

ZHAOBIN MO

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EDUCATION

Columbia University

Ph.D. in Civil Engineering (Advisor: Xuan Di)

Dissertation: "Physics-informed Deep Learning for Trajectory Prediction"

New York, NY

May 2019 – Dec. 2024

Columbia University

M.S. in Civil Engineering (Advisor: Xuan Di)

New York, NY

Aug. 2018 – May 2019

Tsinghua University

B.E. in Automotive Engineering

Beijing, China

Aug. 2013 – Jul. 2017

RESEARCH EXPERIENCE

Columbia University

Research Assistant

New York, NY

Aug. 2018 – Now

Driving Video Prediction

- Predicted subsequent frames in driving videos using **DDPM** trained on the Waymo dataset, achieving a Fréchet Video Distance (FVD) score of 1170.
- Evaluated the generation quality via a downstream **video Q&A** task using EILEV.

Critical Driving Scene Generation

- Developed a pipeline using **YOLOv5** and **Open3D** to generate critical scenarios: adjusted vehicle-to-vehicle distances to generate critical 3D scenarios, and then converted them back to 2D images.
- Developed a framework for generating diverse driving video scenarios conditioned on prompts, utilizing **Stable Diffusion XL (SDXL)** as the neural backbone and **ControlNet** for prompt conditioning.

Evaluating LLM in Understanding Social Norms

- Designed a prompt template for the **LLM-agent** to interpret game-related information (states, actions, and rewards) in Markov games.
- Evaluated that LLM-agent's (**GPT4-empowered**) capacity in understanding social norms, achieving 96% chances of yielding at unsignalized intersections and 91% chances of platooning on highways.

Distilling LLM Knowledge Using Caption Models

- Generated captions for car-collision images using the **LLaMA Adapter V2**. The generated captions naturally serve as training material for training domain-specific language models.
- Evaluated the generated caption by fine-tuning a downstream **Qwen 1.5-1.8b-chat** model; achieving a 20% increase in the accuracy of safety-critical traffic question responses.

AI-empowered Scientific Computing for Solving PDE Systems

- Incorporated **probabilistic models** like **normalizing flow** and **GAN** into **Physics-informed Neural Network** for the **uncertainty quantification (UQ)** of PDE systems.
- Applied this algorithm to the task of traffic state estimation with a **30%** improvement of accuracy.

Reinforcement Learning

- Developed an **Asymmetric Actor Critic** algorithm for traffic signal control in the connected-vehicle environment, achieving 20% less delay compared to the conventional symmetric actor-critic.
- Proposed a two-player game for autonomous vehicle driving test, which uses deep reinforcement learning and **Monte Carlo tree search** to narrow down the searching space.

Spatiotemporal Prediction Using Graph Neural Networks

- Developed an **Attention-based Spatiotemporal Graph Neural Network** to predict the visit counts considering the impact of contextual variables such as COVID-19, point-of-interests (POI) and population.
- Developed a model-agnostic **invariant learning** framework to handle the **Out-of-Distribution (OOD)** issue in spatiotemporal prediction; used **diffusion models** for data augmentation.

PROFESSIONAL EXPERIENCE

Argonne National Laboratory

Research Intern

Lemont, IL

June 2024 – Aug. 2024

Traffic Breakdown Precursors Identification

- Estimated the causes of traffic breakdowns using **Spatiotemporal Graph Neural Network** coupled with **Shapley additive explanations** to compute traffic state attributions.
- Proposed a hierarchical hypergraph method to decrease the computational complexity.

Siemens

Research Intern

Princeton, NJ

June 2022 – Aug. 2022

Power Transmission Admittance Matrix Estimation

- Estimate the power transmission admittance matrix of a **power grid network**. Estimation is conducted on real-world data containing voltage magnitudes and power profiles.
- Implemented different optimization methods: least square, grouped least square, non-convex optimization, and quad programming using MATLAB.
- Implemented **recursive optimization** methods for system identification of power transmission grids using real-world data, recovering the system parameters without voltage phase measurement.

DiDi AI Labs

Algorithm Engineer Intern

Beijing, China

Mar. 2018 – Jul. 2018

Driver Trajectory Data Processing

- Built a Python pipeline to extract spatial aggregation features from ~160K GPS trajectories of DiDi drivers.
- The aggregated feature was used as the feature of a reinforcement-learning based e-hailing algorithm.

Tsinghua University

Full-time Research Assistant

Beijing, China

Dec. 2017 – Jul. 2018

Cooperative Perception

- Developed a cooperative perception algorithm that uses **pyramid scene parsing network** neural networks and scale-invariant feature transform to achieve scenes merging among multiple vehicles.

SELECTED PUBLICATION

1. [AAAI'21] Rongye Shi, **Zhaobin Mo**, and Xuan Di. "Physics-informed Deep Learning for Traffic State Estimation: A Hybrid Paradigm Informed by Second-order Traffic Models", AAAI, 2021.
2. [KDD'22-W] **Zhaobin Mo** and Xuan Di. "Uncertainty Quantification of Car-following Behaviors: Physics-Informed Generative Adversarial Networks", *UrbComp workshop in KDD 2022* (**best paper award**).
3. [ECML-PKDD'22] **Zhaobin Mo**, Yongjie Fu, Daran Xu, and Xuan Di. "TrafficFlowGAN: Physics-informed Flow based Generative Adversarial Network for Uncertainty Quantification", *ECML&PKDD*, 2022.
4. [AAMAS'24] **Zhaobin Mo**, Yongjie Fu, and Xuan Di. "PI-NeuGODE: Physics-Informed Graph Neural Ordinary Differential Equations for Spatiotemporal Trajectory Prediction". *The 2023 International Conference on Autonomous Agents and Multiagent Systems*, 2024.
5. [IAVVC'24] Yongjie Fu, Anmol Jain, Xuan Di, Xu Chen, **Zhaobin Mo**. "DriveGenVLM: Real-world Video Generation for **Vision Language Model** based Autonomous Driving". *IEEE International Automated Vehicle Validation Conference*, 2024.
6. [IAVVC'24] Boxuan Wang, Haonan Duan, Yanhao Feng, Xu Chen, Xuan Di, Yongjie Fu, **Zhaobin Mo**. "Can **LLMs** Understand Social Norms in Autonomous Driving Games?". *IEEE International Automated Vehicle Validation Conference*, 2024.

SKILLS

Programming languages: Python, C/C++, R, SQL, Bash, MATLAB

Frameworks and tools: PyTorch, TensorFlow, OpenCV, ROS, Carla, Hive, Git, AWS, GCP, PyCharm, Visual Studio, Linux