Pedestrian trajectory prediction

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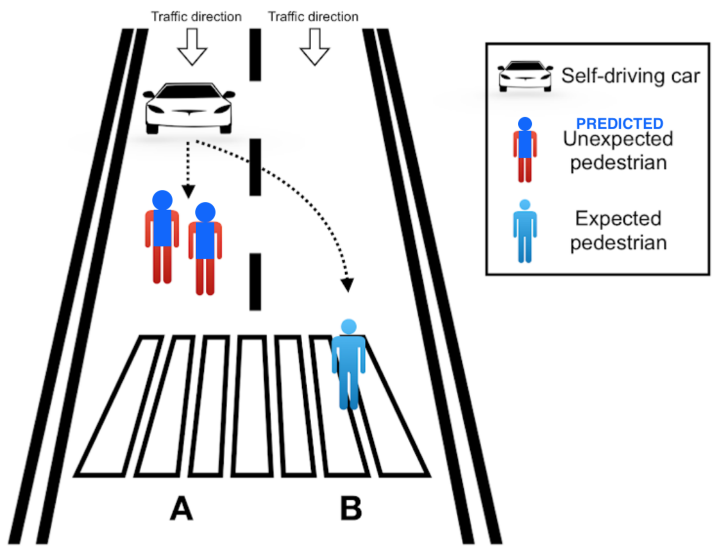
Introduction



- 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

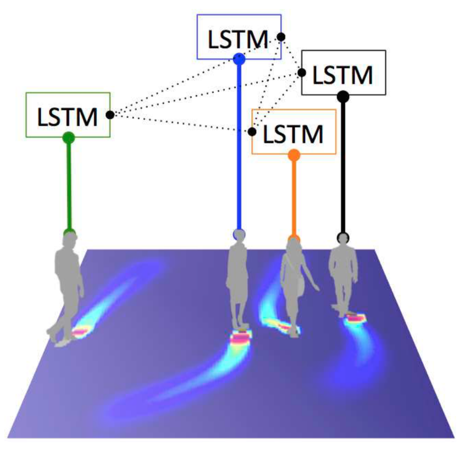


Figure 1: Application

Idea for our Models

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

- One CNN, or one LSTM
- Prediction per pedestrian

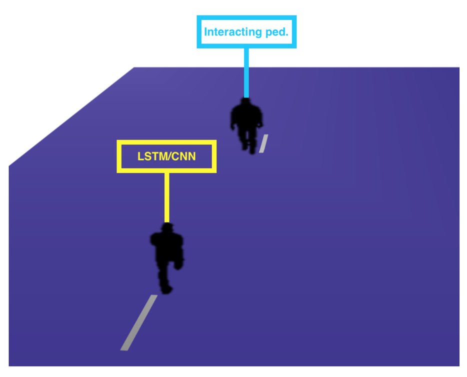


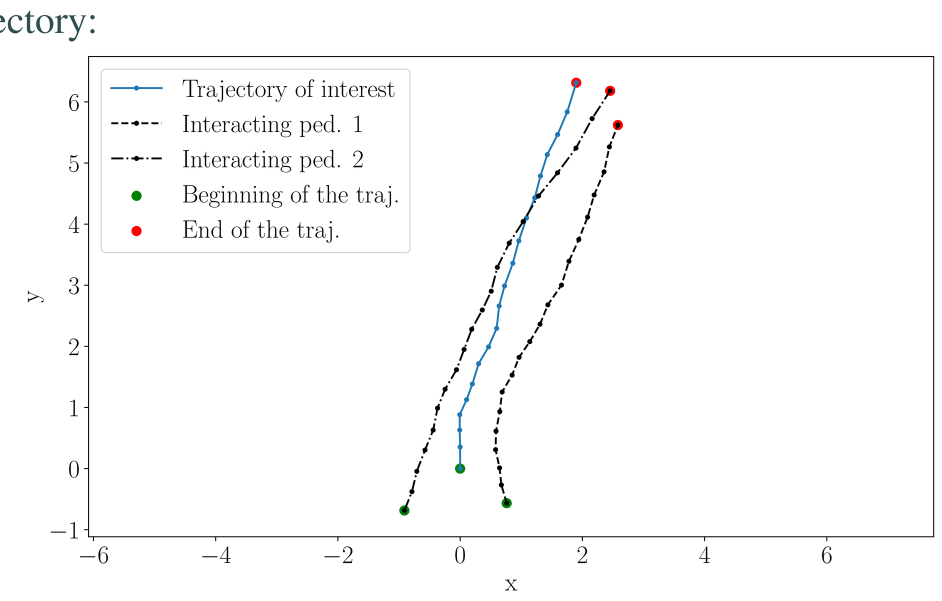
Figure 2: Application

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

Representation of a trajectory:



Final shape of the data:

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

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

Objectives

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

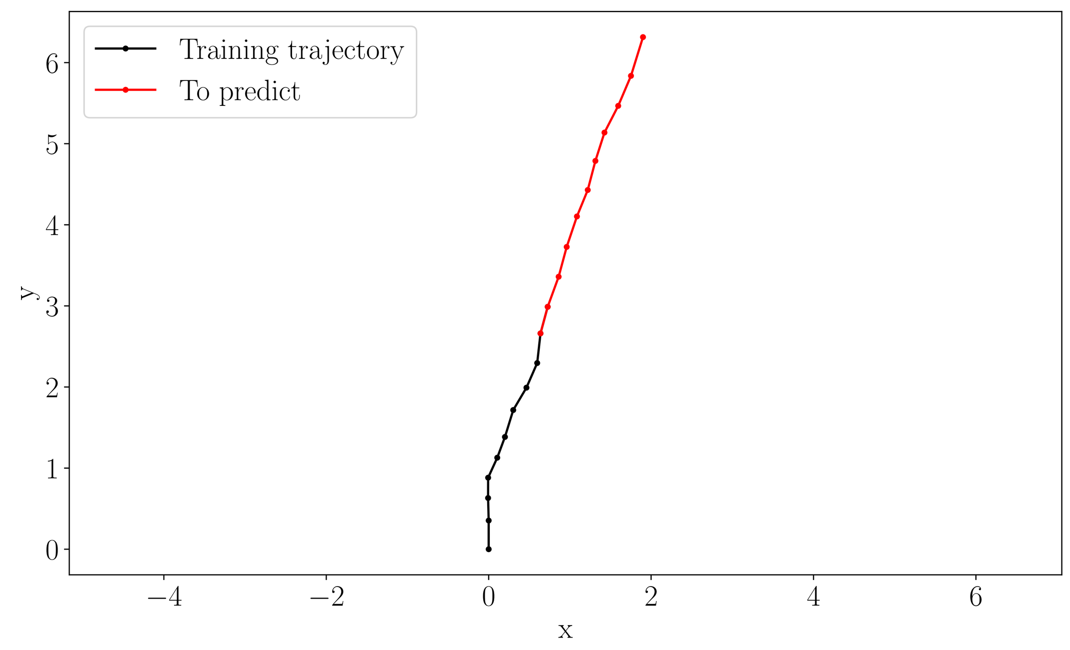
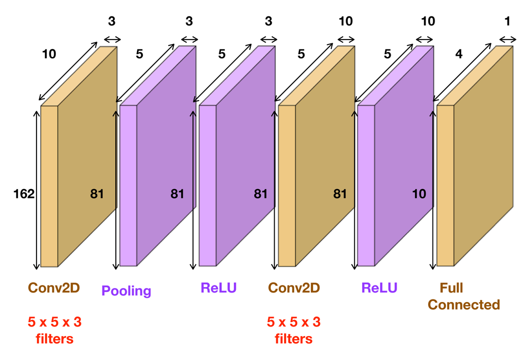


Figure 3

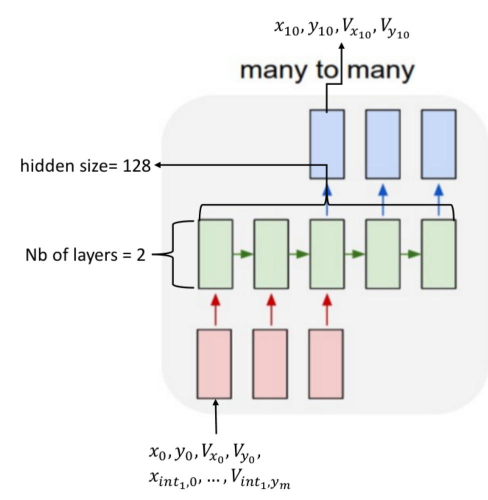
Models

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.

CNN



LSTM



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

1.2 Table

Results with linear prediction:

- Type 1: *Mean* = 0.141, *Final* = 0.322
- Type 2: *Mean* = 0.541, *Final* = 0.93
- Type 3: *Mean* = 0.651, *Final* = 1.457
- Total: *Mean* = 0.512, *Final* = 0.982

		CNN				LSTM			
		Type 1	**Type 2**	**Type 3**	**Total**	**Type 1**	**Type 2**	**Type 3**	**Total**
Coord.	**Mean**	4.696	5.144	4.674	4.176	1.309	0.777	0.862	0.877
	Final	10.246	7.009	10.501	5.602	1.385	0.92	1.108	1.037
Speed	**Mean**	0.567	5.133	1.911	4.17	0.726	0.573	0.651	0.616
	Final	0.77	6.971	3.882	5.587	1.412	1.045	1.231	1.148
2 Losses	**Mean**	1.269	5.134	1.762	**4.163**	0.695	0.532	0.627	**0.581**
	Final	2.727	6.978	3.546	**5.57**	1.302	0.963	1.2	**1.076**
3 Losses	**Mean**	0.549	5.135	3.829	4.163	0.748	0.607	0.681	0.647
	Final	0.758	6.983	4.962	5.573	1.364	1.072	1.308	1.177

Forthcoming Research

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