

Jiaheng Cui

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EDUCATION

University of Georgia

Athens, GA, USA

PhD in Electrical and Computer Engineering, College of Engineering

Jun. 2023 – Present

- **PhD Advisor:** Dr. Yiping Zhao, Dr. Xianyan Chen
- **GPA:** 4.0/4.0
- **Coursework:** *Trustworthy Machine Learning (A); Design of Experiments for Research Workers (A); Machine Learning (A); Bayesian Statistical Methodology with Applications (A); Optimization Algorithms in AI (A)*
- Awarded “College of Engineering Graduate Research Assistantship” for Summer 2023, Fall 2023, and Spring 2024

Northeastern University

Boston, MA, USA

Master in Artificial Intelligence, Khoury College of Computer Sciences

Sept. 2021 – May. 2023

- **GPA:** 3.96/4.0
- **Coursework:** *Programming Design Paradigm (A); Pattern Recognition and Computer Vision (A); Algorithms (A); Advanced Reinforcement Learning (A); Foundations of AI (A); Machine Learning (A-); Human-Computer Interaction (A); Statistical Inference (A)*

Nankai University

Tianjin, China

Bachelor of Science in Statistics, College of Mathematical Sciences

Sept. 2017 - Jun. 2021

- **GPA:** 85.73/100
- **Major Coursework:** *Mathematical Analysis (83); Advanced Algebra and Analytic Geometry (92); Probability Theory (98); Fundamentals of Computer for Science and Engineering (92); Data Structures and Algorithms (92); Database (85); Introduction to Machine Learning (92)*
- Awarded “Graduate with Honor” and “Outstanding Undergraduate Thesis Award”

University of California, Berkeley

Berkeley, CA, USA

Berkeley International Study Program

Aug. 2019 - Dec. 2019

- **GPA:** 3.57/4.0
- **Coursework:** *Numerical Analysis (A); Concepts of Statistics (A-); Introduction to Partial Differential Equations (B)*
- Awarded “Global Nankai” Abroad Study Scholarship

RESEARCH & ACADEMIC EXPERIENCE

Research Assistant in Dr. Yiping Zhao's Lab

University of Georgia, Athens, GA, USA

Graduate Research Assistant

Jun. 2023 – Present

As a PhD researcher in spectroscopic data science, I develop computational frameworks that bridge physical principles and statistical analysis of complex spectral datasets. My expertise lies in uncovering both physical and statistical patterns within Surface-Enhanced Raman Spectroscopy data, which I leverage to design innovative processing algorithms and analytical methodologies. By integrating mathematical modeling with machine learning, I create approaches that translate across diverse applications—from virus detection to environmental monitoring and protein quantification. Beyond data analysis, I establish community resources through open-source algorithm development, while collaborating with industry partners to implement our algorithms in real-world instruments. This combination of fundamental innovation and practical implementation advances both the theoretical capabilities and real-world utility of spectroscopic analysis.

Research Program in Dr. Gang Luo's Lab

Harvard University, Boston, MA, USA

Summer Research Intern

May. 2022 – Oct. 2022

Project: Eyeturn Measurement based on Computer Vision and Cloud Computing

- Used OpenCV to perform traditional Computer Vision processing such as binarization and edge detection on the gazeNet results in order to locate the corneal reflection points for eyes with different colors and sizes.
- Used matrix optimization techniques to do ellipse fitting on the iris, and found the center of the iris based on the binarization results.

- Determined whether the patient had strabismus based on the detection results and ophthalmic knowledge; if so, we were able to quantify the severity of the strabismus.

Course Project: Advanced Reinforcement Learning **Northeastern University, Boston, MA, USA**
Mar. 2022 - May. 2022

Project: **An Improved Approach to Hierarchical Object Detection with Deep Reinforcement Learning**

- Refined the detection strategy by refining the sub-sections that needed to be processed by the agent; updated the state, action, and reward space design of the RL part. Results showed an overall AP increase with simply refining the action-selection strategy.
- Performed experiments with DQN, DDQN, and D3QN; although DDQN achieved the highest observed accuracy, D3QN had the largest mAP.
- The final model using D3QN reduces the average number of steps to process an image from 7 to 4 and the maximum number of steps from more than 10 to 7.

Bachelor Thesis **Nankai University, Tianjin, China**
Jan. 2021 - Jun. 2021

Project: **An Exploration of Transformer-Based Object Detection Technology**

- Proposed modifications to the DETR model, results showed better performance on large object detection tasks and the potential to do vehicle, pedestrian, and sign detection for autonomous driving cars.
- Analyzed the built-in defects of DETR and proposed further theoretical improvement methods
- Won the Best Paper Award for undergraduate students

Research Program in Dr. Hong Zhao's Lab **Nankai University, Tianjin, China**
Research Assistant Jun. 2020 - Mar. 2021

Project: **Copper Wire Melting Mark Classification Algorithm (Jul. 2020 – Mar. 2021)**

- Classified four typical melting mark pictures using C++ and OpenCV.
- Completed the algorithm design to improve the identification accuracy of picture classification by combining our algorithm with classification models.

Project: **Motor Vehicle Fire Scene Information Reporting System (Jun. 2020 - Jul. 2020)**

- Developed a vehicle fire scene information reporting system (an Android APP implemented by JAVA) for Tianjin Fire Research Institute of MEM, which has been put into practical use.

National College Students Innovation Training Program **Nankai University, Tianjin, China**
Group Leader Mar. 2019 - Mar. 2021

Project: **Geometric View and Algorithm Optimization of Generative Adversarial Network (GAN)**

- This project was selected as one of the two national-level projects in the College of Mathematics, Nankai University.
- Explained the principle of GAN with differential geometry and optimal transportation theory.
- Proposed a generative model - OTVAE based on optimal transport and VAE, which could train 10 epochs to obtain the image quality produced by WGAN training 200 epochs with 60% less time.

Course Project: Introduction to Machine Learning **Nankai University, Tianjin, China**
Group Leader Nov. 2020 - Jan. 2021

Project: **Machine Learning Financial Aid Rater**

- Optimized the existing algorithm for aiding economically disadvantaged students at Nankai University.
- Structurized the original unstructured data using tokenization in NLP, realized dimensionality reduction using the t-SNE algorithm, and achieved label refinement using a t-SVM model in semi-supervised learning.
- Nankai University Student Financial Aid Center has adopted the model to rate economically disadvantaged students to provide suggestions to the experts for helping students.

INTERNSHIP EXPERIENCE

OpenBayes **Beijing, China**
AI Engineer Intern Jan. 2020 - Feb. 2020

- Explored the basic algorithm of machine learning and created a 5-chapter tutorial for new interns.

Wuhan Shuosi Software Co., Ltd **Tianjin, China**
Data Scientist Intern Jun. 2019 - Aug. 2019

- Used Numpy, Pandas, and basic analysis methods of Python in processing and interpreting stock data

- Tracked several stocks, collected and cleaned the financial data, performed specific transformations (such as log transformation), and conducted a market analysis with Python.

TECHNICAL SKILLS

- Programming Languages: Python, JAVA, C++, JavaScript
- Others: Git, R, MATLAB, Latex, Markdown, OpenCV, Android Development, Spark, MySQL, Azure

PUBLICATIONS

11. **Jiaheng Cui**, Yanjun Yang, Amit Kumar, Jackelyn Murray, Les Jones, Xianyan Chen, Ralph A. Tripp, Yiping Zhao*, "Surface-Enhanced Raman Scattering for Quantitative Analysis of Virus Adsorption and Competitive Binding on Nanostructured Surfaces," submitted to Journal of Physical Chemistry A, under revision.
10. **Jiaheng Cui**[#], Chenyao Feng[#] (equal contribution), Xulan Chen, Yanjun Yang, Pengju Yin*, Yiping Zhao*, "Improving Protein Quantification with SERS Superspectra and Machine Learning," in preparation.
9. **Jiaheng Cui**, Xianyan Chen, Yiping Zhao*, "Beyond Traditional airPLS: Improved Baseline Removal in SERS with Parameter-Focused Optimization and Prediction," submitted to Analytical Chemistry, under revision.
8. Yufang Liu, Yanjun Yang, Haoran Lu, **Jiaheng Cui**, Xianyan Chen, Ping Ma*, Wenxuan Zhong*, Yiping Zhao*, "Extracting True Virus SERS Spectra and Augmenting Data for Improved Virus Classification and Quantification," ACS Sensors Article ASAP, DOI: 10.1021/acssensors.4c03397.
7. Yanjun Yang, **Jiaheng Cui**, Amit Kumar, Dan Luo, Jackelyn Murray, Les Jones, Xianyan Chen, Sebastian Hülck, Ralph A. Tripp, Yiping Zhao*, "Label-free detection of respiratory virus co-infections: integrating surface-enhanced Raman scattering with deep learning," Proc. SPIE 13298, Photonic Diagnosis, Monitoring, Prevention, and Treatment of Infections and Inflammatory Diseases 2025, 1329802 (19 March 2025).
6. Yanjun Yang, **Jiaheng Cui**, Amit Kumar, Dan Luo, Jackelyn Murray, Les Jones, Xianyan Chen, Sebastian Hülck, Ralph A. Tripp, Yiping Zhao*, "Multiplex Detection and Quantification of Virus Co-infections using Label-free Surface-Enhanced Raman Spectroscopy and Deep Learning Algorithms," ACS Sensors, 10, 1298-1311 (2025).
5. Tao Wang, Yanjun Yang, Haoran Lu, **Jiaheng Cui**, Xianyan Chen, Ping Ma*, Wenxuan Zhong*, Yiping Zhao*, "Functional Regression for SERS Spectrum Transformation Across Diverse Instruments," Analyst 150, 460-469 (2025). (**Selected as journal cover**)
4. Joshua C. Rothstein, **Jiaheng Cui***, Yanjun Yang, Xianyan Chen, Yiping Zhao*, "Ultra-Sensitive Detection of PFASs using Surface Enhanced Raman Scattering and Machine Learning: A Promising Approach for Environmental Analysis," Sensors & Diagnostics 3, 1272-1284 (2024).
3. Yanjun Yang, Hao Li, Dan Luo, **Jiaheng Cui**, Amit Kumar, Leslie Jones, Jackelyn Crabtree, Hemant Naikare, Yung-Yi C. Mosley, Teddy Spikes, Sebastian Hülck, Xianyan Chen, Ralph A. Tripp, Bin Ai, Yiping Zhao, "Detection of SARS-CoV-2 in patient specimens by surface enhanced Raman spectroscopy and deep learning," Proc. SPIE 12999, Optical Sensing and Detection VIII, 129991I (20 June 2024).
2. Yanjun Yang, **Jiaheng Cui**, Dan Luo, Jackelyn Murray, Xianyan Chen, Sebastian Hülck, Ralph Tripp, Yiping Zhao*, "Rapid Detection of SARS-CoV-2 Variants Using ACE2-Based SERS Sensor Enhanced by CoVari Deep Learning Algorithms," ACS Sensors 9, 3158–3169 (2024).
1. Yangxiu Chen, Yanjun Yang, **Jiaheng Cui**, Hong Zhang*, Yiping Zhao*, "Decoding PFAS contamination via Raman spectroscopy: A combined DFT and machine learning investigation," J. Harz. Mater. 465, 133260 (2024).

EXTRACURRICULAR ACTIVITIES

New Media Center of College of Mathematics

Department Officer

Nankai University, Tianjin, China

Jun. 2018 - May. 2019

- Received and processed activity information from other college student organizations in the college and arranged daily news reports on the media platforms
- Led a team of 10 people, organized more than 30 online activities, and released more than 1,000 messages and articles on media platforms within one school year