

Krystal Maughan

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Research Interests: Isogeny-Based Cryptography, Mathematical Cryptography, Elliptic Curves, Random Processes, Computational Number Theory (Arithmetic Geometry), Algebraic Graph Theory

University of Vermont, PhD student

2019-present

Computer Science PhD student, minor in Pure Mathematics

(PhD) classes: Mathematical (Post-Quantum) Cryptography, Elliptic Curves and Modular Forms, Combinatorial Graph Theory, Spectral Graph Theory, Category Theory, Random Probabilistic Graphs, Secure and Distributed Computation, Abstract Algebra I (Groups), III (Rings/Fields/Galois Theory), IV (Category Theory, Lie Algebra), Privacy Law and Policy, Machine Learning, Data Privacy, Software Verification, Computer Human Interaction.

Oral Qualification Exams in: (1) Quantum Computing, Quantum Algorithms and Classical Mathematical Cryptanalysis, (2) Elliptic Curves (3) Graph Theory

RESEARCH EXPERIENCE:

Research Assistant (Vermont)

2021-present

PhD Supervisors: C. Vincent, J. Near: Research on Isogeny-Based Cryptography

- Mathematical Cryptography Research

Research Assistant: P. Rombach: Research on Computational Combinatorics

2022-present

- Algebraic Combinatorial Graph Theory Research

Supervisor: Joe Near: Research on Provable Fairness and (Differential) Privacy

2019-2021

Using Machine Learning. Funded via Amazon Research Award (2020-2022 PI: J. Near, D. Darais).

Working Preprints (Cryptanalysis / Computational Number Theory):

- ❖ Mathematical Cryptography: Work on Compositional Isogeny Schemes (ongoing) 2022-present (PI: C. Vincent, **Maughan, K.**)
- ❖ Computational Number Theory research 2023-present
to be published in proceedings **Women in Numbers : Research Directions in Number Theory : Women in Numbers VI (2024)**
(PIs: Lauter K. PhD, Newton R. PhD, with Li C., **Maughan K.**, Srivastava M.)

Preprints (Data Privacy and Security):

- ❖ "Improving Utility for Analysis of Correlated Columns using Pufferfish Privacy" 2022
(**Maughan, K.** and Near, J.)

Workshop Conference Posters (Cryptanalysis / Computational Number Theory):

- ❖ "Compositional Isogeny Schemes"- poster presented, **CrossFyre at Eurocrypt** 2023
Poster for workshop on Provably Robust Schemes (**Maughan, K**)
- ❖ "Compositional Isogeny Schemes"- presented as poster at **ACM Richard Tapia** 2022
Poster Competition at Conference (**Maughan, K**)

Collaboration on Other Research Projects in Progress:

- ❖ **Research Project** 2023-present
Independent research project
(PI: Lees A., PhD, **K. Maughan**)
- ❖ **Research Project** 2023-present
Independent research project
(PI: Rombach, P., PhD, **K. Maughan**)
- ❖ **Summer of Bitcoin (Virtual)** "Price of Anarchy in Selfish Routing on the Lightning Network" (R. Pickhardt, S. Alscher, **K. Maughan**) 2022

Preprints (Machine Learning):

- ❖ *Prediction Sensitivity: Continual Audit of Counterfactual Fairness in Deployed Classifiers* (**Maughan, K.**, Ngong, I., Near, J.) 2022
(presented as poster at **EAAMO Doctoral Consortium**)
- ❖ "Towards a Measure of Individual Fairness for Deep Learning" 2020
(**Maughan, K.** and Near, J.) - presented as poster for **MD4SG**
- ❖ "Towards Auditability for Fairness in Deep Learning" 2020
(Ngong, I., **Maughan, K.** and Near, J.)- presented as poster for **AFCI at NeurIPS**

Workshop Posters (Machine Learning):

- ❖ "Archipelago Pensée" 2020
(**Maughan, K.**) - presented as a poster for Resistance AI (**RAIS**) at **NeurIPS**

Whitepapers (Data Privacy and Security):

- ❖ *Client Telemetry Aggregation, Microsoft internal* (joint work with: P. Angulo, PhD) 2021

TEACHING EXPERIENCE

- ❖ PhD Teaching Fellow, iSchool Inclusion Institute (i3), "Computational Tools" 2023
 - 1 of 2 PhD applicants chosen to design and teach curriculum for 10-day Summer course at the University of Texas at Austin (with S. Stueve, co-teaching fellow)
 - Provided salary and funded with accommodation, flight and stipend for supplies.
- ❖ Guest Lecturer, "Privacy Law and Policy", University of Vermont (UVM) 2021
 - Presented research work on Impacts of Data Leakage and Data Privacy
- ❖ Graduate Teaching Assistant, University of Vermont (Fall / Spring) 2019-2020
 - Teacher's Assistant for:
 - Compiler Construction (with Haskell)
 - Programming for Engineers (with Matlab)
 - Data Privacy (Differential Privacy, K-anonymity, Machine Learning with Python)
 - Advanced Web Design

GRANT WRITING / PROPOSALS (SELECTED)

- ❖ Summer of Bitcoin, "Price of Anarchy in Selfish Routing On the Lightning Network" (Research proposal with 0.4% acceptance rate, Awarded \$3,000) 2022
- ❖ COST Action Proposal OC-2021-1-25315 "Mathematics and Algorithmics of Group actions and Isogenies for Cryptography" (Secondary Proposer) 2021
- ❖ Microsoft Research, Reinforcement Learning Open Source Festival Proposal (Awarded \$10,000) 2021

GRANT WRITING / PROPOSALS (SELECTED)

- ❖ Google Summer of Code, Proposal to Haskell.org 2018
(Awarded \$6,000)
- ❖ Helium Grant, (for exploring questions on the edge of mainstream thinking) 2018
(1 of 11 chosen out of 700 applicants; Awarded \$1,000)

RESEARCH AWARDS (SELECTED)

2nd Place Winner, Best Research Project (tie with X. Zhang), 2022
UVM CS Research Day for “Price of Anarchy in Selfish Routing on the Lightning Network”
Best Poster, Brilliant Idea Category, Mediterranean Machine Learning Summer School 2021

MERIT-BASED MENTORSHIPS / RESEARCH MENTORSHIPS (SELECTED)

Mentee, LXAI Computer Vision (LXCV) at CVPR (Computer Vision) workshop 2023
- Mentor: F. N. Paravecino, PhD (Research collaborations)

Mentee, Algorithmic Game Theory Workshop (AGT), Economics and Computation 2022
- (mentor: H. Zhang, PhD), paper dissection and Ask me Anything session

Mentee, MD4SG Mentorship Program, with J. Finocchiaro, PhD (1 of 3) 2022-2023

Mentee, AiC Connectors Program with Facebook, with S. Lim, PhD 2022

Mentee, BlackComputeHer Fellowship, with Y. Rankin, PhD, A. Robinson, M.Ed 2022

Mentee, Microsoft’s Tech Resilience (mentors: O. Kroshkina, M. Ward) 2022

Mentee, Google’s CS Research Mentorship Program (CSRMP) with A. Lees, PhD 2021

Mentee, AiC Connectors Program with Facebook with O. Dalleleau, PhD 2021

Mentee, She256 Blockchain Group with P. Mishra, PhD 2021

Mentee, Women in Privacy and Security (WISP), D. Sharma, PhD 2021

Mentee, Algorithmic Game Theory (AGT), Economics and Computation Conference 2020
- Global Outreach Mentorship with S. Gupta, PhD (EC 2020)

Mentee, Mentored by A. Ahmed, PhD, 2020-present
- ICFP 2020, ACM SIGPLAN-Mentorship, organized by T. Ringer

ACADEMIC REVIEWER (SELECTED)

AAAI 2023 Workshop on Privacy Preserving Artificial Intelligence (PPAI), PML4DC (Practical Machine Learning for Developing Countries), ICLR / NeurIPS: Algorithmic Fairness through the Lens of Causality and Privacy, ICLR Distributed and Private Machine Learning (DPML), Tiny Papers Workshop at ICLR 2023 (Co-Area Chair), etc.

REVIEWER (OTHER)

Effective Haskell, by R. Skinner, Springer’s AI Ethics Journal, BAI workshops at NeurIPS

RESEARCH PhD INVITATIONS (ABRIDGED)

Participant, WIN6, (mentors: Lauter K., Newton R.) 2023
- Research project at BIRS, to be published in WIN proceedings 2024 (Banff, Canada)
- Received award for lodging, travel (~1 of 42) (March 26th to March 31st)

Participant, IPAM “Machine Assisted Proofs” (Feb 13-17), (Los Angeles, California) 2023
- Formal methods at the intersection of Pure Mathematics and Computer Science
- Received award for lodging, waived registration
(organized by E. Abraham, J. Avigad, J. Ellenberg, M. Heule, T. Tao, K. Buzzard, T. Gowers)

RESEARCH PhD INVITATIONS (ABRIDGED)

Participant, PCMI Graduate Summer School, "Quantum Computation" (3 weeks)	2023
<ul style="list-style-type: none">- Awarded full funding (housing, registration, flight) (July 16-August 5th)- Coursework on: Quantum and quantum-inspired linear algebra,- Quantum fourier transforms and quantum information theory, LDPC codes- Topological aspects of quantum codes, quantum hamiltonian complexity- Quantum learning theory	
Participant, Twelfth Summer School on Formal Techniques + FMiTF Bootcamp	2023
<ul style="list-style-type: none">- Received admission, housing and funding for flight- Learning Vampire Theorem Prover (May 23rd to June 2nd) (Menlo College, Atherton)	
Participant, ICERM's LMfdb, Computation and Number Theory (LuCaNT) workshop	2023
<ul style="list-style-type: none">- (Provided housing, registration)	
Invited Participant, Lorentz Center, "Machine-Checked Proofs", Leiden, the Netherlands	2023
<ul style="list-style-type: none">- Lean Workshop, Funding TBD (provided housing, funding for travel)	
Invited Participant, High Assurance Crypto Software (HACS) (Tokyo, Japan)	2023
<ul style="list-style-type: none">- (Post-quantum) cryptographic verification workshop (conflicted with WIN6)	
Invited Participant, CrossFyre at Eurocrypt (Lyon, France)	2023
<ul style="list-style-type: none">- Cryptography, Robustness and Provably Secure Schemes for Female Young Researchers: presented research poster	
(Received funding for accommodation, registration and flight courtesy of PQ-Shield)	
Participant, Arizona Winter School, "Point Counting and Applications" (J. Pila)	2023
<ul style="list-style-type: none">- Applications of Point-counting for algebraic points of bounded degree (Tucson, AZ)	
Virtual Participant, "Algebraic Cycles, L-Values, and Euler Systems": MSRI	2023
<ul style="list-style-type: none">- Originally granted registration but opted for virtual attendance	
Virtual Participant, Research Institute for Mathematical Sciences (RIMS)	2023
<ul style="list-style-type: none">- Zeta functions and their representations	
Participant, 1st Roots of Unity reunion, American Institute of Mathematics, Pasadena CA	2023
Participant, Doctoral Consortium at ACM Richard Tapia Conference (Washington, D.C.)	2022
Participant, 1st Roots of Unity Summer School: Arithmetic Geometry group (fully-funded)	2022
<ul style="list-style-type: none">- focus on Arithmetic Geometry and Arithmetic Statistics with six PhD students	
Invited to proceeding AWM Research Symposium at University of Minnesota (UMN))	2022
Invited Participant, IAS/ Park City Mathematics Institute (PCMI)	2022
<ul style="list-style-type: none">- Graduate Summer School, Computational Number Theory (fully-funded: declined offer)	
Virtual Participant, BIRS, Algebraic Methods in Coding Theory and Communication	2022
Virtual Participant, COGENT: Cohomology, Geometry and Explicit Number Theory	2022
Virtual Participant, Stinson66: New Advances in Designs, Codes and Cryptography	2022
Virtual Participant, Arizona Winter School, Southwest Arithmetic Geometry Center	2022
<ul style="list-style-type: none">- Automorphic Forms beyond GL₂: Unitary Groups Study Group (mentor E. Eischen)	
Virtual Participant, West Coast Number Theory (WCNT): Problems in Number Theory	2021
Participant, GREPSEC V :	2021
<ul style="list-style-type: none">- (Graduate Students in Privacy and Security Early Career Workshop)	
Participant, Isogeny-Based Cryptography Winter School	2021
Participant, Post-Quantum Networks Workshop	2021
Participant, PRIMA Summer School	2021
<ul style="list-style-type: none">- Rational curves and moduli spaces in arithmetic geometry	

MERIT-BASED GRANTS / FELLOWSHIPS / SCHOLARSHIPS (ABRIDGED)

Initiative for Cryptocurrencies and Contracts (IC3) Blockchain Bootcamp	2021
- Worked on group project : Fairness consensus for Miner Extractable Value (MEVs)	
- Implemented Aequitas protocol from paper with authors for fairness simulation	
Participant, Self Organizing Conference on Machine Learning (SOCML)	2021
- Machine Learning, and Privacy session, Moderated by U. Erlingsson	2021
- organized by I. Goodfellow (1 of 9 chosen)	
(Privacy Engineering Practice and Respect) PEPR Grant, S&P Oakland	2022
Fellow, BlackComputeHER (2022-2023) (1 of 11)	2022
Scholarship winner (to attend Richard Tapia Celebration of Diversity in Computing)	2022
- (registration, flight, hotel costs, Washington D.C. courtesy BNY Mellon)	
Google Grace Hopper Conference (GHC) Scholarship	2021
WISP & Black Hat USA Briefings Scholarship (1 of 25)	2021
Kernel Fellowship Block III via Gitcoin (Security: Zero Knowledge Proofs project)	2021
Gitcoin Scholarship for Women (for Kernel Fellowship Block III)	2021
She256 Mentorship focused on ZK Snarks (6 months)	2021

OTHER GRANTS/ FELLOWSHIPS (ABRIDGED)

USENIX Security Conference 2021 (via USENIX Diversity Grant via GREPSEC V)	2021
TechX Social Impact / Harvard Franklin Fellowship (1 of 12)	2020
USENIX Enigma Grant	2021
NCAS Workshop participant (NASA Community College Aerospace Scholars)	2016
Who's Who/ Peggy Williams Memorial Scholarship/ Best BFA Award (Best of Major)	2008
Northeast Combinatorics, Discrete Maths Day (lodging)	2022
Upstate Number Theory Conference 2021 (lodging provided)	2021
IEEE Symposium on Security and Privacy (student travel grant, complimentary ticket)	2021
4th Annual ZK-Proof Workshop (complimentary ticket)	2021
WISP Privacy+Security Conference	2021
- EU Data Law / De-Identification Workshop (Scholarship via WISP)	
ICERM (Brown University) Variable Precision in Mathematical & Scientific Thinking	2020
RWC2020 (Real World Crypto: registration, flight, lodging) Grant via IACR	2020
Sage-Days-104 : To work on SageMath Software: Arithmetic Dynamics	2019
Simons Institute (Berkeley) Error-Correcting Codes and High-Dimensional Expansion Boot Camp (attendee)	2019
ICERM (Brown University) Encrypted Search Workshop Grant (Lodging provided)	2019
Cornell Number Theory Conference Grant (Lodging provided)	2019
MSRI (Mathematical Sciences Research Institute) Grants to attend:	
Optimal Transport and applications to machine learning and statistics	2020
Connections for Women:	2019
- Derived Algebraic Geometry, Birational Geometry and Moduli Spaces workshop	
- Introductory Workshop: Derived Algebraic Geometry and Birational Geometry And Moduli Spaces	
Racket Summer School (National Science Foundation Grant)	2018-2019
PLMW (Programming Languages Mentorship Workshop)	2018
ICFP (International Conference Functional Programming)	

OTHER GRANTS/ FELLOWSHIPS (ABRIDGED)

PLMW(Programming Languages Mentorship Workshop)	2018
PLDI (Programming Languages Design and Implementation)	
OPLSS (Oregon Programming Languages Summer School Grant) - declined offer	2018

INSTITUTIONAL PROSPECTIVE FACULTY PhD INVITATIONS

❖ Invited Participant, Rochester Institute of Technology: RIT Pathways to RIT (Pathways from PhD to Faculty programme)	2023
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INDUSTRY PhD INVITATIONS (ABRIDGED)

Participant, Meta's Uniting Scholars in Research (Menlo Park, Palo Alto) (1 of 35)	2022
Virtual Participant, Jane Street's Preview Program, The Game Show / Trading Games	2022
Virtual Participant, Adobe's Experience Day:Research Track (Emerging Devices)(1 of 35)	2022
Participant, Facebook, Amplified: Above & Beyond Computer Science Program (PhDs)	2021
Participant, Facebook's Amplified: Virtual Vivid in Research (1 of 30)	2021
Participant, Galois 1st Summer School on Trustworthy Machine Learning (1 of 35)	2021
Participant (via CSRMP), Google PhD Fellowship Summit	2021
Participant, Jane Street PhD Symposium (New York, remote) (Quant Research)	2021
Participant, TwoSigma Mock Interview Day for Early Career Women (Quant Research)	2021
Participant, Twitter PhD ML Flock Event (New York, Boston office)	2019

GRADUATE SCHOOL INTERNSHIPS

JP Morgan, Quantitative AI Research, Summer Associate (New York) (1 of 10)	2022
Summer of Bitcoin, Blockchain (Lightning Network) PhD Research intern (remote)	2022
Microsoft Research, Independent Contractor, Summer 2021 (New York: remote)	2021
Microsoft, PhD Intern, Summer 2021 (Redmond: remote)	2021
Autodesk, PhD Intern, Summer 2020 (Pier 9, San Francisco: remote)	2020

RELEVANT WORK / INDUSTRY EXPERIENCE (Pre-Grad school)

Mercury Banking (Haskell fintech) : Software Engineering Intern (San Francisco)	2019
Apple, Inc.: Software Engineering Intern (Sunnyvale)	2019
Google Summer of Code: Developer for Haskell.org	2018
Mozilla: Increasing Rust's Reach Developer	2018

OTHER (NON-INDUSTRY) TALKS (ABRIDGED)

"Compositional Isogeny Schemes", Tapia Doctoral Consortium (45 minutes)	2022
"A Journey through Unboundedness of ranks of Elliptic Curves", (15 minute talk)	2022
Roots of Unity Workshop (joint talk with O. Del Guercio and M. Bustos Gonzalez)	
Brown University, Fair February talk on Security, Privacy, Fairness (30 minutes)	2022
Meetup "Math for Math's Sake", Virtual Lightning Talk (10-15 minutes)	2022
"Isogenies, Elliptic Curves and Random Walks on Random Graphs	
"Composable Forgetful Isogenies", Google CSRMP Research Alumni Talk (30 minutes)	2022
"Price of Anarchy in Selfish Routing", Graph Theory and Spectral Graph Theory (15 min)	2022
"Price of Anarchy in Selfish Routing", Google CSRMP Research Alumni Talk (30 minutes)	2022
CS Research Day, "Price of Anarchy in Selfish Routing", UVM (16 min)	2022
"Composable Forgetful Isogeny Graph Cryptography", Google CSRMP Research	2021

OTHER (NON-INDUSTRY) TALKS (ABRIDGED)

"Isogeny Cryptography", School for Poetic Computation, Re-learning to love Maths 2021
PLAID Lab Speaker, "Information Theory: from Spacecraft to Blockchain" 2021

INDUSTRY TALKS (ABRIDGED)

"Isogeny-Based Cryptography", JP Morgan AI Research Cryptography Group (1 hour) 2022
JP Morgan AI Research Weekly Technical Meeting, (New York) (20 min) 2022
JP Morgan AI Research Reading Group Meeting (30 min) 2022
JP Morgan Summer Symposium (10 min) 2022
Women Who Code: SageMath: "Computational (Pure) Mathematics/Graph Theory" 2022
- *Lightning Talk (2-4 min)*
"Prediction Sensitivity for Fairness in AI", Jane Street Symposium (15 minutes) 2021
"Renyi-Differential Privacy", Autodesk UX Group (20 minutes) 2020

CLASSES (OTHER)

Zaiku Group, Software Verification Course (online) 2023
- *Class focused on Quantum Formalism, functional programming and Software verification for Homotopic Minds taught by B. Ahrens using Lean*

CLASSES (AUDIT)

Preliminary Arizona Winter School, Model Theory and Applications, taught by R. Nagloo 2022-2023
Stanford: EE 374 : Internet-Scale Consensus in the Blockchain Era (Spring) 2021
- *Information Theory class focused on scalability and protocols in Blockchain*
- *Taught by D. Tse, PhD through Stanford University*
- *Audited class, scribed for Lecture 11, Spring 2021*
IBM Qiskit Global Summer School (Quantum Computation using Qiskit) 2020

Audit / Other: *Internet Scale Consensus in the Blockchain Era (Information Theory class at Stanford), Matroids & Polytopes, Theory of Algebraic Differential Equations, Elementary Number Theory, Fundamentals of Mathematics, Extremal Graph Theory, Model Theory and Applications.*

Book Clubs:

Quantum Computing (2022), Quantum Computing and Quantum Information (2022-2023: study group with Mathematicians, Physicists and Computer Scientists), HDX Expander Graphs (2022-2023)

Skills: Python, SageMaths, Haskell, LaTeX, Matlab, Jupyter, Pytorch, SQL, AWS, PySpark, Sparklyr, Maplesoft, Tensorflow, Git, Lean, writing proofs.

PRESS (SELECTED)

Publication Featured in Montreal AI Ethics Institute (MAIEI) newsletter 2022
Publication work Featured in BitMEX Research blog 2022
Featured / interviewed in articles / media by Coursera, NASA-JPL, Google, Udacity, The MacArthur Foundation, Venture Beat, The Data Standard, Corecursive Podcast, OpenMined, Career Girls, Dataiku, Scott Hanselman's Podcast, BlackComputeHer, NASA Tech Briefs (40th anniversary), Variety, ACM SPLASH 2022 PLMW Perspectives, the Los Angeles Times, Black Girls Code colouring book on Women Scientists, 2016-present

PRESS (SELECTED)

Women of Silicon Valley, CareerGirls, The Summer of Bitcoin experience (SBOE), Technovation, Rewriting the Code, Montreal AI Ethics Institute, etc.

GUEST WRITER (SELECTED)

[Blogpost](#), *Summer of Bitcoin* (joint with S. Alscher) (Lightning Network routing) 2022

ACADEMIC ASSOCIATION FOR COMPUTING MACHINERY (ACM) MEMBERSHIPS

Student Member, International Association of Cryptologic Research (IACR) 2020-present

SIGecom Special Interest Group on Economics and Computation 2020-present

NON-ACADEMIC MEMBERSHIP

Member, Isogeny Research Club 2023-present

Member, Women in Cryptography 2023-present

Student Member, IEEE Computer Society Technical Committee on Security and Privacy 2021-present

Member, Women in Number Theory 2018-present

Member, QVNTS (Quebec-Vermont Number Theory Seminar) 2021-present

Member, Women in Combinatorics 2021-present

Member, Association for Women in Mathematics 2021-present

Member, She256 2021-present

Member, Women in Security and Privacy (WISP) 2020-present

Member, IEEE Information Theory Society, Santa Clara Valley Chapter 2016-present