Henry Adams

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Academic Employment

Assistant Professor at the Colorado State University Department of Mathematics, 2015–present.

Visiting Assistant Professor at the Duke University Department of Mathematics, 2014–2015

Postdoctoral Fellow at the Institute for Mathematics and its Applications, 2013–2015.

Education

Stanford University, Ph.D. Mathematics, August 2013.
Advisor: Gunnar Carlsson.
Thesis: *Evasion paths in mobile sensor networks*

Stanford University, B.S. Mathematics with honors and distinction, 2007.
Thesis: *Spaces of range image patches*. Minor in Economics.

Grants, Awards, and Fellowships

2019 Simons Collaboration Grant for Mathematicians, on *Reconstruction via metric thickenings*.

2019 Research in Pairs Grant from the Mathematical Research Institute of Oberwolfach, on *Quantifying topology via metric thickenings*, with Florian Frick and Žiga Virk.

2017 DARPA-BAA-16-42 "Prometheus" grant, *Geometric, Topological and Dynamic Features of Early Warning of Contagious Respiratory Infection*. Senior Investigator (Principal Investigator is Professor Michael Kirby).

2015 Research in Pairs Grant from the Mathematical Research Institute of Oberwolfach, on *Behavior of geometric complexes as the scale increases*, with Michał Adamaszek.

2013–2015 Postdoctoral Fellowship at the Institute for Mathematics and its Applications.

2012–2013 Ric Weiland Graduate Fellowship, Stanford University.

2011 Stanford Centennial Teaching Assistant Award.

2007 Undergraduate Research Award, Stanford Mathematics Department.

Research

I am interested in computational topology and geometry, combinatorial topology, and applied topology, including applications to data analysis and to sensor networks.

Research Papers ($^\bullet$ denotes undergraduate student coauthor, * denotes graduate student coauthor)

17. *On Vietoris–Rips complexes of planar curves*, with Ethan Coldren$^\bullet$ and Sean Willmot$^\bullet$. Submitted and available at arXiv:1812.03374, 2019.

16. *Vietoris–Rips complexes of regular polygons*, with Samir Chowdhury*, Adam Jaffe$^\bullet$, and Bonginkosi Sibanda$^\bullet$. Submitted and available at arXiv:1807.10971, 2019.

15. *A fractal dimension for measures via persistent homology*, with Manuchehr Aminian, Elin Farnell, Michael Kirby, Chris Peterson, Joshua Mirth*, Rachel Neville, Patrick Shipman, and Clayton Shonkwiler. Accepted to appear in Abel Symposia, 2019.

14. *On the nonlinear statistics of optical flow*, with Johnathan Bush*, Brittany Carr*, Lara Kassab*, and Joshua Mirth*. Proceedings of Computational Topology in Image Context, LNCS volume 11382:151–165, 2019.

13. *Metric thickenings of Euclidean submanifolds*, with Joshua Mirth*. Topology and its Applications, 254:69–84, 2019.

12. *Metric reconstruction via optimal transport*, with Michał Adamaszek and Florian Frick. SIAM Journal on Applied Algebra and Geometry, 2:597–619, 2018.

11. *Sweeping costs of planar domains*, with Brooks Adams• and Colin Roberts•. In Erin W Chambers, Brittany T Fasy, and Lori Ziegelmeier, eds., *Research in Computational Topology*, pages 71–92, AWM Springer series, volume 13, 2018.

10. *Vietoris–Rips and Čech complexes of metric gluings*, with Michał Adamaszek, Ellen Gasparovic, Maria Gommel*, Emilie Purvine, Radmila Sazdanovic, Bei Wang, Yusu Wang, Lori Ziegelmeier. Proceedings of the 34th International Symposium on Computational Geometry, 3:1–3:15, 2018.

9. *On Vietoris–Rips complexes of ellipses*, with Michał Adamaszek and Samadwara Reddy•. Journal of Topology and Analysis, 1–30, 2017.

8. *The Vietoris–Rips complexes of a circle*, with Michał Adamaszek. Pacific Journal of Mathematics, 290:1–40, 2017.

7. *Random cyclic dynamical systems*, with Michał Adamaszek and Francis Motta. Advances in Applied Mathematics, 83:1–23, 2017.

6. *Persistence images: A stable vector representation of persistent homology*, with Sofya Chepushtanova, Tegan Emerson*, Eric Hanson, Michael Kirby, Francis Motta, Rachel Neville*, Chris Peterson, Patrick Shipman, and Lori Ziegelmeier. Journal of Machine Learning Research, 18(8):1–35, 2017.

5. *Nerve complexes of circular arcs*, with Michał Adamaszek, Florian Frick, Chris Peterson, and Corrine Previte-Johnson. Discrete & Computational Geometry, 56:251–273, 2016.

4. *Evasion paths in mobile sensor networks*, with Gunnar Carlsson. International Journal of Robotics Research 34:90–104, 2015.

3. *Nudged elastic band in topological data analysis*, with Atanas Atanasov and Gunnar Carlsson. Topological Methods in Nonlinear Analysis, 45:247–272, 2015.

2. *Javaplex: A research software package for persistent (co)homology*, with Andrew Tausz and Mikael Vejdemo-Johansson. In Han Hong and Chee Yap, editors, Proceedings of ICMS 2014, Lecture Notes in Computer Science 8592: 129–136, 2014. Software available at `http://appliedtopology.github.io/javaplex`.

1. *On the nonlinear statistics of range image patches*, with Gunnar Carlsson. SIAM Journal on Imaging Sciences 2:110–117, 2009.

Research Talks

2019 Sep, *An introduction to applied topology*, Applied Mathematics Colloquium, CU Boulder.

2019 July, Summer School on Data Science for Dynamical Systems, Lorentz Center, Leiden University, Netherlands.

2019 May, *An introduction to applied topology software*, NSF-CBMS Conference and Software Day on Topological Methods in Machine Learning and Artificial Intelligence, College of Charleston, South Carolina. Also led a week-long research conversation group, and an afternoon-long coding sprint on real-life applied topology examples for beginners.

2019 Apr, Arches Topology Conference, Hurricane, Utah.

2019 Jan, *Metric reconstruction via optimal transport*, AMS Special Session on Topological Data Analysis: Theory and Applications, Joint Mathematics Meetings, Baltimore.

2018 Nov, *An introduction to applied topology*, Symposium of Physics and Mathematics FCFM-IFM at the University of Michoacan, Morelia, Mexico.

2018 Nov, *An introduction to applied topology*, Department Colloquium, Texas State University.

2018 Nov, *Metric reconstruction via optimal transport*, Topology Seminar, Texas State University.

2018 Nov, *Metric reconstruction via optimal transport*, Upstate New York Topology Seminar (UNYTS), University of Albany.

2018 Nov, *An introduction to applied and computational topology*, Data Science Seminar, University of Tennessee.

2018 Apr, *Metric reconstruction via optimal transport*, Lafayette-Lehigh Geometry-Topology Seminar.

2018 Apr, *An introduction to applied topology*, Undergraduate colloquium, Lafayette College.

2018 Mar, *Evasion paths in mobile sensor networks*, Department Colloquium, Williams College.

2018 Jan, *The theory of Vietoris–Rips complexes*, AMS special session on Topological Data Analysis, Joint Mathematics Meetings in San Diego.

2017 Dec, *Evasion paths in mobile sensor networks*, Topological data analysis of exclusion zones, Edinburgh, Scotland.

2017 Oct, *Metric reconstruction via optimal transport*, Applied Algebraic Topology Research Network, Online Seminar.

2017 May, *Metric reconstruction via optimal transport*, 58th Cascade Topology Seminar, University of British Columbia.

2017 Mar, *The theory of Vietoris–Rips complexes*, Applied Topology Seminar, Brown University.

2017 Feb, *Vietoris–Rips complexes of circles, ellipses, and higher-dimensional spheres*, Topology, Geometry, and Data Analysis seminar, Ohio State University.

2017 Jan, *Metric reconstruction via Vietoris–Rips complexes and optimal transport*, Florida International University Winter Conference on Geometry, Topology, and Applications.

2017 Jan, *An introduction to applied and computational topology*, Florida International University Winter Conference on Geometry, Topology, and Applications.

2016 Oct, *An introduction to computational topology*, Computer Science Department Colloquium, Colorado State University.

2016 Oct, *The theory of Vietoris–Rips complexes: What is known and what is open?*, Mini-symposium on Applied and Computational Topology at the SIAM Central States Section Meeting.

2016 July, *What is topology, and how is it applied to data analysis?*, Front Range Computational & Systems Biology Symposium, Colorado State University.

2016 Jan, *Vietoris–Rips complexes of circles and ellipses*, AMS Special Session on Applied and Computational Topology, Joint Meetings, Seattle, WA.

2015 Oct, *Introduction to Javaplex software for persistent homology*, Applied Algebraic Topology Research Network, Student Online Seminar Series.

2015 July, *Introduction to Javaplex software for persistent homology*, Young Topologists' Meeting, EPFL,

Lausanne, Switzerland.

2015 Apr, *The Vietoris–Rips complexes of a circle*, University of Rochester Data Science Colloquium.

2015 Mar, *The Vietoris–Rips complexes of a circle*, Applied Algebraic Topology Research Network, Online Seminar Series.

2015 Jan, *The Vietoris–Rips complexes of a circle*, Department Colloquium, Colorado State University.

2014 Nov, *The Vietoris–Rips complexes of a circle*, Geometry and Topology Seminar, Tulane University.

2014 Nov, *The Vietoris–Rips complexes of a circle*, Applied Topology Seminar, University of Pennsylvania.

2014 Oct, *The Vietoris–Rips complexes of a circle*, Department Colloquium, University of North Carolina at Greensboro.

2014 Sept, *The Vietoris–Rips complexes of a circle*, Geometry and Topology Seminar, North Carolina State University.

2014 Mar, *Evasion paths in mobile sensor networks*, IMA Workshop on Topological Systems: Communication, Sensing, and Actuation, University of Minnesota.

2013 Nov, *Evasion paths in mobile sensor networks*, Rocky Mountain Algebraic Combinatorics Seminar, Colorado Sate University.

2013 Aug, *Evasion paths in mobile sensor networks*, SIAM Conference on Applied Algebraic Geometry, Colorado Sate University.

2013 July, *Evasion paths in mobile sensor networks*, IM PAN (Institute of Mathematics, Polish Academy of Sciences) Applied Topology, Będlewo, Poland.

2013 June, *Evasion paths in mobile sensor networks*, MSRI Workshop on Algebraic Topology, Berkeley, CA.

2013 June, *Evasion paths in mobile sensor networks*, Ayasdi Topology Day, Palo Alto, CA.

2013 May, *Evasion paths in mobile sensor networks*, CompTop Seminar, Stanford University.

2012 Aug, *Evasion paths in mobile sensor networks*, Special Session on Applied and Computational Topology at MAA MathFest, Madison, WI.

2012 July, *Evasion paths in mobile sensor networks*, Algebraic Topology: Applications and New Directions, Stanford University.

2012 July, *Evasion paths in mobile sensor networks*, Minisymposium on Applied Algebraic Topology at SIAM Annual Meetings, Minneapolis, MN.

2012 Mar, *Evasion paths in mobile sensor networks*, Schloss Dagstuhl Seminar on Applications of Combinatorial Topology to Computer Science, Dagstuhl, Germany.

2012 Jan, *Evasion paths in mobile sensor networks*, AMS Special Session on Computational and Applied Topology, Joint Meetings, Boston, MA.

2011 Oct, *Evasion paths in mobile sensor networks*, SIAM Conference on Applied Algebraic Geometry, North Carolina State University.

2011 Oct, *Nudged elastic band in topological data analysis*, SIAM Conference on Applied Algebraic Geometry, North Carolina State University.

2011 June, *Introduction to Javaplex software for persistent homology*, AMS Mathematical Research Community on Computational and Applied Topology, Snowbird, UT.

2011 Jan, *Introduction to JPlex software for persistent homology*, AMS Short Course on Computational Topology, Joint Meetings, New Orleans, LA.

2010 Jan, *Nudged elastic band in topological data analysis*, CompTop Seminar, Stanford University.

2010 Jan, *Nudged elastic band in topological data analysis*, AMS-SIAM Special Session on Applications of Algebraic Geometry, Joint Meetings, San Francisco, CA.

2009 Aug, *Introduction to JPlex software for persistent homology*, CSRI Workshop on Combinatorial Algebraic Topology, Sandia National Laboratories.

2009 June, *Topological data analysis: Understanding optical flow*, IMA Short Course on Applied Algebraic Topology, University of Minnesota.

2009 June, *Introduction to JPlex software for persistent homology*, IMA Short Course on Applied Algebraic Topology, University of Minnesota.

Departmental Talks and Expository Talks

2019 June, *An introduction to applied topology*, an REU at CU Boulder.

2019 Mar, *The waist inequality*, Topology Seminar, Colorado State University.

2018 Nov, *Lovász' proof of the Kneser conjecture*, Topology Seminar, Colorado State University.

2018 May, *Using homotopy colimits to understand infinite simplicial complexes*, Topology Seminar, Colorado State University.

2018 April, *An introduction to homotopy colimits*, Topology Seminar, Colorado State University.

2017 Oct, *Vietoris–Rips complexes of the circle*, Topology Seminar, Colorado State University.

2017 Oct, *Sperner's lemma and fair division*. Colorado State University Math Club.

2017 Sept, *An introduction to Vietoris–Rips complexes*, Topology Seminar, Colorado State University.

2016 Oct, *Cyclic polytopes and nerve complexes*, Rocky Mountain Algebraic Combinatorics Seminar, Colorado Sate University.

2015 Oct, *Evasion paths in mobile sensor networks*, Colorado State University Pattern Analysis Lab.

2015 Sept, *Random cyclic dynamical systems*, Rocky Mountain Algebraic Combinatorics Seminar, Colorado Sate University.

2015 Feb, *Evasion paths in mobile sensor networks*, Duke University Graduate & Faculty Seminar.

2014 Oct, *Vietoris–Rips complexes*, Duke University Graduate & Faculty Seminar.

2014 May, *The Vietoris–Rips complexes of a circle*, IMA Postdoc Seminar, University of Minnesota.

2013 Dec, *Introduction to discrete Morse theory*. Student Topology Seminar, University of Minnesota.

2013 Oct, *What is the Vietoris-Rips complex for evenly spaced points around a circle?*, IMA Postdoc Seminar, University of Minnesota.

2013 July, *Applied topology*. Stanford University Mathematics Camp, Guest Lecture Series, Stanford University.

2012 March, *Evasion paths in mobile sensor networks*, Graduate Student Colloquium, Stanford University.

2011 July, *Applied topology*. Stanford University Mathematics Camp, Guest Lecture Series, Stanford University.

2010 May, *Coverage problems in sensor networks*. Stanford Undergraduate Mathematical Organization, Speaker Series, Stanford University.

Teaching

Colorado State University

Math 366, Introduction to Abstract Algebra, Spring 2019.

Math 301, Introduction to Combinatorial Theory, Fall 2015, 2016, 2018, 2019.

Math 571, Topology II, Spring 2018.

Math 570, Topology I, Fall 2017.

Math 580A2, Topological Data Analysis, Spring 2017. **Developed as a new course.**

Math 435, Projects in Applied Mathematics, Spring 2017 and Spring 2016.

Math 472, Introduction to Topology, Fall 2016.

Duke University

Math 431, Introduction to Analysis, Spring 2015.

Outreach Teaching

Mini-course on *Geometric complexes in applied topology* at the TDA workshop at CIMAT, in Guanajuato, Mexico, January 2020.

Two week course on *Computational Topology* at the Universidad de Costa Rica, Summer 2017.

One week minicourse on *Computational Topology* at the REU program Summer@ICERM 2017.

Instructor, Stanford Summer Engineering Academy Math 41 and 51, Summer 2012.

The goal of the Stanford Summer Engineering Academy is to attract women and minority students to engineering majors. I taught a course on calculus and a course on linear algebra.

Graduate Student Advisees

Joshua Mirth, Department of Mathematics. Masters in Fall 2017. Current PhD student, 4th year.

John Bush, Department of Mathematics. Masters in Fall 2018. Current PhD student, 3rd year.

Lara Kassab, Department of Mathematics. Current PhD student, 2nd year.

Brittany Carr, Department of Mathematics. Current Masters student, 2nd year.

Mark Heim, Department of Mathematics (co-advised by Chris Peterson). Current PhD student, 1st year.

Alex Williams, Department of Mathematics (co-advised by Amit Patel). Current PhD student, 1st year.

Undergraduate student advisees

Lu Xian from Macalester College; main advisor is Professor Lori Ziegelmeier. Research paper *Persistent crocker plots*, 2018–present.

Ethan Coldren, bachelor's thesis and research paper *On Vietoris-Rips complexes of planar curves*, 2018–present.

Sean Willmot, research paper *On Vietoris-Rips complexes of planar curves*, 2017–present.

Adam Jaffe (Stanford University) and Bonginkosi Sibanda (Brown University), via the Summer@ICERM 2017 program. Research paper *Vietoris–Rips complexes of regular polygons*, 2017–present.

Samadwara Reddy via the Duke PRUV Fellowship. Bachelor's thesis *The Vietoris–Rips complexes of finite subsets of an ellipse of small eccentricity* and research paper *On Vietoris–Rips complexes of ellipses*, 2015–2017.

Colin Roberts, bachelor's thesis *Sweeping costs of simply-connected domains* and research paper *Sweeping costs of planar domains*, 2016–2017.

Brooks Adams, research paper *Sweeping costs of planar domains*, 2016–2017.

John Obuch, undergraduate research paper *Crystallization processes in 1-D*, 2016.

Honors option for 3 students (Isabella Zapata, Math 366, Spring 2019; Leah Gibson, Math 301, Fall 2018; Andrea Vigil, Math 301, Fall 2015).

Service and Outreach

Director of the IMA-sponsored Applied Algebraic Topology Research Network, 2017–present (and Associate Director 2016–2017), which features on online research seminar series. Recordings of our seminar are available at our YouTube Channel, which has over 350 subscribers and averages **14 hours watched per week**.

Coach for the Putnam Mathematical Competition at Colorado State University, 2015–present.

Advisor for the Mathematical Contest in Modeling team at Colorado State University, 2016–2017.

Author and maintainer of tutorials for the Javaplex and JPlex software packages for applied topology.

Co-organized a TRIPODS Summer Bootcamp on Topology and Machine Learning at ICERM, 2018, with Jeffrey Brock, Melissa McGuirl, Bjorn Sandstede, Yitzchak Solomon.

Co-organizing an ICERM Topical Workshop on Applied mathematical modeling with topological techniques, Aug 2019, with Maria D'Orsogna, Rachel Neville, Jose Perea, Chad Topaz.

Mini-symposia or special sessions organized:

2018, Minisymposium on *Applied and Computational Topology* at the SIAM Central States Section Meeting, University of Oklahoma, with Mehmet Aktas, Wenwen Li, and Murad Ozaydin.

2018, 7th Annual Minisymposium on Computational Topology at Computational Geometry Week, Budapest, Hungary, with Ellen Gasparovic and Katharine Turner.

2018, AMS special session on *Topological Data Analysis* at the Joint Mathematics Meetings in San Diego CA, with Mikael Vejdemo–Johansson.

2017, Minisymposium on *Symmetric Simplicial Complexes and Polytopes* at the SIAM Conference on Applied Algebraic Geometry, Atlanta GA, with Florian Frick.

2017, Special session on *Recent Advances in Applied Algebraic Topology* at the AMS Spring Western Sectional Meeting, Washington State University, with Bala Krishnamoorthy.

2016, Minisymposium on *Applied and Computational Topology* at the SIAM Central States Section Meeting, University of Arkansas at Little Rock, with Patrick Shipman.

Reviewer for *Mathematical Reviews* (MathSciNet), and a referee for many mathematics and computer science journals (13 reviews in 2017, 13 reviews in 2018).

Organizer of Stanford's Computational Topology Reading Group, 2011-2013.

Teaching Assistant Mentor for the Stanford Mathematics Department, 2011-2013.

Consultant for Stanford's Center for Teaching and Learning, 2011–2012.

Teaching Assistant and Counselor for the Stanford University Mathematics Camp, Summer 2007.

Teaching Assistant and Head Counselor for the Mathematical Logic program at Stanford's Pre-Collegiate Summer Institute, Summer 2007.

Memberships

American Mathematical Society (AMS)

Society for Industrial and Applied Mathematics (SIAM)