Bhargav Narayanan

Born October 11, 1989
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Research

- Extremal, probabilistic and topological combinatorics.
- Discrete probability and related areas in statistical physics.
- Applications of combinatorial and probabilistic techniques to computer science.

Positions

- **Associate Professor of Mathematics**, Rutgers, 2023–Present.
- **Assistant Professor of Mathematics**, Rutgers, 2017–2023.
- **Consulting Researcher**, Microsoft Research, 2018–2022.
- **Research Fellow**, St John's College, Cambridge, 2015–2017.

Education

- **PhD in Mathematics**, Cambridge, 2012–2015.
  Supervised by Prof. Béla Bollobás.
- **MASt in Mathematics (Part III)**, Cambridge, 2011–2012.
  Ranked 1st in the year with an average examination score of 97.2/100.
- **BTech in Computer Science**, IIT Madras, 2007–2011.
  Ranked 1st in the year with a grade point average of 9.86/10.

Grants

- NSF Career Grant DMS-2237138, 2023–2028.
- Sloan Research Fellowship, 2023–2025.
- NSF Grant CCF-1814409, 2021–2024.
- Rutgers Research Council Grant, 2021–2022.
- NSF Grant DMS-1800521, 2018–2022.

Awards & Prizes

- Board of Trustees Research Fellowship for Scholarly Excellence, Rutgers, 2023.
- Simons Visiting Professorship, EPFL, 2021.
- Smith–Knight Prize, Cambridge, 2014.
- Leslie Walshaw Prize and Part III Examination Prize, Cambridge, 2012.
- Ramanujan Studentship, Cambridge, 2011.

– President's Gold Medal, IIT Madras, 2011.

– Honourable Mention, International Mathematical Olympiad, 2007.

Selected Publications

– *Antichain codes*, **Bulletin of the London Mathematical Society**, to appear. With B. Gunby, X. He and S. Spiro.
This paper uses coding-theoretic, combinatorial and probabilistic techniques to prove an abstract (purely combinatorial) generalisation of the results of Sárközy–Szemerédi and Halász connecting arithmetic structure and anti-concentration.

– *Thresholds versus fractional expectation-thresholds*, **Annals of Mathematics**, 194 (2021). With K. Frankston, J. Kahn and J. Park.
Down-set thresholds, **Random Structures & Algorithms**, 63 (2023). With B. Gunby and X. He.
These papers settle various questions about thresholds raised by Kahn, Kalai and Talagrand in the 2000s. In particular, the first paper proves Talagrand's 'threshold conjecture' from 2010 about increasing events in product probability spaces, and related conjectures of Martin, Mézard and Rivoire in statistical physics from 2005.

– *Friendly bisections of random graphs*, **Communications of the American Mathematical Society**, 2 (2022). With A. Ferber, M. Kwan, A. Sah and M. Sawhney.
This paper proves an old conjecture of Füredi from 1988 about bisecting random graphs; interest in this problem was recently renewed owing to its inclusion in Green's list of '100 open problems' (as Problem 91).

– *Spanning surfaces in 3-graphs*, **Journal of the European Mathematical Society**, 24 (2022). With A. Georgakopoulos, J. Haslegrave and R. Montgomery.
This paper resolves a problem posed by Gowers in 2005 on finding spanning surfaces in two-dimensional simplicial complexes.

– *Simplicial homeomorphs and trace-bounded hypergraphs*, **Discrete Analysis**, 2022:6 (2022). With J. Long and C. Yap.
A universal exponent for homeomorphs, **Israel Journal of Mathematics**, 243 (2021). With P. Keevash, J. Long and A. Scott.
These papers prove Nati Linial's 'geometric exponent' conjectures from 2006 about finding homeomorphs in simplicial complexes, and strengthen combinatorial results of Conlon, Fox and Sudakov along the way.

– *Subgraphs of large connectivity and chromatic number*, **Bulletin of the London Mathematical Society**, 54 (2022). With A. Girão.
This paper resolves a problem raised by Alon, Kleitman, Thomassen, Saks and Seymour in 1987 about the interplay between graph colouring and connectivity.

– *The threshold for the square of a Hamilton cycle*, **Proceedings of the American Mathematical Society**, 149 (2021). With J. Kahn and J. Park.
This paper proves a conjecture due to Kühn and Osthus from 2012 about Hamiltonian cycles in random graphs.

– *Disproportionate division*, **Bulletin of the London Mathematical Society**, 52 (2020). With L. Crew and S. Spirkl.
This paper resolves a classical measure partitioning problem using combinatorial arguments, improving upon (folklore) arguments from the 1980s using tools from algebraic topology.

– *Coalescence on the real line*, **Transactions of the American Mathematical Society**, 371 (2019). With P. Balister, B. Bollobás and J. Lee.
This paper answers various questions raised by Holroyd in 2010 about a non-monotone spin model for coalescing domains.

– *On regular 3-wise intersecting families*, **Proceedings of the American Mathematical Society**, 146 (2018). With K. Frankston and J. Kahn.
On symmetric 3-wise intersecting families, **Proceedings of the American Mathematical Society**, 145 (2017). With D. Ellis.
These papers resolve various problems raised by Babai, Cameron, Frankl and Kantor in the late 1970s and early 1980s about the dichotomy between symmetry and structure in extremal set theory.

Mentoring

– **Postdoctoral Researchers**: Sam Spiro (NSF Postdoctoral Fellow, 2022–Present) Benjamin Gunby (Hill Assistant Professor, 2021–Present), Sophie Spirkl (NSF Postdoctoral Fellow, 2018–2019).

– **Graduate Students**: Quentin Dubroff (2020–Present, with J. Kahn), Corrine Yap (2019–2023).

– **Undergraduate Students (summer research)**: Ondřej Chwiedziuk, Tomáš Čížek, Vova Kuznetsov, Ondřej Sladký (2023); Aaditya Raghavan (2021); Filip Čermák, David Fitzpatrick, Jakub Gubáš, Lenka Kopfova, Radek Olsak (2020); Mikhail Beliayeu, Petr Chmel, Adam Jamil, Jan Petr, Tony Zheng (2019).

Service

– **Committees**: Appointments and Promotions Committee, School of Arts and Sciences, Rutgers (2023); Hiring Committee, Maths Department, Rutgers (2020–2022); Graduate Admissions Committee, Maths Department, Rutgers (2019); REU Committee, DIMACS (2018–2020).

– **Editorial Boards**: Combinatorial Theory (2023–2026).

– **Refereeing**: Annals of Mathematics; Journal of the AMS; Advances in Mathematics; Proceedings and Transactions of the AMS; International Mathematics Research Notices; Discrete Analysis; Journal of Combinatorial Theory, Series A and Series B; Combinatorica; Random Structures and Algorithms; Combinatorics, Probability and Computing.

Recent Talks

– *Random Reconstruction in Two Dimensions*, Discrete Mathematics Seminar, MIT, 11/2023.

– *Antichain codes*, Bollobás–Gowers–Leader Birthday Conference, Cambridge, 7/2023.

– *Antichain codes*, Colloquium, University of Illinois, Chicago, 1/2023.

– *Friendly bisections of random graphs*, Atlanta Colloquium, Georgia Tech–Emory, 10/2022.

– *Down-set thresholds*, Combinatorics Meeting, Oberwolfach, 4/2022.

– *Probabilistic Bézout and its applications*, Colloquium, Emory, 2/2022.

– *Probabilistic Bézout and its applications*, IAS Seminar, Princeton, 2/2022.

– *Finding homeomorphs*, PIMS-UVic Discrete Mathematics Seminar, University of Victoria, 1/2021.

– *The threshold for the square of the Hamilton cycle*, Probabilistic Combinatorics Conference, MIPT, Moscow, 9/2020.
– *Thresholds*, Discrete Mathematics and Probability Seminar, Oxford, 4/2020.
– *Thresholds*, Berlin Colloquium, TU Berlin–FU Berlin–HU Berlin, 1/2020.
– *Intersecting families of vectors*, Combinatorics Meeting, Oberwolfach, 1/2020.
– *Intersecting families, product spaces and thresholds*, Combinatorics Seminar, Stanford, 10/2019.
– *Disproportionate division*, Geometry Seminar, Courant, 10/2019.
– *Disproportionate division*, Combinatorics Meeting, BIRS, Banff, 9/2019.
– *Disproportionate division*, Brazilian Mathematical Colloquium, IMPA, 8/2019.
– *Exceptional graphs for the random walk*, Horowitz Seminar, Tel Aviv University, 6/2019.
– *Exceptional graphs for the random walk*, Colloquium, University of Illinois, 3/2019.
– *Coalescence on the real line*, Mathematical Physics Seminar, Rutgers, 11/2018
– *Exceptional graphs for the random walk*, Discrete Mathematics Seminar, MIT, 10/2018.
– *Exceptional graphs for the random walk*, Discrete Mathematics Seminar, Yale, 10/2018.
– *Symmetric intersecting families*, ICM Combinatorics Meeting, São Paulo, 7/2018
– *Symmetric intersecting families*, Atlanta Lecture Series, Georgia Tech–Emory, 4/2018.
– *Hamiltonian surfaces in 3-graphs*, Discrete Mathematics Seminar, Princeton, 2/2018.
– *Hamiltonian surfaces in 3-graphs*, Probabilistic and Extremal Combinatorics Conference, CMSA, Harvard, 2/2018.

Teaching

– Recent Developments in Graph Theory, Graduate course, Rutgers, 2022–2023.
– Recent Developments in Discrete Mathematics, Graduate course, Rutgers, 2022–2023.
– Combinatorics I, Graduate course, Rutgers, 2022–2023.
– Combinatorics II, Graduate course, Rutgers, 2021–2022.
– Combinatorics I, Graduate course, Rutgers, 2021–2022.
– Additive Combinatorics, Rutgers, 2020–2021.
– Putnam Problem Solving Seminar, Rutgers, 2020–2021.
– Combinatorics II, Graduate course, Rutgers, 2019–2020.
– Combinatorics, Undergraduate course, Rutgers, 2019–2020.
– Linear Algebra, Undergraduate course, Rutgers, 2019–2020.
– Methods in Combinatorics, Graduate course, Rutgers, 2018–2019.
– Graph Theory, Undergraduate course, Rutgers, 2018–2019.
– Putnam Problem Solving Seminar, Rutgers, 2018–2019.
– Topics in Graph Theory, Graduate course, Rutgers, 2017–2018.
– Combinatorics, Undergraduate course, Rutgers, 2017–2018.

– Ramsey Theory, Part III course, Cambridge, 2016–2017.

– Topics in Ramsey Theory, Part III Graduate course, Cambridge, 2015–2016.

List of Publications

– Threshold Phenomena

1. *A counterexample to directed-KKL*, 2022, Submitted. With Quentin Dubroff and Shivam Nadimpalli.
https://arxiv.org/abs/2210.02035
2. *Down-set thresholds*, 2021, **Random Structures & Algorithms**, to appear. With Benjamin Gunby and Xiaoyu He.
http://doi.org/10.1002/rsa.21148
3. *The threshold for the square of a Hamilton cycle*, 2020, **Proceedings of the American Mathematical Society**, 149. With Jeff Kahn and Jinyoung Park.
https://doi.org/10.1090/proc/15419
4. *Thresholds versus fractional expectation-thresholds*, 2019, **Annals of Mathematics**, 194. With Keith Frankston, Jeff Kahn and Jinyoung Park.
https://doi.org/10.4007/annals.2021.194.2.2
5. *Sharp thresholds for nonlinear Hamiltonian cycles in hypergraphs*, 2019, **Random Structures & Algorithms**, 57. With Mathias Schacht.
https://doi.org/10.1002/rsa.20919

– Topological Combinatorics

6. *Simplicial homeomorphs and trace-bounded hypergraphs*, 2020, **Discrete Analysis**, 2022:6. With Jason Long and Corrine Yap.
https://doi.org/10.19086/da.36647
7. *A universal exponent for homeomorphs*, 2020, **Israel Journal of Mathematics**, 243. With Peter Keevash, Jason Long and Alex Scott.
https://doi.org/10.1007/s11856-021-2156-7
8. *Disproportionate division*, 2019, **Bulletin of the London Mathematical Society**, 52. With Logan Crew and Sophie Spirkl.
https://doi.org/10.1112/blms.12368
9. *Spanning surfaces in 3-graphs*, 2018, **Journal of the European Mathematical Society**, 24. With Agelos Georgakopoulos, John Haslegrave and Richard Montgomery.
https://doi.org/10.4171/JEMS/1101

– Extremal Set Theory

10. *Antichain codes*, 2022, **Bulletin of the London Mathematical Society**, to appear. With Benjamin Gunby, Xiaoyu He and Sam Spiro.
https://doi.org/10.1112/blms.12909
11. *On symmetric intersecting families of vectors*, 2019, **Combinatorics, Probability and Computing**, 30. With Sean Eberhard, Jeff Kahn and Sophie Spirkl.
https://doi.org/10.1017/S0963548321000079

12. *On symmetric intersecting families*, 2018, **European Journal of Combinatorics**, 86. With David Ellis and Gil Kalai.
https://doi.org/10.1016/j.ejc.2020.103094

13. *On regular 3-wise intersecting families*, 2017, **Proceedings of the American Mathematical Society**, 146. With Keith Frankston and Jeff Kahn.
https://doi.org/10.1090/proc/14153

14. *On symmetric 3-wise intersecting families*, 2016, **Proceedings of the American Mathematical Society**, 145. With David Ellis.
https://doi.org/10.1090/proc/13452

– **Statistical Physics**

15. *Diffusion on graphs is eventually periodic*, 2017, **Journal of Combinatorics**, 10. With Jason Long.
https://doi.org/10.4310/JOC.2019.v10.n2.a3

16. *Coalescence on the real line*, 2016, **Transactions of the American Mathematical Society**, 371. With Paul Balister, Béla Bollobás and Jonathan Lee.
https://doi.org/10.1090/tran/7391

17. *Line percolation*, 2015, **Random Structures & Algorithms**, 52. With Paul Balister, Béla Bollobás and Jonathan Lee.
https://doi.org/10.1002/rsa.20755

– **Discrete Probability**

18. *Reconstructing random pictures*, 2022, Submitted. With Corrine Yap.
https://arxiv.org/abs/2210.09410

19. *Friendly bisections of random graphs*, 2021, **Communications of the American Mathematical Society**, 2. With Asaf Ferber, Matthew Kwan, Ashwin Sah and Mehtaab Sawhney.
https://arxiv.org/abs/2105.13337

20. *Slowdown for the geodesic-biased random walk*, 2019, **Electronic Communications in Probability**, 24. With Mikhail Beliayeu, Petr Chmel and Jan Petr.
https://doi.org/10.1214/19-ECP276

21. *Exceptional graphs for the random walk*, 2018, **Annales de l'Institut Henri Poincaré**, 56. With Juhan Aru, Carla Groenland, Tom Johnston, Alex Roberts and Alex Scott.
https://arxiv.org/abs/1805.06277

22. *Reconstructing random jigsaws*, 2017, **Multiplex and Multilevel Networks**, Oxford University Press. With Paul Balister and Béla Bollobás.
https://doi.org/10.1093/oso/9780198809456.001.0001

23. *Balancing sums of random vectors*, 2016, **Discrete Analysis**, 2018:4. With Juhan Aru, Alex Scott and Ramarathnam Venkatesan.
https://doi.org/10.19086/da.3108

24. *Connections in randomly oriented graphs*, 2015, **Combinatorics, Probability and Computing**, 27 (Special Oberwolfach Issue).
https://doi.org/10.1017/S0963548316000341

– **Graph Theory**

25. *Subgraphs of large connectivity and chromatic number*, 2020, **Bulletin of the London Mathematical Society**, 54. With António Girão.
https://doi.org/10.1112/blms.12569

26. *Long cycles in Hamiltonian graphs*, 2017, **Israel Journal of Mathematics**, 229. With António Girão and Teeradej Kittipassorn.
https://doi.org/10.1007/s11856-018-1798-6

27. *The number of hypergraphs without linear cycles*, 2017, **Journal of Combinatorial Theory, Series B**, 134. With József Balogh and Jozef Skokan.
https://doi.org/10.1016/j.jctb.2018.07.003

28. *The multiplication table problem for bipartite graphs*, 2014, **Combinatorica**, 37. With Julian Sahasrabudhe and István Tomon.
https://doi.org/10.1007/s00493-016-3322-0

29. *Disjoint induced subgraphs of the same order and size*, 2014, **European Journal of Combinatorics**, 49. With Béla Bollobás, Teeradej Kittipassorn and Alex Scott.
https://doi.org/10.1016/j.ejc.2015.03.005

– **Ramsey Theory**

30. *Turán theorems for unavoidable patterns*, 2019, **Mathematical Proceedings of the Cambridge Philosophical Society**, 172. With António Girão.
https://doi.org/10.1017/S030500412100027X

31. *An improved lower bound for Folkman's theorem*, 2017, **Bulletin of the London Mathematical Society**, 49. With József Balogh, Sean Eberhard, Andrew Treglown and Adam Wagner.
https://doi.org/10.1112/blms.12058

32. *Induced subgraphs with many distinct degrees*, 2016, **Combinatorics, Probability and Computing**, 28. With István Tomon.
https://doi.org/10.1017/S0963548317000256

33. *Ramsey graphs induce subgraphs of many different sizes*, 2016, **Combinatorica**, 39. With Julian Sahasrabudhe and István Tomon.
https://doi.org/10.1007/s00493-017-3755-0

34. *Approximations to m-coloured complete infinite hypergraphs*, 2013, **Journal of Graph Theory**, 80. With Teeradej Kittipassorn.
http://doi.org/10.1002/jgt.21853

35. *A canonical Ramsey theorem for exactly m-coloured complete subgraphs*, 2013, **Combinatorics, Probability and Computing**, 23. With Teeradej Kittipassorn.
https://doi.org/10.1017/S0963548313000503

36. *Exactly m-coloured complete infinite subgraphs*, 2013, **Journal of Combinatorial Theory, Series B**, 106.
https://doi.org/10.1016/j.jctb.2014.01.008

– **Extremal Combinatorics**

37. *Counting independent sets in regular hypergraphs*, 2020, **Journal of Combinatorial Theory, Series A**, 180. With József Balogh and Béla Bollobás.
https://doi.org/10.1016/j.jcta.2021.105405

38. *Product-free sets in the free semigroup*, 2018, **European Journal of Combinatorics**, 83. With Imre Leader, Shoham Letzter and Mark Walters.
https://doi.org/10.1016/j.ejc.2019.103003

39. *Catching a fast robber on the grid*, 2015, **Journal of Combinatorial Theory, Series A**, 152. With Paul Balister, Béla Bollobás and Amy Shaw.
https://doi.org/10.1016/j.jcta.2017.06.009

40. *Transference for the Erdős–Ko–Rado theorem*, 2014, **Forum of Mathematics, Sigma**, 3. With József Balogh and Béla Bollobás.
https://doi.org/10.1017/fms.2015.21

41. *On the stability of the Erdős–Ko–Rado theorem*, 2014, **Journal of Combinatorial Theory, Series A**, 137. With Béla Bollobás and Andrei Raigorodskii.
https://doi.org/10.1016/j.jcta.2015.08.002

42. *Separating path systems*, 2013, **Journal of Combinatorics**, 5. With Victor Falgas-Ravry, Teeradej Kittipassorn, Dániel Korándi and Shoham Letzter.
https://doi.org/10.4310/JOC.2014.v5.n3.a4

– **Theoretical Computer Science**

43. *Applications of random algebraic constructions to hardness of approximation*, 2021, **Israel Journal of Mathematics**, to appear, (extended abstract in **FOCS**, 62). With Boris Bukh and Karthik C. S.
https://doi.ieeecomputersociety.org/10.1109/FOCS52979.2021.00032

44. *Coppersmith's lattices and focus groups: an attack on small-exponent* RSA, 2020, **Journal of Number Theory**, 222. With Steve Miller and Ramarathnam Venkatesan
https://doi.org/10.1016/j.jnt.2021.01.002