

# Logan D. Graham

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## EDUCATION

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### **Stony Brook University (SBU)**

Ph.D. Candidate and Fellow in Applied Mathematics & Statistics

Stony Brook, NY

2017–2022 (estimated)

- Advisor: Joseph S.B. Mitchell ([Wikipedia entry](#))
- GPA: 3.9/4.0

### **University of Missouri (MU)**

B.S.: triple major in Economics, Mathematics, and Statistics

Columbia, MO

2012–2016

- Highest honors (i.e., MU's *University Honors*)
- GPA: 3.7/4.0
- Thesis: *The money multiplier and the proliferation of financial crises: an historical and quantitative examination*

## RESEARCH OVERVIEW

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My research is unified under the umbrella term *geometric deep learning*. As my primary objective, I strive to understand the mathematical underpinnings upon which state-of-the-art neural network architectures and pipelines (e.g., deep reinforcement learning) are built. With this pursuit in mind, I leverage tools from algorithms, computational geometry, graph theory, and, broadly, theoretical computer science, emphasizing application-driven theory. The main flavor of application that inspires my work is technology that aids humans in making complex decisions, particularly in economic and optimization contexts. Imperatively, a rigorous understanding of deep learning necessitates a thorough examination of the complex mathematical structures at-play. I focus on savvy-ing these structures.

## RESEARCH KEYWORDS

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algorithmic game theory, algorithms, combinatorial optimization, computational complexity, computational geometry, data structures, deep learning, geometric deep learning, geometric group theory, graph theory, neural networks, probability, reinforcement learning, simulation

## PUBLICATIONS & TALKS

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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. On the adjacency structures of planar point-set triangulations. In *37th International Symposium on Computational Geometry: Young Researcher's Forum*, 2021.
2. Logan D. Graham, Joseph S. B. Mitchell, Gaurish Telang, and Sam van der Poel. The relations between the Delaunay graph hierarchy, proximity graphs, and optimal solutions of the Traveling Salesman Problem. To be submitted to the *38th European Workshop on Computational Geometry*, 2022.
3. Logan D. Graham. On the adjacency structures of meshes on genus-zero surfaces. To be submitted to the *38th European Workshop on Computational Geometry*, 2022.

4. Logan D. Graham. Geometric deep learning: demystifying neural network architectures. Invited talk to be delivered at the Institute for Advanced Computational Sciences, 1/27/2022.
5. Logan D. Graham, David Kraemer, and Wesley Suttle. Multi-agent deep reinforcement learning techniques for coordinated motion planning. In preparation.
6. Logan D. Graham. The Algorithmist's Dilemma and Generative Adversarial Network reductions. In preparation.

## PROGRAMMING & COMPUTING

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- **Python:** highly proficient.  
Favorite libraries include: Numpy, Pytorch, Networkx, functools, Gym, PettingZoo, Scikit-Learn, Pandas, Skorch, etc.
- **Julia:** highly proficient.  
Favorite libraries include: Flux, JuliaGraphs, QuantEcon, JuMP, DataFrames, etc.
- **Rust:** proficient.  
Favorite libraries include: Petgraph, tch-rs, Rayon, etc.
- **C:** hobbyist.
- **C++:** hobbyist.
- **Mathematica:** hobbyist.
- **R:** hobbyist (professional, daily use years ago).
- **Computing:** bash, Excel, git, L<sup>A</sup>T<sub>E</sub>X, Powerpoint, secure computing (e.g., with classified data), Unix/Linux, Vim, VS Code.

## SKILLS & TRAITS

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- **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

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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. My style is primarily functional, but I utilize dynamic, object-oriented data structures for efficiency purposes.

Python is my go-to for initial implementations, given its rich ecosystem. I am bullish on Julia's growth within the space of high-performance scientific computing, and I love the language's generic programming themes (e.g., multiple-dispatch). Rust is my most-loved language, for it is extremely performant, safe, and easy to parallelize; however, Rust currently lags behind both Python and Julia with respect to the quality of its scientific computing ecosystem. Now, I primarily use Rust as part of a two-language-solution to ameliorate performance bottlenecks that arise in my Python code.

## INDUSTRY EXPERIENCE

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### Castleton Commodities International

Intern, FTR Trading Desk

– [CCI website](#)

– Advisors: Yuan Zhou, Ph.D. and Jakob Metzler, M.S.

– Completed full cycles of quantitative research (i.e., beginning at the idea-generation and literature review stages and progressing through the software development and testing processes), delivering custom software to support FTR trading.

Stamford, CT

Summer, 2021

- As one of CCI’s larger desks, the team specializes in trading Financial Transmission Rights (FTRs) – an instrument that derives its value from congestion within the power system – as well as natural gas and other commodities. Comprising the bulk of my internship, two of my projects supported the team’s in-house power-system analytics software. My code (written in Python and in Rust) is currently in-use as a piece of the team’s core auction-preparation routine that traders employ to identify an attractive bidding strategy. My third project involved a subroutine that is applicable to the team’s systematic trading initiatives. This project was initiated by an idea that I pitched to the FTR Team. After the Python-implemented prototype unveiled potential opportunities, team members expressed interest in putting the code into production (as a subroutine within a more sophisticated algorithm) at some point. My internship culminated with a presentation of my work to the FTR Team’s numerous quantitative experts and experienced traders.

**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 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.

**Agrium (now Nutrien)**

Loveland, CO

Data Scientist

2017

- [Nutrien website](#)
- 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* served as a resource that guided my learning.

## ACADEMIC RESEARCH AFFILIATIONS

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### Institute for Advanced Computational Sciences (IACS)

Stony Brook, NY

Ph.D. fellow and trainee (STRIDE fellowship program)

2020–Present

- [IACS website](#).
- Advisor: Klaus Mueller.
- 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.

### SBU Computational Geometry Group

Stony Brook, NY

Ph.D. Candidate, 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. Candidate, 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.

### 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*.

## FELLOWSHIP

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### Science TRaining to Inform DEcisions (STRIDE) Ph.D. fellowship

2020–2022

- 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

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1. Science TRaining to Inform DEcisions (STRIDE) Ph.D. fellowship (renewal) August, 2021–August, 2022
2. Instructor position (full scholarship and stipend), SBU AMS Department Fall, 2021
3. Science TRaining to Inform DEcisions (STRIDE) Ph.D. fellowship August, 2020–August, 2021
4. Research Assistant position (full scholarship and stipend), Joseph S.B. Mitchell Fall, 2020
5. Research Assistant position (full scholarship and stipend), Joseph S.B. Mitchell Spring, 2020
6. Excellence in Teaching Award, SBU AMS Department Fall, 2019
7. Instructor position (full scholarship and stipend), SBU AMS Department Fall, 2019
8. Excellence in Teaching Award, SBU AMS Department Spring, 2019
9. Instructor position (full scholarship and stipend), SBU AMS Department Spring, 2019
10. Alternate Awardee, National Defense Science & Engineering Graduate Fellowship 2019
11. Excellence in Teaching Award, SBU AMS Department Fall, 2018
12. Instructor position (full scholarship and stipend), SBU AMS Department Fall, 2018
13. Teaching Assistant position (full scholarship and stipend), SBU AMS Department Spring, 2018
14. Teaching Assistant position (full scholarship and stipend), SBU AMS Department Fall, 2017
15. University Honors (most prestigious graduation distinction at MU), MU 2016
16. Omicron Delta Epsilon (honors graduation distinction), MU Economics Department 2016
17. Departmental Honors (graduation distinction), MU Economics Department 2016
18. Departmental Honors (graduation distinction), MU Mathematics Department 2016
19. Departmental Honors (graduation distinction), MU Statistics Department 2016
20. Latin Honors, *cum laude* (graduation distinction), MU 2016
21. Honors College Certificate (graduation distinction), MU Honors College 2016
22. Dean’s List (every semester – 8 total), MU College of Arts & Sciences 2012–2016
23. Curator’s Scholarship, MU 2012
24. Missouri Bright Flight award (scored in excess of the 99th percentile on the ACT college admissions test) 2012
25. Mensa International member (scored in excess of the 99.9th percentile on the WISC III IQ test) 1999

## TEACHING

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### **Instructor, SBU AMS Department**

AMS 301: Finite mathematical structures

Summer, 2018; Fall, 2018; Fall, 2021

- Description: graph theory, combinatorics, counting, and algorithms for applied mathematics, mathematics, computer science, and engineering majors. This is a cornerstone, core course in the early-upper level of the applied mathematics undergraduate program.
- Fall, 2021 mean course evaluation: *in progress*. 144 students.
- Fall, 2018 mean course evaluation: 4.81/5. 92 students.
- Summer, 2018 mean course evaluation: 4.63/5. 30 students.

### **Instructor, SBU AMS Department**

AMS 102: Elements of statistics

Spring, 2019; Fall, 2019

- Description: introductory probability and statistics for non-majors.
- Spring, 2019 mean course evaluation: 4.72/5. 70 students.
- Fall, 2019 mean course evaluation: 4.51/5. 176 students.

### **Teaching Assistant, SBU AMS Department**

AMS 412: Mathematical statistics

Spring, 2018

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

## TEACHING PHILOSOPHY

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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.

## MENTORING

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### **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, Hugo is a Ph.D Student at Cornell University, studying operations research.

### **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.

## MISCELLANEOUS ACADEMIC PARTICIPATION

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### 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

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### 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

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### Reading, Exercise, Skiing

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