Xiaoqi (Shirley) Liu

I am a young researcher passionate about statistical learning and information theory. My work is characterised by meticulous attention to detail and compelling storytelling, both in written and verbal formats. I have lived, studied and thrived in four cultures, and have assumed various leadership roles.

Education and Research

PhD, Signal Processing and Communications Lab, University of Cambridge Oct 2019–present
Supervisor: Dr Ramji Venkataramanan (Expected thesis submission: Apr 2024)

Focus:

- Message passing algorithms for a variety of problems: low-rank matrix sketching/ compression, changepoint detection, many-user communications.
- I study algorithms via simulations and probabilistic/ information-theoretic analysis.

Motivation and objective:

- Many modern datasets are inherently structured (e.g. sparsity, low-rank). Most existing state-of-the-art algorithms for inference tasks on structured data are based on convex optimization and they suffer from high complexities.
- Goal of PhD research is to design algorithms that flexibly take advantage of prior knowledge of data structure to achieve complexity savings.

Publications:

- X. Liu and R. Venkataramanan, "Sketching Sparse Low-Rank Matrices With Near-Optimal Sample- and Time-Complexity Using Message Passing," in *IEEE Transactions on Information Theory*, vol. 69, no. 9, pp. 6071-6097, Sept. 2023.
- X. Liu and R. Venkataramanan, "Sketching sparse low-rank matrices with near-optimal sample- and time-complexity," *2022 IEEE International Symposium on Information Theory (ISIT),* Espoo, Finland, 2022, pp. 3138-3143.
- Papers above study the problem of sketching n-by-n low-rank matrices with k-sparse singular vectors where $k \ll n$. Proposed the first scheme with $O(poly(k))$ sample cost and runtime, which depend only on the sparsity k, and not on the ambient dimension n. Existing schemes need at least $O(polylog(n))$ sample cost and $O(poly(n))$ runtime.

Work in preparation (to appear by early 2024):

- X. Liu, P. Cobo, K. Hsieh and R. Venkataramanan, "Massive multiple access with random user activity and coding" (poster at IEEE European School of Information Theory 2023 (ESIT))
- G, Arpino, X. Liu and R. Venkataramanan, "Changepoints detection in high-dimensional linear regression"
- X. Liu and R. Venkataramanan, "On generalising Wormald's differential equation theorem"

Newnham College, University of Cambridge Oct 2015–Jun 2019
BA and MEng in Information and Computer Engineering (Honours with Distinction)

- Simultaneously qualified in Electrical and Information Sciences; Instrumentation and Control.
- Ranked 3%, 7%, 4% and 3% (top first class) respectively each year in my cohort of 300+ people.

Overseas Family School, Singapore Aug 2013–Jun 2015
International Baccalaureate Diploma Programme 45/45 (Bilingual): Higher Level Mathematics, Physics, Economics, and English; Standard Level Business & Management, Chinese Language & Literature all with 7/7.

Scholarships and Awards

2020 British Education Award: One of the 5 winners selected across the UK in recognition of outstanding academic achievements. Congratulated by Number 10 Downing Street. (Nov 2019)

Schlumberger Cambridge International Scholar: Granted with one of the few full PhD studentships by the Cambridge Trust (£49,000 per year). (Oct 2019)

Best Presentation Prize: Awarded at the Engineering Department MEng thesis final presentations. (Jun 2019)

Best Technical Report of the Year: In a month-long control system project, coordinated a group of four to model and design a controller of an industrial evaporator in Simulink. (Jun 2018)

Scholar of Newnham College (2016–2019); **recipient of a college major undergraduate research award** (2018)

Academic Responsibilities and Outreach

Presenter, 2023 IEEE European School of Information Theory (ESIT)
Reviewer, 2023 IEEE International Symposium on Information Theory (ISIT), 2023 International Symposium on

Topics in Coding (ISTC)

Organiser and speaker, 2022 Information Engineering Divisional Conference (Mar 2022): Oversaw logistics for a 100-attendee conference, coordinated with internal and external speakers, provided technical support and concurrently prepared my talk.

Supervisor for Information Theory & Coding and Data Transmission (Oct 2019–present): Arrange biweekly Q&A sessions with third-year undergraduates in groups of three. Described by many students as an insightful and thoughtful supervisor who can simplify complex topics in an easy-going yet rigorous manner.

Postgraduate representative, Engineering Department (Oct 2020–Oct 2022): Organised social events to foster connections among postgraduates through the pandemic, while serving as a conduit for student feedback to departmental boards.

Teaching assistant, Electronic & Information Engineering Track at Cambridge AI+ Programme (Feb 2022, 2023)

Presenter at Signal Processing Seminar on "Martingales & useful analysis tools related to martingales" (Nov 2019)

Selected supervisor for maths introductory tutorials for Newnham STEM first-years (Oct 2017 & Oct 2019)

Invited guest and project leader at the 2019 Micro Distance International Youth Forum (Jul 2019): Designed and led a high popular three-day project on visual information processing, guiding students aged 14–18 in exploring and visualizing compact coding and sparse coding principles through hands-on Matlab experiments.

Work Experience

Microsoft Research (Cambridge, UK), researcher intern Apr 2023–June 2023

- Designed and optimised a novel error correction scheme for Project Silica (cloud data storage on glass)
- Clarified and unified understanding of key performance metric for the team
- Proposed a unifying workflow to systematically evaluate new data storage technologies
- Helped enhance image classification decoder in TensorFlow
- Final presentation praised for exceptional clarity and organisation

MediaTek Inc (Cambourne, UK), software development summer intern Jun 2017–Sep 2017

- Data mining and test automation software development in C#, LINQ, SQL & XML
- Created a GUI application to identify locations with mobile phone GPS signal loss based on log data and accurately restore coordinates; and to display the grouping of base stations in a cellular network into tracking areas
- Prototyped a smart kitchen device using sensors and an Arduino board

WSP | Parsons Brinckerhoff (Cambridge, UK), structural design undergraduate engineer Jun 2016–Aug 2016

- Designed 20+ pieces of steelwork and verified the designs based on first principles
- Studied reinforced concrete design specifications and created a VBA program to systematically validate reinforced concrete slab designs for WSP engineers

Extra-curricular Activities and Volunteering

Cambridge University Synthetic Biology Society (Oct 2017–Jun 2018): Member of the computational modelling team. Simulated a genetic construct in Python which allows a bacterial colony to perform high-pass filtering (edge detection) in response to light patterns

Impact Through Innovation Cambridge (Oct 2017–Jun 2018): Prototyped a circuit design of a medical monitoring device dedicated to an HIV medication adherence study in Tanzania

Flautist, Cambridge University Chinese Orchestra Society (Oct 2016–Jun 2017): Holding a Flute Grade 9 certificate (highest grade for non-professional flautists in China)

Skills and Hobbies

- Proficient in MATLAB, Python (incl. Jax), Git. Familiar with C#, C++, R, VBA, HTML, CSS, LINQ, SQL & XML
- Competent with LTspice for the design and analysis of electrical circuits
- Competent with Tekla, Tedds and RAM for technical steelwork or concrete design
- Familiar with Creo for mechanical design and drawing
- Bilingual in Chinese and English. A sports lover: a half-marathon runner & a regular gym goer

References available upon request