Zhaolu Liu

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EDUCATION

2022-2026 Imperial College London, London

PhD in Mathematics

2020-2021 Imperial College London, London

MRes Biomedical Research (data science stream), Achieved Distinction

2016-2020 Imperial College London, London

MSci Mathematics, Achieved First Class

EXPERIENCE

2023-2025 Research Assistant in EPSRC Statistical Physics of Cognition, **Imperial College London**
Developed a 16-times super-resolution GAN for two-photon calcium imaging

2023-2024 Research Assistant in Pissarides Review funded by Nuffield, **Imperial College London**
Analysed 200 million online job adverts using graph-based clustering and LLM

PROJECTS

2022-2026 Understanding High-Order Interactions
- Developed kernel-based statistical hypothesis tests for detecting high-order interactions, achieving a 100-fold improvement in computational efficiency for causal discovery
- Derived novel information measures to rigorously quantify high-order interactions, achieving 95% accuracy in decoding neural signals and outperforming existing feature selection methods like SHAP.
- Designed a transformer trained on pure synthetic data, enabling accurate causal hypernetwork reconstruction from observational data within seconds.

2021–2025 Super-Resolution for Biomedical Imaging using Deep Learning
- Achieved 16× super-resolution for three image modalities - Nucleic Magnetic Resonance spectroscopy, Mass Spectrometry imaging and two-photon Calcium imaging – enhancing downstream biomedical tasks

2020–2024 Large-Scale Natural Language Processing
- Analysed 200 million job averts using LLM to summarise skills clusters of UK labour market, findings featured at All-Party Parliamentary Group on the Future of Work
- Built a Longformer for 10 million long-context mental health messages, achieving 96% accuracy in predicting texter demographics

AWARDS

"Smartest AI Agent", Fetch.ai Innovation Lab Hackathon (2024), £250, runner-up, London

SIAM AN24 student travel awards (2024), $800, Society for Industrial and Applied Mathematics

Cecilia Tanner Research Funding (2023), £1500, Imperial College London

PUBLICATIONS

Z Liu, RL Peach, M Barahona (2025). *Permutation-Free High-Order Interaction Tests*. Forty-Second International Conference on Machine Learning (ICML 2025).

V Coroian, **Z Liu**, A Sreevathsa, A Liardi, F Rosas, M Barahona, PAM Mediano, *Scaling Up Operational Synergy Estimators to Continuous Distributions* (Under review).

Y Xiang*, **Z Liu***, ME Garcia-Segura, D Simon, B Cao, V Wu, K Robinson, Y Wang, R Battle, RT Murray, X Altafaj, L Peruzzotti-Jametti, Z Takats (2025). *Hyperspectral Image Restoration and Super-resolution with Physics-Aware Deep Learning for Biomedical Applications*. arXiv:2503.02908.

Z Liu, RL Peach, M Barahona (2025). *Information-Theoretic Measures on Lattices for High-Order Interactions*. International Conference on Artificial Intelligence and Statistics 28 (AISTATS 2025).

Z Liu, JM Clarke, B Rohenkohl, M Barahona (2025). *Patterns of Co-Occurrent Skill in UK Job Adverts*. PLOS Complex Systems 2, e0000028.

Y Yan, MT Judge, T Athersuch, Y Xiang, **Z Liu**, B Jimenez, TMD Ebbels (2024). *Resolution Enhancement of Metabolomic J-Res NMR Spectra Using Deep Learning*. Analytical Chemistry 96, 11707

Z Liu, RL Peach, PAM Mediano, M Barahona (2023). *Interaction Measures, Partition Lattices and Kernel Tests for High-Order Interactions*. Advances in Neural Information Processing Systems 36 (NeurIPS 2023).

Z Liu, RL Peach, F Laumann, SV Mengod, M Barahona (2023). *Kernel-based Joint Independence tests for Multivariate Stationary and Nonstationary Time-Series*. Royal Society Open Science 10, 230857.

Z Liu, RL Peach, EL Lawrance, A Noble, MA Ungless, M Barahona (2021). *Listening to Mental Health Crisis Needs at Scale: Using Natural Language Processing to Understand and Evaluate a Mental Health Crisis Text Messaging Service*. Frontier in Digital Health 3, 779091.

REPORTS

R Costa, **Z Liu**, C Pissarides, B Rohenkohl (2024). *New skills, old skills: what is changing in the UK labour market?* Institute for the Future of Work.

R Costa, **Z Liu**, S McNally, L Murphy, C Pissarides, B Rohenkohl, A Valero, G Ventura (2023). *Learning to grow: How to situate a skills strategy in an economic strategy*. Resolution Foundation.

CONFERENCES

ICSDS 2024: IMS International Conference on Statistics and Data Science, Nice (Talk)

CCS 2024: Conference on Complexity Systems, FinEcoNets satellite: Complexity in Economics & Finance, Exeter (Talk)

NetSci 2024, FinEcoNets satellite: Economic & Finance Networks, Quebec City (Talk)

AN24: 2024 SIAM Annual Meeting, Spokane (Poster)

Faculty of Natural Science Postdocs and Fellows Research Showcase 2023, Imperial, London (Talk)

ICIAM 2023: International Congress on Industrial and Applied Mathematics, Higher-order networks for complex systems minisymposium, Tokyo (Talk)

NetSci 2023, TopoNets: Between higher-order mechanisms and phenomena, Vienna (Talk)

HealTAC 2021: Heathcare Text Analytics Conference, online (Poster)

TEACHING

Network Analytics in 2022, 2023, 2024, 2025, Imperial Business School

Analysis in Business in 2023, 2024, 2025, Imperial Business School

Workforce Analytics in 2022, 2023, Imperial Business School

Methods for Data Science in 2022, department of Mathematics, Imperial College London

SKILLS

Language: English (Fluent), Chinese (Native)

Coding: Python (Advanced), MATLAB (Advanced)