

Forest Kobayashi

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CITIZENSHIP	US Citizen	
RESEARCH INTERESTS	Optimal Transport Theory, Analysis of PDEs, Symbolic Computation	
EDUCATION	University of British Columbia , Vancouver, British Columbia. Ph.D. in Mathematics (Expected 2024). <ul style="list-style-type: none">• Advisor: Young-Heon Kim Harvey Mudd College , Claremont, California. B.S. in Mathematics (2020). High Distinction; Honors in Mathematics. <ul style="list-style-type: none">• Thesis: <i>Where the Wild Knots Are</i>• Advisor: Francis Su• URL: https://github.com/redpanda1234/thesis-public HSA concentration: Art	
	Summary of selected coursework († = reading course, ‡ = audited): <ul style="list-style-type: none">• Real Analysis I• Real Analysis II• Graduate Analysis I• Intro. to PDEs• Dynamical Systems• Abstract Algebra I• Representation Theory• Adv. Linear Algebra† Category Theory• Intermed. Probability• Computability & Logic† Homology Theory‡ Algorithms‡ Complexity Thr. (For a complete list including topics, see bedmathandbeyond.xyz/files/coursework.pdf)	
PUBLICATIONS	[P1] Forest Kobayashi and Sam Nelson. “Kaestner brackets”. In: <i>Topology Appl.</i> 282 (Aug. 2020), p. 107324. ISSN: 0166-8641. DOI: 10.1016/j.topol.2020.107324 . arXiv: 1909.09920 [math.GT]. [P2] Madeline Zug et al. “CS for All Academic Identities”. In: <i>J. Comput. Sci. Coll.</i> 33.4 (Apr. 2018), pp. 130–137. ISSN: 1937-4771. URL: http://dl.acm.org/citation.cfm?id=3199572.3199590 . [P3] Illustration work featured in Michael Starbird and Francis Su’s textbook, “Topology Through Inquiry” (AMS). Created > 20 technical diagrams in TikZ, including two featured as cover art. Also served as an informal proofreader for the book, identifying ≈ 4 pages of errata.	
TALKS	[T1] Forest Kobayashi. <i>Kaestner Brackets</i> . UnKnot IV Contributed Talk. July 2019. URL: https://sites.google.com/view/unknot-iv/schedule?authuser=0 .	

HONORS AND
AWARDS

UBC Four Year Doctoral Fellowship: Offered by the department to their “very best students, with priority given to incoming students.” Support of at least CA\$18,200 per year plus tuition over four years of doctoral studies.

NSF Graduate Research Fellowship (Declined for PhD studies in Canada): \$34,000 stipend + \$12,000 tuition honorarium paid annually over a three year period at any US institution.

The Greever Research Prize: Awarded to a Harvey Mudd student who has made an original contribution to the theory of mathematics. Prize given to at most one student per year, and need not be given annually. Selection made by the tenured faculty of the Department of Mathematics.

MAA Undergraduate Student Poster Session Outstanding Poster Prize (2020): Top 15% of Topology posters presented at JMM 2020.

Giovanni Borrelli Mathematics Fellowship (2019-2020): Awarded annually to a Harvey Mudd student in recognition of their outstanding potential for high-quality mathematical research. Includes a \$5000 stipend, with an additional \$1000 for travel costs.

Claremont Center for Mathematical Sciences Best Poster Prize (2019)

Harvey S. Mudd Merit Award (2016–2020): \$10,000 scholarship, “awarded to the top students in the admitted pool who demonstrate superior academic achievement and ability to contribute to the College community.”

Google Tech Challenge Orange County, First Place Team (2019): Regional intercollegiate puzzlehunt and speed-coding competition for the greater LA area.

Presidential Scholars Program Candidate (2016) • National Merit Scholarship Semifinalist (2015)

RESEARCH
EXPERIENCE

2019 Giovanni Borrelli Fellow (HMC) | Knot Theory | Summer 2019

- Advisor: Sam Nelson, Department of Mathematics, Claremont McKenna College. Paper: See [\[P1\]](#).
- Generalized previous work to define a new family of knot invariants called *Kaestner Brackets*, which include many well-known invariants such as the Jones, Alexander, and HOMFLY-PT polynomials as special cases.
- Developed fast algorithms for systematic enumeration of finite birack-related knot invariants. Current implementation runs multiple orders of magnitude faster than the previous standard, in one case completing in just 46.17 seconds on a job for which the previous version was projected to take > 50 days.

Research Intern (UnifyID) | Geometric Machine Learning | Summer 2018

- Advisor: Weiqing Gu, Department of Mathematics, Harvey Mudd College.
- Applied techniques of functional analysis & linear algebra to create geometric machine learning algorithms for [UnifyID](#).
- Helped develop & implement a high-fidelity input vectorization algorithm for time series data. Average-case performance is $O(k)$ (where $k \ll n$), and yields better accuracy when used as feature-extraction than the industry-standard $O(n^2)$ algorithm.
- Wrote a heavily-parallelized data pipeline deployed to amazon EC2 servers, improving preprocessing runtime by an order of magnitude.

Student Researcher (HMC) | CS Education | Summer 2017

- Principal Investigator: Zachary Dodds, Department of Computer Science, Harvey Mudd College.
- Poster presented at SIGCSE 2018, Paper presented at CCSC-SW 2018.
- Examined how best to improve Harvey Mudd's intro-sequence CS courses and integrate meaningful computing coursework into classes in other disciplines (e.g., History, Linguistics, Physics, Math).
- Developed > 100 pages of curricula and assignments, many of which have been integrated into introductory and intermediate level CS courses at HMC.
- Worked with professors outside of the CS department to develop computing-based coursework and teaching tools. Examples: barnes-hut n -body simulations (physics), linear algebra visualizations (math).

Research Assistant (UH Mānoa) | Phylogenetic Reconstruction | Summer 2015

- Principal Investigator: Daniel Rubinoff, University of Hawai'i at Mānoa.
- Assisted in phylogenetic reconstruction of the Hyposmocoma Moth genus through gene analysis.
- Conducted DNA extraction, PCR amplification, and Gel Electrophoresis.

GRADING &
TAING

Topology Grader | Lecturer: Francis Su | Spring 2019

- Served a small class of 11 upperclassmen / advanced underclassmen.
- Held informal tutoring sessions for students, and graded weekly homeworks / homework rewrites. Included detailed personalized feedback for each student, often > 200 words.
- Created an extensive set of guidelines for writing style in informal math documents. Link: <https://bedmathandbeyond.xyz/files/m147-guidelines.pdf>.
- Wrote up detailed solutions keys for selected pssets, examples [here](#) and [here](#).

Discrete Math Grader | Lecturers: Pippenger, Omar, Noquez | Fall 2017

- Served 3 sections of HMC's Discrete Math class, \approx 60 students.

Intro to Computer Science TA | Lecturer: Zachary Dodds | Spring 2017

- TA for a weekly lab section of \approx 80 students. Explained concepts, helped students debug code, and created challenge problems for students.
- Held frequent informal tutoring sessions.

LEADERSHIP &
OUTREACH

CyberMath | Tutor | Summer 2020

- Tutored a group of 4 students in math concepts 2x per week in 3 hour sessions.

Gateway to Exploring Mathematical Sciences | Volunteer | Spring 2019

- TA'ed a workshop introducing 8-10th grade students to concepts in Graph Theory.

Caltech Harvey Mudd Math Competition | Volunteer | Spring 2019

- Helped test-solve exam materials, and graded Individual / Team / Power rounds for [CHMMC](#).

Asso. Students of Harvey Mudd College | Dorm Co-president | 2018 – 2019

- Elected by my peers to serve as one of four Case Dorm Co-presidents. Duties included:

- Bi-weekly attendance of ASHMC Senate meetings, where I served as a representative. The ASHMC Senate decides how to allocate the ASHMC budget (roughly \$200k each year), and creates all on-campus policy.
- Creation and enforcement of all dorm policies (e.g., quiet hours).
- Managing a small discretionary fund of \$3,120 to purchase and maintain public dorm property (e.g., couches, kitchen supplies).
- Organizing dorm-wide events to continue dorm tradition & foster dorm culture. **CIPACS!**

PROGRAMMING
SKILLS

Languages: experienced in **Python**; proficient in **Julia**, **Maple**; working knowledge in **Rust**, **Mathematica**; prior experience in **SWI-Prolog**, **R**, and **Haskell**.

Software & Libraries: expert in **TikZ**; experienced with **L^AT_EX**, **Arch Linux**, **git**, **NumPy**, **Emacs**; working knowledge in **Vim**, **matplotlib**, **pandas**

Selected projects:

- **linear-presentation:** A Python program for converting signed Gauss codes into knot diagrams in which all crossings are colinear. Works for both virtual and classical knots. The algorithm abstracts the strand-routing process to simply pushing symbols between two stacks, bringing runtime down to $O(n)$ (where n is the length of the desired output diagram). Thus the asymptotic performance of the algorithm is provably optimal.
- **pset:** A set of modular **.cls** and **.sty** files for problem sets, scientific papers, books, beamer presentations, and more. Includes lots of little macros for making **L^AT_EX** faster and less painful.
- **knot-invariants:** A Python package for fast enumeration of birack-flavored knot invariants. Also includes some Julia scripts to search for infinite families of such invariants embedded into polynomial rings.
- **svg-to-tikz:** A lightweight transpiler for turning **.svg** images (e.g., Inkscape drawings) into TikZ drawings.
- **Conway-k-regular:** a Python implementation of Conway's game of life on a non-uniform tiling of convex polygons.
- **barnes-rust:** A Rust-implemented Barnes-Hut n -body simulator. Originally based on **euler** (below). Simulation is written to be general over an arbitrary number of spatial dimensions; working in 2D vs. 3D vs. n D is as simple as changing one global constant. All initial conditions are generated at runtime, sampling scalar parameters such as mass, speed, and radial distance from a choice of uniform, normal, or gamma distributions. Speed and distance are then converted into velocity and displacement by projecting down using n -d spherical coordinates. All major data structures are stored in mutexes, then wrapped in thread-safe reference-counting pointers to allow multi-threaded tree recursion somedayTM. Graphics implemented using **piston**, a modular game engine library for Rust.
- **euler:** One repo, two numerical integration projects. The first is a simple matplotlib-based animation engine for implementing & visualizing Euler's method on coupled systems of DE's (e.g., the Lorenz Attractor). The second is the original n -body simulator on which **barnes-rust** was based. Both were used as scaffolding for the CS education research listed above.

OTHER

Foreign Languages:

- Conversational in Mandarin Chinese
- Beginner in Japanese

Music:

- >18 years of Violin experience, including 6 years of chamber music (first violin).

Art:

- Various Photography gigs
- Independent study with [Ken Fandell](#). Portfolio available upon request.
- Delivered a ≈ 10 min talk to the trustees of Harvey Mudd College about Art in the student experience (Spring 2019)

REFERENCES

Sam Nelson (Sam.Nelson@cmc.edu)

Chair, Department of Mathematical Sciences, Claremont McKenna College

Francis Su (su@math.hmc.edu)

Benediktsson-Karwa Professor of Mathematics, Harvey Mudd College

Weiqing Gu (gu@hmc.edu)

McAlister Professor of Mathematics, Harvey Mudd College