Justin Yirka

Ph.D. Candidate in Computer Science, Graduating in 2025

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JustinYirka.com arXiv.org/a/yirka_j_1.html ☐ linkedin.com/in/justinyirka scholar.google.com/citations?user=UxIpR_UAAAAJ youtube.com/@JustinYirka/playlists

Research Interests

Quantum computing and Theoretical computer science Computational complexity theory, Hamiltonian complexity, Quantum algorithms

Education

Ph.D. in Computer Science The University of Texas at Austin (UT) Advised by Scott Aaronson Dissertation: <i>Ougntum Complexity of Physically Inspired Problems and Co</i>	Expected May 2025
M.S. in Computer Science The University of Texas at Austin	2022
 B.S. in Computer Science Virginia Commonwealth University (VCU) B.S. in Mathematical Sciences Specialization in Data Science & Concentration in Pure Math Minor in Physics University Honors 	2018 Concurrent degrees
Research Positions	
R&D Intern Sandia National Laboratories Advised by Ojas Parekh and John Kallaugher Topic: Hardness of estimating optimal product states of local Hamiltonians. Q Max-Cut, and Quantum constrained optimization problems. Alternative que	June 2023–present Quantum Max-Cut, Vector ry models.
Summer School Fellow Los Alamos National Laboratories Advised by Yiğit Subaşı Topic: Near-term (NISQ) quantum algorithms. Studied use of mid-circuit m construct circuits for entanglement spectroscopy which were noise-resilient a Implemented noisy simulations with Qiskit, Python, Unix, Jupyter. Manage algorithms on Honeywell quantum hardware.	Summer 2019 easurements and resets to <i>nd</i> low-width. ed project with git. Tested
Research Assistant Graph Theory Computational Discovery Lab, VCU Supervised by Craig Larson Topic: Automated conjecturing software applied to graph theory. Maintained database of graphs, their properties, and known theorems. Man and programmed using git, GitHub, and Sage/Python.	Summer 2018 aged open-source project
Undergraduate Researcher QuICS, University of Maryland Advised by Andrew Childs, Jianxin Chen, and Amir Kalev Part of NSF REU CAAR Topic: Quantum tomography. Investigated minimum number of Pauli observa a quantum pure state.	Summer 2017 ables necessary to identify

Research Assistant | Quantum Computing Lab, VCU

Advised by Sevag Gharibian

Topic: Complexity theory. Studied quantum oracle classes (e.g. $P^{QMA[log]}$) and Hamiltonian complexity. Helped develop a "quantum PH" and "quantum Toda's Theorem" (QCPH $\subseteq P^{PP^{PP}}$).

Research Papers and Talks

Authors are listed alphabetically, as is standard in TCS, unless marked *. Some conference talks are accompanied by published proceedings. Filled labels • indicate I gave the talk. Links to recordings, slides, etc. are available at justinyirka.com.

B. Holman, R. Ramachandran, and J. Yirka. Quantum search with in-place queries.

- To appear in Proceedings of *Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC),* Bengaluru, India, September 2025.
 - arXiv:2504.03620, April 2025.

J. Yirka. A note on the complexity of the spectral gap problem.

- Preprint. arXiv:2503.02747, March 2025.
- J. Yirka. Even quantum advice is unlikely to solve PP. – Preprint. arXiv:2403.09994 and ECCC:TR24-052, 2024.
- S. Grewal and J. Yirka. The Entangled Quantum Polynomial Hierarchy collapses.
 - In Proceedings of *39th Computational Complexity Conference (CCC)*, Ann Arbor, USA, 2024. doi:10.4230/LIPIcs.CCC.2024.6.
 - arXiv:2401.01453 and ECCC:TR24-006, 2024.

J. Kallaugher, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity classification of product state problems for local Hamiltonians.

- In Proceedings of 16th Innovations in Theoretical Computer Science conference (ITCS), New York, USA, 2025. doi:10.4230/LIPIcs.ITCS.2025.63.
- Contributed talk at Conference on Quantum Information Processing (QIP), Taiwan, 2024.
- arXiv:2401.06725, 2024.

J. Yirka and Y. Subasi.* Qubit-efficient entanglement spectroscopy using qubit resets.

- Quantum, 5:535, 2021. doi:10.22331/q-2021-09-02-535.
- Contributed talk by J. Yirka at Conference for Young Quantum Information Scientists (YQIS), Virtual, 2021.
- Contributed talk at APS March Meeting, Virtual, 2021.
- Contributed talk at 20th Asian Quantum Information Science Conference (AQIS), Virtual, 2020.
- arXiv:2010.03080, 2020.

S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians.

- In Proceedings of 37th Symposium on Theoretical Aspects of Computer Science (STACS), Montpellier, France, 2020. doi:10.4230/LIPIcs.STACS.2020.20.
- Contributed talk at Conference on Quantum Information Processing (QIP), Shenzhen, China, 2020.
- Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018.
- arXiv:1909.05981, 2019.

S. Gharibian, M. Santha, J. Sikora, A. Sundaram, and J. Yirka. Quantum generalizations of the polynomial hierarchy with applications to QMA(2).

- Computational Complexity, 31:12, 2022. doi:10.1007/s00037-022-00231-8.
- Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018. "Long"/plenary talk: top 7% of submissions.
- In Proceedings of 43rd Symposium on Mathematical Foundations of Computer Science (MFCS), Liverpool, UK, 2018. doi:10.4230/LIPIcs.MFCS.2018.58.
- arXiv:1805.11139, 2018.
- S. Gharibian and J. Yirka. The complexity of simulating local measurements on quantum systems. *Quantum*, 3:189, 2019. doi:10.22331/q-2019-09-30-189.
 - In Proceedings of 12th Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), Paris, France, 2017. doi:10.4230/LIPIcs.TQC.2017.2.
 - arXiv:1606.05626, 2016.

Other Research Experience

Non-quantum computing work N. Bushaw, V. Gupta, C. Larson, S. Loeb, M. Norge, J. Parrish, N. Van Cleemput, J. Yirka, and G. Wu. New conditions for graph Hamiltonicity

- *Involve, a Journal of Mathematics,* 18(1):79–89, 2025. 10.2140/involve.2025.18.79.

J. Yirka. Evaluation of TCP header fields for data overhead efficiency.

- Poster at National Conference on Undergraduate Research (NCUR), Asheville, NC, USA, 2016.
- Poster at VCU Symposium for Undergraduate Research and Creativity, Richmond, VA, USA, 2015. Awarded "Launch Award for Outstanding Research Poster"

Workshops and Visits

All-hands meeting Quantum Systems Accelerator, a DOE Research Center Albuquerque, USA	June 2021
Workshop Simons Institute for the Theory of Computing. Berkeley, USA. Quantum Complexity: Quantum PCP, Area Laws, and Quantum Gravity	March 2024
Invited Workshop Schloss Dagstuhl. Virtual. Quantum Complexity: Theory and Application	June 2021
Visiting Researcher University of Paderborn. Germany. Collaboration with Sevag Gharibian Topic: QMA ₁ -hardness of the quantum satisfaction problem (<i>k</i> -QSAT) on qudits of	November 2018 of lower dimensions.
Posters	

Filled labels ► indicate I presented the poster.

- ► J. Kallaugher, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity classification of product state problems for local Hamiltonians. DOE Quantum Systems Accelerator All-Hands meeting. Albuquerque, USA, 2024.
- ► J. Kallaugher, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity classification of product state problems for local Hamiltonians. Sandia Quantum Information Development Networking Day. Sandia National Laboratories, Albuquerque, USA, 2024.

- ► S. Grewal and J. Yirka. The Entangled Quantum Polynomial Hierarchy collapses. Conference on Quantum Information Processing (QIP), Taipei, Taiwan, 2024.
- S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), College Park, MD, USA, 2019.
- S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Workshop on Quantum Computing Theory in Practice (QCTIP), Bristol, UK, 2019.
- ► S. Gharibian, S. Piddock, and J. Yirka. Oracle complexity classes and local measurements on physical Hamiltonians. Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- S. Gharibian, M. Santha, J. Sikora, A. Sundaram, and J. Yirka. Quantum generalizations of the polynomial hierarchy with applications to QMA(2). Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- ► S. Gharibian and J. Yirka. The complexity of simulating local measurements on quantum systems. Conference on Quantum Information Processing (QIP). Seattle, USA, 2017.

Seminars

- PhD Defense. UT Department of Computer Science, 2025.
- PhD Proposal. UT Department of Computer Science, 2024.
- PhD Qualifying Exam talk (RPE). UT Department of Computer Science, 2024.
- Intro to Quantum Hamiltonians with old, new classical, and open questions. UT theory student seminar, 2023.
- Pure state tomography with Pauli observables. QuICS, University of Maryland, 2017.
- Quantum complexity of estimating local physical quantities. VCU Department of Computer Science, 2016. (Only undergraduate invited in previous 5 years.)

Teaching Positions

Head Teaching Assistant UT	Spring 2022, 2023, 2024
Quantum Information Science (Web-based for M.S. program) (CS 388Q) Adapted and led entire course except for pre-recorded lectures. I was responsible for all other content and logistics, handling office hours integrity, and final grades nearly autonomously. Supervised 4 other teach Spring 2022: 200 students, 1500 discussion board posts. Course evaluation	s, student concerns, academic ing assistants. n 4.1 / 5.
Spring 2024: Course evaluation 4.91 / 5.	
Teaching Assistant UT Introduction to Quantum Information Science (Honors course) (CS 358) With Scott Aaronson. Taught recitation and graded assignments.	Fall 2021 H)
Instructor UT International Academy Introduction to Software Engineering (Java) Virtual. Developed entire course including lectures and assignments. Con	Summer 2021 urse evaluation 4.88 / 5.
Teaching Assistant VCU Algebra with Applications (MATH 141) Assisted with daily in-class exercises, offered tutorials, graded assignmen Average student evaluation scores — Fall 2016: 4.78 / 5.0; Spring 2017: 4.3	(2.5 semesters) 2016–2017 ts. 36 / 5.0.

Instructor Department of Parks and Recreation, Prince William County, CPR and first-aid courses for lifeguards	VA 2016–2018
Teaching Assistant VCU Honors Rhetoric (HONR 200) — first-year honors writing and research cou	Fall 2015 rse
Scholarships and Funding	(all dollar amounts in USD)
Quantum seminar and visitor series at UT \$10,000, NSF CIQC Invited speakers: Chinmay Nirkhe (Prof. at Univ. of Washington), Doria	Sep 2024–May 2025 n Rudolph (University of
Paderborn, Germany), Jackson Morris (UCSD)	
Grants for seminar series by VCU RamDev software development club \$1,900, VCU Student Government Association	Sep 2016–May 2018
Mark A. Sternheimer Capstone Design Award \$660, VCU School of Engineering	Nov 2017
 VCU Presidential Scholarship \$110,000, Virginia Commonwealth University Awarded to 0.6% of admitted students. Full cost of 4-year tuition, room, and board. 	2014–2018
WPI Presidential Scholarship [declined] \$80,000, Worcester Polytechnic Institute	2014
Rensselaer Medal Merit Scholarship [declined] \$100,000, Rensselaer Polytechnic Institute	2014
Travel grants	
o \$600 for CCC 2024 in Ann Arbor, USA. CCC travel allowance / NSF.	
o \$1,425 for Simons Institute workshop in Berkeley, CA, USA. NSF CIQC,	2024.
\$500 for QIP 2024 in Taipei, Taiwan. UT Graduate School.	
\circ \$1,600 for QIP 2024 in Taipei, Taiwan. QIP student stipend.	
○ \$1,100 for QIP 2020 in Shenzhen, China. QIP student support / NSF.	
○ \$400 for QIP 2019 in Boulder, CO, USA. QIP student support / NSF.	
\circ \$500 for QIP 2017 in Seattle, USA. VCU Honors College.	
Awards	
Honorable Mention NSF Graduate Research Fellowship Program (NSF Awarded twice, Granted to top 30% of over 12 000 applicants	GRFP) 2019, 2020

Awarded twice. Granted to top 30% of over 12,000 applicants.	, , ,
Pure Mathematics Award VCU College of Humanities and Sciences Student in pure math concentration with highest graduating GPA.	May 2018
University Student Scholar Award Virginia Commonwealth University	Aug 2015
Launch Award for Outstanding Research Poster	March 2015
VCU Symposium for Undergraduate Research For poster <i>Evaluation of TCP header fields for data overhead efficiency</i> .	

Volunteer of the Year | Grade-school robotics program, Prince William County Schools, VA 2014

Service

Journal reviewer: *Quantum* (2024, 2022, 2020)

PC Member: YQIS 2021

Conference subreviewer: STOC 2025, QIP (2025, 2024, 2022), TQC (2023, 2022), ITCS 2023, RAN-DOM 2023, CCC 2022

Extended commitments (> 1 month)	
Chair UT Graduate Representative Association of Computer Science O GRACS representative to UTCS Diversity, Equity, and Inclusion (DEI) C	March 2020–Dec 2021 ouncil.
 Co-Organized Graduate Application Assistance Program mentoring und Ph.D. program. Managed the volunteer mentors. Fall 2020. 	er-represented applicants to
Tutor for remedial math students Manchester High School, Midlothian Up to 4.5 hours per week with several groups of students.	, VA Spring 2019
 Student Advisory Board member VCU Department of Computer Science O Participated in hiring interviews for new faculty in 2017. 	Sep 2016–May 2018
Founder and President RamDev: Software Development at VCU	Apr 2016–May 2018
 Coordinated 40 weekly seminars including 9 corporate speakers and sev Secured and managed \$2400 in funding and resources. Increased weekly attendance to 20+ students, becoming largest C.S. organic 	anization at VCU.
Mentor VCU Honors College freshman mentorship program	Fall 2016
 Volunteer for grade school robotics competitions (FIRST, Vex robotics) Prince William County Schools, VA O Awarded "Volunteer of the Year", 2014. 	2011–2015
Mentor for middle School robotics team (FIRST robotics) Wilder Middle School, Richmond, VA	Fall 2014
Short-term commitments (<1 month)	
Ph.D. application reviewer UT CS Graduate Admissions Committee	Fall 2020
Committee Member UT CS GradFest (admitted Ph.D. visit day)	Spring 2020, Spring 2021
Lead Dossier Reader VCU Honors College graduation dossiers Assessed dossiers and coordinated other readers.	Spring 2016, Spring 2017
Judge Launch Award for Outstanding Research Poster VCU Symposium for Undergraduate Research and Creativity	March 2016
Talks and Panels	
• Panelist at Grad school discussion for underrepresented undergraduat zations, 2020.	tes. UT CS student organi-
• Meeting with U.S. Army Operations Group. I was asked to share my 2018. November 2018.	observations from AQIS
• Talk: Computer Science theory <i>is</i> fun. VCU RamDev software develo	opment club, 2018.
• Panelist at Career workshop for freshman mentorship program. VCU Science, 2017.	Department of Computer

- **Panelist** at Undergraduate conference preparation workshops. VCU Honors College, 2017.
- Talk: Quantum programming (e.g. IBM Q, LIQ*Ui*|}). VCU RamDev software development club, 2017.