

Yansong Qu

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PROFILE

I am currently a Ph.D. student in Civil Engineering (Transportation) at Purdue University - West Lafayette, advised by [Prof. Samuel Labi](#) at the [Center for Connected and Automated Transportation \(CCAT\), Purdue](#) and co-advised by [Prof. Sikai Chen](#) at [Sky-Lab](#) (UW-Madison). My research centers on Artificial Intelligence (AI) in transportation and Intelligent Autonomous Systems, with a particular focus on autonomous driving, human-centered AI, human-robot interaction, reinforcement learning (RL), multimodal large language models (MLLMs), world model, transfer learning, spatiotemporal data mining, and traffic safety. I aim to bridge the gap between theoretical advancements and practical applications, creating innovative AI systems that not only advance academic understanding but also transform real-world transportation, contributing to smarter, safer, and more sustainable mobility solutions for the future.

EDUCATION & EXPERIENCE

Ph.D., Civil Engineering (Transportation), Purdue University, USA

2024-Present

- **Commitment:** Teaching Assistant, Research Assistant.
- **GPA: 4.0/4.0; Rank: top 1%**
- **Research direction:** Autonomous driving, ADAS, human-robot interaction, multimodal large language models, reinforcement learning.
- **Major courses:** Reinforcement Learning, Emerging Transportation Technologies, Introduction to Robot Learning, Vehicular Cyber-Physical Systems.

M.S., Transportation Engineering, Beijing University of Technology, China

2021-24

- **Thesis:** Graph representation learning for spatiotemporal traffic prediction with missing values. (Outstanding Graduation Thesis Award)
- **Research direction:** Spatiotemporal data mining, network modeling, association rules mining.
- **GPA: 3.56/4.0 (87.78/100); Rank: top 5%**
- **Major courses:** Numerical Analysis, Methods of Data Analysis with R Software, Traffic Network Analysis, Traffic Planning Model, Analysis of Traffic Behavior's Characters, Road Safety Engineering

B.S., Transportation Engineering, Dalian Jiaotong University, China

2017-21

- **Thesis:** Reconstruction planning and design of typical congestion sections in cities -- Taking Jiefang Square area as an example.
- **GPA: 3.47/4.0 (84.56/100); Rank: top 10%**
- **Major courses:** Modeling and Applications of Traffic Data, Advanced Mathematics Mechanics of Materials, Probability and Statistics, Transportation System Engineering, Urban Public Traffic Planning

PROJECTS

[CCAT Project] Towards Safe and Efficient Autonomous Driving: A Synergistic Approach with Human Expertise and Multimodal Large Language Models

2025

- Designed a **dual-stage training paradigm** that combines **MLLMs and human expertise** to improve safety in corner cases of autonomous driving.
- **Integrated vision, language, and action modalities with Chain-of-Thought reasoning** for interpretable sequential decision-making and real-time low-level control.
- Developed a **lightweight, fast-responding accident warning system** with real-time detection, localization, and verbal alerts; validated through **closed-loop benchmark evaluations**.

Application for Sichuan Provincial Key Laboratory Open Funding

2023

- Responsible for conducting **research and verification** on the basis of project initiation, developing annual research plans and expected results. Develop **research topics, technical routes, and innovative points** based on the congestion situation of highways in Sichuan Province.
- Conducted **Data processing and modeling**. Re-organize the speed and flow data, analyze missing data patterns, and predict the future traffic states using historical data with missing values.

Prevention and control of expressway congestion in Nanning, Guangxi Province

2022

- Raw traffic flow data and geographical information preprocessing to form inputs and adjacency graphs by Python; multiple missing patterns analysis to stimulate the real scenarios.

- Proposed the spatiotemporal adaptive periodical graph contrast learning framework, to conduct **area-wide traffic prediction** under multiple **missing patterns**.

Graph modeling and transfer generalization for humanoid decision making of autonomous vehicles 2021

- Read and summarize related works on trajectory planning for autonomous vehicle and time series prediction.
- Summarize the factors that may affect the safe driving of drivers by mining association rules in accident data.

SELF-STUDY

Multimodal Large Language Models

2024

- **LLM as reward designer**: Proposed a unified framework that integrates pre-trained Vision-Language Models (VLMs) with RL to generate reward signals using image observation and natural language goals.
- **Fine-tuning VLMs as decision makers**: Fine-tune Qwen2-vl on multiple autonomous driving datasets to output formatted text, parse the open-ended text into legal actions that can directly interact with the environment.

Semantic Scene Completion

2024

- Proposed a **meta-learning-based framework for Semantic Scene Completion (SSC)**, named MetaSSC, which leverages deformable convolution, large-kernel attention, and the Mamba (D-LKA-M) model, to model long-sequence relations of 3D voxels and reduce high deployment costs.

Safety-critical Scenario Generation

2024

- Extract vehicle trajectories from accident videos using **detection and tracking** method.
- Generate safety-critical scenarios in **CARLA** to test **Reinforcement Learning (RL)** algorithms.

TECHNICAL SKILLS

- **Simulators**: CARLA, MetaDrive, Unity, Simulink, SUMO, VISSIM, and TORCS.
- **Programming**: Python (Pytorch/Tensorflow/Jax), Java, C#, MATLAB, R, MySQL, Flink, Linux, and Scenic.
- **Engineering**: Machine learning, deep learning, ADAS, Hardware-in-the-loop test and verification, system analysis, control and planning, computer vision, and sensors (LiDAR, RADAR, Camera).
- **Research**: Academic writing, communication skills, teamwork, critical thinking, and problem-solving.
- **Software**: OFFICE, QIS, GAMS, Overleaf, GraphPad Prism, Visio, and Notion.

PUBLICATIONS

1. **Y. Qu**, Z. Xu, Z. Huang, Z. Sheng, S. Chen, T. Chen, "MetaSSC: Enhancing 3D Semantic Scene Completion for Autonomous Driving through Meta-Learning and Long-sequence Modeling," Communications in Transportation Research (**IF: 12.5**).
2. **Y. Qu**, Z. Li, X. Zhao, and J. Ou, "Towards real-world traffic prediction and data imputation: A multi-task pretraining and fine-tuning approach," Information Sciences. (**IF: 8.2**)
3. **Y. Qu**, J. Rong, Z. Li, and K. Chen, "ST-A-PGCL: Spatiotemporal adaptive periodical graph contrastive learning for traffic prediction under real scenarios," Knowledge-Based Systems. (**IF: 8.8**)
4. **Y. Qu**, Z. Li, Q. Liu, M. Pan, and Z. Zhang, "Crash/Near-Crash Analysis of Naturalistic Driving Data Using Association Rule Mining," Journal of Advanced Transportation. (**IF: 2.3**)
5. Z. Huang[†], Z. Sheng[†], Z. Wan[†], **Y. Qu**, et al. "Sky-Drive: A Distributed Multi-Agent Simulation Platform for Socially-Aware and Human-AI Collaborative Future Transportation," arXiv preprint arXiv:2504.18010.
6. Z. Huang[†], Z. Sheng[†], **Y. Qu**[†], J. You, and S. Chen, "VLM-RL: A Unified Vision Language Models and Reinforcement Learning Framework for Safe Autonomous Driving." arXiv preprint arXiv:2412.15544.
7. Z. Sheng[†], Z. Huang[†], **Y. Qu**, Y. Leng, S. Bhavanam, S. Chen, "CurricuVLM: Towards Safe Autonomous Driving via Personalized Safety-Critical Curriculum Learning with Vision-Language Models." arXiv preprint arXiv:2411.03672.
8. Z. Li, M. Pan, **Y. Qu**, et al. A Method for Evaluating the Safety over the Takeover Process of the Level 3 Automated Vehicles Based on IAHP-EWM-LDM. Journal of Transport Information and Safety.
9. M. Diao, **Y. Qu**, L. Wu, and Z. Li. Traffic flow prediction based on graph wave adaptive spatiotemporal graph convolution network. International Conference on Smart Transportation and City Engineering (STCE 2023).

PRESENTATIONS

1. **Y. Qu** and Z. Li, "TSS-FUS: a temporal-spatial-semantic fusion network for area-wide traffic forecasting," 103rd Transportation Research Board (TRB) Annual Meeting," 103rd Transportation Research Board (TRB) Annual Meeting.
2. **Y. Qu**, J. Chen, Z. Huang, Z. Sheng, Y. Chen, S. Chen, S. Labi, "Towards Safe Autonomous Driving: A Dual-Phase Framework with Vision-Language Models & Human Feedback," International Conference on Transportation and Development (ICTD) 2025.

3. **Y. Qu**, Z. Xu, Z. Huang, Z. Sheng, S. Chen, T. Chen, “MetaSSC: Enhancing 3D Semantic Scene Completion for Autonomous Driving through Meta-Learning and Long-sequence Modeling,” 104th Transportation Research Board (TRB) Annual Meeting.

4. **Y. Qu**[†], Z. Huang[†], Z. Sheng[†], J. Chen, S. Chen, S. Labi, “VL-SAFE: Vision-Language Guided Safety-Aware Reinforcement Learning with World Models for Autonomous Driving,” 11th Midwest Workshop on Control and Game Theory.

SELECTED AWARDS

The First-class Academic Scholarship	Beijing University of Technology	<i>2022-24</i>
Outstanding Graduate Award	Beijing University of Technology	<i>2023-24</i>
Ren Futian (任福田) Transportation Scholarship	Beijing University of Technology	<i>2023-24</i>
The First Prize in National Mathematics Competitions	National Mathematical Society	<i>2020-21</i>
The First Prize in Liaoning Provincial Mathematics Competitions	Liaoning Provincial Mathematical Society	<i>2020-21</i>
The Second Prize in the 28th Dalian University Mathematics Competition for Science and Engineering Majors	Dalian Mathematical Society	<i>2019-20</i>
The Second Prize in National English Competition for College Students	TEFL China	<i>2019-20</i>