

# Robert Rand

## Curriculum Vitae

August 2025

- 📍 Department of Computer Science
- 5730 South Ellis Avenue
- Chicago, IL 60637
- 🏠 <http://rand.cs.uchicago.edu/>
- 📞 773-702-5924
- ✉️ rand@uchicago.edu
- 🐦 @certifiablyrand
- ⌚ rnrand

### Education and Qualifications

2018 Ph.D. University of Pennsylvania  
2011 B.A. Yeshiva University

### Positions held

2020– Assistant Professor, Department of Computer Science, University of Chicago.  
2020– Affiliated Researcher, Argonne National Laboratory.  
2018–2020 Basili Postdoctoral Fellow, Department of Computer Science, University of Maryland.  
2016 Summer Research Fellow, Microsoft Research, Cambridge, United Kingdom.  
2011–2012 Data Scientist, Bundle Corporation, New York.

### Research

- Working at the intersection of Quantum Computing, Programming Languages, and Formal Verification.
- Lead developer of the QWIRE quantum circuit language.
- Co-developer of the SQIR quantum intermediate representation and VOQC compiler for quantum circuits.
- Current projects: Stabilizer-based type systems and program logics, verified ZX calculus optimizer (VyZX), the IN-QWIRE verified quantum library, Kleene algebra for quantum networks (BellKAT), and Qunity, a high-level quantum programming language.

### Refereed Research Papers

1. Anita Buckley, Pavel Chuprikov, Rodrigo Otoni, Robert Soulé, Robert Rand, and Patrick Eugster (2025). A Language for Quantifying Quantum Network Behavior. *Object-Oriented Programming, Systems, Languages & Applications (OOPSLA)*.
2. Mikhail Mints, Finn Voichick, Leonidas Lampropoulos, and Robert Rand (2025). Compositional Quantum Control Flow with Efficient Compilation in Qunity. *Object-Oriented Programming, Systems, Languages & Applications (OOPSLA)*.
3. Anita Buckley, Pavel Chuprikov, Rodrigo Otoni, Robert Soulé, Robert Rand, and Patrick Eugster (2024). An Algebraic Language for Specifying Quantum Networks. *Programming Language Design and Implementation (PLDI)*.
4. Bhakti Shah, William Spencer, Laura Zielinski, Ben Caldwell, Adrian Lehmann, and Robert Rand (2024). ViCAR: Visualizing Categories with Automated Rewriting in Coq. *Applied Category Theory (ACT)*.
5. Anita Buckley, Pavel Chuprikov, Rodrigo Otoni, Robert Rand, Robert Soulé, and Patrick Eugster (2023). Towards an Algebraic Specification of Quantum Networks. *Quantum Networks and Distributed Quantum Computing (QuNet)*.
6. Yuxiang Peng, Kesha Hietala, Runzhou Tao, Liyi Li, Robert Rand, Michael Hicks, and Xiaodi Wu (2023). A formally certified end-to-end implementation of Shor's factorization algorithm. *Proceedings of the National Academy of Sciences (PNAS)*.
7. Finn Voichick, Liyi Li, Robert Rand, and Michael Hicks (2023). Qunity: A Unified Language for Quantum and Classical Computing. *Principles of Programming Languages (POPL)*.
8. Giovanni De Micheli, Jie-Hong R. Jiang, Robert Rand, Kaitlin Smith, and Mathias Soeken (2022). Advances in Quantum Computation and Quantum Technologies: A Design Automation Perspective. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*.
9. Kartik Singhal, Kesha Hietala, Sarah Marshall, and Robert Rand (2022). Q# as a Quantum Algorithmic Language. *Quantum Physics and Logic (QPL)*.
10. Kesha Hietala, Robert Rand, Shih-Han Hung, Liyi Li, and Michael Hicks (2021). Proving Quantum Programs Correct. *Interactive Theorem Proving (ITP)*.
11. Kesha Hietala, Robert Rand, Shih-Han Hung, Xiaodi Wu, and Michael Hicks (2021). A Verified Optimizer for Quantum Circuits. *Principles of Programming Languages (POPL)*.
12. Robert Rand, Aarthi Sundaram, Kartik Singhal, and Brad Lackey (2020). Gottesman Types for Quantum Programs. *Quantum Physics and Logic (QPL)*.

13. Robert Rand, Kesha Hietala, and Michael Hicks (2019). Formal Verification vs. Quantum Uncertainty. *Summit on Advances in Programming Languages (SNAPL)*.
14. Robert Rand, Jennifer Paykin, Dong-Ho Lee, and Steve Zdancewic (2018). ReQWIRE: Reasoning about Reversible Quantum Circuits. *Quantum Physics and Logic (QPL)*.
15. Jennifer Paykin, Robert Rand, and Steve Zdancewic (2017). QWIRE: A Core Language for Quantum Circuits. *Principles of Programming Languages (POPL)*.
16. Robert Rand, Jennifer Paykin, and Steve Zdancewic (2017). QWIRE Practice: Formal Verification of Quantum Circuits in Coq. *Quantum Physics and Logic (QPL)*.
17. Robert Rand and Steve Zdancewic (2015). VPHL: A Verified Partial-Correctness Logic for Probabilistic Programs. *Mathematical Foundations of Programming Semantics (MFPS)*.
18. Kira Adaricheva, James B Nation, and Robert Rand (2013). Ordered Direct Implicational Basis of a Finite Closure System. *Discrete Applied Mathematics*.

## Refereed Workshop Presentations

1. Adrian Lehmann, Ben Caldwell, John Reppy, and Robert Rand (2024). Automated Proof Generation for Associative and Distributive Rewriting with E-Graphs. *E-Graph Research, Applications, Practices, and Human-factors (EGRAPHS)*.
2. Kesha Hietala, Sarah Marshall, Robert Rand, and Nikhil Swamy (2022). Q\*: Implementing Quantum Separation Logic in F\*. *Programming Languages for Quantum Computing (PLanQC)*.
3. Jacob Zweifler, Kesha Hietala, and Robert Rand (2022). QuantumLib: A Library for Quantum Computing in Coq. *The Coq Workshop*.
4. Kesha Hietala, Liyi Li, Akshaj Gaur, Aaron Green, Robert Rand, Xiaodi Wu, and Michael Hicks (2021). Expanding the VOQC Toolkit. *Programming Languages for Quantum Computing (PLanQC)*.
5. Robert Rand, Aarthi Sundaram, Kartik Singhal, and Brad Lackey (2021). Extending Gottesman Types Beyond the Clifford Group. *Programming Languages for Quantum Computing (PLanQC)*.
6. Kartik Singhal, Sarah Marshall, Kesha Hietala, and Robert Rand (2021). Toward a Type-Theoretic Interpretation of Q#. *Programming Languages for Quantum Computing (PLanQC)*.
7. Kesha Hietala, Robert Rand, and Michael Hicks (2020). Tracking Errors through Types in Quantum Programs. *Programming Languages for Quantum Computing (PLanQC)*.
8. Kartik Singhal, Robert Rand, and Michael Hicks (2020). Verified translation between low-level quantum languages. *Programming Languages for Quantum Computing (PLanQC)*.
9. Robert Rand, Jennifer Paykin, and Steve Zdancewic (2018). Phantom Types for Quantum Programs. *Coq for Programming Languages (CoqPL)*.
10. Robert Rand and Steve Zdancewic (2016). Models for Probabilistic Programs with an Adversary. *Probabilistic Programming Semantics (PPS)*.

## Research Talks

- Writing and Compiling High-Level Quantum Programs. QSI Seminar, University of Technology Sydney, 2025.
- Compiling High- and Low-Level Quantum Languages. Workshop on Quantum Software and Theory, Academia Sinica, 2025.
- Verifying Quantum Graphical Calculi. DIMACS Workshop on Quantum Software Systems and Theory, Rutgers University, 2025.
- Verifying Graphical Calculi, Quantum and Classical. MadPL Seminar, University of Wisconsin–Madison, 2025.
- Verifying Graphical Quantum Calculi in a Proof Assistant. Quantum Circuit Design Automation, Banff International Research Station, 2024.
- Verifying the ZX-calculus and its Friends. Running HoTT, NYU Abu Dhabi, 2024.
- Quantum Computing from a PL Perspective. Purdue Programming Languages Colloquium, 2023.
- Verifying Quantum Programs: From Deutsch's Algorithm to Shor's, Boston Principles of Programming and Verification Seminar, 2022.
- Writing and Verifying a Quantum Optimizing Compiler. International Conference on Compiler Construction, 2022. **Keynote**
- Quantum Programming Languages: What they are and what they could be. Towards 400 Qubits: Compilers and Programming Quantum Applications, The Quantum Computing Center, 2022.
- SPLASH 2021: Ask Me Anything (Invited Speaker)

- Quantum Computing from a Programmer’s Perspective. UChicago Quantum Computing Seminar, 2021.
- A Verified Optimizer for Quantum Circuits. 20th Annual High Confidence Software and Systems Conference, 2020.
- Quantum Programming Languages, Verification, and Testing. EPiQC seminar, UChicago, 2020.
- Towards a Verified Quantum Stack. American University Computer Science Colloquium, 2019.
- Verified Quantum Programs for the NISQ Era. AFOSR MURI Review, University of Maryland, 2019.
- Formally Verifying Quantum Protocols. Workshop on Higher Category Approach to Certifiably Correct Quantum Information Processing Systems, 2018.
- Verified Quantum Programming in QWIRE: Optimization and Error Correction. Dagstuhl Seminar on Quantum Programming Languages, 2018.
- Formally Verified Quantum Computing. Yeshiva University Physics Colloquium, 2018.
- Provably Correct Quantum Programming. Hofstra University Mathematics Seminar, 2018.
- Verified Quantum Programming in QWIRE. AFOSR MURI Review, UC Berkeley, 2017.
- Formally Verifying Your Quantum Programs. New Jersey Programming Languages and Systems Seminar, 2017.

## Tutorials

- Ben Caldwell and Robert Rand, Verified Quantum Computing. International Conference on Functional Programming, 2022.
- Robert Rand, Verified Quantum Computing. Principles of Programming Languages, 2020.
- Robert Rand, Quantum Circuits and Quantum Programs; Robert Rand, Formally Verified Quantum Computing. Winter School on Quantum Computing at Emory, 2020.
- Robert Rand and Arthur Azevedo de Amorim, Programs and Proofs in the Coq Proof Assistant. Principles of Programming Languages, 2016.
- Robert Rand and Arthur Azevedo de Amorim, An Introduction to the Coq Proof Assistant. Commercial Users of Functional Programming, September 2015.

## Teaching

- Topics in Formal Verification: Program Logics, University of Chicago, Spring 2025
- Topics in Formal Verification: Fully Automated Luxury Theorem Proving, University of Chicago, Winter 2024
- Programming Languages, University of Chicago, Spring 2023, 2024
- Picturing Quantum Processes, University of Chicago, Fall 2022
- Topics in Formal Verification: Advanced Proof Automation, University of Chicago, Spring 2022
- Quantum Programming and Verification, University of Chicago, Spring 2021
- Programming Proofs, University of Chicago, Winter 2021, Winter 2022, Fall 2023, Winter 2025
- Discrete Mathematics, University of Chicago, Fall 2020, Fall 2021, Winter 2023
- Program Analysis and Understanding, University of Maryland, Spring 2019
- Python Programming, University of Pennsylvania, Fall 2015 and Spring 2016
- Teaching Assistant, Introduction to Algorithms, University of Pennsylvania, Spring 2014
- Teaching Assistant, Automata, Computability, and Complexity, University of Pennsylvania, Fall 2013
- Lab Instructor, Introduction to Algorithms, Yeshiva University, Fall 2010
- Recitation Instructor, Discrete Structures, Yeshiva University, Spring 2009 and 2010

## Service

- Dagstuhl Seminar on Formal Analysis and Verification in Quantum Programming Languages, 2026. Organizer
- Principles of Programming Languages (POPL), 2026. Reviewer
- ACM Transactions on Software Engineering and Methodology, 2025. Reviewer
- Information and Computation, 2025. Reviewer
- DIMACS Workshop on Quantum Software Systems and Theory, 2025. Organizer

- Workshop on Quantum Networks and Distributed Quantum Computing (QuNet), 2025. Program Committee
- Programming Languages Design and Implementation (PLDI), Student Research Competition, 2025. Program Committee
- Midwest Programming Languages Symposium (MWPLS), 2024. Organizer
- Principles of Programming Languages (POPL), 2025 & 2026. Workshops Co-Chair
- Workshop on Quantum Software (WQS), 2024. Program Committee
- Quantum Physics and Logic (QPL), 2024 & 2025. Program Committee
- Quantum Programming (QP), 2024. Program Committee
- Programming Languages Design and Implementation (PLDI), 2024 & 2025. Program Committee
- Verification, Model Checking, and Abstract Interpretation (VMCAI), 2024. Program Committee
- Transactions on Quantum Engineering (TQE), 2024. Reviewer
- Principles of Programming Languages (POPL), 2023. Program Committee
- PeerJ Computer Science, 2023. Reviewer
- Quantum Software Engineering (Q-SE), 2022. Program Committee
- Programming Languages Design and Implementation (PLDI), 2022. Program Committee. *Distinguished Reviewer*
- European Symposium on Programming Languages (ESOP), 2022. Program Committee
- Symposium on Discrete Algorithms (SODA), 2022. Reviewer
- Programming Languages for Quantum Computing (PLanQC), 2020-2025. Program & Organizing Committees
- Quantum Computing and Engineering (QCE), 2021. Program Committee
- Theoretical Computer Science (TCS), 2021. Reviewer
- Quantum Physics and Logic (QPL), 2021. Reviewer
- Transactions on Computational Logic (ToCL), 2021. Reviewer
- Transactions on Software Engineering and Methodology (TOSEM), 2021. Reviewer
- International Conference on Concurrency Theory (CONCUR), 2021
- Principles of Programming Languages (POPL), 2021, 2022. Reviewer
- ACM Transactions on Quantum Computing (ACM-TQC), 2021. Reviewer
- Programming Languages for Quantum Computing (PLanQC), 2020. **PC Chair**
- Object-Oriented Programming, Systems, Languages & Applications (OOPSLA), 2020. External Review Committee
- Asian Symposium on Programming Languages and Systems (APLAS), 2020. Reviewer
- Quantum Cryptography (QCrypt), 2020. Reviewer
- International Colloquium on Automata, Languages and Programming (ICALP), 2020. Reviewer
- International Conference on Functional Programming (ICFP), 2020. Reviewer
- Mathematical Foundations of Computer Science (MFCS), 2020. Reviewer
- Foundations of Software Science and Computation Structures (FoSSaCS), 2020. Reviewer
- Quantum Information Processing (QIP), 2020. Reviewer
- Reversible Computing (RC), 2019. Program Committee
- Principles of Programming Languages (POPL), 2019. Artifact Evaluation Committee
- Programming Languages Design and Implementation (PLDI), 2019. Reviewer
- Applied Science, 2019. Reviewer
- Quantum, 2018–2020. Reviewer
- Journal of Quantum Information Processing (QINP), 2018, 2019. Reviewer
- Journal of Automated Reasoning (JARS), 2017, 2018. Reviewer
- Logic in Computer Science (LICS), 2016, 2018, 2019. Reviewer

- Mathematical Foundations of Programming Semantics (MFPS), 2016. Reviewer
- European Symposium on Programming Languages (ESOP), 2014. Reviewer
- ERGO, An Open Access Journal of Philosophy, 2014. Reviewer

## Awards & Grants

- PI: *Verifying Error-Correcting Codes for Broad Deployment*. Funded by IBM. \$600,000 total, Jan 2025 – Dec 2027.
- Co-PI: *Random Testing Across the Quantum Computing Stack*. Funded by the Air Force Research Laboratory. Project Grant FA95502310406. Joint between University of Maryland (Leonidas Lampropoulos) and University of Chicago (Robert Rand). \$1,200,000 total, Jan 2024 – Dec 2028.
- AFOSR Young Investigator Research Program Award. *Formally Verifying Graphical Quantum Calculi*. Project Grant FA95502310361. \$450,000 total, Jan 2023 – Dec 2025.
- France and Chicago Collaborating in the Sciences (FaCCTS) Award. *QBRICKS for Quantum Compilation*. \$20,000 total, 2023 – 2024. With Benoît Valiron at Université Paris-Saclay.
- Partner Investigator: *Formal Verification of Quantum Logic Circuits*, Project Grant DP220102059. Funded by the Australian Research Council. University of Technology Sydney. \$435,000 total, Jan 2022 – Jan 2025.
- Co-PI: *EPiQC: Enabling Practical-scale Quantum Computing*, Project Grant CCF-1730449. Funded by the National Science Foundation (NSF). University of Chicago. \$4,943,188 total, Mar 2018 – Feb 2023.
- Co-PI: *Software Assurance for Quantum Programs*, Project Grant FA95502110051. Funded by the Air Force Research Laboratory. Joint between University of Maryland (Michael Hicks) and University of Chicago (Robert Rand). \$450,000 total, Jan 2021 – Dec 2023.
- Victor Basili Postdoctoral Fellowship. Aug 2018 – July 2020.