

CHAD GIUSTI

Curriculum Vitae

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Department of Mathematics Kidder Hall 368 Corvallis, OR 97331 USA

Research focus

Topological neuroscience; computation and coding in neural systems; development of topological, algebraic, and geometric methods for scientific applications; topology of spaces of configurations and embeddings

Academic employment

- 2023 – Assistant Professor
Department of Mathematics, Oregon State University
- 2017 – 2022 Assistant Professor
Department of Mathematical Sciences, University of Delaware
Affiliations: Center for Applications of Mathematics in Medicine, Data Science Institute
- 2014 – 2017 Warren Postdoctoral Fellow
Warren Center for Network and Data Science, University of Pennsylvania
- 2012 – 2014 Postdoctoral Researcher
Department of Mathematics, University of Nebraska – Lincoln
- 2010 – 2012 Visiting Assistant Professor
Mathematics Department, Willamette University

Terminal Degree

- 2010 Ph.D. University of Oregon, Mathematics
Advisor: Dev Sinha

Journal Articles

14. Lu Li, Connor Thompson, Gregory Henselman-Petrusek, **Chad Giusti**, and Lori Ziegelmeier
MINIMAL CYCLE REPRESENTATIVES IN PERSISTENT HOMOLOGY USING LINEAR PROGRAMMING: AN EMPIRICAL STUDY WITH USERS GUIDE
Frontiers in Artificial Intelligence: Topology in Real-World Machine Learning and Data Analysis, 2021
13. **Chad Giusti** and Dev Sinha
MOD-TWO COHOMOLOGY RINGS OF ALTERNATING GROUPS
Crelle's Journal (Journal für die reine und angewandte Mathematik), 2020
12. Evelyn Tang, Marcelo Mattar, **Chad Giusti**, Sharon Thomson-Schill, and Danielle S. Bassett
EFFECTIVE LEARNING IS ACCOMPANIED BY INCREASINGLY EFFICIENT DIMENSIONALITY OF WHOLE-BRAIN RESPONSES
Nature Neuroscience, 2019
11. Joshua Cruz, **Chad Giusti**, Vladimir Itskov, and William Kronholm
ON OPEN AND CLOSED CONVEX CODES
Discrete and Computational Geometry, 2019
10. Ann Sizemore, Elizabeth A. Karuza, **Chad Giusti**, and Danielle S. Bassett
KNOWLEDGE GAPS IN THE EARLY GROWTH OF SEMANTIC FEATURE NETWORKS
Nature Human Behavior, 2018
9. Ann Sizemore, **Chad Giusti**, Richard F. Betzel and Danielle S. Bassett
CLIQUES AND CAVITIES IN THE HUMAN CONNECTOME
Journal of Complex Networks, 2017
8. Evelyn Tang, **Chad Giusti**, Graham Baum, Shi Gu, Ari E. Kahn, David Roalf, Kosha Ruparel, Ruben C. Gur, Raquel E. Gur, Theodore D. Satterthwaite, and Danielle S. Bassett
DEVELOPMENTAL INCREASES IN WHITE MATTER NETWORK CONTROLLABILITY SUPPORT A GROWING DIVERSITY OF BRAIN DYNAMICS
Nature Communications, 2017

7. **Chad Giusti**, Lia Papadopoulos, Eli T. Owens, Karen E. Daniels, and Danielle S. Bassett
TOPOLOGICAL AND GEOMETRIC MEASUREMENTS OF FORCE CHAIN STRUCTURE
Physical Review E, 2016
6. Ann Sizemore, **Chad Giusti**, and Danielle S. Bassett
CLASSIFICATION OF WEIGHTED NETWORKS THROUGH MESOSCALE HOMOLOGICAL FEATURES
Journal of Complex Networks, 2016
5. **Chad Giusti**, Robert Ghrist, and Danielle S. Bassett
TWO'S COMPANY, THREE (OR MORE) IS A SIMPLEX: ALGEBRAIC-TOPOLOGICAL TOOLS FOR UNDERSTANDING HIGHER ORDER STRUCTURE IN NEURAL DATA
Journal of Computational Neuroscience, 2016
4. Zitong Zhang, Qawi K. Telesford, **Chad Giusti**, Kelvin O. Lim, and Danielle S. Bassett
CHOOSING WAVELET METHODS, FILTERS, AND LENGTHS FOR FUNCTIONAL BRAIN NETWORK CONSTRUCTION
PLoS ONE, 2016
3. **Chad Giusti**, Eva Pastalkova, Carina Curto, and Vladimir Itskov
CLIQUE TOPOLOGY REVEALS INTRINSIC GEOMETRIC STRUCTURE IN NEURAL CORRELATIONS
Proceedings of the National Academy of Sciences USA, 2015
2. **Chad Giusti** and Vladimir Itskov
A NO-GO THEOREM FOR ONE-LAYER FEEDFORWARD NETWORKS
Neural Computation, 2014
1. **Chad Giusti**, Paolo Salvatore, and Dev Sinha
THE MOD-TWO COHOMOLOGY RINGS OF SYMMETRIC GROUPS
Journal of Topology, 2012

Preprints and drafts

6. Hee Rhang Yoon, Gregor Henselman-Petrusek, Robert Ghrist, Spencer Smith, Yiyi Yu, Lori Ziegelmeier, and **Chad Giusti**
TOPOLOGICAL TRACING OF ENCODED CIRCULAR COORDINATES BETWEEN NEURAL POPULATIONS
5. **Chad Giusti**, Gregory Henselman-Petrusek, and Lori Ziegelmeier
THE BASIS MATCHING COMPLEX: A STREAMLINED FRAMEWORK FOR PERSISTENT HOMOLOGICAL ALGEBRA
4. **Chad Giusti**, Darrick Lee, Vidit Nanda, and Harald Oberhauser,
A TOPOLOGICAL APPROACH TO MAPPING SPACE SIGNATURES
arXiv:2202.00491 [math.FA]
3. Hee Rhang Yoon, Robert Ghrist, and **Chad Giusti**
PERSISTENT EXTENSIONS AND ANALOGOUS BARS: DATA-INDUCED RELATIONS BETWEEN PERSISTENCE BAR-CODES
arXiv:2201.05190 [math.AT]
2. Haibin Hang, **Chad Giusti**, Lori Ziegelmeier, and Gregory Henselman-Petrusek
U-MATCH FACTORIZATION: SPARSE HOMOLOGICAL ALGEBRA, LAZY CYCLE REPRESENTATIVES, AND DUALITIES IN PERSISTENT (CO)HOMOLOGY
arXiv:2108.08831 [math.AT]
1. **Chad Giusti** and Darrick Lee
SIGNATURES, LIPSCHITZ FREE SPACES, AND PATHS OF PERSISTENCE DIAGRAMS
arXiv:2108.02727 [math.AT]

Funding

3. AFOSR BAA FA9550-21-1-0266, Sole PI, Jul. 2021 – June 2024, Total Funding: \$557,034
TOPOLOGICAL IDENTIFICATION AND ANALYSIS OF CYCLIC FEATURES IN NEURAL POPULATION CODING
2. NSF DMS 1854683, Lead PI, Jul. 2019 – Dec 2022, Total Funding: \$559,902, PI Giusti: \$415,948
Collaborative PIs: Gregory Henselman-Petrusek (Princeton), Lori Ziegelmeier (Macalester)
EXACT HOMOLOGICAL ALGEBRA FOR COMPUTATIONAL TOPOLOGY (EXHACT)
1. AFRL BAA FA8750-17-S-7003, Sole PI, Aug. 2018 – Aug. 2019, Total Funding: \$84,946
CLIQUE AND INDEPENDENCE COMPLEX STRUCTURES FOR SENSOR NETWORK ANALYSIS

Recent Invited Talks

- 2023 Oct. Brown U., ICERM Workshop on Topology and Geometry in Neuroscience
 Aug. Kyoto U., International Conference on Industrial and Applied Mathematics 2023, TDA Week Satellite Workshop
 Jun. Sorbonne U. Foundations of Computational Mathematics 2023, Computational Topology and Geometry Workshop
 Mar. Topos Institute, Colloquium
 Feb. U. Florida, Topological Data Analysis Meeting (keynote)
 Feb. U. California at Davis, Mathematics of Data & Decisions Seminar
- 2022 Oct. GEOTOP-A, Web Seminar series on Applications of Geometry and Topology
 Oct. Pennsylvania State U., Mathematical Biology Seminar
 Aug. U. Minnesota, IMA, Algebraic Topology and Topological Data Analysis: A Conference in Honor of Gunnar Carlsson
 Jun. Union College Math Conference, Special Session on Applied Topology
 May Brown U., ICERM Workshop on Topological and Dynamical Analysis of Brain Connectomes
 May U. South Florida, Workshop on Discrete and Topological Models in Molecular Biology
 Apr. Applied Algebraic Topology Research Network, Seminar (online)
 Jan. Oregon State U., Mathematics Colloquium
 Jan. Northeastern U., Mathematics Colloquium
- 2021 Sep. U. Amsterdam, Institute for Advanced Study Lecture Series on TDA and Information Theory.
 Aug. SIAM Conference on Applied Algebraic Geometry, Minisymposium on Algebraic Geometry of Biomedical Data
 Jul. Computational Neuroscience 2021, Workshop on Topological Insights on Brain Structure and Function
 Jun. Society of Mathematical Biology Annual Meeting, Minisymposium on Algebra, Combinatorics, and Topology in Modern Biology
- 2020 Nov. Maynooth U., Mathematics and Statistics Colloquium Talk Series
 Apr. Oregon State U., Applied Topology Seminar
 Jan. U. North Carolina – Chapel Hill, Mathematics Colloquium
- 2019 Dec. Boston U., Mathematics Colloquium
 Nov. AMS Fall Southeastern Section Meeting, Special Session on Applied Topology: Theory and Applications
 Sep. Union College Math Conference, Special Session on Applied Topology
 Jul. International Conference on Industrial and Applied Mathematics 2019, Minisymposium on Topological Data Analysis and Deep Learning
 Jul. Equidiff 2019, Minisymposium on Topological Data Analysis of Dynamical Systems
 Apr. National Institute on Drug Abuse, Invited Special Seminar
 Mar. AMS Spring Southeastern Section Meeting, Special Session on Algebraic and Discrete Methods in Mathematical Biology
- 2018 Nov. École Polytechnique Fédérale de Lausanne, Workshop on Topology and Neuroscience
 Oct. NSF/Boston U. Workshop: Integrating Neurophotonics, Statistical Physics, and Control Theory for Advancing Neuroscience
 Jun. Norwegian Mathematical Society, Abel Symposium
 May U. Houston, Networks Seminar
 Feb. U. South Florida, Mathematics Colloquium
- 2017 Sep. SIAM Central States Section Meeting, Mini-symposium on Applications of Algebraic Topology
 Sep. AMS Fall Southeastern Section Meeting, Special Session on Mathematics of Biomolecules: Discrete, Algebraic and Topological
 Jul. Foundations of Computational Mathematics 2017, Computational Topology and Geometry Workshop
 May Hausdorff Research Institute for Mathematics, International Conference on Applied and Computational Topology
 Feb. Brown U., Brown Institute for Brain Science Colloquium
 Jan. Michigan State U., CMSE Colloquium
 Jan. Joint Mathematics Meetings, AMS Special Session on Statistical Methods in Computational Topology and Applications

Software

3. *ExHACT*, Comprehensive computational homological algebra and data analysis platform
<https://github.com/exhact/exhact> (alpha release)
2. *CliqueTop*, Matlab package for computation of clique topology of symmetric matrices
<https://github.com/nebneuron/cliQUE-top>
1. *CalBlitz*, Fast, modular, low-memory calcium imaging ROI/trace extraction pipeline
<https://github.com/agiovann/CalBlitz>

Press

- 2019 Nov. What's Happening in the Mathematical Sciences, AMS
"THE SHAPE OF DATA" (section on topological neuroscience)
- 2016 Aug. MIT Technology Review
"HOW THE MATHEMATICS OF ALGEBRAIC TOPOLOGY IS REVOLUTIONIZING BRAIN SCIENCE"
- 2015 Dec. Forbes
"THERE'S A GEOMETRIC STRUCTURE HIDDEN INSIDE THE BRAINS OF RATS"
- Oct. Neuroscience News
"NEW MATH METHOD REVEALS STRUCTURE OF NEURAL ACTIVITY"

Book Chapters

2. **Chad Giusti** and Darrick Lee
ITERATED INTEGRALS AND POPULATION TIME SERIES ANALYSIS
in Proceedings of the Abel Symposium, 2020
1. **Chad Giusti** and Dev Sinha
FOX-NEUWIRTH CELL STRUCTURES AND THE COHOMOLOGY OF SYMMETRIC GROUPS
in Configuration Spaces: Geometry, Combinatorics and Topology, 2012

Other writing

3. **Chad Giusti**
Review of NICHE HIERARCHY: STRUCTURE, ORGANIZATION AND ASSEMBLY IN NATURAL SYSTEMS
SIAM Review, 2018
2. **Chad Giusti**
UNSTABLE VASSILEV THEORY
Unpublished 2011, arXiv:1107.4717v1 [math.AT]
1. **Chad Giusti**
PLUMBERS' KNOTS
Unpublished 2011, arXiv:0811.2215v3 [math.AT]

Research visits, workshops, and training programs

- 2023 Fall ICERM Semester Program on Math + Neuroscience: Strengthening the Interplay Between Theory and Mathematics (invited long term visitor)
- 2021 Spring IAS Amsterdam Workshop on High-order interactions: mixing and matching topological and information theory approaches (invited, online)
- 2018 Fall NSF/BU Workshop: Integrating Neurophotonics, Statistical Physics, and Control Theory for Advancing Neuroscience (invited)
- 2015 Summer Neurotechnologies for Analysis of Neural Dynamics, Princeton University
- 2014 Spring Scientific and Engineering Applications of Algebraic Topology, IMA, U. Minnesota (long term visitor)
- 2013 – 2014 "Development of a mathematical tool for rigorous analysis of neural activity sequences", Janelia Research Campus, HHMI (visiting scientist)
- 2012 Summer Summer course in mining and modeling of neuroscience data, Redwood Center for Theoretical Neuroscience, U. California at Berkeley
- 2010 Summer Homotopy Theory of Moduli Spaces, WCATSS, U. Oregon
- 2009 Fall Homology Theories of Knots and Links, MSRI

Current students and trainees

- Postdoc Nikolas Schonsheck
 TOPOLOGICAL COMPARISON OF CODING ACROSS NEURAL POPULATIONS
- PhD Melinda Kleczynski
 Awarded the UD University Dissertation Fellowship.
 TOPOLOGICAL METHODS IN ORNITHOLOGY AND ECOLOGY
- PhD Chung-Ping Lai (Oregon State U., co-advised with C. Escher)
 TBD, RELATED TO PERSISTENT EQUIVARIANT (Co)HOMOLOGY
- PhD Guiliamaria Menara (Università degli Studi di Trieste)
 MAGNITUDE HOMOLOGY FOR DATA ANALYSIS
- PhD Jerome Roehm
 Awarded the 2022 Baxter-Sloyer Award
 RECONSTRUCTION OF STIMULUS SPACES FROM NEURAL ACTIVATION SEQUENCES

Former students and trainees (by completion date)

- 2022 Postdoc Iris Yoon
 IDENTIFYING TOPOLOGICAL STRUCTURES IN SIMULTANEOUSLY OBSERVED SYSTEMS
 currently Assistant Professor of Mathematics at Wesleyan University
- MSDS Kaitlin Canalichio
- MSDS Colin Horgan
- 2021 Postdoc Haibin Hang
 EXACT HOMOLOGICAL ALGEBRA FOR COMPUTATIONAL TOPOLOGY (EXHACT)
- 2019 MS Alex Dishong
 REDUCTION TECHNIQUES FOR THE PERSISTENT HOMOLOGY TRANSFORM ON DIGITAL IMAGES
- 2015 MS Ann Sizemore (U. Pennsylvania, co-advised with D. Bassett)
 PERSISTENT HOMOLOGY OF NETWORK MODELS AND STRUCTURAL HUMAN BRAIN NETWORKS

Undergraduate research projects (IS = Indep. Study, SS = Summer Scholars, GEMS = Groups Exploring the Math. Sciences)

- 2022 GEMS Ziyang Jiang and Marydol Soto Santarriaga
 TRACKING CIRCULAR COORDINATES THROUGH ONE-LAYER FEED-FORWARD NETWORKS
- 2021 GEMS Sunil Narayan and Guiliamaria Menara
 GEOMETRIC INTERPRETATION OF THE MAGNITUDE HOMOLOGY OF SQUARE POLYMINOS
- 2020 IS, SS Kaitlin Canalichio
 MERGE TREE ANALYSIS FOR CLASSIFICATION OF TEAR FILM VIDEOS
 RECIPIENT: 2021 UD MATHEMATICAL SCIENCES UNDERGRADUATE RESEARCH AWARD
- IS Colin Horgan
 COMPUTATIONAL MODELS OF EEG IN TMS AND CAUSALITY ANALYSIS
- GEMS Skylar Hudson and Auguste Gezalyan
 CLOSED CONVEX CODES THAT ARE NOT OPEN CONVEX CODES
- 2018 GEMS Corey Holcomb and Alex Dishong
 TOPOLOGICAL STATISTICS FOR IMAGE ANALYSIS
- SS Miguel Fuentes
 PERCEPTRON GEOMETRIES IN 2-LAYER FEED-FORWARD NETWORKS

Public Talks

- 2016 Jun. U. Pennsylvania, Penn Network Visualization Program
- 2012 May Willamette U., U Think

Posters

- 2014 Feb. Cosyne 2014
- 2013 Dec. Topological Structures in Computational Biology, IMA
- Nov. Neuroscience 2013
- Oct. Modern Applications of Homology and Cohomology, IMA

Teaching (U. Delaware 2017 to 2022, Oregon State U. 2023 to present)

2023	Spring	Algebraic Topology (Math 636)
2023	Winter	Algebraic Topology (Math 635)
2022	Fall	Abstract Algebra (Math 451), Honors Linear Algebra (Math 349)
2022	Spring	Topological Data Analysis (Math 667)
2021	Spring	Mathematical Techniques in Data Science (Math 637)
2020	Fall	Vector Spaces (Math 672)
2019	Fall	Honors Linear Algebra (Math 349)
2019	Spring	Topological Data Analysis (Math 667, new graduate mathematics/data science course)
2018	Fall	Linear Algebra (Math 349), Vector Spaces (Math 672)
2018	Spring	Algebraic Topology (Math 829, new graduate mathematics course)
2017	Fall	Topology and Its Applications (Math 567, new undergraduate mathematics course)
2003 – 2013		38 undergraduate courses at U. Oregon, Willamette U. and U. Nebraska – Lincoln, including: Differential Geometry, Linear Algebra, Several Variable Calculus, Intro to Differential Equations, Honors Differential Equations, Discrete Math, Probability and Statistics, Calculus, Calculus for Life Sciences, Business Calculus, Elementary Functions, College Algebra, Intermediate Algebra, Contemporary Mathematics

Seminars and working groups led

2022	Summer	RAMP Linear Algebra Workshop, U. Delaware
2020	Summer	RAMP Computational Workshop, U. Delaware
2019	Summer	RAMP Linear Algebra Workshop, U. Delaware
2018	Summer	RAMP Computational Workshop, U. Delaware
		Week-long prep workshops for incoming graduate students.
2015	Spring	Applied Topology in Neuroscience, U. Pennsylvania
		Cross-disciplinary graduate/faculty working group for identifying problems in neuroscience which are candidates for algebraic-topological solutions.
2014	Fall	Topological Methods for Complex Systems, U. Pennsylvania
		Graduate/faculty lecture series on topological and categorical structures for use with graphs and networks.
2013	Fall	Algebraic Topology Seminar, U. Nebraska – Lincoln
		Graduate lecture series on the fundamentals of computations of homotopy groups, as a companion to seminars given by M. Hopkins that semester
2013	Summer	Applied Topology, U. Nebraska – Lincoln
		Graduate/faculty lecture series on persistent homology.
2007	Summer	Graduate Student Summer “Pre-School”, U. Oregon
		Two-week course for incoming graduate students covering fundamentals of algebra, analysis and topology.

Workshops and conference sessions (co)organized

2023	June	Workshop: Applied Homological Algebra Beyond Persistence Diagrams, AIM
	Jan.	Special Session on Applied Topology: Theory and Implementation, JMM 2023
2021	May	Hot Topics Workshop: Topological Insights in Neuroscience, MSRI
2019 – 2022		Workshop on Topology: Identifying Order in Complex Systems
		Every semester, location rotates (U. Delaware, U. Pennsylvania, Princeton U. Rutgers U.)
2018	Oct.	Special Session on Applied Algebraic Topology, AMS Fall Eastern Sectional Meeting 2018
2016	Jan.	Algebraic and Topological Methods for Biological Networks (two days), U. Pennsylvania
2015	May	Featured Minisymposium Applications of Algebraic Topology to Neuroscience, SIAM DS 2015

Awards and Fellowships

2017	FOCM 2017 NSF Early Career Travel Award
2015	SIAM Network Science 2015 NSF Early Career Travel Award
2010	Project NExT Fellowship
2009	Jack and Peggy Borsting Award for Scholastic Achievement in Graduate Mathematics
2008	Johnson Fellowship

University Service Activities

- 2023 Mathematics, Geometry/Topology Seminar Organizer, Oregon State U.
- 2023 Mathematics, DEJAI Committee, Oregon State U.
- 2021 Mathematical Sciences, Strategic Hiring Plan Committee, U. Delaware
- 2020 – 2021 Mathematical Sciences, Graduate Studies Committee, U. Delaware
- 2020 – College of Arts and Sciences, Natural Sciences Portfolio Diversity/Equity/Inclusion Taskforce, U. Delaware
- 2020 – Mathematical Sciences, Math Alliance Graduate Program Group, U. Delaware
- 2019 Mathematical Sciences, Advisory Committee, U. Delaware
- 2019 – 2020 Interdisciplinary Neuroscience PhD Program Development Committee, U. Delaware
- 2018 – 2019 Mathematical Sciences, Development Committee, U. Delaware
- 2017 – 2019 Data Science Foundations Cluster Search Committee, U. Delaware
- 2017 – 2018 Mathematical Sciences, Undergraduate Research Coordinator, U. Delaware
- 2017 – 2018 Mathematical Sciences, Undergraduate Affairs Committee, U. Delaware

External Service Activities

- 2017 Program Committee, International Conference on Mathematical Neuroscience 2017
- 2016 – 2022 Abstract Reviewer, COSYNE (2017, 2020, 2023)
- 2010 – 2018 AWM Mentor Network, Mentor

Reviewer/Referee for Academic Publications

Journal of Applied and Computational Topology; SIAM Applied Geometry and Algebra; PLoS Computational Biology; PLoS ONE; Neural Computation; Network Neuroscience; Journal of Computational Chemistry; Journal of Computational Physics; Journal of Neuroscience Methods; Journal of the Royal Society Interface; Brain Structure and Function; Brain Topography; Cerebral Cortex; Applied Network Science; IEEE Transactions on Network Science and Engineering; Oxford University Press; CRC Press

Current Professional Memberships

Association for Women in Mathematics (AWM), National Association of Mathematicians (NAM), Society for Industrial and Applied Mathematics (SIAM), Society for Neuroscience (SfN)