Meixin Zhu

Department of Civil and Environmental Engineering, University of Washington
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INTERESTS

Autonomous Driving, Reinforcement Learning, Driving Behavior, Traffic-Flow Modeling and Simulation, Traffic Signal Control, Multi-Agent Reinforcement Learning

EDUCATION

University of Washington, Seattle, US

- Ph.D. in Intelligent Transportation System — Sep 2018 – Present
  - Advisor: Prof. Yinhai Wang, professor in CEE, adjunct professor in ECE
  - Focus: Autonomous Driving, Driving Behavior, Deep Reinforcement Learning, Artificial Intelligence
  - Core Courses: CSE 546 Machine Learning, CSE 571 Robotics (4.0/4.0), CSE 573 Artificial Intelligence, CSE 576 Computer Vision (4.0/4.0), CSE 547 Machine Learning for Big Data, CSE 599W Reinforcement Learning, CSE 599Q1 Quantum Computing
  - Cumulative GPA: 3.87/4.0

Georgia Institute of Technology, Atlanta, US

- Master of Science in Computer Science — Jan 2021 – Present
  - Specialization: computational perception robotics
  - Cumulative GPA: 4.0/4.0

Tongji University, Shanghai, China

- Master of Science in Communication and Transportation Engineering — Sep 2015 – Jun 2018
  - Advisor: Prof. Xuesong Wang
  - Thesis: Car-Following Behavior Modeling and Its Application in Intelligent Driving
  - Focus: Autonomous driving, reinforcement learning, car-following behavior, and naturalistic driving study
  - Cumulative GPA: 91.2 / 100; Integrated Ranking: 1 / 237
- Bachelor of Science in Traffic Engineering — Sep 2011 – Jun 2015
  - Thesis: Evaluating Advanced Driving Assistance System Based on Naturalistic Driving Data
  - Cumulative GPA: 91.62 / 100; Integrated Ranking: 1 / 205

RESEARCH EXPERIENCE

Software Research Intern, Motional — Jan 2022 – Present

- Behavioral planning for autonomous driving.

Applied Scientist Intern, Amazon — Jun 2021 – Sep 2021

- Last Mile ML Science Team. Developed a new model for last mile delivery optimization.

Research Intern, Oak Ridge National Laboratory (ORNL) — Jun 2019 – Dec 2019

- Signal Timing Control for Large-Scale Networked Intersections
  - Advisor: Hong Wang
  - Proposed three new multi-input and multi-output (MIMO) traffic signal control methods (based on **feedback control, LQR, and bilinear modeling**) that can improve network-wide traffic operations in terms of delay and energy consumption.
  - A 35-intersection network of Bellevue, WA, is used as the basis for the development of the algorithm, where modeling and intersection controls in a globalized setting are established using MIMO linear control theory and high matrix formulation.
  - The proposed control methods were evaluated in a microscopic traffic simulation environment, VISSIM. Simulation results show that the proposed methods have much shorter average travel delays in the network when compared with the delays of conventional pretimed and actuated controls.

Research Assistant, General Motors — Apr 2015 – Jun 2018

- Shanghai Naturalistic Driving Study Data Analyses
  - Collected 60 Chinese drivers' real-world driving data, with a total mileage of 161,055 km.
  - Investigated decision-making mechanisms for essential driving behaviors based on 108,933 car-following events, 17,309 lane-change events, 7,845 cut-in events, and 3,256 vehicle-pedestrian conflicts.
  - Calibrated, validated, and cross-compared five representative car-following models and found that the intelligent driver model (IDM) performed best for Shanghai drivers.
  - Investigated the impact of a forward collision warning system on drivers' car following behavior.

- Developed two autonomous car-following algorithms with deep reinforcement learning: one can perform human-like car following; the other is capable of controlling vehicle velocity in a safe, efficient, and comfortable manner.

Research Assistant, China First Automobile Work (FAW) Corporation   Dec 2011 – Dec 2015

- Driving Behavior Research for Intelligent Collision Avoidance Technology
  - Examined the effects of situational urgency on drivers' collision avoidance behaviors using Tongji University's eight-degree-of-freedom driving simulator.
  - Developed a kinematic-based forward collision warning (FCW) algorithm that is compatible with drivers' risk perceptions and behavioral responses.
  - Implemented the proposed FCW algorithm in Tongji University driving simulator, and evaluated the system's performance, warning timing, and safety benefits.

PUBLICATIONS

Under review and preprints

[1] Z. Cui, **M. Zhu**, S. Wang, P. Wang, Y. Zhou, Q. Cao, C. Kopca, and Y. Wang, "Traffic performance score for measuring the impact of COVID-19 on urban mobility," *arXiv preprint: 2007.00648*, Jul 2020.

[2] **M. Zhu**, J. Hu, H. Yang, Z. Pu, and Y. Wang, "Personalized context-aware multi-modal transportation recommendation," *arXiv preprint: 1910.12601*, Oct 2019.

[3] **M. Zhu**, J. Hu, Z. Pu, Z. Cui, L. Yan, and Y. Wang, "Traffic sign detection and recognition for autonomous driving in virtual simulation environment," *arXiv preprint:1911.05626*, Nov 2019.

[4] **M. Zhu**, S. Du, X. Wang, H. Yang, Z. Pu, and Y. Wang, "Transfollower: Long Sequence Car-Following Trajectory Prediction through Transformer," Jan 2022 (**2022 ASA TSIG student paper award**).

Journal Articles

[1] **M. Zhu**, W. Zhu, J. Lutin, Y. Wang, and Z. Cui, "Developing a statistically valid and practical method to compute state-level bus occupancy rates," *Journal of Transportation Engineering, Part A: Systems*, vol. 147, issue 6, Feb 2021.

[2] P. Sun, X. Wang, and **M. Zhu**, "Modeling car-following behavior on freeways considering driving style,," *Journal of Transportation Engineering, Part A: Systems*, vol. 147, issue 12, Dec 2021.

[3] H. Yang, **M. Zhu**, C. Liu, and Y. Wang, "How fast you will drive? predicting speed of customized paths based on deep neural networks,," *IEEE Transactions on Intelligent Transportation Systems*, Feb 2021 (IF: 6.492).

[4] **M. Zhu**, Y. Wang, J. Hu, X. Wang, and R. Ke, "Safe, efficient, and comfortable velocity control based on reinforcement learning for autonomous driving," *Transportation Research Part C: Emerging Technologies*, vol. 117, pp. 102662, Aug 2020 (IF: 8.089).

[5] **M. Zhu**, X. Wang, and Y. Wang, "Human-like autonomous car-following planning by deep reinforcement learning," *Transportation Research Part C: Emerging Technologies*, vol. 97, pp. 348–368, Dec 2018 (**TR-C most cited paper**, IF: 8.089).

[6] **M. Zhu**, X. Wang, A. Tarko, and S. Fang, "Modeling car-following behavior on urban freeways in Shanghai: a naturalistic driving study," *Transportation Research Part C: Emerging Technologies*, vol. 93, pp. 425–445, Aug 2018 (IF: 8.089).

[7] **M. Zhu**, X. Wang, and J. Hu, "Impact on car following behavior of a forward collision warning system with headway monitoring ," *Transportation Research Part C: Emerging Technologies*, vol. 111, pp. 425–244, Feb 2020 (IF: 8.089).

[8] Z. Pu, **M. Zhu**, Z. Cui, and Y. Wang, "Mining public transit ridership flow and origin-destination information from Wi-Fi and bluetooth sensing data," *IEEE Internet of Things Journal*, Jun 2020 (IF: 9.471).

[9] H. Wang, **M. Zhu**, W. Hong, C. Wang, G. Tao, and Y. Wang, "Optimizing signal timing control for large urban traffic networks using an adaptive linear quadratic regulator control strategy," *IEEE Transactions on Intelligent Transportation Systems*, Aug 2020 (IF: 6.492).

[10] X. Wang, **M. Zhu**, M. Chen, and P. Tremont, "Drivers' rear end collision avoidance behaviors under different levels of situational urgency," *Transportation Research Part C: Emerging Technologies*, vol. 71, pp. 419–433, Oct 2016 (IF: 8.089).

[11] X. Wang, M. Chen, **M. Zhu**, and P. Tremont, "Development of a kinematic-based forward collision warning algorithm using an advanced driving simulator," *IEEE Transactions on Intelligent Transportation Systems*, vol. 17, no. 9, pp. 2583–2591, Sep 2016 (IF: 6.492).

[12] X. Wang, and **M. Zhu**, "Calibrating and validating car-following models on urban expressways for Chinese drivers using naturalistic driving data," *China Journal of Highway and Transport*, vol. 31, issue 9, pp. 129–138, Oct 2018.

[13] M. Yang, X. Wang, and **M. Zhu**, "Driving behavior research based on naturalistic driving study," *Traffic and Transportation*, vol. 33, no. 3 pp. 7–9, Mar 2017.

[14] X. Wang, **M. Zhu**, and M. Chen, "Dimension reduction and multivariate analysis of variance for drivers' forward collision avoidance behavior characteristic," *Journal of Tongji University*, vol. 44, no. 12 pp. 1858–1866, Dec 2016.

[15] X. Wang, **M. Zhu**, and Y. Xing, "Impacts of collision warning system on car-following behavior based on naturalistic driving data," *Journal of Tongji University*, vol. 44, no. 7 pp. 1045–1051, Jul 2016.

[16] X. Wang, **M. Zhu**, and M. Chen, "Impacts of situational urgency on drivers' collision avoidance behaviors," *Journal of Tongji University*, vol. 44, no. 6 pp. 876–883, Jun 2016.

Conference Articles

[1] **M. Zhu**, H. Yang, and C. Liu, and Z. Pu, "Real-time crash identification using connected electric vehicle operation data," *accepted by the 101th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2022.

[2] Y. Liang, **M. Zhu**, Z. Wu, and Y. Wang, "Actor critic reinforcement learning for ecological cooperative adaptive cruise control," *accepted by the 101th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2022.

[3] Z. Cui, M. Tsai, **M. Zhu**, H. Yang, C. Liu, and Y. Wang, "Traffic performance score 2.0: measure urban mobility and online predict near-term traffic like weather forecast," *accepted by the 101th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2022.

[4] R. Xu, X. Wang, **M. Zhu**, and X. Zhu, "Impact of cell phone use on driving risk: a naturalistic driving study," *accepted by the 101th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2022.

[5] H. Yang, C. Liu, R. Ke, **M. Zhu**, and Y. Wang, "RISTS: real-time IoT system for traffic sensing by edge computing and multi-camera vehicle re-identification," *accepted by the 101th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2022.

[6] H. Yang, **M. Zhu**, R. Ke, C. Liu, and Y. Wang, "Novel network-scale traffic sensing approach using multi-camera object tracking and re-identification," *accepted by the 100th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2021.

[7] R. Ke, Z. Cui, Y. Chen, **M. Zhu**, and Y. Wang, "IoT system for real-time near-crash detection for automated vehicle testing," *accepted by the 100th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2021.

[8] Z. Cui, **M. Zhu**, S. Wang, P. Wang, Q. Cao, C. Kopca, and Y. Wang, "Traffic performance score for measuring the impact of COVID-19 on urban mobility," *accepted by the 100th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2021.

[9] P. Sun, X. Wang, and **M. Zhu**, "Modeling car-following behavior on freeways considering driving style," *accepted by the 100th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2021.

[10] **M. Zhu**, X. Wang, and Y. Wang, "Differences in freeway car following: empirical findings from naturalistic driving studies in Shanghai and Ann Arbor," *accepted by the 99th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2020.

[11] Z. Pu, X. Guo, Z. Cui, **M. Zhu**, and Y. Wang, "Mining public transit ridership flow and origin-destination information from wi-fi and bluetooth sensing data," *accepted by the 99th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2020.

[12] Z. Cui, M. Fu, **M. Zhu**, X. Ban, and Y. Wang, "Transportation artificial intelligence platform for traffic forecasting," *accepted by the 99th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2020.

[13] H. Wang, C. Wang, **M. Zhu**, and W. Hong, "Globalized modeling and signal timing control for large-scale networked intersections," in *Proceedings of the 2nd ACM/EIGSCC Symposium On Smart Cities and Communications (SCC 2019)*, Portland, OR, USA:ACM, Sep 2019.

[14] P. Sun, X. Wang, and **M. Zhu**, "Calibrating Car-Following Models on Freeway Based on Naturalistic Driving Study," in *19th COTA International Conference of Transportation Professionals*, Jul 2019.

[15] **M. Zhu**, X. Wang, and J. Hu, "Impact on car following behavior of a forward collision warning system with headway monitoring," *Presentation at the 98th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2019.

[16] X. Wang, L. He, **M. Zhu**, and C. Chai, "Calibrating car-following model on surface roads using Shanghai naturalistic driving study data," *Presentation at the 98th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2019.

[17] **M. Zhu**, X. Wang, and Y. Wang, "Human-like autonomous car-following planning by deep reinforcement learning," *Presentation at the 97th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2018.

[18] X. Wang, M. Yang, and **M. Zhu**, "An exploration of cut-in behavior and gap acceptance using Shanghai Naturalistic Driving data," *Presentation at the 97th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2018.

[19] **M. Zhu**, X. Wang, and Y. Wang, "Human-like autonomous car-following model by deep deterministic policy gradient reinforcement learning," *Accepted for Oral Presentation at the ASCE International Conference on Transportation and Development*, Pittsburgh, Pennsylvania, Jul 2018.

[20] **M. Zhu**, X. Wang, and A. Tarko, "Calibrating car-following models on urban expressways for Chinese drivers using naturalistic driving data," *Oral Presentation at the 96th Annual Meeting of the Transportation Research Board*, Washington D.C., USA, Jan 2017.

[21] **M. Zhu**, and X. Wang, "Impact of a forward collision warning system on headway and reaction time during car following," in *Proceedings of the 14th World Conference on Transport Research*, Shanghai, China, Jul 2016.

[22] **M. Zhu**, X.S. Wang, and X.M. Wang, "Car-following headways in different driving situations: a naturalistic driving study," in *Proceedings of the 16th COTA International Conference of Transportation Professionals*, Shanghai, China, Jul 2016.

[23] X. Wang, and **M. Zhu**, "Car-following headways in different driving situations: a naturalistic driving study in China," in *Proceedings of the 5th International Symposium on Naturalistic Driving Research*, Blacksburg, Virginia, USA, Oct 2016.

Patents

[1] X. Wang, **M. Zhu**, and P. Sun, "A autonomous driving velocity control algorithm based on multi-objective optimization," *C.N. Patent 109709956 A*, filed Dec 2018, and issued May 2019.

[1] X. Wang, **M. Zhu**, and P. Sun, "A human-like autonomous car-following model based on deep reinforcement learning," *C.N. Patent 109733415 A*, filed Jan 2019, and issued May 2019.

[1] X. Wang, **M. Zhu**, and M. Chen, "A forward collision warning algorithm considering heterogeneity of drivers' reaction," *C.N. Patent 105691391 A*, filed Jun 2016, and issued Sep 2017.

Reports

[1] Y. Wang, X. Ban, Z. Cui, and **M. Zhu**, "An artificial intelligence platform for network-wide congestion detection and prediction using multi-source data," *Connected Cities for Smart Mobility toward Accessible and Resilient Transportation Center (C2SMART)*, Jun 2019.

[2] Y. Wang, W. Zhu, and **M. Zhu**, "A connected vehicle-based adaptive navigation algorithm," *Pacific Northwest Transportation Consortium (PacTrans)*, Jun 2019.

[3] Y. Wang, M. Roger, J. Lutin, W. Zhu, **M. Zhu**, "Developing a statistically valid and practical method to compute bus and truck occupancy data," *Federal Highway Administration (FHWA)*, May 2019.

AWARDS & SCHOLARSHIPS ▪ 2022 Transportation Statistics Interest Group (TSIG) Student Paper Award   Jan 2022

- 2nd Place, Transportation Forecasting Competition, TRB AI Committee AED50   Jan 2022
- Graduate Student Travel Award, PacTrans   Jan 2022, Jan 2020
- Most Cited Paper, Transportation Research Part C: Emerging Technologies   Apr 2020
- Wining Award, 2021 Digital China Innovation Contest   Apr 2021
  Top 4 of 1332 teams, Smart Transportation-Collision Detection based on Big Data of Internet of Vehicles.
- Second Place, Poster Competition of 2020 PacTrans Student Transportation Conference   Nov 2020
- Outstanding Graduates of Shanghai, Shanghai Education Commission   Mar 2018
  Top 5%, for outstanding graduate students in Shanghai.
- National Graduate Scholarship (twice), Ministry of Education, China   Oct 2017, Oct 2016
  Top 0.2%, for outstanding graduate students in China.
- Outstanding Student Award, Tongji University   Oct 2016
  One of 44 awardees from the 13,864 graduate students in Tongji.
- China Graduate Mathematical Contest in Modeling, Second Prize   Sep 2016
- Volvo Scholarship, Volvo Group   Dec 2014
  One of 15 awardees in China, for outstanding engineering students.
- National Competition of Transport Science and Technology for Students, Second Prize   May 2014
  One of 8 winning groups in China.
  Project: Traffic Parameter Analysis Platform based on Unmanned Aerial Vehicle (UAV).
- Mathematical Contest in Modeling, Honorable Mention   Jan 2014
  Paper: Modeling the Keep-Right-Except-To-Pass Rule Using Cellular Automaton
- National Endeavor Fellowship (twice), Ministry of Education, China   Nov 2013, Nov 2012
  Top 3% of all the undergraduate students in China.
- China Undergraduate Mathematical Contest in Modeling, Second Prize   Sep 2013
  Top 5% among over 30,000 competition teams in China.

TEACHING& VOLUNTEER

Instructor, CET590 Traffic Systems Operations, University of Washington   Fall 2021
- Basic topics
  - **Traffic System Control**: Pretimed/Actuated Signal Control; Freeway Operations.
  - **Traffic Simulation**: Modeling with VISSIM; VAP; Driver Behavior Models; Behavior Model Calibration.
- Advanced topics:
  - **Traffic System Control**: Proportional–Integral–Derivative (PID) Control; Linear Feedback Control, Model Predictive Control (MPC); Linear Quadratic Regulator (LQR); Deep Reinforcement Learning; Traffic Control Case Studies based on Cutting-Edge Research; Autonomous Driving Research.
  - **Traffic Simulation**: Modeling with SUMO; Python for Controlling VISSIM and SUMO Simulation; Advanced Driver Behavior Modeling Methods including Imitation Learning, Inverse Reinforcement Learning, and Sequence to Sequence Models; Automatic Behavior Model Calibration.

Teaching Assistant, CET590 Traffic Systems Operations, University of Washington   Fall 2020
- Homework grading and tutoring, simulation tutorials, and final exams preparation.

Teaching Assistant, Statistical Analysis in Transportation Engineering, Tongji University   Fall 2017
- Preparing course slides and tutoring students on SAS coding.

Volunteer, Knowledge Discovery and Data Mining (KDD) 2021 Conference   Summer 2021

PROFESSIONAL ACTIVITIES

Reviewer
- IEEE Transactions on Intelligent Vehicles
- Transportation Research Part C: Emerging Technologies
- Transportation Research Record
- Accident Analysis & Prevention
- Journal of Intelligent Transportation Systems
- ACM Transactions on Intelligent Systems and Technology
- IEEE Transactions on Knowledge and Data Engineering
- Human Factors: The Journal of the Human Factors and Ergonomics Society
- Journal of Advanced Transportation
- Journal of Transportation Engineering, Part A: Systems
- IEEE Open Journal of Intelligent Transportation Systems
- IET Intelligent Transport Systems

- Mathematical Problems in Engineering
- International Conference on Machine Learning (ICML)
- Conference on Neural Information Processing Systems (NeurIPS)
- International Conference on Learning Representations (ICLR)
- IEEE International Conference on Robotics and Automation (ICRA)

Subcommittee on Connected and Automated Traffic Flow (CAT-Flow), TRB Committee on Traffic Flow Theory and Characteristics (ACP50)

- Committee Member   Oct 2021 – Present

Connected & Autonomous Vehicles (CAV) Impacts Committee, ASCE Transportation & Development Institute (T&DI)

- Younger Committee Member   Sep 2019 – Present

Artificial Intelligence Committee, ASCE Transportation & Development Institute (T&DI)

- Associate Committee Member   2020 – Present

Street and Highway Operations Committee, ASCE Transportation & Development Institute (T&DI)

- Associate Committee Member   2019 – Present

Associate Member, **American Society of Civil Engineers (ASCE)**   2019 – Present

Student Member, **IEEE, IEEE Intelligent Transportation Systems Society (ITSS)**   2021 – Present

Student Member, **Association for Computing Machinery (ACM)**   2021 – Present

SKILLS   Python, Pytorch, MATLAB, TensorFlow, C, C++, Java, R, SAS, SQL, VISSIM