

# Christopher J. Tralie

*Postdoctoral Fellow  
Duke University  
Department of Mathematics*

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## Research Interests

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

## Education

- 2011 - 2017 **Ph.D.**, *Duke University*, Durham, NC, *Electrical and Computer Engineering*.  
Advisers: Guillermo Sapiro, John Harer  
Dissertation Title: "Geometric Multimedia Time Series"
- 2011 - 2013 **M.S.**, *Duke University*, Durham, NC, *Electrical and Computer Engineering* (GPA 3.9).
- 2007 - 2011 **B.S.E.**, *Princeton University*, Princeton, NJ, *Electrical Engineering with Certificate in Computer Science* (Cum Laude).

## Honors and Awards

- 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*

## Scholarly Activity

- 2018 Journal of Information Fusion Paper Reviewer
- 2018 34th International Symposium on Computational Geometry (SOCG) Paper Reviewer
- 2016 EURASIP Journal on Audio, Speech, and Music Processing Paper Reviewer
- 2016 Summer School Teaching Assistant At Technical University of Munich on "Topological Time Series Analysis - Theory And Practice"
- 2015/2016 MIREX Music Benchmarking Competition Task Captain in "Cover Song Identification"
- 2015 US Air Force Research Labs Visiting Faculty Research Program
- 2015 CIARP 2015 Conference Paper Reviewer

- 2014 Wrote a large portion of 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)
- 2013 - Member of "Information Initiative at Duke" (IID)
- Present

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## Publications

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)*, 2016.

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

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

Christopher J Tralie. *Geometric Multimedia Time Series*. Duke ph.d. dissertation, Department of Electrical and Computer Engineering, Duke University, 2017.

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

Christopher J Tralie. 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.

Christopher J Tralie. Self-similarity based time warping. *arXiv preprint arXiv:1711.07513*, 2017.

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

Christopher J Tralie and Jose A Perea. (quasi) periodicity quantification in video data, using topology. *To Appear: SIAM Journal on Imaging Sciences*, 2017.

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*, 2018.

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## Invited Talks

- 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)
- 2014 "A Head of Our Times: Reimagining the Heads in the Brummer Collection via Real-Time Face Mapping" with Amanda Lazarus at "The Age of Sensing 5th International Conference on Remote Sensing in Archeology"

## Teaching and Mentorship

- Duke Undergraduate Research Mentored: Roger Zou (CS/Math), Marshall Ratliff (Math), Joy Patel (CS/Math), Derrick Nowak (Math), Julia Ni(Math), Dev Dabke (CS/Math), Erin Taylor (CS/Math)
- 2017 Summer@ ICERM Topological Data Analysis Co-Instructor / Teaching Assistant
- 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 Guest Lecturer on "Topological Time Series Analysis" at Duke University (two lectures, one 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 - Member of Duke University Certificate in College Teaching (CCT) Program
- Present 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

## 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