Hemanshu Kaul

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Professional Experience and Education

Associate Professor, Fall 2012 - present
Assistant Professor, Fall 2006 - Spring 2012
Department of Applied Mathematics, Illinois Institute of Technology, Chicago.

Co-Director, Computational Decision Science and Operations Research (CDSOR) Program, Illinois Institute of Technology, 2015 - present.

Ph.D. Mathematics, University of Illinois at Urbana-Champaign, 2006.
Topics in Stochastic Combinatorial Optimization and Extremal Graph Theory
Advisors: Professors Sheldon H. Jacobson and Douglas B. West
Research Assistant, Simulation and Optimization Laboratory, UIUC, 2001 - 2006.

M.Sc. Mathematics, Indian Institute of Technology, Bombay, 1999.

Recognition and Support

Over 29 invited talks in conferences in USA, Canada, and South Korea, including 6 international conferences, 16 AMS and SIAM meetings, and 6 one-hour plenary talks.

Over 40 invited colloquium and seminar talks in universities in USA, Canada, South Korea, China, and India.

Invited as an expert external examiner for 9 PhD theses at universities in the USA, India, and Singapore.

Board of Trustees Award for Excellence in Teaching 2019, University-wide award, Illinois Tech.

Excellence in Teaching Award 2017, College of Science, Illinois Tech.

Distinguished Teaching Fellow, College of Science, Illinois Tech, 2016-2019.

NSF grant 1559606, Extremal Combinatorics at Illinois III Conference, **PI**, $32400, 2016-17.

NSA grant H98230-16-1-0056, Extremal Combinatorics at Illinois III Conf., **PI**, $24900, 2016-17.

Invited Visiting Faculty, Gwangju Institute of Science and Tech, South Korea, Nov 2013.

Invited Visiting Faculty, Center for Discrete Math, Zhejiang Normal Univ, China, Oct 2013.

ERIF funding award for an interdisciplinary project in Transportation Networks with collaborators in Computer Science, and Transportation Engineering, Illinois Tech, 2009-2010.

AMS Project NExT Fellow, Mathematical Association of America, 2007-2008, selected as one of the six fellows of the American Mathematical Society for this professional development program of the MAA on instruction, advising, research, and academic citizenship.

Inter-disciplinary Research Award and Travel Grant, Applied Mathematics Program, University of Illinois at Urbana-Champaign, Spring 2006.

Invited to propose, develop, and teach, a new graduate course in advanced combinatorics, Department of Mathematics, University of Illinois at Urbana-Champaign, Fall 2005.

Fellowship for Academic Excellence, National Board for Higher Mathematics, India, 1997-1998 and 1998-1999.

Research Interests

Discrete Mathematics, especially Graph Theory, Network Optimization, and related models, algorithms, and interdisciplinary applications in transportation networks and computer science. Also, ethical aspects of mathematical and optimization models, and particularly in equitable allocation of resources. Recent topics include: Enumerative and extremal problems in chromatic graph theory, including algebraic and probabilistic methods and perspectives; Models and algorithms for equitable allocation of resources and for interdependent networks.

Publications

Some Highlights:
- 48 papers published or under review in leading international journals in combinatorics, discrete math, optimization, and algorithms, including Advances in Applied Mathematics, Algorithmica, Combinatorica, Combinatorics, Probability and Computing, European J. of Combinatorics, European J. of Operational Research, J. of Combinatorics, J. of Graph Theory, Mathematical Programming, Random Stuctures & Algorithms, and SIAM Journal on Discrete Mathematics.
- 7 papers have at least one undergraduate student co-author, and 18 papers have at least one graduate student co-author.
- Select papers' contributions are highlighted below.

Book

- *Advances in Interdisciplinary Applied Discrete Mathematics*, (co-editor with H.M. Mulder), Interdisciplinary Mathematical Sciences, Volume 11, World Scientific Publishing, 2010, 275pp.

Publications and Preprints[†]

- *On a Spectral Turán Problem for a Fixed Tree*, (with D. Desai and B. Kudarzi[g]), submitted for publication.

  Results on spectral radius and extremal graphs for family of n-vertex graphs forbidden to have a fixed tree T, that generalize the seminal results of Nikiforov (2010) and go beyond the recently proved Spectral Erdös-Sós conjecture.

- *Shameful Inequalities for List and DP Colorings of Graphs*, (with J. Mudrock and G. Sharma[g]), submitted for publication.

  Extends the Shameful conjecture for chromatic polynomial (proved in 2000) to the context of enumerative functions for list colorings and DP-colorings.

- *Counting List Colorings of Unlabeled Graphs*, (with J. Mudrock), submitted for publication.

  Extends Hanlon's work (1985) on chromatic polynomial for unlabeled graphs to the context of list color function, and lays foundation for comparing these two enumerative functions for unlabeled graphs.

- *A Polynomial Method for Counting Colorings of Sparse Graphs*, (with S. Dahlberg and J. Mudrock), submitted for publication.

  Gives a simple algebraic tool, as opposed to ad hoc arguments, for proving exponentially many colorings for many notions of coloring, including DP colorings and signed colorings, in the general framework of S-labeled graphs.

- *On strongly and robustly critical graphs*, (with A. Bernshteyn, J. Mudrock, G. Sharma[g]), sub-

[†] Next to an author name, superscript of g, resp. u, indicates a graduate student, resp. undergraduate student, coauthor at the time of writing the paper

mitted for publication.

Extends the notions of criticality for understanding chromatic choosability (from 2009 and 2021) to the context of DP-coloring.

- *Counting Packings of List Colorings of Graphs*, (with J. Mudrock), submitted for publication.

  Shows the enumerative function for counting multiple pairwise disjoint list colorings asymptotically equals the corresponding enumerative function for ordinary colorings, a generalization of a long series of results on list color function going back to Donner (1992) that answered a question of Kostochka and Sidorenko (1990).

- *DP-Coloring of Graphs from Random Covers*, (with A. Bernshteyn, D. Dominik[g], J.Mudrock), Random Structures & Algorithms, to appear, 2025.

  Initiates the study of DP-coloring from random covers (or equivalently, independent transversals in random-lifts, introduced and studied since 2000) and proves a threshold behavior in terms of max density of the given graph.

- *Flexible List Colorings: Maximizing the Number of Requests Satisfied*, (with R. Mathew, J. Mudrock, M. Pelsmajer), J. of Graph Theory, 106 (2024), 887-906.

  Improves previous results by guaranteeing a larger proportion of requested colors are satisfied, and lays the foundation for study of the largest possible such proportion (shown to be reciprocal of the Hall ratio) with new techniques and many conjectures.

- *The DP Color Function of Clique-Gluings of Graphs*, (with M. Maxfield[u], J. Mudrock, S. Thomason[u]), Enumerative Combinatorics and Applications, 4 (2024), article S2R11.

  Resolves questions of Dong and Yang (2021) on whether DP-color function of clique gluings of graphs has similar behavior as chromatic polynomial.

- *An Algebraic Approach for Counting DP-3-colorings of Sparse Graphs*, (with S. Dahlberg and J. Mudrock), European Journal of Combinatorics, 118 (2024), article 103890.

  Designs a polynomial whose non-zeros in a grid capture the DP-3-colorings of a graph, so that Alon and Furedi's enumerative version of the Combinatorial Nullstellensatz guarantees exponentially many such colorings for sparse graphs.

- *An Improved Algorithm for Finding Maximum Outerplanar Subgraphs*, (with Gruia Calinescu, and Bahareh Kudarzi[g]), Discrete Applied Mathematics, 342 (2024), 207-217.

  Current best approximation ratio for the NP-hard maximum outerplanar subgraph problem.

- *On Polynomial Representations of the DP Color Function: Theta Graphs and Their Generalizations*, (with C. Halberg[u], A. Liu[u], J. Mudrock, P. Shin[u], S. Thomason[u]), Journal of Combinatorics, 15 (2024), 451-478.

  Builds evidence towards the conjecture that the DP color function asymptotically equals a polynomial (not necessarily the chromatic polynomial).

- *On the List Color Function Threshold*, (with A. Kumar[u], J. Mudrock, P. Rewers[u], P. Shin[u], K. To[u]), J. of Graph Theory, 105 (2024), 386-397.

  Disproves a conjecture of Thomassen (2009) that asked whether the list color function equals the chromatic polynomial always when number of colors is larger than the list chromatic number by a constant.

- *A Note on Fractional DP-Coloring of Graphs*, (with D. Dominik[g], J. Mudrock), Discrete Mathematics, 347 (2024), article 114123.

- *Bounding the List Color Function Threshold from Above*, (with A. Kumar[u], A. Liu[u], J. Mudrock, P. Rewers[u], P. Shin[u], M.S. Tanahara[u], K. To[u]), Involve, 16 (2023), 849-882.

- *Longitudinal network models and permutation-uniform Markov chains*, (with W. Schwartz[g], and S. Petrovic), Scandinavian Journal of Statistics, 50 (2023), 1201-1231.

  Models longitudinal network data, including exponential random graph models (ERGMs), that vary according to certain discrete-time Markov chains, by combining ideas from Markovian exponential families, permutation-uniform Markov chains, various (temporal) ERGMs, and statistical notions of dyadic independence and exchangeability.

- *Non-chromatic-adherence of the DP Color Function via Generalized Theta Graphs*, (with M. Bui[u], M. Maxfield[u], J. Mudrock, P. Shin[u], S. Thomason[u]), Graphs and Combinatorics, 39 (2023), article 42.

- *DP-Coloring the Cartesian Product of Graphs*, (with J. Mudrock, G. Sharma[g], Q. Stratton[g]), J. of Graph Theory, 103 (2023), 285-306.

  Uses DP color function, the DP analogue of the chromatic polynomial, with proabailistic arguments to study the DP-chromatic number of the Cartesian product of graphs, extending the classical result on the gap between list chromatic number and chromatic number.

- *A Generalization of the Graph Packing Theorems of Sauer-Spencer and Brandt*, (with B. Reiniger), Combinatorica, 42 (2022), 1347-1356.

  A degree sequence based generalization of the celebrated Sauer-Spencer packing theorem (1978) which also captures Brandt's tree packing theorem (1994) leading to the characterization of its extremal graphs.

- *A Linear Input Dependence Model for Interdependent Networks*, (with A. Rumpf[g]), European Journal of Operational Research, 302 (2022), 781-797.

  Extends the classic, and efficient, Network Simplex algorithm to the setting of interdependent networks by giving a combinatorial characterization of the basis in this generalized setting.

- *The DP Color Function of Joins and Vertex-Gluings of Graphs*, (with J. Becker[u], J. Hewitt[u], M. Maxfield[u], J. Mudrock, D. Spivey[u], S. Thomason[u], T. Wagstrom[u]), Discrete Mathematics, 345 (2022), article 113093.

- *Equitable Choosability of Disjoint Unions of Stars*, (with J. Mudrock, T. Wagstrom[u]), Graphs and Combinatorics, 38 (2022), article 163.

- *Network Design of Public Transit with Social Access Objectives*, (with A. Rumpf[g]), EAAMO '21: ACM Conference on Equity and Access in Algorithms, Mechanisms, and Optimization 2021, Article 16, 2021, 1-17.

  A flexible public transit network design model which guarantees equitable accessibility to social resources while ensuring that the system costs and transit times remain within a preset margin of their current levels. Accepted after a competitive process to this ACM conference.

- *On Equitable List Arboricity of Graphs*, (with J. Mudrock, M. Pelsmajer),The Australasian J. of Combinatorics, 80 (2021), 419-441.

- *On the Chromatic Polynomial and Counting DP-Colorings*, (with J. Mudrock), Advances in Applied Mathematics, 123 (2021), article 102131.

  Introduces and lays the foundations of study of DP-color function, a DP-coloring enumerative function, including the fundamental question of how it compares to the chromatic polynomial. Listed as a top eight cited paper in this leading journal in algebraic combinatorics, since 2021.

- *Partial DP-Coloring of Graphs*, (with J. Mudrock, M. Pelsmajer), Discrete Mathematics, 344 (2021), article 112306.
- *Criticality, The List Color Function, and List Coloring the Cartesian Product of Graphs*, (with J. Mudrock), J. of Combinatorics, 12 (2021), 479-514.

  First of a series of our papers that for a notion of coloring beyond ordinary coloring such as list coloring in this paper, relate notions of graph criticality with the enumerative functions of colorings, to answer questions about the corresponding chromatic number.

- *Combinatorial Nullstellensatz and DP-Coloring of Graphs*, (with J. Mudrock), Discrete Mathematics, 343 (2020), article 112115.

  Initiates the study of applying the Combinatorial Nullstellensatz to DP-coloring of graphs even though unlike list coloring, the Alon-Tarsi theorem does not apply to DP-coloring.

- *A Simple Characterization of Proportionally 2-Choosable Graphs*, (with J. Mudrock, M. Pelsmajer, R. Reiniger), Graphs and Combinatorics, 36 (2020), 679-687.
- *A Note on the Chromatic Number of the Square of Kneser Graph $K(2k+1,k)$*, (with JH. Kang), Discrete Mathematics, 343 (2020), article 111630.

  Best result towards a question of Furedi (2002) on chromatic number of the square of Kneser graph $K(2k+1,k)$ that asymptotically matches the conjectured value.

- *List Coloring a Cartesian Product with a Complete Bipartite Factor*, (with J. Mudrock), Graphs and Combinatorics, 35 (2019), 1571-1583.
- *Proportional Choosability: a new list analogue of equitable coloring*, (with J. Mudrock, M. Pelsmajer, R. Reiniger), Discrete Mathematics, 342 (2019), 2371-2383.

  A new notion of list equitable coloring that, unlike equitable coloring and equitable choosability, is monotonic in number of colors and montone under the subgraph relation.

- *On Alon-Tarsi Number and Chromatic-choosability of Cartesian Products of Graphs*, (with J. Mudrock, The Elect. Journal of Combinatorics, 26 (2019), article P1.3.

  A proof in this paper has been featured in two graduate textbooks by Xuding Zhu on Combinatorial Nullstellensatz and by Dan Cranston on methods for graph coloring.

- *On Graph Fall-Coloring – Existence and Constructions*, (with C. Mitillos), Graphs and Combinatorics, 35 (2019), 1633-1646.

  Construction of graphs with Fall-sets, all k s.t. the graph is k-Fall colorable, that are arbitrarily long arithmetic progressions with any prescribed common difference, giving a very general solution to a question of Dunbar et al. (2000).

- *Total Equitable Choosability of Graphs*, (with J. Mudrock, M. Pelsmajer), Graphs and Combinatorics, 34 (2018), 1637-1649.
- *On Graph Fall-Coloring – Operators and Heredity*, (with C. Mitillos, Journal of Combinatorial Mathematics and Combinatorial Computing, 106 (2018), 125-151.
- *New Methodology for Transportation Investment Decisions with Consideration of Project Interdependencies*, (with Z. Li, S. Kapoor, E. Veliou, B. Zhou, C. Lee, Transportation Research Record: J. of the Transportation Research Board of the National Academies, 2285 (2012), 36-46.

  A new model for calculating benefits of projects from standard additive measure to a new (Hyper)graph Knapsack Problem based measure and its computationally effective implementation.

- *Packing of Graphic n-tuples*, (with A. Busch, M. Ferrara, S. Hartke, M.S. Jacobson, D.B. West), Journal of Graph Theory, 70 (2012), 29-39.

  Proves the counterpart of the classic Sauer-Spencer packing theorem (1978) for graphic sequences, and a generalization of Kundu's k-factor theorem (1973) that partly answers a conjecture of Brualdi (1976).

- *Maximum Series-Parallel Subgraph: Approximation Algorithms*, (with G. Calinescu, C.G. Fernandes, A. Zelikovsky), Algorithmica, 63 (2012), 137-157.
  A short refereed conference version in: Graph-Theoretic Concepts in Computer Science 2009, Lecture Notes in Computer Science, 5911 (2010), 54-65.

  First non-trivial approximation ratio bound for the NP-hard max series-parallel subgraph problem that is still the best known ratio.

- *Reductions for the Stable Set Problem*, (with E.C. Sewell, S.H. Jacobson), Algorithmic Operations Research, 6 (2011), 40-55.

- *Distinguishing Chromatic Number of Cartesian Products of Graphs*, (with J. Choi[g] and S. Hartke), SIAM Journal on Discrete Mathematics, 24 (2010), 82-100.

  Builds methods to prove general results for (close to) optimal proper coloring of a graph that breaks all its non-trivial automorphisms.

- *Long Local Searches for Large Bipartite Subgraphs*, (with D.B. West), SIAM Journal on Discrete Mathematics, 22 (2008), 1138-1144.

  Answers questions of Cowen and West (2002) by giving bounds, that are still the best known, on the worst number of greedy flips needed to get a large bipartite subgraph.

- *On a Graph Packing Conjecture of Bollobás, Eldridge, and Catlin*, (with A. Kostochka, G. Yu), Combinatorica, 28 (2008), 469-485.

  This is still the best general result towards the famous Bollobás-Eldridge conjecture of 1978.

- *Analyzing the Performance of Simultaneous Generalized Hill Climbing Algorithms*, (with D.E. Vaughan, S.H. Jacobson), Computational Optimization and Applications, 37 (2007), 103-119.

- *Extremal Graphs for a Graph Packing Theorem of Sauer and Spencer*, (with A. Kostochka), Combinatorics, Probability and Computing, 16 (2007), 409-417.

  An extension of the celebrated result of Sauer and Spencer (1978).

- *New Global Optima Results for the Kauffman NK Model: Handling Dependency*, (with S.H. Jacobson), Mathematical Programming, 108 (2006), 475-494.

  Equitable coloring of a dependency graph of random variables is used to generalize to this setting the classic bound of Arnold and Groenveld (1979) on expectation of order statistics, and applied to the stochastic combinatorial optimization model under study.

- *Global Optima Results for the Kauffman NK Model*, (with S.H. Jacobson), Mathematical Programming, 106 (2006), 319-338.

Invited Conference and Seminar Talks

Some Highlights:
- Over 29 invited talks in conferences in USA, Canada, and South Korea, including 6 international conferences, 16 AMS and SIAM meetings, and 6 one-hour plenary talks.
- Over 40 invited colloquium and seminar talks in universities in USA, Canada, South Korea, China, and India.

Computer Science Seminar, Indian Institute of Technology, Hyderabad, India, May 2025.

Graph Theory and Combinatorics Seminar, U. of Illinois at Urbana-Champaign, April 2025.

Topology and Combinatorics Seminar, Ajou U., South Korea, May 2024.

GIST College Colloquium, Gwangju Inst of Science and Tech, South Korea, May 2024.

Graph Theory Seminar, Konkuk U., South Korea, May 2024.

Graph Theory and Combinatorics Seminar, U. of Illinois at Urbana-Champaign, April 2024.

Graph Theory Seminar, U. of Central Florida, Feb 2024.

International Conference on Graph Theory and its Applications, Amrita University, India, Dec 2023, Plenary speaker. (Declined due to travel constraints.)

Combinatorics and Graph Theory Seminar, Georgia Tech, Nov 2023.

Special Session on Topics in Combinatorics and Graph Theory, AMS Eastern meeting, SUNY Buffalo, Sept 2023.

Invited session on Generalizations of Chromatic Polynomial, Canadian Discrete and Algorithmic Mathematics Conference, CanaDAM 2023, Winipeg, June 2023.

Special Session on Advanced Topics in Graph Theory and Combinatorics, AMS SouthEastern meeting, Georgia Tech, Mar 2023.

Combinatorics and Graph Theory Seminar, Michigan State U., Feb 2023.

Graph Theory and Combinatorics Seminar, U. of Illinois at Urbana-Champaign, April 2022.

Discrete Mathematics Seminar, U. of British Columbia, Canada, February 2022.

ARCSIN (Algebra, Representations, Combinatorics and Symmetric functions in INdia) Seminar, Indian Institute of Science, Bangalore, January 2022.

PyData Chicago Colloquium, Chicago, December 2021.

GIST College Colloquium, Gwangju Institute of Science and Technology, South Korea, Dec 2021.

Mathematics Colloquium, U. of Colorado Denver, September 2021.

SoReMo (Socially Responsible Modeling and Design) Colloquium, Chicago, September 2021.

Graph Theory and Combinatorics Seminar, Illinois State University, Normal, October 2020.

Mathematics Colloquium, Indraprastha Institute of Information Technology, Delhi, India, July 2020.

Special Session on Topics in Extremal Problems and Structural Graph Theory, AMS Western Meeting, U. of California Riverside, October 2019. (Cancelled)

Graph Theory and Combinatorics Seminar, Illinois State University, Normal, April 2019.

Special Session on Recent Developments in Graph Theory, AMS Southeastern Meeting, Auburn U., March 2019.

Special Session on Extremal and Probabilistic Combinatorics, AMS Central Meeting, U. of Michigan, Ann Arbor, October 2018.

Combinatorics Seminar, U. of Illinois at Chicago, October 2018.

International Workshop on Graph Theory, Ewha Women's U., Seoul, South Korea, Jan 2018.

Graph Theory and Combinatorics Seminar, U. of Illinois at Urbana-Champaign, October 2017.

GIST College Colloquium, Gwangju Inst of Science and Tech, South Korea, July 2017.

Special Session on Extremal, Probabilistic, and Structural Graph Theory, AMS Central Meeting, Indiana U., Bloomington, April 2017.

Discrete Mathematics Seminar, U. of West Georgia, January 2017.

Special Session on Extremal and Probabilistic Combinatorics, AMS Central Meeting, U. of Minnesota, Minneapolis, October 2016.

Special Session on Extremal Graph Theory, AMS Central Meeting, ND State U., Fargo, April 2016.

Special Session on Recent Advances in Graphs and Matroids, AMS Central Meeting, Loyola U., Chicago, October 2015.

Special Session on Graphs, Hypergraphs, and Set Systems, AMS Central Meeting, Loyola U., Chicago, October 2015.

GIST Workshop and Conference on Graph Theory, Gwangju Inst of Science and Tech, South Korea, July 2015.

Special Session on Graph and Hypergraph Theory, AMS Central Meeting, U. of Wisconsin, Eau Claire, September 2014.

Chicago Area SIAM Student Conference, Northwestern U., April 2014. (1-hour Plenary talk)

Mathematics Colloquium, National Institute of Mathematical Sciences, South Korea, November 2013.

KAIST Discrete Math Seminar, Korea Advanced Institute of Science and Technology, South Korea, November 2013.

GIST College Colloquium, Gwangju Inst. of Science and Tech., South Korea, November 2013.

60th KPPY Combinatorics Workshop, Kyungpook National U., South Korea, November 2013. (1-hour Plenary Talk)

Discrete Math Seminar, Yeungnam U., South Korea, November 2013.

Discrete Math Colloquium, Zhejiang Normal U., China, October 2013.

Special Session on Graph Theory, AMS-MAA Joint Math Meetings, San Diego, CA, January 2013.

Seminar on Computational Transportation Science, U. of Illinois, Chicago, March 2012.

Mathematics Colloquium, U. of Colorado, Denver, January 2012.

Special Session on Extremal and Probabilistic Combinatorics, AMS Central Meeting, U. of Nebraska, Lincoln, October 2011.

Special Session on Graph Theory, AMS Central Meeting, U. of Iowa, Iowa City, March 2011.

40th Kyungpook National U.-Pusan National U.-Pohang Math Institute Joint Symposium on Combinatorics, Daegu, South Korea, June 2010. (1-hour Plenary Talk)

Discrete Mathematics Seminar, U. of Colorado, Denver, June 2010.

Special Session on Graph Theory, AMS Eastern Meeting, Rutgers U., NJ, May 2010.

Mathematics Colloquium, U. of Nebraska, Lincoln, NE, February 2010.

Special Session on Graph Theory, AMS Southeastern Meeting, Boca Raton, FL, October 2009.

Mathematics Colloquium, Iowa State U., Ames, March 2008.

SIAM Minisymposium on Graph Coloring and Partitioning, AMS-MAA Joint Mathematics Meetings, San Diego, CA, January 2008.

Mathematics Colloquium, U. of Illinois, Chicago, April 2007.

86th Annual Meeting of the Illinois Section of the Mathematical Association of America, Western Illinois U., Macomb, March 2007. (1-hour Plenary Talk)

13th SIAM Conference on Discrete Mathematics, Victoria, British Columbia, Canada, June 2006.

DIMACS/DIMATIA/Renyi Combinatorial Challenges Meeting, DIMACS Center, Rutgers U., New Jersey, April 2006.

Mathematics Colloquium, U. of Dayton, February 2006.

Mathematics Colloquium, Western Washington U., January 2006.

Mathematics Colloquium, Southern Illinois U., January 2006.

Mathematics Colloquium, U. of Central Florida, Orlando, November 2005.

Applied Math Seminar, Illinois Institute of Technology, Chicago, October 2005.

Mathematics and Engineering Colloquium, U. of Georgia, Athens, March 2005.

Applied Math Colloquium, Illinois Institute of Technology, Chicago, March 2005.

Industrial Engineering Colloquium, U. of Minnesota, Minneapolis-St.Paul, February 2005.

Graph Theory and Combinatorics Seminar, UIUC, March 2005; March 2004; April 2003.

Nonlinear Dynamics and Complex Systems Seminar, Dept. of Physics, UIUC, December 2004.

Discrete Math Seminar, U. of Central Florida, Orlando, November 2004.

Student Advising and Mentorship

Some Highlights:

- Advisor to 8 PhD students graduated from 2015 to 2025 with another expected to graduate in 2026.
- Invited as an expert external examiner for 9 PhD theses at universities in the USA, India, Singapore.
- Research advisor to 6 graduated M.S. students, and 1 current MS student.
- 8 B.S. and M.S. students from Illinois Tech who have done research or taken courses in discrete math with me, and otherwise been mentored by me, have gone on to do a PhD in Discrete Math from other universities including UCLA, UIUC, Cornell, etc.
- Conducted research with over 32 undergraduate students from Illinois Tech and other institutions. Several of these students have gone on to PhD programs.
- Illinois Tech team advisor for the Mathematical Contest in Modeling (MCM), the premier math modeling competition with over 10000 teams from around the world, from 2015 onwards.
- Advisor for semester-long team projects each spring semester (2014 onwards) based on open-ended real-world modeling problems to give a comprehensive experience to all applied math majors at Illinois Tech.

Awards to Students

- **Menger Student Award**, Illinois Tech, to my PhD students - Gunjan Sharma (2024), Jeffrey Mudrock (2018).
- **Honorable mention, NSF Graduate Fellowship**, 2016, to my PhD student William Schwartz.
- **Meritorious Winners** in MCM (Mathematical Modeling Contest) 2016 and 2019, awarded to the team of 3 Illinois Tech undergraduates, advised by me, for placing in the 99.5 percentile among 10000+ teams from universities around the world.
- **Outstanding Undergraduate Research in Mathematics** by the Illinois Section of Mathematics Association of America, awarded to my students YoungJu Jo (1st prize) and Chris Mitillos (2nd prize), April 2009.

Ph.D. Students

- *Alaittin Kirtisoglu*, Ph.D. in Applied Math, current (expected to graduate in 2026).
  Network design for equitable allocation of resources.
- *Bahareh Kudarzi*, Ph.D. in Applied Math, graduating in May 2025.
  Spectral and algorithmic problems on graphs.
- *Daniel Dominik*, Ph.D. in Applied Math, graduating in May 2025.
  Random and fractional perspectives on DP-coloring of graphs.
  Continuing as Math faculty, Thornton Township High School, Harvey, IL USA.
- *Gunjan Sharma*, Ph.D. in Applied Math, graduated May 2024.
  Extremal and Enumerative Problems on DP-coloring of Graphs.
  Visiting Assistant Professor of Mathematics and CS, Lake Forest College, IL USA.
- *William Schwartz*, Ph.D. in Applied Math, graduated Dec 2021 (joint adviser Sonja Petrovic).
  Optimization and Statistics on Temporal Network Models.
  Associate Director, Secretariat Economists. Co-founder, Ingraham and Schwartz Auction Advisers.
- *Adam Rumpf*, Ph.D. in Applied Math, graduated May 2020.
  Mathematics of Civil Infrastructure Network Optimization.
  Assistant Professor of Teaching in Applied Math, Florida Polytechnic University, FL USA.

– *Jeffrey Mudrock*, Ph.D. in Applied Math, graduated May 2018.
The List Coloring problem and its Equitable Variants.
Assistant Professor of Mathematics, University of South Alabama, AL USA.

– *Christodoulos Mitillos*, Ph.D. in Applied Math, graduated July 2016.
Fall-Coloring of Graphs.
Lecturer of Mathematics, University of Cyprus, Cyprus.

– *Jinyu Huang*, Ph.D. in Applied Math, graduated July 2015.
Approximation Algorithms for Matroid Optimization.
Assistant Professor of Computer Science, Sichuan University of Science and Engineering, China.

– *Ph.D. Thesis Committee member, Illinois Tech*: Li Zhang (CS, 2025+), Ivan Gvozdanovic (Math, 2024+), Yi Zhang (CS, 2023+), Miles Bakenhus (Math, 2022+), Mohit Hota (CS, 2024), Xiaolang Wang (CS, 2023), Jin Zhang (Chemical Engg., 2019), Praneeth Tota (CS, 2019), Dane Wilburne (Math, 2018), Razane Tajjedine (ECE, 2018), Gergely Balint (Math, 2014), Junghwan Shin (CS 2013), Syed Q. Ahmad (ECE 2013), Brindha Hariharane (CS 2012), Oscar Ortega (Math 2008).

– *Ph.D. Thesis Examiner, External*: Jacob Dunham (Math, U. of Colorado, 2024+), James Anderson (Math, Georgia Tech, 2024), Meiqiao Zhang (Math, Nanyang Tech U., Singapore, 2024), Rebecca Robinson (Math, U. of Colorado Denver, 2021), Lujia Wang (Math, U. of Illinois at Chicago, 2018), Justin Hilyard (Math, U. of Notre Dame, 2014), Rajmonda Caceres (Math and CS, U. of Illinois at Chicago, 2012), B. Bhattacharjya (Math, Indian Institute of Technology, Kanpur, 2009).

M.S. Students

– *Anne Ullyot*, M.Sc. in Applied Math, current.
Working on a graph coloring problem

– *Jason Cho*, M.Sc. in Applied Math, graduated Dec 2023.
Thesis on "Independence And Graphical Models For Fitting Real Data".

– *Christian Tomlins*, M.Sc. in Applied Math, graduated May 2022 (joint adviser Rob Ellis).
Thesis on Distinguishing List Colorings of Graphs.
Analyst at Dept. of Defense.

– *Quinn Stratton*, M.Sc. in Applied Math, graduated May 2020.
Research on DP-Coloring of Cartesian Products of Graphs.
Lecturer of Mathematics at Lewis University.

– *Hongwei Jin*, M.Sc. in Applied Math, graduated May 2015.
Thesis on new stochastic optimization models and algorithms for "Microgrid with Renewable Energy".
PhD in Computer Science at UIC. Researcher at Argonne National Lab.

– *Mary Fidler*, M.Sc. in Applied Math, graduated July 2011.
Thesis on new algorithms for "The Simple Equal Flow Problem On Generalized Networks".
Researcher in New Mexico Consortium for applications of discrete optimization.

– *Joseph Srigiri*, M.Sc. in Applied Math, graduated May 2009.
Thesis on original research in Computational Discrete Geometry and Optimization on "Stochastic Models for the Art Gallery Problem: A Computational Study".
Commodities trader in Finance industry.

– *M.Sc. Thesis Committee member, Illinois Tech*: James Panek (Math 2017), Ben Grimmer (CS 2016), Melinda Bulin (Math 2015), Yunjiao Liu (Math 2014), Lujia Wang (Math 2013), James Williamson (Math 2011), Daniel Tietzer (Math 2011), Hong Liu (Math 2010).

Undergraduate Students

- Undergraduate students advised at Illinois Tech from 2008 to present:
  - *Leonardo Marciaga*, Undergrad in Applied Math, Summer 2024 - present.
    Original research on list coloring of Cartesian product of graphs. Paper to be submitted for publication in Summer 2025.
  - *Illinois Tech Team advisor*, The Mathematical Contest in Modeling (MCM) (2015 to 2022 annually); Kryptos Cryptanalysis Competition (2014, 2015, 2016). Teams were awarded as Meritorious Winners (99.5 percentile) in MCM 2016 and 2019, with Honorable Mention (90 percentile) in MCM 2015, as Amateur Codebreakers in Kryptos 2015 and 2016.
  - *Advisor* for 7-9 different research projects in each Spring semester, 2014 to 2025 (excl. 2020). Research on open-ended real-world problems based on international MCM modeling contests for 10+ weeks. These research experiences form an integral part of education of Applied Math majors at Illinois Tech.
  - *5 CS and Engg. students* from Brazil sponsored by IIE under the BSMP program, Summer 2016. 2 original research projects using data from the City of Chicago to analyze real-world optimization and modeling problems related to transportation projects.
  - *7 Math, CS, and Engg. students* from Brazil sponsored by IIE under the BSMP program, Summer 2017. 3 original research projects on real-world optimization and modeling problems related to transportation projects.
  - *Unsuk Heo*, Undergrad in ECE, Fall 2011.
    Readings and original research in optimization of assignment problems with ordinal preferences.
  - *Cheng Chang*, Undergrad in Applied Math, Summer 2011-Fall 2011.
    Readings and original research in coloring graph tensor products.
  - *Cory Knapp*, Undergrad in Applied Math, Spring 2010 - Summer 2010.
    Original research in Graph Theory on "Fall-coloring"; Supported by a Federal Work Study grant.
  - *Christodoulos Mitillos*, Undergrad in Applied Math and CS, Summer 2008 - Summer 2009.
    Original research in Graph Theory on "On Fall-coloring of Graphs". Awarded Second prize for 'Outstanding Undergraduate Research in Mathematics' by the Illinois Section of Mathematics Association of America, April 2009; Awarded the Illinois Tech College of Science and Letters' Summer Scholarship 2008.
  - *YoungJu Jo*, Undergrad in Applied Math and ECE, Summer 2008 - Summer 2009.
    Original research in Discrete Geometry that improves previous known bounds on a long-standing conjecture on "Guarding Orthogonal Art Galleries with Holes". Awarded First prize for 'Outstanding Undergraduate Research in Mathematics' by the Illinois Section of MAA, April 2009.
  - *Applied Math Freshmen*, Fall 2006 - Fall 2015.
    Projects (expository report including self-discovered proofs and computer code) on topics like 'Theory and Algorithms for Stable Matchings' with groups of 2-3 students.

- Undergraduate students co-advised with J. Mudrock at College of Lake County (CLC) from 2019 to 2022, on research projects on extremal and enumerative problems on list coloring and DP-coloring of graphs, leading to 7 publications :
  - *Jack Becker*, CLC, DePaul U. (MS). Summer 2020 and Spring 2021.
  - *Manh Vu Bui*, CLC. Spring 2021.
  - *Charlie Halberg*, CLC & U. of Utah. Summer 2020.
  - *Jade Hewitt*, CLC & Illinois Tech. Summer 2020.

- *Akash Kumar*, CLC. Fall 2021.
- *Andrew Liu*, Stevenson High School, CLC & MIT. Summer 2020, and Spring 2022.
- *Michael Maxfield*, CLC & U. Wisconsin at Madison. Summer 2020, Fall 2020, Spring 2021.
- *Patrick Rewers*, CLC & Purdue. Summer 2021.
- *Paul Shin*, Stevenson High School, CLC & Dartmouth, U. Chicago (PhD). Summer 2020 and Summer 2021.
- *David Spivey*, CLC. Summer 2020.
- *Michael Tanahara*, CLC. Spring 2022.
- *Seth Thomason*, CLC & Southern Illinois U. Summer 2020, Spring 2021, and Summer 2021.
- *Khue To*, CLC. Fall 2021.
- *Tim Wagstrom*, CLC & UIC, U. Rhode Island (PhD). Fall 2019, Spring 2020, Summer 2020.

High School Students

- *Derek Hardin*, IMSA (Illinois Math and Science Academy), 2010 - 2011
  Original research on the long-standing Hedetniemi-Lovasz Conjecture on coloring tensor product of graphs; Poster and presentation at IMSA Colloquium. Undergrad at MIT.
- *Andrew Liu* and *Paul Shin*, Stevenson High School, 2020-21. See above for their research projects and time-periods. Undergrad at MIT and Dartmouth, respectively.

Teaching and Curriculum Experience

Some Highlights:
- Created a new M.S. program in Operations Research jointly with CS, and modernized the existing M.S. program in Applied Math.
- Created 4 new courses from scratch, and completely revised and updated 6 other courses. These courses range over topics like linear algebra, real analysis, math modeling, optimization, combinatorics, and graph theory.
- Taught 15 different courses over the whole range of the curriculum from first year undergrads to advanced PhD students.
- Given the Board of Trustees Award for Excellence in Teaching 2019, University-wide award (one per year).
- Given the Excellence in Teaching Award 2017 for College of Science (one per year).
- Honored as Distinguished Teaching Fellow, College of Science, (one of total 5 awardees).

Faculty Member, Department of Applied Mathematics, Illinois Tech, Fall 2006 - present.

- Instructor for the following courses: *Introduction to the Profession* (Math 100), *Calculus I* (Math 151), *Calculus II* (Math 152), *Multivariate & Vector Calculus* (Math 251), *Elementary Linear Algebra* (Math 332), *Introduction to Math Modeling* (Math 380), *Real Analysis* (Math 400), *Number Theory* (Math 410), *Applied Abstract Algebra* (Math 430), *Linear Optimization* (Math 435 & 535), *Combinatorics* (Math 453), *Graph Theory and applications* (Math 454 & 553), *Mathematical Modeling* (Math 486 & 522), *Discrete Applied Math I* (Math 553), *Modern Methods in Discrete Applied Math* (Math 554).
- Undergraduate and graduate curriculum development -
  - M.Sc. in *Computational Decision Sciences and Operations Research*, new inter-disciplinary graduate program with CS, developed (with S. Kapoor, CS) in 2014-15, approved in 2015.
  - *M.Sc. program in Applied Math*, modernized and completely restructured in 2018-19 (as chair of the committee), approved in 2019.

– Particular courses like:

Introduction to the Profession (Math 100), revised existing course to incorporate history, philosophy, and ethics of mathematics with mathematical proofs and computational experimentation, in order to give a motivating and exciting introduction to mathematics at the college level to incoming applied math majors.

Elementary Linear Algebra (Math 332), revised the existing course to better suit students from Applied Math, CS, and Engineering by creating an exciting mix of rigorous proofs, algorithms, and applications. Taking this course regularly attracts non-math majors to take double majors or minor in applied math.

Mathematical Modeling (Math 380; Math 486 & 522): developed a new course to build understanding of applied mathematics as a thought-process and a toolbox for the study of real-world phenomenon with an emphasis on the modeling process using concepts and tools from continuous, discrete, and probabilistic mathematics. A semester-long project on open-ended real-world problems that utilize their comprehensive mathematical knowledge to formulate, modify, justify, and computationally analyze models. Math 380 is now a required course for Applied Math majors and also attracts students from CS, Mech Engg, EE, and other majors.

Real Analysis (Math 400), developed new flipped version of the course with pre-recorded video lectures, lecture notes, weekly problems for in-class discussion, HW problems with content related to extracurricular historical and analytic content as well as connections with other parts of mathematics. This course transformation was very well received by the students, despite online teaching during the pandemic.

Number Theory (Math 410), developed a new course on fundamentals of number theory and its modern applications in cryptography, which has attracted undergraduate students from Applied Math, CS, and ECE.

Linear Optimization (Math 435 & 535): developed a new course incorporating the geometric and linear algebraic basis of algorithms, duality, integer programming, and applications to large scale optimization, which has attracted graduate and undergraduate students from Applied Math, CS, Physics, ECE, Chem. Engg., Data Science, CDSOR.

Graph Theory and Applications (Math 454): revised an existing joint undergrad-grad course to make it an appropriate course for undergraduate students from various backgrounds with an emphasis on building a strong foundation in discovering and communicating discrete mathematics. It attracts students from Applied Math, CS, ECE, and Physics.

Graduate Graph Theory (Math 553): replaced an existing joint undergrad-grad course with a core-course for graduate students with advanced topics that incorporate modern probabilistic and algebraic techniques. It has attracted students from Applied Math, CS, and ECE.

Modern Methods in Discrete Math (Math 554): developed a new course in Combinatorics applying modern methods from probability, abstract algebra, linear algebra, entropy, MCMC, etc. that has attracted graduate and talented undergraduate students from Applied Math, CS, and ECE.

Graduate Student, Department of Mathematics, UIUC, Fall 1999-Spring 2006.

- Proposer, developer, and instructor for a semester-long graduate course, *Topics in Probabilistic Methods for Discrete Mathematics*, taken by faculty and students from Math, CS, Physics, and ECE, Fall 2005.
- Co-author, successful proposal for graduate course on *Discrete and Convex Geometry*, 2003.

Academic Service to the Profession

Some Highlights:

- Organized 4 international conferences and workshops, and 6 minisymposia/ special sessions.
- Organizing a Discrete Math seminar at Illinois Tech with 10+ talks each semester, on Zoom since 2020, with speakers and attendees from around the world.
- Building connections between communities in algebraic graph theory and extremal graph theory through organization of these seminars and conferences across these communities with researchers at all stages of their careers.

Review Panel Member, AAAS (American Association for Advancement of Science) international research grant proposals in Applied Math, 2014; National Science Center, Poland, research grant proposals in Computer Science and Informatics, 2020, 2022 (declined); French National Research Agency (ANR), research grant proposals in mathematics, 2025 (declined).

Member, MAA (Mathematical Association of America) National Committee on Minority Participation in Mathematics, 2009-2012.

Editor, Newsletter, SIAM Activity Group on Discrete Mathematics, 2012-2014.

Referee for the journals: Acta Mathematica Sinica, Algebraic Statistics, Ars Combinatoria, Bulletin of Korean Mathematical Society (multiple papers), Complexity, Discrete Mathematics (multiple papers), Discrete Applied Mathematics (multiple papers), Electronic J. of Combinatorics (multiple papers), J. of Combinatorial Mathematics and Combinatorial Computing (multiple papers), J. of Combinatorial Theory Series B (multiple papers), J. of Graph Theory (multiple papers), J. of Mathematical Society of Japan, Mathematical Finance, Mathematics of Computation, Naval Research Logistics (multiple papers), Order, SIAM J. on Discrete Mathematics (multiple papers), Theoretical Computer Science, Operations Research.

Conference (Co-)Organizer:

- *Workshop on Algebraic, extremal, and structural methods and problems in graph coloring*, virtually hosted by Sparse Graphs Coalition (Europe), 19th-23rd Feb 2024. 45+ researchers in Algebraic and Extremal Combinatorics from USA, Canada, Europe, and Asia built long-term collaborations by working on open problems in small groups for a full week and continuing afterwards. 2+ papers have already resulted from this workshop with more expected.
- *Special Session on Recent Progress in Chromatic Graph Theory*, AMS Virtual meeting, April 2023. Researchers, from leaders to beginners, in Algebraic and Extremal Combinatorics working in chromatic graph theory from USA, Canada, Europe, and Asia.
- *Special Session on Enumerative and Extremal Problems in Chromatic Graph Theory*, AMS meeting, May 2022, Online (originally at University of Denver). Researchers, from leaders to beginners, in Algebraic and Extremal Combinatorics working in chromatic graph theory from USA, Canada, Europe, and Asia.
- *Extremal Combinatorics in Illinois (EXCILL III) Conference*, Illinois Tech, Chicago, August 2016. Over 140 researchers from all over the world attended and the invited speakers were the topmost international researchers in the field. Funded by grants from NSF and NSA.
- *Workshop in honor of Professor Douglas West's 60th Birthday*, Institute for Mathematics and its Applications, University of Minnesota, Minneapolis, June 2014. Over 80 Leading researchers from 7 countries around the world participated. Funded by IMA.
- *Special Session on Graphs and Hypergraphs*, AMS Central Section Meeting, Notre Dame, November 2010.
- *47th Midwest Graph Theory Conference (MIGHTY)*, Illinois Tech, Chicago, November 2008. Over 90 participants, including 38 speakers, from all over US.

– *Special Session on Graph Theory*, AMS Central Section Meeting, Bloomington, April 2008.
– Project NExT panel discussion on '*Early Career Grants: possible sources and proposal writing*', Joint Mathematics Meeting, San Diego, January 2008.
– *Special Session on Graph Theory*, AMS Central Section Meeting, Chicago, October 2007.
– Joint DePaul University-IIT Reading Seminar in Discrete Mathematics, Fall 2006-Fall 2008. 5 faculty members and over 10 students from both universities participated.
– Chair, *Session on Special Topics in Networks & Graphs*, INFORMS annual meeting, Nov 2005.

Service to the Home Institution

Some Highlights:
- Co-director and co-advisor for interdisciplinary M.S. program in Operations Research.
- Advised the SIAM chapter at Illinois Tech, which has been leading student oriented mathematical professional and social activities in the department and university.
- Active member of a wide variety of university, college and department level committees, especially related to mental health of students, strategic planning at university and departmental level, undergraduate research, graduate studies, and improvement in teaching.
- Regular organization of panel discussions with alumni and faculty aimed at students preparing for research, internships, and graduate school.

Co-Director & Co-Advisor, M.Sc. CDSOR, 2015-present.

Co-created this new interdisciplinary graduate program with S. Kapoor of CS; activities include: advising students on Math coursework and requirements, as well as on career planning; co-authoring annual official assessment report; marketing efforts for the program and contacting potential industrial partners for internships, etc.

Co-Advisor, SIAM Student Chapter, Illinois Tech, 2012-present.

SIAM chapter is active in organizing activities, including talks, panel discussions on career advice, an annual student conference with participants from all over the midwest, and social events, including a series of talks introducing all mathematics research groups, and a new series of talks on 'my favorite theorem' to popularize mathematics, with funding from SIAM and the student government.

University and College level committees,

– Campus-wide JED Task Force for mental health resources, programming, and policies, Illinois Tech, 2024-present.
– University Undergraduate Research Committee, Illinois Tech, Fall 2019-present (Chair, 2023-present).
– University Graduate Studies Committee, Spring 2023 and occasionally in other semesters.
– Core faculty, Socially Responsible Modeling, Computation, and Design (SoReMo), 2020-present.
– College of Computing Dean review committee, Illinois Tech, Fall 2023.
– University On-Site Provisional Admission Committee (OSPA), Illinois Tech, College of Science representative to India, 2018-2019.
– Distinctive Teaching Fellows Committee, College of Science, Illinois Tech, 2016-2018.
– University Strategic Plan Assessment Advisory Board (SPAAB), Illinois Tech, College of Science representative, 2014-2016.
– University Library Committee, Illinois Tech, Department representative, 2007-2012.

Department level committees,

- Graduate Studies Committee, Applied Math, IIT, Fall 2016-present.
- Applied Math Faculty Search Committee, IIT, 2023-24, 2012-13.
- Applied Math Department Publicity and Visibility Ad-hoc Committee, 2020.
- Research & Joint Faculty Appointments Ad-hoc Committee, Applied Math, IIT, Fall 2020.
- Organizing committee (Chair), Virtual Departmental Graduation ceremony and social gathering, Applied Math, IIT, May 2020, and May 2021.
- Applied Math Department MS Program Reorganization Committee, Chair 2018.
- Applied Math Department Strategic Plan Committee, 2018.
- Faculty Teaching Evaluations Committee, Applied Math, IIT, Spring 2017-2019.
- Academic Unit Committee for Promotion and Tenure, IIT, Chair 2016-17.
- Academic Unit Review Committee for mid-term Tenure-track Faculty, IIT, 2013, Chair 2016.
- Academic Unit Review Committee for Senior Lecturers, IIT, 2012, 2013.
- Mathematics General Education Committee, IIT, 2009.

Organizer,

- Discrete Mathematics Research Seminar, Illinois Tech, 2007-08, 2010-2011, 2012-13, 2016-present, (with speakers each semester from universities in US, Canada, Europe, Asia).
- Alumni seminar talk and student discussion, one campus visit each semester 2024-present.
- Panel discussion on 'How to prepare for and apply to graduate school', 2019-present annually, (with D. Stasi and SIAM/AWM chapters).
- Panel discussion on 'Research and Internship opportunities for undergrads', 2023-present annually, (with SIAM chapter).
- Undergraduate Math Competition, Illinois Tech, 2008-2013 annually, (with I. Cialenco, M. Pelsmajer, and SIAM chapter)
- Student Poster Competition, Menger Day, Illinois Tech, 2008-2013 annually.
- Department Colloquium, Illinois Tech, 2008-09.
- Pan-IIT Interdisciplinary Seminar Series on "Networks and Optimization", IIT, Spring 2009 (with R. Ellis and M. Pelsmajer).

Department Representative, Local High School Students visit to IIT (multiple years); Graduate School Fair/ Open House/ Welcome/ Discovery Day at IIT, and at the AMS-MAA-SIAM Joint Math Meetings, and at the Chicago Area Undergraduate Research Symposium, (each multiple years); CAMRAS Scholarship interviews (multiple years); Menger Day Poster Competition Judge (multiple years); IIT Research Day Graduate Student Poster Competition Judge (multiple years).

Illinois Tech Liaison, Mathematical Association of America, 2007-2016.