Mark Sellke

Positions

2023- **Assistant Professor of Statistics**, *Harvard University*

Fall 2022 **Member**, *Institute for Advanced Study*

2022-2023 **Postdoctoral Scientist**, *Amazon*

Education

2018-2022 **PhD in Mathematics**, *Stanford University*
Advised by Andrea Montanari and Sébastien Bubeck

2017-2018 **M.A.St. in Mathematics with Distinction**, *University of Cambridge*

2014-2017 **B.S. in Mathematics**, *MIT*

Selected Fellowships and Awards

- NeurIPS: Outstanding Paper Award 2021
- Symposium on Discrete Algorithms (SODA): Best Paper Award 2020
- Symposium on Discrete Algorithms (SODA): Best Student Paper Award 2020
- William R. and Sara Hart Kimball endowed Stanford Graduate Fellowship 2018-2022
- NSF Graduate Research Fellowship 2017-2022
- William Lowell Putnam Competition: 1st place 2014
- International Mathematical Olympiad: Gold Medalist 2013, 2014

Research

50. Hessian Spectrum at the Ground State in Spherical Spin Glasses. arXiv:2409.15728
49. Free Energy Universality of Spherical Spin Glasses. With Mehtaab Sawhney. arXiv:2408.13701
48. Localization of Random Surfaces with Monotone Potentials and an FKG-Gaussian Correlation Inequality. arXiv:2402.18737
47. No Free Prune: Information-Theoretic Barriers to Pruning at Initialization. With Tanishq Kumar and Kevin Luo. **ICML 2024**. arXiv:2402.01089
46. Mean square displacement of Brownian paths perturbed by bounded pair potentials. With Volker Betz and Tobias Schmidt. arXiv:2312.02709
45. A Constructive Proof of the Spherical Parisi Formula. With Brice Huang. arXiv:2311.15495
44. Sampling from Mean-Field Gibbs Measures via Diffusion Processes. With Ahmed El Alaoui and Andrea Montanari. arXiv:2310.08912
43. Strong Topological Trivialization of Multi-Species Spherical Spin Glasses. With Brice Huang. arXiv:2308.09677

42. Optimization Algorithms for Multi-Species Spherical Spin Glasses. With Brice Huang. **J. Stat. Phys.**, Vol 191 (2024) no. 29. arXiv:2308.09672

41. Effective mass of the Fröhlich Polaron and the Landau-Pekar-Spohn conjecture. With Rodrigo Bazaes, Chiranjib Mukherjee, and S.R.S. Varadhan. arXiv:2307.13058

40. Shattering in Pure Spherical Spin Glasses. With Ahmed El Alaoui and Andrea Montanari. arXiv:2307.04659

39. Asymptotically Optimal Pure Exploration for Infinite-Armed Bandits. With Xiao-Yue Gong. **NeurIPS 2023**. arXiv:2306.01995.

38. On Size-Independent Sample Complexity of ReLU Networks. **Info. Proc. Lett.**, Vol. 186 (2024), 106482. arXiv:2306.01992

37. Incentivizing Exploration with Linear Contexts and Combinatorial Actions. **ICML 2023**. arXiv:2306.01990

36. The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses. **Comm. Pure Appl. Math.**, 2024. arXiv:2305.07956

35. Tight Space Lower Bound for Pseudo-Deterministic Approximate Counting. With Ofer Grossman and Meghal Gupta. **FOCS 2023**. arXiv:2304.01438

34. Algorithmic Threshold for Multi-Species Spherical Spin Glasses. With Brice Huang. arXiv:2303.12172

33. Almost Quartic Lower Bound for the Fröhlich Polaron's Effective Mass via Gaussian Domination. **Duke Math Journal**, accepted. arXiv:2212.14023

32. Improved Lower Bound for Frankl's Union-Closed Sets Conjecture. With Ryan Alweiss and Brice Huang. **Electron. J. Combin.**, Vol. 31 (2024) no. 3, P3.35. arXiv:2211.11731

31. Free Energy Subadditivity for Symmetric Random Hamiltonians. **J. Math. Phys.**, Vol. 64 (2023) no. 4: 043302. arXiv:2208.11279

30. When Does Adaptivity Help for Quantum State Learning? With Sitan Chen, Brice Huang, Jerry Li, and Allen Liu. **FOCS 2023**. Also presented at **QIP 2023**. arXiv:2206.05265

29. Sampling from the Sherrington-Kirkpatrick Gibbs measure via algorithmic stochastic localization. With Ahmed El Alaoui and Andrea Montanari. **FOCS 2022**. arXiv:2203.05093

28. The Pareto Frontier of Instance-Dependent Guarantees in Multi-Player Multi-Armed Bandits with no Communication. With Allen Liu. **COLT 2022**. arXiv:2202.09653

27. Local algorithms for Maximum Cut and Minimum Bisection on locally treelike regular graphs of large degree. With Ahmed El Alaoui and Andrea Montanari. **Random Struct. Alg.**, 2023. arXiv:2111.06813

26. Tight Lipschitz Hardness for Optimizing Mean Field Spin Glasses. With Brice Huang. **Comm. Pure. Appl. Math.**, accepted. Conference version in **FOCS 2022**. arXiv:2110.07847

25. Iterative Feature Matching: Toward Provable Domain Generalization with Logarithmic Environments. With Yining Chen, Elan Rosenfeld, Tengyu Ma, and Andrej Risteski. **NeurIPS 2022**. arXiv:2106.09913

24. A Universal Law of Robustness via Isoperimetry. With Sébastien Bubeck. **Journal of the ACM**, Vol. 70 (2023) no. 2, Article 10, 1-18. Conference version in **NeurIPS 2021**. **Outstanding Paper Award**. arXiv:2105.12806

23. Optimizing Mean-Field Spin Glasses with External Field. **Electronic J. Probab.**, Vol. 29 (2024) no. 4, 1-47. arXiv:2105.03506

22. Tensor Quasi-Random Groups. **Proc. AMS Series B**, Vol. 9 (2022), 12-21. arXiv:2103.11048

21. Cutoff for the Asymmetric Riffle Shuffle. **Ann. Probab.**, Vol. 50 (2022) no. 6, 2244-2287. arXiv:2103.05068

20. Metric Transforms and Low Rank Matrices via Representation Theory of the Real Hyperrectangle. With Josh Alman, Timothy Chu, Gary Miller, Shyam Narayanan, and Zhao Song. **NeurIPS 2024 (spotlight presentation)**. arXiv:2011.11503

19. Cooperative and Stochastic Multi-Player Multi-Armed Bandit: Optimal Regret With Neither Communication Nor Collisions. With Sébastien Bubeck and Thomas Budzinski. **COLT 2021**. arXiv:2011.03896.

18. Algorithmic Pure States for the Negative Spherical Perceptron. With Ahmed El Alaoui. **J. Stat. Phys.**, Vol. 189 (2022), no. 27. arXiv:2010.15811

17. Approximate Ground States of Hypercube Spin Glasses are Near Corners. **Comptes Rendus Math.**, Vol. 359 (2021) no. 9, 1097-1105. arXiv:2009.09316

16. Metrical Service Systems with Transformations. With Sébastien Bubeck, Niv Buchbinder, and Christian Coester. **ITCS 2021**. arXiv:2009.08266

15. Vertex Sparsification for Edge Connectivity. With Parinya Chalermsook, Syamantak Das, Bundit Laekhanukit, Yunbum Kook, Yang P. Liu, Richard Peng, and Daniel Vaz. **SODA 2021**. arXiv:2007.07862. (Subsumes *Vertex Sparsifiers for c-Edge Connectivity* with Yang P. Liu and Richard Peng, arXiv:1910.10359.)

14. Online Multiserver Convex Chasing and Optimization. With Sébastien Bubeck and Yuval Rabani. **SODA 2021**. arXiv:2004.07346

13. Covering Irrep(S_n) With Tensor Products and Powers. **Math. Annalen**, Vol. 388 (2024), 831-865. arXiv:2004.05283

12. The Price of Incentivizing Exploration: A Characterization via Thompson Sampling and Sample Complexity. With Aleksandrs Slivkins. **Operations Research**, Vol. 71 (2023) no. 5, 1706-1732. Conference version in **EC 2021**. arXiv:2002.00558

11. Optimization of Mean-field Spin Glasses. With Ahmed El Alaoui and Andrea Montanari. **Ann. Probab.**, Vol. 49 (2021) no. 6, 2922-2960. arXiv:2001.00904

10. Chasing Convex Bodies Optimally. **GAFA Seminar Notes**, 2023. Conference version in **SODA 2020**. **Best Paper and Best Student Paper**. arXiv:1905.11968

9. Non-Stochastic Multi-Player Multi-Armed Bandits: Optimal Rate With Collision Information, Sublinear Without. With Sébastien Bubeck, Yuanzhi Li, and Yuval Peres. **COLT 2020**. arXiv:1904.12233

8. First-Order Bayesian Regret Analysis of Thompson Sampling. With Sébastien Bubeck. **IEEE Trans. Info. Theory**, Vol. 69 (2023), no. 3, 1795-1823. Conference version in **ALT 2020**. arXiv:1902.00681

7. Competitively Chasing Convex Bodies. With Sébastien Bubeck, Yin Tat Lee, and Yuanzhi Li. **STOC 2019** and **SICOMP Special Issue** 52 (1), 67-81. arXiv:1811.00887

6. Chasing Nested Convex Bodies Nearly Optimally. With Sébastien Bubeck, Bo'az Klartag, Yin Tat Lee, and Yuanzhi Li. **SODA 2020**. arXiv:1811.00999

5. Exact minimum number of bits to stabilize a linear system. With Victoria Kostina, Yuval Peres, and Gireeja Ranade. **IEEE Trans. Auto. Control**, November 2021. Conference version in **IEEE CDC 2018**. arXiv:1807.07686

4. Stabilizing a system with an unbounded random gain using only a finite number of bits. With Victoria Kostina, Yuval Peres, and Gireeja Ranade. **IEEE Trans. Info. Theory**, Vol. 67, no. 4, 2554-2561, Apr. 2021. Conference version in **IEEE ISIT 2018**. arXiv:1805.05535

3. Approximating Continuous Functions by ReLU Nets of Minimal Width. With Boris Hanin. arXiv:1710.11278

2. The Saxl Conjecture for Fourth Powers via the Semigroup Property. With Sammy Luo. **J. Alg. Comb.**, 45 (2017), 33-80. arxiv:1511.02387

1. On the Number of 2-protected Nodes in Tries and Suffix Trees. With Mark Daniel Ward, Jeffrey Gaither, and Yushi Homma. **Discrete Mathematics and Theoretical Computer Science**, Vol. AQ (2012), 381-398

Other Research

3. An Analytical, Mathematical Annuloplasty Ring Curvature Model for Planning of Valve-in-Ring Transcatheter Mitral Valve Replacement. With Matthew Park, Mateo Marin-Cuartas, Pearly Pandya, Yuanjia Zhu, Robert Wilkerson, David Holzhey, Michael Borger, and Y. Joseph Woo. **J. Thoracic and Cardiovascular Surgery (JTCVS) Techniques**, Vol. 20 (August 2023), 45-54.

2. A Novel Accelerated Fatigue Testing System for Pulsatile Applications of Cardiac Devices Using Widely Translatable Cam and Linkage-Based Mechanisms. With Matthew Park, Annabel Imbrie-Moore, Yuanjia Zhu, Mateo Marin-Cuartas, Robert Wilkerson, and Y. Joseph Woo. **Medical Engineering & Physics**, Vol. 109 (2022), 103896.

1. Biomimetic Six-Axis Robots Replicate Human Cardiac Papillary Muscle Motion: Pioneering the Next Generation of Biomechanical Heart Simulator Technology. With Annabel Imbrie-Moore, Matthew Park, Michael Paulsen, Rohun Kulkami, Hanjay Wang, Yuanjia Zhu, Justin Farry, Alexandra Bourdillon, Christine Callinan, Haley Lucian, Camille Hironaka, Daniela Deschamps, and Y. Joseph Woo. **J. Royal Society Interface**, Vol. 17 (2020), no. 173.

Invited Talks

77. MIT Probability Seminar: Algorithmic Thresholds for Perceptron Models (2024/12)

76. Brown Probability Seminar: Algorithmic Thresholds for Perceptron Models (2024/12)

75. McGill CRM-ISM Probability Seminar: Algorithmic Spin Glass Theory (2024/11)
74. Cornell Statistics: Provably Efficient Computation of the NPMLE in Gaussian Location Models (2024/10)
73. Princeton Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/10)
72. Purdue Computer Science: Algorithmic Spin Glass Theory (2024/08)
71. BIRS Workshop *Frontiers of Statistical Mechanics and Theoretical Computer Science*: Algorithmic Spin Glass Theory (2024/08)
70. Peking University: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/07)
69. Stanford Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/05)
68. TU Darmstadt: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/05)
67. NYU Probability: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/04)
66. MIT Stochastics and Statistics: Confinement of Unimodal Probability Distributions and an FKG-Gaussian Correlation Inequality (2024/03)
65. Harvard Theory of Computation: Diffusion Sampling from Spin Glasses (2023/11)
64. Lehigh-Minnesota Online Probability Seminar: The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses (2023/11)
63. Northwestern Probability: Algorithmic Thresholds for Spherical Spin Glasses (2023/11)
62. Harvard CMSA Conference on Big Data: Algorithmic Thresholds for Spherical Spin Glasses (2023/08)
61. Cargèse: Statistical Physics & Machine Learning Back Together Again (2023/08)
60. Santa Fe Institute 2023: On Hardness for Stable Sampling
59. Rhein-Main Kolloquium Stochastik: Gaussian Correlation Inequality and the Polaron (2023/06)
58. TU Darmstadt Colloquium: Algorithmic Thresholds in Mean-Field Spin Glasses (2023/06)
57. Porquerolles: The Threshold Energy of Low Temperature Langevin Dynamics for Pure Spherical Spin Glasses (2023/06)
56. International Purdue Symposium on Statistics: Algorithmic Stochastic Localization for the SK Model (2023/06)
55. Waterloo Probability: Algorithmic Thresholds in Mean-Field Spin Glasses (2023/04)

54. IAS Computer Science and Discrete Mathematics: Algorithmic Stochastic Localization for the SK Model (2022/11)
53. Harvard Statistics: Algorithmic Stochastic Localization for the SK Model (2022/11)
52. Columbia Probability: Algorithmic Stochastic Localization for the SK Model (2022/10)
51. Duke Statistical Science: Algorithmic Stochastic Localization for the SK Model (2022/10)
50. Stony Brook Information Geometry and Machine Learning Webinar: Chasing Convex Bodies (2022/09)
49. IAS Probability: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/09)
48. MIT EECS Group Meeting: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/08)
47. Youth in High Dimensions: A Universal Law of Robustness via Isoperimetry (2022/06)
46. Simons Workshop *Multi-Agent Reinforcement Learning and Bandit Learning*: Multi-Player Bandits without Communication (2022/05)
45. Oxford Statistics Group Meeting: A Universal Law of Robustness via Isoperimetry (2022/04)
44. Google Algorithms: A Universal Law of Robustness via Isoperimetry (2022/04)
43. Lawrence Livermore National Lab: A Universal Law of Robustness via Isoperimetry (2022/03)
42. SIAM Imaging Science Minisymposium *Recent Advances on Stable Neural Networks*: A Universal Law of Robustness via Isoperimetry (2022/03)
41. Purdue Industrial Engineering: A Universal Law of Robustness via Isoperimetry (2022/03)
40. MIT Probability: Tight Algorithmic Thresholds in Mean-Field Spin Glasses (2022/03)
39. Yale Statistics and Data Science: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/03)
38. CMU Computer Science: Geometric Aspects of Optimization, Old and New (2022/02)
37. MIT Group Meeting: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
36. Harvard Statistics: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
35. Wharton Statistics: Algorithmic Thresholds in Mean-Field Spin Glasses (2022/02)
34. Columbia IEOR: Geometric Aspects of Optimization, Old and New (2022/01)
33. NYU Math and Data: Geometric Aspects of Optimization, Old and New (2022/01)
32. MIT Sloan OR/Stat Seminar: Geometric Aspects of Optimization, Old and New (2022/01)
31. Columbia Statistics: Geometric Aspects of Optimization, Old and New (2022/01)
30. University of Chicago Probability: Cutoff for the Asymmetric Riffle Shuffle (2022/01)
29. Simons *Probability, Geometry, and Computation in High Dimensions* Reunion Workshop: Tight Lipschitz Hardness for Optimizing Mean-Field Spin Glasses (2022/01)

28. Yale Statistics and Data Science: Algorithmic Thresholds in Mean-Field Spin Glasses (2021/11)
27. NSF-Simons Collaboration on the Theoretical Foundations of Deep Learning:
    A Universal Law of Robustness via Isoperimetry (2021/11)
26. UCLA Probability: Algorithms and Hardness for Optimizing Mean-Field Spin Glasses (2021/10)
25. INFORMS Session on *Learning and Optimization in Decision Making*:
    Chasing Convex Bodies (2021/10)
24. Stanford Probability Seminar: Cutoff for the Asymmetric Riffle Shuffle (2021/10)
23. Stanford ML Group Meeting: A Universal Law of Robustness via Isoperimetry (2021/10)
22. Simons Workshop *Rigorous Evidence for Information-Computation Trade-offs*:
    Tight Algorithmic Thresholds for Optimizing Mean-Field Spin Glasses (2021/09)
21. BIRS: Algorithmic Pure States for the Negative Spherical Perceptron (2021/08)
20. MSR Redmond: Pareto-Optimal Collision-Free Regret for Multi-Player Bandit (2021/08)
19. Stanford Statistics Group Meeting: A Universal Law of Robustness via Isoperimetry (2021/08)
18. MSR Redmond: The Price of Incentivizing Exploration (2021/07)
17. Montréal MLOpt: A Universal Law of Robustness via Isoperimetry (2021/07)
16. Berkeley EECS Group Meeting: The Price of Incentivizing Exploration (2021/06)
15. NSF-Simons Collaboration on the Theoretical Foundations of Deep Learning:
    Algorithmic Pure States for the Negative Spherical Perceptron (2021/04)
14. Cornell Probability: Algorithmic Pure States for the Negative Spherical Perceptron (2020/11)
13. Berkeley Theory Lunch: Chasing Convex Bodies (2020/11)
12. Online Geometric Analysis Seminar: Chasing Convex Bodies (2020/11)
11. MIT Algorithms and Complexity Seminar: Chasing Convex Bodies (2020/02)
10. Stanford Theory Lunch: Chasing Convex Bodies (2019/10)
9. TCS+ September 2019: Chasing Convex Bodies (2019/09)
8. University of Washington Theory Lunch: Chasing Convex Bodies (2019/08)
7. MSRI Mathematics of Machine Learning Summer School: Chasing Convex Bodies (2019/08).
6. Microsoft Research NYC: Chasing Convex Bodies (2019/07)
5. Microsoft Research Redmond: Chasing Convex Bodies (2019/07)
4. Microsoft Research Redmond: Small Loss Bounds for Thompson Sampling (2018/09)
3. Brown University: How Wide Does a Neural Net Need to be? (2018/05)

2. Microsoft Research Redmond: How Wide Does a Neural Net Need to be? (2017/09)
1. Purdue Combinatorics Group Meeting: The Saxl Conjecture for Fourth Powers (2015/08)

Conference, Workshop, and Other Presentations

22. NeurIPS 2023: Asymptotically Optimal Pure Exploration for Infinite-Armed Bandits (poster)
21. Harvard Statistics Fall 2023 PhD Student Retreat: Research Overview Lightning Talk
20. ICML 2023: Incentivizing Exploration with Linear Contexts and Combinatorial Actions (poster)
19. FOCS 2022: Algorithmic Stochastic Localization for the Sherrington-Kirkpatrick Model
18. IAS Postdoctoral Short Talk: Algorithmic Spin Glass Theory
17. COLT 2022: The Pareto Frontier of Instance-Dependent Guarantees in Multi-Player Multi-Armed Bandits with no Communication
16. NeurIPS 2021: A Universal Law of Robustness via Isoperimetry (poster and oral)
15. NeurIPS 2021 StratML Workshop: The Price of Incentivizing Exploration (poster)
14. Simons/IFML Joint Symposium 2021: A Universal Law of Robustness via Isoperimetry (poster)
13. Simons 2021 Annual Meeting on Mathematical and Scientific Foundations of Deep Learning: A Universal Law of Robustness via Isoperimetry (poster)
12. COLT 2021: Cooperative and Stochastic Multi-Player Multi-Armed Bandit
11. ICML 2021 Workshop *Overparameterization: Pitfalls & Opportunities*: A Universal Law of Robustness via Isoperimetry (oral spotlight presentation)
10. EC 2021 Workshop *Operations of People-Centric Systems*: The Price of Incentivizing Exploration
9. EC 2021: The Price of Incentivizing Exploration
8. Math Olympiad Program 2021: Introduction to Belief Propagation
7. SODA 2021: Online Multiserver Convex Chasing and Optimization
6. ALT 2020: First-Order Bayesian Regret Analysis of Thompson Sampling
5. SODA 2020: Chasing Convex Bodies Optimally
4. SODA 2020: Chasing Nested Convex Bodies Nearly Optimally
3. STOC 2019: Competitively Chasing Convex Bodies
2. Joint Math Meetings 2016: The Saxl Conjecture for Fourth Powers
1. MIT SPUR 2015: The Saxl Conjecture for Fourth Powers

Reviewer Service

Journals: PNAS, Forum of Math Pi, Duke Math Journal (quick opinion), Communications on Pure and Applied Math (quick opinion), Annals of Probability, Communications in Mathematical Physics, Probability Theory and Related Fields, Probability and Mathematical Physics, Annals of Applied Probability, Random Structures and Algorithms, Journal of the ACM, SICOMP, IEEE Transactions on Information Theory, Mathematical Statistics and Learning (quick opinion), Discrete and Computational Geometry, Mathematical Research Letters, Mathematics of Operations Research, Journal of Statistical Mechanics, American Economic Review Insights, Entropy

Conferences: SODA, ITCS, AISTATS (2025), STOC, ITCS, ICALP (2024); STOC, FOCS, ITCS, ICML, NeurIPS (2023); STOC, FOCS, NeurIPS, American Control Conference (2022); STOC, FOCS, COLT, ITCS, NeurIPS (2021); ICML, COLT, SPAA (2020); NeurIPS (2019)