Pedestrian trajectory prediction

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Abstract

In the machine learning domain, a lot of recent work have been made concerning the human trajectories forecasting. We decide to pick two of them build with the same inputs in order to challenge their results. The first model, which is obviously the most effective according the literature, is a LSTM and the second one is a CNN.

Introduction

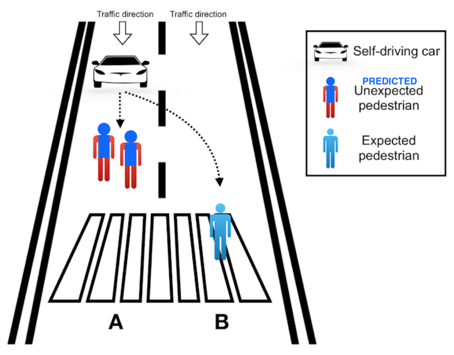

Figure 1: Application

- Trajectory prediction is crucial for improving autonomous vehicles behaviour
- Could avoid situations seen in the ethical lectures

Previous Work

In their project, they used different components to make the structure:

- One LSTM per pedestrian
- Social Pooling
- Prediction per frame

In our project, we use used the following structures independently :

- One CNN, or one LSTM
- Prediction per pedestrian

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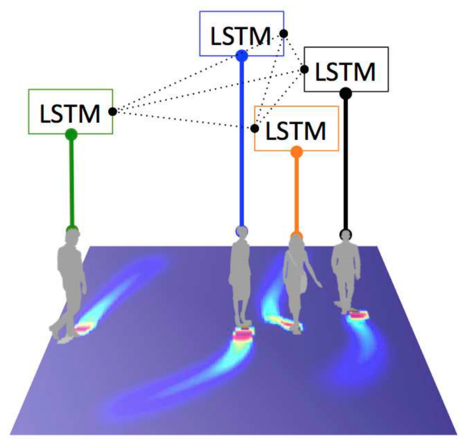

Figure 2: Application

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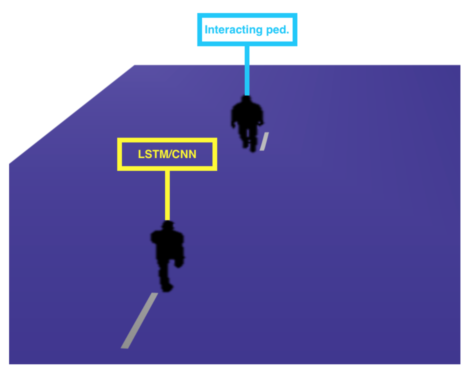

Figure 3: Application

Data

The preprocessing is divided in 5 steps:

1. Isolate each trajectory along with its interaction
2. Normalize the trajectories: the first point is at $(0, 0)$; the second is at $(0, y_1)$
3. Calculate axis velocities V_x and V_y
4. For each frame, if there is an interacting pedestrian we add his/her coordinates and speed otherwise we add zeros
5. Data augmentation: flip and add noise to trajectories

We have a file with:

Frame Number	ID	x	y	V_x	V_y
0	i	0	0	0	0
10	i	0	y_1	0	V_{y_1}
⋮	⋮	⋮	⋮	⋮	⋮

- Pedestrians ID
- Frame number
- Twenty sets of x and y coordinates per pedestrian

Objectives

- Train on the 10 first coordinates and speed and their interaction
- Predict the next 10
- Inputs have the following shape: $[10, N, 4 * N_{inter}]$

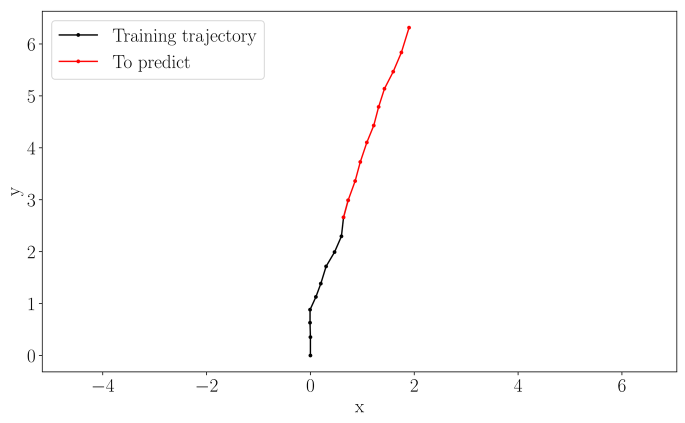

Figure 4

Models

0.1 CNN

Inputs: sequence of coordinates and velocities of the trajectory of interest and of the interacting trajectories
Outputs: sequence of predicted coordinates and velocities for a trajectory of interest

0.2 LSTM

Inputs: sequence of coordinates and velocities of the trajectory of interest and of the interacting trajectories
Outputs: sequence of predicted coordinates and velocities for the trajectory of interest

1 Results

1.1 Introduction

To calculate the correctness of the prediction two indicators are used:

1. The final displacement error: $e_{fin} = \sqrt{(X_{gt,n} - X_{pred,n})^2}$
2. The mean displacement error: $e_{mean} = \sqrt{\frac{\sum_{i=0}^{n}(X_{gt,i} - X_{pred,i})^2}{(n)}}$

Depending on the inputs two ways are possible to find the predicted coordinates:

1. If the coordinates are predicted: directly use them
2. If the velocities are predicted: $X_t = X_{t-1} + V_t \cdot 0.4$, with 0.4 the time between two frames in seconds

Four different cases, that corresponds to four losses, are tested for each model:

1. Predict coordinates with loss defines as $L_1 = (X - X_{pred})^2$ with $X = [x, y]$
2. Predict speeds with loss defines as $L_2 = (V - V_{pred})^2$ with $V = [V_x, V_y]$
3. Predict both coordinates and speeds with loss defines as $L = L_1 + L_2$
4. Predict both coordinates and speeds with loss defines as $L = L_1 + L_2 + L_3$, with $L_3 = (X - X_{t-1} + V_t * 0.4)^2$

Test set separate in three trajectory types:

1. Static
2. Linear trajectories
3. Non-linear trajectories

Forthcoming Research

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Acknowledgements

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