

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

## 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*

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## Publications

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### 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. *arXiv preprint arXiv:1809.07131 (In Submission)*, 2018.

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### 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), Karlsruhe, Germany*, pages 1234–1241. IEEE, 2013.

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.

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### 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

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 in submission).

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 Upcoming 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

- 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 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 - Member of "Information Initiative at Duke" (IID)
- Present
- 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 “Carlab” ELE 302 Junior Electrical Engineering Design Project.

EE Core Lab (2010) 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