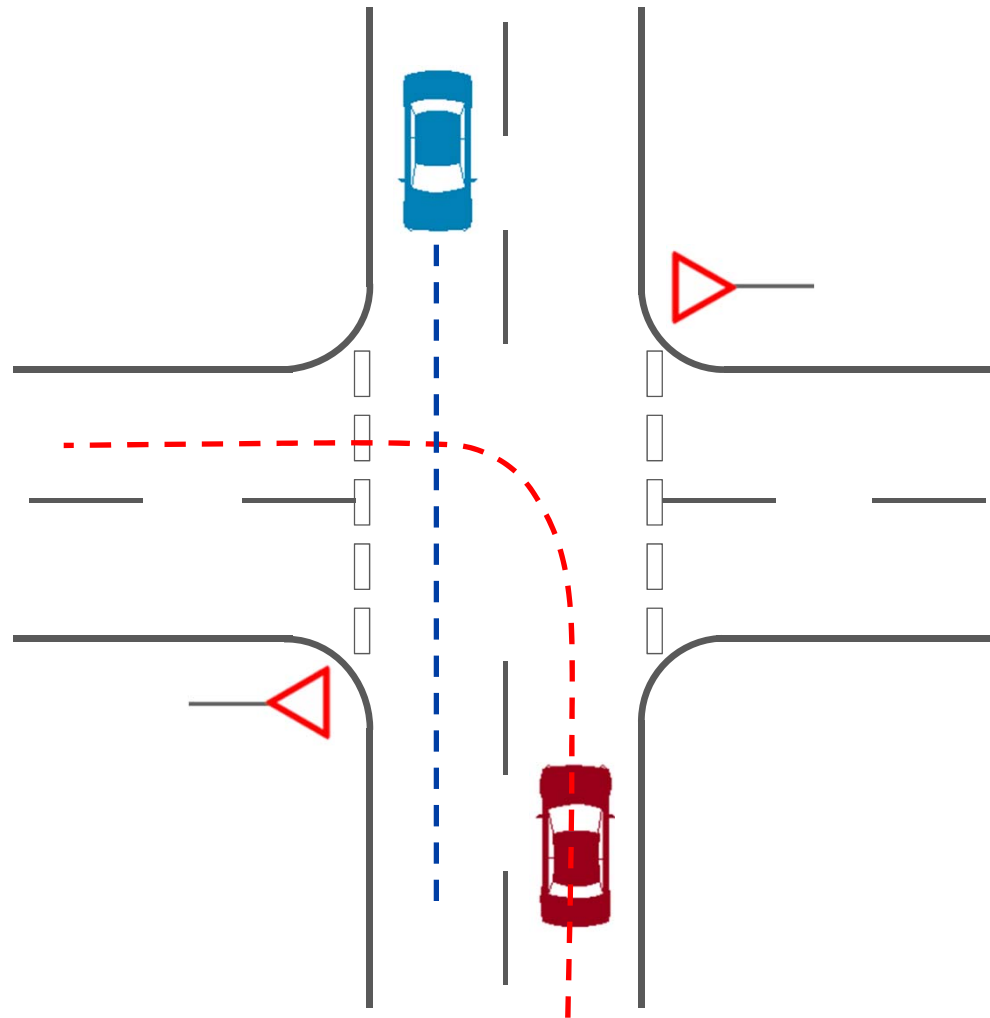




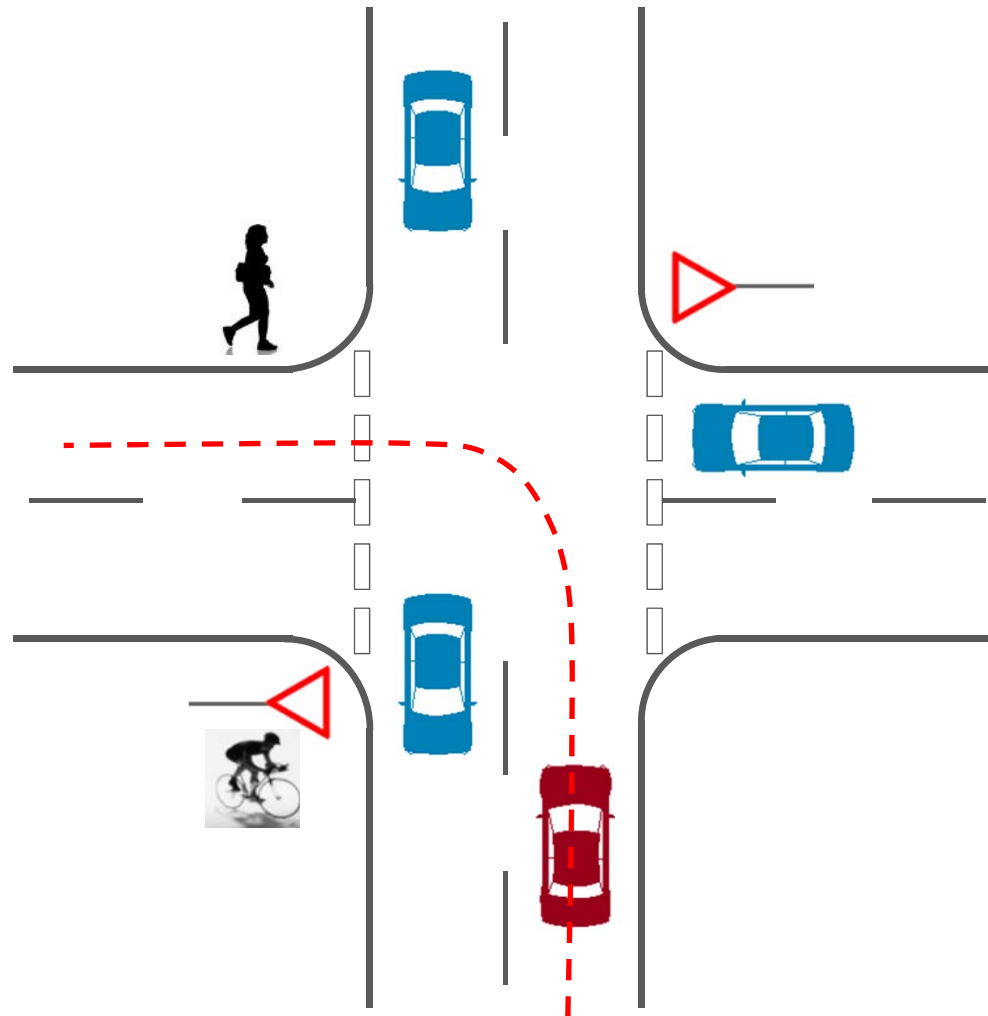
## No-Other-Vehicles



# Only-One-Vehicle-Ahead



# Much happening



# Left Turn Across Path/Opposite Direction (LTAP/OD)

Naturalistic driving data analysis



On-road experiments



Test-track experiments

