Luke Hawranick

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Research Interests

Discrete mathematics, extremal combinatorics, enumerative combinatorics, graph theory, and combinatorial algorithms.

Education

West Virginia University, Morgantown, WV Expected: *May 2025*
Honors B.S. in Mathematics, Honors B.S. in Computer Science
Minors: Statistics, Music Performance
GPA: 4.0

Research Experience

Mathematics Capstone, West Virginia University *December 2023 -*
Morgantown, WV

- Investigating extremal problems involving monochromatic matchings in an ordered, 2-edge-colored complete graph G.
- Improved a published linear upper bound by a constant on the number of vertices required to realize a monochromatic nest-free matching of fixed size in G.
- Sharpening a lower bound on the chromatic number of the line graph of G with adjacency adjusted according to specific types of matchings.

Computer Science Capstone, West Virginia University *August 2021 - May 2022, February 2024 -*
Morgantown, WV

- Implemented four selected published approximation algorithms and an exact linear program for the unweighted Tree Augmentation Problem.
- Designed and implemented a naïve randomized algorithm.
- Executed all algorithms across controlled input instances from six classes of trees of at most $10,000$ vertices, contrasting metrics of space, time, and solution quality.

Iowa State Math REU, Iowa State University *June 2024 - August 2024*
Ames, IA

- Introduced a framework to approach sophisticated enumeration of maximal independent sets (MIS's) in a grid-like graph class with walks along a digraph.
- Compared the per-vertex growth rate of the set of MIS's across subclasses of grid-like graphs.
- Characterized several statistics of the set of MIS's, such as the number of non-isomorphic MIS's and the average size of an MIS, within subclasses of grid-like graphs.
- Communicated the main results and conjectures to a wide array of audiences.

Summer Undergraduate Research Fellowship, National Institute of Standards and Technology, *Gathersburg, MD* *May 2023 - August 2023*

- Contrasted two methods of buffering messages for IPC using MPI (Message Passing Interface) for highly parallel programs that are used for large-scale simulations.
- Modeled the behavior of message passing in an existing particle simulator in C
- Developed runtime tests to run on an HPC cluster, varying MPI libraries, compilers, and message sizes for each buffering protocol, contrasting runtimes.
- Presented findings to the research group and program coordinators, emphasizing more diverse future testing as a priority.

Summer Undergraduate Research Experience, West Virginia University *June 2022 - August 2022*
Morgantown, WV

- Designed a randomized MST verification algorithm to simplify a deterministic linear time algorithm that relied heavily on preprocessing.
- Utilized a one-sided error, false-based, Monte Carlo subprocess which randomly sampled edges.

Preprints

L. Axelrod, N. Bickel, A. Halfpap, L. Hawranick, A. Parker, C. Swain. Statistics of Maximial Independent Sets in Grid-Like Graphs. In preparation (38 pages), 2024.

L. Hawranick, M. Williamson, J. Restanio, K. Subramani, C. Klingler. An Empirical Analysis of Approximation Algorithms for the Unweighted Tree Augmentation Problem. In preparation (24 pages), 2024.

Mentoring

Mathematics Tutor, West Virginia University *January 2021 -*

- Provided academic support to 50+ different students each semester in various mathematical courses (e.g., College Algebra through Differential Equations) through active learning techniques, personalized learning plans, and CRT teaching methods.
- Adapted teaching style to accommodate for meeting location (in-person, virtual) and student experience in mathematics.
- Developing long-term student success in mathematics by providing personalized student plans that emphasized deep understanding of keep concepts.

MATH 104**,** 122 **Learning Assistant**, West Virginia University *Spring 2022, Fall 2023*

- Facilitated classes of 30 students' learning during lab sections of College Algebra and Quantitative Reasoning.
- Assisted students during class by employing active learning techniques, such as guided group discussions and facilitating problem-solving activities, alongside traditional methods, like step-by-step explanation and example-based instruction.

Presentations

"Enumerating Maximal Independent Sets in Grid-like Graphs", Joint Mathematics Meetings, Seattle, WA. *January 2025*

"An Empirical Evaluation of Algorithms for Simple Stochastic Games", The 17th Multi-Disciplinary International Conference on Artificial Intelligence, virtual. *November 2024*

"Inter-node Communication Performance Tuning", National Institute of Standards and Technology SURF Colloquium, Gaithersburg, MD. *August 2023*

"A Randomized Minimum Spanning Tree Verification Algorithm for Dense Graphs", Summer Symposium, West Virginia University, Morgantown, WV. *July 2022*

"An Empirical Analysis of Approximation Algorithms for the Unweighted Tree Augmentation Problem", Spring Symposium, West Virginia University, Morgantown, WV. *April 2022*

Honors and Awards

AMS Travel Award ($1,200) *November 2024*
Joint Mathematics Meetings

NSF REU Research Award ($3,600) *March 2024*
Iowa State University

Eberly Scholar ($2,000) *April 2023*
West Virginia University

NIST Research Fellowship Award ($6,600) *March 2023*
NIST Gaithersburg

Summer Undergraduate Research Experience Award ($4,000) *March 2022*
West Virginia University

Technical Skills

Programming Languages: C, Python, Java, MATLAB, JavaScript, TypeScript.

Miscellaneous: LaTeX, SageMath, Git, HPC, HTML, CSS.

Professional Development

Conference on Discrete Mathematics and Applications, West Virginia University, Morgantown, WV (attendee). *April 2024*

9th Annual Lake Michigan Workshop on Combinatorics and Graph Theory, Western Michigan University, Kalamazoo, MI (attendee). *April 2024*

Graduate Student Combinatorics Conference, Cargenie Mellon University, Pittsburgh, PA (attendee). *March 2024*