

Boris Hanin

CONTACT INFORMATION	bhanin@princeton.edu hanin.princeton.edu
RESEARCH INTERESTS	Theory of deep learning, mathematical physics, spectral theory, random matrix theory
EMPLOYMENT	2020 - present Assistant Professor, ORFE, Princeton 2017 - 2020 Assistant Professor, Department of Mathematics, Texas A&M 2014 - 2017 NSF Postdoctoral Fellow, Department of Mathematics, MIT (Sponsoring Scientist: Professor Alice Guionnet)
VISITING POSITIONS	Spring 2020 Visiting Scientist, Google, Mountain View, CA Summer 2019 Visiting Scientist, Foundations of Deep Learning Program, Simons Institute, Berkeley, CA Spring 2019 Visiting Scientist, Facebook AI Research, NYC
EDUCATION	2009 - 2014 Ph.D. in Mathematics, Northwestern University <ul style="list-style-type: none">• Thesis Title: <i>Correlations and Pairing Between Zeros and Critical Points of Random Polynomials</i>• Advisor: Professor Steve Zelditch 2005 - 2009 B.S. in Mathematics (with honors), Stanford University <ul style="list-style-type: none">• Thesis Title: <i>Billiards in Polygons</i>• Advisor: Professor Ravi Vakil
GRANTS	2019 - 2022 NSF HDR TRIPODS - <i>Texas A&M Research Institute for Interdisciplinary Foundations of DATA Science</i> (Recommended for funding: final confirmation pending, \$1,416,522) 2019 - 2022 NSF Probability Grant - <i>Random Neural Networks</i> (DMS-1855684, \$150,000) 2014 - 2017 NSF Postdoctoral Fellowship (DMS-1400822, \$150,000)
SUBMITTED FOR PUBLICATION	<ol style="list-style-type: none">1. Hanin, B. and Paouris G. <i>Non-asymptotic Results for Singular Values of Gaussian Matrix Products</i>. Available online: <https://arxiv.org/abs/2005.08899>.2. Hanin, B. and Zelditch, S. <i>Interface Asymptotics of Wigner-Weyl Distributions for the Harmonic Oscillator</i>. Available online: <https://arxiv.org/abs/1903.12524>.3. Hanin, B. and Zelditch, S. <i>Interface Asymptotics of Eigenspace Wigner distributions for the Harmonic Oscillator</i>. Available online: <https://arxiv.org/abs/1901.06438>.4. Hanin, B. and Sellke, M. <i>Approximating Continuous Functions by ReLU Nets of Minimal Width</i>. Available online: <https://arxiv.org/abs/1710.11278>

PUBLICATIONS

1. Daubechies, I., DeVore, R., Foucart, S., Hanin, B. and Petrova, G. *Nonlinear Approximation and (Deep) ReLU Nets*. Constructive Approximation (special issue on Deep Networks in Approximation Theory).
2. Canzani, Y. and Hanin, B. *Local Universality for Zeros and Critical Points of Monochromatic Random Waves*. Communications in Mathematical Physics (in press).
3. Hanin, B. and Nica, M. *Finite Depth and Width Corrections to the Neural Tangent Kernel*. Spotlight ICLR 2020.
4. Hanin, B. and Nica, M. *Products of Many Large Random Matrices and Gradients in Deep Neural Networks*. Communications in Mathematical Physics (in press).
5. Hanin, B. *Universal Function Approximation by Deep Neural Nets with Bounded Width and ReLU Activations*. Mathematics 2019, 7(10), 992 (Special Issue on Computational Mathematics, Algorithms, and Data Processing).
6. Hanin, B. and Rolnick, D. *Deep ReLU Nets have Surprisingly Few Activation Regions*. Accepted: Advances in Neural Information Processing Systems, 2019.
7. Hanin, B., Epstein, M., and Lundberg E. *The Lemniscate Tree of a Random Polynomial*. Annales De L'Institut Fourier (in press), 2019.
8. Hanin, B. and Beck, T. *Level Spacings and Nodal Sets at Infinity for Radial Perturbations of the Harmonic Oscillator*. International Math Research Notices. 2018. <<https://doi.org/10.1093/imrn/rny290>>.
9. Beck, T., Hanin, B., and Hughes, S. *Nodal Sets of Functions with Finite Vanishing Order*. Calculus of Variations and PDE. Beck, T., Becker-Kahn, S. Hanin, B. Calc. Var. (2018) 57: 140.
10. Hanin, B. and Rolnick, D. *Complexity of Linear Regions in Deep Networks*. International Conference on Machine Learning, 2019.
11. Hanin, B. *Which Neural Net Architectures Give Rise to Exploding and Vanishing Gradients?*. Advances in Neural Information Processing Systems, 2018, pp. 582–591.
12. Hanin, B. and Rolnick, D. *How to Start Training: The Effect of Initialization and Architecture*. Advances in Neural Information Processing Systems, 2018, pp. 571–581.
13. Hanin, B., Zelditch, S., and Zhou, P. *Scaling of Harmonic Oscillator Eigenfunctions and Their Nodal Sets Around the Caustic*. Communications in Mathematical Physics. Vol. 350, no. 3, pp. 1147–1183, 2017.
14. Canzani, Y. and Hanin, B. *C^∞ Scaling Asymptotics for the Spectral Function of the Laplacian*. The Journal of Geometric Analysis. January 2018, Volume 28, Issue 1, pp 111 - 122.
15. Hanin, B. *Pairing of Zeros and Critical Points for Random Polynomials*. Annales de l'Institut Henri Poincaré (B) Probabilites et Statistiques. Volume 53, Number 3 (2017), 1498-1511.
16. Canzani, Y. and Hanin, B. *Scaling Limit for the Kernel of the Spectral Projector and Remainder Estimates in the Pointwise Weyl Law*. Analysis and PDE, Vol. 8 (2015), No. 7, pp. 1707-1731.
17. Canzani, Y. and Hanin, B. *High Frequency Eigenfunction Immersions and Supremum Norms of Random Waves*. Electronic Research Announcements. MS 22, no. 0, January 2015, pp. 76 - 86.

18. Hanin, B. *Pairing of Zeros and Critical Points for Random Meromorphic Functions on Riemann Surfaces*. Mathematics Research Letters, Vol. 22 (2015), No. 1, pp. 111-140.
19. Hanin, B., Zelditch, S., and Zhou, P. *Nodal Sets of Random Eigenfunctions for the Isotropic Harmonic Oscillator*, International Mathematics Research Notices, Vol. 2015, No. 13, pp. 4813 - 4839.
20. Hanin, B. *Correlations and Pairing Between Zeros and Critical Points of Gaussian Random Polynomials*. International Math Research Notices (2015), Vol. (2), pp. 381-421.
21. Hanin, L., Fisher, R., Hanin, B. *An Intriguing Property of the Center of Mass for Points on Quadratic Curves and Surfaces*, Mathematics Magazine, v. 80, No. 5, pp. 353-362, 2007.

INVITED TALKS

1. June 2019. COE Seminar (Johns Hopkins)
2. May 2019. Approximation Theory 16 (Vanderbilt).
3. May 2019. Southeastern Probability Conference (Duke).
4. March 2019. Colloquium (UC Boulder).
5. March 2019. ECE Seminar (Rice).
6. February 2019. Machine Learning Seminar (CUNY).
7. February 2019. Machine Learning Seminar (NYU).
8. February 2019. Probability Seminar (NYU).
9. January 2019. Scientific Machine Learning (ICERM).
10. November 2018. Workshop on Deep Learning (Texas A&M).
11. November 2018. Machine Learning and Physics (CUNY).
12. November 2018. Colloquium (TCU).
13. October 2018. Winedale Workshop (UT Austin).
14. August 2018. Theory Seminar (Facebook AI Research, NYC).
15. August 2018. Probability Seminar (Columbia).
16. August 2018. Summer Informal Regional Functional Analysis Seminar (Texas A&M).
17. June 2018. Stochastic Processes and Applications 2018 (Göthenburg, Sweden).
18. May 2018. Theory Seminar (IBM Research Tel-Aviv).
19. May 2018. Learning Seminar (Hebrew University).
20. April 2018. Probability Seminar (Paris 5).
21. April 2018. Probability Seminar (Luxembourg).
22. April 2018. Theory Seminar (DeepMind).
23. April 2018. Probability Seminar (Northwestern).
24. January 2018. CSAIL Machine Learning Seminar (MIT).
25. October 2017. Geometry Seminar (Texas A&M).
26. September 2017. Probability Seminar (Texas A&M).
27. September 2017. Mathematical Physics and Harmonic Analysis Seminar (Texas A&M).
28. April 2017. Probability Seminar (UC Boulder).

29. April 2017. Colloquium (UC Boulder).
30. April 2017. AMS Sectional Meeting Special Session on Microlocal Analysis and Spectral Theory (Pullman, WA).
31. April 2017. Colloquium (UC Colorado Springs).
32. March 2017. Probability Seminar (Columbia).
33. February 2017. Colloquium (Texas A&M).
34. December 2016. Analysis Seminar (Florida Atlantic University, Boca Raton).
35. November 2016. AMS Sectional Meeting Special Session on Harmonic Analysis and Dispersive PDE (Raleigh, NC).
36. November 2016. Analysis and PDE Seminar (UNC Chapel Hill).
37. August 2016. Workshop: Probabilistic Methods in Spectral Geometry and PDE (Centre de Recherches Mathématiques, Montreal).
38. June 2016. Geometry of Quantum Hall States Workshop (Simons Center for Geometry and Physics).
39. June 2016. Geometry of Quantum Hall States Workshop (Simons Center for Geometry and Physics).
40. April 2016. Probability Seminar (Institut Fourier, Grenoble).
41. April 2016. Holon Meeting on Complex and Harmonic Analysis (Tel Aviv).
42. April 2016. Analysis Seminar (Tel Aviv).
43. April 2016. Mathematical Physics Seminar (Physics Dept. Technion, Israel).
44. April 2016. Analysis and Probability Seminar (U. Penn and Temple).
45. March 2016. Analysis and PDE Seminar (McGill).
46. March 2016. Mathematical Physics Seminar (Northeastern).
47. February 2016. Analysis and PDE Seminar (Brown).
48. February 2016. New Mexico Analysis Seminar (Univ. New Mexico, Albuquerque).
49. February 2016. Analysis and PDE Seminar (UC Berkeley).
50. January 2016. AMS Joint Meetings Special Session on Global Harmonic Analysis (Seattle).
51. December 2015. Conference on Geometry of the Quantum Hall Effect (Uni. Köln).
52. November 2015. Differential Geometry Seminar (Harvard).
53. June 2015. Workshop: Quantum Geometry, Stochastic Geometry, Random Geometry, you name it (Simons Center for Geometry and Physics).
54. June 2015. Large N Limit Problems in Kähler Geometry (Simons Center for Geometry and Physics).
55. February 2015. Analysis and PDE Seminar (MIT).
56. June 2014. Complex Geometry Summer School (Milan, Italy).
57. May 2014. Frontier Probability Days Conference (University of Arizona, Tuscon).
58. March 2014. Topology and Geometry Seminar (Hebrew University, Jerusalem).
59. March 2014. Analysis Seminar (Tel-Aviv University).
60. March 2014. Horowitz Seminar (Tel-Aviv University).
61. January 2014. PDE, Complex Analysis and Differential Geometry Seminar (Notre Dame).

62. May 2013. Trondheim Spring School 2013 in Point Processes and Complex Analysis (Trondheim, Norway).
63. November 2012. Complex Geometry Seminar (organized jointly between Johns Hopkins University and University of Maryland College Park).
64. October 2012. Colloquium (Idaho State University).
65. July 2012. Workshop on Manifolds of Metrics and Probabilistic Methods in Geometry and Analysis (Centre de Recherches Mathématiques, Montreal).

PROFESSIONAL SERVICE	2019 - present	Member of TAMIDS Research Committee
ACADEMIC AWARDS	2018 - 2019	Texas A&M Math Department Award for Outstanding Teaching for: "For his outstanding teaching of undergraduate and graduate courses, and his extremely successful graduate topics course in fall 2018 that had an enrollment of 100+."
	2012 - 2013	Outstanding Graduate Student Teaching Award. Given by Northwestern's Judd and Marjorie Weinberg College of Arts and Sciences College.
	2011 - 2012	Gelfand Award. Given by Northwestern Mathematics Department. Citation: "for impressive progress in his research and his contributions to department life."
	2011 - 2012	Mathematics Department Graduate Teaching Assistant Award. Given by Northwestern Mathematics Department for best TA.

TEACHING EXPERIENCE	Fall 2018	Instructor, Theory and Practice of Deep Learning (A&M)
	Fall 2017	Instructor, Multivariable Calculus Math 221 (A&M - two sections)
	Winter 2016	Instructor, Multivariable Calculus 18.02A (MIT)
	Fall 2015	Instructor, Multivariable Calculus 18.02A (MIT)
	Fall 2014	TA, Introduction to Differential Equations 18.03 (MIT)
	Winter 2013	TA, Honors Real Analysis MATH 321-1 (NU)
	Fall 2012	TA, Probability Theory MATH 310-1 (NU)
	Fall 2012	TA, Foundation of Higher Mathematics MATH 310-1 (NU)
	Winter 2011	TA, Probability Theory MATH 310-2 (NU)
	Winter 2011	TA, Honors Real Analysis MATH 321-2 (NU)
	Fall 2011	TA, Honors Real Analysis MATH 321-1 (NU)
	Fall 2011	TA, Probability Theory MATH 310-1 (NU)
	Fall 2010	TA, Foundations of Higher Mathematics MATH 300-1 (NU)
Fall 2010	TA, Probability Theory MATH 310-1 (NU)	