Johnathan Bush

University of Florida
Department of Mathematics
PO Box 118105
Gainesville, FL 32611-8105

Office: 496 Little Hall
Email: bush.j@ufl.edu
Website: https://people.clas.ufl.edu/bush-j/

Research

I am a Post-Doctoral Associate in the Department of Mathematics at the University of Florida. I work in applied, computational, and algebraic topology.

As a member of the NSF-Simons Southeast Center for Mathematics and Biology, I work with interdisciplinary collaborators at the mathematics-biology interface.

Education

Ph.D. Mathematics, Colorado State University, August 2021.

Advisor: Dr. Henry Adams.

Thesis: *Topological, Geometric, and Combinatorial Aspects of Metric Thickenings*

M.S. Mathematics, Colorado State University, December 2018.

Advisor: Dr. Henry Adams.

Thesis: *Vietoris–Rips Thickenings of the Circle and Centrally–Symmetric Oribitopes*

B.A. Mathematics with High Honors, University of Montana, May 2016.

Advisor: Dr. George McRae.

Thesis: *Rethinking Leibniz' Infinitesimals*.

University Scholar – Davidson Honors College. Minor in Physics.

Academic Employment

Post-Doctoral Associate at the University of Florida Dept. of Mathematics, 2021–present.

I am primarily funded as a Post-Doctoral Associate by the NSF-Simons Southeast Center for Mathematics and Biology, with additional support provided by the University of Florida College of Liberal Arts and Sciences.

Graduate Research Assistant at Colorado State University Dept. of Mathematics, 2020–2021.

I was funded for four semesters as a Graduate Research Assistant under NSF Grant #1934725, *DELTA: Descriptors of Energy Landscapes by Topological Analysis*.

Graduate Teaching Assistant at Colorado State University Dept. of Mathematics, 2016–2019, 2021.

Publications

Preprints

Topological feature selection for time series data, with Peter Bubenik. Available at arXiv:2310.17494, 2023.

Gromov–Hausdorff distances, Borsuk–Ulam theorems, and Vietoris–Rips complexes, with Henry Adams, Nate Clause, Florian Frick, Mario Gómez, Michael Harrison, R. Amzi Jeffs, Evgeniya Lagoda, Sunhyuk Lim, Facundo Mómoli, Michael Moy, Nikola Sadovek, Matt Superdock, Daniel Vargas, Qingsong Wang, and Ling Zhou. Available at arXiv:2301.00246, 2023.

Peer-reviewed research articles

The topology of projective codes and the distribution of zeros of odd maps, with Henry Adams and Florian Frick. Michigan Mathematical Journal, to appear, 2023.

Toroidal Coordinates: Decorrelating Circular Coordinates With Lattice Reduction, with Luis Scoccola, Hitesh Gakhar, Nikolas Schonsheck, Tatum Rask, Ling Zhou, and Jose A. Perea. 39th International Symposium on Computational Geometry (SoCG), 2023.

Representations of energy landscapes by sublevelset persistent homology: an example with n-alkanes, with Joshua Mirth, Yanqin Zhai, Enrique G. Alvarado, Howie Jordan, Mark Heim, Bala Krishnamoorthy, Markus Pflaum, Aurora Clark, Y Z, and Henry Adams. Journal of Chemical Physics, 154:114114, 2021.

Operations on metric thickenings, with Henry Adams and Joshua Mirth. In: Spivak, D., & Vicary, J. (Eds.), Proceedings of Applied Category Theory Conference, Electronic Proceedings in Theoretical Computer Science 328:1-15, 2020.

Metric thickenings, Borsuk–Ulam theorems, and orbitopes, with Henry Adams and Florian Frick. Mathematika 66:79–102, 2020.

A torus model for optical flow, with Henry Adams, Brittany Carr, Lara Kassab, and Joshua Mirth. Pattern Recognition Letters 129:304-310, 2020. [Conference version, *On the nonlinear statistics of optical flow*, published in Proceedings of Computational Topology in Image Context, LNCS 11382:151–165, 2019.]

Book Chapter

Topological Data Analysis, with Henry Adams and Joshua Mirth. In: Carter, N. (Ed.), Data Science for Mathematicians, Chapman & Hall/CRC, New York, 2020. DOI 10.1201/9780429398292.

TEACHING

University of Florida

Linear Algebra for Data Science, MAS 4115, Spring 2024.

Linear Algebra for Data Science, MAS 4115, Spring 2023.

Linear Algebra, MAS 4105, Spring 2022.

Colorado State University

Calculus for Physical Scientists III, Math 261, Spring 2021.

Introduction to Ordinary Differential Equations, Math 340, Fall 2019.

Calculus for Physical Scientists III, Math 261, Spring 2019.

Calculus for Physical Scientists III, Math 261, Fall 2018.

Calculus for Physical Scientists I, Math 160, Spring 2018.

Calculus for Physical Scientists I, Math 160, Fall 2017.

Calculus for Biological Scientists I, Math 155, Summer 2017.

Calculus for Physical Scientists II, Math 161 (teaching assistant), Spring 2017.

Calculus for Physical Scientists II, Math 161 (teaching assistant), Fall 2016.

University of Montana

Grader and tutor:

Calculus II, Math 172, Fall 2014.

Honors Calculus II, Math 182, Spring 2014.

Honors Calculus I, Math 181, Fall 2013.

TALKS

Upcoming Talks

2024 Jan, Joint Mathematics Meeting, AMS/AIM Special Session "Applied Topology Beyond Persistence Diagrams," San Francisco, California.

Research Talks

2023 Dec, *Topological feature selection for time series: an example with* C. elegans *neuronal data* Southeast Center for Mathematics and Biology monthly meeting, Georgia Tech.

—— Nov, *Persistent homology and topological feature selection for time series data*, Geometry Seminar, University of Georgia.

—— Nov, *Topological feature selection for time series: an example with* C. elegans *neuronal data* Topology and Dynamics Seminar, University of Florida.

—— Nov, *Topological feature selection for time series: an example with* C. elegans *neuronal data*, UF-FSU Geometry and Topology Conference, Florida State University.

—— Oct, *Topological feature selection for time series: an example with* C. elegans *neuronal data*, Topology and Geometry in Neuroscience workshop, ICERM.

—— Apr, *The topology of projective codes and the distribution of zeros of odd maps*, AMS Spring Central Sectional Meeting at the University of Cincinnati.

—— Feb, *Topological data analysis for* C. elegans *neuronal data*, Southeast Center for Mathematics and Biology monthly meeting, Georgia Tech.

—— Jan, *Gromov-Hausdorff distances, Borsuk-Ulam theorems, and Vietoris-Rips complexes*, Topology and Dynamics Seminar, University of Florida.

—— Jan, *Sublevel set persistent homology of energy landscapes: examples from chemistry and mathematics*, Joint Mathematics Meeting, Mathematics Research Communities special session "Data Science at the Crossroads of Analysis, Geometry, and Topology," Boston, Massachusetts.

2022 Nov, *Vietoris–Rips complexes, projective codes, and zeros of odd maps*, Topology and Data Science Seminar at The University of Oklahoma.

—— Apr, *Vietoris–Rips complexes, projective codes, and zeros of odd maps*, Topology, Geometry, and Data Analysis Seminar, The Ohio State University.

—— March, *Gromov–Hausdorff distances between spheres*, Topology and Dynamics Seminar, University of Florida.

—— Feb, *Topological data analysis for* C. elegans *locomotion and neuronal data*, Southeast Center for Mathematics and Biology monthly meeting, Georgia Tech.

—— Feb, *Vietoris–Rips complexes of spheres and generalizations of the Borsuk–Ulam theorem*, UF/FSU Topology & Geometry Meeting, University of Florida.

2021 Nov, *Sublevel-set persistent homology of the n-alkane potential energy landscapes,* AMS Fall Southeastern Sectional Meeting, Topological Data Analysis and its Applications in Biological Systems.

—— Dec, *On Borsuk–Ulam theorems and convex sets*, Vietoris–Rips/Tight Span Joint CSU–OSU Seminar, The Ohio State University.

—— Oct, *Vietoris–Rips thickenings (Part II)*, Topology and Dynamics Seminar, University of Florida.

—— Oct, *Vietoris–Rips thickenings (Part I)*, Topology and Dynamics Seminar, University of Florida.

—— May, *Topological, geometric, and combinatorial aspects of metric thickenings*, Ph.D. final defense, Colorado State University.

—— Apr, *Maps of Vietoris-Rips metric thickenings into euclidean spaces*, Vietoris–Rips/Tight Span Joint CSU–OSU Seminar, The Ohio State University.

2020 Dec, *Borsuk–Ulam theorems for maps into higher-dimensional codomains*, Topology, Geometry and Applications Student Seminar, The Ohio State University.

—— Oct, *Borsuk–Ulam theorems for maps into higher-dimensional codomains*, AMS Fall Western Sectional Meeting, University of Utah.

—— July, *Operations on metric thickenings*, Applied Category Theory Conference, Massachusetts Institute of Technology.

—— July, *Borsuk–Ulam theorems for maps into higher-dimensional codomains*, Applied Algebraic Topology Research Network.

—— March, *A torus model for optical flow*, SIAM Front Range Student Conference, University of Colorado at Denver.

2019 Nov, *Metric thickenings of spheres*, Ph.D. preliminary examination, Colorado State University.

—— July, *Metric thickenings, orbitopes, and Borsuk–Ulam theorems*, Young Topologists Meeting 2019, École polytechnique fédérale de Lausanne, Lausanne, Switzerland.

—— June, *Metric thickenings, orbitopes, and Borsuk–Ulam theorems*, The 1st Midwest Graduate Student Conference: Geometry and Topology Meet Data Analysis and Machine Learning, The Ohio State University.

—— Apr, *Metric thickenings, orbitopes, and Borsuk–Ulam theorems*, Topology Seminar, Colorado State University.

—— Jan, *On the nonlinear statistics of optical flow*, Workshop on Computational Topology in Image Context, Universidad de Málaga, Spain.

2018 Oct, *Vietoris–Rips thickenings of the circle and centrally–symmetric orbitopes*, SPLINTER Seminar, Colorado State University.

—— Oct, *Vietoris–Rips thickenings of the circle and centrally–symmetric orbitopes*, master's thesis defense, Colorado State University.

—— Oct, *Vietoris–Rips thickenings of the circle and centrally–symmetric orbitopes*, SIAM Central States Sectional Meeting, Applied and Computational Topology session, The University of Oklahoma.

Expository and Departmental Talks

2022 Nov, *An introduction to nonstandard analysis*, University Math Society at the University of Florida.

—— April, *Vietoris–Rips complexes and the Gromov–Hausdorff distance*, Graduate Mathematics Association Colloquium, University of Florida.

—— Feb, *What is Topological Data Analysis?*, Undergraduate Mathematics Colloquium, University of Florida.

2021 Oct, *Math job panel*, Professional Development Seminar, University of Florida.

—— Oct, *An introduction to topological data analysis*, University Math Society, University of Florida.

2020 Nov, *Vietoris–Rips persistent homology and neighborhoods of embedded metric spaces*, Data Science Seminar, Colorado State University.

—— Oct, *Diameter-extremal subsets of spheres*, Greenslopes Seminar, Colorado State University.

—— Feb, *Generalizations of the Borsuk–Ulam theorem through convex geometry and cohomology*, SPLINTER Seminar, Colorado State University.

—— Feb, *Applications of Schur polynomials to the study of Barvinok–Novik orbitopes*, Greenslopes Seminar, Colorado State University.

2019 Nov, *Grothendieck's six operations on sheaves*, Category Theory Lab, Colorado State University.

—— Sept, *Borsuk-Ulam theorems and metric thickenings of spheres*, SPLINTER Seminar, Colorado State University.

—— Sept, *Borsuk-Ulam theorems in various guises and generalizations*, Greenslopes Seminar, Colorado State University.

—— Aug, *Homotopical categories $K^*(\mathcal{A})$*, Category Theory Lab, Colorado State University.

—— Apr, *An introduction to nonstandard analysis*, Greenslopes Seminar, Colorado State University.

—— Feb, *Comma categories*, Category Theory Lab, Colorado State University.

2018 Nov, *Ends and coends*, Category Theory Lab, Colorado State University.

—— Sept, *An introduction to applied algebraic topology*, Greenslopes Seminar, Colorado State University.

—— Aug, *Topoi and the category of sets*, Category Theory Lab, Colorado State University.

2016 Apr, *Rethinking Leibniz' infinitesimals*, University of Montana Conference on Undergraduate Research, University of Montana.

2014 Nov, *An ultrafilter construction of the hyperreal numbers*, Undergraduate Mathematics Seminar, University of Montana.

—— Aug, *Exploring Leibniz' infinitesimals*, Pi Mu Epsilon Student Paper Session, MAA Mathfest.

Service and Administrative

Undergraduate research

2022 – present, Organized independent reading and research on topics in applied topology

Niccolo Turillo (fall 2022)
Sean Florek (fall 2022 – present)
Nathan Weaver (spring 2023 – present)

Conference and Workshop organization

2024 Jan, Co-organizer of AMS Special Session "Applied Topology: Theory, Algorithms, and Applications" at the Joint Mathematics Meeting, San Francisco, California.

2023 Feb, Co-organizer of *University of Florida Topological Data Analysis conference*, University of Florida.

2022 March, Co-organizer of *Bridging Applied and Quantitative Topology*, virtual.

Peer-Review

2022, Symposium on Computational Geometry

2019, Symposium on Computational Geometry

Seminar Organization

2023 – present, Organizer of *Topological Data Analysis Seminar*, University of Florida.

2021 – present, Co-organizer of *Applied Algebraic Topology Research Network: Vietoris–Rips Seminar*.

2019 – 2020, Co-organizer of *Category Theory Lab*, Colorado State University.

2019, Co-organizer of *Greenslopes Seminar*, Colorado State University.

Miscellaneous

2019, Volunteer for Math Jam Junior at Windsor Charter Academy.

2016 – 2019, Volunteer for the annual Math Day at Colorado State University.

2013 – 2015, President of the University of Montana Mathematics Club.

2014 – 2016, President of the University of Montana chapter of Alpha Lambda Delta Honor Society.

Technical skills

Very experienced with Python, NumPy, scikit-learn, Pandas, LaTeX

Some experience with Mathematica, R, Julia, Tensorflow

Last updated: December 14, 2023