August 2025

JOSH ALMAN

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THEORETICAL COMPUTER SCIENTIST

Positions

Columbia University

Associate Professor (without tenure), Department of Computer Science, **Jan 2026-present**
Assistant Professor, Department of Computer Science, **July 2021-Dec 2025**
Fu Foundation School of Engineering and Applied Science

Harvard University **2019-2021**

Michael O. Rabin Postdoctoral Fellow, Theory of Computing Group

Education

Massachusetts Institute of Technology **2017-2019**

Ph.D. in Computer Science
Advisors: Ryan Williams and Virginia Vassilevska Williams
Thesis: Linear Algebraic Techniques in Algorithms and Complexity

Stanford University **2014-2016**

M.S. in Computer Science
Advisors: Ryan Williams and Virginia Vassilevska Williams

Massachusetts Institute of Technology **2010-2014**

B.S. in Mathematics

Selected Honors

- The Benjamin Franklin NextGen Award, Franklin Institute, 2026
- David & Lucile Packard Foundation Fellowship for Science and Engineering, 2024
- Google Research Scholar Award, 2024
- NSF CAREER Award, 2023
- Best Paper Award at SOSA 2023
- Machtey Award for Best Student Paper at FOCS 2019
- Best Student Paper Award at CCC 2019
- European Association of TCS Distinguished Dissertation Award, 2019
- George M. Sprowls Award for outstanding Ph.D. theses in Computer Science at MIT, 2019
- Michael Cohen Award for Best MIT Theory of Computation Student Paper, 2017
- Special Issue Papers at STOC 2021, FOCS 2019, CCC 2019, and FOCS 2018
- NSF Graduate Research Fellowship, 2014-2017
- Represented Stanford at the ACM International Collegiate Programming Contest World Finals, 2016
- Top 25 at the Putnam Math Competition, 2012
- Member of Phi Beta Kappa Honor Society since 2014

Publications

Copies of all my publications can be found at joshalman.com/publications

Learning Functions of Halfspaces
with Shyamal Patel, Rocco Servedio
58th Annual ACM Symposium on the Theory of Computing (STOC 2026)

Poly-Attention: a General Scheme for Higher-Order Self-Attention
with Sayak Chakrabarti, Toniann Pitassi
14th International Conference on Learning Representations (ICLR 2026)

Two Heads Are Better than One: Simulating Large Transformers with Small Ones
with Hantao Yu
39th Conference on Neural Information Processing Systems (NeurIPS 2025), spotlight presentation

Kronecker Powers, Orthogonal Vectors, and the Asymptotic Spectrum
with Baitian Li
to appear in 66th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2025)

Faster Exact Learning of k-term DNFs with Membership and Equivalence Queries
with Shivam Nadimpalli, Shyamal Patel, Rocco Servedio
to appear in 66th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2025)

Low Rank Matrix Rigidity: Tight Lower Bounds and Hardness Amplification
with Jingxun Liang
In 57th Annual ACM Symposium on the Theory of Computing (STOC 2025)

DNF Learning via Locally Mixing Random Walks
with Shivam Nadimpalli, Shyamal Patel, Rocco Servedio
In 57th Annual ACM Symposium on the Theory of Computing (STOC 2025)

Fine-Grained Complexity in a World Without Cryptography
with Yizhi Huang, Kevin Yeo
In 44th Annual International Conference on the Theory and Applications of Cryptographic Techniques (EUROCRYPT 2025)

Fundamental Limitations on Subquadratic Alternatives to Transformers
with Hantao Yu
In 13th International Conference on Learning Representations (ICLR 2025)

Sparsity Lower Bounds for Probabilistic Polynomials
with Arkadev Chattopadhyay, Ryan Williams
In 16th Innovations in Theoretical Computer Science Conference (ITCS 2025)

More Asymmetry Yields Faster Matrix Multiplication
with Ran Duan, Virginia Vassilevska Williams, Yinzhan Xu, Zixuan Xu, Renfei Zhou
In 36th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2025)

Improving the Leading Constant of Matrix Multiplication
with Hantao Yu
In 36th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2025)

Faster Algorithms for Average-Case Orthogonal Vectors and Closest Pair Problems
with Alexandr Andoni, Hengjie Zhang
In 8th Symposium on Simplicity in Algorithms (SOSA 2025)

Metric Transforms and Low Rank Representations of Kernels
with Timothy Chu, Gary Miller, Shyam Narayanan, Mark Sellke, Zhao Song
In 38th Conference on Neural Information Processing Systems (NeurIPS 2024), spotlight presentation

The Fine-Grained Complexity of Gradient Computation for Training Large Language Models
with Zhao Song
In 38th Conference on Neural Information Processing Systems (NeurIPS 2024)

Finer-Grained Hardness of Kernel Density Estimation
with Yunfeng Guan
In 39th Computational Complexity Conference (CCC 2024)

How to Capture Higher-Order Correlations? Generalizing Matrix Softmax Attention to Kronecker Computation
with Zhao Song
In 12th International Conference on Learning Representations (ICLR 2024), spotlight presentation

Tensor Ranks and the Fine-Grained Complexity of Dynamic Programming
with Ethan Turok, Hantao Yu, Hengzhi Zhang
In 15th Innovations in Theoretical Computer Science Conference (ITCS 2024)

Fast Attention Requires Bounded Entries
with Zhao Song
In 37th Conference on Neural Information Processing Systems (NeurIPS 2023)

Bypass Exponential Time Preprocessing: Fast Neural Network Training via Weight-Data Correlation Preprocessing
with Jiehao Liang, Zhao Song, Ruizhe Zhang, Danyang Zhuo
In 37th Conference on Neural Information Processing Systems (NeurIPS 2023)

Generalizations of Matrix Multiplication can solve the Light Bulb Problem
with Hengjie Zhang
In 64th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2023)

Matrix Multiplication and Number On the Forehead Communication
with Jarosław Błasiok
In 38th Computational Complexity Conference (CCC 2023)

Faster Walsh-Hadamard and Discrete Fourier Transforms From Matrix Non-Rigidity
with Kevin Rao
In 55th Annual ACM Symposium on the Theory of Computing (STOC 2023)

Smaller Low-Depth Circuits for Kronecker Powers
with Yunfeng Guan, Ashwin Padaki
In 34th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2023)

Faster Walsh-Hadamard Transform and Matrix Multiplication over Finite Fields using Lookup Tables
In 6th Symposium on Simplicity in Algorithms (SOSA 2023)
Best Paper Award at SOSA 2023

Optimal-Degree Polynomial Approximations for Exponentials and Gaussian Kernel Density Estimation
with Amol Aggarwal
In 37th Computational Complexity Conference (CCC 2022)

Parameterized Sensitivity Oracles and Dynamic Algorithms using Exterior Algebras
with Dean Hirsch
In *49th International Colloquium on Automata, Languages, and Programming (ICALP 2022)*

Kronecker Products, Low-Depth Circuits, and Matrix Rigidity
In 53rd Annual ACM Symposium on the Theory of Computing (STOC 2021)
Invited to special issue of SIAM Journal on Computing for STOC

A Refined Laser Method and Faster Matrix Multiplication
with Virginia Vassilevska Williams
In 32nd Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2021)
Covered by Kevin Hartnett in Quanta Magazine [link]

Algorithms and Hardness for Linear Algebra on Geometric Graphs
with Timothy Chu, Aaron Schild, Zhao Song
In 61st Annual IEEE Symposium on Foundations of Computer Science (FOCS 2020)

OV Graphs are (Probably) Hard Instances
with Virginia Vassilevska Williams
In 11th Innovations in Theoretical Computer Science Conference (ITCS 2020)

Faster Update Time for Turnstile Streaming Algorithms
with Huacheng Yu
In 31st Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2020)

Faster Deterministic and Las Vegas Algorithms for Offline Approximate Nearest Neighbors in High Dimensions
with Timothy M. Chan, Ryan Williams
In 31st Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2020)

Predicate Encryption from Bilinear Maps and One-Sided Probabilistic Rank
with Robin Hui
In 17th Theory of Cryptography Conference (TCC 2019)

Efficient Construction of Rigid Matrices Using an NP Oracle
with Lijie Chen
In 60th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2019)
Machtey Award for Best Student Paper at FOCS 2019
Invited to special issue of SIAM Journal on Computing for FOCS

Limits on the Universal Method for Matrix Multiplication
In 34th Computational Complexity Conference (CCC 2019)
Best Student Paper Award at CCC 2019
Invited to special issue of ToC for CCC

An Illuminating Algorithm for the Light Bulb Problem
In 2nd Symposium on Simplicity in Algorithms (SOSA 2019)

Limits on All Known (and Some Unknown) Approaches to Matrix Multiplication
with Virginia Vassilevska Williams
In 59th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2018)
Invited to special issue of SIAM Journal on Computing for FOCS

Cell-Probe Lower Bounds from Online Communication Complexity
with Joshua Wang, Huacheng Yu
In 50th Annual ACM Symposium on the Theory of Computing (STOC 2018)

Further Limitations of the Known Approaches for Matrix Multiplication
with Virginia Vassilevska Williams
In 9th Innovations in Theoretical Computer Science Conference (ITCS 2018)

Dynamic Parameterized Problems and Algorithms
with Matthias Mnich, Virginia Vassilevska Williams
In 44th International Colloquium on Automata, Languages, and Programming (ICALP 2017)

Probabilistic Rank and Matrix Rigidity
with Ryan Williams
In 49th Annual ACM Symposium on the Theory of Computing (STOC 2017)
Michael Cohen Award for Best MIT Theory of Computation Student Paper

Theoretical Foundations of Team Matchmaking
with Dylan McKay
In 16th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2017)

Polynomial Representations of Threshold Functions and Algorithmic Applications
with Timothy M. Chan, Ryan Williams
In 57th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2016)

Probabilistic Polynomials and Hamming Nearest Neighbors
with Ryan Williams
In 56th Annual IEEE Symposium on Foundations of Computer Science (FOCS 2015)

Laurent Phenomenon Sequences
with Cesar Cuenca, Jiaoyang Huang
Journal of Algebraic Combinatorics 43, 589-633 (2016)

Circular Planar Electrical Networks: Posets and Positivity
with Carl Lian, Brandon Tran
Journal of Combinatorial Theory, Ser. A 132, 58-101 (2015).

Invited Talks

The Last 15 Years of Improvements to the Exponent of Matrix Multiplication
- Workshop on Algebraic Complexity Theory (plenary speaker), June 2026
- Simons Institute Workshop on Matrix Multiplication, Oct 2025

Fine-Grained Complexity in a World Without Cryptography
- Charles River Crypto Day, Apr 2025

Fine-Grained Complexity and the Pursuit of Fast Attention
- EPFL Theory Seminar, May 2026
- UPenn Theory Seminar, May 2026
- UC Berkeley Theory Lunch, Nov 2025
- EnCORE Institute (UCSD) Workshop on Theoretical Perspectives on LLMs, Mar 2025

Algorithms and Hardness for Attention and Kernel Density Estimation

- Yale Foundations of Data Science Colloquium, Sept 2024
- Summer Quant Speaker Series at Seven Eight Capital, Aug 2024
- Google NY Theory seminar, May 2024

Fast Attention Requires Bounded Entries

- Simons Institute Workshop on Sketching and Algorithm Design, Oct 2023

Faster Walsh-Hadamard Transform from Matrix Non-Rigidity

- Harvard Theory Seminar, May 2025
- University of Chicago Combinatorics and Theoretical Computer Science Seminar, Nov 2024
- UT Austin Theory Seminar, March 2024
- Princeton Theory Lunch, Feb 2023
- DIMACS Workshop on Lower Bounds and Frontiers in Data Structures, Aug 2022

Generalizations of Matrix Multiplication can Solve the Light Bulb Problem

- Morgan Stanley ML Research Seminar, Sept 2023
- Centre de Recherches Mathématiques (Montreal) Workshop on Tensors in Algebraic Complexity and Combinatorics, Dec 2022
- University of Warsaw AGATES Algebraic Geometry and Complexity Theory Workshop, Nov 2022

Algorithms and Barriers for Fast Matrix Multiplication (Survey talk)

- University of Pittsburgh Electrical and Computer Engineering Seminar, Oct 2024
- Duke University Biostatistics and Bioinformatics Seminar, Feb 2022
- Complexity of Matrix Computations Online Seminar, Dec 2021
- Georgetown University Computer Science Seminar, Nov 2021

A Refined Laser Method and Faster Matrix Multiplication

- Toulouse Mathematics Institute Workshop on Geometry and Complexity Theory, Apr 2022
- MIT Algorithms and Complexity Seminar, May 2021
- AMS Western Sectional Meeting, session on Quivers, Tensors, and their Applications, May 2021

Kronecker Products, Low-Depth Circuits, and Matrix Rigidity

- Columbia University Theory Seminar, Oct 2021
- University of Washington Theory Seminar, May 2021
- Oxford-Warwick Complexity Meetings, Apr 2021

Faster Update Time for Turnstile Streaming Algorithms

- Stanford University Theory Seminar, Jan 2020
- Google Mountain View Theory Seminar, Jan 2020

Limits on the Universal Method for Matrix Multiplication

- SIAM Annual Meeting, Minisymposium on Lower Bounds in Numerical Linear Algebra, July 2021
- AMS Sectional Meeting at the University of Virginia, session on Tensors and Complexity, Mar 2020
- Northeastern Theory Seminar, Dec 2019
- University of Chicago Combinatorics and Theoretical Computer Science Seminar, Oct 2019
- MIT Combinatorics Seminar, Sept 2019

Efficient Construction of Rigid Matrices Using an NP Oracle

- BIRS Workshop on Algebraic Techniques in Computational Complexity, July 2019

Limits on All Known (and Some Unknown) Approaches to Matrix Multiplication

- Highlights of Algorithms Invited Speaker, June 2019
- MIT Algorithms and Complexity Seminar, Oct 2018
- Schloss Dagstuhl Seminar on Algebraic Methods in Computational Complexity, Sept 2018
- China Theory Week at Tsinghua University, Sept 2018
- Oxford/Clay Mathematics Institute Workshop on Complexity Theory, July 2018

Dynamic Parameterized Problems and Algorithms

- SIAM DM Conference, Minisymposium on Modification Problems to Discrete Structures, June 2018

Cell-Probe Lower Bounds from Online Communication Complexity

- MIT Algorithms and Complexity Seminar, May 2017

Probabilistic Rank and Matrix Rigidity

- TCS+ Online Seminar, Mar 2017

Polynomial Representations of Threshold Functions with Algorithmic Applications

- IT University of Copenhagen Theory Seminar, Aug 2016

Probabilistic Polynomials and Hamming Nearest Neighbors

- SODA Workshop on Multi-dimensional Proximity Problems, Jan 2016
- Simons Institute Workshop on Connections between Algorithm Design and Complexity Theory, Oct 2015

Positivity Phenomena in Circular Planar Electrical Networks

- University of Michigan Combinatorics Seminar, Feb 2014

Research Internships

IBM Research – Almaden Research Center **Summer 2017**

Worked in the Principles and Methodologies group

Service and Outreach

Program Committees:

- 67th IEEE Symposium on Foundations of Computer Science (FOCS 2026)
- 17th Innovations in Theoretical Computer Science Conference (ITCS 2026)
- 37th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2026)
- 32nd Annual European Symposium on Algorithms (ESA 2024)
- 7th Symposium on Simplicity in Algorithms (SOSA 2024)
- 51st International Symposium on Mathematical Foundations of Computer Science (MFCS 2023)
- 54th Annual ACM Symposium on Theory of Computing (STOC 2023)
- 63rd IEEE Symposium on Foundations of Computer Science (FOCS 2022)
- 30th Annual European Symposium on Algorithms (ESA 2022)
- 13th Innovations in Theoretical Computer Science Conference (ITCS 2022)
- 5th Symposium on Simplicity in Algorithms (SOSA 2022)

Leadership Activities:

- Organizer of DIMACS Workshop on Algebraic Techniques in Fine-Grained Complexity, Summer 2026
- Co-Organizer of Simons Institute Workshop on Matrix Multiplication, Oct 2025
- Co-Organizer of UCSD EnCORE Institute Workshop on Fine-Grained Complexity, May 2025
- Local co-organizer of Innovations in Theoretical Computer Science (ITCS) conference hosted at Columbia University, Jan 2025
- Co-organizer of NY Theory Day, Dec 2024 (NYU Tandon) and May 2025 (Columbia)
- Co-coach of Columbia ICPC programming contest team, 2023-present
- Board of Editors, Theory of Computing (journal), 2022–present
- Co-Organizer of STOC Workshop on MCSP and Hardness Magnification, July 2020

Other Conference Reviewing: STOC, FOCS, SODA, CCC, NeurIPS, ICLR, SOSA, ICALP, ITCS, ESA, SoCG, FSTTCS, ISSAC, STACS, SPAA, CSR, SWAT, MFCS, FUN, WADS, COCOON, *etc.*

Other Journal Reviewing: Nature, ACM Transactions on Algorithms, Journal of Computational Geometry, Computational Complexity, Theory of Computing, Electronic Journal of Combinatorics, Random Structures & Algorithms, Theoretical Computer Science, SIAM Journal on Computing, SIAM Journal on Discrete Mathematics, *etc.*

Volunteering:

- Team Leader for Ghana at the 2021 International Math Olympiad; coach and teacher 2013-present
- Taught over 50 Computer Science and Math classes for Middle and High School students through the Educational Studies Programs at MIT and Stanford