

Curriculum Vitae  
KATHRYN A. LINDSEY

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		Citizenship:	U.S.A.

**Employment**

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|--------------|--|
| 2023-present | Associate Professor, Department of Mathematics, Boston College.  |
| 2017-2023    | Assistant Professor, Department of Mathematics, Boston College.  |
| 2014-2017    | Dickson Instructor & N.S.F. Mathematical Sciences Postdoctoral Research Fellow,<br>University of Chicago. Advisor: Amie Wilkinson. |

**Education**

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|-----------|---|
| 2010-2014 | Ph.D. in Mathematics, Cornell University. Advisor: John Smillie.        |
| 2007-2010 | M.S. Special in Mathematics, Cornell University. Advisor: John Smillie. |
| 2003-2007 | B.A. in Mathematics, Williams College. Advisor: Cesar Silva.            |

**Research Interests**

- Mathematics of Machine Learning:  
I use geometry/topology/dynamics to prove theorems about how/why deep neural networks work.
- Dynamical Systems:  
Iterative dynamics with connections to geometry; specifically, holomorphic dynamics, Thurston sets, Teichmuller dynamics, ergodic theory.

**Grants & Fellowships**

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| 2021 | NSF DMS SCALE MoDL Program Award # 2133822, Collaborative Research: Probabilistic, Geometric, and Topological Analysis of Neural Networks, From Theory to Applications, joint with E. Grigsby (\$300,000). |
| 2019 | NSF DMS Analysis Program Award #1901247, Shapes of Julia sets, Thurston Sets, and Neural Networks (\$150,000).   |
| 2018 | “Women in STEM” co-PI Major Grant, Institute for Liberal Arts, Boston College (\$24,000).  |
| 2018 | Research Incentive Grant, Boston College (\$14,600).   |
| 2014 | NSF Mathematical Sciences Postdoctoral Research Fellowship (\$150,000).  |

2009	NSF Graduate Research Fellowship (\$120,000).
2009	DoD National Defense Science and Engineering Graduate Fellowship (\$120,000).
2008	U.S. State Department Critical Languages Scholarship (Mandarin Chinese).
2007	Cornell University Graduate Fellowship.

### Awards

2010	Robert John Battig Graduate Prize, Cornell University - awarded annually by the Cornell math faculty to a Ph.D. candidate “based on excellence and promise in mathematics”
2007	Highest Honors in Mathematics, Williams College
2007	Magna Cum Laude, Williams College
2007	Phi Beta Kappa, Williams College

### Research Program Participation

Fall 2023	Semester program "Math + Neuroscience: Strengthening the Interplay between Theory and Mathematics," ICERM, Providence, RI.
Fall 2013	Research Fellow, Semester program "Low-dimensional Topology, Geometry & Dynamics," ICERM, Providence, RI.
2017 Jun.	Mathematics Research Community, Dynamical Systems: Smooth, Symbolic & Measurable, Snowbird, Utah.
2013 Jun.	Mathematics Research Community, Complex Dynamics, Snowbird, Utah.
2006 summer	SMALL REU Ergodic Theory research group, Williams C.

### Publications

2023	Hidden symmetries of ReLU neural networks (with E. Grigsby, D. Rolnick). To appear in ICML 2023, preprint online at <a href="https://arxiv.org/abs/2306.06179">https://arxiv.org/abs/2306.06179</a> .
2022	On the deck groups of iterates of bicritical rational maps (with S. Koch and T. Sharland). Submitted, preprint online at <a href="https://arxiv.org/abs/2210.03148">https://arxiv.org/abs/2210.03148</a> .
2022	Bicritical rational maps sharing a common iterate (with S. Koch, T. Sharland). To appear in <i>International Math. Research Notices</i> .
2022	Functional dimension of feedforward ReLU neural networks (with J. E. Grigby, R. Meyerhoff, C. Wu). Submitted, preprint online at <a href="https://arxiv.org/pdf/2209.04036.pdf">https://arxiv.org/pdf/2209.04036.pdf</a> .

- 2022 Local and global topological complexity measures of generic, transversal ReLU neural network functions (with J. E. Grigsby, M. Masden). Submitted, preprint online at <https://arxiv.org/abs/2204.06062>.
- 2022 Existence of maximum likelihood estimates in exponential random graph models (with H. Bayly, A. Khanna). Submitted, preprint online at <https://arxiv.org/abs/2204.04757>.
- 2021 Master Teapots and entropy algorithms for the Mandelbrot set (with G. Tiozzo, C. Wu). Submitted, preprint online at <https://arxiv.org/abs/2112.14590>.
- 2021 The shape of Thurston's Master Teapot (with H. Bray, D. Davis, C. Wu). *Advances in Mathematics*, vol 377, 2021.
- 2020 On transversality of bent hyperplane arrangements and the topological expressiveness of ReLU neural networks (with J. E. Grigsby). *SIAM Journal on Applied Algebra and Geometry*, vol 6, issue 2, 2020.
- 2020 A characterization of Thurston's Master Teapot (with C. Wu). To appear in *Ergodic Theory & Dynamical Systems*.
- 2019 Degree-d-invariant laminations (with W. Thurston, H. Baik, G. Yan, J. Hubbard, Tan Lei, D. Thurston). In collection *What's Next?: The Mathematical Legacy of William P. Thurston*, Princeton University Press, 2020.
- 2019 Horocycle flow orbits and lattice surface characterizations (with J. Chaika). *Ergodic Theory & Dynamical Systems*, Vol. 39, Issue 6, pp 1441-1461, 2019.
- 2017 A Game of Life on Penrose Tilings (with D. Bailey). Preprint online at <https://arxiv.org/abs/1708.09301>.
- 2016 Fekete polynomials and shapes of Julia sets (with M. Younsi). *Transactions of the American Math. Soc.*, 371 (2019), pp. 8489-8511, 2016
- 2016 Convex shapes and harmonic caps (with L. DeMarco). *Arnold Math. Journal*, April 2017, Volume 3, Issue 1, pp. 97-117, 2016. (Special volume for 25th anniversary of Institute for Mathematical Sciences.)
- 2016 Infinite type flat surface models of ergodic systems. *Discrete and Continuous Dynamical Systems - A.*, vol 36 (10), pp. 5509-5553, 2016.
- 2015 Shapes of polynomial Julia sets. *Ergodic Theory & Dynamical Systems*, vol 35 (06), 2015.
- 2015 Counting invariant components of hyperelliptic translation surfaces. *Israel Journal of Math.*, 210, pp. 125-146, 2015.

2009 On ergodic transformations that are both weakly mixing and uniformly rigid (with James, Koberda, Silva, Speh). *New York Journal of Math.*, 15, pp. 393-403, 2009.

2008 Measurable Sensitivity (with James, Koberda, Silva, Speh). *Proc. Amer. Math. Soc.*, 136, pp. 359-3559, 2008.

### Advising

2023-present Ph.D. advisor to Yaoying Fu, Boston C.

2020-present Ph.D. advisor to Laura Seaberg, Boston C.

2018-2023 Ph.D. advisor to Ethan Farber, Boston C.

2020-2022 M.S. geophysics thesis committee member for Hong Cai (fractal structure of earthquake faults), Boston C.

2020-2021 Undergraduate thesis advisor to Henry Bayly & Alexander Benanti, Boston C.

2020-2021 Secondary undergraduate thesis advisor to Jieqi Di, Boston C.

2019 fall Supervised undergraduate research project on neural networks, Boston C.

2018 summer Employed 3 undergraduate math majors as research assistants, Boston C.

2015 summer Supervised 3 undergraduate research (REU) projects (two in ergodic theory, one in complex dynamics), U. Chicago.

### Conference Organization

2023 American Math. Society Special Session on "Dynamics, Geometry & Group Actions, Joint Math Meetings, Jan. 2023, Boston, MA.

2020 American Math. Society Special Session on Geometric Dynamics and Billiards, American Math. Soc. Spring Sectional Meeting (virtual), Mar. 21-22, 2020.

2018 14<sup>th</sup> William Rowan Hamilton Geometry and Topology Workshop, *Group Actions and ergodic theory in geometry and topology*, Trinity College, Dublin, Ireland.

2018 American Math. Society Special Session on *Dynamical Systems: Smooth, Symbolic & Measurable*, Joint Math Meetings, San Diego.

2014 *What's Next? the legacy of Bill Thurston*, June 23-27, 2014, Cornell U., Local organizing committee.

### Seminar Organization

2018-2020 Co-founder and co-organizer of Dynamics Seminar, Boston C.

2017-2022 Organizer of First Year Research Seminar, Boston C.

2015-2017	Co-organizer of Dynamics Seminar, U. Chicago
2013-2014	Organizer of Dynamical Systems Seminar, Cornell U.
2009-2010	Organizer of Olivetti Club (weekly graduate student seminar), Cornell U.
2008-2009	Organizer of “What Is...?” Seminar, Cornell U.

### Selected Invited Talks

2023 Nov.	Open Problems Seminar, Math+Neuroscience Semester, I.C.E.R.M.
2023 Nov.	GeomTop Seminar, Brown U.
2023 Sep.	Colloquium, Mathematics Department, George Mason U.
2023 Jul.	Poster presentation at the 40th International Conference on Machine Learning, Honolulu, HI.
2023 Apr.	Dynamical Systems Seminar, Boston U.
2023 Mar.	One World Seminar Series on the Mathematics of Machine Learning, virtual.
2023 Mar.	A Dynamical Weekend at Wesleyan, Wesleyan U.
2023 Jan.	AMS Special Session on Topology, Algebra, and Geometry in the Mathematics of Data Science, Joint Math Meetings.
2022 Oct.	Earth and Environmental Sciences Department Seminar, Boston College.
2022 Jun.	Minisymposium on computational topology, Computational Geometry Week 2022, Berlin, Germany.
2022 May	Number Theory Seminar, Oregon State U.
2022 May	Houston Workshop on Hyperbolic Dynamical Systems, U. Houston.
2022 Feb.	Pacific Northwest Sem. on Topology, Algebra & Geometry in Data Science.
2022 Jan.	Algebraic Dynamics Seminar, Harvard University.
2021 Sep.	Colloquium, U. Wisconsin-Milwaukee.
2021 Jun.	Colloquium, SUMMER@ICERM, ICERM.
2021 Mar.	Panel Discussion, Williams College.

- 2020 Dec. Colloquium, University of Warwick, U.K.
- 2020 Oct. Online working seminar in ergodic theory, U. Utah.
- 2020 Oct. Dynamics Seminar, U. Wisconsin-Madison.
- 2020 Jul. Quasiworld workshop, U.C.L.A.
- 2020 Jun. Informal Geometry and Dynamics Seminar, Harvard U.
- 2019 Nov. Illustrating Dynamics and Probability, I.C.E.R.M.
- 2019 Nov. Geometry/Topology Seminar, Yale U.
- 2019 Oct. Ergodic Theory Seminar, The Ohio State U.
- 2019 Jun. Dubrovnik IX, Dubrovnik, Croatia.
- 2019 Apr. Dynamics Seminar, U. Toronto.
- 2019 Mar. Dynamics Seminar, U. Chicago.
- 2019 Jan. MAA invited paper session “Beauty and Art from Research Mathematics,” Joint Math. Meetings, Baltimore.
- 2018 Sep. Workshop on Neural Networks and Machine Learning, Boston C.
- 2018 May International Congress on Mathematical Physics, Dynamical Systems session, Montréal, Canada.
- 2018 Apr. Informal Geometry and Dynamics Seminar, Harvard U.
- 2018 Apr. Advancing Women’s Impact in Mathematics Symposium, Worcester Polytechnic Institute.
- 2018 Apr. Workshop on Dynamical Systems and Related Topics, U. Maryland.
- 2018 Mar. Dynamics seminar, Cornell U.
- 2018 Mar. Oliver Club colloquium, Cornell U.
- 2018 Mar. Colloquium, Brown U.
- 2018 Mar. Dynamics Seminar, Boston U.
- 2018 Mar. Colloquium, U. Saskatoon.

- 2018 Jan. AMS Special Session on Math. Research from the SMALL Undergraduate Research Program, Joint Math. Meetings, San Diego.
- 2017 Nov. Geometric Group Theory and Topology Seminar, Tufts U.
- 2017 Aug. William Rowan Hamilton Geometry and Topology Workshop, Trinity C., Dublin, Ireland.
- 2017 Jul. Special Session on Arithmetic Dynamics, Mathematical Congress of the Americas, Montréal, Canada.
- 2017 Apr. AMS Special Session on Discrete Structures in Conformal Dynamics and Geometry, Indiana U.-Bloomington.
- 2017 Feb. Chicago Actions Now, U. of Illinois-Chicago.
- 2017 Feb. Women in Math Symposium, U. Chicago.
- 2017 Jan. Colloquium, George Washington U.
- 2017 Jan. Colloquium, UT Austin.
- 2016 Dec. Colloquium, Boston C.
- 2016 Dec. Colloquium, Washington U. in St. Louis.
- 2016 Nov. Midwest Dynamical Systems Conference, Indiana U.-Purdue U.-Indianapolis.
- 2016 Nov. Colloquium, U. Wisconsin-Madison.
- 2016 Oct. Complex Analysis Seminar, U. Michigan Ann Arbor.
- 2016 Oct. Midwest Workshop on Asymptotic Analysis, Indiana U.-Purdue U.-Fort Wayne.
- 2016 Aug. Cycles on Moduli Spaces, Geometric Invariant Theory, and Dynamics, Institute for Computational and Experimental Mathematics, Providence, RI.
- 2016 May Workshop on Flat Surfaces and Dynamics of Moduli Space, Banff International Research Station Casa Matemática Oaxaca, Mexico.
- 2016 Apr. Dynamics Seminar, Stony Brook U.
- 2016 Apr. Geometry Group Theory & Dynamics Seminar, Tufts U.
- 2016 Mar. British Mathematics Colloquium, Ergodic Theory Special Session, Bristol U., Bristol, United Kingdom.
- 2016 Mar. Dynamics Seminar, Bristol University, Bristol, United Kingdom.

- 2016 Mar. 50<sup>th</sup> Spring Topology and Dynamics Conference, Baylor U.
- 2016 Feb. Dynamical Systems Seminar, U. of Maryland-College Park.
- 2015 Nov. Teichmüller Theory Seminar, Indiana U.-Bloomington.
- 2015 Aug. Dynamical developments: a conference in complex dynamics and Teichmüller theory, in honor of John Hubbard's 70<sup>th</sup> birthday. Jacobs U., Bremen, Germany.
- 2015 Apr. Dynamical Systems Seminar, Northwestern U.
- 2015 Mar. Midwest Women in Mathematics Symposium, Dominican U.
- 2015 Feb. Dynamics Seminar, Indiana U.-Purdue U.-Indianapolis.
- 2014 Nov. Geometry and Topology Seminar, Stanford U.
- 2014 Oct. Math Department Seminar, Beloit C.
- 2014 Aug. Wasatch Topology Conference, Park City, Utah.
- 2014 Apr. Dynamical Systems Seminar, Northwestern U.
- 2014 Apr. Workshop on Dynamical Systems and Related Topics, U. Maryland.
- 2014 Mar. Geometry Seminar, U. of Michigan-Ann Arbor.
- 2014 Jan. Special Session on Complex Dynamics, Joint Math Meetings, Baltimore.
- 2013 Aug. International Conference and Workshop on Surfaces of Infinite Type, Universidad Nacional Autonoma de Mexico, Campus Morelia, Mexico.
- 2013 May Dynamics seminar, U. Chicago.
- 2013 May Faculty Seminar, Williams C.
- 2012 Nov. Séminaire COOL, Institut Henri Poincaré, Paris, France.
- 2012 Nov. Holomorphic Dynamics Seminar, Université d'Angers, France.
- 2012 Mar. Informal Seminar: Dynamics and Geometry, Harvard U.
- 2011 Apr. Action Now Wandering Seminar, Ben Gurion U, Israel.
- 2010 Nov. Oxtoby Centennial Conference, Bryn Mawr C.

**Teaching**

2023 fall	Math 3321: Analysis I, BC
2023 fall	Math 8810: Real Analysis, BC
2023 spring	Math 2202: Multivariable Calculus, 2 sections, B.C.
2022 fall	Math 8810: Real Analysis, B.C.
2022 spring	Math 2202: Multivariable Calculus, B.C.
2021 fall	Math 8831: Geometry & Topology III, B.C.
2020 fall	Math 8810: Real Analysis, B.C.
2020 fall	Math 3320: Introduction to Analysis, B.C.
2020 spring	Math 2216: Introduction to Abstract Mathematics, B.C.
2019 fall	Math 8810: Real Analysis, B.C.
2018 fall	Math 1105: Calculus II AP (for math/science majors), B.C.
2017 fall	Math 8855: Topics in Geometry & Topology, B.C.
2017 fall	Math 1102: Calculus I (Math/Science Majors), B.C.
2017 spring	Math 20500: Analysis in $R^n$ III, U. Chicago.
2016 spring	Math 20300: Analysis in $R^n$ I, U. Chicago.
2015 autumn	Math 15300: Calculus III, U. Chicago.
2009-2014 sum	Nautical Science, Sea Education Association, SSV Corwith Cramer.
2012 summer	Math 1110: Calculus I, Cornell U.
2009 spring	Teaching Assistant, Math 2130: Calculus III, Cornell U.
2008 fall	Teaching Assistant, Math 1910: Calculus for Engineers, Cornell U.

**Outreach and Service**

2023	NSF Panelist
2021-present	American Math. Soc. Mathematics Research Communities Advisory Board
2021-2022	Website committee, math dept., Boston C.

- 2021            NSF Panelist
- 2021            Public lecture “Dynamical Roots” (joint with G. Tiozzo and Y. M. He).
- 2020            NSF Panelist
- 2019 summer    Taught one-month course about fractals for 9<sup>th</sup> and 10<sup>th</sup> grade high school students, U. Chicago Young Scholars Program.
- 2019-2020      Graduate admissions committee, math dept., Boston C.
- 2018-2019      Hiring committee, math dept., Boston C.
- 2018-2019      Distinguished lecturer committee, math dept., Boston C.
- 2018-2019      Prize committee, math dept., Boston C.
- 2018            Co-organizer of “Women in STEM” lectures series, Boston C.
- 2017 summer     Taught two-week course for 9<sup>th</sup> and 10<sup>th</sup> grade high school students on complex dynamics, Young Scholars Program, U. Chicago.
- 2016 summer     Taught dynamical systems unit (joint with A. Brown, H. Masur), Research Experience for Undergraduates, U. Chicago.
- 2015 summer     Taught ergodic theory unit, Research Experience for Undergraduates, U. Chicago.
- 2016 Apr.        Presentation for U. Chicago Math Club.
- 2015            Made short video for use in American Math. Society production of “Who wants to be a mathematician?”
- 2013-2014       Committee to Consider the Future Access to Mathematical Literature at Cornell U.
- 2010-2013       President, Cornell Student Chapter of the Association for Women in Mathematics.
- 2012 summer     Mentor to four students in Summer Math Institute, Cornell U.
- 2010            Co-Founded Cornell U. Student Chapter of the Association for Women in Math.
- 2007-2010       Class Representative, Mathematics Department, Cornell U.
- 2009            Wrote online Math Explorers Club unit *Introduction to Tilings*.
- 2009 Dec.        Guest speaker in Math 5080: Mathematics for Secondary School Teachers, Cornell
- 2009 Mar.        Led enrichment activities, Boynton Middle School “Math Day.”

2004-2007      Student Mathematics and Statistics Advisory Board, Williams C.

2006-2007      Grievance Committee, Williams C.

2005-2006      Calendar and Schedule Committee, Williams C.

### **Organizational Memberships**

American Mathematical Society

Association for Women in Mathematics

### **Other Skills**

Computing:      Mathematica, Python, Sage, LaTex

Languages:      English (native), French (fluent), Chinese (intermediate), Hindi (beginner)

Maritime:      U.S.C.G. Merchant Mariner Credentials:  
                  200 GRT Near-Coastal Mate, 100 GRT Inland Master,  
                  AB Sail with Lifeboatman certification,  
                  >500 days of sea time  
                  Watch leader (3rd mate) with Sea Education Association

Music:      Pedal harp

Art:      Ceramics - wheel throwing