Henry Fleischmann

hfleischmann3@gmail.com

EDUCATION

Carnegie Mellon University (expected)   Pittsburgh, PA

Ph.D. in Computer Science   Aug. 2024–

University of Cambridge   Cambridge, England

MASt in Pure Mathematics with Distinction   Oct. 2023–June 2024

University of Michigan   Ann Arbor, MI

Honors Program, Residential College   Sep. 2019–May 2023

B.S. with Highest Distinction, Highest Honors in Mathematics, and Highest Honors in Computer Science. GPA: 4.0.

RESEARCH EXPERIENCE

University of Michigan   Ann Arbor, MI

Computer Science Honors Thesis   Aug. 2022–Aug. 2023

Advisor: Greg Bodwin

- Studied adjacency oracles for problems in network design, finding optimal sublinear time algorithms for spanning subgraphs and sublinear time algorithms for multiplicative distance spanners.

Rutgers, the State University of New Jersey   Piscataway, NJ

Center for Discrete Math and Theor. Computer Science (DIMACS)   June 2023–Sept. 2023

Advisor: Karthik C. S.

- Served as a graduate student mentor for Karthik's projects.
- Proved hardness of approximation results for a myriad of variants of clustering from machine learning.
- Studied Euclidean Steiner trees for the regular simplex, proving new high-dimensional structural results and providing the first explicit construction of candidate-optimal Euclidean Steiner trees for the regular simplex.

Rutgers, the State University of New Jersey   Piscataway, NJ

Center for Discrete Math and Theor. Computer Science (DIMACS) NSF REU   May 2022–June 2023

Advisor: Karthik C. S.

- Introduced a new gap preserving hardness reduction from Set Packing to Metric Steiner Tree.
- Proved APX-hardness of Metric Steiner Tree with edge weights restricted to any l_p-metric.
- Proved APX-hardness of the Euclidean Discrete Steiner Tree problem, suggesting that the Euclidean Steiner Tree problem is APX-hard in high dimensions, contrasting Arora's seminal PTAS.
- Proved APX-hardness of the max norm Continuous Steiner Tree problem via reduction from graph coloring, the first new hardness result on the continuous problem in several decades.
- Subreviewer for the International Colloquium on Automata, Languages, and Programming (ICALP '23) and the Symposium on Discrete Algorithms (SODA '23).

University of Michigan Ann Arbor, MI

LoG(M), Policy Analyst for the CLOSUP at the Ford School of Public Policy Jan. 2021–June 2022

Advisors: Jon X. Eguia, Gregory Herschlag, Jonathan Mattingly, Tim Ryan, and Samuel Hansen

- Quantified the state of redistricting in Michigan using Monte Carlo Markov Chain methods from the MGGG Redistricting Lab (Recombination and Merge-Split).
- Developed a computational tool for quantifying fairness of redistricting proposals for the Michigan Independent Citizens Redistricting Commission.
- Synthesized Michigan voting, census, and precinct shapefile data to construct a Multi-Scale Merge-Split Markov Chain Monte Carlo compatible graph, working alongside the Duke redistricting group.
- Applied Jurisdictional Partisan advantage measure to each enacted state map in the country.
- Co-Developer of the IPPSR Partisan Advantage Tracker, an online tool to evaluate redistricting maps available at ippsr.msu.edu/pat.
- Issued policy report summarizing partisan advantage results and analyzing trends in results based on map authors, comparison to other common measures, and methodology.

Williams College Williamstown, MA

SMALL Mathematics NSF REU June 2021–Aug. 2021

Advisors: Steven J. Miller, Eyvindur Palsson, Charles Wolf, and Leo Goldmakher

- Worked on a wide range of projects encompassing discrete geometry, additive combinatorics, random matrix theory, and combinatorial game theory.
- Studied variations of the Erdős Distance problem in the angle setting, proving the new best lower and upper bounds for numerous central quantities.
- Contributed in resolving a conjecture of Kim and Roush about the additive irreducibility of subsets of the integers.
- Described a new ensemble of matrices converging to the symmetrized Rayleigh distribution and provided a new proof of the convergence of the circulant Hankel ensemble.
- Explored the game theoretic structure of the generalized Zeckendorf game, a method of construction of base φ decompositions of integers.
- Refereed several papers for the Journal of Number Theory and Rose-Hulman Undergraduate Mathematics Journal.

Rochester Institute of Technology Rochester, NY

NSF REU in Extremal Graph Theory and Dynamical Systems June 2020–Aug. 2020

Advisor: Brendan Rooney

- Studied a generalization of domination problems in graphs, efficient (j,k)-domination.
- Extended known results to strong products of graphs, Cayley graphs, and quotient graphs.
- Established necessary and sufficient conditions for the existence of dominating functions using spectral graph theory.

ACCEPTED PAPERS

1. G. Bodwin and H. Fleischmann, Spanning adjacency oracles in sublinear time, *15th Innovations in Theoretical Computer Science* **287** (ITCS 2024), 19:1–19:21. https://arxiv.org/abs/2308.13890.
2. H. Fleischmann, S. Gavva, and Karthik C.S., On Approximability of Steiner Tree in l_p-metrics, *Proceedings of the 2024 Annual ACM-SIAM Symposium on Discrete Algorithms* (SODA 2024), 1669–1703. https://arxiv.org/abs/2306.02189.

3. H. L. Fleischmann, S. J. Miller, E. A. Palsson, E. Pesikoff, and C. Wolf, Optimal point sets determining few distinct angles, *Australasian Journal of Combinatorics*, **87(1)** (2023), 165–181.

4. B. Baily, J. Dell, I. Durmić, H. L. Fleischmann, F. Jackson, I. Mijares, S. J. Miller, E. Pesikoff, L. Reifenberg, A. S. Reina, Y. Yang, The Bergman Game, *The Fibonacci Quarterly*, **60(5)** (2022), 18–39.

5. H. L. Fleischmann, H. B. Hu, F. Jackson, S. J. Miller, E. A. Palsson, E. Pesikoff, and C. Wolf, Distinct Angle Problems and Variants, *Discrete & Computational Geom*etry, (2023). https://arxiv.org/abs/2108.12015.

6. H. L. Fleischmann, S. V. Konyagin, S. J. Miller, E. A. Palsson, E. Pesikoff, and C. Wolf, Distinct Angles in General Position, *Discrete Mathematics*, **346(4)** (2023), 113283. https://arxiv.org/abs/2206.04367.

7. T. Dunn, H. L. Fleischmann, F. Jackson, S. Khunger, S. J. Miller, L. Reifenberg, A. Shashkov, and S. Willis, Limiting Spectral Distributions of Families of Block Matrix Ensembles, *PUMP Journal of Undergraduate Research*, **5** (2022), 122–147.

SUBMITTED PAPERS

8. Inapproximability of Minimum Diameter Clustering for Few Clusters (with Kyrylo Karlov, Karthik C. S., Ashwin Padaki, and Stepan Zharkov). https://arxiv.org/abs/2312.02097.

9. On Steiner trees of the regular simplex (with Guillermo A. Gamboa Q., Karthik C. S., Josef Matějka, and Jakub Petr). https://arxiv.org/abs/2312.01252.

10. Irreducibility Over the Max-Min Semiring (with Benjamin Baily, Justine Dell, Faye Jackson, Steven J. Miller, Ethan Pesikoff, and Luke Reifenberg). https://arxiv.org/abs/2111.09786.

PREPRINTS/IN PREPARATION

11. Large sets are sumsets (with Benjamin Baily, Justine Dell, Charlie Dever, Adam Dionne, Faye Jackson, Leo Goldmakher, Gal Gross, Steven J. Miller, Ethan Pesikoff, Huy Pham, Luke Reifenberg, and Vidya Venkatesh).

OTHER PAPERS

12. Evaluating the Outcome of the 2022 United States Redistricting Cycle: A Nonpartisan Review. Gerald R. Ford School of Public Policy CLOSUP Student Working paper.

13. Efficient (j,k)-Domination on Chess Graphs (with Daniela Elizondo, Brendan Rooney, and Rachel Thornton).

RESEARCH PRESENTATIONS

15th Innovations in Theoretical Computer Science (ITCS24) — Berkeley, CA
On Approximability of Steiner Tree in l_p-metrics — February 2, 2024

ACM-SIAM Symposium on Discrete Algorithms (SODA24) — Alexandria, VA
On Approximability of Steiner Tree in l_p-metrics — January 8, 2024

Weizmann Institute of Science Algorithms Seminar — Rehovot, Israel
Spanning Adjacency Oracles in Sublinear Time — August 2, 2023

2023 Joint Mathematics Meetings   Boston, MA
Angle Variants of the Erdős Distinct Distance Problem   January 7, 2023

University of Michigan CS Theory Lunch Seminar   Ann Arbor, MI
Inapproximability of the Discrete Steiner Tree Problem in l_p-metrics   December 9, 2022

University of Michigan Undergraduate Student Mathematics Seminar   Ann Arbor, MI
A correspondence between Vertex Cover and Steiner Trees in Hamming Space   September 9, 2022

Combinatorial Structures and Processes Student Workshop 2022   Prague, Czechia
Hardness of Approximation of Steiner Trees in Metric Spaces   August 1, 2022

Annual Workshop in Combinatorial and Additive Number Theory 2022   New York City, NY
Erdos Distinct Angle Problems   May 26, 2022

2022 Joint Mathematics Meetings   Seattle, WA
Modeling Redistricting with Gerrychain   April 4, 2022
Angle Variants of the Erdős Distinct Distance Problem   April 4, 2022
The Erdős Distance Problem for Angles   April 4, 2022

2021 Young Mathematicians Conference   Columbus, OH
Erdos Distinct Angle Problems   August 20, 2021
Reducibility of Sets in Generalized Settings   August 21, 2021
Limiting spectral measure of random circulant Hankel matrices.   August 22, 2021

Goldwater Scholar Community 2021 Symposium   Fully Remote
Efficient (j, k)-domination in chess graphs   August 7, 2021

Southeastern Intl. Conf. on Combinatorics, Graph Theory and Computing   Boca Raton, FL
Conditions for Efficient (j, k)-Domination   March 8, 2021

2021 Joint Mathematics Meetings   Washington, D.C.
Efficient (j, k)-domination in chess graphs   January 7, 2021

Discrete and Computational Mathematics Seminar at RIT   Rochester, NY
Efficient (j, k)-domination in chess graphs   October 23, 2020

2020 Young Mathematicians Conference   Columbus, OH
Efficient (j, k)-domination in chess graphs   August 15, 2020

EMPLOYMENT
University of Michigan   Ann Arbor, MI

Instructional Aide for EECS 477, Introduction to Algorithms   Aug. 2022—Dec. 2022
- Wrote solutions for biweekly problem sets. Designed and taught weekly discussion sections. Held office hours. Graded exams.

University of Michigan   Ann Arbor, MI

Grader for Math 465, Introduction to Combinatorics   Aug. 2020–Dec. 2020
- Managed shifting class homework to an online format via Gradescope for the pandemic. Graded weekly homework assignments with detailed feedback on proof structure. Handled regrade requests.

VOLUNTEER EXPERIENCE

University of Michigan   Ann Arbor, MI

STEM Society   Aug. 2021–Apr. 2023
- Wrote and taught lesson plans for "STEM Saturday" events every semester—days of teaching local underserved students fun STEM topics (cryptography, etc.).

University of Michigan Math Circles   Jan. 2020–Apr. 2022
- Guided middle school and high school students during interactive math talks.

University of Michigan Science Olympiad   Feb. 2020
- Volunteered as an event supervisor for a Division B event, proctoring and grading for the event

Williams College   Williamstown, MA

SMALL REU Outreach   June 2021–Aug. 2021
- Wrote engaging, thought-provoking lesson plans for local elementary schools to increase interest in mathematics. The lessons centered on the so-called "chocolate bar game," parity game arguments, basic geometry, and spreadsheet fluency.

HONORS/AWARDS

Outstanding Graduating Senior Award, UM Math Dept.   Apr. 2023
National Science Foundation Graduate Research Fellowship, NSF   Mar. 2023
Churchill Scholar   Dec. 2022
Marshall Scholar alternate   Nov. 2022
Rhodes Scholarship finalist   Nov. 2022
Distinguished Staff Scholarship, University of Michigan   June 2022
Jack Meiland Scholar, UM LSA Honors Program (awarded to one top rising senior)   Apr. 2022
Outstanding Undergrad. Researcher Award Hon. Mention, CRA   Dec. 2021, 2022
Pamela J. Mackintosh Undergraduate Research Award, UM Library   June 2021
Book Industry Charitable Foundation Scholarship, Binc   Aug. 2020, June 2021
Evelyn O. Bychinsky Award, UM Math Dept.   May 2021
Goldwater Scholar, Barry Goldwater Scholarship Foundation   Mar. 2021
Frank H. and Agnes A. Davis Scholarship, UM Math Dept.   Mar. 2019

SKILLS

Technical: C++, Python, C, LaTeX, ARMv8, OCaml, Rust
Language: Spanish, full professional proficiency