Shi Jie Samuel Tan

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Education

University of Maryland, College Park College Park, MD
Ph.D. in Computer Science (Temp. Advisors: Andrew Childs and Daniel Gottesman) *Aug 2023 - Present*

Haverford College Haverford, PA
B.S. in Computer Science, Mathematics & Physics, *magna cum laude, GPA: 3.966* *Aug 2019 - May 2023*

Graduate Courses: Intro to Quantum Information Processing, Quantum Control & Metrology, Quantum Error Correction and Fault Tolerance, Quantum Mechanics, Randomized Algorithms
Relevant Undergraduate Courses: Abstract Algebra, Analysis of Algorithms, Real Analysis, Probability, Scientific Computing, Statistical Physics, Theory of Computation

Research Experience

University of Maryland College Park, MD
Quantum Computing Research Assistant (PI: Daniel Gottesman) *Nov 2023 - Present*

- Project 1: Finding ways to implement fault-tolerant logical operations on QLDPC codes.

Los Alamos National Laboratory Los Alamos, NM
Quantum Research Fellow (Mentors: Yiğit Subaşı & Sam Slezak) *Jun 2023 - Present*

- Project 1: Designed ancilla state for quantum phase estimation using classical signal processing techniques and analytically proved its average-case optimality. Contributed talk at APS March Meeting 2024.
- Project 2: Fixing the quantum metropolis sampling algorithm by modifying the phase estimation protocol and reviewing the quantum detailed balance condition.

California Institute of Technology Pasadena, CA
Quantum Computing Research Fellow (Mentors: John Preskill & Chris Pattison) *May 2022 - Present*

- Project 1: Numerically analyzed the resilience of surface codes against error bursts caused by cosmic rays. Derived the phase diagram for the accuracy threshold of the MWPM decoder and the teraquop footprint. Presented poster at QEC 2023. First author manuscript in preparation.
- Project 2: Working on the manuscript that proves the existence of an accuracy threshold for Union-Find decoder algorithm.

University of Maryland College Park, MD
Quantum Computing Research Assistant (Mentor: Matthew Coudron) *May 2021 - May 2023*

- Project 1: Reviewed and proposed minor edits for the construction of block-encodings and syntheses to approximate output probabilities of low-depth 3D quantum circuits. Acknowledged in the paper accepted by FOCS 2021 & QIP 2021.
- Project 2: Extended the algorithm from Project 1 to approximate output probabilities for low-depth quantum circuits that have not only 3 dimensions but any fixed number of dimensions. Co-first author of paper presented as a talk at TQC 2022 and presented poster at QIP 2022.
- Project 3: Attempted to design a quasi-polynomial time algorithm for AC^0 postprocessing of 2D geometrically-local low-depth quantum circuits for decision problems.

Haverford College Haverford, PA
Algorithms Research Assistant (PI: Sara Mathieson) *May 2020 - May 2023*

- Project 1: Validated *thread*, the algorithm to reconstruct ancestral haplotypes from endogamous Amish population and improved the algorithm's accuracy rate to 90%. Co-authored paper published in PLOS Comp. Bio. 2021.
- Project 2: Designed a KNN algorithm to reduce false positives from the identical-by-descent (IBD) segments identified by IBD detection software. First author manuscript in preparation.

Publications and Pre-Prints

[1] D. Patel, **S.J.S. Tan (co-first author)**, Y. Subaşı, and A. Sornborger. Optimal coherent quantum phase estimation via tapering. *arXiv preprint arXiv:2403.18927*, 2024

[2] Y. Deng and **S.J.S. Tan (co-first author)**. Random walks on the generalized symmetric group: Cutoff for the one-sided transposition shuffle. *arXiv preprint arXiv:2211.10462*, 2022

[3] S. Dontha, **S.J.S. Tan (co-first author)**, S. Smith, S. Choi, and M. Coudron. Approximating Output Probabilities of Shallow Quantum Circuits Which Are Geometrically-Local in Any Fixed Dimension. In *Proceedings of the 17th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2022)*, 2022. https://doi.org/10.4230/LIPIcs.TQC.2022.9

[4] K. Finke, M. Kourakos, G. Brown, H.T. Dang, **S.J.S. Tan**, Y. Simons, S. Ramdas, A. Schäffer, R. Kember, M. Bućan, and S. Mathieson. Ancestral haplotype reconstruction in endogamous populations using identity-by-descent. *PLOS Computational Biology*, 2021. https://doi.org/10.1371/journal.pcbi.1008638

Oral and Poster Presentations

[1] "Tapered Quantum Phase Estimation." APS March Meeting 2024, March 4-8, 2024.

[2] "Resilience of the surface code to error bursts." 6th International Conference on Quantum Error Correction (QEC), October 30-November 3, 2023.

[3] "Proving the existence of an accuracy threshold for the Union-Find decoder." Caltech SFP Summer Seminar Day, August 18, 2022.

[4] "Comparison of cohort-based identical-by-descent (IBD) segment finding methods for endogamous populations." In Proceedings of the 13th ACM International Conference on Bioinformatics, Computational Biology and Health Informatics (ACM-BCB 2022), August 7-10, 2022. https://doi.org/10.1145/3535508.3545104

[5] "Approximating Output Probabilities of Shallow Quantum Circuits which are Geometrically-local in any Fixed Dimension." 17th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2022), July 11-15, 2022.

[6] "Approximating Output Probabilities of Shallow Quantum Circuits which are Geometrically-local in any Fixed Dimension." 25th Annual Conference on Quantum Information Processing (QIP 2022), Poster Presentation, 2022.

[7] "Improvements to ancestral haplotype reconstruction in pedigrees." 7th-8th International Conference on Algorithms for Computational Biology (AlCoB 2020 & 2021), November 9-11, 2021.

[8] "Improvements to ancestral haplotype reconstruction in pedigrees." Research in Computational Molecular Biology - 25th Annual International Conference (RECOMB 2021), August 29-September 1, 2021.

[9] "Simulation of Low-Depth Quantum Circuits." University of Maryland Research Experience for Undergraduates Combinatorics and Algorithms for Real Problems (REU-CAAR) Research Presentation, August 13, 2021.

[10] "Validating Ancestral Haplotype Reconstruction In Endogamous Populations using Identical-by-Descent." Haverford College Marian E. Koshland Integrated Natural Sciences Center (KINSC) Undergraduate Science Research Symposium, 2020.

Awards and Fellowships

2023 MathQuantum Graduate Fellowship (University of Maryland)
2023 QuICS Lanczos Graduate Fellowship (University of Maryland)
2023 Louis B. Green Prize in Physics and Astronomy (Haverford College)
2023 Phi Beta Kappa
2023 Los Alamos National Laboratory Quantum Computing Summer School Fellowship
2023 Singloh Hsu Scholarship (Haverford College)
2023 Computing Research Association (CRA) Outstanding Undergraduate Researcher Award Finalist
2022 Caltech Summer Undergraduate Research Fellowship
2022 ACM-BCB 2022 Undergraduate Travel Award
2022 Philly Codefest 2022 (Best Hack for Social Good)
2022 Marian E. Koshland Integrated Natural Sciences Center Summer Scholarship (Haverford College)
2022 QIP 2022 Student Travel Award
2021 An Zhu-Google University of Maryland REU-CAAR Fellowship
2020 Brian Kovaric Fellowship (Haverford College)
2020 Major League Hacks (MLH) Local Hack Day International Winner
2019 HackNY, New York City (Honorable Mention)
2018 Singapore Technologies Engineering Ltd Overseas Scholarship (Turned down)
2018 Singapore Armed Forces Army Learning Innovation Award
2016 Prime Minister's Book Prize (Ministry of Education, Singapore)

Work Experience

Haverford College Haverford, PA
Teaching Assistant *Aug 2020 - May 2023*

- Hold office hours and grade for analysis of algorithms, quantum mechanics and theory of computation
- Run Math Question Center & tutor multivariable calculus, real analysis, linear & abstract algebra

Innosparks Singapore
Junior Software Developer *Jul 2018 - Jan 2019*

- Built APIs for prototype submitted to Singapore's Ministry of Health & National University Hospital

BigBulb Studio Singapore
Co-founder and Software Developer *Nov 2017 - Apr 2019*

- Offered tech consulting and developed company websites for small and medium enterprises

Singapore Armed Forces Singapore
Assistant Platoon Commander (1st Lieutenant) *Jan 2016 – Nov 2017*

- Trained over 100 officer cadets into logistics officers and planned local and overseas military exercises

Outreach and Community Service

CodeForPhilly Philadelphia, PA
Co-lead and Software Engineer (MATchmapper) *Feb 2020 – May 2023*

- Co-founded MATchmapper to offer data insights on the opioid crisis for Health Federation Philadelphia and the Department of Public Health
- Constructed Django web application and data pipeline to scrape public databases and built PostgreSQL database and interactive map on Heroku for more than 500 healthcare providers

Haverford College Haverford, PA
Co-head of HaverCode *Nov 2019 - May 2023*

- Organize computer science-related academic, industry and social events for faculty and students