

# Sizhe (Alex) Xu

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## EDUCATION

### New York University

Master of Science - Urban Data Science

Sept 2024 - June 2026

- **Courses:** Urban Computing & AI, Data Science, Deep Learning, Computer Vision, Large Language and Vision Models, Transportation and Logistics, Innovative City Governance, Probability and Stochastic Processes

### Dalian Jiaotong University

Bachelor of Engineering - Electronic Engineering

Sept 2020 - June 2024

- **Courses:** Analog Electronics, Object-Oriented Programming, Algorithm Design, Machine Learning

## PUBLICATIONS

- [1]. **Sizhe Xu\***, Renzhao Liang\*, Chenggang Xie, Jingru Chen, Feiyang Ren, Shu Yang, Takahiro Yabe, "Abstain Mask Retain Core: Time Series Prediction by Adaptive Masking Loss", *Advances in Neural Information Processing Systems* (2025) **Spotlight (top 5%)**. \* Denotes equal contribution.
- [2]. **Sizhe Xu**, Renzhao Liang, Jun Han, Qitong Sun, "A Hybrid Framework for Evaluating and Enhancing Syntactic and Semantic Diversity in Low-Resource Text Generation", *Under Review* (2025).
- [3]. **Sizhe Xu**, Boyang Li, Donghak Lee, Takahiro Yabe, "Thinking on the Move (ToM): A Framework for LLM-Agent-based Reinforcement Learning in Urban Mobility Simulation", *In Progress* (2025).
- [4]. Boyang Li, **Sizhe Xu**, Yulin Wu, Takahiro Yabe, "A Generalized RoPE for  $n$ -Dimensional Position Embedding", *In Progress* (2025).

## RESEARCH

### Abstain Mask Retain Core: Time Series Prediction by Adaptive Masking Loss

Co-first Author, Neural Information Processing Systems (NeurIPS) 2025 Spotlight

Mar 2025 - Aug 2025

- **Theoretical Innovation:** Challenged the prevailing long-sequence information gain hypothesis by identifying a counterintuitive phenomenon where strategic input truncation enhances forecasting accuracy. Leveraged the Information Bottleneck theory to formalize the trade-off between compression and prediction, proposing that explicit redundancy reduction in the latent space is critical for effective temporal signal extraction.
- **Methodological Framework:** Proposed **Adaptive Masking Loss with Representation Consistency (AMRC)**, a novel optimization framework consisting of two mechanisms: an **Adaptive Masking Loss** that utilizes stochastic approximation to dynamically identify and retain discriminative temporal segments, and an **Embedding Similarity Penalty** that enforces geometric consistency between input embeddings and output manifolds to mitigate semantic inconsistency and representation collapse.
- **Performance Achievement:** Demonstrated that the proposed constraints effectively restructure the optimization landscape, suppressing the learning of noise and irrelevant fluctuations. Validated the method's architecture-agnostic capability to enhance generalization and robustness across diverse backbones on standard multivariate benchmarks.

### A Hybrid Framework for Evaluating and Enhancing Syntactic and Semantic Diversity

First Author, Under Review

Jan 2025 - July 2025

- **Theoretical Innovation & Methodology:** Proposed a dual-stage hybrid generation paradigm to address the homogenization trade-off in low-resource NLG. Strategically decoupled syntactic skeleton generation from semantic refinement by utilizing probabilistic generative priors to capture diverse latent structures, followed by contextualization to ensure linguistic fidelity. This approach effectively reconstructs grammatically sound text while preserving the structural variance often lost in direct LLM generation.
- **Metric Design: SynDiv:** Pioneered SynDiv, a reference-free metric for quantifying syntactic diversity without relying on gold standards. Innovatively modeled dependency parse trees as graphs and utilized Graph Laplacian spectral decomposition to extract fine-grained structural features from eigenvectors, enabling mathematically rigorous assessment of syntactic heterogeneity in unsupervised settings.
- **Performance & Insight:** Demonstrated that the hybrid framework induces Gaussian-like distributions in both semantic and syntactic feature spaces, significantly mitigating inherent training data biases. The augmented data yielded improvement on fine-grained sentiment classification (GoEmotions) establishing a strong correlation between structural diversity and model generalization boundaries.

### Thinking on the Move (ToM): Generative ABM for Urban Simulation

NYU Center for Urban Science and Progress (Mentor: Prof. Takahiro Yabe)

June 2025 - Present

- **Generative Agent Architecture:** Developed a novel generative agent-based modeling framework that utilizes fine-tuned open-source LLMs as the cognitive core of urban agents. By aligning the LLMs with granular mobility traces from Safegraph and Cuebiq data, the framework successfully enables agents to simulate complex, non-linear human decision-making processes and trajectory planning, surpassing the predictive accuracy of traditional gravity and discrete choice models.
- **Predictive Analytics & Causal Inference Framework:** Proposed a counterfactual reasoning mechanism within the simulation to assess the impact of spatial interventions. Enabled the system to generate high-fidelity what-if scenarios, moving beyond correlation-based forecasting to provide mechanistic insights into how urban infrastructure changes causally propagate through collective mobility behaviors and retail dynamics

# Intelligent School District Advisory Service

NYU Center for Urban Science and Progress (Mentor: Prof. Zhaoxi Zhang)

Guided Study

Dec 2024 - Apr 2025

- **Data Engineering:** Architected a robust spatial-data infrastructure to integrate heterogeneous urban substrates, harmonizing disparate educational metrics with geospatial contexts. Addressed data inconsistency challenges through automated validity monitoring and advanced spatial indexing, establishing a unified analytical foundation for high-dimensional urban modeling.
- **Geospatial Analysis:** Developed a context-aware advisory framework that synergizes GIS with LLMs. Implemented EduRAG to translate complex spatial-performance metrics into personalized insights, effectively bridging the gap between quantitative urban analytics and user-centric decision-making.

## EXPERIENCE

### SnowFox Technology Co., Ltd.

Founder & Embedded System Architect

Remote

Nov 2022 - Apr 2024

- **Resource-Constrained Sensor Fusion:** Architected a low-latency sensor fusion framework for wearable MEMS inertial arrays. Implemented a multi-rate Extended Kalman Filter with optimized fixed-point quaternion arithmetic, effectively resolving gimbal lock issues and drift accumulation on power-constrained microcontrollers.
- **Edge-Cloud Biomechanical Analytics:** Developed a hierarchical motion analysis pipeline fusing Inverse Kinematics solvers with edge-deployed Bi-directional RNNs. Enabled real-time extraction of biomechanical features and movement classification, establishing a robust data synchronization protocol with AWS IoT Core for large-scale trajectory analysis.
- **System Validation & Deployment:** Validated the system's robustness and fault tolerance through extensive field testing in dynamic alpine environments, demonstrating stable performance under extreme temperature variations and high-impact motion scenarios.

### Autonomous Mobile Manipulation Platform (Smart Car Competition)

Student Research Lead

Dalian, China

Dec 2022 - July 2023

- **Cyber-Physical System Design:** Led the development of an autonomous mobile robot integrating perception, decision-making, and actuation modules. Designed a holonomic motion control architecture for the Mecanum-wheeled chassis, utilizing customized PCBs to facilitate high-frequency communication between perception units and motor drivers.
- **State Estimation & Control:** Implemented a closed-loop control system fusing gyroscopic data with odometry via Kalman Filtering. Addressed non-linearities in mechanical transmission through PID parameter optimization, significantly enhancing trajectory tracking precision and dynamic stability against mechanical vibrations.
- **Efficient Perception-Actuation Pipeline:** Deployed MobileNetV3 on edge processors for real-time target recognition. Engineered an automated manipulation logic that synchronizes visual feedback with mechanical arm inverse kinematics, achieving end-to-end autonomy in dynamic sorting tasks.

## PROJECTS

### Multi-modal Context-aware RAG System

Dec 2024 - June 2025

Developed RAG system handling text, images, and structured data with hybrid search and hallucination detection.

**Tech:** LangChain, Pinecone, FAISS, HuggingFace Transformers, CLIP

### Small Object Image Segmentation

Mar 2024 - June 2024

Active contour framework integrating improved YOLOv8, enhancing boundary precision and segmentation accuracy.

**Tech:** PyTorch, OpenCV, YOLOv8, FPN, EMA, TensorRT, ONNX

### Ecological Model for Fungal Biocontrol

Aug 2022 - Mar 2023

Fungal growth management system for optimizing ecological balance and maximizing agricultural profitability.

**Tech:** Tensorflow, RLlib, MADDPG, PSO, PostgreSQL, Optuna, ArcGIS, Folium

## SKILLS SUMMARY

**Languages:** Python, Rust, C++, R, SQL, Go, JAVA, L<sup>A</sup>T<sub>E</sub>X, Swift

**Frameworks:** Scikit, PyTorch, LangChain, CUDA, Django, Spring Boot, Unity, NodeJS

**Tools:** SolidWorks, Docker, Kubernetes, ArcGIS, vLLM, Git, ONNX

**Platforms:** Ubuntu, Kali, Raspberry Pi, ROS, NVIDIA Jetson, GCP, AWS

## HONORS AND AWARDS

- Spotlight Poster Presentation at NeurIPS 2025 - Sept, 2025
- Best Technical Contribution Award - Global Data Dive Competition - Feb, 2025
- Finalist of NYU CUSP Public Data Challenge - Oct, 2024
- NYU CUSP Experiential Scholars - Sept, 2024
- First Prize of National Intelligent Car Competition - Aug, 2023
- Bronze Medal in the China Collegiate Programming Contest (CCPC) - Oct, 2023

## REFERENCES

**Takahiro Yabe:** Assistant Professor at the Department of Technology Management and Innovation and the Center for Urban Science + Progress, New York University.

**Joseph Chow:** Institute Associate Professor at the Department of Civil and Urban Engineering, Deputy Director of C2SMARTER University Transportation Center, New York University.

**Zhaoxi Zhang:** Assistant Professor at the College of Design, Construction and Planning, University of Florida (formerly Postdoctoral Researcher at NYU CUSP during the mentorship period).