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.

Contact information

- Signal Processing and Communications Lab, Engineering Dept, Trumpington St, Cambridge CB2 1PZ, UK
- Phone: +44 07494 054968 Email: xl394@cam.ac.uk

Education and Research

PhD, Trinity Hall college, University of Cambridge Oct 2019–present
Supervisor: Professor Ramji Venkataramanan (Expected thesis submission: Apr 2024)

Focus:

Design iterative algorithms (e.g. message passing) for a variety of problems: low-rank matrix sketching/ compression, changepoint detection, many-user communications; study them 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 complexity.
- Goal of PhD research and beyond 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 sketching n-by-n low-rank matrices with k-sparse singular vectors where $k \ll n$. Proposed first scheme with $O(poly(k))$ sample cost and runtime, which depend only on sparsity k, and not on ambient dimension n. Existing schemes need at least $O(polylog(n))$ sample cost and $O(poly(n))$ runtime.

Work in preparation:

- 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)), to be submitted to ISIT by early 2024
- G, Arpino, X. Liu and R. Venkataramanan, "Changepoints detection in high-dimensional linear regression", to be submitted to ICML by early 2024
- X. Liu and R. Venkataramanan, "On generalising Wormald's differential equation theorem"

BA and MEng, Newnham College, University of Cambridge Oct 2015–Jun 2019

Major: 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

Schlumberger Cambridge International Scholar: full PhD studentship by Cambridge Trust (£49,000 per year)
2020 British Education Award: One of 5 winners selected across UK in recognition of outstanding academic achievements. Congratulated by Number 10 Downing Street (Nov 2019)
Best Presentation Prize: Awarded at Engineering Department MEng thesis final presentations (Jun 2019)
Best Technical Report of the Year (Jun 2018)
Scholar of Newnham College (2016–2019); **recipient of major college 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 100-attendee conference, coordinated with speakers, provided tech 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 students as insightful and thoughtful supervisor who can "explain complex topics in an easy-going manner"

Postgraduate representative, Engineering Department (Oct 2020–Oct 2022): Organised social events to foster connections among postgraduates through COVID, 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 2019 Micro Distance International Youth Forum (Jul 2019): Designed and led three-day project on visual information processing, guiding students aged 14–18 in exploring and visualizing compact coding and sparse coding principles through MATLAB experiments.

Work Experience

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

- Designed and optimised novel error correction scheme for Project Silica (cloud data storage on glass)
- Clarified key information-theoretic performance metric for the team
- Proposed 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 GUI application to identify locations with mobile phone GPS signal loss based on log data and accurately restore coordinates; and to display 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 designs from first principles
- Studied reinforced concrete design specifications and created VBA program to systematically validate reinforced concrete slab designs

Extra-curricular Activities and Volunteering

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

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

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

Skills and Hobbies

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

Referees

Prof Ramji Venkataramanan (Engineering Dept, Cambridge), Prof Ioannis Kontoyiannis (Maths Dept, Cambridge)