Robert Rand

Curriculum Vitae

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Education and Qualifications

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

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 type systems ("Gottesman types"), Verified ZX calculus optimizer (VyZX), the INQWIRE verified quantum library, a language for measurement-based quantum computing (MCLANG), and $\lambda_{Q\#}$, a formal core of the Q# programming language.

Refereed Research Papers

1. K. Hietala, R. Rand, S.-H. Hung, L. Li, and M. Hicks (2021). Proving Quantum Programs Correct. In: *12th International Conference on Interactive Theorem Proving (ITP 2021)*.
2. K. Hietala, R. Rand, S.-H. Hung, X. Wu, and M. Hicks (2021). A verified Optimizer for Quantum Circuits. In: *Proceedings of the 48th ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2021)*.
3. R. Rand, A. Sundaram, K. Singhal, and B. Lackey (2020). Gottesman Types for Quantum Programs. In: *Proceedings of the 17th International Conference on Quantum Physics and Logic (QPL 2020)*. Vol. 20.
4. R. Rand, K. Hietala, and M. Hicks (2019). Formal Verification vs. Quantum Uncertainty. In: *3rd Summit on Advances in Programming Languages (SNAPL 2019)*.
5. R. Rand, J. Paykin, D.-H. Lee, and S. Zdancewic (2018). ReQWIRE: Reasoning about Reversible Quantum Circuits. In: *Proceedings of the 15th International Conference on Quantum Physics and Logic (QPL 2018)*.
6. J. Paykin, R. Rand, and S. Zdancewic (2017). QWIRE: A Core Language for Quantum Circuits. In: *Proceedings of the 44th ACM SIGPLAN Symposium on Principles of Programming Languages (POPL 2017)*.
7. R. Rand, J. Paykin, and S. Zdancewic (2017). QWIRE Practice: Formal Verification of Quantum Circuits in Coq. In: *Proceedings of the 14th International Conference on Quantum Physics and Logic (QPL 2017)*.
8. R. Rand and S. Zdancewic (2015). VPHL: A Verified Partial-Correctness Logic for Probabilistic Programs. In: *The 31st Conference on the Mathematical Foundations of Programming Semantics (MFPS XXXI)*.
9. K. Adaricheva, J. B. Nation, and R. Rand (2013). Ordered Direct Implicational Basis of a Finite Closure System. *Discrete Applied Mathematics* **161**(6), 707–723.

Refereed Workshop Papers

1. K. Hietala, L. Li, A. Gaur, A. Green, R. Rand, X. Wu, and M. Hicks (2021). Expanding the VOQC Toolkit. In: *The Second International Workshop on Programming Languages for Quantum Computing (PLanQC 2021)*.
2. R. Rand, A. Sundaram, K. Singhal, and B. Lackey (2021a). Extending Gottesman Types Beyond the Clifford Group. In: *The Second International Workshop on Programming Languages for Quantum Computing (PLanQC 2021)*.
3. K. Singhal, S. Marshall, K. Hietala, and R. Rand (2021). Toward a Type-Theoretic Interpretation of Q#. In: *The Second International Workshop on Programming Languages for Quantum Computing (PLanQC 2021)*.
4. K. Hietala, R. Rand, and M. Hicks (2020). Tracking Errors through Types in Quantum Programs. In: *The First International Workshop on Programming Languages for Quantum Computing (PLanQC 2020)*.

5. K. Singhal, R. Rand, and M. Hicks (2020). Verified translation between low-level quantum languages. In: *The First International Workshop on Programming Languages for Quantum Computing (PLanQC 2020)*.
6. R. Rand, J. Paykin, and S. Zdancewic (2018). Phantom Types for Quantum Programs. In: *The Fourth International Workshop on Coq for Programming Languages (CoqPL 2018)*.
7. R. Rand and S. Zdancewic (2016). Models for Probabilistic Programs with an Adversary. In: *Probabilistic Programming Semantics (PPS 2016)*.

Research Talks

- Quantum Programming Languages: What they are and what they could be. Towards 400 Qubits: Compilers and Programming Quantum Applications, The Quantum Computing Center, 2022.
- 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

- 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

- Instructor, Quantum Programming and Verification, University of Chicago, Spring 2021
- Instructor, Programming Proofs, University of Chicago, Winter 2021, Winter 2022
- Instructor, Discrete Mathematics, University of Chicago, Fall 2020, Fall 2021
- Instructor, Program Analysis and Understanding, University of Maryland, Spring 2019
- Instructor, 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

- Principles of Programming Languages (POPL), 2023. Program Committee
- Quantum Software Engineering (Q-SE), 2022. Program Committee
- Programming Languages Design and Implementation (PLDI), 2022. Program Committee

- European Symposium on Programming Languages (ESOP), 2022. Program Committee
- Symposium on Discrete Algorithms (SODA), 2022. Reviewer
- Programming Languages for Quantum Computing (PLanQC), 2021. Program Committee, Organizing Committee
- 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

- Co-PI: 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 (DOD - USAF - AFMC). 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.