Predicting Pedestrian Behavior in Urban Traffic Scenarios Using Deep Learning Methods

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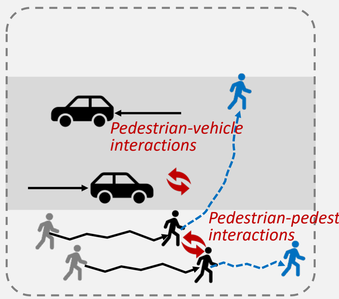
Abstract: This research project aims to use deep learning (DL) to predict pedestrian behavior in urban traffic. We have proposed two novel DL methods that consider pedestrian social interactions and pedestrian-vehicle interactions in prediction. We use the real-world urban traffic dataset released by Google Waymo to build our models and try to develop transferable models. The outcomes of this project contribute to the development of automated vehicles and driver assistant systems.

INTRODUCTION

- **Motivation:**

Accurately predicting pedestrian behavior is crucial for automated vehicles to better understand pedestrians in complex scenarios to avoid pedestrian-vehicle collisions.

- **Problem definition:**

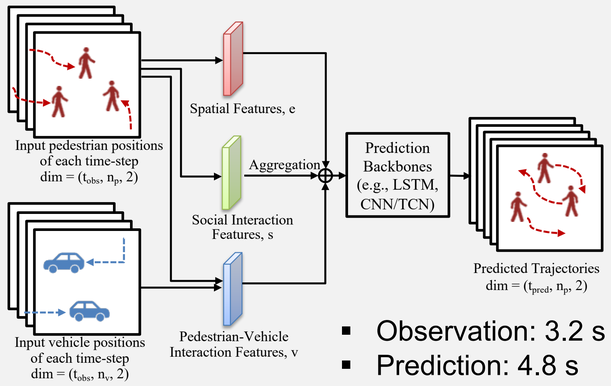


Challenges:
- Randomness
- Interactions
- Representations
- Real-world scenarios

- **Dataset - Waymo Open Dataset**

- Dense urban traffic scenes
- Vehicle's view
- 450 scenes
- 20,967 frames

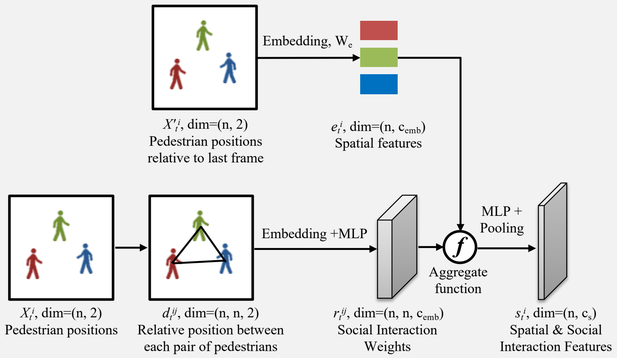
OVERALL PREDICTION FRAMEWORK



- Observation: 3.2 s
- Prediction: 4.8 s

PEDESTRIAN SOCIAL INTERACTIONS

- **Social Interaction Extractor:**



Comparing with Social-STGCNN (SOTA):
- ✓ Do not need to construct the graph.
- ✓ Learn the weights, do not have non-linear calculation.

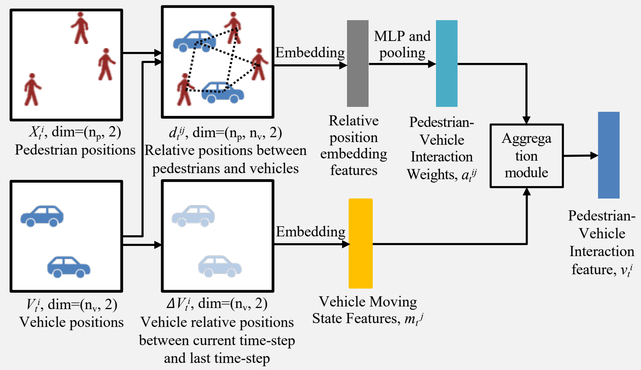
- **Results: More accurate and faster.**

Time (ms)	Preprocessing	Inference	Total
Social-STGCNN	12.61	3.20	15.81
Social-IWSTCNN (ours)	0.23 (**x 54.8**)	3.15	3.38 (**x 4.7**)

More Info: This work has been published and presented on IEEE-IV 21 conference. The paper can be found here (or scan the QR code): https://doi.org/10.1109/IV48863.2021.9575958

PEDESTRIAN-VEHICLE INTERACTIONS

- **Pedestrian-Vehicle Interaction Extractor:**



- **Results: More accurate.**

Model	ADE	FDE	Interaction Used in the Model
LSTM	0.392	0.844	No Interaction
Social-LSTM (2016)	0.402	0.840	Social Interaction
Social-GAN (2018)	0.386	0.826	Social Interaction
SI-PVI-LSTM (ours)	**0.372**	**0.796**	Social Interaction Pedestrian-Vehicle Interaction

More Info: This work has been published and presented on 8th IEEE-ICCAR conference. The paper can be found here (or scan the QR code): https://doi.org/10.1109/ICCAR55106.2022.9782673

TRANSFERABLE MODELS

- **Question:** Could the model trained on one dataset be used on a new untrained dataset that has a different distribution?
- **Goal:** To develop a transferable model that learns generic motion features.
- **Method:** Transfer learning. Minimizing the distribution gap.

Waymo Data — ETH data

LATEST PUBLICATIONS

1. **Zhang, C.** and Berger, C. (2022). Analyzing Factors Influencing Pedestrian Behavior in Urban Traffic Scenarios Using Deep Learning. In Transport Research Arena (TRA) 2022. Elsevier.
2. **Zhang, C.** and Berger, C. (2022). Learning the Pedestrian-Vehicle Interaction for Pedestrian Trajectory Prediction. In 2022 8th International Conference on Control, Automation and Robotics (ICCAR) (pp. 230-236). IEEE.
3. **Zhang, C.**, Berger, C., and Dozza, M. (2021). Social-IWSTCNN: A social interaction-weighted spatio-temporal convolutional neural network for pedestrian trajectory prediction in urban traffic scenarios. In 2021 IEEE Intelligent Vehicles Symposium (IV) (pp. 1515-1522). IEEE.
4. **Zhang, C.** and Berger, C. (2022). Pedestrian Behavior Prediction Using Deep Learning Methods for Urban Scenarios: A Review. In submission to IEEE Transactions on Intelligent Transportation Systems.

SUPERVISION & CONTACT

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