

Education and Professional Experience

Nanyang Technological University

Singapore

Presidential Postdoctoral Fellowship

Dec 2023 - Now

- **Supervisor:** Xia Kelin
- Developed topological deep learning tools for machine learning tasks on molecular data, with applications in protein and material design
- Designed algorithms to extract topological features from the shape of molecules, utilizing mathematical toolkits such as algebraic topology, and tested the methods on learning tasks with chemical and biological molecular data

The University of Edinburgh, Heriot-Watt University

Edinburgh, UK

PhD in Applied Mathematics

Sep 2019 - Nov 2023

- MAC-MIGS CDT scholarship, a joint Doctoral Training Programme with Integrated Study in Mathematical Modelling, Analysis and Computation between The University of Edinburgh and Heriot-Watt University
- **Supervisors:** Des Higham, Kostas Zygalakis
- **Thesis:** Laplacians for Structure Recovery on Directed and Higher-order Graphs
- **Research Interests:** Graph-based algorithms, Graph models, Node embedding, Spectral clustering, Graph mining, Learning on graphs

National University of Singapore

Singapore

M.Sc in Statistics (Honours with Distinction)

2017 - 2019

Nanyang Technological University

Singapore

BSc (Hons) in Physics (First Class Honours)

2011 - 2015

- Dean's List (top 5% of cohort)
- Singapore Government Merit Undergraduate Scholarship

Awards

Turing Enrichment Award

London, UK

Alan Turing Institute

Oct 2022

Offer PhD students the opportunity to enrich and enhance their current research by accessing the facilities and opportunities available at The Alan Turing Institute and its partners as well as a grant to undertake research activity.

Associate Fellowship

UK

Advanced Higher Education

Sep 2022

In recognition of attainment against the UK Professional Standards Framework for teaching and learning support in higher education

Outstanding Talk Award

Online

SIAM Workshop on Network Science (NS22)

Sep 2022

Teaching Award

UK

The University of Edinburgh

Sep 2022

Laura Wisewell Travel Scholarship

UK

The University of Edinburgh

Jun 2022

MATH+ Thematic Einstein Semester Summer School Travel Award

Germany

Zuse Institute Berlin

Jun 2022

MAC-MIGS Travel Fund

UK

EPSRC

2019 - 2023

MAC-MIGS CDT Scholarship (Fully Funded)

UK

EPSRC

2019

Dean's List (top 5% of cohort)

Singapore

Nanyang Technological University

2014

Singapore Government Merit Undergraduate Scholarship (Fully Funded)

Singapore

Ministry of Education of Singapore

2011

Publications

- **Gong, X.**, Higham, D.J., Zygalakis, K., and Bianconi, G. Higher-order Connection Laplacians for Directed Simplicial Complexes. *Journal of Physics: Complexity*. 2024 Feb 12
- **Gong, X.**, Higham, D.J. and Zygalakis, K. Generative hypergraph models and spectral embedding. *Scientific Report* 13, 540 (2023). <https://doi.org/10.1038/s41598-023-27565-9>

- **Gong, X.**, Higham, D.J. and Zygalakis, K., 2021. Directed network Laplacians and random graph models. *Royal Society open science*, 8(10), p.211144.
- Lu, X., Utama, M.I.B., Lin, J., **Gong, X.**, Zhang, J., Zhao, Y., Pantelides, S.T., Wang, J., Dong, Z., Liu, Z. and Zhou, W., 2014. Large-area synthesis of monolayer and few-layer MoSe₂ films on SiO₂ substrates. *Nano letters*, 14(5), pp.2419-2425.

Manuscript

- Tan, J., Wee, J.J., **Gong, X.**, and Xia, K. Mathematics-assisted Peptide-based Machine Learning Model (MAP-ML) for anticancer peptide prediction.
- Wee, J.J., **Gong, X.**, Tuschmann, W., and Xia, K. Cohomology-based ultrametric Gromov-Hausdorff distance for quantifying structural similarity.

Talks & Presentations

Sunbelt Conference 2024 Oral Presentation, “Generative hypergraph models and spectral embedding”	Edinburgh, UK Jun 2024
Conference on Complex Systems 2022 (CCS 2022) Poster Presentation, “Spectral Embedding and Associated Generative Models for Hypergraphs”	Palma de Mallorca, Spain Oct 2022
SIAM Workshop on Network Science Outstanding Talk Award, Lightning Talk, “Generative Hypergraph Models and Spectral Embedding”	Online Sep 2022
4th IMA Conference on The Mathematical Challenges of Big Data Contributed Talk, “Hypergraph Generative Models and Associated Spectral Embedding Algorithms”	Oxford, UK Sep 2022
Conference on Network Science (NetSci) Contributed Talk, “Hypergraph Generative Models and Associated Laplacians”	Online Jul 2022
AAAI 2022 Workshop on Graphs and More Complex Structures for Learning and Reasoning Short Paper, “Visualizing and Quantifying Linear and Periodic Structures in Directed Networks”	UK Feb 2022
Oxford Network Seminar Seminar Talk, “Random Graph Interpretation of Directed Graph Laplacians”	Online Dec 2021
10th International Conference on Complex Networks & Their Applications Contributed Talk, “Random Graph Interpretation of Directed Graph Laplacians”	Online Nov 2021
Conference on Complex Systems Contributed Talk, “Directed Random Graph Models and Their Associated Laplacians”	Online Oct 2021
Oxford-Warwick-Edinburgh Network Science Workshop Contributed Talk, “Mapping Directed Networks Using the Magnetic Laplacian”	Online Mar 2021
Cambridge Joint CDT Student Conference Contributed Talk, “Mapping Directed Networks Using the Magnetic Laplacian”	Online Dec 2020

Events Participation

Jun 2022 Mathematics of Complex Social Systems Summer School , Participant	Berlin, Germany
Jul 2021 Networks 2021 (Joint Sunbelt and NetSci Conference) , Participant	Online
Jun 2021 SIAM-IMA Edinburgh - Study Group with Industry , Participant in the project “Generating Irregular Sequences for Seismic Imaging Problems”	Online
Dec 2020 Conference on Complex Systems 2020 (CCS 2020) online , Participant	Online
Sep 2020 AgriFood Data Study Group: Evaluating the UK’s resilience to supply chain shocks , Participant	Online
May 2020 ICMS and MAC-MIGS Modelling Camp 2020 , Participant	Edinburgh, UK

Teaching Experience

MATH08058 Calculus and its Applications Tutor and Marker	The University of Edinburgh Spring 2022
<ul style="list-style-type: none"> • An undergraduate course offered to College of Science and Engineering students to develop calculus skills • Facilitated weekly problem-solving tutorials, marked assignments and final exams 	

MATH11197 Research Skills for Computational and Applied Mathematics

The University of Edinburgh

Tutor and Marker

Fall 2020

- A Master's level course to develop research skills through a set of programming exercises, workshops and group projects
- Facilitated programming workshops, soft-skill workshops; marked programming assignments and final reports

School of Physical and Mathematical Sciences Learning Centre

Nanyang Technological

University

Peer Tutor

2014

- One-to-one tutoring with undergraduate students on Fluid Mechanics, Classical Mechanics, Quantum Mechanics, and experiment modules

Research Projects

Directed Laplacian on Simplicial Complexes

Edinburgh, UK

Turing Enrichment Scheme

Aug 2022 - Now

- **Collaborators:** Ginestra Bianconi, Desmond Higham, Konstantinos Zygalakis
- Developed theories for directed simplicial complexes
- Extended directed graph Laplacian such as the Magnetic Laplacian to higher-order graphs

Spectral Embedding and Generative Hypergraph Models

Edinburgh, UK

The University of Edinburgh

Aug 2021 - Aug 2022

- **Supervisors:** Desmond Higham, Konstantinos Zygalakis
- Studied spectral algorithms for hypergraphs that captures higher-order interactions
- Established the connection between novel random graph models and spectral algorithms
- Performed numerical experiments on synthetic and real hypergraph from social sciences for node embedding, clustering, and link prediction

Visualizing and Quantifying Structures in Directed Networks

Edinburgh, UK

The University of Edinburgh

May 2020 - Aug 2021

- **Supervisors:** Desmond Higham, Konstantinos Zygalakis
- Analyzed spectral algorithms for clustering and mapping directed graphs
- Derive associated random graph models and proposed workflow for comparing structures based on the models
- Ran experiments on synthetic and real networks from ecology, biology and social sciences for graph visualization and structure recovery

Efficient Approximation of Pricing Functions

Edinburgh, UK

The University of Edinburgh

Jan - Mar 2020

- **Supervisors:** Aretha Teckentrup, Abdul-Lateef Haji-Ali
- Enhanced the efficiency of option price estimation by generating training data using multi-level Monte Carlo, and estimating price function using Gaussian process regression

Opinion Dynamics

Edinburgh, UK

The University of Edinburgh

Oct - Dec 2019

- **Supervisor:** Ben Goddard
- Simulated and studied the behaviors of opinion dynamics models including the voter model, the Deffuant model and the HK model

Modified Dealer's Model for the Electricity Market

Singapore

Nanyang Technological University

Aug 2014 - May 2015

- **Supervisor:** Cheong Siew Ann
- Modelled the spiking behaviour of the electricity market using modified dealer's model; studied the spike statistics and the impact of model parameters

The Minority Game Model

Singapore

Nanyang Technological University

Jun 2012 - Aug 2012

- **Supervisor:** Chew Lock Yue
- Simulated the dynamics of a system using the Minority Game Model and studied the influence of agent memory and strategy pool on the volatility of the system

EVENTS CO-ORGANIZED

NTU-NUS Joint Workshop on Applied Topology and Geometry for AI

Singapore

Nanyang Technological University

Feb 2024

Organized workshop to present recent advancements in both the theories of algebraic topology and geometry, as well as their applications within AI and data science.

MAC-MIGS Research Afternoon on Learning Complex Structures on Graphs

Edinburgh, UK

MAC-MIGS CDT

Jul 2022

Invited speakers to present recent advances in the research on learning graph structures, such as clustering and structure recovery on graphs and hypergraphs

Networks Book Club

Online

2021-2022

Held regular online meetings to discuss books and topics on network science, such as graph representation learning, dynamics and modularity on graphs, and natural language processing

Networks Reading Group

The University of Edinburgh

Ran regular face-to-face meetings in Edinburgh to discuss papers on graphs and networks covering topics such as graph neural networks, community detection, and spectral clustering

Edinburgh, UK

2022 - Now

Reviewer

Neurocomputing

PROFESSIONAL SOCIETIES

Society for Industrial and Applied Mathematics

The Institute of Mathematics and its Applications

Other Experience

Quantitative Market Analyst

Rio Tinto

Built statistical models such as time series forecasting; designed optimization model for planning and scheduling

Singapore

Apr 2017 - Jul 2019

Geophysicist

CGG

Performed seismic image processing using techniques such as inversion algorithm, wave equation, and signal processing

Singapore

Jul 2015 - Apr 2017

Skills

Programming Python, Matlab R, C/C++, HTML/CSS, SQL

Miscellaneous Linux, Shell, \LaTeX , Tableau, Power BI, Git

Languages English, Chinese

Languages

English Professional proficiency

Chinese Native proficiency