Justin Yirka

Graduating in 2025 Ph.D. Student in Computer Science

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Research Interests

Quantum computing, Theoretical computer science, Complexity theory and Hamiltonian complexity

Education

University of Texas at Austin (UT)

Ph.D. in Computer Science   Expected graduation: May 2025
    Adviser: Scott Aaronson

M.S. in Computer Science   2022

Virginia Commonwealth University (VCU)

B.S. in Computer Science — Specialization in Data Science   2018
B.S. in Mathematical Sciences — Concentration in Pure Mathematics   Concurrent degrees
    Minor in Physics, University Honors College

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

J. Yirka.
Even quantum advice is unlikely to solve PP.
– arXiv:2403.09994 and ECCC:TR24-052, March 2024.

S. Grewal and J. Yirka.
The Entangled Quantum Polynomial Hierarchy Collapses.
○ To appear in Proceedings of *39th Computational Complexity Conference* (*CCC*), Ann Arbor, MI, USA, July 2024.
● Poster at Conference on Quantum Information Processing (QIP), Taipei, Taiwan, January 2024.
– arXiv:2401.01453 and ECCC:TR24-006, January 2024.

J. Kallaugher, 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.   (authors not ordered alphabetically)
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.
- o 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.
- o Poster at Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), College Park, MD, USA, 2019.
- o 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.
- o Poster at Conference on Quantum Information Processing (QIP), Boulder, CO, USA, 2019.
- o Contributed talk at Asian Quantum Information Science Conference (AQIS), Nagoya, Japan, 2018. — **"Long"/plenary talk: top 7% of submissions**.
- o 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.
- o Contributed talk at Conference on the Theory of Quantum Computation, Communication, and Cryptography (TQC), Paris, France, 2017.
- • 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"**

Research Experience

Positions..

R&D Intern   June 2023–present
Sandia National Laboratories
    Supervisors: Ojas Parekh and John Kallaugher
    Topic: Hardness of estimating optimum product states of local Hamiltonians. Quantum constrained optimization problems.

Summer school / Research Assistant   Summer 2019
Los Alamos National Laboratories Quantum Computing Summer School
    Supervisor: Yiğit Subaşı
    Topic: Near-term (NISQ) quantum algorithms. Studied use of qubit resets to construct circuits for
    entanglement spectroscopy which were noise-resilient *and* low-width.

Research Assistant   Summer 2018
Graph Theory Computational Discovery Lab, Virginia Commonwealth University
    Supervisor: Craig Larson
    Topic: Automated conjecturing and graph theory. Studied conditions for graph Hamiltonicity. Assisted
    with programming and open-source project management.

Undergraduate Researcher (NSF REU C.A.A.R.)   Summer 2017
Joint Center for Quantum Inform. and Computer Science (QuICS), University of Maryland
    Supervisor: Andrew Childs
    Topic: Quantum tomography. Investigated minimum number of Pauli observables necessary to identify
    a quantum pure state.

Undergraduate Research Assistant   2015–2016
Quantum Computing Lab, Virginia Commonwealth University
    Supervisor: Sevag Gharibian
    Topic: Complexity theory. Studied quantum oracle classes (e.g. $\mathrm{P}^{\mathrm{QMA}[\log]}$) and complexity of simulating
    local measurements. Helped develop a "quantum PH" and "quantum Toda's Theorem" ($\mathrm{QCPH} \subseteq \mathrm{P}^{\mathrm{PP}^{\mathrm{PP}}}$).

Workshops and Visits

All-hands meeting   June 2024
Quantum Systems Accelerator (a Dept. of Energy Quantum Research Center)
    Attended on behalf of my advisor at UT Austin

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

Invitation-only workshop   June 2021
Schloss Dagstuhl — Quantum Complexity: Theory and Application

Visiting Researcher   November 2018
University of Paderborn, Germany
    Collaboration with Sevag Gharibian
    Topic: Complexity theory and algorithms. Studied QMA_1-hardness of the quantum satisfaction problem
    (k-QSAT) given qudits of lower dimensions.

Research Seminars

Research Preparation Exam on "Complexity Classification of Product State Problems for Local
Hamiltonians".
UT Computer Science department. 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.
Department of Computer Science, VCU. 2016. (Only undergraduate invited in previous 5 years.)

Teaching Experience

The University of Texas at Austin (UT)..

Head Teaching Assistant   Spring 2022, 2023, 2024
Quantum Information Science (Web-based for online M.S. program)
> All lecture content was pre-recorded by S. Aaronson. I was responsible for all other content and logistics, handling office hours, student concerns, academic integrity, and final grades nearly autonomously, with S. Aaronson as instructor of record. Supervised 4 other teaching assistants.
> For the first run of the course, I was fully responsible for modifying the homework, exams, and grading for the online format and for ensuring a successful addition to the growing MSCS program at UT.
> Spring 2022: 200 students, over 1500 discussion board posts. Course evaluation 4.1 / 5.
> Spring 2024: Course evaluation 4.91 / 5.

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

Instructor   Summer 2021
UT International Academy: Software Engineering
> Virtual. Introductory course for international undergraduate students. I independently designed the entire course. Course evaluation 4.88 / 5.

Virginia Commonwealth University (VCU)..

Teaching Assistant   (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.

Mentor for first-year student   Fall 2016
Honors College freshman mentorship program

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

Other...

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

Scholarships and Funding   (all dollar amounts in USD)

Co-PI: quantum computing seminar series at UT with invited speakers   Expected fall 2024
approx. $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.

Travel grants

Travel grant to CCC 2024 in Ann Arbor, MI, USA	2024
$600, CCC travel allowance / NSF	
Travel grant to a Simons Institute workshop in Berkeley, CA, USA	2024
$1,425, CIQC (an NSF Quantum Challenge Institute)	
Travel grant to QIP 2024 in Taipei, Taiwan	2024
$500, UT Graduate School	
Travel grant to QIP 2024 in Taipei, Taiwan	2024
$1,600, QIP student stipend	
Travel grant to QIP 2020 in Shenzhen, China	2020
$1,100, QIP student support / NSF	
Travel grant to QIP 2019 in Boulder, CO, USA	2019
$400, QIP student support / NSF	
Travel grant to QIP 2017 in Seattle, USA	2017
$500, VCU Honors College	

Awards

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

Pure Mathematics Award May 2018
VCU College of Humanities and Sciences
> Student in pure math concentration with highest graduating GPA.

Launch Award for Outstanding Research Poster 2015
VCU Symposium for Undergraduate Research and Creativity
> For poster *Evaluation of TCP header fields for data overhead efficiency*.

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

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 Spring 2020–Fall 2021
UT Graduate Representative Association of Computer Science (GRACS)
- 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 Fall 2020
UT CS Graduate Admissions Committee

Panelist — Grad school discussion for underrepresented undergraduates August 2020
UT CS student organizations

GradFest (admitted Ph.D. visit day) committee member   Spring 2020
UT Department of Computer Science

Tutor for remedial math students at local high school   Spring 2019
Manchester High School, Midlothian, VA
    Up to 4.5 hours per week with several groups of students.

Meeting with U.S. Army Operations Group   November 2018
    I was asked to share my observations from AQIS 2018.

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.

Talk — Computer Science theory *is* fun   April 2018
VCU RamDev software development club

Senior Reader for Honors program graduation dossiers   (2 academic years) 2016–2017
VCU Honors College
    Coordinated other readers.

Panelist — Career workshop for freshman mentorship program   2017
VCU Department of Computer Science

Panelist — Undergraduate conference preparation workshops   2017
VCU Honors College

Talk — Quantum programming (e.g. IBM Q, LIQ$Ui|\rangle$)   2017
VCU RamDev software development club

Judge — Launch Award for Outstanding Research Poster   2016
VCU Symposium for Undergraduate Research and Creativity

Organizer — Local Hack Day of Richmond, VA   2016
Major League Hacking (MLH) and VCU Department of Computer Science
    Co-organized event for 30 students including 12 high school students.

Volunteer for grade school robotics competitions (FIRST, Vex robotics)   2011–2015
Prince William County Schools, VA
    ○ Awarded "Volunteer of the Year", 2014.

Mentor to middle school robotics team (FIRST robotics)   Fall 2014
Wilder Middle School, Richmond, VA