Logan D. Graham

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EDUCATION

Stony Brook University (SBU) — Stony Brook, NY
Ph.D. Candidate and Fellow in Applied Mathematics & Statistics — 2017–2022 (estimated)

- Advisor: Joseph S.B. Mitchell (Wikipedia entry)
- GPA: 3.93/4.00

University of Missouri (MU) — Columbia, MO
B.S.: triple major in Economics, Mathematics, and Statistics — 2012–2016

- Highest honors (i.e., MU's "University Honors")
- GPA: 3.70/4.00
- Thesis: *The money multiplier and the proliferation of financial crises: an historical and quantitative examination*

RESEARCH OVERVIEW

My research is characterized by a handful of primary themes: algorithms, optimization, computational complexity, and game theory. Broadly, my goal is to establish provable performance guarantees to deepen our mathematical understanding of artificial intelligence, machine learning, big data, and automation. With this pursuit in mind, I draw from my background in discrete mathematics and theoretical computer science to emphasize application-driven theory. The main application that inspires my work is technology that aids humans in making complex decisions, particularly in economic and optimization contexts. Loosely put, if humans are to use technology to aid us in decision-making, then it is imperative that we have rigorous (i.e., mathematically-proven) guarantees on how such technology behaves.

RESEARCH KEYWORDS

algorithmic game theory, algorithms, combinatorial optimization, computational complexity, computational geometry, data structures, graph theory, probability, resource allocation, sensor networks, simulation, stochastic processes

ACADEMIC AFFILIATIONS

SBU Computational Geometry Group — Stony Brook, NY
Ph.D. Student Researcher — 2017–Present

- Advisors: Esther M. Arkin, Jie Gao, and Joseph S.B. Mitchell.
- Contributed to and led numerous projects pertaining to algorithms, computational complexity, computational geometry, data structures, graph theory, and sensor networks.

SBU Algorithms Group — Stony Brook, NY
Ph.D. Student Researcher — 2017–Present

- Advisors: Esther M. Arkin, Michael A. Bender, Rezaul A. Chowdhury, Jie Gao, Joseph S.B. Mitchell, and Steven S. Skiena.
- Facilitated progress and lent technical expertise on numerous projects involving algorithms, computational complexity, data structures, graph theory, and randomized algorithms.

Institute for Advanced Computational Sciences (IACS)   Stony Brook, NY
Ph.D. fellow and trainee (STRIDE fellowship program)   2020–Present
- IACS website.
- Advisor: Klaus Meuller.
- Developing interdisciplinary skills to lead complex data-enabled research. Training elements span spatial data, advanced visual data analytics, high-performance and data-centric computing, communication – including interpersonal skills and modern media, decision making, and journalism.

MU Undergraduate Research Mentor Program   Columbia, MO
Undergraduate Mentee   Summer 2014
- Advisor: J. Isaac (Zack) Miller.
- Project: *Time series analysis and modeling with applications in the R programming language.*

INDUSTRY RESEARCH

Numerica Corporation   Fort Collins, CO
Research Scientist Intern   Summer, 2020
- Numerica website
- Advisors: Neil K. Dhingra, Ph.D. and Michael G. Moore, Ph.D.
- Project: interceptor guidance with asymmetric information
- I developed highly-efficient game-theoretic software used in artificial intelligence-based modern missile-interception scenarios. In the missile defense scenario under consideration, the threat player evades the interceptor player, but these players' information structures are asymmetric. Thus, a careful game-theoretic model is essential. In particular, the naive approach to solving these games runs in exponential-time ($\Omega(2^n)$, where n is the size of the game tree). After implementing von Stengel's sequence-form solution, these games can be solved in linear time ($O(n)$). My code (written in the cutting-edge Julia language) provided an end-to-end solution for the game-theoretic navigation problem. I communicated my progress and presented the results to over a dozen Ph.D.-level researchers at Numerica.

Numerica Corporation   Fort Collins, CO
Research Scientist Intern   Summer, 2019
- Advisors: Neil K. Dhingra, Ph.D. and Joseph Knuth, Ph.D.
- Project: efficient resource utilization in the Numerica telescope network
- I designed and implemented algorithms and data structures to efficiently schedule coordinated telescope trajectories. These telescopes regularly collect observations of celestial objects in order to help Numerica maintain a precise, updated database. This applied project demanded a practical solution for an NP-hard optimization problem with numerous layers. I blended the solutions of several optimization problems together to get Numerica's telescopes to coordinate their actions as a team when observing celestial objects. My work culminated with action-ready software that I integrated into Numerica's systems. I communicated and presented my results and techniques to both the directly-responsible research team and other relevant parties within Numerica in order to enhance understanding of the techniques and to facilitate effective software deployment.

PUBLICATIONS

In my field (broadly, theoretical computer science), authorship is typically shared equally. All entries herein feature equal authorship. Accordingly, authors' names are listed alphabetically, not ordinally with respect to the extent of contribution.

1. Logan D. Graham, "The Algorithmist's Dilemma: automating the problem-selection and problem-perturbation processes", working paper, to be submitted in 2020.

2. Logan D. Graham, "The Periodic Traveling Salesman Problem", working paper, to be submitted in 2020.

3. Logan D. Graham, Hugo Mainguy, and Sam Van der Poel, "On the intersection of the Delaunay graph hierarchy and optimal solutions of the Traveling Salesman Problem", working paper, to be submitted in 2020-2021.

4. Neil K. Dhingra and Logan D. Graham, "Three blind mice: extending the game of Cops & Robbers on graphs to incorporate a new style of information asymmetry", working paper, to be submitted in 2020-2021.

5. Logan D. Graham, "Triangulation dual graphs: algorithms for recognition and visualization", working paper, to be submitted in 2021.

6. Logan D. Graham and Jessica Maghakian, "Intelligible AI for detecting gerrymandering and reasoning about fairness in a human-like manner", working paper, to be submitted in 2021.

7. Logan D. Graham, "Algorithmic Strategic Moves", working paper, to be submitted in 2021.

Programming & Computing

- **Julia:** highly proficient (favorite language).
- **Python:** highly proficient.
- **Rust:** proficient.
- **C:** hobbyist.
- **C++:** hobbyist.
- **Mathematica:** hobbyist.
- **R:** hobbyist (professional, daily use years ago).
- **Computing:** bash, Excel, git, LaTeX, Powerpoint, secure computing (e.g., with classified data), Unix/Linux, Vim.
- I am broadly interested in learning about high-performance, GPU-centric, and distributed computing.

Skills & Traits

- **Communication:** public speaking to a variety of audiences and technical levels, teaching and tutoring, passion for writing and storytelling.
- **Leadership:** mentoring, group leadership on research efforts, setting goals with and organizing the workloads of subordinates, group leadership as an instructor, numerous leadership training sessions.
- **Character:** inquisitive, loves puzzles and intellectual challenges, dedicated, confident, pressure-seeking, driven by team's success rather than personal success, comfortable admitting mistakes to superiors, passionate about mathematics and computing to the point at which the probability of burnout is infinitesimal.
- **Classified Clearance:** active U.S.A. Classified-Secret security clearance.

Programming Philosophy

My strength is writing highly-efficient code that leverages cutting-edge results from the algorithms literature. Highly-performant, industrial-strength code demands a thorough understanding of algorithms and data structures. As we operate in big data settings, the efficiency with which algorithms and data structures scale with large data sets is of the utmost concern. That is, a sturdy theoretical foundation is essential for the modern, elite programmer. Equally important is a deep understanding of programming paradigms and a few use-case-orthogonal languages. When writing my own code, I subscribe to the concepts emphasized in generic programming and object-oriented programming, in particular. I use the scripting languages Python and Julia for high-level tasks, and I employ the systems languages C and Rust for performance-critical code (Julia – my favorite language – is a tremendously fast, compiled language, and sometimes its performance renders a systems-language translation unwarranted).

Industry and Government Experience

Agrium
Loveland, CO

Data Scientist
2017

- Led financial big data analysis software development efforts with substantial autonomy. Communicated insights to non-technical decision-makers (i.e., board members of a mega-corporation).
- I wrote extensive data science software in the R language that merged, cleaned, modeled, and performed statistical analyses on millions of observations of big financial data. As a result of these efforts, I unveiled $20+ million of practicable annual savings opportunities for Agrium. The promising nature of such discoveries culminated in a high-stakes presentation to the president of Agrium's U.S. retail operations along with several other high-ranking executives. At the time, Agrium was a large, international agricultural company with a market capitalization of roughly $15 billion. Now, after a merger, Agrium is part of Nutrien.

Rollins Capital Partners
Columbia, MO

Quantitative Analyst Intern
Summer, 2016

- Lent quantitative background in working on special assignments as requested by fund manager. Received one-on-one mentoring from a highly-successful hedge fund and private equity fund manager, John Wright.
- In particular, I studied the VIX, a popular volatility-tracking index. I also studied the history of modern financial crises in depth under John Wright's tutelage. In doing so, I read *The Great Contraction: 1929-1933* (Friedman and Schwartz), *The Panic of 1907* (Bruner and Carr), *On the Brink: inside the race to stop the collapse of the global financial system* (Paulson), *Too Big to Fail* (Sorkin), *The Quants* (Patterson), *This Time is Different* (Reinhart and Rogoff), *Lords of Finance: the bankers who broke the world* (Ahamed), among other pieces of the literature.

Cornerstone Wealth Management
Des Peres, MO

Quantitative Researcher Intern
Summer, 2015

- Enhanced an automated fund-selection screening tool for a fund-of-funds portfolio.
- I worked for a fund manager who invested in mutual funds and index funds. In doing so, I gained experience with finance, fundamental analysis, and financial data analysis from fund manager, Alan F. Skrainka, C.F.A. His book *Principle Based Investing* (Skrainka) served as a resource that guided my learning.

Missouri House of Representatives
Jefferson City, MO

Legislative Intern
2013

- Communicated with constituents and took notes in committee meetings.
- I served the state of Missouri as an intern for Representative Michele Kratky. I wrote a weekly newsletter that provided updates from the capitol, and I fielded emails, phone calls, and in-person visits. My notes from committee meetings were circulated to Rep. Kratky's policy-making colleagues.

Fellowship

Science TRaining to Inform DEcisions (STRIDE) Ph.D. fellowship
2020–2021 academic year

- Won a highly-selective, NSF-affiliated fellowship that provides competitive funding while I earn my Ph.D.
- STRIDE website.
- SBU's NSF-affiliated STRIDE fellowship is awarded to roughly six STEM Ph.D. students each year. Winners of the selective fellowship are provided with $34k+ stipends (the same rate as that provided by other top-paying NSF fellowships) and full tuition scholarships. The fellowship includes a substantial training component in which data-visualization, communication to and engagement of broad audiences, and technology-aided decision-support are emphasized. Experience in leading research efforts in industry is developed through an internship component.

Awards

1. Science TRaining to Inform DEcisions (STRIDE) Ph.D. fellowship — 2020–2021 academic year
2. Research Assistant position (full scholarship and stipend), Joseph S.B. Mitchell — Fall, 2020
3. Research Assistant position (full scholarship and stipend), Joseph S.B. Mitchell — Spring, 2020
4. Excellence in Teaching Award, SBU AMS Department — Fall, 2019
5. Instructor position (full scholarship and stipend), SBU AMS Department — Fall, 2019
6. Excellence in Teaching Award, SBU AMS Department — Spring, 2019
7. Instructor position (full scholarship and stipend), SBU AMS Department — Spring, 2019
8. Alternate Awardee, National Defense Science & Engineering Graduate Fellowship — 2019
9. Excellence in Teaching Award, SBU AMS Department — Fall, 2018
10. Instructor position (full scholarship and stipend), SBU AMS Department — Fall, 2018
11. Teaching Assistant position (full scholarship and stipend), SBU AMS Department — Spring, 2018
12. Teaching Assistant position (full scholarship and stipend), SBU AMS Department — Fall, 2017
13. University Honors (most prestigious graduation distinction at MU), MU — 2016
14. Omicron Delta Epsilon (honors graduation distinction), MU Economics Department — 2016
15. Departmental Honors (graduation distinction), MU Economics Department — 2016
16. Departmental Honors (graduation distinction), MU Mathematics Department — 2016
17. Departmental Honors (graduation distinction), MU Statistics Department — 2016
18. Latin Honors, *cum laude* (graduation distinction), MU — 2016
19. Honors College Certificate (graduation distinction), MU Honors College — 2016
20. Dean's List (every semester – 8 total), MU College of Arts & Sciences — 2012–2016
21. Curator's Scholarship, MU — 2012
22. Missouri Bright Flight award (scored in excess of the 99th percentile on the ACT college admissions test) — 2012
23. Mensa International member (scored in excess of the 99.9th percentile on the WISC III IQ test) — 1999

Teaching Philosophy

Effective teaching demands effective communication. This communication should be bidirectional – the learning environment must be such that students feel comfortable asking questions. This is easier said than done. In order to facilitate student involvement, I employ techniques such as engaging students with practice problems during lecture, asking students to link a concept to their own experiences and areas of interest, and pausing to encourage students to phrase concepts in their own words by briefly communicating with their classmates. Students' questions, comments, and engagement are absolutely essential to their learning.

TEACHING

Instructor, SBU AMS Department

AMS 102: Elements of statistics
Fall, 2019

  - Description: introductory probability and statistics for non-majors.
  - Mean course evaluation: 4.51/5. 176 students.

Instructor, SBU AMS Department

AMS 102: Elements of statistics
Spring, 2019

  - Mean course evaluation: 4.72/5. 70 students.

Instructor, SBU AMS Department

AMS 301: Finite mathematical structures
Fall, 2018

  - Description: graph theory, combinatorics, counting, and algorithms for mathematics, computer science, and engineering majors.
  - Mean course evaluation: 4.81/5. 92 students.

Instructor, SBU AMS Department

AMS 301: Finite mathematical structures
Summer, 2018

  - Mean course evaluation: 4.63/5. 30 students.

Teaching Assistant, SBU AMS Department

AMS 412: Mathematical statistics
Spring, 2018

  - Description: rigorous presentation of statistical tests, regression, estimation, etc. for mathematics majors.

Teaching Assistant, SBU AMS Department

AMS 310: Survey of probability and statistics
Fall, 2017

  - Description: intermediate, application-focused study of data analysis, probability theory, and statistics for both mathematics majors and non-majors.

MENTORING

Hugo Mainguy

Undergraduate and Master's student, SBU AMS Department
2018–Present

  - I lead Hugo in independent study and research pertaining to computational geometry, optimization, algorithms, graph theory, and combinatorial geometry. We began working together when Hugo was an undergraduate. Now, he is completing his master's degree and undergraduate degree concurrently. Hugo will apply for Ph.D. programs soon. Hugo, Sam (see below), and I work as a three-person team.

Sam Van der Poel

Undergraduate and Master's student, SBU AMS Department
2018–Present

  - I lead Sam in independent study and research pertaining to computational geometry, optimization, algorithms, graph theory, and combinatorial geometry. We began working together when Sam was an undergraduate. Now, he is completing his master's degree and undergraduate degree concurrently. Sam will soon apply for Ph.D. programs. Sam, Hugo (see above), and I work as a three-person team.

Invited Talks & Participation

Software Carpentry Workshop in the R language

Assistant Instructor, 8 hours · 9/12/2020

- − I guided students in R programming and basic command-line operations. This workshop was affiliated with the Institute for Advanced Computational Sciences (IACS) at SBU.

Algorithms & Computational Geometry

Talk, 1 hour · 12/6/2019

- − I delivered a one hour talk *Algorithms & Computational Geometry* in the SBU class AMS 103: Applied Mathematics in Modern Technology. I introduced non-experts to my area of research and its exciting applications to the audience's areas of interest and expertise.

Extracurricular Activities

Tiger Tutors · Columbia, MO

Co-founder · 2015–2016

- − I co-founded a free tutoring service at MU, encouraging participation from all students of all socioeconomic backgrounds. Our group was a licensed club, and we received a minimal budget from the university for supplies and advertising.

Delta Tau Delta Fraternity · Columbia, MO

Member and Academics Chair · 2012–2016

- − I was a member of the Delta Tau Delta Fraternity, a leader on MU's campus in philanthropy, fun, academic excellence, community service, brotherhood, and involvement.

Wounded Warrior Project · Columbia, MO

Volunteer · 2012–2016

- − I volunteered and co-hosted an annual barbeque fundraising event while at MU.

Juvenile Diabetes Research Foundation · Columbia, MO

Volunteer · 2012–2016

- − I volunteered and co-hosted an annual walk/run fundraising event while at MU.

Rockin' Against Multiple Sclerosis · Columbia, MO

Volunteer · 2012–2016

- − I volunteered at annual fundraising events while at MU.

Hobbies

Reading

- − I collect books, usually non-fiction. Reading well-written mathematics and computer science textbooks satisfies my need for intellectual stimulation. I also enjoy reading about financial history. Occasionally, I'll read a piece of fiction.

Skiing

- − I love to ski, often when visiting family in Colorado. Particularly, I enjoy powder and moguls (but I also like zipping down a low-traffic, groomed run every now and then).

Exercise

– Running, cycling, hiking, and mountaineering are some of my favorite pastimes.

Drinking Coffee

– *A mathematician is a device for turning coffee into theorems.* – Alfréd Rényi.
As a mathematician (and as a programmer), it comes as no surprise that I am a coffee connoisseur. Dark roast, espresso, and cappuccino are my favorites.

Guitar

– While I'm not the greatest guitarist, I enjoying playing my Fender Telecaster and my Alvarez acoustic guitars. Born and raised in Missouri, country music is in my blood. I also like several varieties of rock.