

# Robert Rand

## Curriculum Vitae

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📍 Department of Computer Science  
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## 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.