# Zilong Zhao

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## EDUCATION

**Wuhan University,** China *Expected June 2024*
Master of Philosophy in **Cartography and Geographic Information Science**

- **Research interest:** Human Mobility, GIS, Computational Social Science, Transport Geography, ITS
- **Supervisors:** Prof. Luliang Tang, Prof. Qingquan Li.
- Average score: **91.16** / 100, **National Scholarship** (2023)

**Wuhan University,** China *2019.03-2020.06*
Minor in **Business Administration**

- Cumulative GPA: 3.76 / 4.00

**Wuhan University,** China *2017.09-2021.06*
Bachelor of Engineering in **Geodesy and Geomatics Engineering**

- Cumulative GPA: **3.82** / 4.00, Average score: **91.09** / 100, Ranking: **3** / 265, **National Scholarship** (**Twice**)
- **Thesis Topic:** Traffic State Perception and Data Imputation Based on Spatio-Temporal Trajectory Data. (**Outstanding Bachelor's Thesis**)

## PUBLICATIONS

- **Zilong Zhao**, Luliang Tang, Mengyuan Fang, Xue Yang, Chaokui Li, Qingquan Li (2023). Toward urban traffic scenarios and more: A spatio-temporal analysis empowered low-rank tensor completion method for data imputation. **International Journal of Geographical Information Science**. DOI: 10.1080/13658816.2023.2234434. (SCI, **JCR Q1**, IF=5.7, **TOP Journal in GIS**)
- **Zilong Zhao**, Luliang Tang, Chang Ren, Xue Yang, Zihan Kan, Qingquan Li. (2023). Diagnosing Urban Traffic Anomalies by Integrating Geographic Information and Tensor Theory. **GIScience & Remote Sensing**. (SCI, **JCR Q1**, IF=6.7, **TOP Journal in GIS**, Accepted (Nov. 28))
- **Zilong Zhao**, Luliang Tang, Xue Yang, Huazu Zhang, Guangyue Li, and Qingquan Li (2023). Identifying critical urban intersections from a fine-grained spatio-temporal perspective. **Travel Behaviour and Society**, 34, 100649. DOI: 10.1016/j.tbs.2023.100649. (SSCI, JCR Q2, **IF=5.2**)
- Guangyue Li, **Zilong Zhao***, Xiaogang Guo, Luliang Tang, Huazu Zhang, Jinghan Wang (2023). Towards integrated and fine-grained traffic forecasting: A spatio-temporal heterogeneous graph transformer approach. **Information Fusion**, 102, 102063. DOI:10.1016/j.inffus.2023.102063 (**Corresponding author**, JCR Q1, **IF=18.6**, **TOP Journal in AI**)
- Zhiyu Yan, Xiaogang Guo, **Zilong Zhao**, Luliang Tang (2023). Achieving fine-grained urban flood perception and spatio-temporal evolution analysis based on social media. **Sustainable Cities and Society**, 105077. DOI: 10.1016/j.scs.2023.105077 (SCI, JCR Q1, **IF=11.7**, **TOP Journal in Urban Studies**)
- **Zilong Zhao**, Mengyuan Fang, Luliang Tang, Xue Yang, Zihan Kan, and Qingquan Li. (2022). The impact of community shuttle services on traffic and traffic-related air pollution. **International Journal of Environmental Research and Public Health**, 19(22), 15128. DOI: 10.3390/ijerph192215128
- Luliang Tang, **Zilong Zhao***, Xue Yang, Zihan Kan, Qingquan Li, et al. (2022). Road crowdsensing with high spatio-temporal resolution in big data era. **Acta Geodaetica et Cartographica Sinica**, 51(6):1070-1090. DOI: 10.11947/j.AGCS.2022.20220155 (**Corresponding author**, Top Chinese Journal)

- **Zilong Zhao** (2020). Research on application of differential grey neural network-AR model based on wavelet decomposition in the settlement prediction of metro tunnel. **Bulletin of Surveying and Mapping**, 2020(S1):99-103.
- Guangyue Li, **Zilong Zhao***, Yang Chen, Luliang Tang, Jinghan Wang, Xu Chu, Chaokui Li. Towards Complex Urban Traffic Forecasting: A Fully Attentional Approach Enhanced by Graph Representation. **IEEE Transactions on Intelligent Transportation Systems**. (**Corresponding author**, JCR Q1, **IF=8.5**, Under review)

## RESEARCH EXPERIENCE

### GeoAI | Tensor Theory & Urban Sensing

**Urban sensing and data imputation based on spatio-temporal trajectory data** *2020.10-2021.12*

*Core researcher, funded by the National Key R&D Program of China (No. 2017YFB0503604)*

- Adopt a manifold embedding approach to depict the local geometric structure of spatio-temporal domains, and propose a novel Spatio-Temporal constrained Low-Rank Tensor Completion (ST-LRTC) method.
- The proposed method achieves stable and accurate imputation results even in extreme scenarios with large missing rates or non-random missing patterns.
- This study won the **Grand Prize** of the 12th National College Students' Science and Technology Thesis Competition on Surveying and Mapping; **Excellent Bachelor's Thesis** of Wuhan University (2021).

**Urban traffic anomaly diagnosis based on crowdsourcing big data** *2021.09-2022.08*

*Core researcher, funded by the National Science Foundation of China (No. 41671442)*

- A novel Spatio-Temporal constrained Low-Rank Sparse Tensor (ST-LRST) method is proposed to decompose urban traffic data into normal and anomalous components.
- Perform comprehensive analyses of the spatio-temporal characteristics of complex urban anomalies and reveal the mobility patterns under special events.

### GeoAI | Deep Learning & Behaviour Modelling

**Fine-grained traffic state forecasting for complex urban scenarios** *2022.02-2023.08*

*Member, funded by the National Science Foundation of China (No. 42271449)*

- For complex topologies, dual graphs are constructed to emphasize the modeling of turning relationships.
- Propose Graph Representation enhanced Fully Attentional Spatial-Temporal network (GR-FAST) for Complex Urban Traffic Forecasting.
- Innovatively define a Heterogeneous Road network Graph and perform Heterogeneous Spatial Embedding to depict the inherent heterogeneity and synergistic relationships of fine-grained elements in road networks.
- Propose a novel Spatio-Temporal Heterogeneous Graph Transformer (STHGFormer) to achieve integrated and fine-grained traffic forecasting that considers both road segments and intersection turns.

**Machine learning-driven settlement analysis and prediction for metro tunnels** *2019.09-2020.10*

*Core researcher, funded by Wuhan University (No. S2019214021)*

- A wavelet decomposition-based differential gray neural network-AR model is proposed to address the impact of non-stationary sequences on the prediction accuracy of gray neural networks.
- This study won the **First Prize** (Top 2) in the 15th Science and Technology Paper Competition of School of Geodesy and Geomatics, Wuhan University.

### Human Mobility & Urban Sustainability

**Multi-scale spatiotemporal modeling and analysis for network-constrained flow** *2023.04-Present*

*Core researcher, funded by the Fundamental Research Funds for the Central Universities*

- Innovatively propose path flow to compensate for the lack of detailed description of crowd movement processes in OD flow.

- Achieve definition, modeling, storage, distance calculation and similarity metrics for path flow.
- Develop spatio-temporal interaction behavior based Path Flow Similarity - Time (PFS-T) and co-travel distance based Path Flow Similarity - Space (PFS-S).

**The impact of low-carbon transport on traffic and traffic-related air pollution** *2021.03-2022.11*

*Core researcher, funded by the National Science Foundation of China (No. 41971405)*

- Propose a complete framework to quantitatively assess the positive impacts of community shuttle services.
- Develop a novel method to adaptively generate shuttle stops with maximum service capacity based on crowd movement data, and design shuttle routes with minimum mileage by genetic algorithm.
- Conduct a fine-grained quantitative assessment of the extent to which community shuttle services alleviate traffic congestion and reduce traffic-related air pollution.

**Critical Node Identification and Resilience Assessment of Urban Road Networks** *2022.03-2023.08*

*Core researcher, funded by the National Science Foundation of China (No. 41901394)*

- Upgrade the intersection evaluation scale to turn-level, propose the concept of Turning Sub-Node (TSN) and constructs a refined TSN topology network.
- Develop an urban Intersection Evaluation framework from a Fine-grained Spatio-Temporal perspective (IE-FST) to achieve a refined and dynamic evaluation of urban intersections.
- Achieve spatio-temporal pattern perception of urban intersection importance and provide traffic management measures for different types of TSNs to improve urban transport efficiency.

## PROJECT EXPERIENCE

**AI-based key technology for unmanned inspection of extra-high arch dams** *2021.01-2022.12*

*Core developer, funded by HuaNeng Lancang river hydropower INC. (No. XWDC2020/P26)*

- Propose a UAV trajectory planning method for complex scenes of extra-high arch dams, which accounts for multiple constraints such as positioning signal, dam segment design, flight duration, and acquisition accuracy.
- Develop a collaborative acquisition technology for dam surface data from UAV swarms considering the spatial and temporal distribution characteristics of GNSS signals from arch dams.
- **Patent:** A trajectory planning method for automatic inspection operation of extra-high arch dams by UAV (No. 202111411213X)

**Turn-level traffic flow sensing and prediction technology based on spatio-temporal trajectory big data fusion** *2020.05-2021.12*

*Core researcher and developer, funded by Huawei Technologies Co., Ltd. (No. YBN2018095106)*

- Develop a spatio-temporal analysis empowered low-rank tensor completion method for traffic data imputation, by considering the continuity, periodicity and transitivity of traffic flow.
- Construct a 'segment-turn' based traffic topology graph (named dual graph), and develop a fine-grained traffic prediction method with graph attention network to achieve turn-level prediction of traffic states.

**Warehouse picking problems in large scale and complex scenarios** *2020.03-2022.08*

*Project Leader, funded by Jingdong Logistics, and DC Holdings*

- Propose the concept of replacement recheck table and construct a dynamic adjustment algorithm applicable to multi-zone type warehouse and complex picking problems.
- Combined with the specific situation of enterprise logistics warehouse picking, realize multi-perspective and whole process of warehouse picking path optimization.
- This study won the **Grand Prize** (Top 1) in MathorCup College Mathematical Modeling Challenge, 2020; **Winning Prize** in Digital China Holdings Campus Geek Contest, 2022.

## CONFERENCE PRESENTATIONS

- **The 2022 International Graduate Workshop on GeoInformatics** (IGWG2022), Session 2-1. "To what extent can community shuttle services enhance transport efficiency and improve the surrounding environment?" (Oral Presentation).
- **The 18th Annual Conference on Theory and Methods of Geographic Information Science**, 2023. "Spatio-temporal low-rank sparse tensor model and its application in urban anomaly analysis" (Oral Presentation).
- **The Global Smart Cities Summit** cum **The 3rd International Conference on Urban Informatics** (GSCS&ICUI 2023), Session 1: GeoAI for Human Mobility: Emerging Technologies and Applications. "ST-LRTC: A Spatio-Temporal analysis empowered Low-Rank Tensor Completion method for missing traffic data imputation" (**Best Presentation Award**).
- **ACM SIGSPATIAL** International Workshop on the Human Mobility Prediction Challenge (HuMob-Challenge 2023). "Large-Scale Human Mobility Prediction Based on Periodic Attenuation and Local Feature Match", Nov. 2023, Hamburg, Germany.

## HONORS

- **National Scholarship**, Ministry of Education of China, **Three times** (**2019**, **2020**, **2023**).
- **National Encouragement scholarship**, Ministry of Education of China, 2018.
- **First Prize Scholarship**, Wuhan University, **Three times** (2019, 2020, 2023).
- **Merit Student**, Wuhan University, Twice (2019, 2020).
- **Best Presentation Award**, International Society for Urban Informatics, 2023.
- **Outstanding Graduate Student**, Wuhan University, Twice (2022, 2023).
- **Second Prize Scholarship**, Wuhan University, 2022.
- **Advanced Individual**, China Graduate Student Innovation and Practice Series Competition (2021, 2022)
- **Outstanding Freshman Scholarship for Graduate Students**, Wuhan University, 2021.
- **Laboratory Scholarship for Outstanding Masters Students**, LIESMARS (Wuhan University), 2021.
- **Outstanding Graduates**, Wuhan University, 2021.
- **Outstanding Bachelor's Thesis**, Wuhan University, 2021.
- **Excellent Student Cadre**, Wuhan University, 2020.
- **Advanced Individual of Social Work**, Wuhan University, 2019.
- **Outstanding Student**, Wuhan University, 2018.
- **Outstanding Volunteer**, Wuhan University, 2018.

## COMPETITION AWARDS

- **National First Prize** in **National Mathematical Modeling Contest**, 2019.
- **Meritorious Winner** in **Interdisciplinary Contest in Modeling**, 2019.
- **Grand Prize** (**Top 1**) in MathorCup College Mathematical Modeling Challenge, 2020.
- **First Prize** (Top 2) in the 15th Science and Technology Paper Competition of School of Geodesy and Geomatics, 2020.
- **First Prize** in National University Students Electrical Math Modeling Competition, 2021.
- **Grand Prize** in the 12th National College Students' Science and Technology Paper Competition on Surveying and Mapping, 2021.
- **National Second Prize** in the 18th China Post-Graduate Mathematical Contest in Modeling, 2021.
- **Winning Prize** in Digital China Holdings Campus Geek Contest, 2022.
- **National Third Prize** in China Postgraduate 'Carbon Peaking and Carbon Neutrality' Innovation and Creativity Contest, 2022.
- **Top-10 Score** in the Human Mobility Prediction Challenge, MIT Connection Science, 2023.