Lionel Levine

Department of Mathematics, Cornell University

2023 – Professor

2019 – 2023 Frank Spitzer and Narahari Umanath Prabhu Associate Professor

2017 – 2019 Associate Professor

2011 – 2017 Assistant Professor

Department of Mathematics, MIT

2008 – 2011 C.L.E. Moore Instructor

Education

2002 – 2007 **Ph.D.** in Mathematics, University of California, Berkeley

1998 – 2002 **A.B.** in Mathematics, Harvard University

Funding

2023 – 2025 Open Philanthropy grant for AI safety research

2015 – 2020 National Science Foundation CAREER Grant DMS-1455272

2014 – 2016 Alfred P. Sloan Research Fellowship

2011 – 2014 National Science Foundation Grants DMS-1105960 and DMS-1243606

2008 – 2011 National Science Foundation Postdoctoral Research Fellowship

2002 – 2007 National Science Foundation Graduate Research Fellowship

Awards

2020 Fellow of the American Mathematical Society

2018 – 2019 Simons Fellowship

2018 – 2019 Von Neumann Fellowship, Institute for Advanced Study

2014 Good Judgment Project "Superforecaster"

2013 Paul R. Halmos - Lester R. Ford Award, Mathematical Association of America

Research Interests

Probability, combinatorics, statistical physics, multi-agent learning, AI safety

Ph.D. students

Andrew Melchionna (Ph.D. 2023)
Hannah Cairns (Ph.D. 2022)
Feng Liang (Ph.D. 2022)
Ryan McDermott (Ph.D. 2021)
Lila Greco (Ph.D. 2020)
Swee Hong Chan (Ph.D. 2019)

Postdocs mentored

Ahmed Bou-Rabee (2022–2023)
Christian Noack (2019–2021)
Lilla Tothmérész (2017–2018)
Viktor Kiss (2017–2018)
Wilfried Huss (2015–2016)
Ecaterina Sava-Huss (2015–2016)
Daniel C. Jerison (2014–2017)
John Pike (2013–2016)

Publications and Preprints

preprints 1. Elliot Glazer et al.,
FrontierMath: A benchmark for evaluating advanced mathematical reasoning in AI.
arXiv:2411.04872

2. Rowan Hess and Lionel Levine,
How to quantify the coherence of a set of beliefs.
arXiv:2412.02777

3. Robin Kaiser, Lionel Levine, and Ecaterina Sava-Huss
Locally Markov walks on finite graphs.
arXiv:2412.13766

2025 4. Viktor Kiss, Lionel Levine, and Lilla Tóthmérész,
The devil's staircase for chip-firing on random graphs and on graphons.
Random Structures and Algorithms (2025) 66, e21255.

2024 5. Wilson Wu, John X. Morris, and Lionel Levine,
Do language models plan ahead for future tokens?
CoLM 2024

6. Lionel Levine and Vittoria Silvestri,
Universality Conjectures for Activated Random Walk.
Probability Surveys (2024) 21: 1-27

7. Lionel Levine and Feng Liang,
Exact sampling and fast mixing of Activated Random Walk.
Electronic Journal of Probability (2024) 29:1–20

2023 8. Lila Greco and Lionel Levine, *Branching in a Markovian environment.*
Markov Processes and Related Fields (2023) v.29, Issue 1, 1–33

2022 9. Swee Hong Chan and Lionel Levine,
Abelian networks IV. Dynamics of nonhalting networks
Memoirs of the American Mathematical Society (2022) Volume 276 Number 1358

10. Lionel Levine, Hanbaek Lyu, and John Pike,
Double jump phase transition in a soliton cellular automaton.
International Math Research Notices (2022) 665–727

2021 11. Lionel Levine and Vittoria Silvestri,
How far do Activated Random Walkers spread from a single source?
Journal of Statistical Physics (2021) vol. 185 article 18

12. Swee Hong Chan, Lila Greco, Lionel Levine, and Peter Li, *Random walks with local memory.*
Journal of Statistical Physics (2021) vol. 184 article 6

2019 13. Shirshendu Ganguly, Lionel Levine, and Sourav Sarkar,
Formation of large-scale random structure by competitive erosion.
Annals of Probability (2019) 47:3649–3704

14. Daniel C. Jerison, Lionel Levine, and John Pike,
Mixing time and eigenvalues of the abelian sandpile Markov chain.
Transactions of the American Mathematical Society (2019) 372:8307–8345

15. Bob Hough, Daniel C. Jerison, and Lionel Levine, *Sandpiles on the square lattice.*
Communications in Mathematical Physics (2019) 367:33–87.

16. Lionel Levine and Vittoria Silvestri,
How long does it take for Internal DLA to forget its initial profile?
Probability Theory and Related Fields (2019) 174:1219–1271.

17. Alexander E. Holroyd, Lionel Levine, and Peter Winkler, *Abelian logic gates.* Combinatorics, Probability, and Computing (2019) 28:388–422.

2018 18. Wilfried Huss, Lionel Levine and Ecaterina Sava-Huss, *Interpolating between random walk and rotor walk.* Random Structures & Algorithms (2018) 52.2:263–282

2017 19. Lionel Levine, Wesley Pegden and Charles K. Smart, *The Apollonian structure of integer superharmonic matrices.* Annals of Math (2017) 186:1–67

20. Elisabetta Candellero, Shirshendu Ganguly, Christopher Hoffman and Lionel Levine, *Oil and water: a two-type internal aggregation model.* Annals of Probability (2017) 45:4019–4070

21. Lionel Levine and Yuval Peres, *Laplacian growth, sandpiles and scaling limits.* Bulletin of the American Mathematical Society (2017) 54:355–382

22. Lionel Levine and Ramis Movassagh, *The gap of the area-weighted Motzkin spin chain is exponentially small.* Journal of Physics A: Mathematical and Theoretical (2017) 50:255302

23. Shirshendu Ganguly, Lionel Levine, Yuval Peres and James G. Propp, *Formation of an interface by competitive erosion.* Probability Theory and Related Fields (2017) 168:455–509

2016 24. Benjamin Bond and Lionel Levine, *Abelian networks I. Foundations and examples.* SIAM Journal on Discrete Mathematics (2016) 30:856–874.

25. Benjamin Bond and Lionel Levine, *Abelian networks II. Halting on all inputs.* Selecta Mathematica (2016) 22:319–340.

26. Benjamin Bond and Lionel Levine, *Abelian networks III. The critical group.* Journal of Algebraic Combinatorics (2016) 43:635–663.

27. Laura Florescu, Lionel Levine and Yuval Peres, *The range of a rotor walk.* The American Mathematical Monthly, (2016) 123(7):627–642.

28. Matthew Farrell and Lionel Levine, *CoEulerian graphs.* Proceedings of the American Mathematical Society (2016) 144:2847–2860.

29. Matthew Farrell and Lionel Levine, *Multi-Eulerian tours of directed graphs.* Electronic Journal of Combinatorics (2016) 23:P2.21.

30. Lionel Levine, Mathav Murugan, Yuval Peres and Baris Ugurcan, *The divisible sandpile at critical density.* Annales Henri Poincaré (2016) 17(7):1677–1711.

31. Lionel Levine, Wesley Pegden and Charles K. Smart, *Apollonian structure in the abelian sandpile.* Geometric And Functional Analysis (2016) 26(1):306–336.

2015 32. Lionel Levine, *Threshold state and a conjecture of Poghosyan, Poghosyan, Priezzhev and Ruelle.* Communications in Mathematical Physics (2015) 335(2):1003–1017

33. Louis J. Billera, Lionel Levine and Karola Mészáros, *How to decompose a permutation into a pair of labeled Dyck paths by playing a game.* Proceedings of the American Mathematical Society (2015) 143:1865–1873.

2014 34. Lionel Levine and Yuval Peres, *The looping constant of $\mathbb{Z}^d$.* Random Structures & Algorithms (2014) 45:1–13

35. David Jerison, Lionel Levine and Scott Sheffield, *Internal DLA and the Gaussian free field.* Duke Mathematical Journal (2014) 163(2):267–308

36. Laura Florescu, Shirshendu Ganguly, Lionel Levine and Yuval Peres, *Escape rates for rotor walks in* $\mathbb{Z}^d$. SIAM Journal on Discrete Mathematics (2014) 28(1):323–334.
37. David Jerison, Lionel Levine, and Scott Sheffield. *Internal DLA for cylinders*, in *Advances in Analysis: The Legacy of Elias M. Stein* (2014): 189.

2013 38. Lionel Levine, Scott Sheffield and Katherine E. Stange, *A duality principle for selection games.* Proceedings of the American Mathematical Society (2013) 141(12):4349–4356.

39. David Jerison, Lionel Levine and Scott Sheffield, *Internal DLA in higher dimensions.* Electronic Journal of Probability (2013) 18(98):1–14.
40. Tobias Friedrich and Lionel Levine, *Fast simulation of large-scale growth models.* Random Structures & Algorithms (2013) 42:185–213.
41. Christopher J. Hillar, Lionel Levine and Darren Rhea, *Equations solvable by radicals in a uniquely divisible group.* Bulletin of the London Mathematical Society (2013) 45:61–79.

2012 42. David Jerison, Lionel Levine and Scott Sheffield, *Logarithmic fluctuations for internal DLA.* Journal of the American Mathematical Society (2012) 25:271–301.

43. Lionel Levine and Katherine E. Stange, *How to make the most of a shared meal: plan the last bite first.* American Mathematical Monthly (2012) 119:550–565.
44. Giuliano Giacaglia, Lionel Levine, James Propp and Linda Zayas-Palmer. *Local-to-global principles for the hitting sequence of a rotor walk.* Electronic Journal of Combinatorics (2012) 19:P5.

2011 45. Lionel Levine, *Sandpile groups and spanning trees of directed line graphs.* Journal of Combinatorial Theory A (2011) 118:350–364.

46. Lionel Levine, *Parallel chip-firing on the complete graph: devil's staircase and Poincaré rotation number.* Ergodic Theory and Dynamical Systems (2011) 31:891–910

2010 47. Anne Fey, Lionel Levine and David B. Wilson, *Driving sandpiles to criticality and beyond.* Physical Review Letters (2010) 104:145703.

48. Anne Fey, Lionel Levine and David B. Wilson, *The approach to criticality in sandpiles.* Physical Review E (2010) 82:031121.
49. Anne Fey, Lionel Levine and Yuval Peres, *Growth rates and explosions in sandpiles.* Journal of Statistical Physics (2010) 138:143–159.
50. Lionel Levine and Yuval Peres, *Scaling limits for internal aggregation models with multiple sources.* Journal d'Analyse Mathématique (2010) 111:151–219.
51. Lionel Levine and James Propp, *What is a sandpile?* Notices of the American Mathematical Society (2010) 57:976–979.
52. Wouter Kager and Lionel Levine, *Rotor-router aggregation on the layered square lattice.* Electronic Journal of Combinatorics (2010) 17:R152.
53. Wouter Kager and Lionel Levine, *Diamond aggregation.* Mathematical Proceedings of the Cambridge Philosophical Society (2010) 149:351–372.

2009 54. Lionel Levine and Yuval Peres, *Strong spherical asymptotics for rotor-router aggregation and the divisible sandpile.* Potential Analysis (2009) 30:1–27.

55. Itamar Landau and Lionel Levine, *The rotor-router model on regular trees.* Journal of Combinatorial Theory A (2009) 116:421–433.
56. Lionel Levine, *The sandpile group of a tree.* European Journal of Combinatorics (2009) 30:1026–1035.

2008 57. Alexander E. Holroyd, Lionel Levine, Karola Meszaros, Yuval Peres, James Propp and David B. Wilson, *Chip-firing and rotor-routing on directed graphs*, in "In and Out of Equilibrium 2," Progress in Probability vol. 60, 331–364.

58. Lionel Levine and Yuval Peres, *Spherical asymptotics for the rotor-router model in* $\mathbb{Z}^d$. Indiana University Mathematics Journal (2008) 57:431–450.

2007 59. Christopher J. Hillar and Lionel Levine, *Polynomial recurrences and cyclic resultants.* Proceedings of the American Mathematical Society (2007) 135:1607–1618.

2006 60. Lionel Levine, *Fractal sequences and restricted Nim.* Ars Combinatoria (2006) 80:113–127.

Selected Talks

2024 Nov. Cornell Physics Colloquium
Oct. Isaac Newton Institute, Cambridge, UK (minicourse)
Aug. Cornell Oliver Club
Feb. University of Miami mathematics colloquium
2023 Dec Online Seminar on Undergraduate Mathematics Education (OLSUME)
Apr. La Sapienza probability seminar, Rome, Italy
Feb. Alignment Workshop, OpenAI, San Francisco
2022 Dec. SPCS2022 in honor of Deepak Dhar receiving the Boltzmann Medal
2021 Oct. Berkeley probability seminar
Apr. University of Washington probability seminar
Mar. Duke probability seminar
Mar. University of Birmingham applied math seminar
2020 Oct. One World probability seminar
Oct. AMS Sectional meeting (two talks)
2019 Jun. Joint Meeting of the Vietnam and American Mathematical Societies, Quy Ngon, Vietnam
Mar. IAS discrete math seminar
Mar. University of Chicago probability seminar
Feb. ICTS program on universality in random structures, Bangalore, India (4 lectures)
Feb. IIT Mumbai mathematics colloquium
2018 Sep. Penn State MASS seminar and mathematics colloquium
Jul. Montreal workshop on challenges in probability and statistical physics
2017 Oct. Stony Brook mathematics colloquium
Oct. Princeton probability seminar
Sep. Cornell probability and dynamics (joint seminar)
Jul. Mathematical Congress of the Americas, Special session on probability, Montreal, Canada
2016 Nov. Berkeley probability seminar
Apr. Finger Lakes Probability Seminar
Jan. CIRM workshop on nonequlibrium statistical physics, Marseilles, France
2015 Oct. CIB Conference on statistical physics on transitive graphs, EPFL Lausanne, Switzerland
Aug. MAA Centennial, Invited session on "Arithmetic of Spheres"
Apr. Harvard random matrix and statistical physics seminar
Feb. Triangle Lectures in Combinatorics

2014 Dec. Tufts mathematics colloquium
Jun. CIRM Conference on Random Media, Marseille, France
May MIT probability seminar
Apr. University of Arizona mathematics colloquium
2013 Nov. UPenn combinatorics and probability seminar
Oct. Midwest Probability Colloquium
Aug. Mathematical Congress of the Americas, special session on applied combinatorics
Jan. Cornell applied mathematics colloquium
2012 Dec. Tel Aviv University mathematics colloquium
Dec. Weizmann Institute geometric functional analysis and probability seminar
Apr. University of Connecticut mathematics colloquium
2011 Nov. 80^{th} birthday conference in honor of Harry Kesten
Mar. MSRI workshop on free boundary problems
Jan. University of British Columbia mathematics colloquium
2010 Feb. IMPA probability seminar, Rio de Janeiro, Brazil
Jan. University of Washington / PIMS mathematics colloquium
2009 Oct. Dartmouth computer science colloquium
Jul. 27th Brazilian Colloquium of Mathematics, Rio de Janeiro
2008 Aug. CRM Workshop on Laplacian growth and related topics, Montreal
2007 Oct. International symposium on stochastic large scale interacting systems, Fukuoka, Japan

Professional Service

- Editor, *Combinatorial Theory* (2020–2025). Formerly published by Elsevier, *Combinatorial Theory* is now a mathematician-run journal, owned by its Editorial Board.
- Co-organizer, Cornell Probability Summer School (2013, 2014, 2019, 2022).
- Co-organizer, Invited session at the World Congress in Probability and Statistics, July 2016.
- Co-organizer, AIM workshop on generalizations of chip-firing and the critical group, July 2013.
- Co-organizer, Special session on Laplacian growth, AMS/MAA joint meetings, Jan. 2011.
- Co-organizer, Cornell probability seminar (2012–2023)
- Co-organizer, MIT probability seminar (2008–2011)

Journals and Conferences Refereed

Advances in Mathematics
American Mathematical Monthly
Annals of Combinatorics
Annals of Probability
Archive for Rational Mechanics and Analysis
Combinatorics, Probability and Computing
Communications in Mathematical Physics
Discrete Mathematics
Duke Mathematical Journal
Electronic Journal of Combinatorics

Foundations of Computer Science (**FOCS**)

Geometric and Funcional Analysis

International Mathematics Research Notices

Journal d'Analyse Mathematique

Journal of the American Mathematical Society

Journal of Combinatorial Theory A

Journal of Integer Sequences

Journal of Physics A

Journal of Statistical Physics

Linear Algebra And Its Applications

Mathematics of Operations Research

Notices of the American Mathematical Society

Physica A

Physical Review E

Potential Analysis

Probability Theory and Related Fields

Random Structures & Algorithms

SIAM Journal on Discrete Mathematics

Stochastic Processes And Their Applications

Symposium on Discrete Algorithms (**SODA**)

Symposium on Theory of Computing (**STOC**)

Teaching

2025	Graduate Probability I (MATH 6710)
2024	Math for AI Safety (MATH 7710, graduate topics class in probability)
2023	Strategy, Cooperation, and Conflict (MATH 1340)
2022	Graduate Probability I (MATH 6710)
	Limits of discrete random structures (MATH 7710, graduate topics class in probability)
2021	Graduate Probability I (MATH 6710)
	Calculus I (MATH 1110)
	Graduate Probability II (MATH 6720)
2020	Abelian Networks (MATH 7710, graduate topics class in probability)
	Graduate Probability I (MATH 6710)
	Nonlinear Dynamics and Chaos (MATH 4210/ MAE 5790)
	Graduate Probability II (MATH 6720)
2019	Graduate Probability I (MATH 6710)
2018	Graduate Probability II (MATH 6720)
2017	Graduate Probability II (MATH 6720)
	Stohastic Processes (MATH 4740)
2016	Mathematics and Politics (MATH 1340)
2015	Stochastic Processes (MATH 4740)
2014	Graduate Probability I (MATH 6710)
	Stochastic Processes (MATH 4740)
2013	Stochastic Processes (MATH 4740)
2012	Laplacian Growth (MATH 7770, graduate topics class in probability)
2011	Algebraic Combinatorics (18.312) at MIT

Mentoring and Outreach

2025	Faculty sponsor of CAIA (Cornell AI Alignment student club)
2024	Mentor for SPAR (Supervised Program for Alignment Research)
2023	Mentored undergraduate Oliver Hopcroft on *eliciting from language models*.
2022	Mentored undergraduates Rowan Hess and Luchen Shi on *rectifying inconsistent priors*; Aidan O'Gara on *eliciting from language models*; Lukas Berglund on *deceptive alignment*; Katrina Brown and Aditya Syam on *multi-agent reinforcement learning*.
2021	Mentored undergraduate Bryan Lu on a *stochastic model of attention*.
2019	Taught a five-week minicourse on *probability, combinatorics, and computation* for gifted high school students at the PROMYS program.
	Designed a research project on *ladder sandpiles* for PROMYS students Siddhant Chaudhary and Ashwin Padaki. They presented their results at the 2020 Joint Math Meetings.
2018	Designed research projects on *random spanning trees* and *greedy avoidance of arithmetic progressions* for PROMYS undergraduates and high school students
	Spoke on *the future of prediction* at the MAA New York sectional meeting
2017	Supervised senior thesis research for Cornell math major Peter Li. Peter's thesis topic: *The vector-valued martingale invariance principle*
	Designed a research project on *random game trees* for PROMYS students
2016	PROMYS alumni lecture, Boston University, July 6, 2016.
	Math Awareness Public Lecture, Cornell, April 29, 2016.
2015	Designed a research project on *box-ball solitons* for PROMYS students Karthik Karnik and Mikaeel Yunus, and sponsored them for the Siemens and JSHS competitions.
2014	Supervised senior thesis research for Cornell undergraduate Matthew Farrell. Matt's thesis title: *The halting problem for chip-firing on finite directed graphs*
	Supervised research for Cornell undergraduates Young Jun Song and Matt Weatherly.
2013	Supervised senior thesis research for Cornell undergraduate Diwakar Raisingh. Diwakar's thesis title: *Toward an axiomatic characterization of the smash sum*
	Presented on *the sandpile group of a graph* at the Cornell Math Club.
2012	Presented on *patterns in coin-flipping* to an audience of secondary school teachers.
	Contributed mathematical art to MSRI's Wild Beauty outreach event.
2011	Presented on *primes in Pascal's triangle* at the Boston Math Circle.
	Co-mentored high school student Ziv Scully in MIT's PRIMES program.
2009–2011	Mentored MIT undergraduates Joshua Alman, Ben Bond, Giuliano Giacaglia, Neil Gurram, Damien Jiang, Aviva Siegel and Linda Zayas-Palmer in the UROP program.