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

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## 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](https://ieeexplore.ieee.org/document/10120641),” 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](https://ieeexplore.ieee.org/document/9834693),” *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 *kn*. 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)](https://shirleyliuxq.github.io/ESIT_GMAC_poster_final.pdf)), 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)