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 & Physics, *magna cum laude* *Aug 2019 - May 2023*

Graduate Courses: Algebraic Topology (Spring 2025), Concentration Inequalities, Intro to Quantum Information Processing, Quantum Algorithms (Spring 2025), 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 *Nov 2023 - Present*

- Under the supervision of Prof. Daniel Gottesman, I am exploring ways to implement practical fault-tolerant protocols with quantum LDPC codes in low-dimensional architectures. I also worked with Prof. Murphy Yuezhen Niu on quantum metrology strategies using quantum signal processing.

Los Alamos National Laboratory Los Alamos, NM
Quantum Research Fellow *Jun 2023 - Present*

- Working under Dr. Yiğit Subaşı and Dr. Andrew Sornborger, I derived the optimal ancilla state for quantum phase estimation using classical signal processing techniques and analytically proved its average-case optimality. Under the supervision of Dr. Subaşı and Dr. Samuel Slezak, I am exploring how we can fix the quantum metropolis sampling algorithm for Gibbs state preparation and quantize the classical parallel tempering algorithm.

California Institute of Technology Pasadena, CA
Quantum Computing Research Fellow *May 2022 - June 2024*

- Under the supervision of Prof. John Preskill and Chris Pattison, I studied the resilience of surface codes against error bursts caused by cosmic rays and global control noise. We attempted to prove the existence of an accuracy threshold for the Union-Find decoder algorithm.

University of Maryland College Park, MD
Quantum Computing Research Assistant *May 2021 - May 2023*

- Under the supervision of Prof. Matthew Coudron, we developed a classical algorithm to approximate output probabilities for low-depth quantum circuits that have any constant number of dimensions. We 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 *May 2020 - May 2023*

- Working under Prof. Sara Mathieson and other collaborators, we validated *thread*, the algorithm to reconstruct ancestral haplotypes from endogamous Amish population and improved the algorithm's accuracy rate to 90%. We designed a KNN algorithm to reduce false positives from the identical-by-descent (IBD) segments identified by IBD detection software.

Publications and Pre-Prints

[1] **S.J.S. Tan** and L. Stambler. Effective distance of higher dimensional hgps and weight-reduced quantum ldpc codes. *arXiv preprint arXiv:2409.02193*, 2024

[2] **S.J.S. Tan**, C. A. Pattison, M. McEwen, and J. Preskill. Resilience of the surface code to error bursts. *arXiv preprint arXiv:2406.18897*, 2024

[3] **S.J.S. Tan**, H.T. Dang, S. Keim, M. Bucan, and S. Mathieson. Identity-by-descent (ibd) segment outlier detection in endogamous populations using pedigree cohorts. *bioRxiv*, pages 2024–08, 2024

[4] 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

[5] 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

[6] 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

[7] 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 Presentations

[1] "Effective Distance of Higher-Dimensional HGPs and Weight-Reduced Quantum LDPC Codes." Invited talk at the University of Maryland Communication, Control and Signal Processing (CCSP) Seminar, October 17, 2024.

[2] "Signal-Processing Phase Estimation against Time-dependent Errors." Contributed talk at the 19th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2024), September 9-13, 2024. **(Presented by co-author)**

[3] "Tapered Quantum Phase Estimation." Contributed talk at the APS March Meeting 2024, March 4-8, 2024. **(Presented by co-author)**

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

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

[6] "Simulation of Low-Depth Quantum Circuits." Contributed talk at the University of Maryland Research Experience for Undergraduates Combinatorics and Algorithms for Real Problems (REU-CAAR) Research Presentation, August 13, 2021. **(Co-presented)**

Poster Presentations

[1] "Tapered Quantum Phase Estimation." 19th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC 2024), September 9-13, 2024.

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

[3] "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

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

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

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

[7] "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

2024 National University of Singapore Development Grant
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 Marian E. Koshland Integrated Natural Sciences Center Summer Scholarship (Haverford College)
2021 An Zhu-Google University of Maryland REU-CAAR Fellowship
2020 Brian Kovaric Fellowship (Haverford College)
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