# PEDESTRIAN TRAJECTORY PREDICTION USING AI


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SHAPE-IT ESR 3



This work has been published and presented on IEEE-IV 21 conference. The pre-print paper can be found here on arXiv or scan the QR code: (license: CC BY-NC-SA)
https://arxiv.org/pdf/2105.12436.pdf

Pre-print paper


This project aims to predict the future trajectories of pedestrians using deep learning network in urban traffic scenario. It is a part of the SHAPE-IT ESR3 project "Classifying and Predicting Interactions Between AV and VRUs Using AI". In this work, we consider both the past individual trajectories, and the social interaction between pedestrians. We use the real-world urban traffic dataset recently released by Waymo to train and test our algorithm.

## BACKGROUND

- **Motivation:**

Pedestrians are essential participants in urban traffic scenarios because they are vulnerable and need protection. Accurately predicting pedestrian trajectories can help to reduce the risk of potentially hazardous situations.

- **Problem definition:**

Use past trajectories $X_t^i = (x_t^i, y_t^i), 1 \leq t \leq T_{obs}$ to predict future trajectories $\hat{Y}_t^i = (x_t^i, y_t^i)$, $T_{obs} + 1 \leq t \leq T_{pred}$, where $i \in \{1, \dots, n\}$, n is the number of pedestrians in each frame.

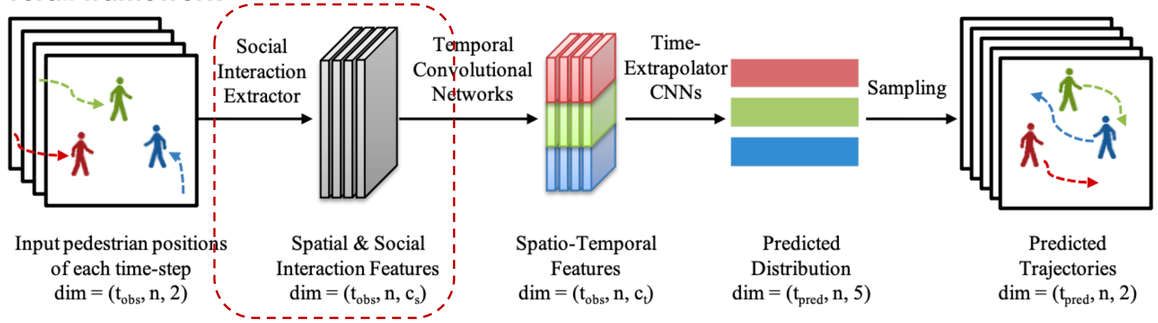
- **Challenges:**

- Represent Movement State
- Deal with Randomness
- Model Social Interaction
- Use in Urban Traffic Scenarios

## OUR PROPOSED MODEL

The proposed Social Interaction-Weighted Spatio-Temporal Convolutional Neural Network (Social-IWSTCNN) model.

- **Overall framework**




- **Social Interaction Extractor:**

**Comparing** with previous best state-of-the-art method (Social-STGCNN):

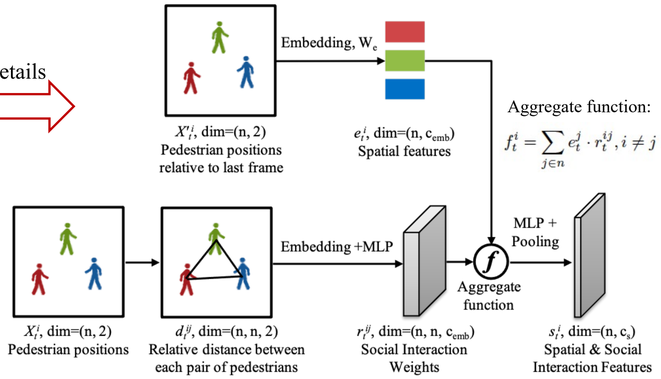
**Social-STGCNN:**
- Use graph representation, need to construct the graph
- Need to compute non-linear weights:

$$a_t^{ij} = \frac{1}{\sqrt{(x_i^i - x_t^j)^2 + (y_t^i - y_t^j)^2}}$$

V.S.

**Our proposed module:**
- Do not need to construct the graph
- Learn the weights, do not have non-linear calculation.

Details




## DATASET – WAYMO OPEN DATASET

Using urban scenarios in **Waymo Open Dataset**:
- 450 urban traffic scenarios (374 training, 76 test)
- Each spans 20 seconds, in real-world traffic

In this work, we **RE-TRAINED** all the compared models.

## EXPERIMENT AND RESULTS

- **Settings:**

Input: 3.2 sec pedestrian trajectories in the past.
Output: 4.8 sec trajectories in the future.

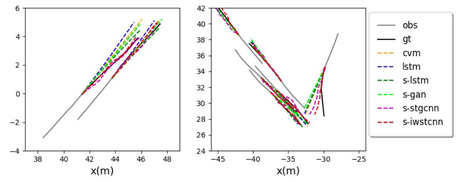
- **Quantitative evaluation** shows the error is smaller (better).

- **Inference speed** is much faster.

INFERENCE TIME COMPARISON (SPEED UP).

| Time | Pre-processing | Inference | Total |
|---|---|---|---|
| Social-STGCNN | 12.61 | 3.20 | 15.81 |
| Social-IWSTCNN (with graph construction) | 2.90 (x4.3) | 2.93 | 5.83 (x2.7) |
| Social-IWSTCNN | 0.23 (**x54.8**) | 3.15 | 3.38 (**x4.7**) |

- **Qualitative evaluation** shows the algorithm can handle different scenarios.




## FUTURE WORK

- Predict high-level pedestrian behavior, i.e. the crossing intention of pedestrian.
- Consider the interaction between pedestrians and vehicles / Automated Vehicles when predicting the pedestrian behavior.

## SUPERVISION & CONTACT DETAILS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## AFFILIATIONS & ACKNOWLEDGEMENT

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