Michael P. Casey

mpcasey@math.duke.edu

Research Interests

I am currently interested in developing fast algorithms for high-dimensional data analysis, particularly for various notions of geometric or topological “structure” in data, using ideas and methods from dynamics, global analysis, algebraic topology, and probability. I find it fascinating when any of these fields sheds light on the others, and especially rewarding when such viewpoints enable new algorithms in the discrete setting with stronger or faster guarantees.

The projects in preparation below are backbones in manifold learning for point clouds and persistent homology in computational topology, respectively, but both have much wider applications. The first project uses randomization in a crucial way, while the second project uses several ideas from algebraic topology and dynamical systems. I should like to study further applications of these or related ideas in the near future. In particular, through work in the second project, I have become interested in new techniques for numerical linear algebra.

I also like to study questions in global analysis, topology, and dynamics that are stimulated by biological questions, especially for networks, cell complexes, and collective motion. These questions may have a stochastic component as well.

Current Projects in Preparation

Approximate k-Nearest Neighbors in High Dimensions
Fast Gaussian Elimination for Sparse Matrices with Field Coefficients

Specialties

Topology
Algorithms
Probability
Global Analysis
Applied Math

Areas of Interest

(Computational) Topology and (Computational) Geometry
Cell Complexes
Multiscale Analysis
Mathematical Biology
Algorithms for High-Dimensional Data Analysis
Randomized Algorithms
Numerical Linear Algebra
(Stochastic or Topological) Dynamical Systems (on complexes and networks)

Education

Mathematics Ph.D.
Duke University
May 2017, expected

Mathematics M.S.
Duke University
March 2013

Mathematics B.A.
Princeton University
May 2011

Department Talks

Duke Graduate Algebra Seminar
Introduction to Cofibrations and Homotopy Colimits
November 2015

Duke Graduate/Faculty Seminar
Less Common Views of Matrices through Discrete Vector Fields and CW-Complexes
November 2015

Duke Graduate Geometry Seminar
Discrete Morse Theory for Cell Complexes
February 2015

Duke Mathematical Biology Colloquium
Presented background papers in the journal club
2 per semester

Duke Stochastic Reading Group
Log-Sobolev Inequalities via the Gamma_2-Calculus and the Curvature-Dimension Condition
Spring 2015, 3-parts

Teaching

Certificate in College Teaching
Spring 2017, upon graduation

Instructor Math 111L: Lab Calculus I
Fall 2016

Instructor Math 111L: Lab Calculus I
Fall 2015

TA Math 112L: Lab Calculus II
Spring 2014, 2 sections

TA Math 216: Linear Algebra
Spring 2013, 2 sections

TA Math 41L: Introduction to Calculus II with Applications
Fall 2011

Service and Mentoring

Organized a reading group in Stochastic Processes and Diffusion Operators
Fall 2015

Math Bio Summer Workshop: mentored one student on a proposed project
Summer 2015

Math Bio Summer Workshop: mentored one student on a proposed project
Summer 2012

Ran the department tea for 1 week
Every Fall

Conferences

Joint Mathematics Meetings

January 2016, Seattle, WA

Duke Conference on Probability and Combinatorial Optimization
Spring 2015

Southeastern Probability Conference
Spring 2015

Bobfest: "Flows and Patterns: the Physics of Fluids, Granular Materials, and Soft Matter"
October 2013

Seminars at Duke

Mathematical Biology Seminar and Corresponding Colloquium
Any network or collective motion related talk in the Center for Nonlinear and Complex Systems (CNCS), Physics Colloquium, or even Analysis seminars.
Machine Learning Seminar
DNAC (Duke Network Analysis) Seminar
iiD (Information Initiative at Duke) Postdoc Seminar
Data Seminar
Probability Seminar
Graduate/Faculty Seminar
Duke Computer Science Colloquium