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Differences in pedestrian trajectory predictions for high- and low-density situations

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Abstract

In recent years, there has been a rising interest in pedestrian trajectory prediction methods. Real-world applications, such as autonomous vehicles or social robots, are reasons for that. Other reasons are advancements in deep learning architectures like long short-term memory networks or generative adversarial networks, which are mostly used for this task [1]. In the literature, these algorithms are trained with data taken from low-density situations where just a few pedestrians are involved to learn the pedestrian behaviours, especially local interactions. After that, single pedestrian trajectories are predicted over a relatively short time horizon.

In this contribution, we aim to investigate how these algorithms can be used for high-density situations. Yet, there is almost no real-world trajectory data from crowds available. Therefore, we trained the algorithms on experimental data [2] as well as synthetic data that we generated through simulations with the GAMA platform [3]. Important is to train on data of different density levels so that the algorithm can learn the relationship between density and velocity (fundamental diagram). In previous studies, error-metrics like the average-displacement error (ADE) or final displacement error (FDE) allow quantifying the prediction accuracy [4]. However, we argue that these metrics are not sufficient for high-density situations. Indeed, dense dynamics are mainly governed by the physical body-exclusion of pedestrians. Yet, the results show that the deep learning algorithms describe collisions and large overlapping between the pedestrians in crowded scenarios, even for algorithms relying on interacting pools like the social-LSTM [4]. The ADE and FDE metrics do not account for such features. It seems to be necessary to use other error metrics like collision number or overlapping factor to fairly quantify the trajectory prediction quality in dense situations. We compare different collision-related indicators using real trajectories and predictions of classical knowledge-based models and deep learning algorithms. This study's findings reveal that while the learning algorithms provide improved trajectory accuracy, collisions are better handled by the knowledge-based models.

Keywords
human trajectory predictions, deep learning, synthetic data, high- and low-density scenarios, pedestrian collision

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