XIAOHUI ZHANG

https://tjzxh.github.io/academic-life/

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EDUCATION

Ph.D., **Traffic Engineering** — 2021 – 2025
Tongji University & National University of Singapore — China & Singapore

B.S. & M.S., **Traffic Engineering** — 2013 – 2020
Tongji University — Shanghai, China

B.S., **Mathematics with Applied Mathematics** (Minor) — 2013 – 2015
Tongji University — Shanghai, China

WORK EXPERIENCE

Alibaba Group – Amap (Gaode) – HD (High Definition) Map — 2020 – 2021
Data Engineer — Beijing, China

RESEARCH INTERESTS

1. Stochastic traffic flow theory

Overview: Model traffic as a complex system, mathematically exploring how traffic flow characteristics emerge from stochastic interactions among vehicles.

- **Stochastic traffic modeling from microscopic behavior**: A conditional distribution for leader–follower interactions, combined with the maximum entropy principle, is proposed to derive the probabilistic flow–density relation, bridging stochastic interactions with macroscopic traffic characteristics.
- **Capacity drop as a phase transition:** Drawing on phase transition and critical phenomena theory, capacity drop is modeled as a collective response to speed disturbances, which originate from microscopic interactions and propagate across the platoon at critical density.

Future Directions: Extend the framework to incorporate lateral movements and temporal dynamics, moving toward a comprehensive stochastic theory of two-dimensional traffic flow evolution.

2. New AI technologies for autonomous driving

Overview: Apply and advance AI, including reinforcement learning and deep learning, to learn decision-making in autonomous driving.

- **Driving decision making with deep reinforcement learning**: DRL is applied in traffic simulator Vissim to learn the optimal driving policy, and further enhanced through a hierarchical framework integrating rule-based models, demonstrating both interpretability and adaptability in traffic flow optimization.
- **Learning human driving behaviors with deep learning**: HRC-LSTM which combines LSTM with data aggregation is proposed to minimize the cumulative error and precisely predict vehicle's trajectories, reproducing consistent car-following and lane-changing behaviors with empirical data.

Future Directions: Explore generative AI for traffic simulation and autonomous driving testing, and integrate AI methods with analytical modeling to enhance interpretability and trustworthiness.

3. Autonomous driving's impacts on traffic

Overview: Explore how the AI-driven AV reshapes traffic dynamics, with the goal of ensuring that AV serves the public good by enhancing, rather than disrupting, the overall traffic flow.

- **String stability analysis of neural network-based car-following models**: A theoretical framework consisting of equilibrium states estimation, non-differentiable function approximation, stability criteria derivation and partial derivative calculation is proposed to investigate the string stability of neural network based car-following models.
- **Traffic-level impacts of mixed traffic consisting of automated vehicles**: A data-driven probabilistic modeling framework is proposed for mixed traffic flow, enabling the input of real-world AV trajectory datasets and output of the stochastic fundamental diagram under given AV penetration rates and AV spatial distributions.

Future Directions: Conduct holistic evaluations of AV impacts beyond efficiency, including safety, robustness; incorporate human factors (e.g., the degradation of AV and driver takeover); and develop traffic-adaptive control strategies to smooth the traffic.

PUBLICATIONS

With over **450 citations**, I have published multiple papers in leading journals such as **Transportation Research Part C (JCR Q1, IF 7.9)** and **Communications in Transportation Research (JCR Q1, IF 14.5)**.

- (Under Review) **Zhang, X.**, Sun, Jie, Sun, Jian, 2025. A micro-macroscopic model of capacity drop: effects of disturbance propagation. *Transportation Research Part B: Methodological*.
- **Zhang, X.**, Yang, K., Sun, Jie, Sun, Jian, 2025. Stochastic fundamental diagram modeling of mixed traffic flow: A data-driven approach. *Transportation Research Part C: Emerging Technologies* 179, 105279.
- **Zhang, X.**, Sun, Jie, Sun, Jian, 2025. On the stochastic fundamental diagram: A general micro-macroscopic traffic flow modeling framework. *Communications in Transportation Research* 5, 100163.
- **Zhang, X.**, Sun, Jie, Zheng, Z., Sun, Jian, 2024. On the string stability of neural network-based car-following models: A generic analysis framework. *Transportation Research Part C: Emerging Technologies* 160, 104525.
- **Zhang, X.**, Sun, Jie, Wang, Y., Sun, Jian, 2023. A Hierarchical Framework for Multi-Lane Autonomous Driving Based on Reinforcement Learning. *IEEE Open Journal of Intelligent Transportation Systems* 4, 626–638.
- **Zhang, X.**, Sun, Jie, Qi, X., Sun, Jian, 2019. Simultaneous modeling of car-following and lane-changing behaviors using deep learning. *Transportation Research Part C: Emerging Technologies* 104, 287–304.
- Ye, Y.[*], **Zhang, X.**[*], Sun, J., 2019. Automated vehicle's behavior decision making using deep reinforcement learning and high-fidelity simulation environment. *Transportation Research Part C: Emerging Technologies* 107, 155–170.
- Zhou, D., Ma, Z., **Zhang, X.**, Sun, J., 2022. Autonomous vehicles' intended cooperative motion planning for unprotected turning at intersections. *IET Intelligent Transport Systems* 16, 1058–1073.

ACADEMIC SERVICE & MENTORSHIP

- Reviewer for Transportmetrica A: Transport Science
- Mentored graduate thesis project on mixed traffic flow modeling

PROFESSIONAL SKILLS

- Experienced in Python, MATLAB
- Experienced in traffic simulation software Vissim, SUMO
- Experienced in mathematical modeling and applying new AI methods

AWARDS & HONORS

- Outstanding Thesis Award 2020
- Scholarships of Tongji University 2014, 2015, 2019
- The Second Prize in the National Post-Graduate Mathematical Contest in Modeling 2017
- The Meritorious Winner in the Mathematical Contest in Modeling 2016
- The Second Prize in the Shanghai Mathematics Competitions 2014

LANGUAGE PROFICIENCY

- IELTS 7 (Listening 7 Reading 8.5 Writing 6.5 Speaking 6)

RELEVANT COURSES

- Mathematical Foundation of Reinforcement Learning, Machine Learning, Optimization Theory, Mathematical Modeling, Statistical Analysis, Mathematical Analysis
- Traffic Flow Theory, Transportation Network Modeling and Analysis, Traffic Flow Simulation, Transportation Engineering