# Paul Louis Bendich

Curriculum Vitae


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**Research Interests**: Computational Topology and Geometry, Algebraic Topology, Stratified Spaces, Machine Learning and Statistics

## Education

**Duke University** — Durham, NC
*Ph.D. in Mathematics* — 8/2003–8/2008

**Duke University** — Durham, NC
*M.A. in Mathematics* — 8/2003–2/2005

**Grinnell College** — Grinnell, IA
*B.A. in Physics* — 8/1997–5/2001

## Employment

- Assistant Research Professor (regular-rank), Department of Mathematics, Duke University, 4/2014- present
- Associate Director for Curricular Engagment, the Information Initiative at Duke (iiD), 7/2014- present
- Senior Mathematician, Geometric Data Analytics, 7/2014- present
- Visiting Assistant Professor, Department of Mathematics, Duke University, 1/2011- 3/2014
- Postdoctoral Associate, IST Austria, 8/2009–12/2010.
- Instructor, Department of Mathematics, Pennsylvania State University, 8/2008–7/2009.

## Publications

### 1 Journal Publications

- *Topological and Statistical Behavior Classifiers for Tracking Applications*, Paul Bendich, Sang Chin, Jesse Clarke, John Harer, Elizabeth Munch, David Porter, David Rouse, Nate Strawn, and Adam Watkins. IEEE Trans. on Aerospace and Electronic Systems, to appear.
- *Persistent Homology Analysis of Brain Artery Trees*, Paul Bendich, J.S. Marron, Ezra Miller, Sean Skwerer, and Alex Pieloch. Annals of Applied Statistics, to appear.
- *Probabilistic Frechet Means and Statistics on Vineyards*, Liz Munch, Kate Turner, Paul Bendich, Sayan Mukherjee, Jonathan Mattingly, and John Harer. Electronic Journal of Statistics, Volume 9, pp. 1173-1204.

- *Homology and Robustness of Level and Interlevel Sets*, Paul Bendich, Herbert Edelsbrunner, Dmitriy Morozov, and Amit Patel. Homology, Homotopy and Applications, Vol. 15 (2013), No. 1, pp.51-72.
- *A Point Calculus for Interlevel set Homology*, Paul Bendich, Sergio Cabello and Herbert Edelsbrunner. Pattern Recognition Letters (2012), 1436-1444.
- *Improving Homology Estimates with Random Walks*, Paul Bendich, Taras Galkovskyi and John Harer. Inverse Problems 27 (2011) 124002.
- *Persistent Intersection Homology*, Paul Bendich and John Harer. Foundations of Computational Mathematics, 11 (2011), no. 3, 305-336.
- *Computing Robustness and Persistence for Images*, Paul Bendich, Herbert Edelsbrunner, and Michael Kerber. IEEE Trans. Visual. and Comput. Graphics, 2010, pp. 1251-1260.

## 2 Conference Proceedings Publications

- *Cover Song Identification with Timbral Shape Sequences*, Christopher J. Tralie and Paul Bendich. Proceedings of the 2015 International Symposium on Music Information Retrieval, to appear.
- *Multi-scale Local Shape Analysis and Feature Selection for Machine Learning Applications*, with Ellen Gasparovic, John Harer, Rauf Ismailov, and Linda Ness. Proceedings of the 2015 International Joint Conference on Neural Networks, to appear.
- *Local Homology Transfer and Stratification Learning* with Bei Wang and Sayan Mukherjee. Proceedings of the Twenty-Third Annual ACM-SIAM Symposium on Discrete Algorithms Pages 1355-1370, 2012.
- *Persistent Homology under Non-Uniform Error* with Herbert Edelsbrunner, Michael Kerber, and Amit Patel. Proc. 35th Internat. Sympos. on Math. Found, of Comput, Science, 2010, pp. 12-23.
- *The Robustness of Level Sets* with Herbert Edelsbrunner, Dmitriy Morozov, and Amit Patel. Proc. 18th Europ. Sympos. Algorithms, 2010, pp. 1-10.
- *Inferring Local Homology from Sampled Stratified Spaces* with David Cohen-Steiner, Herbert Edelsbrunner, John Harer, and Dmitriy Morozov. Proc. 48th Sympos. on Found. of Comput. Science, 2007, pp. 536-546.

## 3 Dissertation

- *Analyzing Stratified Spaces Using Persistent Versions of Intersection and Local Homology*, Ph.D. Thesis, Duke University,2008.

## Undergraduates Mentored

- *Topology, Statistics, and Brain Data*, Data RTG, Summer 2014:
  - Carmen Cox (Duke)
  - Derrick Nowak (Duke)
  - Henry Farrell (Cornell)
  - Dong-Hwan Moon (Williams)
  - Alex Pieloch (Duke)
- *Multi-scale Topology for Signals and Images*, Data RTG, Summer 2013:
  - Bingxi Lin (Bryn Mawr)
  - Michael Ogez (Duke)
  - Benjamin Dreyzen (UNC)

  - Joshua Martin (UNC-Greensboro)
- Marshall Ratliff, Duke PRUV 2015
  - Senior Thesis: *Introducing the Cover Tree to Music Information Retrieval*
- Bryan Jacobsen, Duke PRUV 2012
  - Senior Thesis: *A Fast Approximate Algorithm for Local Homology*

## Courses Taught

- *Combinatorics*, Duke Fall 2015.
- *Linear Algebra*, Duke, Fall 2013 and Spring 2014.
- *The Emerging Science of Complex Data (First-Year Seminar)*, Duke, Spring 2012 and Spring 2013.
- *Topology with Applications*, Duke, Fall 2012 and Fall 2014.
- *Topology*, Duke, Fall 2011.
- *Computational Topology*, IST Austria, Fall 2010.
- *Linear Algebra*, Penn State, Spring 2009.
- *Business Calculus II*, Penn State, Spring 2009.
- *Calculus I*, Penn State, Fall 2008.
- *Linear Algebra and Differential Equations*, Duke, Summers 2008 and 2007.
- *Laboratory Calculus II*, Duke, Summer 2006, Spring 2006.
- *Laboratory Calculus I*, Duke Fall 2005.

## Departmental and University Service

- Director, Data+ Program, The Information Initiative at Duke (iiD), 7/2014–Present.
- Director, Data Expeditions Program, The Information Initiative at Duke (iiD), 7/2014–Present.
- Coordinator, Research Training Grant (Structure in Complex Data), Duke, 1/2011–Present.
- Coordinator, Summer Undergraduate Research Program, Duke, 1/2011–Present.
- Organizer, Data Seminar, Duke, 8/2011–Present.
- Member and Founder, Graduate Student Calculus Curriculum Committee, Duke, Fall 2008.

## Workshops Organized

- Spring Topology and Dynamics Conference, Session on Applied Topology, University of Richmond, March 2014.
- LDHD: Topological Data Analysis, workshop at SAMSI, Feburary 2014.
- Computational Topology, workshop at Symposium on Computational Geometry, Chapel Hill, NC, June 2012.
- Computational Topology, workshop at SIAM Conference on Applied Algebraic Geometry, Raleigh, NC, October 2011.

## Seminar and Conference Talks

- *Persistent Homology Analysis of Brain Artery Trees*, DCAT, Copenhagen, 11/2014.
- *Topological Features for Machine Learning*, team-talk with Nate Strawn, Data Seminar, Duke University, 4/2014.
- *Persistent Local Homology: Theory, Applications, Computational Innovations*, Workshop on Topology and Statistics, SAMSI, 2/2014.
- *Persistent Homology: theory and computational innovations*, Algorithm Theory Seminar, North Carolina State University, 11/2013.
- *Stratifications and Persistent Homology*, SATANA Seminar, University of Illinois at Urbana-Champaign, 11/2013.
- *Brain-artery Trees and Persistent Homology*, iiD Seminar, Duke, 11/2013.
- *Probabilistic Frechet Means and Statistics on Vineyards*, Workshop on Applied Algebraic Topology, Bremen, 8/2013.
- *Stratification Learning via Local Homology Inference*, AMS Sectional, Boulder, CO, 4/2013.
- *Tracking with Persistence*, BANFF, 10/2012.
- $\Phi$-*SoMap*, AMS-MAA Joint Meetings, Boston, MA, 1/2012.
- *Persistence Diagrams and the Information they Carry*, Data Seminar, Duke, 8/2011.
- *Stratification Learning via Local Homology Inference*, Invited Talk, INRIA-Saclay, 10/2010.
- *The 2-Point Formula*, CTIC, 10/2009.
- *Elevation on Stratified Spaces via Intersection Homology*, DARPA TDA meeting, 1/2009.
- *Teaching Without much Lecturing*, Education Seminar, Penn State, 1/2009.
- *Persistent Intersection Homology*, Algorithms Seminar, Duke, 3/2008.
- *Local Homology Vineyards*, DARPA TDA meeting, 1/2008.
- *Persistence*, Grad-Fac Seminar, Duke, 10/2007.
- *Persistent Local Homology*, DARPA TDA meeting, 5/2006.

## Professional Service

- Reviewer for Journal of Topology and Analysis
- Reviewer for SIAM Journal of Computing
- Reviewer for Symposium on Computational Geometry
- Reviewer for Symposium on Artificial Intelligence and Statistics
- Reviewer for Symposium on Discrete Algorithms
- Reviewer for Experimental Mathematics
- Reviewer for Foundations of Computational Mathematics
- Reviewer for Inverse Problems
- Reviewer for Discrete and Computational Geometry
- Reviewer for Revista Matematica Complutense