Boris Hanin **bhanin@princeton.edu**

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
2005 - 2009	B.S. in Mathematics (with honors), Stanford University

Awards and Grants

2024 - 2027	*Sloan Fellowship in Mathematics*
2022	*Alfred Rheinstein Faculty Award (School of Engineering and Applied Sciences at Princeton)*
2022 - 2027	*CAREER: Random Neural Nets and Random Matrix Products* (NSF DMS-2143754, $577,241)
2022 - 2025	*Collaborative Research: Probabilistic, Geometric, and Topological Analysis of Neural Networks, From Theory to Applications* (NSF DMS-2133806, $500,000)
2019 - 2023	*Random Neural Networks* (NSF DMS-1855684, $150,000)
2014 - 2017	NSF Postdoctoral Fellowship (DMS-1400822, $150,000)

Submitted for Publication

1. J. Q. Davis, B. Hanin, L. Chen, P. Bailis, I. Stoica. M. Zaharia. *Networks of Networks: Complexity Class Principles Applied to Compound AI Systems Design.* Available online: arXiv:2407.16831.
2. B. Hanin, A. Zlokapa *Bayesian Inference with Deep Weakly Nonlinear Networks*, Available online: arXiv:2405.16630.
3. L. Chen, J. Q. Davis, B. Hanin, P. Bailis, M. Zaharia, I. Stoica, and J. Zou. *Are More LLM Calls All You Need? Towards Scaling Laws of Compound Inference Systems.* Available online: arXiv:2403.02419.
4. S. Favaro, B. Hanin, D. Marinucci, I. Nourdin, and G. Peccati. *Quantitative CLTs in Deep Neural Networks*, Available online: arXiv:2307.06092.

Journal Articles on Neural Nets

1. G. DeZoort, B. Hanin. *Principles for Initialization and Architecture Selection in Graph Neural Networks with ReLU Activations.* In Press: SIAM Journal on Mathematics of Data Science, 2024.
2. Hanin, B. *Random Fully Connected Neural Networks as Perturbatively Solvable Hierarchies.* In Press: Journal of Machine Learning Research, 2024.

3. Hanin, B., Zlokapa, A., *Bayesian Interpolation with Deep Linear Networks.* In Press: Proceedings of the National Academy of Sciences. Volume 120, No. 23., Pages e2301345120, 2023.
4. Hanin, B. *Random Neural Networks in the Infinite Width Limit as Gaussian Processes.* The Annals of Applied Probability 33 (6A), 4798-4819, 2023.
5. Hanin, B. and Paouris G. *Non-asymptotic Results for Singular Values of Gaussian Matrix Products.* Geometric and Functional Analysis 31 (2), 268-324, 2021.
6. DeVore, R., Hanin, B. and Petrova, G. *Neural Network Approximation.* Acta Numerica 30, 327-444, 2021.
7. Daubechies, I., DeVore, R., Foucart, S., Hanin, B. and Petrova, G. *Nonlinear Approximation and (Deep) ReLU Nets.* Constructive Approximation, 1-46, 2021.
8. Hanin, B. and Nica, M. *Products of Many Large Random Matrices and Gradients in Deep Neural Networks.* Communications in Mathematical Physics, 1-36, 2019.
9. 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).

Conference Articles on Neural Nets

1. Hanin, B., Iyer, G., Rolnick, D., *Maximal Initial Learning Rates in Deep ReLU Networks.* Proceedings of the 40th International Conference on Machine Learning, PMLR 202:14500-14530, 2023. Available online: arXiv:2212.07295.
2. Chen, W., Huang, W. Gong, X., Hanin, B. and Wang, Z. *Deep Architecture Connectivity Matters for Its Convergence: A Fine-Grained Analysis.* NeurIPS 2022. Available online: arXiv:2205.05662.
3. Hanin, B., Jeong, R., and Rolnick, D. *Deep ReLU Networks Preserve Expected Length.* ICLR 2022. Available online: arXiv:2102.10492.
4. Hanin, B. and Sun, Y. *Data Augmentation as Stochastic Optimization.* NeurIPS 2021. Available online: arXiv:2010.11171.
5. Hanin, B. and Nica, M. *Finite Depth and Width Corrections to the Neural Tangent Kernel.* Spotlight ICLR 2020.
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. and Rolnick, D. *Complexity of Linear Regions in Deep Networks.* International Conference on Machine Learning, 2019.
8. Hanin, B. *Which Neural Net Architectures Give Rise to Exploding and Vanishing Gradients?.* NIPS 2018.
9. Hanin, B. and Rolnick, D. *How to Start Training: The Effect of Initialization and Architecture.* NIPS 2018.

Journal Articles on Spectral Theory

1. Hanin, B. and Zelditch, S. *Scaling Asymptotics of Spectral Wigner Functions.* Journal of Physics A 55 (41), 2022. Special Edition on Claritons and the Asymptotics of Ideas: the Physics of Michael Berry.
2. Hanin, B. and Zelditch, S. *Interface Asymptotics of Wigner-Weyl Distributions for the Harmonic Oscillator.* Journal d'Analyse, Volume 147, pages 69-98, 2022.
3. Hanin, B. and Zelditch, S. *Interface Asymptotics of Eigenspace Wigner distributions for the Harmonic Oscillator.* Communications in Partial Differential Equations 45 (11), 1589-1620, 2021.

4. Canzani, Y. and Hanin, B. *Local Universality for Zeros and Critical Points of Monochromatic Random Waves*. Communications in Mathematical Physics 378 (3), 1677-1712, 2020.
5. Hanin, B. and Beck, T. *Level Spacings and Nodal Sets at Infinity for Radial Perturbations of the Harmonic Oscillator*. Int. Math Research Notices. 2018.
6. Beck, T., Hanin, B., and Hughes, S. *Nodal Sets of Functions with Finite Vanishing Order*. Calculus of Variations and PDE. Calc. Var. (2018) 57: 140.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.

Journal Articles on Random Polynomials

1. 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.
2. Hanin, B., Epstein, M., and Lundberg E. *The Lemniscate Tree of a Random Polynomial*. Annales de l'Institut Fourier, 70 (4), 1663-1687, 2020.
3. Hanin, B. *Pairing of Zeros and Critical Points for Random Polynomials*. Annales de l'Institut Henri Poincaré (B). Volume 53, Number 3 (2017), 1498-1511.
4. Hanin, B. *Correlations and Pairing Between Zeros and Critical Points of Gaussian Random Polynomials*. International Math Research Notices (2015), Vol. (2), pp. 381-421.

Publications on Other Topics

1. Contributed research to "The principles of deep learning theory," published by Cambridge University Press in 2022 and written by Roberts, Daniel A. and Yaida, Sho. Available online: arXiv:2106.10165.
2. Hanin, L., Fisher, R., Hanin, B. *An Intriguing Property of the Center of Mass for Points on Quadradtic Curves and Surfaces*, Mathematics Maganize, v. 80, No. 5, pp. 353-362, 2007.

Teaching Awards

2020 - 2023	Letter of Commendation for Teaching, School of Engineering and Applied Science at Princeton (each year).
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+."

Invited Courses

1. Winter 2024. Mathematics of Deep Learning at University of Luxembourg.
2. Winter 2023. Deep Learning Theory at Tor Vergata University, Rome.
3. Summer 2022. Les Houches Summer School on Statistical Physics of Machine Learning (joint with Yasaman Bahri)

Professional Service

2023 - present	Associate Editor, Advances in Theoretical and Mathematical Physics
2023 - present	Associate Editor, Mathematics of Operations Research
2021 - present	Associate Editor, Pure and Applied Analysis
2021 - present	Sole organizer, Princeton ML Theory Summer School
June 2023	Co-organizer, Workshop on Foundations of Data Science and Machine Learning at FoCM 2023
April 2023	Co-organizer, Neural Networks for Physics (Princeton Center for Theoretical Sciences)
2019 - 2021	Program Committee Mathematical and Scientific Machine Learning (MSML)
2019 - 2020	Member of TAMIDS Research Committee

Invited Talks

1. June 2025. Workshop and ML and PDEs, Banff International Research Center (Granada, Spain)
2. May 2025. DeepMind Seminar Series
3. May 2025. Oxford Machine Learning and Data Science Seminar
4. April 2024. Perimeter Institute ML Seminar
5. April 2024. UC Berkeley Spectral Theory Seminar
6. March 2024. UIUC ML Seminar (virtual)
7. February 2024. Workshop on ML in Science (Brin Research Center, UMD)
8. September 2023. Wharton Statistics PRiML Seminar
9. September 2023. Harvard Statistics Colloquium
10. August 2023. IAIFI 2023 Summer Workshop on Physics and Machine Learning (IAIFI, Boston)
11. August 2023. Two-day program on the theoretical aspects of Machine Learning at the Center for Brain Minds and Machines Summer School in Woods Hole, MA.
12. August 2023. Workshop on "Statistical Physics and Machine Learning: Back Together Again" (CNRS Cargese Physics Center, Corsica)
13. June 2023. 2023 Deep Learning: Theory, Algorithms, and Applications (Fondazione Bruno Kessler)
14. May 2023. International Conference on Approximation Theory and Beyond (Vanderbilt)
15. May 2023. CMSA Probability Seminar (Harvard)
16. March 2023. 2023 Workshop on Machine Learning Theory and Foundations (Beijing - remote)
17. March 2023. Artificial Intelligence and Mathematics Seminar (Remote Seminar Series run by Istituto per le Applicazioni del Calcolo)

18. March 2023. Undergraduate Colloquium (Northwestern Math)
19. March 2023. Theoretical Physics for Machine Learning, Aspen Center For Physics (Aspen)
20. February 2023. Quantitative Social Science Colloquium (Princeton)
21. February 2023. AI Institute for Artificial Intelligence and Fundamental Interactions Colloquium (Boston)
22. January 2023. External Seminar Series, Gatsby Institute for Neuroscience (University College London)
23. November 2023. Institute for Foundations of ML (Austin)
24. October 2022. Workshop on Machine Learning and It's Applications (National University of Singapore)
25. October 2022. Mathematics and Data Seminar (NYU)
26. September 2022. Machine learning in Madrid (virtual)
27. June 2022. Special Seminar in Debora Marks' Computational Biology Lab (Harvard Medical School)
28. March 2022. One World Machine Learning Seminar (virtual)
29. November 2021. Mathematical Physics Seminar (UC Boulder)
30. November 2021. Industrial Systems and Information Theory Seminar (Univ. Minnesota)
31. October 2021. Dynamics Seminar (Georgia Inst. Tech.)
32. October 2021. Probability and Combinatorics Seminar (Ohio State University)
33. October 2021. Probability Seminar (Edinburgh)
34. November 2020. Workshop on Seeking Low-dimensionality in Deep Neural Networks (SLowDNN).
35. October 2020. Joint Israeli Probability Seminar.
36. October 2020. Mathematical Machine Learning Seminar (Max Planck Institute, UCLA)
37. September 2020. Probability Seminar (UW Madison)
38. September 2020. Keynote: Advances in Data Science and Operations Research
39. February 2020. Probability Seminar (UCLA)
40. February 2020. Harmonic Analysis and PDE Seminar (Berkeley)
41. January 2020. Statistics Colloquium (U Chicago)
42. December 2019. Applied & Computational Math Seminar (Simon Fraser University)
43. November 2019. DeepMath Conference (Princeton Club, NYC)
44. October 2019. UT Austin/Texas A&M Conference on Probability and Related Fields
45. October 2019. Computer Engineering and Systems Group Seminar (Texas A&M)
46. June 2019. COE Seminar (Johns Hopkins)
47. May 2019. Approximation Theory 16 (Vanderbilt).
48. May 2019. Southeastern Probability Conference (Duke).
49. March 2019. Colloquium (UC Boulder).
50. March 2019. ECE Seminar (Rice).

51. February 2019. Machine Learning Seminar (CUNY).
52. February 2019. Machine Learning Seminar (NYU).
53. February 2019. Probability Seminar (NYU).
54. January 2019. Scientific Machine Learning (ICERM).
55. November 2018. Worskhop on Deep Learning (Texas A&M).
56. November 2018. Machine Learning and Physics (CUNY).
57. November 2018. Colloqium (TCU).
58. October 2018. Winedale Workshop (UT Austin).
59. August 2018. Theory Seminar (Facebook AI Research, NYC).
60. August 2018. Probability Seminar (Columbia).
61. August 2018. Summer Informal Regional Functional Analysis Seminar (Texas A&M).
62. June 2018. Stochastic Processes and Applications 2018 (Göthenburg, Sweden).
63. May 2018. Theory Seminar (IBM Research Tel-Aviv).
64. May 2018. Learning Seminar (Hebrew University).
65. April 2018. Probability Seminar (Paris 5).
66. April 2018. Probability Seminar (Luxembourg).
67. April 2018. Theory Seminar (DeepMind).
68. April 2018. Probability Seminar (Northwestern).
69. January 2018. CSAIL Machine Learning Seminar (MIT).
70. October 2017. Geometry Seminar (Texas A&M).
71. September 2017. Probability Seminar (Texas A&M).
72. September 2017. Mathematical Physics and Harmonic Analysis Seminar (Texas A& M).
73. April 2017. Probability Seminar (UC Boulder).
74. April 2017. Colloquium (UC Boulder).
75. April 2017. AMS Sectional Meeting Special Session on Microlocal Analysis and Spectral Theory (Pullman, WA).
76. April 2017. Colloquium (UC Colorado Springs).
77. March 2017. Probability Seminar (Columbia).
78. February 2017. Colloquium (Texas A&M).
79. December 2016. Analysis Seminar (Florida Atlantic University, Boca Raton).
80. November 2016. AMS Sectional Meeting Special Session on Harmonic Analysis and Dispersive PDE (Raleigh, NC).
81. November 2016. Analysis and PDE Seminar (UNC Chapel Hill).
82. August 2016. Workshop: Probabilistic Methods in Spectral Geometry and PDE (Centre de Recherches Mathématiques, Montreal).
83. June 2016. Geometry of Quantum Hall States Workshop (Simons Center for Geometry and Physics).
84. June 2016. Geometry of Quantum Hall States Workshop (Simons Center for Geometry and Physics).
85. April 2016. Probability Seminar (Institut Fourier, Grenoble).

86. April 2016. Holon Meeting on Complex and Harmonic Analysis (Tel Aviv).
87. April 2016. Analysis Seminar (Tel Aviv).
88. April 2016. Mathematical Physics Seminar (Physics Dept. Technion, Israel).
89. April 2016. Analysis and Probability Seminar (U. Penn and Temple).
90. March 2016. Analysis and PDE Seminar (McGill).
91. March 2016. Mathematical Physics Seminar (Northeastern).
92. February 2016. Analysis and PDE Seminar (Brown).
93. February 2016. New Mexico Analysis Seminar (Univ. New Mexico, Albuquerque).
94. February 2016. Analysis and PDE Seminar (UC Berkeley).
95. January 2016. AMS Joint Meetings Special Session on Global Harmonic Analysis (Seattle).
96. December 2015. Conference on Geometry of the Quantum Hall Effect (Uni. Köln).
97. November 2015. Differential Geometry Seminar (Harvard).
98. June 2015. Workshop: Quantum Geometry, Stochastic Geometry, Random Geometry, you name it (Simons Center for Geometry and Physics).
99. June 2015. Large N Limit Problems in Kähler Geometry (Simons Center for Geometry and Physics).
100. February 2015. Analysis and PDE Seminar (MIT).
101. June 2014. Complex Geometry Summer School (Milan, Italy).
102. May 2014. Frontier Probability Days Conference (University of Arizona, Tuscon).
103. March 2014. Topology and Geometry Seminar (Hebrew University, Jerusalem).
104. March 2014. Analysis Seminar (Tel-Aviv University).
105. March 2014. Horowitz Seminar (Tel-Aviv University).
106. January 2014. PDE, Complex Analysis and Differential Geometry Seminar (Notre Dame).
107. May 2013. Trondheim Spring School 2013 in Point Processes and Complex Analysis (Trondheim, Norway).
108. November 2012. Complex Geometry Seminar (organized jointly between Johns Hopkins University and University of Maryland College Park).
109. October 2012. Colloquium (Idaho State University).
110. July 2012. Workshop on Manifolds of Metrics and Probabilistic Methods in Geometry and Analysis (Centre de Recherches Mathématiques, Montreal).