Curriculum Vitae
PETER BUBENIK

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Gainesville, FL 32611–8105   Date of CV: March 2024

Research interests

Topological data analysis and persistence theory. More broadly: topology, machine learning, statistics, algebra, biology and other applications.

Education/Employment

2020 –	Professor, Dept of Mathematics, University of Florida
2015 – 2020	Associate Professor, Dept of Mathematics, University of Florida (Preeminence hire)
2010 – 2015	Associate Professor, Dept of Mathematics, Cleveland State University
2005 – 2010	Assistant Professor, Dept of Mathematics, Cleveland State University
2003 – 2005	Postdoctoral Fellow, Swiss Federal Institute of Technology at Lausanne (EPFL) (mentor: Kathryn Hess)
2003 Ph.D.	University of Toronto, Mathematics (advisor: Paul Selick)
1997 M.Sc.	University of Toronto, Mathematics (advisor: Stephen Halperin)
1996 B.Sc	University of Guelph, Guelph, ON, Canada, Mathematics and Physics (with Honors)

Appointments / Visiting positions

2022	Academic Visitor, University of Oxford, The Mathematical Institute
2014 – 2017	Founding Director, Applied Algebraic Topology Research Network, funded by the IMA
2007	Scientific Researcher, Fields Institute, Geometric Applications of Homotopy Theory
2006	General Member, MSRI, Computational Applications of Algebraic Topology

Scientific/Academic honors, grants

2024	Invited Address, Fall 2024 Southeastern Sectional Meeting of the American Mathematical Society (AMS)
2023 – 2026	NSF DMS Research Award 2324353, Topological Learning with Multiparameter Persistent Homology ($220,000) sole PI
2022	NSF-CBMS Lecturer, Topological Data Analysis and Persistence Theory
2019 – 2022	University of Florida Term Professorship Award
2018 – 2024	NSF/Simons Research Center: Southeast Center for Mathematics and Biology, NSF DMS - 1764406, Simons award number 594594, Research subgrant RK153-G2 ($531,120) sole PI
2018 – 2022	ARO Research Award W911NF1810307, A topological heat map for data analysis ($429,881) sole PI
2017 – 2018	UFII SEED Fund, Robust Hyperspectral Image Analysis via Computational Topology ($40,000)
2013 – 2016	AFOSR Research Award FA9550-13-1-0115, Statistical Inferences from the Topology of Complex Networks ($279,430)
2011 – 2013	CSU Faculty Scholarship Initiative Award ($4,943)
2009	NSF Award DMS-0834140, CBMS Regional Conference in the Mathematical Sciences, Algebraic Topology in Applied Mathematics, ($34,108)
2008 – 2011	CSU Faculty Research Development Program Award, ($9,282)
2000 – 2001	Ontario Graduate Scholarship in Science and Technology ($15,000)
1998 – 2000	NSERC Post-Graduate Scholarship B ($34,800)
1996 – 1998	NSERC Post-Graduate Scholarship A ($31,200)
1992 – 1996	Canada Scholarship ($10,000)

Editorial activities

2021 –	Editor, Foundations of Computational Mathematics (FoCM)
2020 –	Editorial board reviewer, Journal of Machine Learning Research (JMLR)
2019 –	Editor, Homology, Homotopy and Applications (HHA)
2016 –	Associate Editor, SIAM Journal on Applied Algebra and Geometry (SIAGA)

Publications (with hyperlinks in electronic version)

Submitted research articles and preprints

7. Hubert Wagner, Nickolas Arustamyan, Matthew Wheeler, and Peter Bubenik. *Mixup Barcodes: Quantifying Geometric-Topological Interactions between Point Clouds*, 18pp. arXiv:2402.15058 [math.AT]

6. Peter Bubenik and Jose A. Velez-Marulanda. *Exact weights and path metrics for triangulated categories and the derived category of persistence modules*, 7pp. arXiv:2402.04242 [math.CT]

5. Peter Bubenik *Relative cell complexes in closure spaces*, 7pp. arXiv:2312.13227 [math.GN]

4. Peter Bubenik and Johnathan Bush. *Topological feature selection for time series data*, 15pp. arXiv:2310.17494 [math.AT]

3. Iryna Hartsock, Eunbi Park, Jack Toppen, Peter Bubenik, Elena S. Dimitrova, Melissa L. Kemp, and Daniel A. Cruz. *Topological data analysis of pattern formation of human induced pluripotent stem cell colonies*, 27pp. + 19pp. Suppl.

2. Peter Bubenik and Nikola Milićević. *Eilenberg-Steenrod homology and cohomology theories for Čech's closure spaces*, 39pp. arXiv:2112.13421 [math.AT]

1. Peter Bubenik, Vin de Silva, and Jonathan Scott. *Categorification of Gromov-Hausdorff Distance and Interleaving of Functors*, 35pp. arXiv:1707.06288 [math.CT]

Peer-reviewed research articles

2024 39. Peter Bubenik and Nikola Milićević. *Homotopy, Homology and Persistent Homology Using Closure Spaces and Filtered Closure Spaces*, Journal of Applied and Computational Topology, accepted, 53pp. arXiv:2104.10206 [math.AT]

38. Peter Bubenik and Iryna Hartsock. *Topological and metric properties of spaces of generalized persistence diagrams*, Journal of Applied and Computational Topology, (2024), 53pp. doi:10.1007/s41468-023-00157-2

37. Peter Bubenik and Michael Catanzaro. *Multiparameter persistent homology via generalized Morse theory*, Fields Institute Communications, in press, 21pp. arXiv:2107.08856 [math.AT]

2023 36. Michael J. Catanzaro, Sam Rizzo, John Kopchick, Asadur Chowdury, David R Rosenberg, Peter Bubenik, and Vaibhav A. Diwadkar. *Topological data analysis captures task-driven fMRI profiles in individual participants: A classification pipeline based on persistence*, Neuroinformatics, (2023). doi:10.1007/s12021-023-09645-3

35. Peter Bubenik, Jonathan Scott, and Donald Stanley. *Exact weights, path metrics, and algebraic Wasserstein distances*, Journal of Applied and Computational Topology, **7**, 185—219 (2023). doi:10.1007/s41468-022-00091-9 arXiv:1809.09654 [math.RA]

2022 34. Peter Bubenik and Alexander Elchesen. *Virtual persistence diagrams, signed measures, Wasserstein distances, and Banach spaces*, Journal of Applied and Computational Topology, **6**, 429–474 (2022). doi:10.1007/s41468-022-00091-9 arXiv:2012.10514 [math.AT]

33. Peter Bubenik and Alexander Elchesen. *Universality of persistence diagrams and the bottleneck and Wasserstein distances*, Computational Geometry, **105-106**, 101882 (2022) 18pp. doi:10.1016/j.comgeo.2022.101882 arXiv:1912.02563 [math.AT]

32. Leo Betthauser, Peter Bubenik, and Parker Edwards. *Graded persistence diagrams and persistence landscapes*, Discrete and Computational Geometry, **67**, 203–230 (2022). doi:10.1007/s00454-021-00316-1 arXiv:1904.12807 [math.AT]

31. Matthew Wheeler, Jose Bouza, and Peter Bubenik. *Activation Landscapes as a Topological Summary of Neural Network Performance*, 2021 IEEE International Conference on Big Data (Big Data), (2021), pp. 3865–3870. doi:10.1109/BigData52589.2021.9671368 arXiv:2110.10136 [cs.LG]

2021 30. Parker Edwards, Kristen Skruber, Nikola Milićević, James B. Heidings, Tracy-Ann Read, Peter Bubenik, and Eric A. Vitriol. *TDAExplore: quantitative analysis of fluorescence microscopy images through topology-based machine learning*, Patterns, **2** (2021), no.11, 100367. 11pp + 17pp Suppl. doi:10.1016/j.patter.2021.100367 bioRxiv:2021.06.13.448249

29. Ashleigh Thomas, Kathleen Bates, Alex Elchesen, Iryna Hartsock, Hang Lu, and Peter Bubenik. *Topological data analysis of C. elegans locomotion and behavior*, Frontiers in Artificial Intelligence, **4**:668395 (2021) 16pp. doi:10.3389/frai.2021.668395 arXiv:2102.09380 [math.AT]

28. Peter Bubenik. *Discussion of 'Event History and Topological Data Analysis'*, Biometrika, **188** (2021), no.4, 785–788. doi:10.1093/biomet/asab022 arXiv:2205.03310 [math.ST]

27. Peter Bubenik and Nikola Milićević. *Homological Algebra for Persistence Modules*, Foundations of Computational Mathematics, **21**, 1233–1278 (2021). doi:10.1007/s10208-020-09482-9 arXiv:1905.05744 [math.AT]

2020 26. Peter Bubenik and Alexander Wagner. *Embeddings of Persistence Diagrams into Hilbert Spaces*, Journal of Applied and Computational Topology, **4**, 339–351 (2020). doi:10.1007/s41468-020-00056-w arXiv:1905.05604 [cs.LG]

25. Peter Bubenik. *The persistence landscape and some of its properties*, In: Baas N., Carlsson G., Quick G., Szymik M., Thaule M. (eds) Topological Data Analysis. Abel Symposia, vol 15. Springer, 2020. pp 97–117. doi:10.1007/978-3-030-43408-3_4 arXiv:1810.04963 [math.AT]

24. Peter Bubenik, Michael Hull, Dhruv Patel, and Benjamin Whittle. *Persistent homology detects curvature*, Inverse Problems, **36** (2020) 025008 (23pp). doi:10.1088/1361-6420/ab4ac0 arXiv:1905.13196 [cs.CG]

23. Paul Bendich, Peter Bubenik, and Alexander Wagner. *Stabilizing the unstable output of persistent homology computations*, Journal of Applied and Computational Topology, **4**, 309–338 (2020). doi:10.1007/s41468-019-00044-9 arXiv:1512.01700 [cs.CG]

2019 22. Vic Patrangenaru, Peter Bubenik, Robert L. Paige, and Daniel Osborne. *Challenges in Topological Object Data Analysis*, Sankhya A, **81** (2019), 244–271. doi:10.1007/s13171-018-0137-7 arXiv:1804.10255 [stat.ME]

2018 21. Peter Bubenik and Tane Vergili. *Topological spaces of persistence modules and their properties*, Journal of Applied and Computational Topology, **2** (2018), 233–269. doi:10.1007/s41468-018-0022-4 arXiv:1802.08117 [math.AT]

2017 20. Peter Bubenik, Vin de Silva, and Vidit Nanda. *Higher interpolation and extension of persistence modules*, SIAM Journal on Applied Algebra and Geometry **1** (2017), 272–284. doi:10.1137/16M1100472 arXiv:1603.07406 [math.AT]

19. Peter Bubenik and Pawel Dlotko. *A persistence landscapes toolbox for topological statistics*, Journal of Symbolic Computation **78** (2017), 91–114. doi:10.1016/j.jsc.2016.03.009 arXiv:1501.00179 [cs.CG]

2016 18. Violeta Kovacev-Nikolic, Peter Bubenik, Dragan Nikolic, and Giseon Heo. *Using persistent homology and dynamical distances to analyze protein binding*, Statistical Applications in Genetics

and Molecular Biology **15** (2016) no. 1, 19–38. doi:10.1515/sagmb-2015-0057 arXiv:1412.1394 [stat.ME]

2015 17. Peter Bubenik, Vin de Silva and Jonathan Scott. *Metrics for generalized persistence modules*, Foundations of Computational Mathematics **15** (2015), no. 6, 1501–1531. doi:10.1007/s10208-014-9229-5 arXiv:1312.3829 [math.AT]

16. Peter Bubenik. *Statistical topological data analysis using persistence landscapes*, Journal of Machine Learning Research **16** (2015), 77–102. jmlr.org/papers/volume16/bubenik15a arXiv:1207.6437 [math.AT]

2014 15. Peter Bubenik and Jonathan A. Scott. *Categorification of persistent homology*, Discrete and Computational Geometry **51** (2014), no. 3, 600–627. doi:10.1007/s00454-014-9573-x arXiv:1205.3669 [math.AT]

14. Yuliy Baryshnikov, Peter Bubenik, and Matthew Kahle. *Min-Type Morse Theory for Configuration Spaces of Hard Spheres*, International Mathematical Research Notices **2014** (2014), no. 9, 2577–2592. doi:10.1093/imrn/rnt012 arXiv:1108.3061 [math.AT]

2012 13. Peter Bubenik. *A comment to "A microbiology primer for pyrosequencing"*, Quantitative Bio-Science **31** (2012), no. 2, 85–86. `https://qbs.kmu.ac.kr:442/!Board/down.php?wd=4&bf_code=105`

12. Peter Bubenik. *Simplicial models for concurrency*, Electronic Notes in Theoretical Computer Science **283** (2012), 3–12. doi:10.1016/j.entcs.2012.05.002 arXiv:1011.6599 [cs.DC]

2011 11. Peter Bubenik and Leah H. Gold. *Graph products of spheres, associative graded algebras and Hilbert series*, Mathematische Zeitschrift **268** (2011), no. 3–4, 821–836. doi:10.1007/s00209-010-0697-2 arXiv:0901.4493 [math.AT]

2010 10. Peter Bubenik, Gunnar Carlsson, Peter T. Kim, and Zhiming Luo. *Statistical topology via Morse theory, persistence, and nonparametric estimation*, Algebraic Methods in Statistics and Probability II, Contemporary Mathematics **516** (2010), 75–92. doi:10.1090/conm/516/10167 arXiv:0908.3668 [math.ST]

2009 9. Moo K. Chung, Peter Bubenik, and Peter T. Kim. *Persistence diagrams of cortical surface data*, in Information Processing in Medical Imaging 2009, Lecture Notes in Computer Science **5636** (2009), 386–397. doi:10.1007/978-3-642-02498-6_32

8. Peter Bubenik. *Models and van Kampen theorems for directed homotopy theory*, Homology, Homotopy and Applications **11** (2009), no. 1, 185–202. euclid.hha/1251832565 arXiv:0810.4164 [math.AT]

7. Peter Bubenik. *Context for models of concurrency*, Electronic Notes in Theoretical Computer Science **230** (2009), 3–21. doi:10.1016/j.entcs.2009.02.014 arXiv:math/0608733 [math.AT]

2008 6. George A. Bubenik and Peter Bubenik. *Palmated antlers of moose may serve as a parabolic reflector of sounds*, European Journal of Wildlife Research **54** (2008), 533–535. doi:10.1007/s10344-007-0165-4

5. Peter Bubenik. *Separated Lie models and the homotopy Lie algebra*, Journal of Pure and Applied Algebra **212** (2008), no. 2, 350–369. doi:10.1016/j.jpaa.2007.05.018 arXiv:math/0406405 [math.AT]

2007 4. Peter Bubenik and Peter T. Kim. *A statistical approach to persistent homology*, Homology, Homotopy and Applications **9** (2007), no. 2, 337–362. euclid.hha/1201127341 arXiv:math/0607634 [math.AT]

3. Peter Bubenik and John A.R. Holbrook. *Densities for random balanced sampling*, Journal of Multivariate Analysis **98** (2007), no. 2, 350–369. doi:10.1016/j.jmva.2006.01.007 arXiv:math/0608737 [math.ST]

2006   2. Peter Bubenik and Krzysztof Worytkiewicz. *A model category for local po-spaces*, Homology, Homotopy and Applications **8** (2006), no. 1, 263–292. doi:10.4310/HHA.2006.v8.n1.a10 arXiv:math/0506352 [math.AT]

2005   1. Peter Bubenik. *Free and semi-inert cell attachments*, Transactions of the American Mathematical Society **357** (2005), no. 11, 4533–4553. doi:10.1090/S0002-9947-05-03989-9 arXiv:math/0312387 [math.AT]

PhD Dissertation

2003   1. Peter Bubenik. *Cell attachments and the homology of loop spaces and differential graded algebras*, Ph.D. thesis, University of Toronto (2003), v+108pp. arXiv:math/0601421 [math.AT]

Conference abstracts (peer-reviewed and/or invited)

2015   3. Peter Bubenik. *Persistent homology and Hilbert spaces*, in *Computational Geometric and Algebraic Topology*, abstracts from 11 October – 17 October 2015, organized by Benjamin Burton, Herbert Edelsbrunner, Jeff Erickson, and Stephan Tillmann. Oberwolfach Report No. 45 (2015), draft 41–43. preliminary_OWR_2015

2008   2. Peter Bubenik. *Statistical persistent homology*, in *Computational Algebraic Topology*, abstracts from June 29th – July 5th, 2008, organized by Gunnar Carlsson and Dmitry Kozlov, Oberwolfach Report No. 29 (2008), 1611–1613. 10.4171/OWR/2008/29

2004   1. Peter Bubenik. *Context for models of concurrency*, in *Proceedings of the Workshop on Geometry and Topology in Concurrency and Distributed Computing*, Amsterdam, The Netherlands, BRICS Notes Series (2004), no. 2 33–49. NS-04-2

Other publications

2003   3. Zhi-Ming Luo, Peter Bubenik, and Peter T. Kim. *Closed model categories for presheaves of simplicial groupoids and presheaves of 2–groupoids*, 17pp. arXiv:math/0301045 [math.AT]

1997   2. Peter Bubenik. *A quasi-isomorphism for $\tilde{C}_*(X)$*. Master's Thesis, University of Toronto (1997), 9pp.

1994   1. Peter Bubenik and J.J. Simpson, A. Frumkin, H. Schwarcz, and D.C. Ford) *U-series dating of speleothems by gamma spectrometry*. Manuscript # $(GWP)^2$-NP94-03, (1994), 5pp.

Lecture series, lectures, and presentations

Lecture series

2022 Aug.   NSF-CBMS Conference on Topological Data Analysis and Persistence Theory at Valdosta State University [10 lectures, three exercise sessions, and three computer labs]

2021 June   38th Annual Workshop in Geometric Topology, Texas Christian Univ, Forth Worth TX, (Plenary speaker): Topological Data Analysis [3 hours of lectures] (online)

2019 Jan.   Kyoto University, Japan (Plenary speaker): Learning geometry using topology and persistence landscapes, Algebraic distances for persistent homology [2 hours of lectures]

2017 Jan.   Ocoyoacac, Mexico, (CIMAT): Topological Data Analysis [12 hours of lectures and workshops]

2016 June   Brookings, South Dakota (MAA Summer Seminar): Topological Data Analysis [2 hours of lectures and a 3 hour workshop]

2015 Dec.   Queretaro, Mexico (CIMAT): Topological Data Analysis [3 hours of lectures]

—— Feb.   Sendai, Japan (Tohoku Univ.): Topological Data Analysis [3 hours of lectures]

Keynote talk

2021 Feb.   University of North Carolina - Greensboro. Helen Barton Lecture: Summaries and Distances in Topological Data Analysis (online)

2018 Nov.　U. of Manitoba, Canada. Faculty of Science Interdisciplinary speaker series: Learning the shape of data

Plenary speaker

2019 June　Ohio State University 1st Midwest Graduate Student Conference: Geometry and Topology meet Data Analysis and Machine Learning. Learning the shape of data using persistence landscapes

Invited (international audience)

2023 Sept.　Computational Persistence 2023, Purdue Univ, West Lafayette, IN: Persistence: from Algebra to Analysis

—— Aug.　10th International Congress on Industrial and Applied Mathematics (ICIAM 2023), Waseda University, Tokyo, Japan: Topological Data Analysis for Biological Images and Video

2022 Dec.　Interactions of representation theory and topological data analysis, Centre for Advanced Study, Norwegian Academy of Science and Letters, Oslo, Norway: Weights and metrics for exact categories and triangulated categories

—— Oct.　GEOTOP-A Topological Data Analysis for Biological Images and Video (online)

—— June　Algebraic Topology: Methods, Computation and Science (ATMCS10), Oxford, UK: Persistent homology using filtered closure spaces

—— May　Workshop on Discrete and Topological Models in Molecular Biology, Univ of South Florida, Tampa, USA: Topological Data Analysis for Biological Images and Video

—— Jan.　Applied Algebraic Topology, London Math Society workshop, Queen Mary U. London, UK: Path metrics and algebraic Wasserstein distances (online)

2021 Nov.　Computational Persistence Workshop, Purdue Univ, West Lafayette, IN: A topological heat map for persistence (online)

—— Sept.　TES Thematic Mini-Conference, Berlin Mathematics Research Center, Berlin, Germany: Topological Data Analysis for Biological Images and Video (online)

—— July　Mathematical Congress of the Americas, Buenos Aires, Argentina: Adjoint functors and symmetric monoidal categories for topological data analysis (online)

—— July　Metrics in Multiparameter Persistence, Lorentz Center, Univ Leiden, Netherlands: Algebraic distances for generalized persistence modules (online)

2020 Dec.　NeurIPS 2020, Vancouver, BC, Canada: Topological Data Analysis for Cell Biology Images (online)

—— Oct.　Applied Algebraic Topology Research Network: Homological Algebra for Persistence Modules (online)

—— June　SIAM Conference on Mathematics of Data Science (MDS20), Cincinnati, OH: Topological Data Analysis for Biological Images (online)

2019 Dec.　Canadian Mathematical Society Winter Meeting, Toronto, ON, Canada: Distances and Angles for Topological Data Analysis

—— July　SIAM Conference on Applied Algebraic Geometry, Bern, Switzerland: Algebraic distances for persistent homology

2018 June　Abel Symposium, Geiranger, Norway: Multiparameter Persistence and Generalized Morse Theory

—— May　TGDA@OSU TRIPODS, Columbus, OH: Topological spaces of persistence modules and their properties

2017 Dec.　Brown U. (NSF TRIPODS workshop) Topological Data Analysis for Geometry not Topology

—— Aug.　Banff, Canada (BIRS): A pictorial approach to persistent homology

—— July　Barcelona, Spain (FoCM 2017): Stabilizing the unstable output of persistent homology computations

—— May   Bonn, Germany (HIM): Stabilizing the unstable output of persistent homology computations
—— Jan.   Atlanta, GA (AMS National Meeting): An Introduction to Topological Data Analysis
—— Jan.   Atlanta, GA (AMS National Meeting): Discovering Geometry using Topological Data Analysis
2016 Nov.   Montreal, Canada (CRM): Probabilistic Persistent Homology
—— Sept. Columbus, OH (MBI): Topological analysis of biological data using persistence landscapes
—— July   Toronto, Canada (World Congress in Probability and Statistics): An Introduction to Topological Data Analysis
—— May   Columbus, OH: Higher Interpolation and Extension for Persistence Modules
—— Apr.   Oxford, UK: Topological Data Analysis
2015 Oct.   Oberwolfach, Germany: Persistent homology and Hilbert spaces
—— Aug.   Victoria, Canada: Topological Data Analysis and Machine Learning
—— June   Toronto, Canada (Fields): Topological Data Analysis and Representation Theory
2014 Nov.   Copenhagen, Denmark: Statistical Topological Data Analysis
—— Oct.   Applied Algebraic Topology Research Network: Statistical Topological Data Analysis
—— Oct.   Halifax, Canada: Category theory in Topological Data Analysis
—— May   Vancouver, Canada: Generalized persistence modules, stability and generalized factors
—— May   Toronto, Canada (Fields): Statistical topological data analysis using persistence landscapes
—— Feb   Research Triangle Park, NC (SAMSI): Statistical topological data analysis
2013 July   Bedlewo, Poland: Persistent homology, metrics on diagrams and metric space valued functions
—— July   Bremen, Germany: Metrics on diagrams and persistent homology
2012 Oct.   Banff, Canada (BIRS): Inference using a new topological statistic, the persistence landscape
—— May   Columbus, OH (MBI): Toward statistical topology
—— Jan.   U. Pennsylvania Applied Topology Seminar: Persistence landscapes and categorification
—— Jan.   Boston, MA (AMS National Meeting): Persistent homology and statistical inference
2010 Jan.   Aalborg, Denmark: Cubes, simplices, horns and necklaces: concurrency and quasi-categories
2009 Aug.   Cleveland State U. (NSF/CBMS): Algebraic topology and statistics
—— Mar.   Banff, Canada (BIRS): Persistent homology and nonparametric regression
—— Jan.   Washington, DC (AMS National Meeting): Estimating the topology of functions on manifolds
2008 June   Oberwolfach, Germany: Statistical persistent homology
2006 Sept. Berkeley, CA (MSRI): A statistical approach to persistent homology
—— May   London, Canada (SSC Annual Meeting): A statistical approach to persistent homology
2005 Mar.   Montpellier, France: Using context and model categories to define directed homotopies
—— Feb.   Ottawa, Canada: Persistent homology and the analysis of high dimensional data (two talks given on behalf of Gunnar Carlsson)
2004 July   London, Canada: Towards a model category for local po-spaces

Contributed (international audience)

2008 July   Paris, France: Extremal models of concurrent systems, and directed van Kampen theorems
2006 Oct.   Berkeley, CA (MSRI): Quillen and concurrency
2005 Feb.   Ottawa, Canada: Persistent homology and directional statistics
2004 Oct.   Amsterdam, Netherlands: Context for models of concurrency

Invited (domestic audience; not including seminars)

2023 Feb.   Montana State University (math colloquium) Morse theory and Topological Data Analysis
2021 Dec.   U. Michigan Dearborn (math colloquium) Topological Data Analysis (online)
—— Aug.   Air Force Institute of Technology (math and stats colloquium) Topological Data Analysis (online)

—— Feb.   Northeastern University (math colloquium) Summaries and Distances in Topological Data
          Analysis (online)
2020 Nov. United States Military Academy West Point (math colloquium) Topological Data Analysis
          for Cell Biology Images (online)
2019 Apr. U. of Tennessee – Knoxville (math colloquium) An introduction of topological data analysis
2018 Sept. Northeastern U. (math colloquium) Mathematical aspects of topological data analysis
2017 Oct. Florida State U. (math colloquium) Topological data analysis
—— Feb.   U. Florida: Persistent homology
2014 Nov. Arlington, VA (AFOSR): Statistical topological data analysis
—— June   U. Florida (math colloquium): Toplogical data analysis
2013 Dec. Arlington, VA (AFOSR): Statistical inferences from the topology of complex networks
—— Feb   Ohio State U. (math colloquium): Categorification in applied topology
2012 Feb. Incline Village, NV (DARPA): Categorification of applied topology
2010 Nov. Case Western Reserve U. (math colloquium) Topology, statistics and brain imaging
—— Oct.   U. Virginia (stats colloquium): Nonparametric regression for topology, and brain imaging
2008 Oct. Kalamazoo, MI (AMS sectional meeting): An introduction to directed homotopy theory
—— Apr.   U. Akron (math colloquium): Directed and concurrent computing
2005 Feb. Cleveland State U. (math colloquium): A mathematical model for concurrent systems
1995 May   U. Manitoba, Winnipeg, Canada (Can Undergrad Math Conf): Random balanced samples

Seminars and other specialized topics talks
2023 Sept. U. Florida Topology and Dynamics: Persistence: from Algebra to Analysis
—— Sept. U. Florida Analysis: A Riesz-Markov-Kakutani representation theorem for metric spaces with
          a distinguished subset and relative optimal transport
—— June   KTH, Opponent at a public defence of doctoral thesis, Stockholm, Sweden: Introduction to
          Topological Data Analysis
—— Feb.   Centro de Investigación en Matemáticas (CIMAT) Applied Geometry and Topology Seminar,
          Guanajuato, GTO, Mexico: Persistent homology using filtered closure spaces (online)
2022 Sept. U. Florida Topology and Dynamics: Exact weights, path metrics, and algebraic Wasserstein
          distances
—— Apr.   U. Florida Topology and Dynamics: Persistent homology using closure spaces and filtered
          closure spaces
—— Mar.   Dartmouth U. Machine Learning Seminar, Activation Landscapes: a topological summary of
          neural networks (online)
—— Mar.   Queen Mary U. London, London, UK: Statistics and Data Science Seminar, Applied Algebraic
          Topology Using Čech's closure spaces
—— Feb.   Applied Topology Seminar, U. of Oxford, Oxford, UK: Applied Algebraic Topology Using
          Čech's closure spaces
2021 Nov. U. Florida Topology and Dynamics: Multiparameter persistent homology via generalized
          Morse theory (online)
2020 Nov. U. Florida Topology and Dynamics: Topology and Deep Learning (online)
2019 Sept. U. Florida Topology and Dynamics: Algebraic distances for persistent homology
—— Nov.   U. Florida SIAM: An introduction to Topological Data Analysis
—— May.   SCMB PI talk: Learning Geometry in Biological Images using Topological Data Analysis
2018 Oct. U. Florida Topology and Dynamics: The persistence landscape and some of it properties
—— Aug.   Georgia Tech U. SCMB Kickoff: Learning the shape of data
—— Feb.   Michigan State U. Machine Learning: Learning the shape of data
2017 Sept. U. Florida Topology and Dynamics: Topological spaces of persistence modules (2 talks)
2016 Feb. U. Florida Topology and Dynamics: Interpolation and Extension of Persistence Modules

2016 Feb.   U. Florida Topology and Dynamics: Interleaving, Gromov-Hausdorff, and dynamical systems
2015 Sept. U. Florida Comp. Inf. Sci. & Eng. Algorithms and Theory: Learning the shape of data
—— Sept. U. Florida Topology and Dynamics: Persistent homology (2 talks)
2014 Fall   Cleveland State U. Topology-Geometry-Algebra: Representations and persistence (5 talks)
—— Spr.   Cleveland State U. Topology-Geometry-Algebra: Random simplicial complexes (3 talks)
2013 Nov.   Ohio State U. Topology, Geometry, Data: A central limit theorem for topology
—— Nov.   IAS/Penn/Rutgers Workshop on Topology: A central limit theorem for topology
—— Spr.   Cleveland State U. Topology-Geometry-Algebra: Polynomial differential forms (5 talks)
2011 Spr.   Cleveland State U. Topology-Geometry-Algebra: Discrete Morse Theory (6 talks)
2010 Feb.   Ohio State U. Geometry Topology Data: Assembling geometric data, statistics & topology
2009 Apr.   Penn State U. Altoona Topology: Directed homotopy theory
—— Apr.   Wayne State U. Topology: Directed homotopy theory
2008 Nov.   Duke U. Probability: Estimating the topology of functions on manifolds from noisy samples
—— Nov.   U. Oregon Topology: An introduction to directed homotopy theory
—— Mar.   John Carroll U. Geometry/Topology: Directed van Kampen theorems (2 talks)
2007 Nov.   John Carroll U. Geometry/Topology: Directed topology and concurrent systems (2 talks)
—— Aug.   U. Guelph Mathematics and Computer Science: A mathematical model for parallel computing
2005 Oct.   John Carroll U. Geometry/Topology: The geometry and topology of point cloud data
—— May   EPFL Statistics: A statistical approach to algebraic topology
—— Feb.   Stanford U. Applied Topology: A statistical approach to persistent homology
2004 Nov.   U. Guelph Mathematics: A mathematical model for concurrent systems

Outreach talks, panels, and other presentations

2023 Apr.   Community School of Naples Mathematics Honor Socity: Does Data have Shape?
—— Apr.   U. Florida Undergraduate Mathematics Society: Computing the Shape of Data
2022 Oct.   U. Florida Simple words: Topological data analysis
2021 Aug.   Applied Algebraic Topology Research Network: Interview of Kathryn Hess (online)
2018 Mar.   U. Florida Informatics Institute Annual Symposium: Topological Data Analysis and Hyperspectral Imaging
—— Jan.   U. Florida Data Science Institute Symposium: Learning the shape of data
2017 Mar.   U. Florida Graduate Mathematics Association Colloquium: Geometry, Algebra, Topology and Data
—— Jan.   National Intelligence University, Advanced Data Analytics Curriculum Development Workshop
2015 Sept. U. Florida Graduate Mathematics Association Colloquium: Topological Data Analysis
2014 July   NASA Glenn Research Center (Summer intern seminar): An introduction to computational topology and topological data analysis
2012 Feb.   Cleveland State U. Undergraduate Student Seminar: Surfaces using paper, scissors and tape
2011 Mar.   Cleveland State U. Undergraduate Student Seminar: Hands-on knot theory
2010 Sept. Cleveland State U. Undergraduate Student Seminar: Hands-on knot theory

Organizing activities (conferences, meetings, etc.)

2024   Feb.   Organizer: University of Florida Topological Data Analysis conference.
2023   July   Scientific Committee Member: TDA week 2023, Kyoto University, Kyoto, Japan
2023   Feb.   Organizer: University of Florida Topological Data Analysis conference.
2022   Jan.   Organizer: University of Florida Topological Data Analysis conference.
2020   June   Organizer (with Vidit Nanda, Don Stanley, and Stephen Theriault): Workshop on Topological Data Analysis, Fields Institute, Toronto, ON, Canada (online).

2020	June	Scientific Committee Member: Algebraic Topology: Methods, Computation, and Science, Ohio State University, Columbus, OH (postponed due to COVID-19).
2020	Jan.	Organizer: University of Florida Topological Data Analysis conference.
2019	Nov.	Organizer (with Natasha Jonoska): AMS Special Session on Applied Topology: Theory and Applications. U Florida.
2018	Aug.	Organizer (with Ryan Budney and Michael Lesnick): CMO/BIRS workshop on Multiparameter Persistent Homology at Casa Matematica Oaxaca (CMO), Mexico.
2018	June	Scientific Committee Member (with Ulrich Bauer, Paul Bendich, Benjamin Burton, Tamal Dey, Michael Lesnick, Frank Lutz, and Amit Patel): Algebraic Topology: Methods, Computation and Science, IST Austria.
2018	May	Scientific Committee (with Larry Wasserman): TRIPODS Center Workshop on Theory and Foundations of Topology Geometry and Data Analysis, Columbus, OH.
2017	Feb.	Organizer (with Phil Boyland): UF/FSU Topology and Dynamics Conf., Gainesville, FL
2017	Jan.	Organizer: Applied Algebraic Topology Research Network Seminar Series (6 speakers)
2016	Sept.	Organizer: Applied Algebraic Topology Research Network Seminar Series (6 speakers)
2016	Jul.	Scientific Committee Member (with Omer Bobrowski, Jacek Brodzki, Massimo Ferri, Elizabeth Munch, Giovanni Petri, Radmila Sazdanovic, Francesco Vaccarino, and Dhandapani Yogeshwaran): Conference on Applied Topology: Computation, Methods, and Science, Turin, Italy
2016	Jan.	Organizer: Applied Algebraic Topology Research Network Seminar Series (8 speakers)
2015	Oct.	Organizer: Applied Algebraic Topology Research Network Seminar Series (5 speakers)
2015	Jan.	Organizer: Applied Algebraic Topology Research Network Seminar Series (12 speakers)
2014	Sept.	Organizer: Applied Algebraic Topology Research Network Seminar Series (9 speakers)
2013	Aug.	Organizer (with Dmitriy Morozov and Mikael Vejdemo Johansson): SIAM Mini-symposium on Applied and Computational Topology at the Conference on Applied Algebraic Geometry, Fort Collins, CO
2012	Oct.	Lead Organizer (with Matthew Kahle): Special Session on Applied Topology at the AMS Sectional Meeting, Akron, OH
2009	Aug.	Lead Organizer (with John Oprea): NSF/CBMS conference on Algebraic Topology in Applied Mathematics at Cleveland State University
		NSF DMS-0834140: $34,108 (lead PI)
2009	Mar.	Lead Organizer (with Gunnar Carlsson and Peter T. Kim): BIRS Workshop on Data Analysis using Computational Topology & Geometric Statistics at Banff, Canada

Advisory boards

2017 –	Applied Algebraic Topology Research Network https://aatrn.net Summary: Promotes and enables collaboration in algebraic topology applied to the sciences and engineering by connecting researchers through a virtual institute. Seed funding provided by the Institute for Mathematics and its Applications (IMA).

Referee and review activities

Journals refereed (80 total)

    Advances in Mathematics
    Algebraic and Geometric Topology
    Annals of Applied Statistics
    Applicable Algebra in Engineering, Communication and Computing
    Bernoulli Journal
    Bulletin of Mathematical Biology
    Canadian Journal of Mathematics
    Discrete and Computational Geometry
    European Journal of Applied Mathematics
    Forum of Mathematics, Sigma
    Foundations of Computational Mathematics
    Glasgow Mathematical Journal
    Homology, Homotopy and Applications
    IEEE Transactions on Network Science and Engineering
    Inverse Problems
    International Journal of Computational Geometry and Applications
    Journal of Applied and Computational Topology
    Journal of Computational Geometry
    Journal of Homotopy and Related Structures
    Journal of Machine Learning Research
    Revista Matemática Iberoamericana
    Journal of Mathematics and Music
    Journal of Multivariate Analysis
    Journal of Pure and Applied Algebra
    Journal of Topology
    Mathematical Methods in the Applied Sciences
    Order
    Physica D
    Proceedings of the American Mathematical Society
    Proceedings of the National Academy of Sciences
    SIAM Journal of Applied Algebra and Geometry
    Theoretical Computer Science
    Theory and Applications of Categories
    Topological Methods in Nonlinear Analysis
    Topology Proceedings
    Transactions on Pattern Analysis and Machine Intelligence

Conference proceedings refereed

    AWM/Springer
    Abel Symposium

Conferences refereed

    Algebraic Topology: Computation, Methods and Science (ATMCS)
    Symposium on Computational Geometry (SOCG)

Granting agencies review panel(2 total)

National Science Foundation (NSF)

Granting agencies ad-hoc reviewer(12 total)

Air Force Office of Scientific Research (AFOSR)
Army Research Office (ARO)
Austrian Science Fund (FWF)
Banff International Research Station (BIRS)
Department of Energy (DOE)
Israel Science Foundation (ISF)
National Science Foundation (NSF)
National Sciences and Engineering Research Council of Canada (NSERC)
Swiss National Science Foundation (SNSF)

Books refereed

Cambridge University Press
Springer (2 reviews)
American Mathematical Society

External reviewer for PhD defense

Ecole polytechnique, Theo Lacombe (student of Steve Oudot and Marco Cuturi), 2020
Oxford Univ, Oliver Vipond (student of Ulrike Tillmann and Vidit Nanda), 2021
Tampere Univ, Markus Klemetti (student of Eero Hyry), 2021

Miscellaneous review activities

- Book chapter – Springer
- Tenure and Promotion External Letter
- External M.Sc. thesis review (for Violeta Kovacev-Nikolic, student of Giseon Heo, University of Alberta, 2012)
- *AMS Mathematical Reviews* reviewer (26 reviews)

Teaching activities

Course development at Florida

2017	Special Topics in Mathematics: Topological Data Analysis (MAT 4930) I developed a new course to introduce our undergraduate students to topology and how it can be used in applications, and also to introduce some of the most important tools in modern data science.
2017	Advanced Topics in Topology 2 (MAT 6932) I have developed a course to introduce our graduate students to some powerful mathematical tools for organizing mathematical structures and computations: category theory, homological algebra and spectral sequences.
2016	Advanced Topics in Topology (MTG 7396) I have developed a course to introduce our graduate students to new areas of current research in topology and their connections with other ares of mathematics and the sciences.

Course development at Cleveland State

2015	Special Topics in Mathematics – Topology (MTH 493/593) I developed a new course in Topological Data Analysis, accessible to students without prior knowledge of topology, in which they spent half of their class time in a computer lab learning to use Matlab to analyze data with topological tools.

2008–2013   Real Analysis (MTH 381 and MTH 415/515) This course had not been taught in many years. I redeveloped it and led the creation of a new cross-listed course accessible to undergraduate and graduate students to help ensure its viability.

Courses taught at Florida

2023 Spring Topology 2 (MTG 6347)
2022 Fall   Topology 1 (MTG 6346)
2021 Spring Elements of/Introduction to Topology 2 (MTG 4303/5317)
2020 Fall   Special Topics – Topological Data Analysis and Machine Learning (MAT 4930)
2020 Spring Advanced Topics in Topology 2 (MTG 7347)
2019 Fall   Advanced Topics in Topology 1 (MTG 7346)
2019 Spring Topology 2 (MTG 6347)
2018 Fall   Topology 1 (MTG 6346)
2018 Spring Elements of/Introduction to Topology 2 (MTG 4303/5317)
2017 Fall   Elements of/Introduction to Topology 1 (MTG 4302/5316)
2017 Fall   Special Topics – Topological Data Analysis (MAT 4930)
2017 Spring Advanced Topics in Topology 2 (MAT 6932)
2016 Fall   Advanced Topics in Topology (MTG 7396)
2016 Spring Topology 2 (MTG 6347)
2015 Fall   Topology 1 (MTG 6346)

Courses taught at Cleveland State

2015 Spring Special Topics in Mathematics – Topology (MTH 493/593)
2014 Spring Calculus 2 (MTH 182)
2013 Fall   Real Analysis (MTH 415/515)
2013 Spring Junior Seminar (MTH 396)
2013 Spring Calculus 1 (MTH 181)
2012 Fall   Linear Algebra/Functions of Several Variables (MTH 514)
2012 Fall   Calculus 1 (MTH 181)
2011 Summer Calculus 1 (MTH 181)
2011 Summer Precalculus 1 (MTH 167)
2011 Spring Calculus 1 (MTH 181)
2011 Spring Precalculus 2 (MTH 168)
2010 Fall   Special Topics - Topology (MTH 493/593)
2010 Fall   Statistical Methods (MTH 323)
2010 Spring Junior Seminar (MTH 396
2010 Spring Precalculus 2 (MTH 168)
2009 Fall   Geometry (MTH 333)
2009 Fall   Multivariable Calculus (MTH 281)
2009 Spring Differential Geometry (MTH 434/534)
2009 Spring Junior Seminar (MTH 396)
2009 Spring Precalculus 1 (MTH 167)
2008 Fall   Honors Calculus 2 (MTH 182H)
2008 Spring Analysis (MTH 381)
2008 Spring Honors Calculus 2 (MTH 182H)
2007 Fall   Geometry (MTH 333)
2007 Fall   Honors Calculus 2 (MTH 182H)
2007 Spring Geometry (MTH 333)
2007 Spring Honors Calculus 2 (MTH 182H)

2006 Spring Honors Calculus 2 (MTH 182H)
2006 Spring Calculus 2 (MTH 182)
2005 Fall   Calculus 1 (MTH 181)

Courses taught at Toronto

2001 Fall   Calculus 1 (MAT 186)

Seminars organized at Florida

2016 Spring Student Applied Topology Seminar: I started this new weekly seminar in which eight
                students gave talks.

Mentoring activities

Postdocs mentored at Florida

2021–   Johnathan Bush
2019–   Matthew Wheeler
2019–2021   Ashleigh Thomas
2018–2019   Michael Hull (now Assistant Professor at UNC-Greensboro)
2016–2018   Michael Catanzaro (now Assistant Professor at Iowa State Univ)

Ph.D. students advised at Florida

2023–   Wanchen Zhao
2023–   Zachary Thomas
2022–   Himanshu Yadav
2018–2023   Iryna Hartsock, graduating May 2023 (now a postdoc at the Moffitt Cancer Center)
2017–2022   Alexander Elchesen, graduated May 2022 (now a 3-year postdoc at Colorado State
             Univ)
2017–2021   Nikola Milicevic, graduated May 2021 (now a 3-year postdoc at Penn State Univ)
2016–2020   Parker Edwards, graduated May 2020 (was a 3-year postdoc at Univ of Notre Dame,
             and now a tenure-track Assistant Professor at Florida Atlantic University)
2016–2020   Alexander Wagner, graduated May 2020 (was a Phillip Griffiths Assistant Research
             Professor at Duke Univ for 3 years, and is now a Research Scientist at Teledyne Tech-
             nologies)
2016–2018   Leo Betthauser, graduated Dec 2018 (now a Senior Research Scientist at Microsoft
             Research)

Masters students supervised at Florida

2017–2018   Dhruv Patel (now PhD student in Statistics at UNC-Chapel Hill)

Undergraduate students supervised at Florida

2020–2023   Jiun Cho: Topological data analysis
2020–2023   Ryan Elkind: Topological data analysis and biomedical images
2020–2021   Vishweshwar Ramanakumar: Topological data analysis and deep neural networks
2020–2021   Max Zhang: Topological data analysis and deep neural networks (transferred to Cornell
             Univ)
2020–2022   Jenesis Escobar: Topological data analysis and computer vision
2019–2020   Gianfranco Cortes: Multiparameter persistent homology

2019–2020   David Freeman: Topological data analysis of biological images (now a PhD student in Atmosphere Ocean Science and Mathematics at the Courant Institute)
2019   Ana Pilar Ysasi Cillero: Persistent homology of random walks (now a graduate student at the Univ of Chicago)
2018–2020   Jose Bouza: Topological Data Analysis Tools for R (now a graduate student in Computer Science at Univ of Florida)
2016–2018   Samuel Rizzo: Topological Data Analysis of fMRI data (now a graduate student in Mathematics at Vanderbilt)
2016–2017   Dhruv Patel: Persistent Homology and Curvature (now a PhD student in Statistics at UNC-CH)
2015–2018   Benjamin Whittle: Persistent Homology and Curvature

Visiting researchers at Florida

2016–2017   Tane Vergili (now at Karadeniz Technical University, Trabzon, Turkey)

Other graduate student independent study supervised at Florida

2016   Nicolas Sizemore: Representation Theory of Quivers
2015   Alexander Gruber: Persistence Landscapes

Undergraduate Minority/Multicultural Mentoring (UMMP) at Florida

2019–2020   Xinyi Zhang
2018–2019   Emma Viola
2016–2017   Dylan Santalo

Masters students advised at Cleveland State

2013–2014   Luo Yixi: Persistent homology of random polynomials
2011–2012   Brian Feister: Topology, geometry and brain imaging

Visiting Masters students mentored

2013–2014   Coralie Spahn (EPFL, Switzerland; at Cleveland State)

Undergraduate students supervised at Cleveland State

2014   Zachary McCarthy: Color theory and matrix groups
2014   Kelton Anderson: Knot theory
2013–2014   Matthew McDonald: Moiré patterns
2010–2011   Arlist Hunter: Complex analysis
2010–2011   Eden Kovacik: Knot theory
2010–2011   Daniel Limeer: Probability theory and graphs

University service

University committees at Cleveland State

2012 – 2014   College Budget and Planning
2011 – 2014   University Research Council
2010 – 2014   Graduate Council

Departmental service

Departmental committees at Florida

2023 –	Center for Applied Mathematics (Co-Director)
2023 –	Graduate Commitee
2022 – 2023	Tenure-track Faculty Search Commitee
2020 –	Tenure and Promotion Commitee
2019 – 2020	Tenure-track Faculty Search Commitee (Chair, hired two tenure-track faculty)
2019 – 2021	Chair's Advisory Commitee
2018 – 2021	VAP (Postdoc) Search Committee (Chair)
2017 – 2018	Faculty Search Committee (hired six tenure-track faculty)
2016 – 2018	Steering Committee (Speaker: 2017 – 2018))
2016 – 2021	Hiring Plan Committee
2015 – 2016	Postdoc Search Committee (Chair)
2015 – 2021	Colloquium, Conferences, Visitors & Travel
2015 –	PhD Topology Exam Committee (Chair: 2018 – 2019)
2015 –	First-Year Topology Exam Committee (Chair: 2017 – 2018)

Mentoring at Florida

2023 –	Henry Adams
2022 –	Jeremy Booher
2021 –	Hubert Wagner
2021 –	Johnathan Bush
2019 – 2020	Ashleigh Thomas
2019 – 2020	Matthew Wheeler
2018 – 2023	Luca Di Cerbo

Departmental committees at Cleveland State

2013 – 2014	Appointments (chair)
2013 – 2014	Graduate Program
2010 – 2011	Appointments (chair)
2010 – 2011	Graduate Program
2009 – 2010	Graduate Program (chair)
2009 – 2010	Colloquium (chair)
2007 – 2011	Appointments
2007 – 2010	Undergraduate Advising
2007 – 2010	Library
2007 – 2008	Computer Needs and Math Lab
2005 – 2006	Graduate Program

Departmental committees at Toronto

2000 – 2001	Graduate
1998 – 1999	Graduate

PhD Dissertation committees

Alexander Donald (in progress, Florida, Mathematics)
Aditya De Saha (in progress, Florida, Mathematics)
Deep Kundu (in progress, Florida, Mathematics)
Yara Skaf (2023, Florida, Mathematics)
Lauren Wickman (2022, Florida, Mathematics)
Jamie Scott (2022, Florida, Mathematics)
Trevor Davila (2020, Florida, Mathematics)
Alexander Gruber (2019, Florida, Mathematics)
Lacey Johnson (2019, Florida, Mathematics)
Joshua Hiller (2017, Florida, Mathematics)
Ryan Madden (2016, Cleveland State, Mechanical Engineering)

Publicity

Publicity at Florida

2021	Nov.	AAAS EurekAlert: News release on TDAExplore
2018	May	NSF: Announcement of NSF/Simons $10M Center
2018	May	Simons Foundation: Announcement of NSF/Simons $10M Center
2018	May	GATech: Announcement of NSF/Simons $10M Center
2018	June	Florida CLAS: Article on NSF/Simons $10M Center
2016	Feb.	Article in the Feb/Mar 2016 issue of the MAA Focus magazine advertising the MAA Summer School for which I was the keynote speaker.

Publicity at Cleveland State

2014	Mar.	Article in Engaged, CSU eDigest, on my persistence landscape.
2014	Apr.	CSU Office of Research: Featured Researcher video
2013	Apr.	Cleveland Stater: Front page article on AFOSR grant
2013	Mar.	Engaged, CSU blog: Article on geometry of complex data
2008	Mar.	Plain Dealer (Cleveland daily): Front page article on antlers and sound
2008	Mar.	NPR/CBC As it happens: National broadcast on antlers and sound
2008	Mar.	Ottawa Citizen (daily newspaper): Article on antlers and sound
2008	Mar.	National Post (Canadian daily): Article on antlers and sound
2008	Mar.	The Guardian: Article on antlers and sound
2008	Mar.	The Independent: Article on antlers and sound
2008	Mar.	BBC: Article on antlers and sound