Boris Hanin

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RESEARCH INTERESTS	Theory of deep learning, random matrix theory, mathematical physics, spectral 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
	2005 - 2009	B.S. in Mathematics (with honors), Stanford University

GRANTS		
	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 - 2022	*Random Neural Networks* (NSF DMS-1855684, $150,000)
	2014 - 2017	NSF Postdoctoral Fellowship (DMS-1400822, $150,000)

SUBMITTED FOR PUBLICATION

1. Hanin, B., Zlokapa, A., *Bayesian Interpolation with Deep Linear Networks.* Available online: arXiv:2212.14457.

2. Hanin, B., Iyer, G., Rolnick, D., *Maximal Initial Learning Rates in Deep ReLU Networks.* Available online: arXiv:2212.07295.

3. Hanin, B. *Random Fully Connected Neural Networks as Perturbatively Solvable Hierarchies.* Available online: arXiv:2204.01058.

4. Hanin, B. *Ridgeless Interpolation with Shallow ReLU Networks in 1D is Nearest Neighbor Curvature Extrapolation and Provably Generalizes on Lipschitz Functions.* Available online: arXiv:2109.12960.

5. Hanin, B. and Sellke, M. *Approximating Continuous Functions by ReLU Nets of Minimal Width.* Available online: arXiv:1710.11278.

PUBLICATIONS

1. Hanin, B. *Random Neural Networks in the Infinite Width Limit as Gaussian Processes.* Annals of Applied Probability (In Press: 2023). Available online: arXiv:2107.01562.

2. 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.

3. 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.

4. Hanin, B., Jeong, R., and Rolnick, D. *Deep ReLU Networks Preserve Expected Length.* ICLR 2022. Available online: arXiv:2102.10492.

5. Hanin, B. and Zelditch, S. *Interface Asymptotics of Wigner-Weyl Distributions for the Harmonic Oscillator.* Journal d'Analyse (in press).

6. Hanin, B. and Sun, Y. *Data Augmentation as Stochastic Optimization.* NeurIPS 2021. Available online: arXiv:2010.11171.

7. Hanin, B. and Paouris G. *Non-asymptotic Results for Singular Values of Gaussian Matrix Products.* Geometric and Functional Analysis 31 (2), 268-324, 2021.

8. DeVore, R., Hanin, B. and Petrova, G. *Neural Network Approximation.* Acta Numerica 30, 327-444, 2021.

9. 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.

10. Daubechies, I., DeVore, R., Foucart, S., Hanin, B. and Petrova, G. *Nonlinear Approximation and (Deep) ReLU Nets.* Constructive Approximation, 1-46, 2021.

11. 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.

12. Hanin, B. and Nica, M. *Finite Depth and Width Corrections to the Neural Tangent Kernel.* Spotlight ICLR 2020.

13. Hanin, B., Epstein, M., and Lundberg E. *The Lemniscate Tree of a Random Polynomial.* Annales de l'Institut Fourier, 70 (4), 1663-1687, 2020.

14. Hanin, B. and Nica, M. *Products of Many Large Random Matrices and Gradients in Deep Neural Networks.* Communications in Mathematical Physics, 1-36, 2019.

15. 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).

16. Hanin, B. and Rolnick, D. *Deep ReLU Nets have Surprisingly Few Activation Regions.* Accepted: Advances in Neural Information Processing Systems, 2019.

17. Hanin, B. and Beck, T. *Level Spacings and Nodal Sets at Infinity for Radial Perturbations of the Harmonic Oscillator.* Int. Math Research Notices. 2018.

18. 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.

19. Hanin, B. and Rolnick, D. *Complexity of Linear Regions in Deep Networks.* International Conference on Machine Learning, 2019.

20. Hanin, B. *Which Neural Net Architectures Give Rise to Exploding and Vanishing Gradients?.* NIPS 2018.

21. Hanin, B. and Rolnick, D. *How to Start Training: The Effect of Initialization and Architecture.* NIPS 2018.

22. 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.

23. 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.

24. 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.

25. 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.

26. 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.

27. 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.

28. 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.

29. Hanin, B. *Correlations and Pairing Between Zeros and Critical Points of Gaussian Random Polynomials.* International Math Research Notices (2015), Vol. (2), pp. 381-421.

30. 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.

OTHER

1. Contributed Research to "The principles of deep learning theory," published by Cambridge University Press in 2022 and written by Roberts, Daniel A., Sho Yaida. Available online: arXiv:2106.10165.

ACADEMIC AWARDS

2022	Alfred Rheinstein Faculty Award from School of Engineering and Applied Sciences at Princeton.
2021	Letter of Commendation for Teaching, School of Engineering and Applied Science at Princeton.
2020	Letter of Commendation for Teaching, School of Engineering and Applied Science at Princeton.
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 2023. Mini-course on Deep Learning Theory at Tor Vergata University, Rome.

2. Summer 2022. Les Houches Summer School on Statistical Physics of Machine Learning (joint with Yasaman Bahri)

PROFESSIONAL SERVICE	2021 - present	Sole organizer, Princeton ML Theory Summer School
	2021 - present	Member of Editorial Board, Pure and Applied Analysis
	2019 - present	Program Committee Mathematical and Scientific Machine Learning (MSML)
	2019 - 2020	Member of TAMIDS Research Committee