

Predicting Individual Discomfort in Autonomous Driving

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Introduction

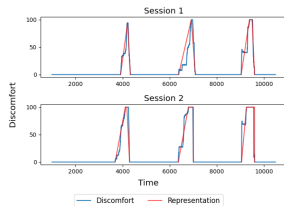
- Driving - a cooperative task between a human and a technical system that perceives, interacts, and decides
- Comfort - a subjective, pleasant state of relaxation resulting from confidence in safe vehicle operation, which is achieved by the removal or absence of uneasiness and distress
- One of the most often mentioned uncomfortable situations - distance keeping
- Driving simulator study - measured discomfort data



Ego perspective of participants car approaching a truck

Discomfort Measurements Representation

- Level of discomfort between 0 and 100
- New meaningful representation using five derived features:
 - Area under the curve - amount of discomfort overall
 - Global maximum - maximum discomfort intensity
 - Onset - when the discomfort started
 - Slope - how fast was the maximum discomfort reached
 - Duration - for how long did the discomfort last



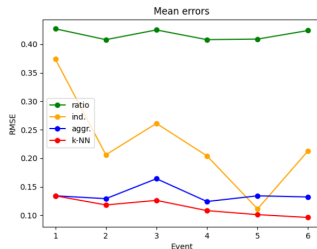
Reconstructed discomfort curve using the five-feature representation

Predictive Modeling Task

- Main goal: Predict an individual's discomfort curve
- Discomfort curve represented using the five features
- When a discomfort inducing event occurs, an individual's reaction is obtained
- Use that to predict discomfort curves for future events, through our 5-feature curve representation
- Approach: k-Nearest Neighbors with $k = 11$
- Find nearest neighbors who reacted similarly to all events until now
- Based on that, make a prediction for current event
- Cold start: Use the aggregated discomfort curve feature values of all other participants, in contrast to a refined neighborhood

Results

- Baseline models:
 - Speed-to-distance ratio (static)
 - Previous discomfort average (individual)
 - Average of other participant's discomfort
- k-NN better than baseline
- Better neighborhoods found over time



Mean RMSE values of predicted discomfort curve feature values