

Visual Prediction of Driver Behavior in Shared Road Areas

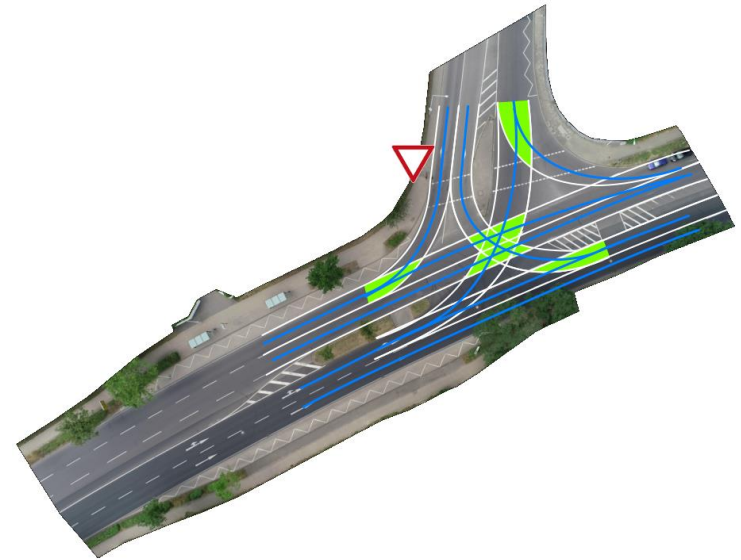
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Chair of Telerobotics and Sensor Data Fusion

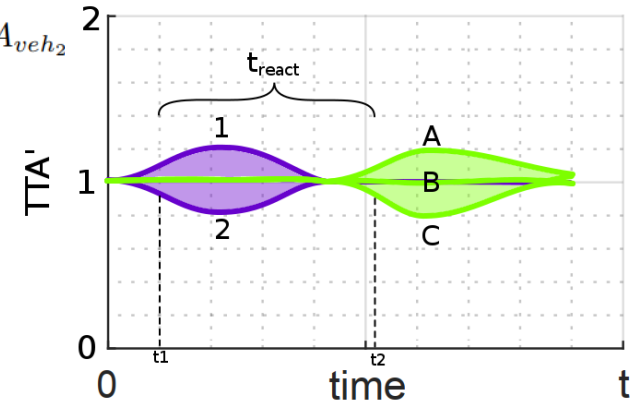
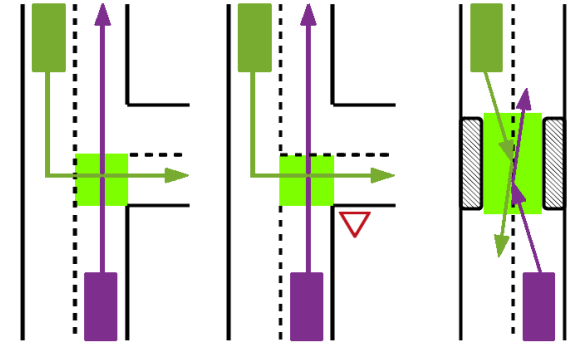
Milan, 2021



Outline of the approach

Idea: Interactions are resource competitions for a shared region

- Identify static interaction regions from topology (overlapping lanes)
- Extract motion goals for traffic participants
- Check for possible colliding trajectories based on Time to Arrival (TTA) at interaction region $TTA = \frac{d}{v_0}$ $\Delta TTA = TTA_{veh1} - TTA_{veh2}$
- Classify behavior based on $TTA' = \frac{TTA(t) - TTA(t + \Delta t)}{\Delta t}$
- Attention/awareness, collaboration in behavior

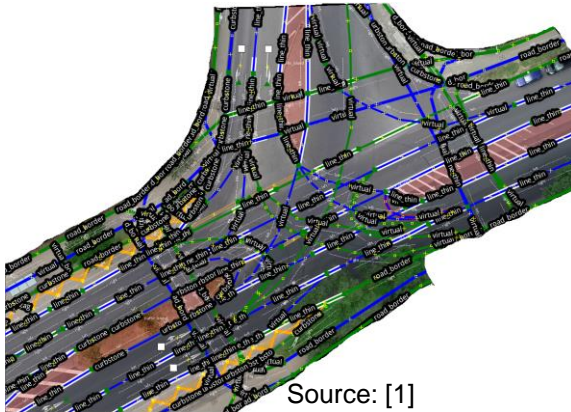


Topology and interaction regions

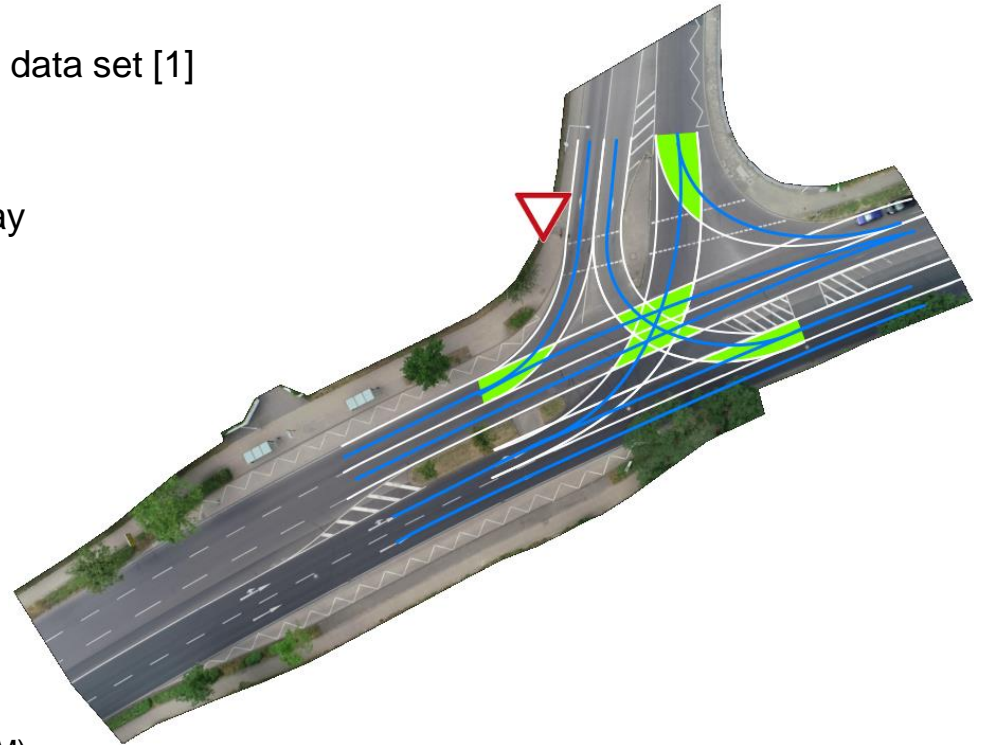
Topology and vehicle motion extracted from inD data set [1]

- Provided as lanelets for all kinds of vehicles

Extract overlapping lanes, determine right-of-way



Source: [1]



Behavior analysis of interactions

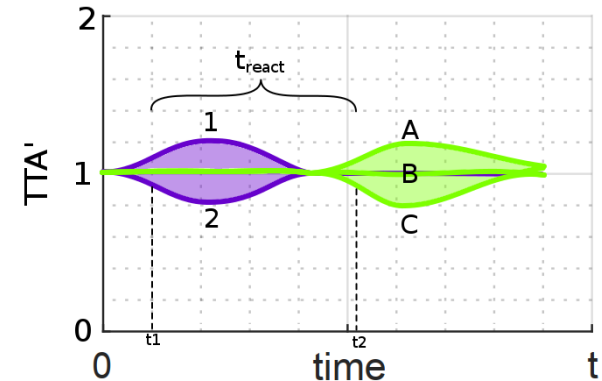
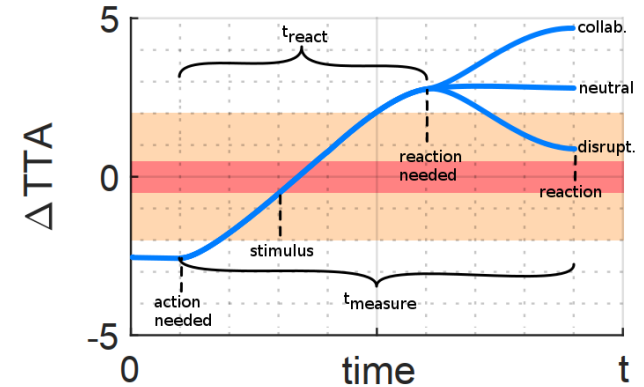
- Influences of each vehicle not clear in ΔTTA

Individual behavior: $TTA' = \begin{cases} < 1, & \text{vehicle slows down} \\ = 1, & \text{expected velocity} \\ > 1, & \text{vehicle accelerates} \end{cases}$

- Add stimulus (purple) and await a reaction of the opponent (green)

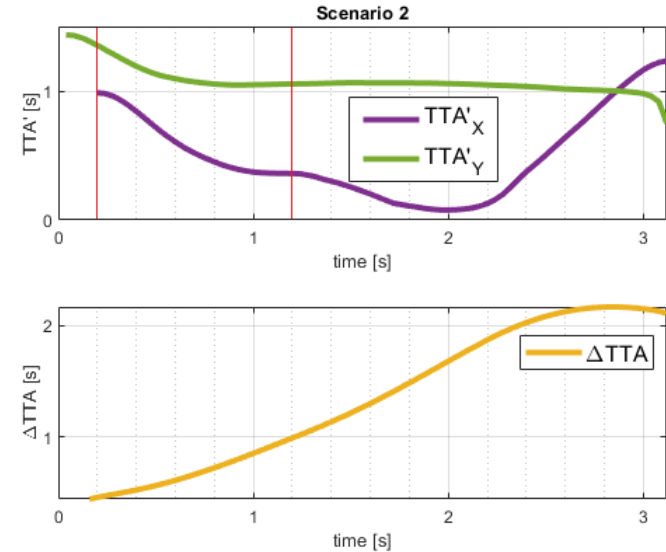
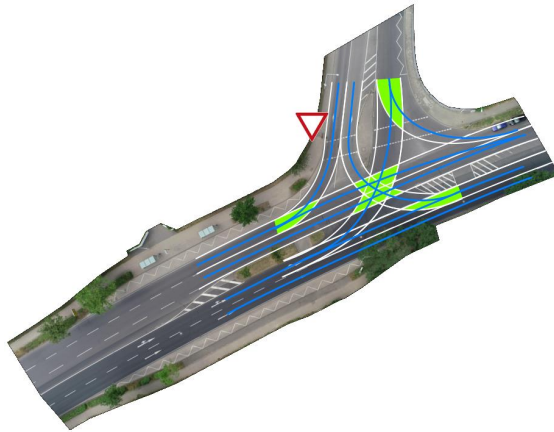
$$B_{veh} = \begin{cases} \text{passive, active} \\ \text{collaborative, neutral, disruptive} \end{cases}$$

$$B_{veh} = \begin{cases} \text{collab.}, & s(TTA'_2 - 1) \neq s(TTA'_1 - 1) \\ \text{neutral}, & (TTA'_2) \approx 1 \\ \text{disruptive}, & s(TTA'_2 - 1) = s(TTA'_1 - 1) \end{cases}$$



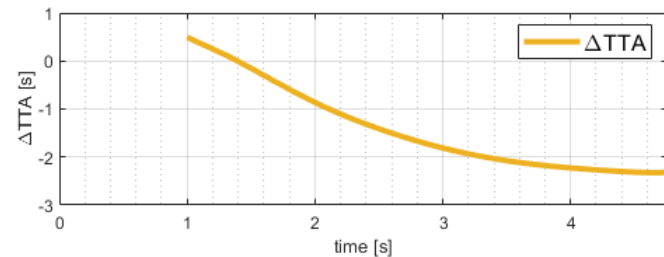
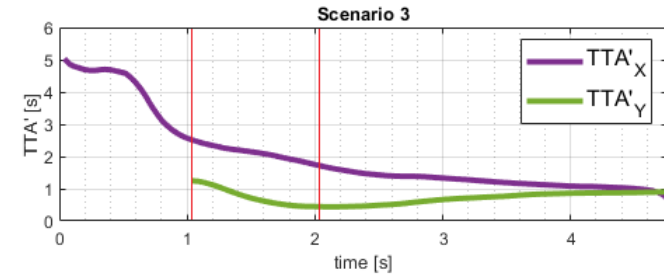
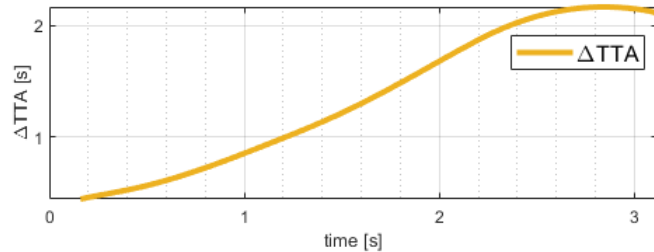
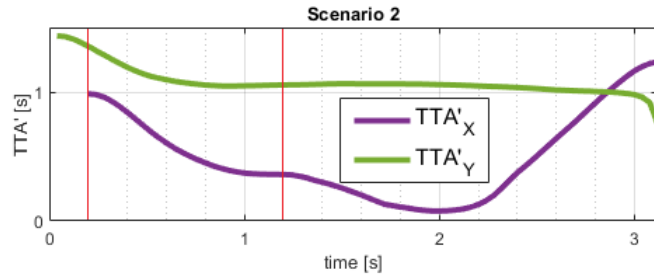
Example: Merging at an intersection

X from top, turning right, Y from right, going straight
 - Most likely: X will yield and wait for Y



Differences in behavior in temporal analysis

Adapt prediction to changes in behavior: unexpected action/reaction



Conclusions

Vehicles act and react to other's behavior in three main categories

The approach identifies typical and unexpected behavior quickly

TTA' is a meaningful property for behavior analysis

Interactions can be classified by means of awareness/activeness and collaboration by analyzing a stimulus input and the opponents reaction

Sources

[1] Bock et al., “The inD Dataset: A Drone Dataset of Naturalistic Road User Trajectories at German Intersections”, 2019, arXiv preprint [arXiv:1911.07602](https://arxiv.org/abs/1911.07602)