

# 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.

## RESEARCH

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

### Papers

(\* denotes undergraduate coauthor)

1. *Vietoris–Rips complexes of regular polygons*, with Samir Chowdhury, Adam Jaffe\*, and Bonginkosi Sibanda\*. Preprint, 2018.
2. *Metric reconstruction via optimal transport*, with Michał Adamaszek and Florian Frick. Submitted and available at [arXiv:1706.04876](https://arxiv.org/abs/1706.04876), 2018.
3. *Metric thickenings of Euclidean submanifolds*, with Joshua Mirth. Submitted and available at [arXiv:1709.02492](https://arxiv.org/abs/1709.02492), 2018.
4. *Sweeping costs of planar domains*, with Brooks Adams\* and Colin Roberts\*. To appear in the AWM-IMA Springer series, 2018.
5. *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. 34th International Symposium on Computational Geometry, 3:1–3:15, 2018.
6. *On Vietoris–Rips complexes of ellipses*, with Michał Adamaszek and Samadwara Reddy\*. *Journal of Topology and Analysis*, 1–30, 2017.
7. *The Vietoris–Rips complexes of a circle*, with Michał Adamaszek. *Pacific Journal of Mathematics*, 290:1–40, 2017.
8. *Random cyclic dynamical systems*, with Michał Adamaszek and Francis Motta. *Advances in Applied Mathematics*, 83:1–23, 2017.

9. *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.
10. *Nerve complexes of circular arcs*, with Michał Adamaszek, Florian Frick, Chris Peterson, and Corrine Previte-Johnson. *Discrete & Computational Geometry*, 56:251–273, 2016.
11. *Evasion paths in mobile sensor networks*, with Gunnar Carlsson. *International Journal of Robotics Research* 34:90–104, 2015.
12. *Nudged elastic band in topological data analysis*, with Atanas Atanasov and Gunnar Carlsson. *Topological Methods in Nonlinear Analysis*, 45:247–272, 2015.
13. *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>.
14. *On the nonlinear statistics of range image patches*, with Gunnar Carlsson. *SIAM Journal on Imaging Sciences* 2:110–117, 2009.

## Research Talks

- 2018 Nov, *Title TBD*, 1st Annual Upstate New York Topology Seminar (UNYTS).
- 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 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 State University.
- 2013 Aug, *Evasion paths in mobile sensor networks*, SIAM Conference on Applied Algebraic Geometry, Colorado State 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.
- 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 June, *Topological data analysis: Understanding optical flow*, IMA Short Course on Applied Algebraic Topology, University of Minnesota.

### Departmental Talks and Expository Talks

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

- 2018 April, *An introduction to homotopy colimits*, Applied Topology Seminar, Colorado State University.
- 2017 Oct, *Vietoris–Rips complexes of the circle*, Applied 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*, Applied Topology Seminar, Colorado State University.
- 2016 Oct, *Cyclic polytopes and nerve complexes*, Rocky Mountain Algebraic Combinatorics Seminar, Colorado State 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 State 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.

### Software Talks and Demonstrations

- 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.
- 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.
- 2009 Aug, *Introduction to JPlex software for persistent homology*, CSRI Workshop on Combinatorial Algebraic Topology, Sandia National Laboratories.
- 2009 June, *Introduction to JPlex software for persistent homology*, IMA Short Course on Applied Algebraic Topology, University of Minnesota.

## TEACHING

### Colorado State University

- 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.

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

### Duke University

Math 431, Introduction to Analysis, Spring 2015.

### Outreach Teaching

I taught a two week course on Applied and Computational Topology at the Universidad de Costa Rica, Summer 2017.

I taught a 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.

## AWARDS, FELLOWSHIPS, AND GRANTS

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)

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

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

Ric Weiland Graduate Fellowship, Stanford University, 2012-2013.

Stanford Centennial Teaching Assistant Award, 2011.

Undergraduate Research Award, Stanford Mathematics Department, 2007.

## GRADUATE STUDENT ADVISEES

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

John Bush, Department of Mathematics. Current PhD student.

## SERVICE AND OUTREACH

Director of the IMA-sponsored Applied Algebraic Topology Research Network, 2017-present (and Associate Director 2016-2017).

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.

Undergraduate student advisees:

Sean Willmot, *A classification of planar curves whose Vietoris-Rips graphs are cyclic*, 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.

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

Mini-symposia or special sessions organized:

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

TRIPODS Summer Bootcamp on *Topology and Machine Learning* at ICERM, Providence RI, August 2018, with Jeffrey Brock, Melissa McGuirl, Bjorn Sandstede, and Yitzchak Solomon.

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

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

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

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

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

Reviewer for *Mathematical Reviews* (MathSciNet), and a referee for many mathematics and computer science journals.

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

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

I observed and gave feedback to math department graduate student teachers.

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

I observed and gave feedback to graduate student teachers from all departments, served on Q&A panels, and ran mid-quarter student evaluations.

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)