Detecting atypical motion for early awareness of potential safety-critical situations
Identify atypical motion by deviation of actual to predicted trajectory

Atypical behavior
- Real world data is complex, as are situations
- Find general approach, suitable to multiple situations
- Trajectory analyses: rare labeled data or prototypes, use semi-supervised approach
How do critical situations look like? How to identify black spots of infrastructure?

What are atypsics?
- Atypical behavior can give hints to unknown safety issues: imagine potholes
- Atypical behavior can be part of a conflict (assuming conflicts are rare events)

Approach: Detect unexpected behavior
- Main idea: if future behavior (fig. 1) cannot be sufficiently predicted
  by a well-trained and generalizing neural net, the behavior is unexpected and thus seldom/atypical
- this is shown in severe discrepancies from observed and predicted trajectory

Trajectory prediction
- Predict the next points from a number of (observational) points with a RNN which is autoencoder-like (fig. 2)
- Trained trajectory prediction on 4839 vehicle trajectories, observation length 10, prediction length 10 (@25 fps)
- Use Average Displacement Error (ADE) as metric

Detection of atypsics
- Classify point as atypical, if prediction loss is greater than specific percentile of distribution of training losses
- Classify trajectory as atypical, if in a sliding window > 50% is atypical

Evaluation: Find abrupt and strong brakings of right-turning cars
- Field test (fig. 3):
  - driving of encounters of right-turning vehicle and crossing cyclist
  - Results in test set for atypsics of 60 normal/15 atypical traj.
  - 90th percentile of training loss as point classifier and sliding window size of 7 points yields highest f1 score (imbalanced data set)

Conclusion & Outlook
Single events like strong brakings can be found (feature: velocity) in a data-driven manner
- Apply to all modalities (cars, pedestrians and cyclists)
- Extend feature vector by taking position, heading, acceleration into account
- Compare to [Gap Time + Time To Conflictpoint] in this use case
- Early: awareness:
  - Use methods to find further atypical or critical incidents
  - Examine incidents and describe early trigger
  (how can these situations be forecasted or detected early?)