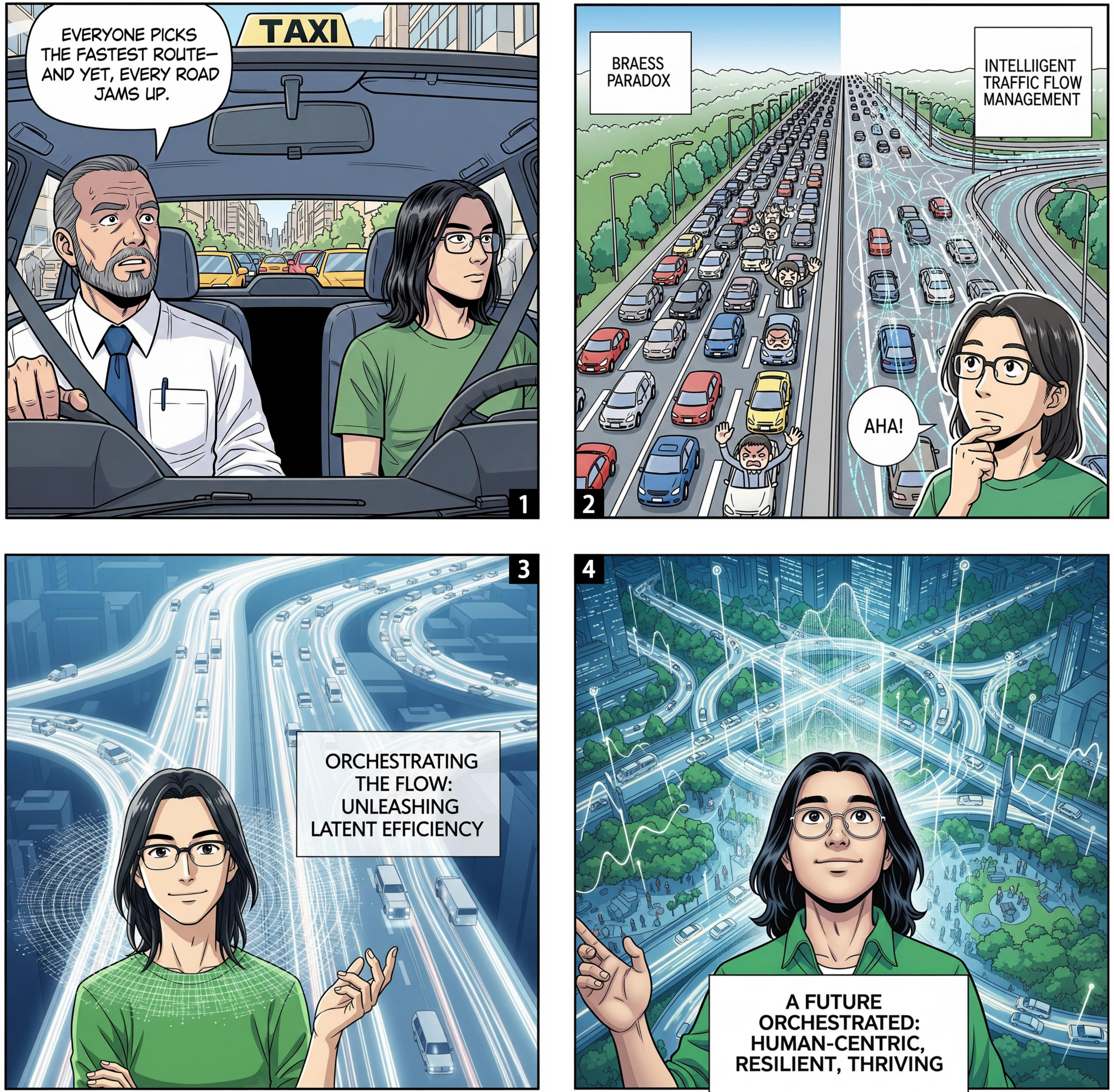
PORTFOLIO in
Intelligent Transportation & Urban Mobility

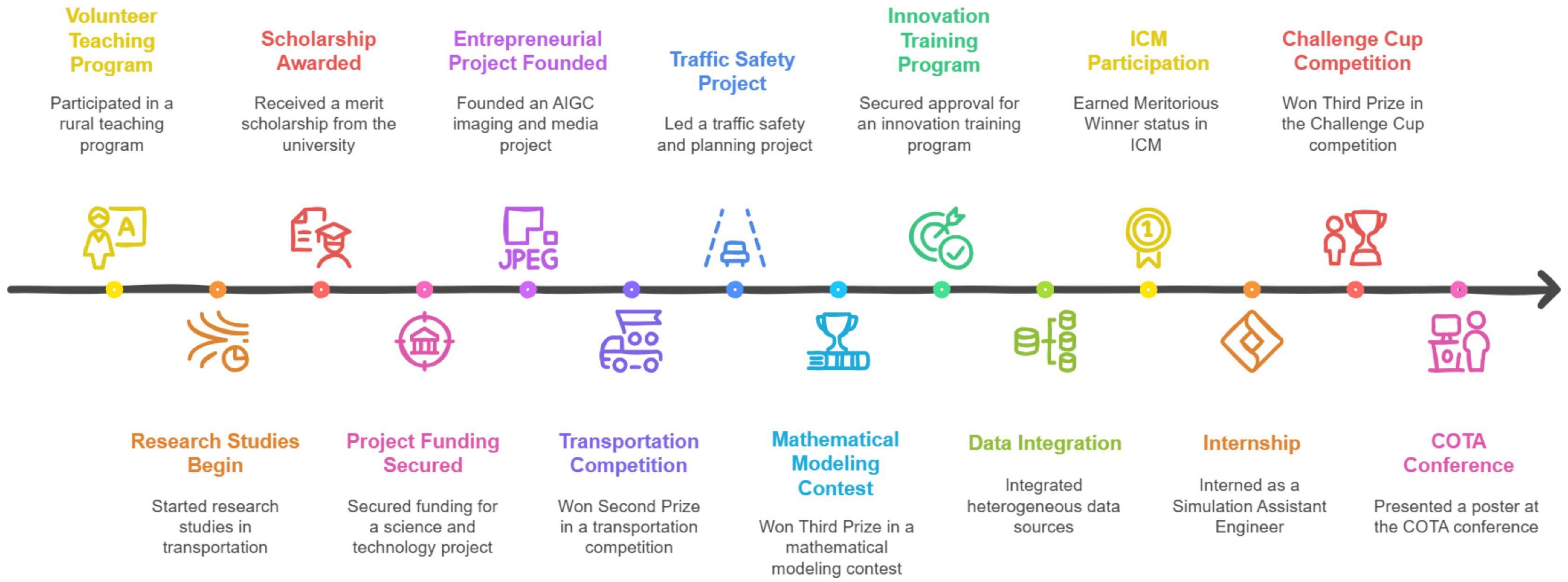
Deng Haopeng



My inquiry into intelligent transportation originates from a profound paradox: the frequent divergence of **rational individual choices** from **collective mobility efficiency**. This fundamental tension, epitomized by *Braess's Paradox*, crystallized my conviction that the solution extends far beyond mere infrastructural expansion. Instead, it lies in actively **'orchestrating the flow'**—leveraging **intelligent, data-driven** mechanisms to foster seamless coordination. This conceptual pivot is the primary driving force behind my research, dedicated to engineering truly **efficient, resilient, and human-centric** transportation systems for tomorrow's cities.

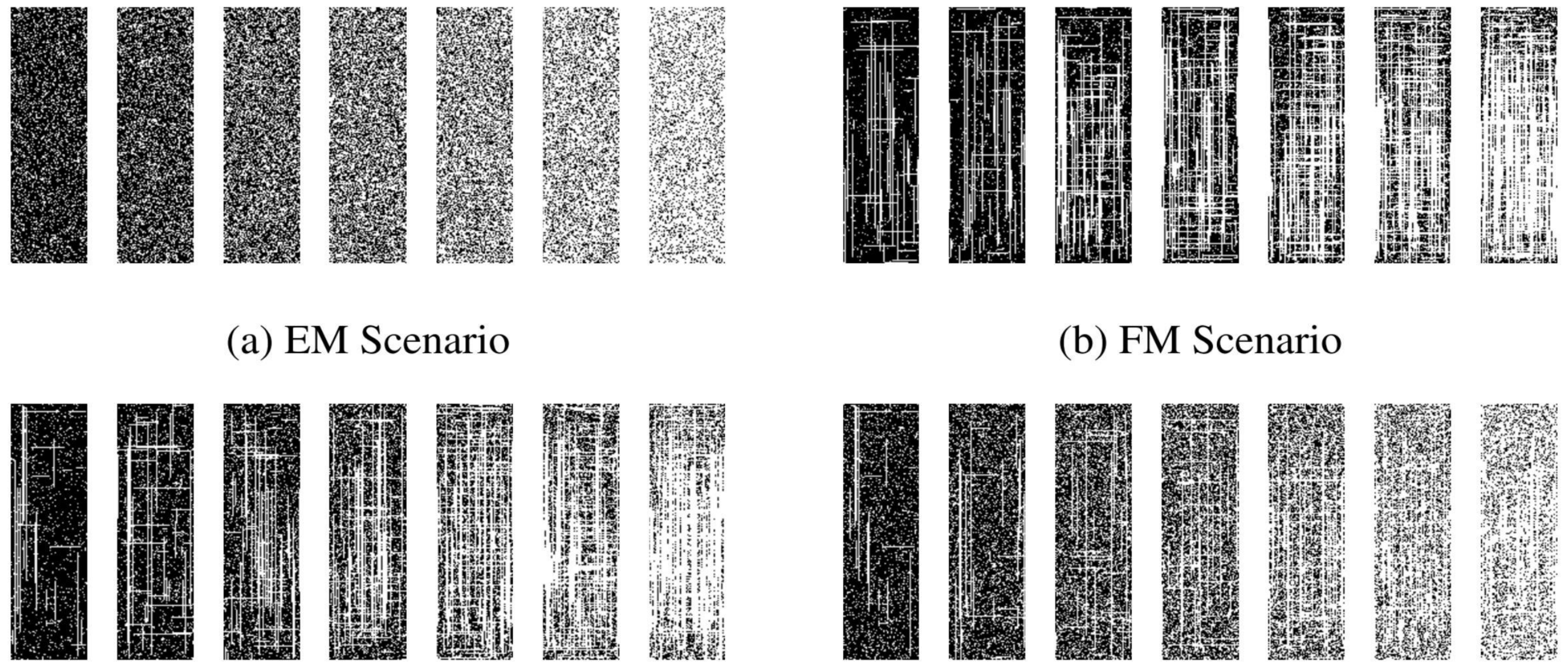
My Research Interests and Core Skills

Academic and Professional Timeline



LRTC-ATSN: Adaptive Truncated Schatten Norm for Traffic Data Imputation with Complex Missing Patterns

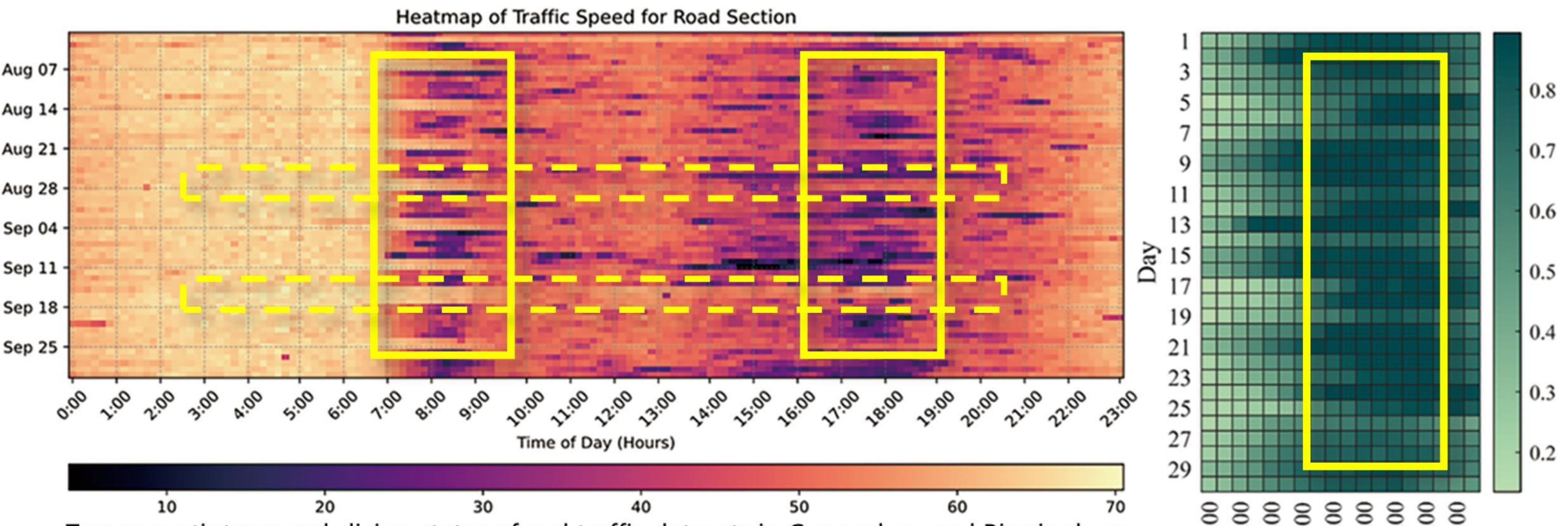
Ⅰ. Identifying the Problem and Constructing Simulation Scenarios.



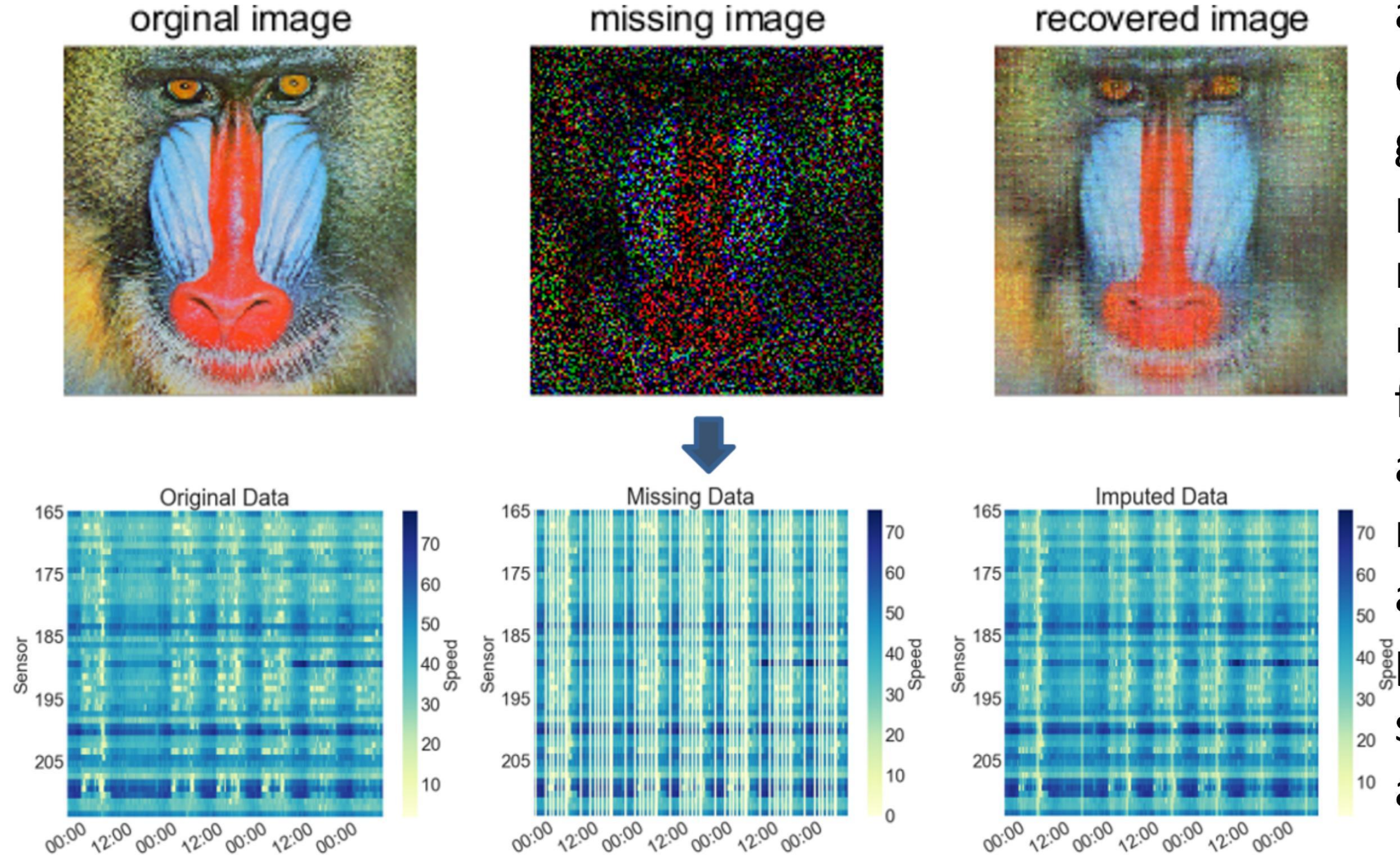
(a) EM Scenario (b) FM Scenario

(c) MM (0.2EM, 0.8FM) Scenario (d) MM (0.4EM, 0.6FM) Scenario

Facing complex missing patterns in urban traffic data caused by sensor failures and environmental factors, I formulated three real-world data loss structures—element-wise (EM), fiber-wise (FM), and mixed (MM)—within traffic flow tensors, establishing a rigorous testbed for developing recovery algorithms.

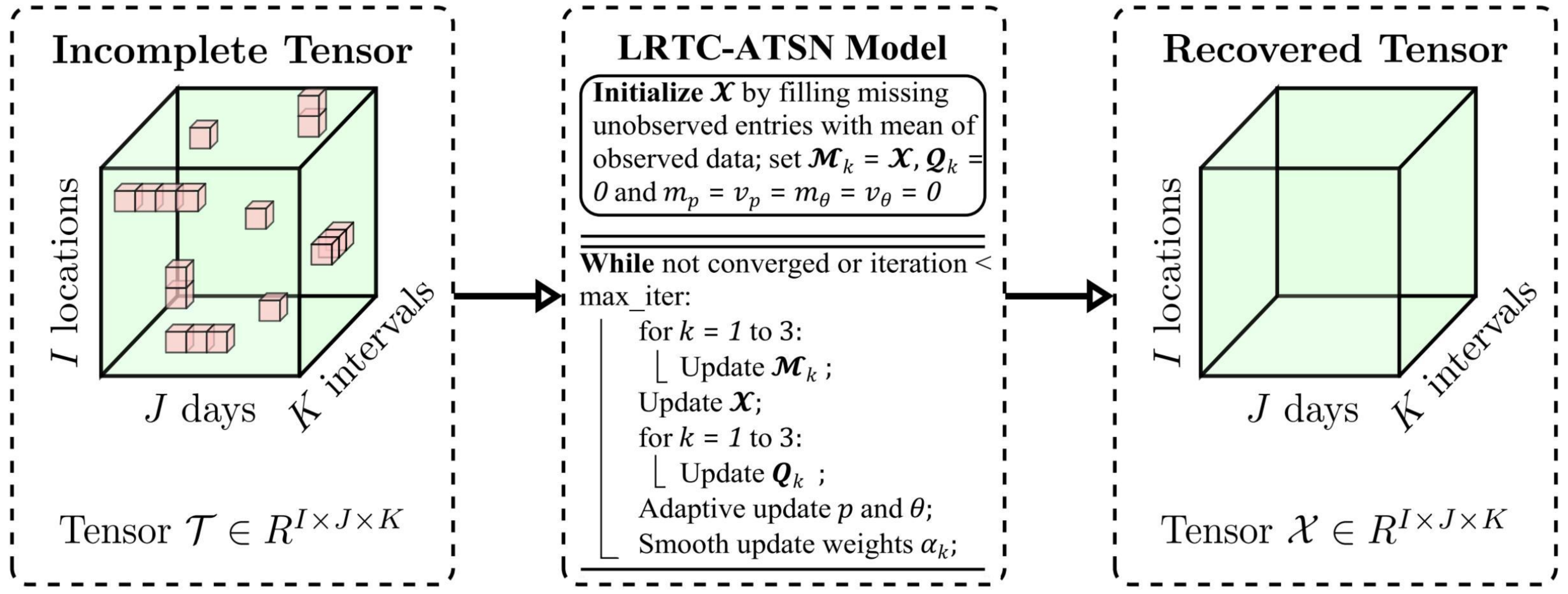


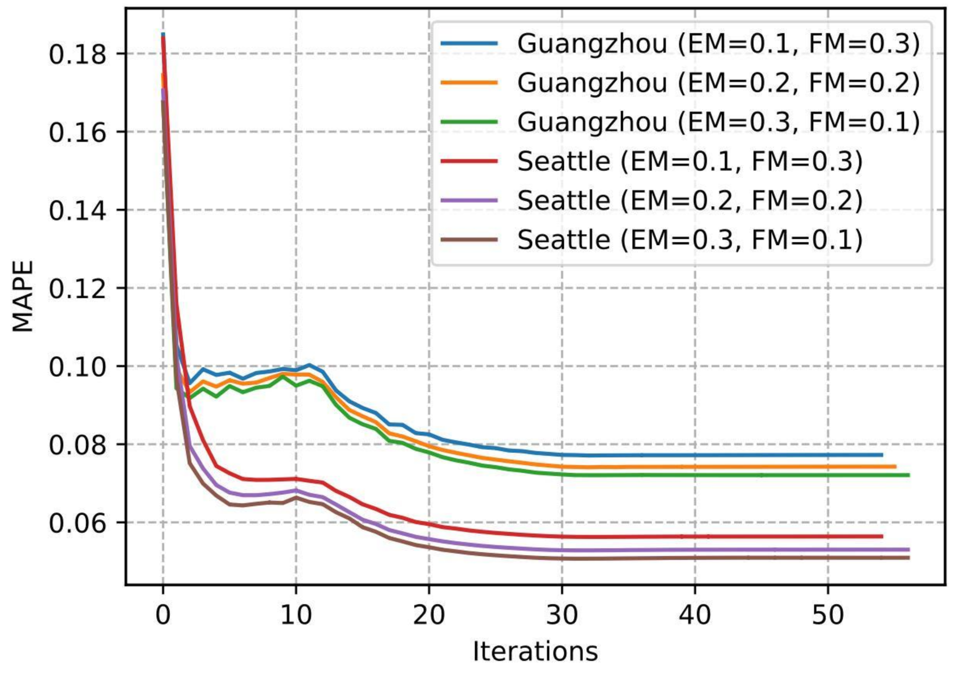
Tensor spatiotemporal slicing states of real traffic datasets in Guangzhou and Birmingham



Ⅱ. LRTC-ATSN Model and Solving Algorithm.

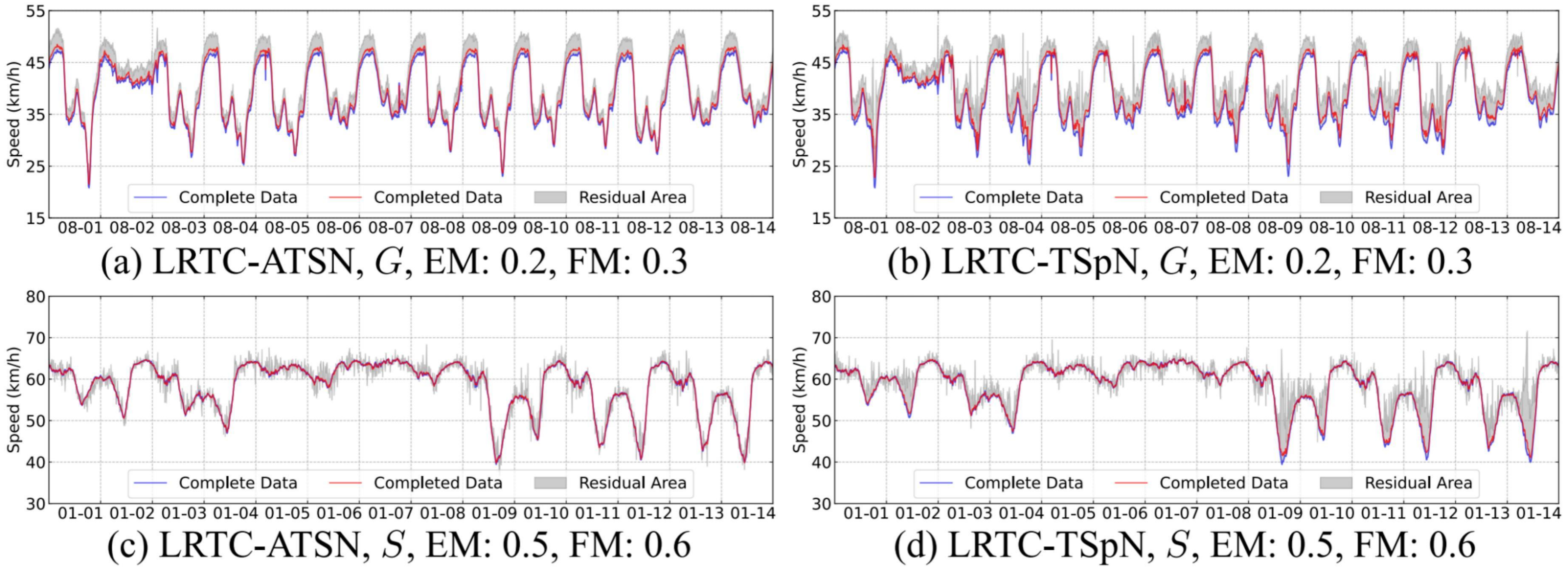
Real-world traffic data slices show spatiotemporal correlation, providing a foundation for data completion. Inspired by the LRMC algorithm in image restoration, I extend it to LRTC, using local or global features to infer missing parts from partial observations. By replacing the traditional nuclear norm with the Schatten norm, a flexible low-rank approximation is achieved, and the ADMM and TGST methods are combined with an adaptive update mechanism to progressively approach the optimal solution, ensuring efficient and accurate traffic data imputation.





(a) Convergence behavior (MAPE)

Ⅲ. Experimental results across different datasets and missing patterns.



(a) LRTC-ATSN, G, EM: 0.2, FM: 0.3 (b) LRTC-TSpN, G, EM: 0.2, FM: 0.3

(c) LRTC-ATSN, S, EM: 0.5, FM: 0.6 (d) LRTC-TSpN, S, EM: 0.5, FM: 0.6

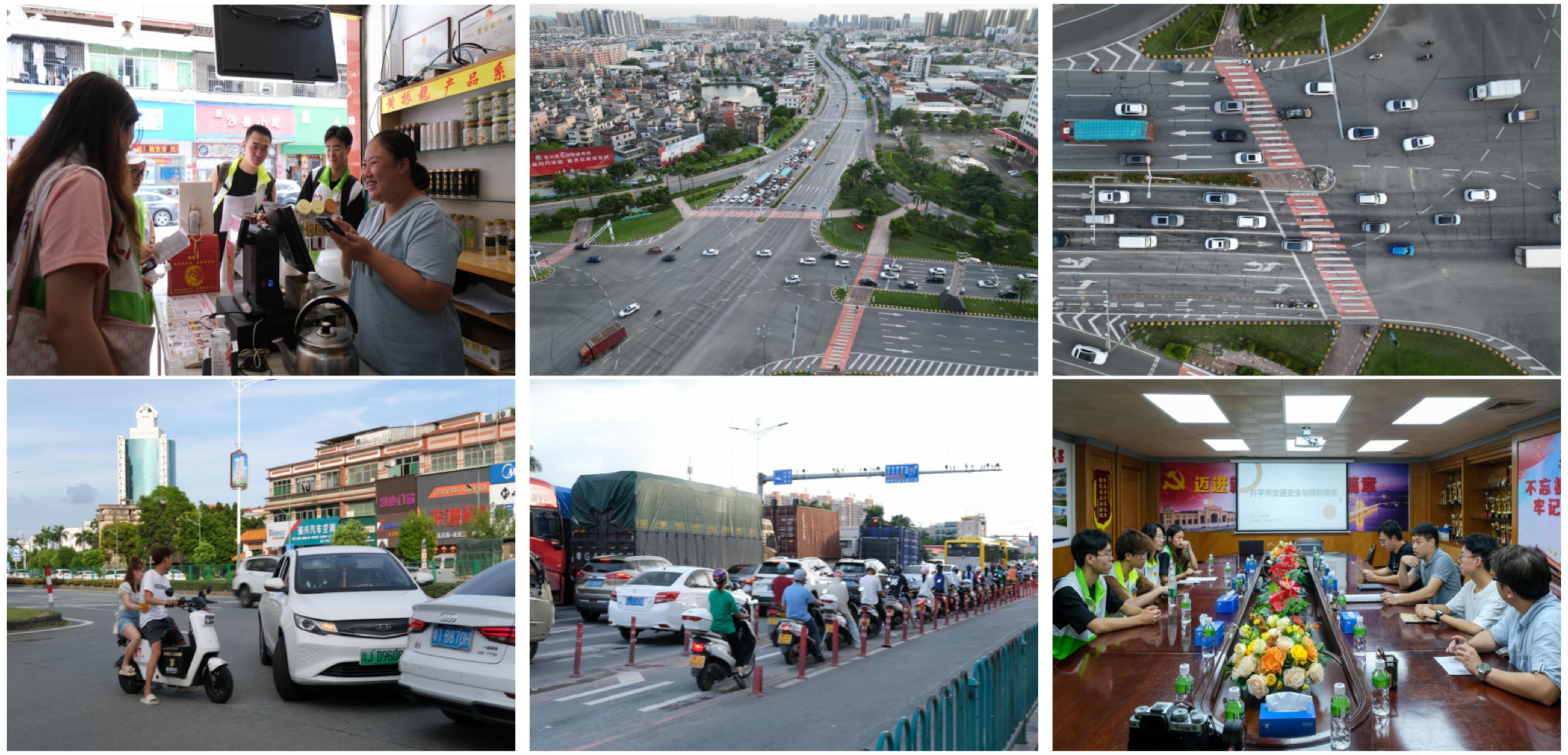
Datasets	Missing Pattern	TMR	BPMF	BGCP	HaLRTC	LRTC-TNN	LRTC-TSpN	LRTC-ATSN
G	EM 0.1 FM 0.1	19.60%	0.106/4.412	0.104/4.321	0.088/3.561	0.073/3.160	0.073/3.132	**0.072/3.097**
	EM 0.3 FM 0.3	48.62%	0.108/4.491	0.104/4.318	0.098/3.929	0.082/3.530	0.081/3.423	**0.078/3.360**
	EM 0.5 FM 0.5	69.75%	0.112/4.665	0.103/4.316	0.109/4.301	0.089/3.849	0.087/3.689	**0.087/3.676**
	EM 0.7 FM 0.7	85.00%	0.119/4.951	0.104/4.320	0.123/4.800	0.098/4.195	0.093/**3.943**	**0.093**/3.947
	EM 0.9 FM 0.9	95.85%	0.139/5.675	0.107/4.473	0.819/33.808	0.111/4.627	0.105/4.409	**0.105/4.355**
S	EM 0.1 FM 0.1	18.52%	0.098/5.526	0.100/5.613	0.071/3.952	0.052/3.329	0.052/3.318	**0.050/3.233**
	EM 0.3 FM 0.3	47.91%	0.099/5.616	0.101/5.615	0.082/4.440	0.060/3.761	0.058/3.583	**0.057/3.582**
	EM 0.5 FM 0.5	69.37%	0.103/5.818	0.099/5.555	0.098/5.078	0.072/4.359	**0.065/3.966**	0.066/4.028
	EM 0.7 FM 0.7	84.80%	0.114/6.327	0.101/5.640	0.121/5.959	0.090/5.274	0.077/**4.531**	**0.076**/4.590
	EM 0.9 FM 0.9	95.78%	0.169/8.529	0.105/5.900	0.200/9.356	0.360/23.742	0.113/6.135	**0.101/5.758**

Best results are marked in bold font.

Tested on real-world datasets from **Guangzhou** and **Seattle**, the model reduced **MAPE** and **RMSE** by **10.6%** and **6.1%**, respectively, under conditions with up to **95.85%** missing data, while accelerating convergence by over **20%** compared to the best-performing baseline.

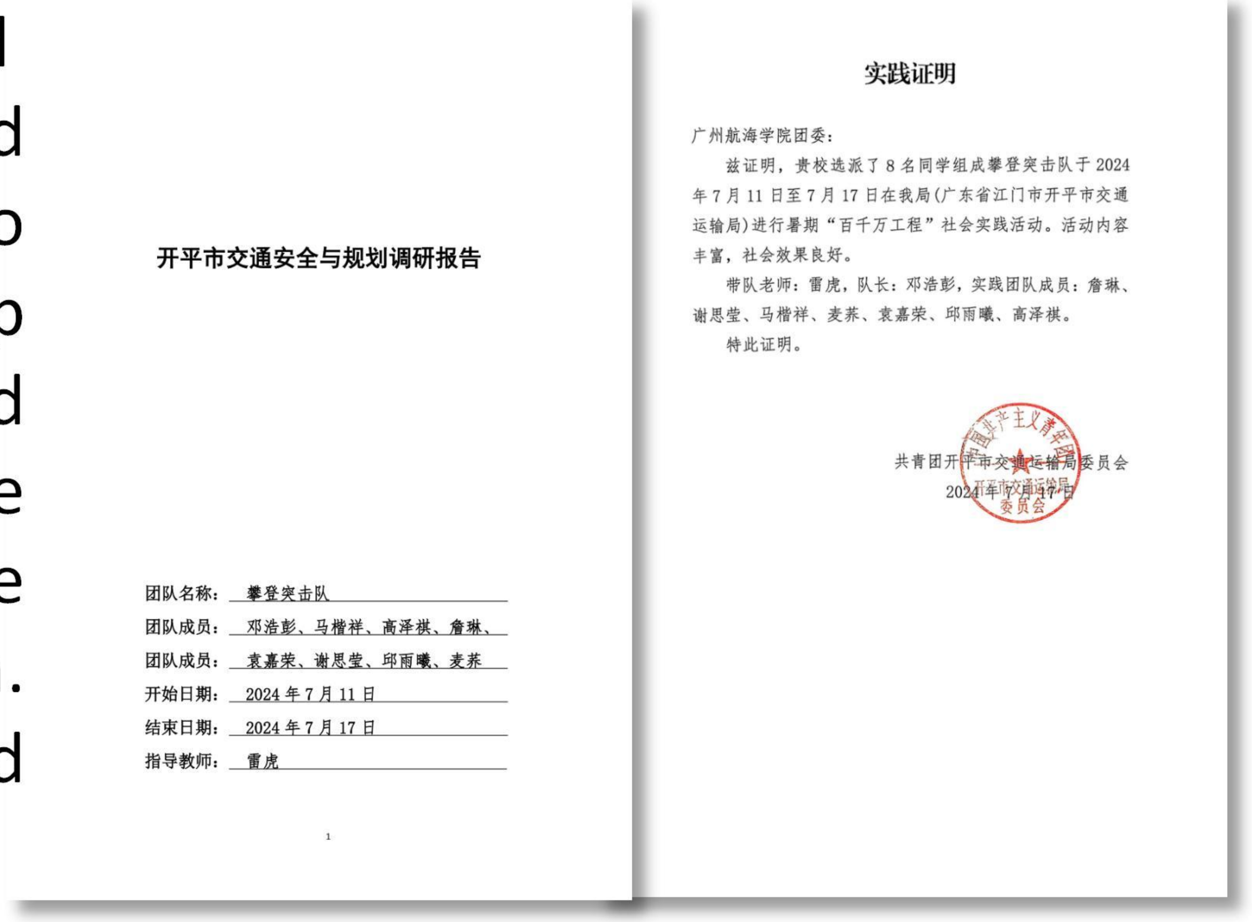
Investigation and Research on Traffic Safety and Planning in Kaiping City

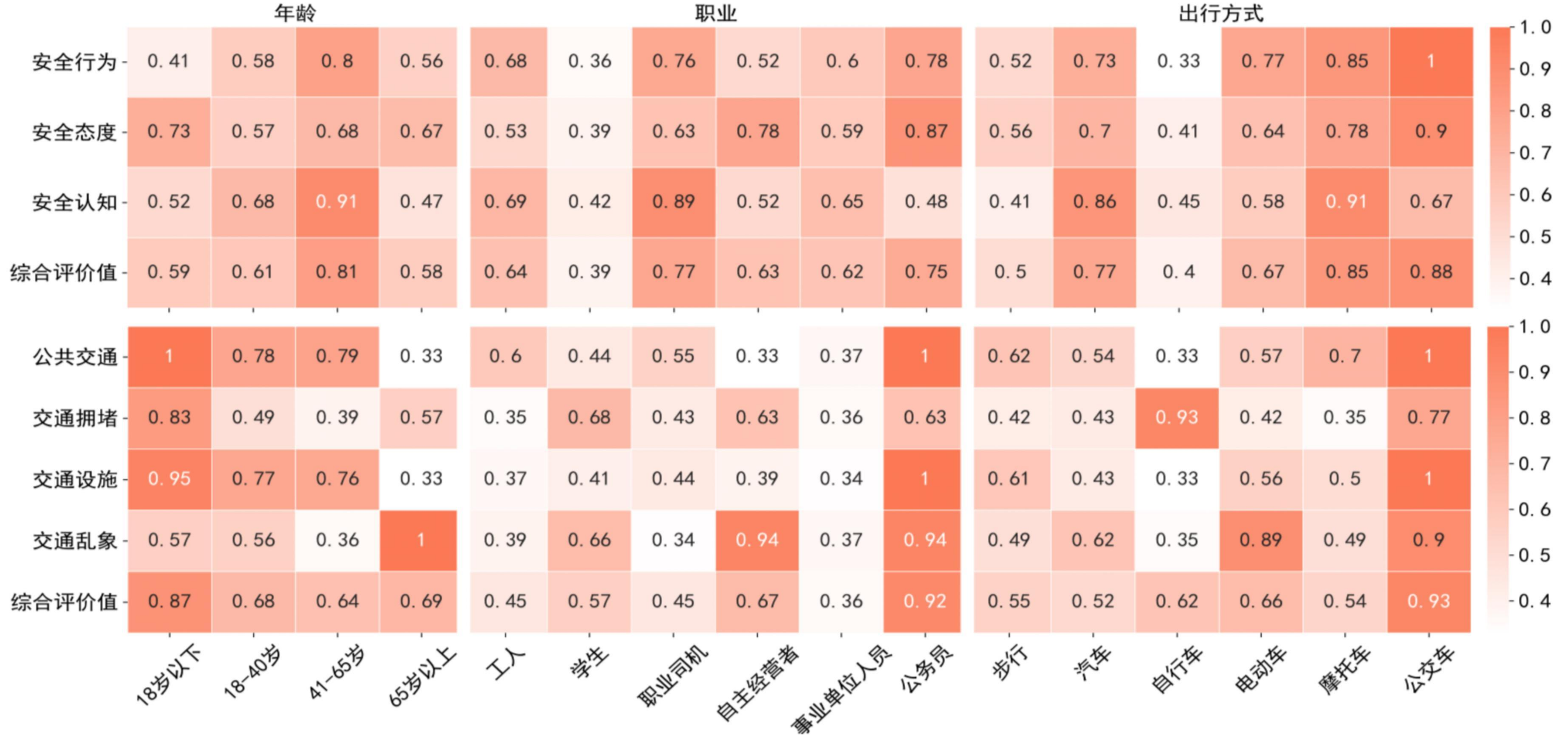
In collaboration with the Municipal Transportation Department, I analyzed traffic accident and violation data to identify accident hotspots and associated hazard types, subsequently designing two targeted questionnaires. Leading a 7-member team, I then conducted extensive fieldwork, utilizing questionnaire surveys, in-depth interviews, road inspections, and drone aerial photography to collect comprehensive data on traffic flow, vehicle management, and pedestrian dynamics.



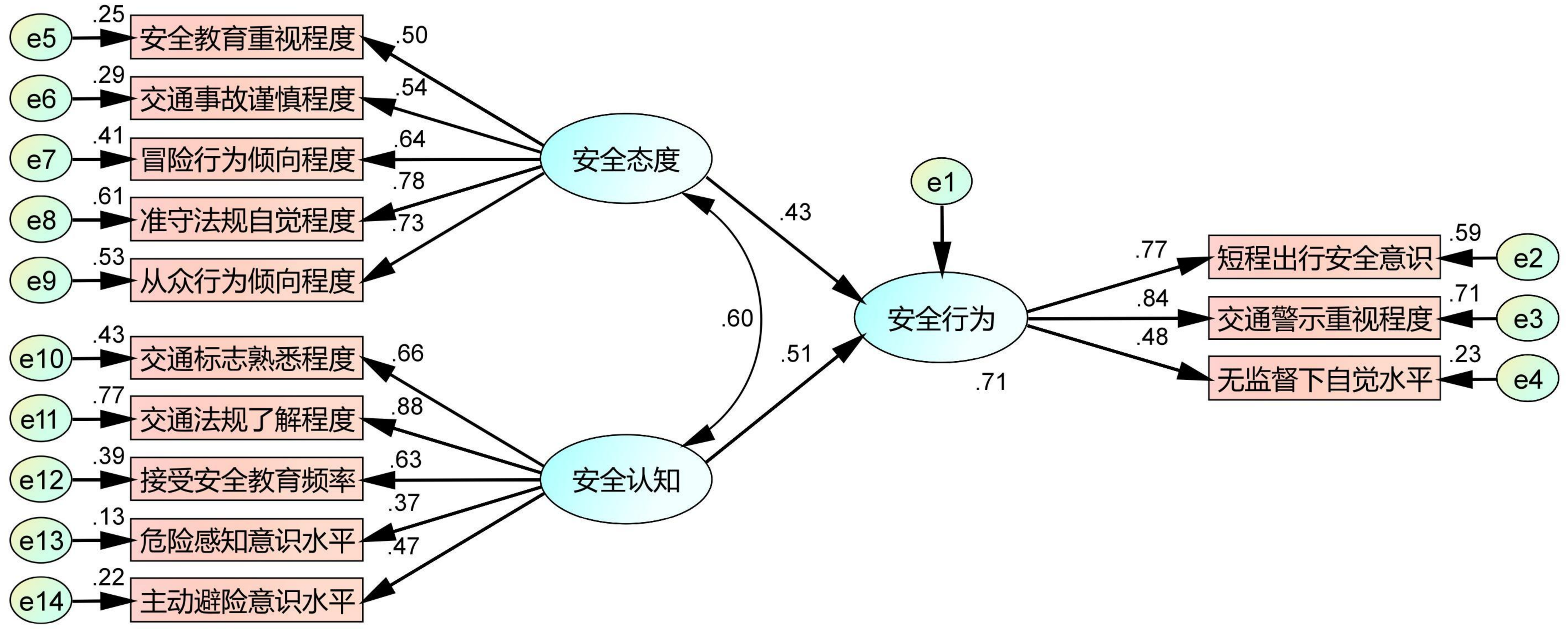
I . Statistical Analysis of Traffic Safety and Planning.

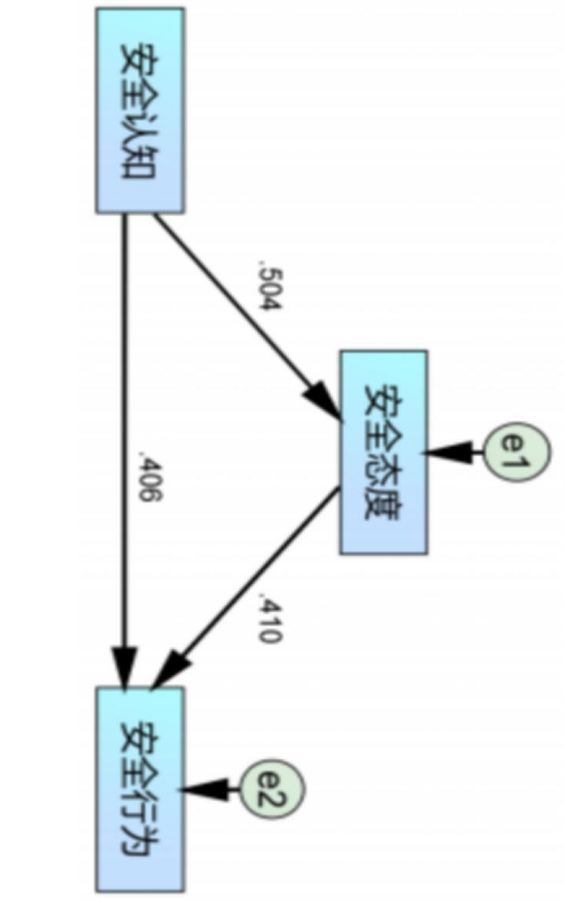
I used SPSS and LLM tools to analyse survey data and interview recordings, identifying key issues and proposing actionable solutions. This led to two technical documents:one on the relationship between traffic safety behavior, attitude, and cognition via Structural Equation Modeling, and the other assessing Kaiping City’s traffic governance using Grey Relational Analysis and Fuzzy Evaluation. The project’s final report was subsequently adopted by the Municipal Transportation Bureau.





Up: Traffic Safety Evaluation Across Different Groups Down: Traffic Planning Evaluation Across Different Groups





Analysis of the Relationship Path among Traffic Safety Cognition, Attitude, and Behavior

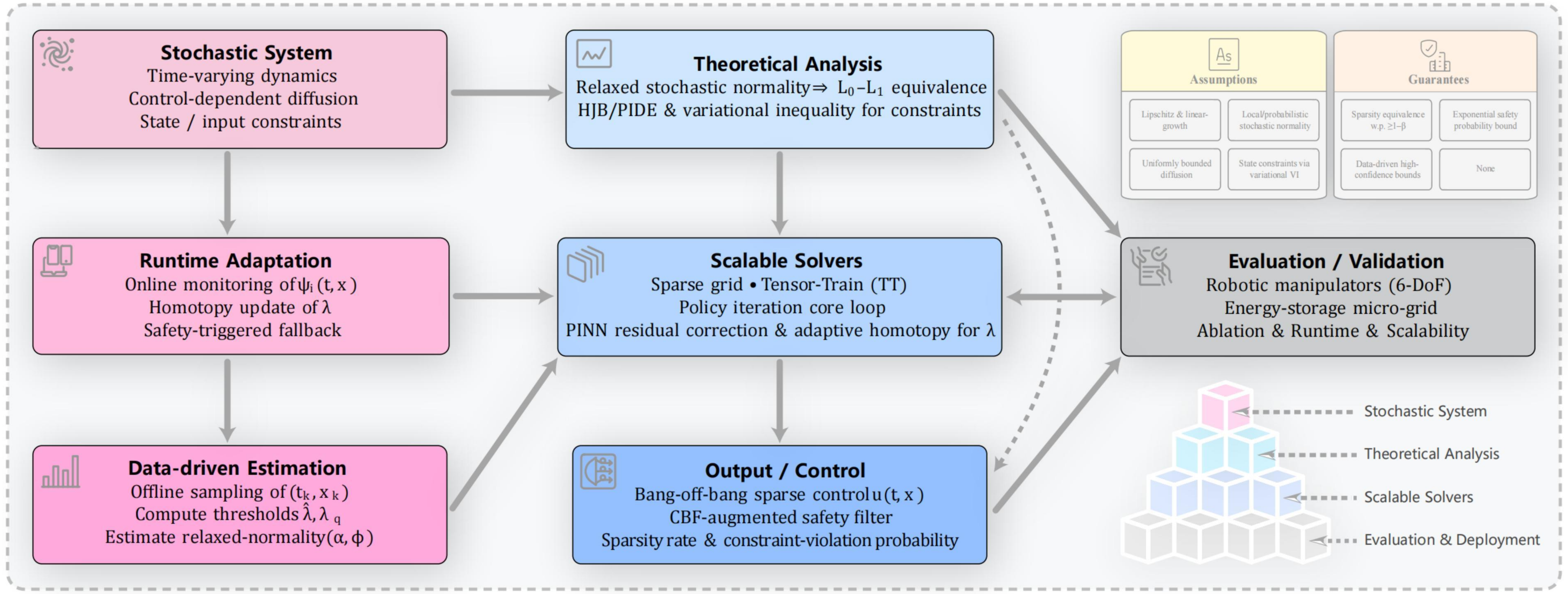
Ⅱ. Existing Issues and Improvement Recommendations

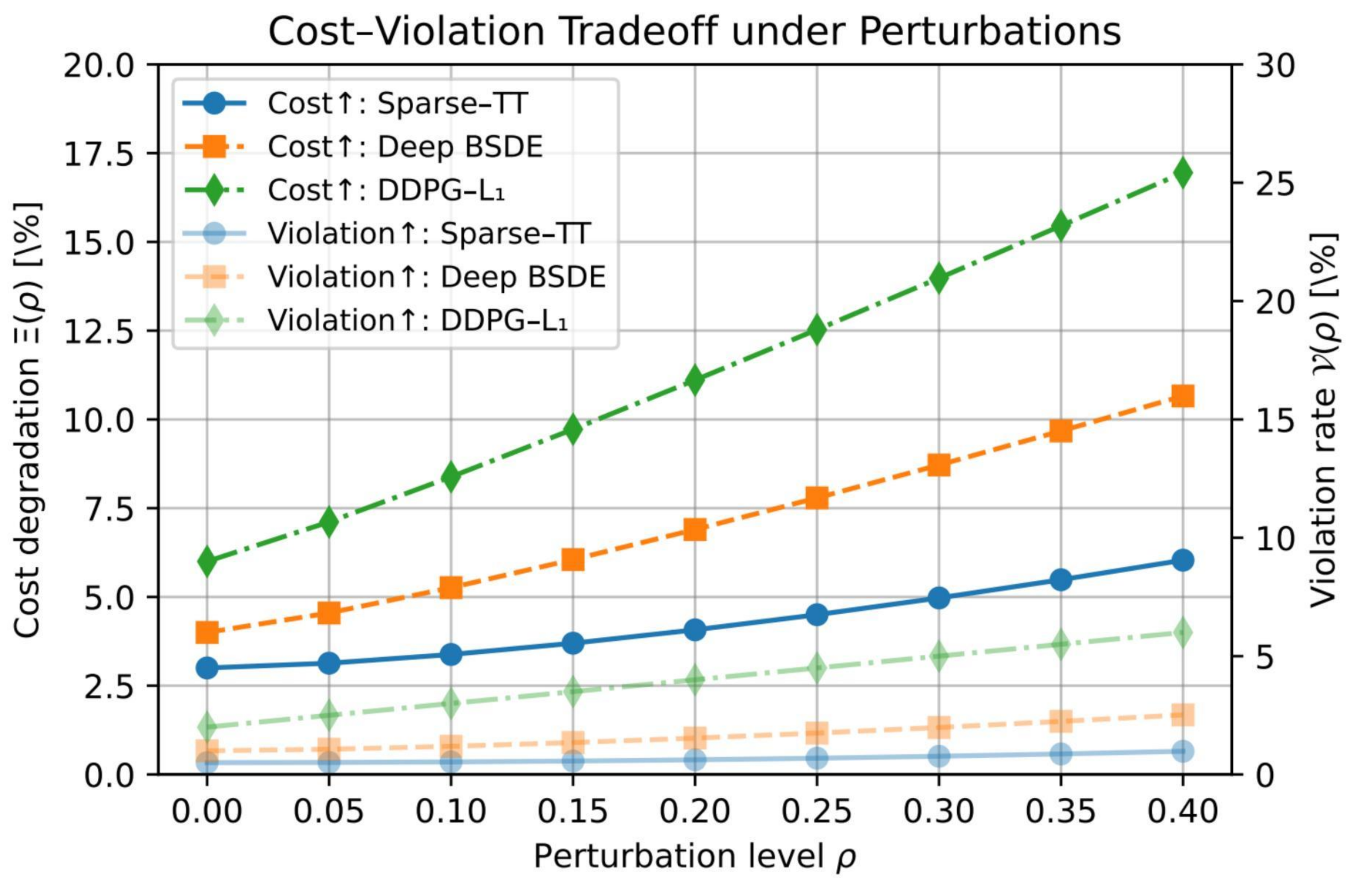
The G325 National Road in the urban area faces issues such as chaotic truck management, pedestrian crossing difficulties, imbalanced parking supply, uneven facility distribution, weak non-motorized vehicle management, and low traffic safety awareness. To address these, it’s recommended to invest in intelligent infrastructure, optimize traffic flow and parking layout, enhance age-friendly facilities, improve non-motorized vehicle management, and strengthen traffic safety education. For details, please scan the QR code on the right.

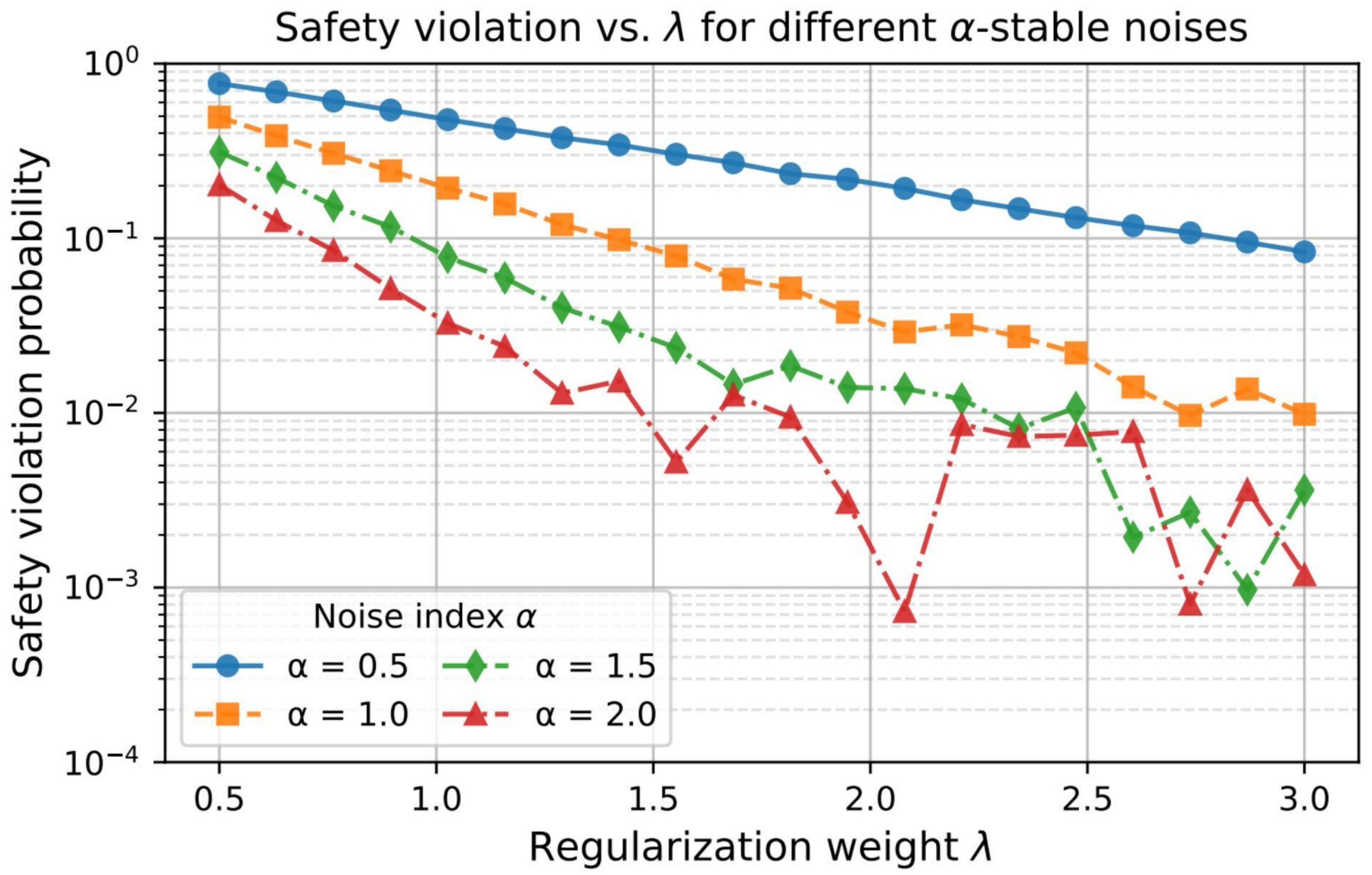
Ongoing Projects: Control Theory & Traffic Flow Theory

Sparse Stochastic Control for Time-Varying Systems with Control-Dependent Diffusion

This work introduces a Sparse-TT framework for sparse stochastic optimal control in time-varying systems with control-dependent diffusion, establishing an approximate equivalence between ℓ_0 and ℓ_1 optimal control formulations. It integrates sparsity, stochasticity, and safety via variational inequalities for state and control constraints. It uses sparse grids, Tensor-Train decomposition, and neural networks, with experiments on robotic and energy systems showing improved control sparsity, safety, and efficiency in high-dimensional systems.



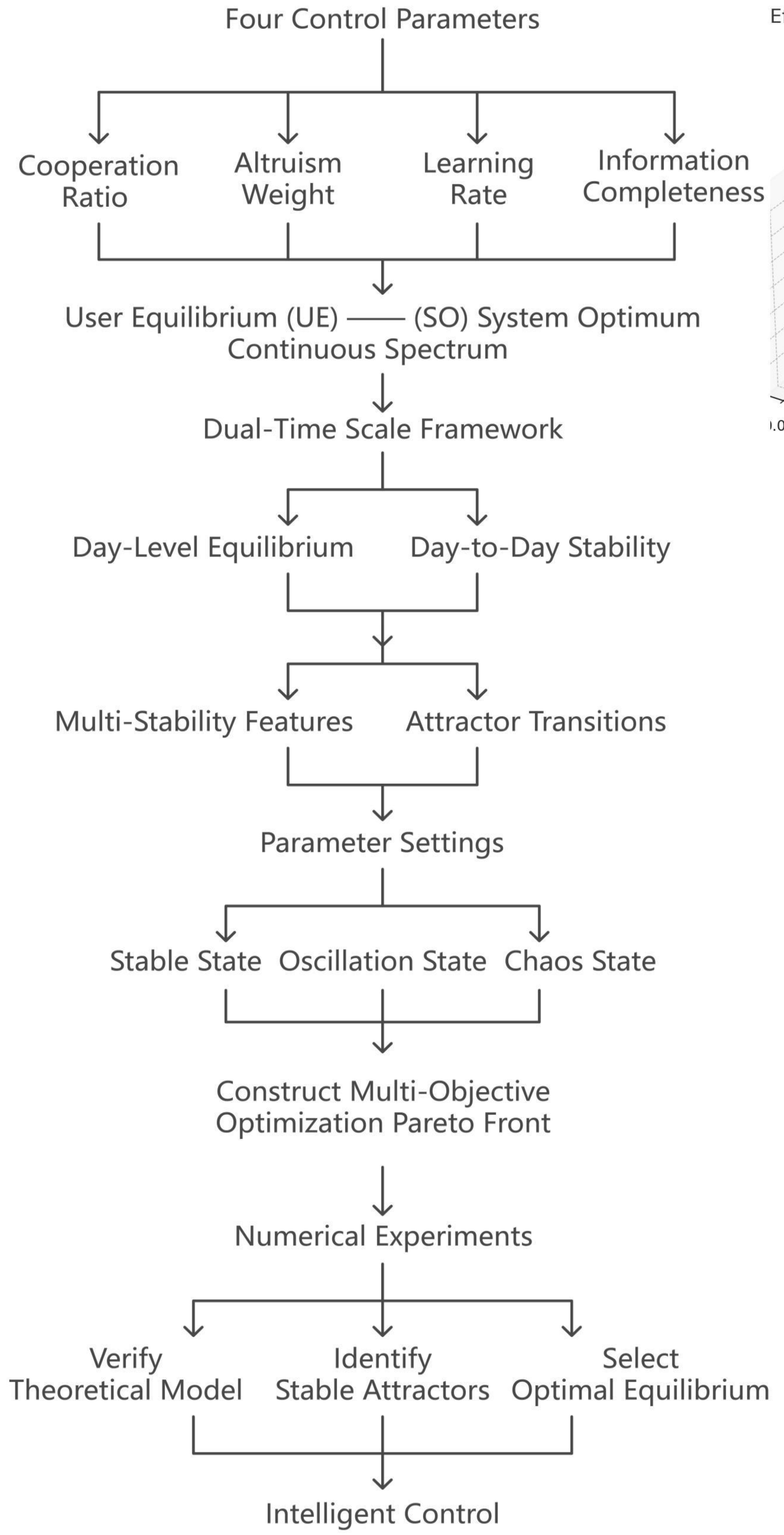


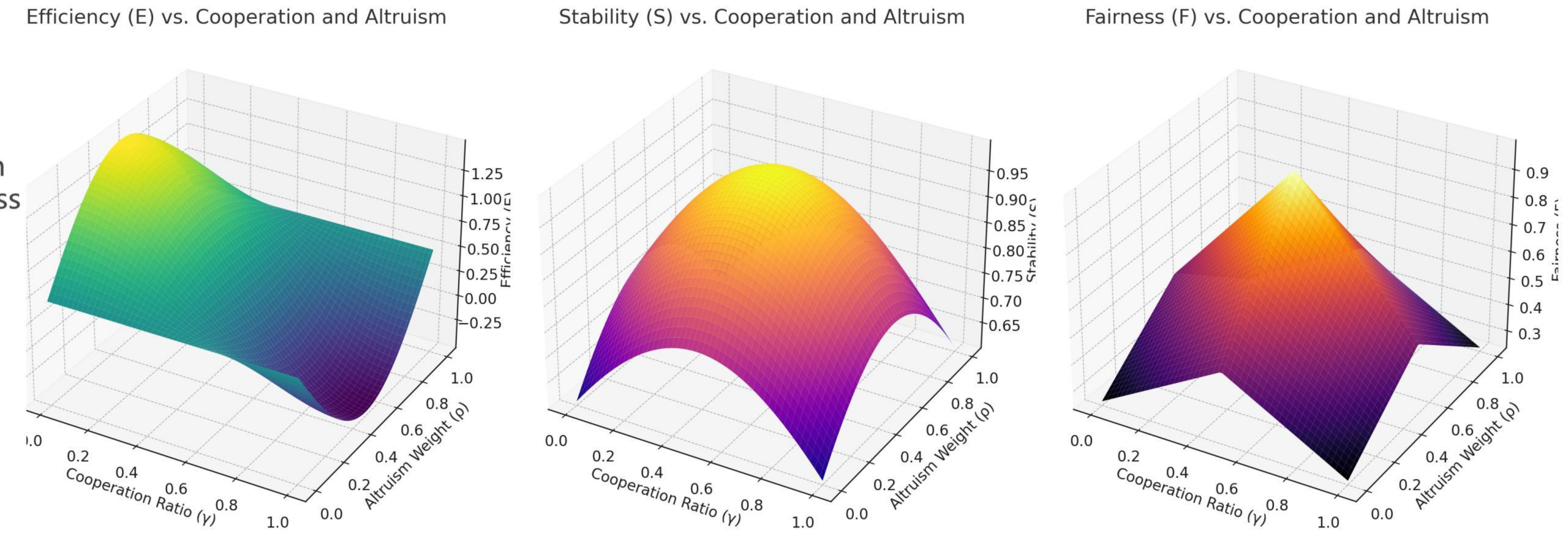


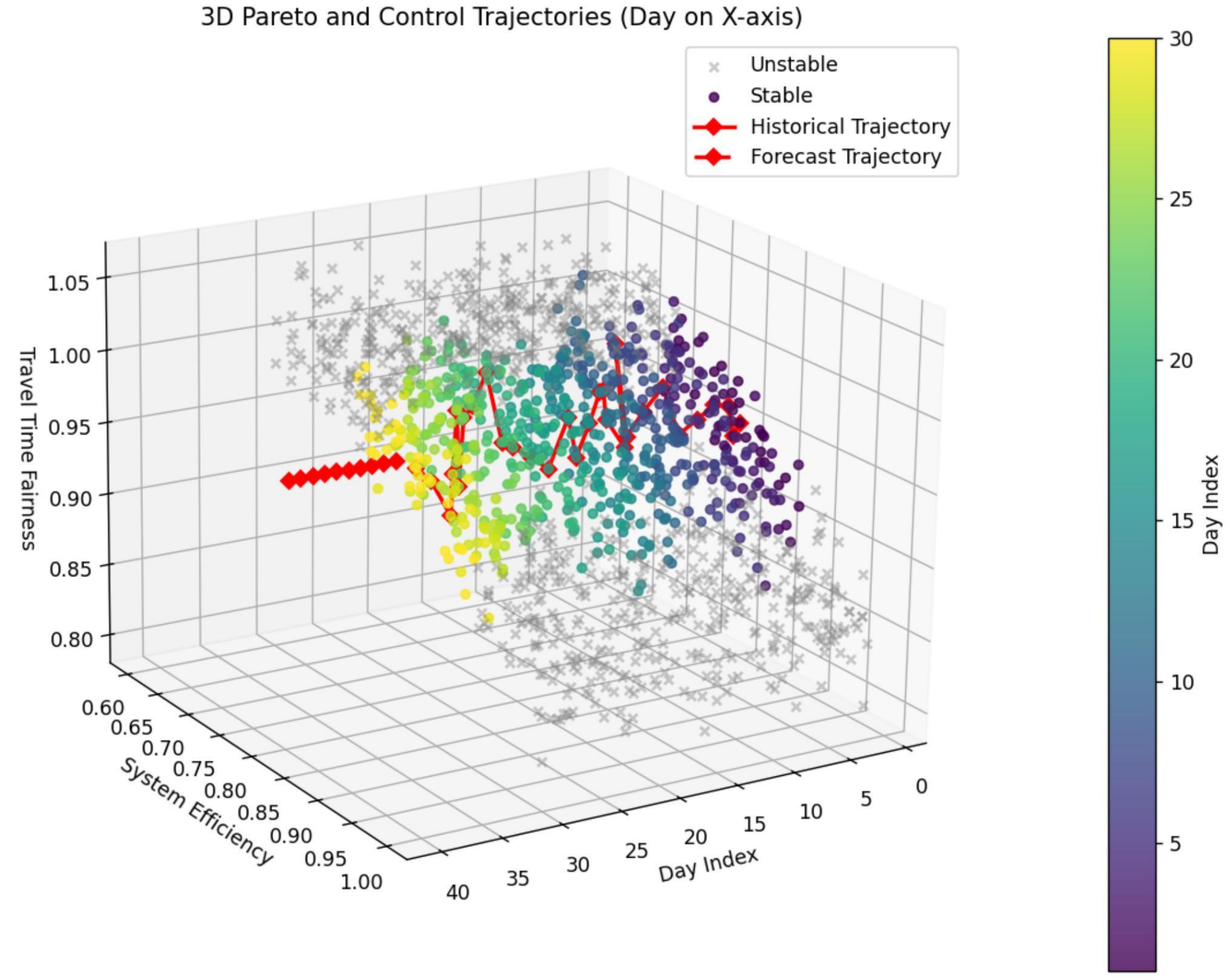
The left chart demonstrates Sparse-TT maintaining low cost and violation under perturbations, outperforming Deep BSDE and DDPG-L1. The right chart indicates that lower α-stable noise benefits more from higher regularization (λ), with diminishing returns at higher noise levels, emphasizing Sparse-TT's robustness and efficiency.

Mixed-Autonomy Traffic Assignment: Bridging Efficiency, Stability, and Fairness

Autonomous driving and connected vehicle technologies are rapidly transforming urban transportation, yet current Dynamic Traffic Assignment (DTA) research mainly focuses on the extremes of user equilibrium (UE) and system optimum (SO). While moderate cooperation among Connected and Autonomous Vehicles (CAVs) can enhance system efficiency, few studies explore the interaction between cooperation, learning mechanisms, and information completeness in a theory-dynamics-multi-objective framework.







This work proposes a DTA model with a dual-time scale UE–SO continuous spectrum, controlled by four parameters: cooperation ratio, altruistic weight, learning rate, and information completeness. Using bifurcation and chaos theory, we reveal the multi-stability and attractor transitions in the network’s parameter space and construct an efficiency–fairness Pareto frontier with stability constraints.