

Dmitriy (Tim) Kunisky

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CONTACT INFORMATION	Kline Tower, Yale University 219 Prospect Street, Office 1321 New Haven, CT 06511	dmitriy.kunisky@yale.edu http://www.kunisky.com
RESEARCH INTERESTS	My focus is on probability theory and discrete mathematics with applications to statistics, data science, algorithms, and optimization. In particular: <ul style="list-style-type: none">· computationally-hard regimes in optimization and statistical problems;· average-case analysis of convex relaxations of combinatorial optimization;· pseudorandomness and derandomizing results on computational hardness and random matrix theory;· convex optimization in proof assistants and experimental mathematics;· discrepancy theory and its algorithmic applications.	
EMPLOYMENT	Yale University Postdoctoral Associate in Computer Science	New Haven, CT 07/2021–Present
	· Hosted by Daniel Spielman	
EDUCATION	Courant Institute of Mathematical Sciences Ph.D. in Mathematics	New York, NY 09/2016–05/2021
	· Dissertation: <i>Spectral Barriers in Certification Problems</i> , advised by Afonso Bandeira and Gérard Ben Arous	
	Princeton University A.B. <i>summa cum laude</i> in Mathematics	Princeton, NJ 09/2010–06/2014
	· Certificate in Applications of Computing	
	· Senior Thesis: <i>The Theft and the Honest Toil: Applications of Large Cardinal Axioms to the Theory of Measurable Selection</i> , advised by John Burgess	
	· Junior Independent Paper: <i>Discrete Applications of Brownian Motion</i> , advised by Michael Damron	
PUBLICATIONS	Optimality of Glauber dynamics for general-purpose Ising model sampling and free energy approximation. Dmitriy Kunisky. <i>Proceedings of the 2024 Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2024)</i> , to appear.	
	The spectrum of the Grigoriev-Laurent pseudomoments. Dmitriy Kunisky, Christopher Moore. <i>SIAM Journal of Discrete Mathematics (SIDMA)</i> , to appear.	
	A degree 4 sum-of-squares lower bound for the clique number of the Paley graph. Dmitriy Kunisky, Xifan Yu. <i>Proceedings of the 38th Computational Complexity Conference (CCC 2023)</i> .	

The discrepancy of unsatisfiable matrices and a lower bound for the Komlós conjecture constant. Dmitriy Kunisky. *SIAM Journal of Discrete Mathematics (SIDMA)*, 37, No. 2, 2023.

Subexponential-time algorithms for sparse PCA. Yunzi Ding, Dmitriy Kunisky, Alexander S. Wein, Afonso S. Bandeira. *Foundations of Computational Mathematics*, 2023.

Dual bounds for the positive definite functions approach to mutually unbiased bases. Afonso S. Bandeira, Nikolaus Doppelbauer, and Dmitriy Kunisky. *Sampling Theory, Signal Processing, and Data Analysis* 20, No. 18, 2022.

Strong recovery of geometric planted matchings. Dmitriy Kunisky, Jonathan Niles-Weed. *Proceedings of the 2022 Annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2022)*.

Linear programming and community detection. Alberto Del Pia, Aida Khajavirad, Dmitriy Kunisky. *Mathematics of Operations Research*, 2022.

Hypothesis testing with low-degree polynomials in the Morris class of exponential families. Dmitriy Kunisky. *Proceedings of the 34th Conference on Learning Theory (COLT 2021)*.

Spectral planting and the hardness of refuting cuts, colorability, and communities in random graphs. Afonso S. Bandeira, Jess Banks, Dmitriy Kunisky, Christopher Moore, Alexander S. Wein. *Proceedings of the 34th Conference on Learning Theory (COLT 2021)*.

Average-case integrality gap for non-negative principal component analysis. Afonso S. Bandeira, Dmitriy Kunisky, Alexander S. Wein. *Mathematical and Scientific Machine Learning (MSML 2021)*.

The average-case time complexity of certifying the restricted isometry property. Yunzi Ding, Dmitriy Kunisky, Alexander S. Wein, Afonso S. Bandeira. *IEEE Transactions on Information Theory*, 2021.

A tight degree 4 sum-of-squares lower bound for the Sherrington-Kirkpatrick Hamiltonian. Dmitriy Kunisky, Afonso S. Bandeira. *Mathematical Programming* 190, No. 1, 2021.

Mapping political communities: a statistical analysis of lobbying networks in legislative politics. In Song Kim, Dmitriy Kunisky. *Political Analysis* 29, No. 3, 2021.

Computational hardness of certifying bounds on constrained PCA problems. Afonso S. Bandeira, Dmitriy Kunisky, Alexander S. Wein. *Proceedings of the 11th Innovations in Theoretical Computer Science Conference (ITCS 2020)*.

Notes on computational hardness of hypothesis testing: predictions using the low-degree likelihood ratio. Dmitriy Kunisky, Alexander S. Wein, Afonso S. Bandeira. *International Society for Analysis, its Applications and Computation (ISAAC) Congress 2019*.

Connections between sum-of-squares optimization and structured tight frames. Afonso S. Bandeira, Dmitriy Kunisky. *Wavelets and Sparsity XVIII (Volume 11138), International Society for Optics and Photonics (SPIE 2019)*.

Sum-of-squares optimization and the sparsity structure of equiangular tight frames. Afonso S. Bandeira, Dmitriy Kunisky. *Proceedings of the 13th International Conference on Sampling Theory and Applications (SampTA 2019)*.

Hysteresis control of the epithelial-mesenchymal transition dynamics generates a distinct program with metastatic abilities. Toni Celià-Terrassa, Caleb Bastian, Daniel Liu, Brian Ell, Yong Wei, Jose Zamalloa, Andres M Blanco, Xiang Hang, Thomas Pisano, Dmitriy Kunisky, Herschel Rabitz, Yibin Kang. *Nature Communications* 9, No. 1, 2018.

PREPRINTS

Fitting an ellipsoid to random points: predictions using the replica method. Antoine Maillard, Dmitriy Kunisky. [arxiv:2310.01169](https://arxiv.org/abs/2310.01169), 2023.

Online algorithms and lower bounds for average-case matrix discrepancy. Dmitriy Kunisky, Peiyuan Zhang. [arxiv:2307.10055](https://arxiv.org/abs/2307.10055), 2023.

Spectral pseudorandomness and the road to improved clique number bounds for Paley graphs. Dmitriy Kunisky. [arxiv:2303.16475](https://arxiv.org/abs/2303.16475), 2023.

Generic MANOVA limit theorems for products of projections. Dmitriy Kunisky. [arxiv:2301.09543](https://arxiv.org/abs/2301.09543), 2023.

On the concentration of Gaussian Cayley matrices. Afonso S. Bandeira, Dmitriy Kunisky, Dustin G. Mixon, Xinmeng Zeng. [arxiv:2212.00066](https://arxiv.org/abs/2212.00066), 2022.

Positivity-preserving extensions of sum-of-squares pseudomoments over the hypercube. Dmitriy Kunisky. [arXiv:2009.07269](https://arxiv.org/abs/2009.07269), 2020.

A Gramian description of the degree 4 generalized elliptope. Afonso S. Bandeira, Dmitriy Kunisky. [arXiv:1812.11583](https://arxiv.org/abs/1812.11583), 2018.

INVITED TALKS

Gramian constructions of sum-of-squares lower bounds and the spectra of pseudomoments. SIAM Conference on Applied Algebraic Geometry. July 2023.

Spectral limit theorems for submatrices and products of projections. Probability Seminar, MIT. April 2023.

Spectral pseudorandomness and the clique number of the Paley graph. Stochas-

tics and Statistics Seminar, MIT. March 2023.

What average-case optimization can tell number theory. Industrial and Systems Engineering Seminar, Lehigh University. February 2023.

Spectral pseudorandomness and the clique number of the Paley graph. BIRS-CMO Workshop on Learning in Networks, CMO Oaxaca. November 2022.

The degree 4 sum-of-squares relaxation of the clique number of Paley graphs. AMS Fall Western Sectional Special Session on Algebraic Combinatorics and Applications in Harmonic Analysis, University of Utah. October 2022.

Dual bounds for the positive semidefinite functions approach to mutually unbiased bases. CodEx Online Seminar. February 2022.

Strong recovery of geometric planted matchings. Workshop on Rigorous Evidence for Information-Computation Trade-Offs, Simons Institute for the Theory of Computing. September 2021.

A positivity-first approach to sum-of-squares over the hypercube. Workshop on Computational Phase Transitions, Simons Institute for the Theory of Computing. September 2020.

The low-degree method for identifying statistical-to-computational gaps. MOKA-PLAN Seminar, INRIA Paris. February 2020.

Certifying bounds on random quadratic programs is hard. SIERRA Seminar, INRIA Paris. February 2020.

Hardness of certification for random optimization problems. Computer Science Theory Seminar, Columbia University. April 2019.

Hardness of certification for random optimization problems. Seminar on Algebra, Statistics, and Optimization, MIT. March 2019.

HONORS

Predocctoral Summer Fellowship, New York University
Graduate Research Initiative Award, New York University
Harold Grad Memorial Prize, New York University
Best Poster Award, Princeton Day of Optimization 2018
Charles Newman Fellowship, New York University
Honorable Mention, NSF Graduate Research Fellowship
Phi Beta Kappa Society (Early Admission), Princeton University
Shapiro Award for Academic Excellence, Princeton University

TEACHING

Modern Probability for Theoretical Computer Science
Yale University

Spring 2023

Sum-of-Squares Optimization
Yale University

Spring 2022

Mathematical Statistics (Teaching Assistant)
New York University

Fall 2020

Discrete Mathematics (Teaching Assistant)
New York University

Summer 2020

Probabilistic Time Series Analysis (Teaching Assistant)
New York University

Fall 2018

Algebra II (Teaching Assistant)
Princeton University

Spring 2013

SERVICE

Reviewed for publications: Journal of Machine Learning Research (JMLR), Information and Inference: A Journal of the IMA, SIAM Journal on Mathematics of Data Science (SIMODS), Annals of Probability, Digital Signal Processing, Mathematical Programming, IEEE Transactions on Signal Processing, IEEE Transactions on Information Theory, Discrete & Computational Geometry, AMS Mathematical Reviews.

Reviewed for conferences: COLT 2018, FOCS 2020, MSML 2020, CCC 2021, FOCS 2021, MSML 2021, MSML 2022, SODA 2022, STOC 2023, SODA 2024.

Organized Courant Institute student probability seminar, Fall 2018–Spring 2021.

INDUSTRY
EXPERIENCE

Google, Inc.
Software Engineer

Mountain View, CA; New York, NY
10/2014–07/2016

- Developed interactive semantic code differencing tools for working with complex search ranking algorithms.
- Improved machine learning infrastructure for semantic parsing tasks in natural language processing.