Rachel Lawrence

Researcher, Theoretical Computer Science

Education

2017 – 2023 **Ph.D. Electrical Engineering and Computer Science**, *University of California, Berkeley*.
Research interests: Graph dynamical systems; combinatorial optimization; algorithm design; fairness, privacy, and security in machine learning. *GPA 4.00*

2016 **Bachelor of Science, Applied Mathematics**, *Yale University*.
Senior Thesis: Constructive Counting of Hamiltonian Cycles in Dense and Regular Directed Graphs.

Research

2017 – 2023 **U.C. Berkeley EECS**, *Ph.D., Theoretical Computer Science*.
Thesis: Simplicial Reaction Networks and Dynamics on Graphs

Selected works:

Quadratic Dynamical Systems. Proved the global attractor conjecture and persistence conjecture in the matroid setting, providing a first-of-its-kind proof characterizing the steady states of matroid quadratic dynamical systems. Additional work presents applications to sampling algorithms on combinatorial structures, and novel conditions for convergence in the general detailed balanced setting.

Randomized Zero Forcing. Proved new upper and lower bounds on the likelihood of selecting a zero forcing set in the randomized zero forcing constraint propagation problem, with applications to the inverse eigenvalue problem on graphs.

Minimum Rank of Graphs. Computational hardness result demonstrating that determining whether a graph has minimum rank three is complete for the existential theory of the reals.

Differentially Private GANs. Designed attacks and defenses against generative adversarial neural networks (GANs); designed and tested GANs with differential privacy guarantees and robustness to adversarial examples.

2020 **Microsoft Research**, *Research Intern, Essex Data Science*.
Performed the first analysis of dynamic graph data from the cortical organoid connectome, a stem-cell model for early brain development. Contributions included theoretical analysis of sampling and community detection on novel random graph models, and empirical study of time-series signalling data.

2016 – 2017 **Reservoir Labs, Inc.**, *Software Engineer*.
Development and medical research applications of ENSIGN, a high-performance tool for unsupervised hypergraph analysis using tensor decompositions. Design, development, and testing of a compiler optimized for a specialized SIMD architecture.

2015 – 2016 **Yale Department of Mathematics**, *SUMRY Fellow*.
Developed algebraic and combinatorial methods to determine incidence of arcs in the projective plane. Proved that the number of 10-arcs in a finite projective plane is not quasipolynomial. Selected for presentation at MathFest 2015 and the Ohio State Young Mathematicians' Conference; published as: *Counting Arcs in the Projective Plane via Glynn's Algorithm.* (2016), Journal of Geometry.

2016 **Pixar Animation Studios**, *Research and Development Intern*.
Developed an original tool for art-directable cloth simulation for use in Pixar animated feature films as a member of Pixar's computer graphics research group. Work presented at SIGGRAPH 2016.

2013 – 2014 **Yale University**, *Research Intern*.
Department of Mathematics. Designed algorithms using driven iterated function systems for pattern recognition in time-series data.
Center for Statistical Genomics and Proteomics. Designed and implemented algorithms to study pleiotropy in genetic pathways implicated in Bipolar Disorder and Schizophrenia through GWAS data.

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Teaching

2018, 2021 **U.C. Berkeley**, *Graduate Student Instructor.*
Taught classes and designed course materials for CS 70: Discrete Mathematics and Probability Theory. 2022 recipient of the Berkeley EECS Outstanding Graduate Student Instructor Award.

2018 **Stanford Pre-Collegiate Studies**, *Instructor.*
Artificial Intelligence (Primary Instructor). Designed and taught an original, intensive three-week course, including daily instruction along with supplementary coding and written assignments.
Computer Security and Machine Learning (Teaching Assistant). Led discussion section lectures and labs.

2013 – present **Splash at Yale**, *Executive Director (2015-16), Nonprofit Board (present).*
Directed Yale Splash, a 501(c) non-profit educational outreach organization. Organized five annual outreach programs for secondary school students, oversaw day-to-day organizational functions, developed and taught more than 20 original courses, and coordinated a conference for program leaders nationwide.

2016 – 2018 **Learning Unlimited**, *Board Member.*
Elected board member of Learning Unlimited, a nonprofit providing opportunities for accessible, interdisciplinary learning for secondary school students. Advised and coordinated educational outreach programs and conferences at over 50 participating universities, reaching over 20,000 students.

2015 – 2016 **HackYale**, *Board Member and Instructor.*
Designed, and taught computer science and graphic design courses for students of all backgrounds. Delivered weekly lectures to classes of 25 undergraduate and graduate students.

2015, 2016 **Yale University**, *Course Grader.*
Course grader for CPSC 365: Design and Analysis of Algorithms.

Academic Honors

2017 – 2022 **National Physical Sciences Consortium Graduate Fellowship**.
National fellowship supporting graduate study sponsored by the US Department of Defense

2022 **Berkeley EECS Outstanding TA Award**.
Departmental award recognizing exceptional teaching performance

2020-2021 **AMS Mathematics Research Communities**.
NSF-sponsored research and mentorship program supporting early-career mathematicians

2021 **D.E. Shaw Zenith Fellowship**.
Educational fellowship for graduate students in technology and computational finance

2015 **SUMRY Fellowship**.
Awarded for 10-week intensive summer research program at the Yale Department of Mathematics

2014 **Davenport College Richter Fellowship**.
Yale College fellowship awarded for independent study and research

2013, 2014 **Yale College Dean's Research Fellowship**.
Research fellowship awarded for undergraduate work in STEM

Languages

Experienced: Python, MATLAB, C++, SageMath

Working knowledge: R, Java, Mathematica, HTML, CSS

Service

Women in Computer Science and Engineering, Berkeley, *Outreach Co-coordinator.*
Berkeley Algorithms Office Hours, *Research Consultant.*
Berkeley Computer Science Graduate Student Association, *Board Member.*
EECS Mentorship Programs, *PhD Peer Mentor, Visit Days Mentor, Consulting Tutor.*
MoMath Mathematics Outreach Seminar and Training Program, *Selected Participant.*