

## Xiaoqi (Shirley) Liu

I have broad interests in **statistical learning** and **information theory**.  
I derive theoretical limits on the lowest algorithmic complexity needed for solving statistical inference problems, and develop mathematically principled, efficient algorithms that approach these limits.

### Contact information

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### Education and Research

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**PhD, Trinity Hall college, University of Cambridge**

Oct 2019–present

**Supervisor: Professor Ramji Venkataramanan**

(Expected thesis submission: May 2024)

**Thesis:** Message passing algorithms for high-dimensional statistical problems, featuring structured signals:

- compression (sketching) of sparse, low-rank matrices (e.g. adjacency matrices of large social networks)
- changepoint detection (mixed linear regression) in heterogeneous data (e.g. genomics, financial data)
- reliable communications (encoding and decoding information) for large user networks

**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*, Espoo, Finland, 2022, pp. 3138–3143.

**Work in review/ preparation:**

**X. Liu**, P. Cobo and R. Venkataramanan, “Many-user multiple access with random user activity” (poster at *2023 IEEE European School of Information Theory (ESIT)*), submitted to *2024 IEEE International Symposium on Information Theory*, draft available on request

**X. Liu**, K. Hsieh and R. Venkataramanan, “Coded many-user multiple access via Approximate Message Passing”, submitted to *2024 IEEE International Symposium on Information Theory*, draft available on request

G. Arpino, **X. Liu** and R. Venkataramanan, “Changepoints detection in high-dimensional linear regression”, submitted in 2024, draft available on request

**X. Liu** and R. Venkataramanan, “On generalising Wormald’s differential equation method for analysing random graph processes” (in progress)

**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): High Level Mathematics, Physics,

Economics, English; Standard Level Business & Management, Chinese Language & Literature all with 7/7.

### Scholarships and Awards

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**Schlumberger Cambridge Trust International Scholar:** full PhD studentship (£49,000/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 undergraduate research award** (2018)

### Academic Service and Outreach

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**Reviewer, 2023 IEEE International Symposium on Information Theory (ISIT), 2023 International Symposium on Topics in Coding (ISTC)**

**Organiser and speaker, 2022 Cambridge Information Engineering Divisional Conference** (Mar 2022): Oversaw logistics for 100-attendee conference, coordinated with speakers 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”

**Co-supervisor of MEng projects** (Oct 2022–present): help students formulate research questions in statistical learning, conduct experiments and present results in verbal and written formats

**Postgraduate representative, Engineering Department** (Oct 2020–Oct 2022): Organised social events to foster connections among postgraduates through COVID; provided student feedback to departmental boards

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

**Selected supervisor for maths 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 to explore compact coding and sparse coding principles through MATLAB experiments.

## Work Experience

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

- Designed novel error correction scheme for project Silica (cloud data storage on glass), which increased transmission rate by 5-10%
- 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 PyTorch
- Final presentation attracted ~50 audience, and 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 engineer** Jun 2016–Aug 2016

- Designed 20+ pieces of steelwork and verified designs from first principles
- Taught myself reinforced concrete design specifications and created VBA program to systematically validate reinforced concrete slab designs

## Extra-curricular Activities and Volunteering

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**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

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- Proficient in Python (incl. JAX), MATLAB, Git, Slurm. Familiar with C#, C++, VBA, HTML, CSS, LINQ, SQL, XML, R & PyTorch
- 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

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**Prof Ramji Venkataramanan** (rv285@cam.ac.uk, Department of Engineering, Cambridge)

**Prof Ioannis Kontoyiannis** (ik355@cam.ac.uk, Department of Pure Mathematics & Mathematical Statistics, Cambridge)

**Dr Ioan Stefanovici** (Ioan.Stefanovici@microsoft.com, Microsoft Research Cambridge)

**Dr Richard Black** (rjblack@microsoft.com, Microsoft Research Cambridge)