Making Crosswalks Smarter: Using Sensors and Learning Algorithms to Safeguard Heterogenous Road Users

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Semi-Controlled Crosswalks

Pedestrian Tracking

STATE LAW YIELD TO WITHIN CROSSWALK
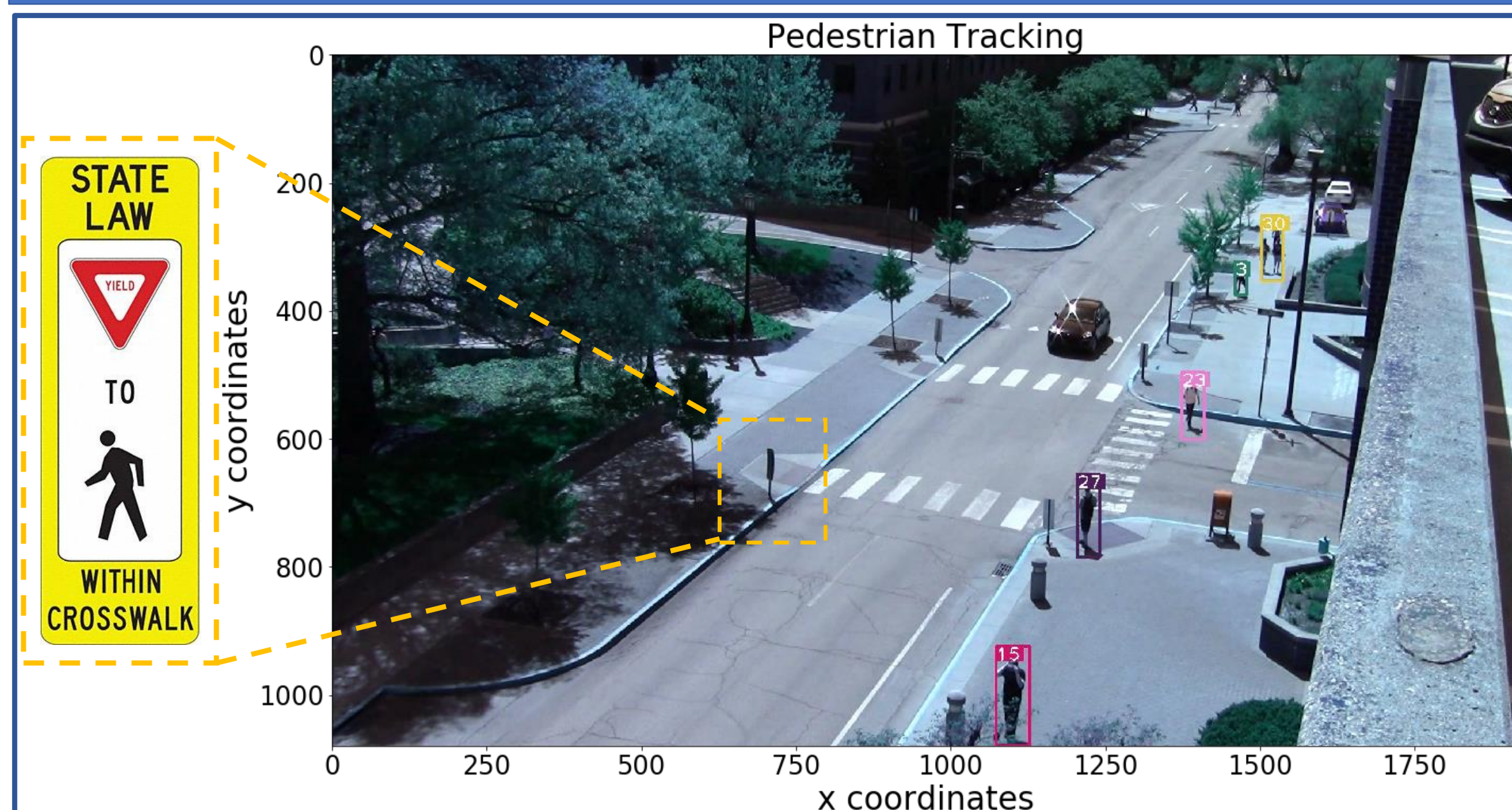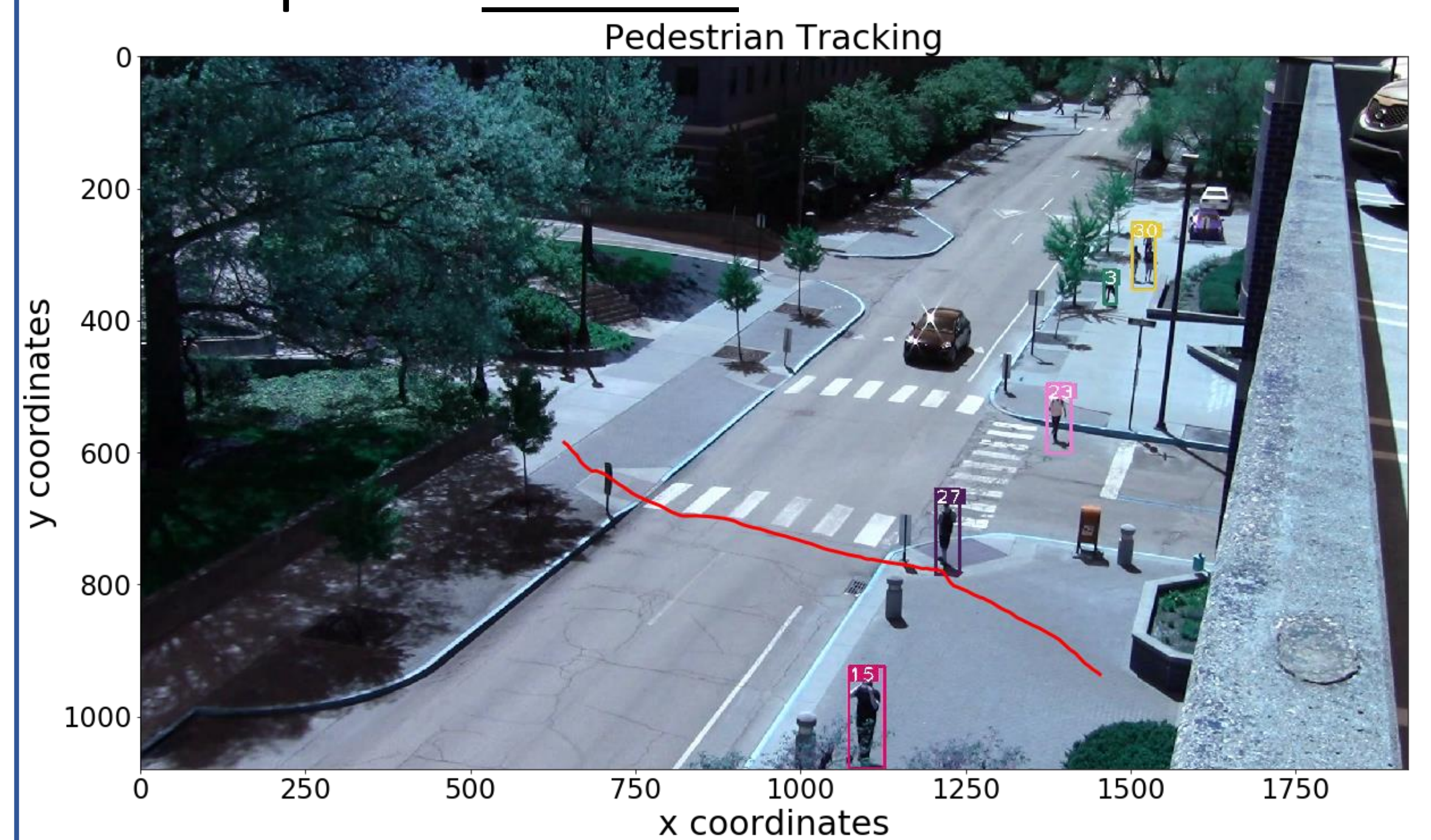
Ambiguity: "Yield to Pedestrian <u>within</u> crosswalks".

Research Question: How do heterogeneous road users interpret the sign message?

Objective: <u>Observe</u> and <u>analyze</u> how people interpret the sign message.
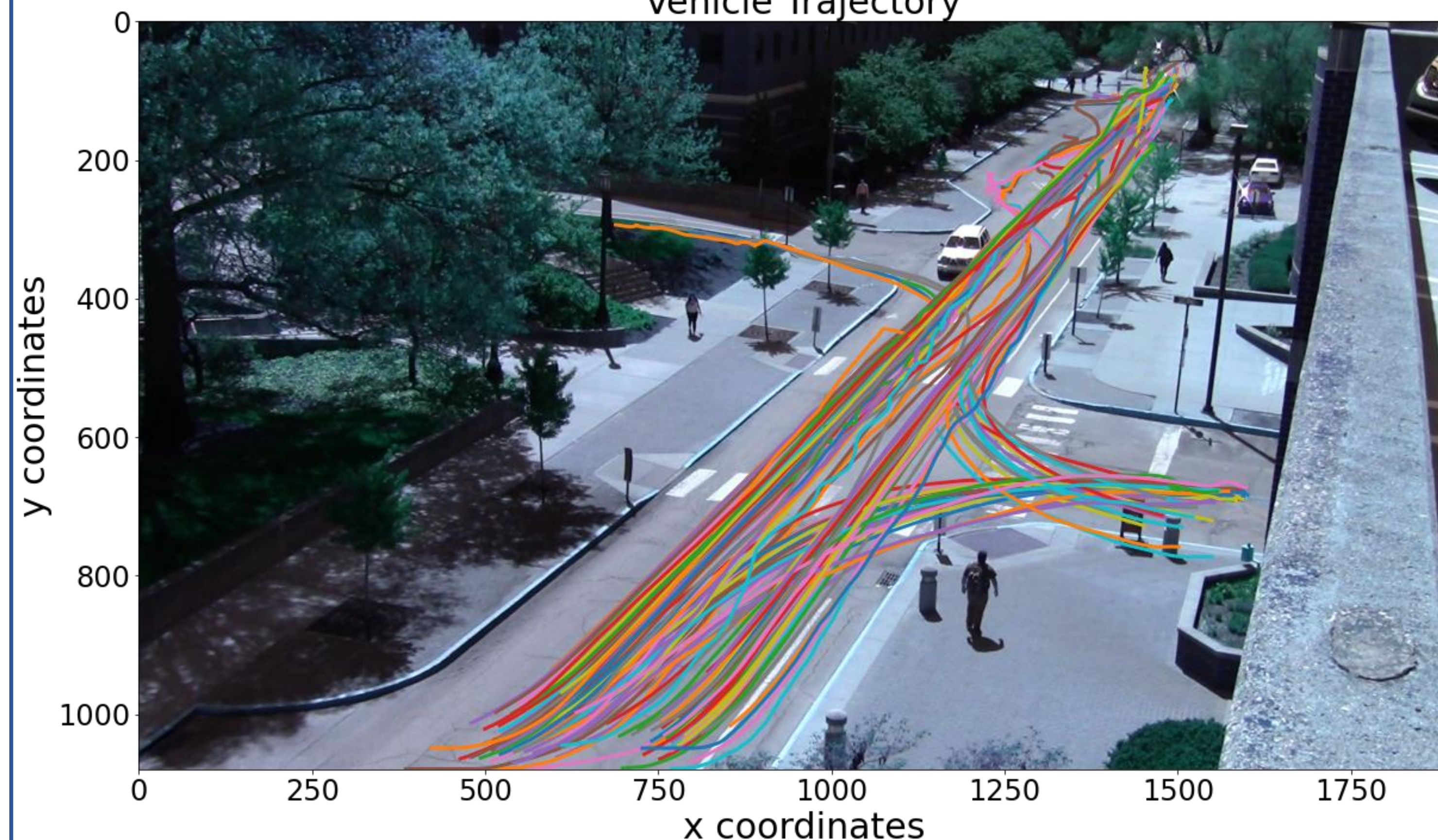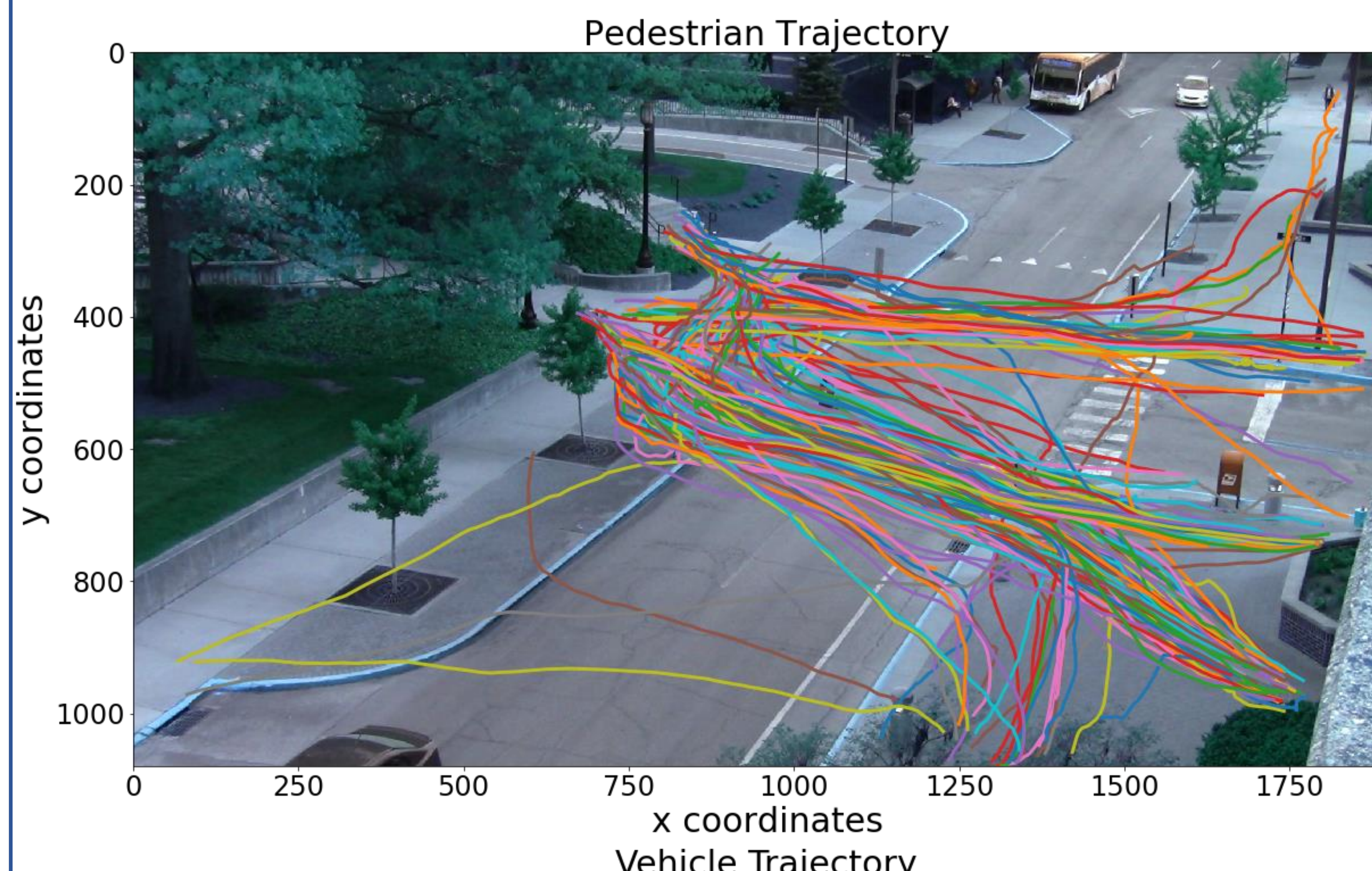
Observing & Tracking

Key: Analyzing behaviors of heterogeneous road users requires "<u>numbers</u>".

Pedestrian Tracking

A Large Scale Spatial Temporal Trajectory Dataset

o   Over <u>1 million</u> instances are included.
o   Records include more than 800 pedestrians/cyclists interacting with more than 500 motorists.
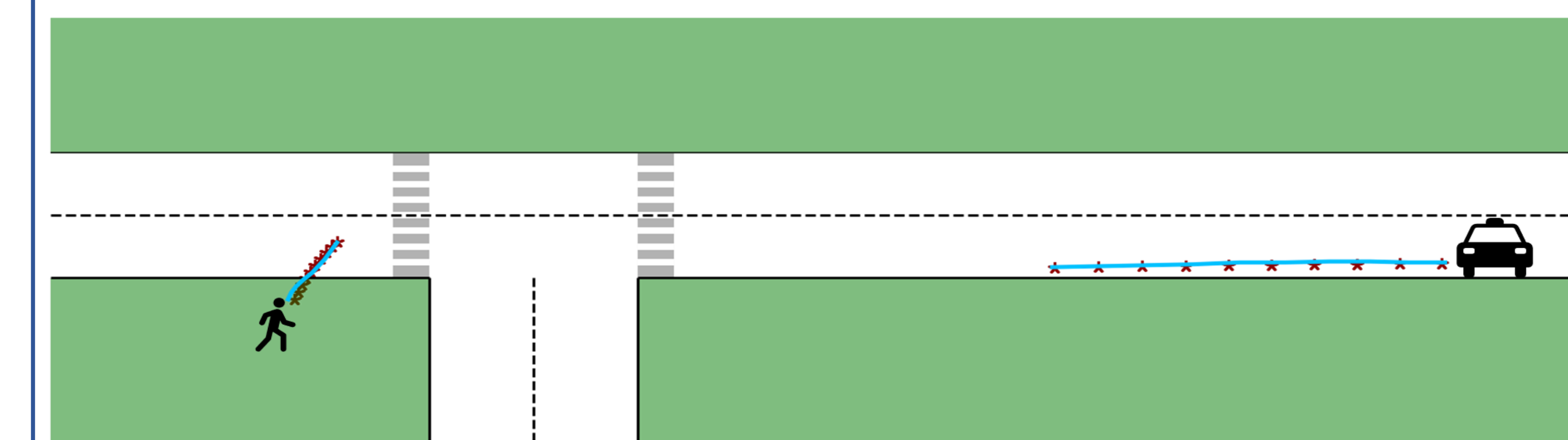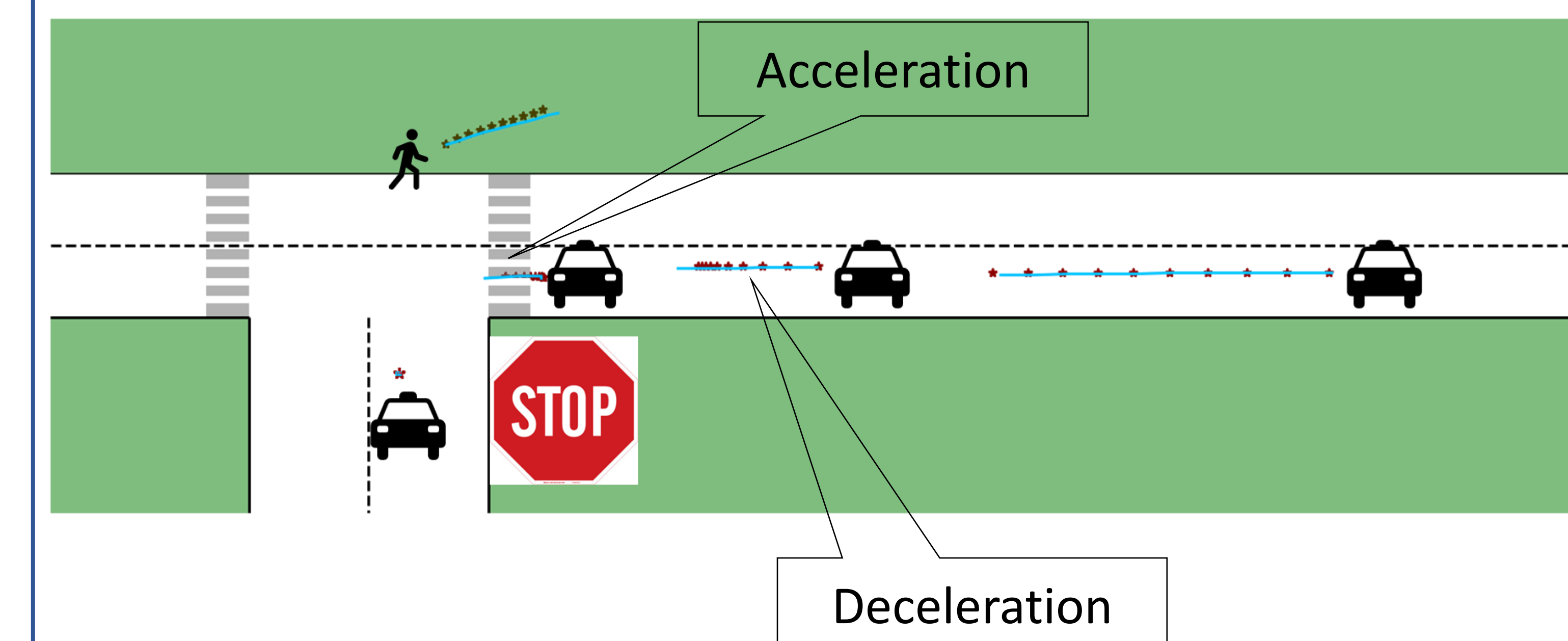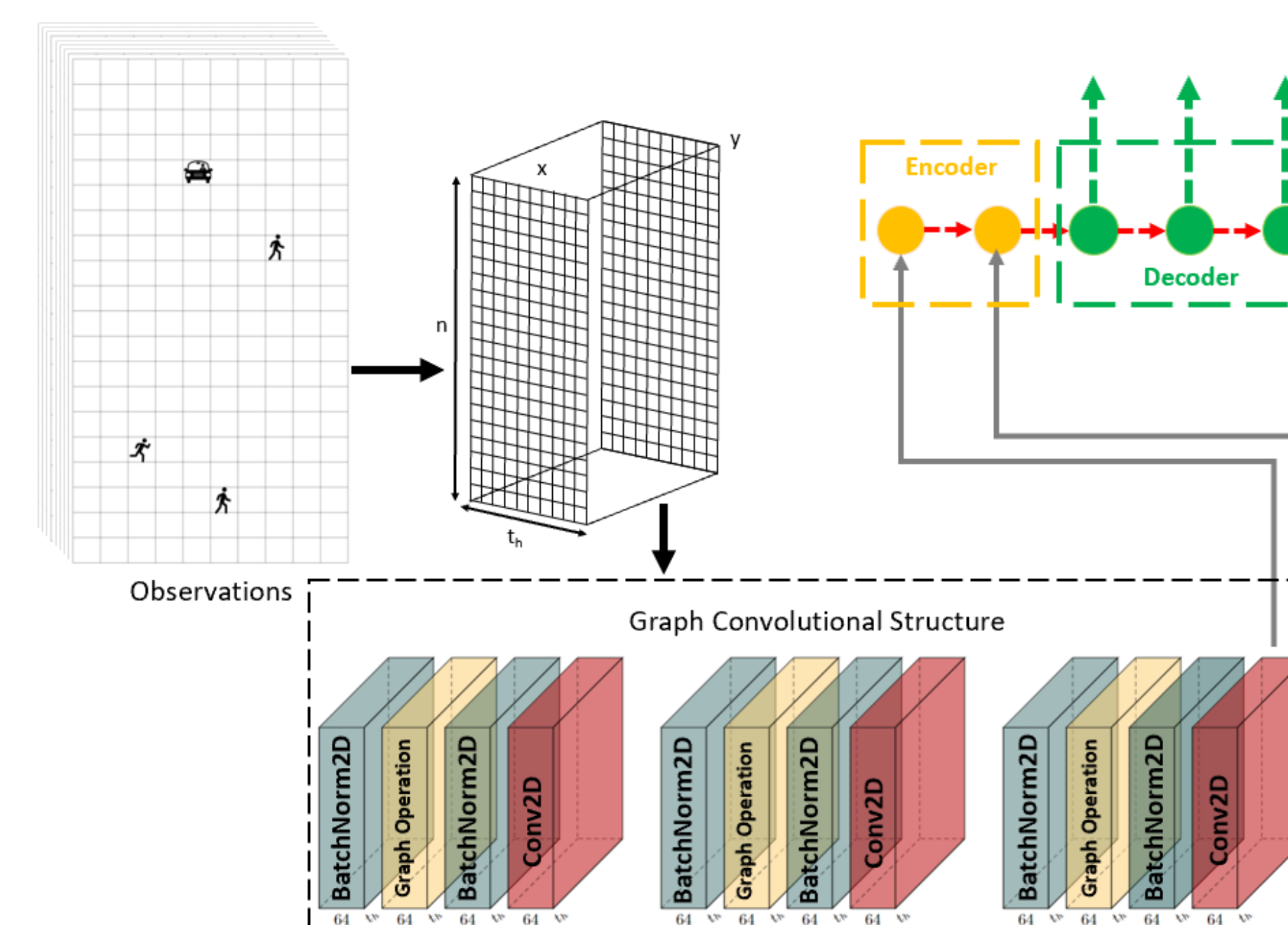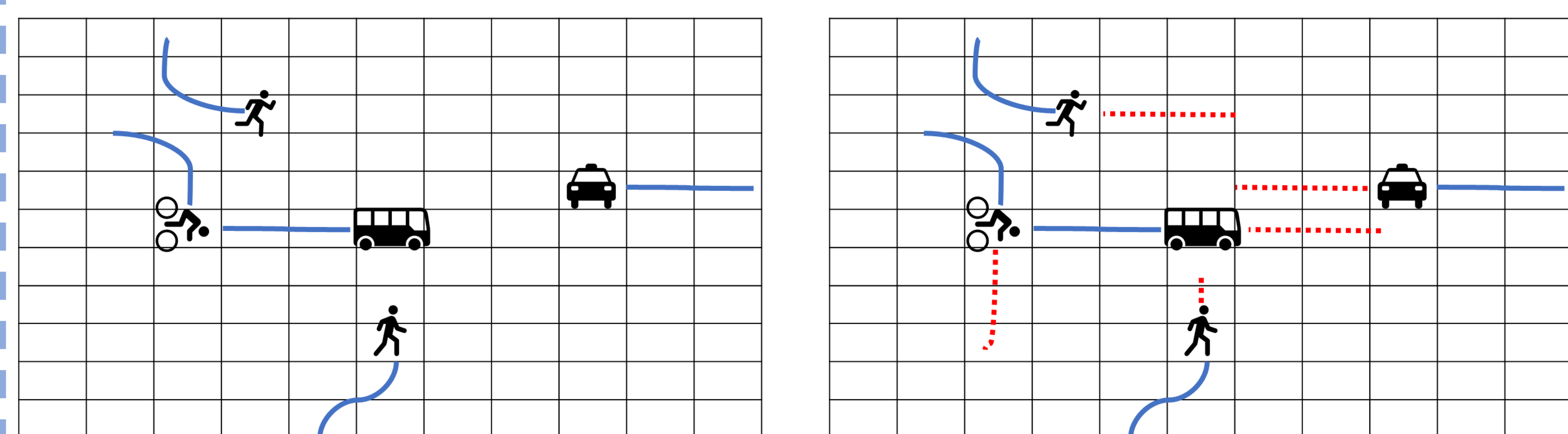

Pedestrian Trajectory

Vehicle Trajectory

Motion Predictions (ST-GCN-Seq2Seq)

Big Idea: Predict future trajectories of heterogeneous road users based on their observed trajectories and interactions.

Model Comparisons

Evaluation Metric	Prediction Horizon (s)	Social Force	Seq2Seq	Social-LSTM	ConvSP-LSTM	ST-GCN-Seq2Seq
RMSE (m)	0.5	0.406	0.672	0.256	0.267	**0.196**
	1	0.661	1.082	0.322	0.343	**0.234**
	1.5	0.783	1.287	0.359	0.385	**0.272**
	2	1.022	1.704	0.447	0.481	**0.341**
	2.5	1.140	1.916	0.498	0.538	**0.377**
	3	1.371	2.348	0.638	0.706	**0.452**

Experiments

Scenario 1 (Pedestrian-Motorist Interaction):

Scenario 2 (Hybrid Interactions):

Acceleration
STOP
Deceleration

Conclusions

1. **An open-sourced large-scale trajectory dataset.**

2. **Smart interaction at crosswalks:**
   o   Notify a subject road user of motion predictions of surrounding road users in <u>real time</u>.

3. **Design of an intelligent tracking system at crosswalks:**
   o   The appropriate sensor (Miovision) can be deployed to capture the spatial-temporal positions of each road user.
   o   Cellphone applications can be developed for tracking and motion predictions.