


Justin Yirka

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

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arXiv.org/a/yirka_j_1.html

 linkedin.com/in/justinyirka

 scholar.google.com/citations?user=UxIpR_UAAAAJ

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) Expected May 2025

Advised by Scott Aaronson

M.S. in Computer Science | The University of Texas at Austin 2022

B.S. in Computer Science | Virginia Commonwealth University (VCU) 2018

B.S. in Mathematical Sciences Concurrent degrees

Specialization in Data Science & Concentration in Pure Math

Minor in Physics

University Honors

Research Positions

R&D Intern | Sandia National Laboratories June 2023–present

Supervisors: Ojas Parekh and John Kallaugh

Topic: Hardness of estimating optimum product states of local Hamiltonians. Quantum Max-Cut and Vector Max-Cut. Quantum constrained optimization problems.

Summer School Fellow | Los Alamos National Laboratories Summer 2019

Supervisor: Yiğit Subaşı

Topic: Near-term (NISQ) quantum algorithms. Studied use of mid-circuit measurements and resets to construct circuits for entanglement spectroscopy which were noise-resilient *and* low-width.

Research Assistant | Graph Theory Computational Discovery Lab, VCU Summer 2018

Supervisor: Craig Larson

Topic: Automated conjecturing software applied to graph theory. Maintained database of graphs, their properties, and known theorems. Managed open-source project and programmed using git, GitHub, and Sage/Python.

NSF REU Researcher | QuICS, University of Maryland Summer 2017

Supervisor: Andrew Childs

Topic: Quantum tomography. Investigated minimum number of Pauli observables necessary to identify a quantum pure state.

Research Assistant | Quantum Computing Lab, VCU 2015–2016

Supervisor: 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” ($QCPH \subseteq P^{PPP}$).

Research Papers

Authors listed alphabetically unless noted. Filled labels indicate I gave the presentation.

J. Yirka. Even quantum advice is unlikely to solve PP.

- Preprint. arXiv:2403.09994 and ECCC:TR24-052, March 2024.

S. Grewal and J. Yirka. The Entangled Quantum Polynomial Hierarchy Collapses.

- Proceedings of *39th Computational Complexity Conference (CCC)*, Ann Arbor, MI, USA, July 2024. doi:10.4230/LIPIcs.CCC.2024.6.
- Poster at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
- arXiv:2401.01453 and ECCC:TR24-006, January 2024.

J. Kallaugh, O. Parekh, K. Thompson, Y. Wang, and J. Yirka. Complexity Classification of Product State Problems for Local Hamiltonians.

- Contributed talk at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
- arXiv:2401.06725, January 2024.

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

(authors not ordered alphabetically)

- *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.
- Poster at Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), College Park, MD, USA, 2019.
- Poster at Workshop on Quantum Computing Theory in Practice (QCTIP), Bristol, UK, 2019.
- Poster at Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- 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.
- Poster at Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- 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.
 • Poster at Conference on Quantum Information Processing (QIP). Seattle, USA, 2017.
 – arXiv:1606.05626, 2016.
- 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”**

Other Research Experience

Workshops and Visits.....

All-hands meeting | Quantum Systems Accelerator, a DOE QIS Research Center June 2024
 Attended on behalf of my advisor at UT Austin

Workshop | Simons Institute for the Theory of Computing Mar. 2024
 Quantum Complexity: Quantum PCP, Area Laws, and Quantum Gravity

Invited Workshop | Schloss Dagstuhl June 2021
 Quantum Complexity: Theory and Application

Visiting Researcher | University of Paderborn, Germany November 2018
 Collaboration with Sevag Gharibian
 Topic: Complexity theory and algorithms. Studied QMA₁-hardness of the quantum satisfaction problem (k -QSAT) given qudits of lower dimensions.

Seminars.....

- Complexity Classification of Product State Problems for Local Hamiltonians. 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 online M.S. program)
 Adapted and led entire course except for pre-recorded lectures.
 I was responsible for all other content and logistics, handling office hours, student concerns, academic integrity, and final grades nearly autonomously. Supervised 4 other teaching assistants.
 For the first run of the course, I was responsible for adapting old course materials for the online format.
 Spring 2022: 200 students, 1500 discussion board posts. Course evaluation 4.1 / 5.
 Spring 2024: Course evaluation 4.91 / 5.

Teaching Assistant | UT Fall 2021
 Introduction to Quantum Information Science (Honors course)
 With Scott Aaronson. Taught recitation and graded assignments.

Instructor | UT International Academy Summer 2021
 Introduction to Software Engineering (Java)
 Virtual. Developed entire course including assignments. Course evaluation 4.88 / 5.

Teaching Assistant | VCU (2 semesters) 2016–2017
 Algebra with Applications (MATH 141)
 Assisted with daily in-class exercises, offered tutorials, graded assignments.
 Average student evaluation scores — Fall 2016: 4.78 / 5.0; Spring 2017: 4.36 / 5.0.

Instructor | Department of Parks and Recreation, Prince William County, VA 2016–2018
 CPR and first-aid courses for lifeguards

Teaching Assistant | VCU Fall 2015
 Honors Rhetoric (HONR 200) — first-year honors writing and research course

Scholarships and Funding (all dollar amounts in USD)

Co-PI | Quantum computing seminar series at UT with invited speakers Fall 2024
 \$10,000, CIQC (an NSF Quantum Challenge Institute)

Grants for seminar series by VCU RamDev software development club 2016–2018
 \$1,900, VCU Student Government Association

Mark A. Sternheimer Capstone Design Award 2017
 \$660, VCU School of Engineering
 Grant for developing and testing senior project mobile app.

VCU Presidential Scholarship 2014–2018
 \$110,000, Virginia Commonwealth University
 Awarded to 0.6% of admitted students.
 Full cost of 4-year tuition, room, and board.

WPI Presidential Scholarship [declined] 2014
 \$80,000, Worcester Polytechnic Institute

Rensselaer Medal Merit Scholarship [declined] 2014
 \$100,000, Rensselaer Polytechnic Institute

Travel grants.....

- \$600 for CCC 2024 in Ann Arbor, MI, USA. CCC travel allowance / NSF.
- \$1,425 for Simons Institute workshop in Berkeley, CA, USA. CIQC (an NSF Quantum Challenge Institute).
- \$500 for QIP 2024 in Taipei, Taiwan. UT Graduate School.
- \$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.
- \$500 for QIP 2017 in Seattle, USA. VCU Honors College.

Awards

Honorable Mention | NSF Graduate Research Fellowship Program (NSF GRFP) 2019, 2020
 Awarded twice. Granted to top 30% of over 12,000 applicants.

Pure Mathematics Award | VCU College of Humanities and Sciences May 2018

Student in pure math concentration with highest graduating GPA.

University Student Scholar Award | Virginia Commonwealth University 2015

Launch Award for Outstanding Research Poster 2015

| VCU Symposium for Undergraduate Research

For poster *Evaluation of TCP header fields for data overhead efficiency*.

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

Service

Journal reviewer: *Quantum* (2022, 2020)

PC Member: YQIS 2021

Conference subreviewer: QIP (2024, 2022), TQC (2023, 2022), ITCS 2023, RANDOM 2023, CCC 2022

Chair | UT Graduate Representative Association of Computer Science Spring 2020–Fall 2021

- GRACS representative to UTCS Diversity, Equity, and Inclusion (DEI) Council.

- Co-Organized Graduate Application Assistance Program mentoring under-represented applicants to Ph.D. program. Managed the volunteer mentors. Fall 2020.

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

Tutor for remedial math students | Manchester High School, Midlothian, VA Spring 2019

Up to 4.5 hours per week with several groups of students.

Student Advisory Board member (2 academic years) 2016–2018

| VCU Department of Computer Science

- Participated in hiring interviews for new faculty in 2017.

Founder and President (2.5 academic years) 2016–2018

| RamDev: Software Development at VCU

- Coordinated 46 weekly seminars including 9 corporate speakers and several hackathon trips.

- Secured and managed \$2400 in funding and resources.

- Increased weekly attendance to 20+ students, becoming largest C.S. organization at VCU.

Mentor | VCU Honors College freshman mentorship program Fall 2016

Lead Dossier Reader | VCU Honors College graduation dossiers (2 academic years) 2016–2017

Assessed dossiers and coordinated other readers.

Judge | Launch Award for Outstanding Research Poster 2016

VCU Symposium for Undergraduate Research and Creativity

Co-Organizer | Local Hack Day of Richmond, VA 2016

Event for 30 students including 12 high school students.

Sponsored by Major League Hacking (MLH).

Volunteer for grade school robotics competitions (FIRST, Vex robotics) 2011–2015

| Prince William County Schools, VA

- Awarded “Volunteer of the Year”, 2014.

Mentor for middle School robotics team (FIRST robotics) Fall 2014

| Wilder Middle School, Richmond, VA

Talks and Panels.....

- **Panelist** at Grad school discussion for underrepresented undergraduates. UT CS student organizations, 2020.
- Meeting with U.S. Army Operations Group. I was asked to share my observations from AQIS 2018. November 2018.
- **Talk:** Computer Science theory *is* fun. VCU RamDev software development club, 2018.
- **Panelist** at Career workshop for freshman mentorship program. VCU Department of Computer Science, 2017.
- **Panelist** at Undergraduate conference preparation workshops. VCU Honors College, 2017.
- **Talk:** Quantum programming (e.g. IBM Q, $\text{LIQUi}| \rangle$). VCU RamDev software development club, 2017.