Prediction of Traffic User Behavior using Trajectory Data of Bicycles

Master‘s Thesis of Moritz Kies

Mentoring:
M.Sc. Georgios Grigoropoulos
Dr. rer. nat. Andreas Keler

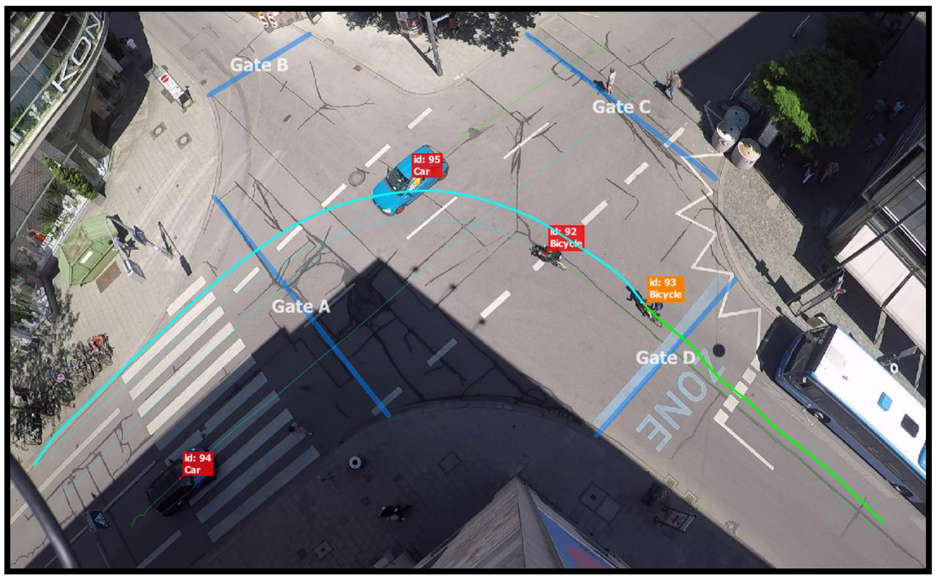


Fig. 1: Tracking of Traffic Participants with a Tracking Software (tracked trajectories are shown as colored lines)

Trajectory prediction of moving targets is a major problem in the autonomous vehicle domain. For planning collision-free trajectories, knowledge about the future position of other traffic participants is required. The goal of this thesis is to develop a model that is able to predict bicycle trajectories based on previously observed bicycle trajectory data. The provided video data consists of videos from an unsignalized intersection with no separate bicycle lanes in the old town of Munich. The trajectory data is extracted from the video files with a tracking software in a sufficient temporal resolution. To fulfil certain requirements regarding the desired application, the trajectory data is analyzed and processed. Erroneously tracked trajectories are removed. The remaining data is largely inhomogeneous concerning the amount of maneuver types for each approach of the intersection. The full data set, consisting of 1,113 bicycle trajectories, is split up to subsets for training, validation, and test purposes.

The prediction model works based on the assumption that bicyclists, having a certain intention like turning or going straight, show similar motion patterns as other bicyclists that had the same intention. These motion patterns are included in the trajectory data (spatial coordinates, velocity, and acceleration). Therefore, the algorithm applies a nearest neighbor search to the observed target trajectory in the training database of full bicycle trajectories. The observation length of the target bicycle was set to a value of 2.2 seconds upon which the prediction is to be made. In the first step, the model searches the most common maneuver type among the five nearest neighbors of the observed trajectory. A validated weights function assigns weights for the ordered nearest neighbors (nearest, second nearest, …). The prediction of the intended maneuver happens upon the most common maneuver with the highest weight.

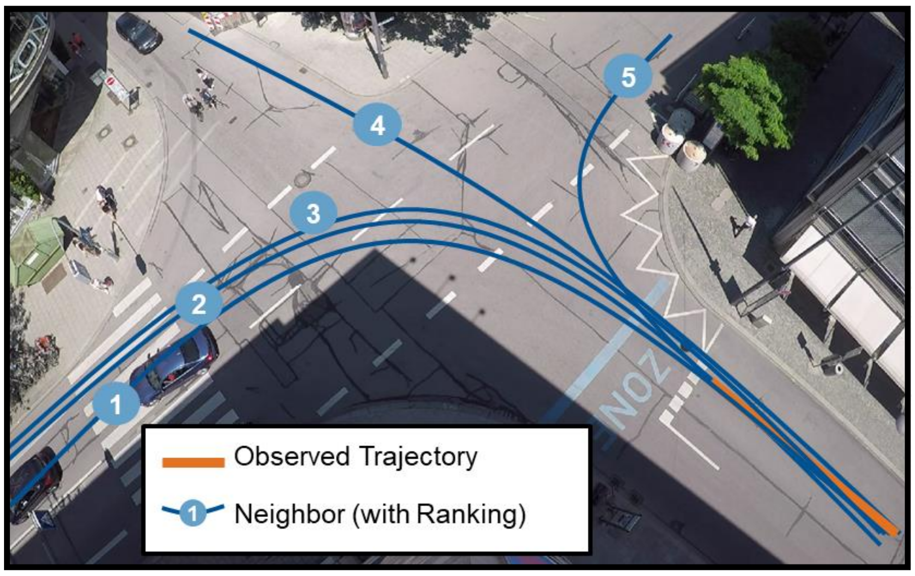
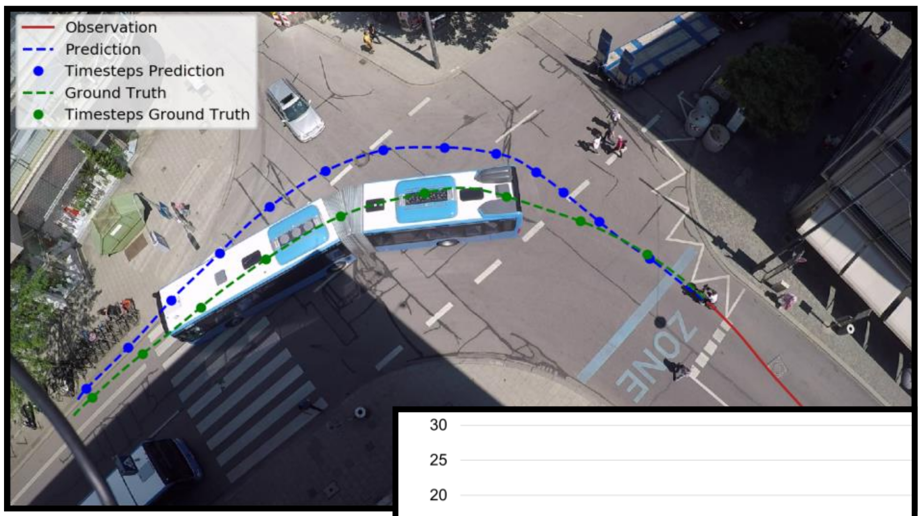


Fig. 2: Illustration of the Prediction Algorithm (in this case the maneuver estimate for the observed trajectory would be “left-turn”)

The method is evaluated on the left-turning bicycles in the test data set. Based on the test data set of bicycle trajectories, 32 out of 48 left-turning bicycles are predicted correctly. As the left-turning bicycles made up about a quarter of the training data set, the model works better than a purely stochastic approach. For bicycles approaching from a side road, the model has difficulties to differentiate between the maneuver “straight” and “left-turn” (as both have to give way). For bicycles riding on the priority road, the model has higher prediction accuracies concerning the prediction of the maneuver “left-turn”. The metrics “Average Displacement Error” (ADE) and “Final Displacement Error” (FDE) are used for the evaluation of the spatial prediction accuracy of the model. Regardless of the fact whether the prediction of the maneuver is true or false, both metrics showed increasing prediction inaccuracy with increasing prediction horizon. A visualization scheme is provided, which plots the observed, the ground truth, and the predicted trajectory on a video frame of the real traffic situation, including time steps in a temporal resolution of one second.



	1	2	3	4	5	6	7	8	9
ADE	0.11	0.38	1.01	2.01	3.17	4.36	5.47	6.46	7.27
FDE	0.22	0.92	2.90	5.99	9.01	11.50	13.23	14.36	14.55

Prediction Horizon [sec]

Fig. 3: Visualization of the predicted Trajectory (top) and calculation of the corresponding Evaluation Metrics (right)