Forecasting Human Trajectory from Scene History


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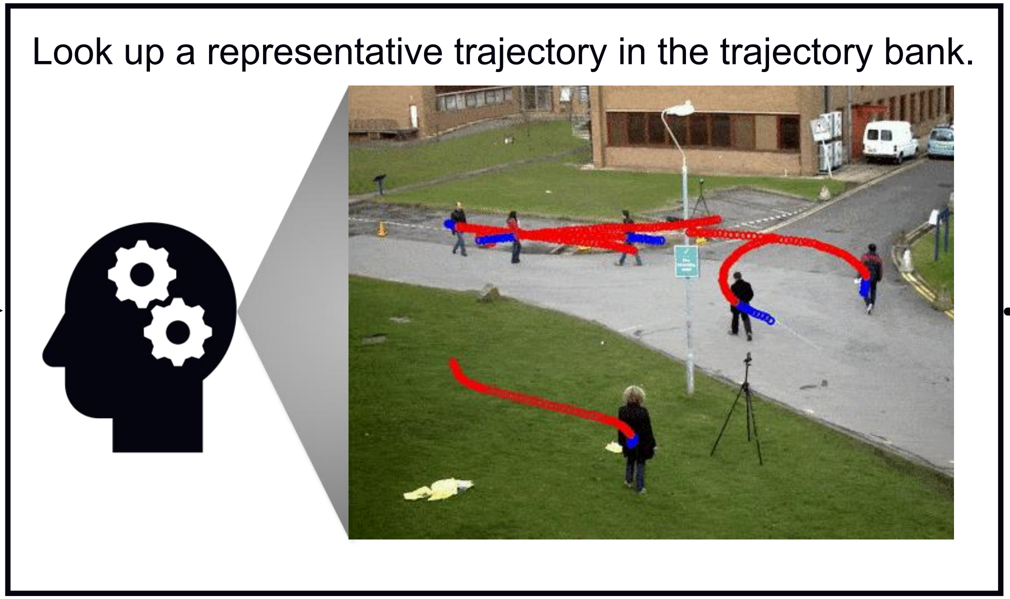
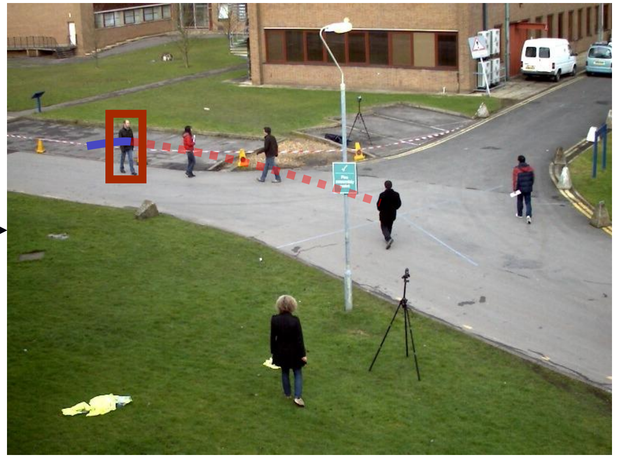
Background

“History Doesn't Repeat Itself, but It Often Rhymes”
– Mark Twain.





Human trajectory prediction (HTP)

Introduction

- Predicting a target person’s future path from a video clip.
- Applied in many intelligent systems, including autonomous vehicles, care robots, and surveillance systems.

Challenge & Motivation

- Randomness and subjectivity of human movement (e.g., abrupt and sharp turns))
- The moving patterns of human in a constrained scenario typically conform to a limited number of regularities.

Introduction

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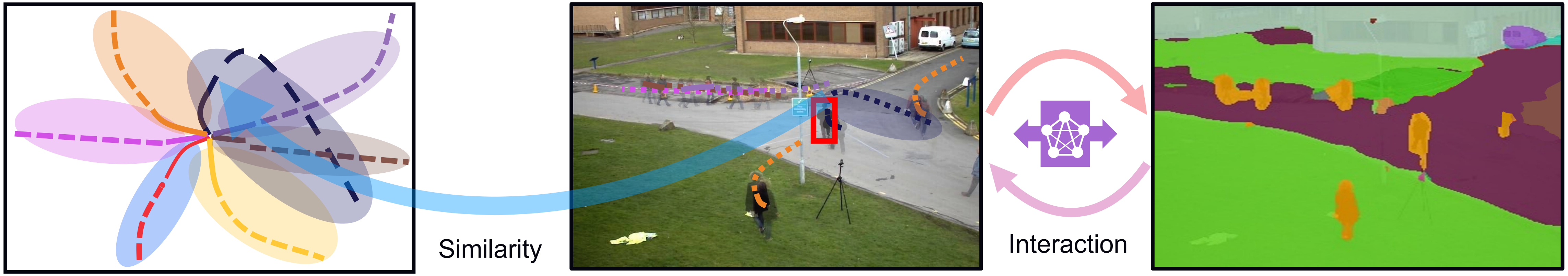

Historical group trajectories

Observation

Surroundings

Main ideas

01.

Since a person's subsequent trajectory has likely been traveled by others, we design a group trajectory bank module to extract representative group trajectories as the candidate for future path.

02.

The moving patterns of human are constrained by the current scenario, thus we propose a cross-modal interaction module to model the interaction between individual past trajectory and its surroundings.

03.

To alleviate the uncertainty from randomness and subjectivity, we introduce curve smoothing (CS) into current evaluation metrics. Finally, We validate the efficacy of our framework on common benchmarks.

Method

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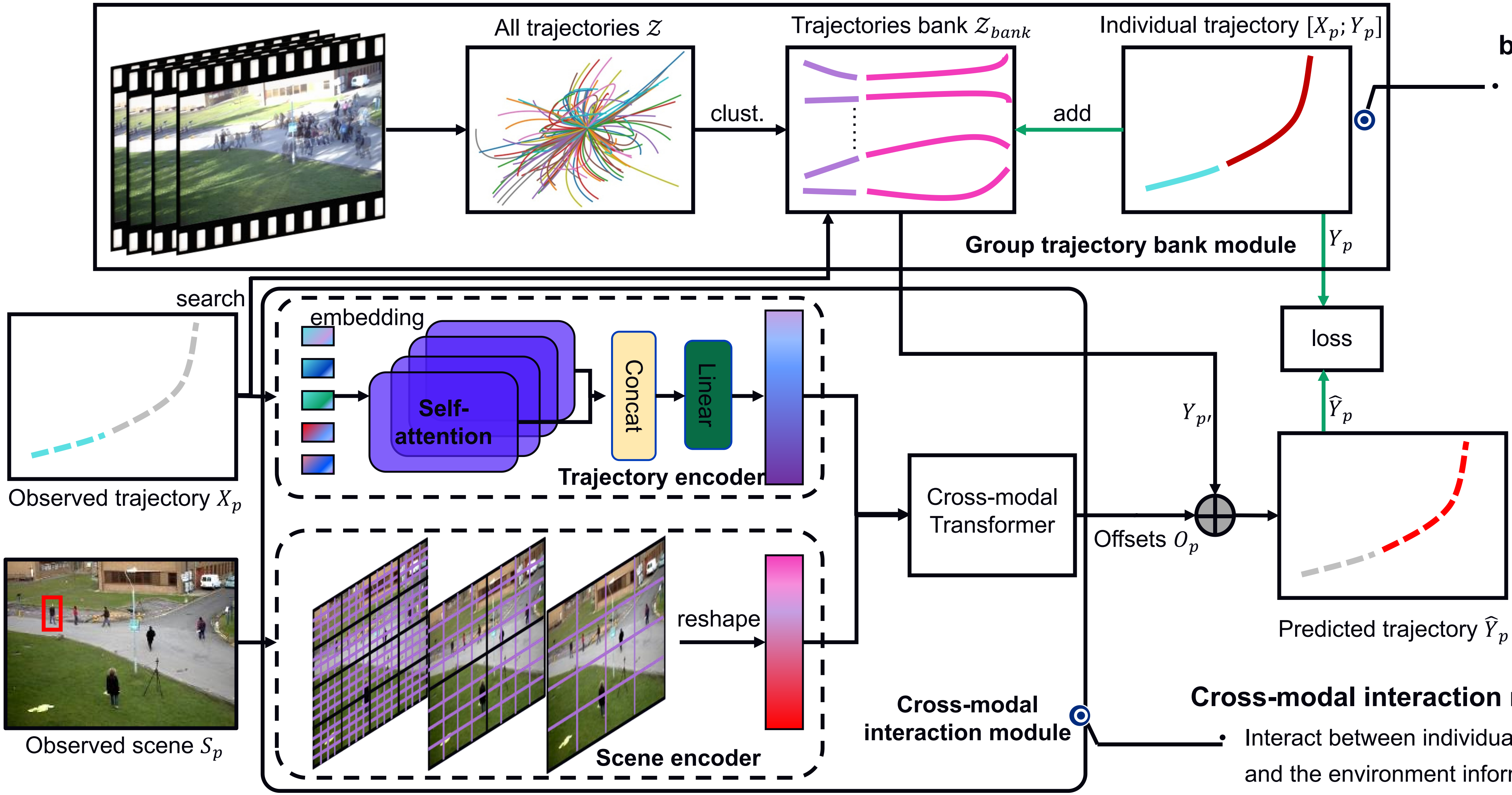


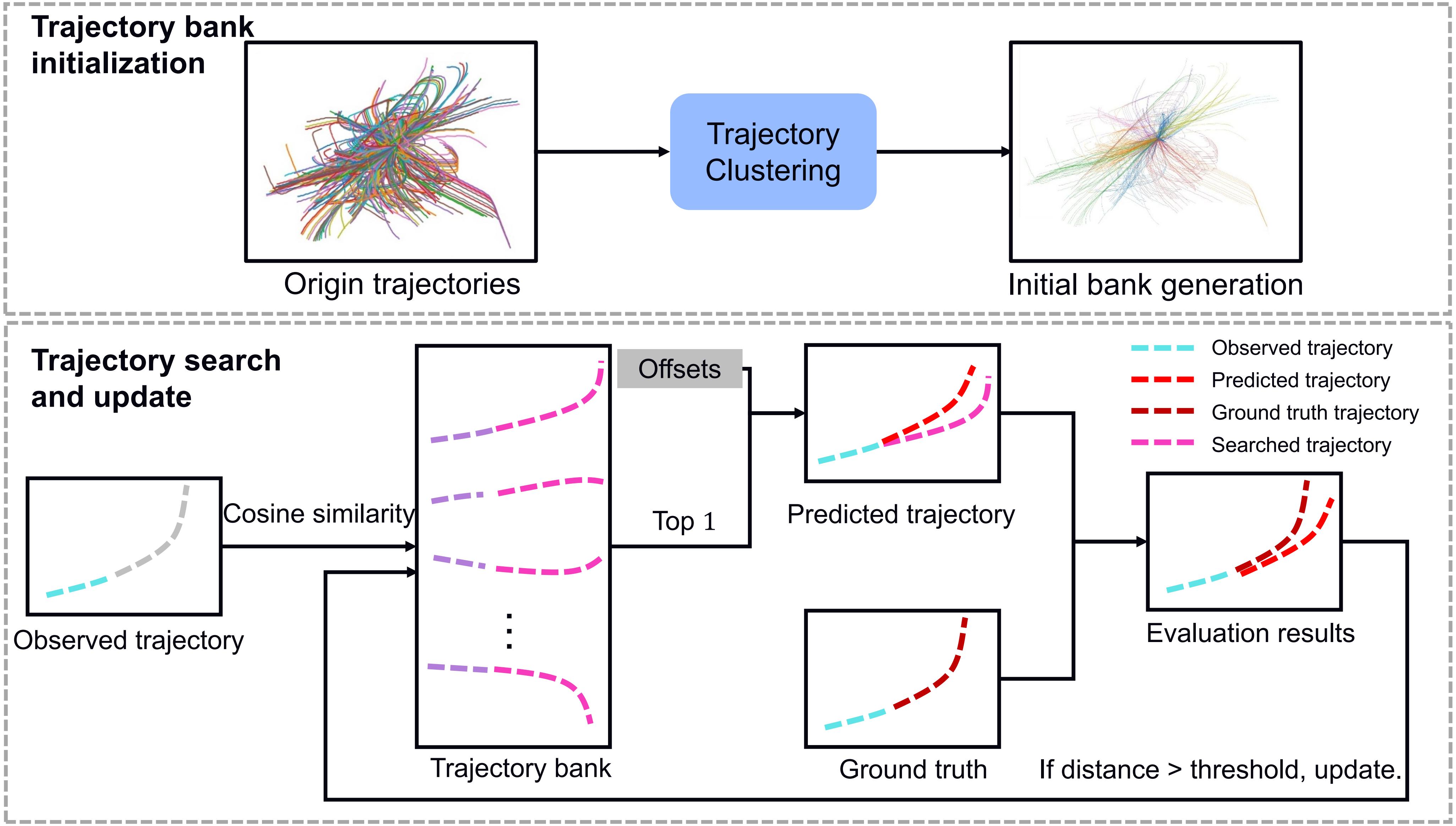
Group trajectory bank module (GTB)

- Construct the representative group trajectories in the scene, including bank initialization, trajectory search, and trajectory update.

Cross-modal interaction module (CMI)

- Interact between individual past trajectory and the environment information

Method



Trajectory bank initialization
Origin trajectories
Trajectory Clustering
Initial bank generation
Trajectory search and update
Observed trajectory
Cosine similarity
Trajectory bank
Offsets
Top 1
Predicted trajectory
Ground truth
Evaluation results
If distance > threshold, update.
Observed trajectory
Predicted trajectory
Ground truth trajectory
Searched trajectory

Method

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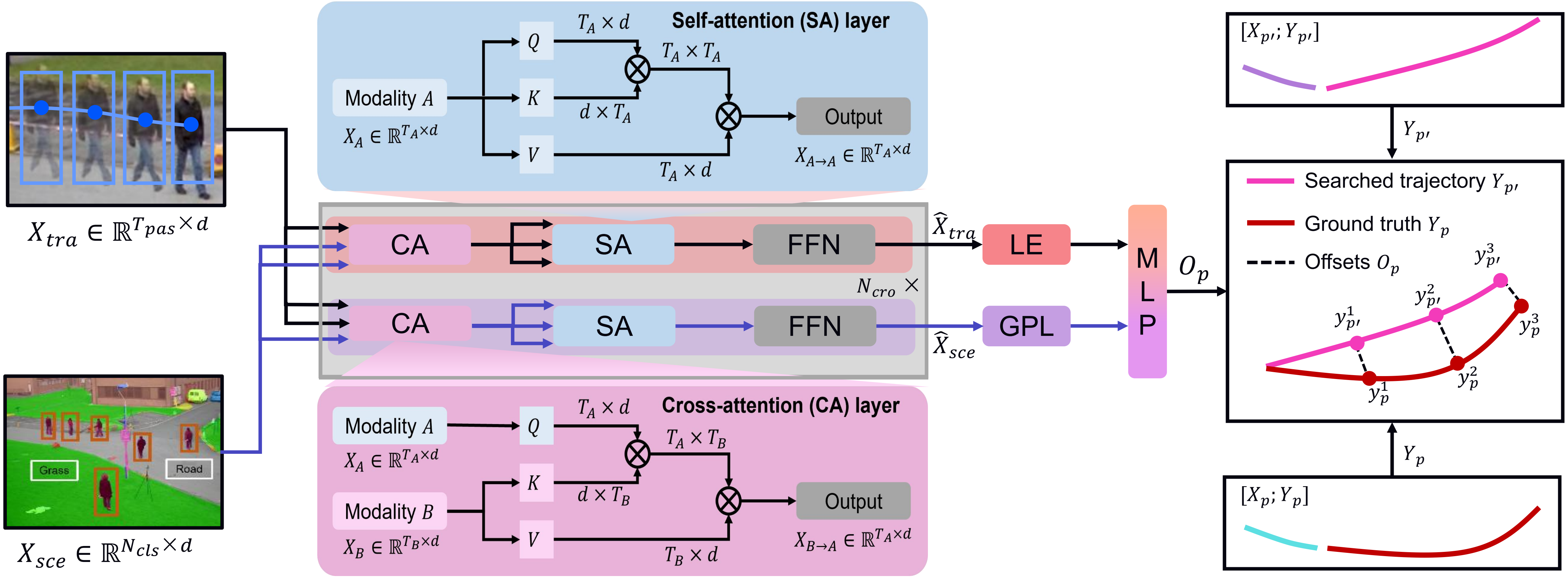
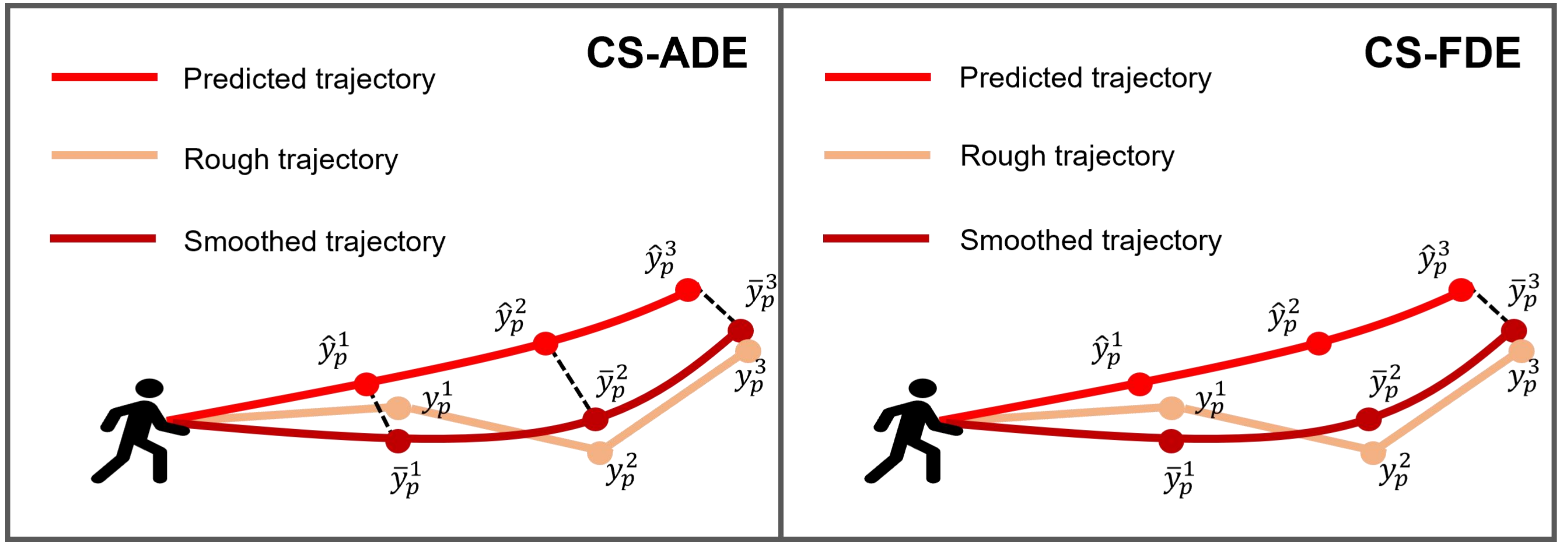


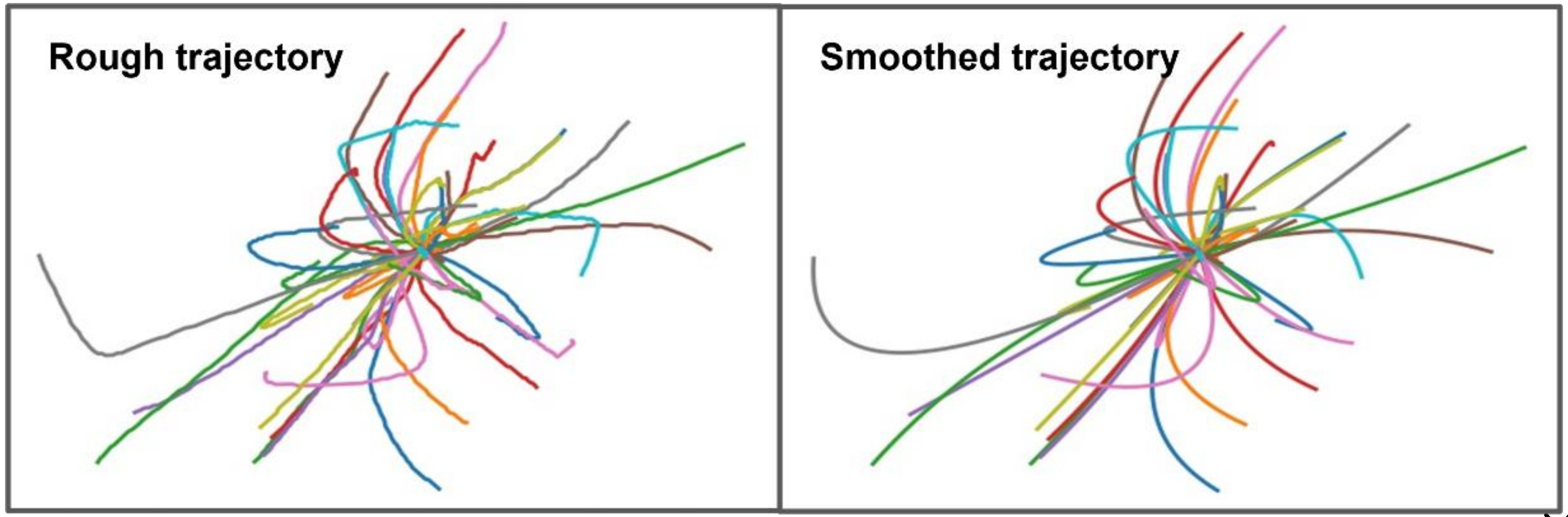
An illustration of cross-modal transformer. The trajectory features and scene features are fed into the cross-modal transformer to learn the offsets between the searched trajectory and the ground-truth trajectory.

Method

The illustration of our proposed metrics, CS-ADE and CS-FDE.



Visualization of some samples after curve smoothing.



Results

Comparison of SOTA methods on PAV dataset.

Method	Evaluation metrics: CS-ADE↓ / CS-FDE↓ (in pixels)			
	PETS	ADL	VENICE	AVG
SS-LSTM (WACV'18)	39.42 / 107.24	16.52 / 50.40	10.37 / 23.63	22.10 / 60.42
Social-STGCN (CVPR'20)	43.40 / 117.85	24.34 / 57.22	14.42 / 38.66	27.39 / 71.24
Next (CVPR'19)	37.54 / 98.56	16.82 / 46.39	8.37 / 19.32	20.91 / 54.76
MANTRA (CVPR'20)	39.05 / 106.89	17.26 / 50.64	12.50 / 29.08	22.94 / 62.20
Ynet (ICCV'21)	36.46 / 93.53	15.07 / 41.64	**7.10 / 16.11**	19.54 / 50.43
SHENet (Ours)	**34.49 / 78.40**	**14.42 / 38.67**	7.76 / 18.31	**18.89 / 45.13**

Comparison of SOTA methods on ETH/UCY datasets.

Method	Evaluation metrics: ADE↓ / FDE↓ (in meters)					
	ETH	HOTEL	UNIV	ZARA1	ZARA2	AVG
SS-LSTM (WACV'18)	1.01 / 1.94	0.60 / 1.34	0.71 / 1.52	0.41 / 0.89	0.31 / 0.68	0.61 / 1.27
Social-STGCN (CVPR'20)	0.75 / 1.38	0.61 / 1.40	0.58 / 1.03	0.42 / 0.70	0.43 / 0.71	0.56 / 1.05
MANTRA (CVPR'20)	0.70 / 1.76	0.28 / 0.68	0.51 / 1.26	0.25 / 0.67	0.20 / 0.54	0.39 / 0.98
AgentFormer (ICCV'21)	0.52 / 0.84	0.15 / 0.22	0.34 / 0.72	**0.18** / 0.33	0.16 / 0.30	0.27 / 0.48
Ynet (ICCV'21)	0.47 / 0.72	**0.12 / 0.18**	0.27 / 0.47	0.20 / 0.34	**0.15 / 0.24**	0.24 / 0.39
SHENet (Ours)	**0.41 / 0.61**	0.13 / 0.20	**0.25 / 0.43**	0.21 / **0.32**	**0.15** / 0.26	**0.23 / 0.36**

Results

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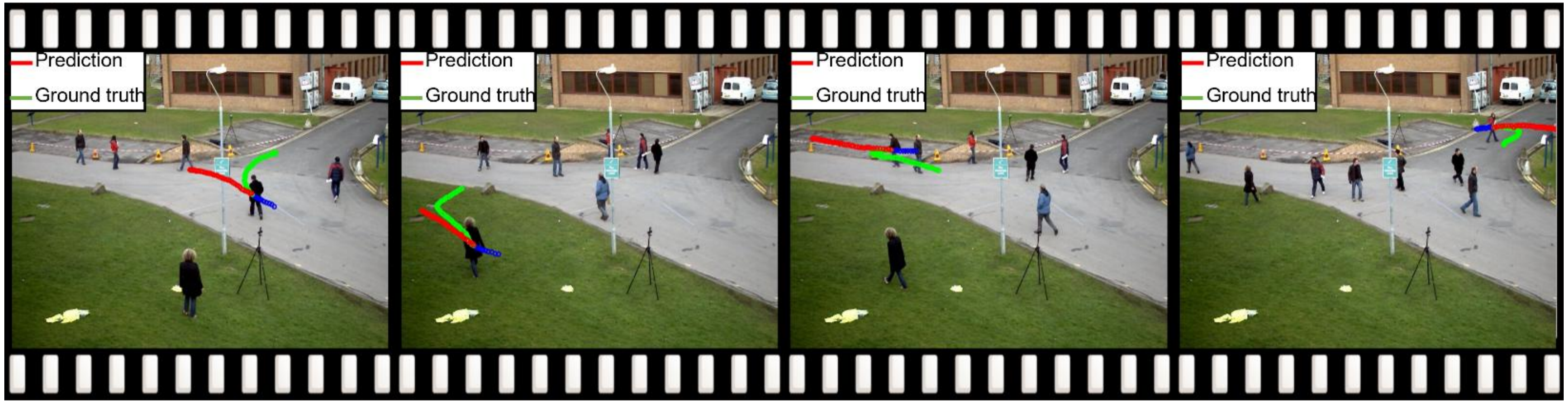
Qualitative visualization of our method and SOTA methods.

Results



Results without curve smoothing

Results with curve smoothing

Conclusion

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- A novel method that fully utilizes scene history for human trajectory prediction.

Please check our project page for more details:
https://github.com/MaKaRuiNah/SHENet