Christopher J. Tralie

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Research Interests

Geometric signal processing, applied topology, nonlinear time series analysis, music information retrieval, video processing, computer graphics

Academic Positions

8/1/2019 - Present	**Assistant Professor of Mathematics And Computer Science**, *Ursinus College. Collegeville, Pennsylvania.*
1/2019 - 6/2019	**Postdoctoral Fellow, Department of Chemical And Biomedical Engineering**, *Johns Hopkins University. Baltimore, Maryland.*
4/2017 - 12/2018	**Postdoctoral Associate, Department of Mathematics**, *Duke University. Durham, North Carolina.*

Education

2011 - 2017	**Ph.D.**, ***Duke University***, Durham, NC, *Electrical and Computer Engineering with Certificate in College Teaching.*
	Advisers: Guillermo Sapiro, John Harer
	Dissertation Title: "Geometric Multimedia Time Series"
2011 - 2013	**M.S.**, ***Duke University***, Durham, NC, *Electrical and Computer Engineering.*
2007 - 2011	**B.S.E.**, ***Princeton University***, Princeton, NJ, *Electrical Engineering with Certificate in Computer Science* (Cum Laude).

Honors and Awards

2018	Deezer Hacking Audio And Music Research (HAMR) Best Code Award, Paris, France
2016	Top 5% Teachers At Duke: Dean's award for ranking among top 5% (university wide) in student evaluations for *Quality of Course or Intellectual Stimulation*, Duke University, Spring 2016
2015	Duke University Department of Electrical Engineering Best Poster Award
2015	Duke University Bass Family Teaching Fellowship
2011	National Science Foundation Graduate Fellowship
2011	G. David Forney Jr. Prize in Signals and Systems at Princeton University
2009	Summer Undergraduate Fellowship in Robotics at Duke University: *Awarded through the National Science Foundation's Research Experience for Undergraduates (REU) Program*
2007	Lockheed Martin National Merit Scholar
2006	Pennsylvania Governor School for the Sciences, *Carnegie Mellon University*

Publications

Journal Publications

Paul Bendich, Ellen Gasparovic, John Harer, and Christopher J. Tralie. Scaffoldings and spines: Organizing high-dimensional data using cover trees, local principal component analysis, and persistent homology. *Research in Computational Topology*, 13, 2018.

Christopher J Tralie. Self-similarity based time warping. *arXiv preprint arXiv:1711.07513 (In Submission)*.

Christopher J. Tralie and Jose A. Perea. (quasi)periodicity quantification in video data, using topology. *SIAM Journal on Imaging Sciences*, 11(2):1049–1077, 2018.

Boyan Xu, Christopher J. Tralie, Alice Antia, Michael Lin, and Jose A. Perea. Twisty takens: A geometric characterization of good observations on dense trajectories. *Journal of Applied And Computational Topology (JACT)*, 2019.

Published Refereed Conference Proceedings

Travis Deyle, Christopher J Tralie, Matthew S Reynolds, and Charles C Kemp. In-hand radio frequency identification (rfid) for robotic manipulation. In *IEEE International Conference on Robotics and Automation (ICRA), Karusruhe, Germany*, pages 1234–1241. IEEE, 2013.

Francis Motta and Christopher J. Tralie. Hyperparameter optimization of topological features for machine learning applications. In *Proceedings of the 18th IEE International Conference on Machine Learning Applications (ICMLA 2019): 2019 Dec 16-18; Boca Raton, Florida, USA*, 2019.

Christopher J Tralie. Early mfcc and hpcp fusion for robust cover song identification. In *18th International Society for Music Information Retrieval (ISMIR), Suzhou, China*, 2017.

Christopher J Tralie. Cover song synthesis by analogy. In *19th International Society for Music Information Retrieval (ISMIR), Paris, France*, 2018.

Christopher J Tralie and Paul Bendich. Cover song identification with timbral shape sequences. In *16th International Society for Music Information Retrieval (ISMIR), Malaga, Spain*, pages 38–44, 2015.

Christopher J Tralie, Paul Bendich, and John Harer. Multi-scale geometric summaries for similarity-based sensor fusion. In *The 40th IEEE Aerospace Conference, Big Sky, Montana*, 2019.

Christopher J Tralie and Matthew Berger. Topological eulerian synthesis of slow motion periodic videos. In *IEEE International Conference on Image Processing, Athens, Greece*, 2018.

Christopher J Tralie, Abraham Smith, Nathan Borggren, Jay Hineman, Paul Bendich, Peter Zulch, and John Harer. Geometric cross-modal comparison of heterogenous sensor data. In *Proceedings of The 39th IEEE Aerospace Conference, Big Sky, Montana*, 2018.

Furkan Yesiler, Chris Tralie, Albin Andrew Correya, Diego F Silva, Philip Tovstogan, Emilia Gómez Gutiérrez, and Xavier Serra. Da-tacos: A dataset for cover song identification and understanding. In *Proceedings of the 20th Conference of the International Society for Music Information Retrieval (ISMIR 2019): 2019 Nov 4-8; Delft, The Netherlands.[Canada]: ISMIR; 2019.* International Society for Music Information Retrieval (ISMIR), 2019.

Peer Reviewed Short Papers / Abstracts

Paul Bendich, Ellen Gasparovic, John Harer, and Christopher Tralie. Geometric models for musical audio data. In *Proceedings of the 32st International Symposium on Computational Geometry (SOCG), Boston, MA*, 2016.

Jose Perea and Christopher Tralie. Sliding windows and persistence. *The Journal of The Acoustical Society of America (JASA), Boston, MA*, 2017.

Christopher Tralie and Amanda Lazarus. A head of our times: Reimagining the heads in the brummer collection via real-time face mapping. *The Age of Sensing 5th International Conference on Remote Sensing in Archeaology, Durham, NC*, 2014.

Christopher Tralie, Nathaniel Saul, and Rann Bar-On. Ripser.py: A lean persistent homology library for python. *The Journal of Open Source Software (JOSS)*, 2018.

Christopher J Tralie. High dimensional geometry of sliding window embeddings of periodic videos. In *Proceedings of the 32st International Symposium on Computational Geometry (SOCG), Boston, MA*, 2016.

Christopher J. Tralie, Goodwin S. Matthew, and Guillermo Sapiro. Automated detection of stereotypical motor movements in children with autism spectrum disorder using geometric feature fusion. *International Society for Autism Research (INSAR), Rotterdam, The Netherlands*, 2018.

Whitepapers / Not Peer Reviewed

Christopher J Tralie. Cover songs via sequences of local mfcc self-similarity matrices. In *Music Information Retrieval Evaluation Exchange (MIREX)*, 2015.

Christopher J Tralie. Cover song identification using similarity fusion of hpcps, mfccs, and mfcc ssms. In *Music Information Retrieval Evaluation Exchange (MIREX)*, 2017.

Christopher J Tralie. Graphditty: A software suite for geometric music structure visualization. In *19th International Society for Music Information Retrieval (ISMIR), Late Breaking Session*, 2018.

Christopher J Tralie and John Harer. Moebius beats: The twisted spaces of sliding window audio novelty functions with rhythmic subdivisions. In *18th International Society for Music Information Retrieval (ISMIR), Late Breaking Session*, 2017.

In Preparation

John Harer, Francis Motta, and Christopher J Tralie. Polynomial time computable ordered merge tree metrics using hyperbolic structures.

Undergraduate Research Supervised

2019	Elizabeth Dempsey. "Parallel Dynamic Time Warping for Musical Audio Synchronization." Fall 2019 independent study.
2019	Benjamin Klybor. "Self-Similarity Scattering Transforms for Large Scale Cover Song Identification." Fall 2019 independent study
2019	Parker Fairchild. "A Javascript/WebGL Implementation of FaceJam." Fall 2019 independent study
2017-2018	Alice Antia (Math), Michael Lin (Math), Boyan Xu (Math). "Twisty takens: A geometric characterization of good observations on dense trajectories." Summer@ICERM research project (also journal paper).
2017-2018	Dev Dabke (CS/Math), Erin Taylor (CS/Math). "Geometric Approaches for Basketball Player Trajectory Analysis." Duke Math senior honors thesis / academic writing mentorship.
2017	Biraj Pandey (Math), Tim Sudijno (Math). "Recurrence in Dynamic Networks." Summer@ICERM research project.
2015	Marshall Ratliff (Math). "Introducing the Cover tree to Music Information Retrieval." Duke Math senior honors thesis.
2014	Joy Patel (Math/CS). "Towards Automated Synapse Detection in Electron Microcopy Image." Semester long independent study
2014	Julia Ni (Math), Joy Patel (Math/CS), Courtney Bennett Smith (Math), Roger Zou (Math). "Mitochondria Detection in 3D Brain Images." Duke Data Plus summer project.
2014	Marshall Ratliff (Math), Derrick Nowak (Math). "Classifying Musical Genres: An Investigation into Sorting Music using Topology." Duke Data Plus summer project.

Teaching / Mentoring

2019	CS 476: Computer Graphics. `www.ctralie.com/Teaching/CS476_F2019`
2019	MATH 111: Calculus 1. `www.ctralie.com/Teaching/MATH111_F2019`
2019	Invited to lead a workshop at WiMIR (Women in Music Information Retrieval) on "To What Extent Do Cyclic Inconsistencies Exist in Musical Preferences?" in Delft, The Netherlands
2019-Present	Mentor in WiMIR: Women in Music Information Retrieval
2018	Participant in the WiMIR: Women in Music Information Retrieval Workshop in Paris, France
2018	Co-Instructor At Summer School on Topological Data Analysis at Levico Terme, Italy. Labs found at `http://github.com/ctralie/TDALabs`
2018-Present	STEAM-Center / CyberPatriot Mentor at Lakeland Elementary/Middle School in Baltimore, Maryland
2017	Summer@ ICERM Topological Data Analysis Co-Instructor / Teaching Assistant
2016	Summer School Teaching Assistant At Technical University of Munich, Germany on "Topological Time Series Analysis - Theory And Practice"
2016	Instructor of Record of a new course I designed, CS/MATH 290: "Digital 3D Geometry," at Duke University. A ground up approach to 3D geometry with a statistics and signal processing focus. Assignments in Javascript/WebGL on sound modeling in virtual acoustic environments and modeling rotations. Assignments in numpy on 3D shape statistics, 3D shape alignment, and spectral mesh processing. `http://www.ctralie.com/Teaching/COMPSCI290`
2016-2018	Guest Lecturer on Topological Data Analysis at Duke University (three lectures: two for Dr. John Harer and one for Dr. Francis Motta)
2015	3D geometry and computer graphics independent study mentor to two high school students from North Carolina School for Science and Math
2014	Guest lecture / lab design in "Data Expeditions" on "Topology + Music Audio Data" and "Musical Pitches And Chroma Features," sponsored by the Information Initiative at Duke
2014	Mentor in 9 Week "Data and Brains" Undergraduate NSF Summer Research Program at Duke University sponsored by the math department
2013 - 2017	Member of Duke University Certificate in College Teaching (CCT) Program Participated in "College Teaching Practicum" spring 2013 and "Teaching Triangles" teaching evaluations spring 2016
2009 - 2011	Princeton University Engineering "Interactor" Assisted a faculty member and advised eight freshman engineering students with their courses
2008 - 2011	Princeton University Peer Math Tutor Tutored Undergraduate students one-on-one in Math 104: Calculus 2, Math 201: Multivariable Calculus, Math 203: Advanced Multivariable Calculus, and Math 202: Linear Algebra

2010   Princeton University Math Study Hall Facilitator
         Selected to lead a pilot weekly study hall program sponsored by the math department

Grants

2017   Helped write the Air Force Office of Scientific Research (AFOSR) grant "Geometric And Topological Methods for Multi-Modal Data Analysis And Fusion," which was successfully funded (joint with Paul Bendich and John Harer)

2014   Wrote the technical overview for the NSF Big Data Grant "Topological Data Analysis and Machine-Learning with Community-Accepted Features" (Award No. 1447491), which was successfully funded (joint with Paul Bendich and John Harer)

Invited Talks

2020   "Topology-Guided Analysis And Synthesis of (Quasi)Periodic Phenomena in Multimedia Data." University of Florida Applied Topology Seminar.

2019   "Designer Takens: A Tale of Twisted Time Series." Union College Mathematics Conference.

2019   "2-Torus And Beyond: (Spatio)Temporal Takens with A Twist." Workshop on Topology: Identifying Order in Complex Systems, University of Pennsylvania.

2019   "Audio Cover Song Identification: Beyond The Notes." Bryn Mawr College Computer Science Colloquium

2019   "Audio Cover Song Identification: Beyond The Notes." Northeast Music Information Special Interest Group (NEMISIG) Meeting, Brooklyn College

2019   "Topological Periodicity Analysis in Multimedia Time Series": Joint Math Meeting (JMM) Baltimore, MD

2018   "Geometric Audiovisual Signal Processing (GASP!): Video And Music Processing with A Twist": Telecom Paristech

2018   "Audio Cover Songs: Analysis And Synthesis": Duke University Data Dialogue Seminar

2017   "From Musical Rhythms To Vibrating Vocal Folds: Geometric (Quasi)Periodicity Quantification in Multimedia Time Series." NC State Department of Mathematics

2017   "Topological Rhythm Hierarchy Quantification in Musical Audio." SIAM Conference on Applied Algebraic Geometry, Georgia Tech.

2016   "Geometry Aided Music Structure Analysis And Cover Song Identification" (SAS)

2015   "Intro to the Duke Cluster and Data Hacks" (Duke University)

2014   "The Geometry and Topology of Musical Audio Data" (Duke University)

Conference / Journal Reviewing

2019   20th International Society for Music Information Retrieval Conference (ISMIR)

2019   Annals of Applied Statistics

2019   35th International Symposium on Computational Geometry (SOCG)

2018   19th International Society for Music Information Retrieval Conference (ISMIR)

2018   Journal of Information Fusion (INFUS)

2018   34th International Symposium on Computational Geometry (SOCG)

2016   EURASIP Journal on Audio, Speech, and Music Processing

| 2015 | Iberoamerican Congress on Pattern Recognition (CIARP) |

Other Scholarly Activity

2013 - Present	Member of "Information Initiative at Duke" (IID)
2015-2017	MIREX Music Benchmarking Competition Task Captain in "Cover Song Identification"
2015	US Air Force Research Labs (AFRL) Visiting Faculty Research Program

Industry Experience

| 2008 | Lockheed Martin Summer Internship in Software Development |

Wrote an R&D project management plugin for the Eclipse IDE (contributed over 17k Lines of Code)

Programming Languages and Lab Experience

Programming Languages	C, C++, Java, Python, Javascript, Matlab, Perl, HTML, OpenGL/WebGL, Linux Tools, Java Applet Development, ROS robot operating system
Master's Project in Radar Signal Processing (2012)	Created a 2D positioner robot from scratch to move a K-band horn antenna in front of a 4'x4'x4' anechoic box, and used this apparatus to create SAR images
Undergraduate EE Core Lab (2010)	"Carlab" ELE 302 Junior Electrical Engineering Design Project. Replaced radio control systems on an RC-sized car with our own autonomous control circuits. Programmed a DSP56800 series microprocessor to implement PID cruise control, PWM steering control, and line following using a C2 camera and the NTSC video standard

Spoken Languages

| Native | English |
| Proficient | French |