

# ZHICHAO HOU

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Institute: AMSS, CAS

## EDUCATION

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### North Carolina State University, Raleigh, United States

September 2023-June 2028

- PhD in Computer Science

Advisor: Xiaorui Liu

- Research focus: Graph Neural Networks, Adversarial Attacks and Defense

### Academy of Mathematics and Systems Science, Beijing, China

September 2020-June 2023

- MS in Applied Mathematics

Advisor: Lingyu Wu

- Research focus: Optimal Transport, Deep Learning, Bioinformatics

### Beijing Normal University, Beijing, China

September 2016 - June 2020

- BS in Applied Mathematics

GPA: 92.67/100

- Liyun Class by the National Top-notch Talent Cultivation Plan

### Tufts University, Medford and Somerville, Massachusetts, United States

June 2018-August 2018

- Exchange Student (Coding Bootcamp)

## SCHOLARSHIPS & AWARDS

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First-class scholarship of Beijing Normal University

2017, 2018, 2019

Champion of Mingyue Cup Basketball Match of Beijing Normal University

2017, 2018

Second-class prize of BNU Mathematical Modeling Contest

2018

First-class prize of National Mathematical Modeling Contest

2018

Third-class prize of National Mathematics Competition

2018

Honorable Mention of MCM

2019

Outstanding graduates in Beijing Normal University

2020

## RESEARCH EXPERIENCE

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### Robust Graph Neural Networks with Directed Graphs

Advisor: Prof. Xiaorui Liu

North Carolina State University

March 2023 - Now

- Constructed a high-level directed message passing scheme for undirected GNNs, such as GCN, GAT and APPNP.
- Designed a novel directed adaptive attack to test the robustness of our model.
- Our directed MP scheme is significantly robust to graph adversarial attacks both in both transferable and adaptive sense.

### Equivariant Spatio-Temporal Attentive Graph Networks

Advisor: Prof. Wenbing Huang

Institute for AI Industry Research, Tsinghua University

May 2022 - December 2022

- Designed a novel Equivariant Discrete Fourier Transform (EDFT) to extract periodic patterns
- Constructed an Equivariant Spatial Module (ESM), and an Equivariant Temporal Module (ETM) with the attention mechanism, to process spatial and temporal message passing, respectively
- Evaluated our model on three real datasets corresponding to the molecular level, protein level and macro level. Experimental results verify the effectiveness of ESTAG compared to typical equivariant GNNs

## **PathExpSurv: Pathway Expansion for Explainable Survival Analysis and Disease Gene Discovery**

Advisors: Prof. [Lingyu Wu](#) & [Zheng Xia](#)

*Operations Research Laboratory, Academy of Mathematics and Systems Science*

*Computational Biology Laboratory, Oregon Health and Science University*

- Proposed a two-phase training scheme to pre-train bioinformed net with prior information and continue to train it to explore the possible expansion of prior pathways
- Expanded the prior pathways based on trained link weights under 100 random experiments
- Performed reliable downstream analyses to validate the model interpretability and effectiveness

## **SCARP: Single-Cell ATAC-seq analysis via Network Refinement with peaks location information**

Advisor: Prof. [Lingyu Wu](#)

*Operations Research Laboratory, Academy of Mathematics and Systems Science*

- Constructed the relation matrix based on the cell-peak accessible relationships and peak-peak co-accessibility
- Aggregated information with the Network Refinement (NR) diffusion method
- Leveraged SCARP to improve cell clustering performance and reveal new significant cell subpopulations

## **Wasserstein Distributionally Robust Optimization (WDRO)**

Advisor: Prof. [Lingyu Wu](#)

*Operations Research Laboratory, Academy of Mathematics and Systems Science*

*August 2019 - June 2020*

- Studied the theory of WDRO and deduced the analytical form of dual DRO with a complete proof
- Performed analysis of WDRO in classical ML problems (classification, regression, MLE, MMSE)
- WDRO achieved better generalization and robustness against classical method (SVM, Gaussian MLE, KF)

## **Approximation Algorithms in Wasserstein Distance**

Advisors: Prof. [Li Cui](#) & [Jun Liu](#)

*Computational Mathematics Laboratory, Beijing Normal University*

*May 2018 - May 2019*

- Studied intensively on fundamental theories about the Sinkhorn and Gibbs-OT algorithms
- Implemented Sinkhorn and Gibbs-OT algorithms in image registration problem

## **PUBLICATIONS & MANUSCRIPTS**

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- **Zhichao Hou**, Xitong Zhang, Wei Wang, Charu C. Aggarwal, Xiaorui Liu. Can Directed Graph Neural Networks be Adversarially Robust? Submitted to *2023 Neurips*. Under review. [[Arxiv](#)]
- Wendi Yu, **Zhichao Hou**, Xiaorui Liu. Automated Polynomial Filter Learning for Graph Neural Networks. Submitted to *2023 CIKM*. Under review. [[Arxiv](#)]
- **Zhichao Hou**, Jirui Yuan, Wenbing Huang. Equivariant Spatio-Temporal Attentive Graph Networks for Physical Dynamics Simulation. Submitted to *2023 Neurips*. Under review.
- **Zhichao Hou**, Jiacheng Leng, Jiating Yu, Zheng Xia, Ling-Yun Wu. PathExpSurv: Pathway Expansion for Explainable Survival Analysis and Disease Gene Discovery. Submitted to *2022 Bioinformatics*. Under review. [[BioRxiv](#)]
- Jiating Yu, Duanchen Sun, **Zhichao Hou**, Ling-Yun Wu. Single-Cell ATAC-seq analysis via Network Refinement with peaks location information. Submitted to *2022 Nature Methods*. Under review. [[BioRxiv](#)]

## **INDUSTRIAL EXPERIENCE**

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### **Spatial-Temporal Attentional GNN in Traffic Flow Prediction**

Mentor: Prof. [Wenbing Huang](#)

*Institute for AI Industry Research, Tsinghua University*

*Intelligent Transportation Department, Baidu*

*March 2022 - June 2022*

- Proposed graph learner to learn the dynamic graph structure from traffic flow data
- Constructed STAGNN to capture the spatial and temporal dependencies of the traffic spatial-temporal graph

- Achieved 25% performance improvement comparing to Baidu official baseline

### **Financial Time Series Data Generation with SigCWAN**

*AI-Quant Ltd, Beijing*

Mentor: Dr. Ge Wang

*June 2021 - September 2021*

- Got insight into the drawbacks of GAN & WGAN in data generation
- Researched on SigCWGAN which leveraged path signature as a tool to improve WGAN
- Improved model training stability & robustness and the generated data passed six financial data tests

## **PROGRAMMING & LANGUAGE SKILLS**

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**Programming**   Python, PyTorch, R, MATLAB, C, Keras, LaTeX

**TOEFL iBT**   99/120