4167 McHenry Library
Santa Cruz, CA 95064
kymiller@ucsc.edu
kmill.github.io

Kyle Miller

Academic Appointments

2021–present **Postdoc**, *University of California*, Santa Cruz, CA

2022–2023 **Postdoc**, *Université Paris-Saclay (FMJH)*, Orsay, France

Research Interests

I am interested in finding ways that computers can be used in mathematics, education, and engineering. I work on formalization with interactive theorem provers, and I am exploring applications of this technology beyond formal verification.

I also study low-dimensional topology, virtual knot theory, and singularity theory.

Education

2014–2022 **Ph.D.**, *University of California*, Berkeley, CA
Advisor: Ian Agol.
Thesis: *Singularity theory for extended cobordism categories and an application to graph theory.*

2008–2012 **S.B.**, *Massachusetts Institute of Technology*, Cambridge, MA
Major: Mathematics with Computer Science. Minor: Music.

Professional Experience

2023– **Research Software Engineer**, *Lean Focused Research Organization (FRO)*
I look for, specify, and implement improvements to improve the experience in using Lean, the functional programming language and interactive theorem prover.

Su2015 **Software Engineer**, *Swift Navigation, Inc.*, San Francisco, CA
Designed and implemented *Plover*, an experimental programming language for linear algebra in embedded applications, with Scott Kovach.

2013–2014 **Research assistant**, *Microsoft Research New England*, Cambridge, MA
Empirical microeconomics research with Markus Mobius and Susan Athey regarding news bias in social media. Implemented analyses to run efficiently on hundreds of terabytes of data.

2012–2013 **Software Engineer**, *Vecna Technologies, Inc.*, Cambridge, MA
Enterprise Java software for online healthcare systems.

Publications and Preprints

Published

2023 *The homological arrow polynomial for virtual links*, Journal of Knot Theory and Its Ramifications (2023), arXiv:2207.02427.

2021 Anderson, Baker, Gao, Kegel, Le, Miller, Onaran, Sangston, Tripp, Wood, and Wright, *L-space knots with tunnel number* > 1 *by experiment*, Experimental Mathematics (2021), arXiv:1909.00790.

2018 McPhail-Snyder and Miller, *Planar diagrams for local invariants of graphs in surfaces*, Journal of Knot Theory and Its Ramifications (2020), arXiv:1805.00575.

Preprints

2020 *All the ways I know how to define the Alexander Polynomial* (link to pdf)

Unpublished

2020 Gusakov, Mehta and Miller, *Formalizing Hall's Marriage Theorem in Lean.* arXiv:2101.00127.

In preparation

The design of the mathlib graph theory library

The two-variable virtual Yamada polynomial.

Surface graph invariants as extended 2D TQFTs.

Indexed stream fusion, with Scott Kovach and Fredrik Kjolstad

Talks

Invited

Jan 2024 Special Session on Algebraic Structures in Knot Theory. *The homological arrow polynomial for virtual links.*

Sep 2023 Workshop on Libraries of Formal Proofs and Natural Mathematical Language, EuroProofNet. *Informalizing formalized mathematics using the Lean theorem prover.*

Apr 2023 University of Frieburg algebra seminar. *Informalizing formalized mathematics using the Lean theorem prover.*

Apr 2023 Languages, Systems, and Data Seminar. *Informalizing formalized mathematics using the Lean theorem prover.*

Nov 2022 Université Paris-Saclay seminar on computer formalization of mathematics. *Some thoughts on formalizing basic knot theory.*

Nov 2021 UC Santa Cruz geometry and analysis seminar. *The homological arrow polynomial.*

Nov 2021 Oklahoma State University topology seminar. *The homological arrow polynomial.*

Jan 2021 Special Session on Developments in Spatial Graphs, JMM. *A 2D TQFT approach to topological graph polynomials and graphs in thickened surfaces.*

Dec 2019 University of Virginia geometry seminar. *A TQFT approach to topological graph polynomials.*

Nov 2019 Rice topology seminar. *Invariants of graphs in thickened surfaces from topological graph polynomials.*

Nov 2019 Special Session on Invariants of Knots and Spatial Graphs, Fall Western Sectional Meeting of the AMS. *Invariants of virtual spatial graphs based on topological graph polynomials.*

Expository

Su2020 UC Berkeley Lean seminar. 3 talks about math in the Lean proof assistant.

Fa2019 Student 3-manifold seminar, UCB. 6 talks on topics in 3-manifold topology.

Sp2019 Student 3-manifold seminar, UCB. 8+ talks on combinatorial 3-manifold topology.

Feb 2019 3-manifold seminar, UCB. *The arithmeticity of figure eight knot orbifolds.*

Nov 2018 3-manifold seminar, UCB. *What is an alternating knot?*

Sep 2018 GRASP, UCB. *The Jones polynomial and the Temperley–Lieb category.*

Nov 2017 Knot theory topics course, UCB. *Quandles.*

Sep 2017 3-manifold seminar, UCB. *Spatial graph invariants.*

Apr 2017 Knot Another Seminar, UCB. *The Alexander ideal.*

Workshops attended

Jun 2022 Sage Days Duluth, to further development of SnapPy and Sage

Service

Reviewed for Annales de l'Institut Henri Poincaré D: Combinatorics, Physics and their Interactions.

2021–present Maintainer for `mathlib`, the Lean mathematics library.

2021–present Maintainer for `pyquiz`, a tool for constructing Canvas math quizzes with randomness.

2020–present Contributor to `mathlib`.

Fa2019 **Student 3-Manifold Seminar (organizer)**, *University of California*, Berkeley, CA

Su2019 **KnotFolio**, an online program for recognizing and identifying drawings of knots and links. https://kmill.github.io/knotfolio

Sp2019 **Student 3-Manifold Seminar (organizer)**, *University of California*, Berkeley, CA

2015–2019 **Directed Reading Program (mentor)**, *University of California*, Berkeley, CA
Fall 2015, Spring 2017, Fall 2017, Fall 2018, Fall 2019.

Teaching Experience

University of California, Santa Cruz

Wi2024 Math 11B Calculus with Applications (172 students)

Sp2022 Math 116 Combinatorics

Wi2022 Math 110 Number Theory

University of California, Berkeley

Fa2020 Discussion sections, Math 54 Linear Algebra

Sp2020 Discussion sections, Math 1B Calculus

Sp2017 Discussion sections, Math 55 Discrete Mathematics

Fa2016 Discussion sections, Math 54 Linear Algebra

Su2016 Lecture and discussion sections, Math 54 Linear Algebra

Sp2016 Discussion sections, Math 54 Linear Algebra

Fa2015 Discussion sections, Math 1B Calculus

Sp2015 Discussion sections, Math 1A Calculus

Fa2014 Discussion sections, Math 1A Calculus

Awards

2018–2019 Awarded support by the UCB NSF Research Training Group in Geometry and Topology for Spring 2018, Spring 2019, Summer 2019, and Fall 2019.

2009 MIT Licklider UROP prize for the best undergraduate research project in the area of human-computer interaction.