Jonathan Michael Bloom

CONTACT

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CURRENT POSITIONS

Massachusetts Institute of Technology, Cambridge, Massachusetts
CLE Moore Instructor and NSF Postdoctoral Fellow September 2011 - present

Broad Institute of Harvard and MIT, Cambridge, Massachusetts
Affiliate, Data Sciences and Data Engineering September 2014 - present

RESEARCH INTERESTS

Computational biology, high-dimensional data analysis, and machine learning; statistics education; topology and geometry via Morse, Floer, and Khovanov homology.

EDUCATION

Columbia University, New York, New York September 2006 - May 2011
Ph.D., Mathematics, May 2011
Advisor: Peter Ozsváth
Thesis: *Monopole Floer Homology, Link Surgery, and Odd Khovanov Homology*
M.Phil., Mathematics, May 2009
M.A., Mathematics, May 2007

Harvard University, Cambridge, Massachusetts September 2000 - June 2004
B.A., Mathematics, *magna cum laude*

POSITIONS AND FELLOWSHIPS

NSF Mathematical Sciences Postdoctoral Research Fellowship
Postdoctoral Fellow, supervised by Tomasz S. Mrowka September 2011 - present

Broad Institute of Harvard and MIT, Cambridge, Massachusetts
Postdoctoral Fellow, Genomics Platform and Cancer Group June - August 2014

Mathematical Sciences Research Institute, Berkeley, California
Program Associate, Homology Theories of Knots and Links January 2010 - May 2010

Harvard University, Cambridge, Massachusetts
Instructor and Eliot House Non-Resident Tutor September 2005 - May 2006
Taught three calculus courses, advised students, awarded *Certificate of Distinction in Teaching.*

John Huston Finley Traveling Fellowship, Africa, Asia, Oceania, South America
Finley Fellow July 2004 - June 2005
Taught math around the world; awarded to one graduating student by Eliot House, Harvard College.

PUBLICATIONS

J. Bloom. *The combinatorics of Morse theory with boundary.*
Proceedings of 19th Gokova Geometry-Topology Conference (2013), 44–88.

J. Bloom. *A link surgery spectral sequence in monopole Floer homology.*
Advances in Mathematics **226** (2011), no. 4, 3216–3281.

J. Bloom. *Odd Khovanov homology is mutation invariant.*
Mathematical Research Letters **17** (2010), no. 1, 1–10.

J. Bloom. *Monopole Floer homology, link surgery, and odd Khovanov homology.* Dissertation at:
`http://math.mit.edu/~jbloom/Bloom_PhD_Thesis_2011.pdf`

In preparation

J. Baldwin, J. Bloom. *The monopole category and invariants of bordered 3-manifolds.* We extend monopole Floer homology to the framework of 2+1+1 TQFT by constructing a finitely-generated A_∞-category $\mathcal{C}(\Sigma)$ for a surface Σ, a gauge-theoretic analogue of the Fukaya category of $\mathrm{Sym}^g(\Sigma)$.

Genetics

Broad Institute, Cambridge, Massachusetts — July 2014 - present

In DSDE, I led the investigation of optimal coverage in GWAS to quantify tradeoffs between cost, depth, sensitivity, and power to detect association. Via PIs Ben Neale and Daniel MacArthur, this work has influenced large upcoming studies to lower target coverage for PCR-free whole genomes.

For the genomics platform, I authored white papers on sample swap and trio detection which have influenced the production pipeline. I also investigated new approaches to quality scores compression.

Yossi Farjoun and I developed and implemented a Bayesian graphical model for detecting contamination in tumor samples without need for a paired normal. We plan to optimize the model using synthetically-mixed cancer/stroma/contamination data from Gady Getz's group.

In response to mislabeling, I wrote a statistical tool in Python which independently determines when two DNA read groups are derived from the same library, necessary for removing duplicates in variant calling. I am now re-implementing the tool in Java for incorporation into the production pipeline.

Amit Majithia and I investigated the use of combinatorial pooling to cost-efficiently sequence genes of interest across a large population. I wrote a Python simulation based on DNA Sudoku demonstrating dramatic efficiency gains on empirical data for the gene PPARG (diabetes risk).

Statistics Education

MIT 18.05: Introduction to Probability and Statistics

Under a grant from the Davis Education Foundation (PI Haynes Miller), Jeremy Orloff and I transformed the math department's introductory probability and statistics course into a flipped, active learning class using the MITx platform. We created a comprehensive set of written materials unifying Bayesian and frequentist inference, together with Matlab and R projects. Enrollment has jumped by 50%, the overall course rating has increased from 4.5 to 6.2/7, and my teaching was rated 6.5, 6.4, and 6.6/7. We also created and ran a 4-day statistics education workshop for local professors in Port-au-Prince, Haiti. Course featured on MIT OpenCourseWare and OCW Educator: `http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/`

Teaching

Massachusetts Institute of Technology, Cambridge, Massachusetts

Co-Instructor

- Intro. to Probability and Statistics (18.05) with Jeremy Orloff — Spring 2013, 2014

Recitation Instructor

- Intro. to Probability and Statistics (18.05, 2 sections), Jeremy Orloff — Spring 2012
- Differential Equations (18.03, 2 sections), David Jerison — Spring 2011

Columbia University, New York, New York

Instructor

- Knots and Dynamics, original undergraduate research seminar `http://math.mit.edu/~jbloom/knotdyn.html` — Fall 2009
- Calculus IV, multivariable and vector calculus — Summer 2008

Teaching Assistant

- Modern Algebra II, Dave Bayer — Fall 2009
- Calculus III, Aaron Lauda — Fall 2009
- Fixed-point Floer Homology REU, Robert Lipshitz and Tim Perutz — Summer 2009
- Algebraic Topology I (graduate), Tim Perutz — Fall 2008

- Modern Geometry II (graduate), Michael Thaddeus — Spring 2008
- Modern Geometry I (graduate), Michael Thaddeus — Fall 2007

Harvard University, Cambridge, Massachusetts

Instructor

- Calculus II (Math Xb, two classes) — Spring 2006
- Calculus I (Math Xa) — Fall 2005

Teaching Assistant

- Theory and Practice of Teaching Number Theory, John Boller — Summer 2003
- Linear Algebra and Multivariable Calculus (Math 23a), John Boller — Fall 2001

Mater Spei College, Francistown, Botswana — Summer 2004

Taught algebra and geometry in English at a secondary school.

Colegio Franco-Inglés, Viña del Mar, Chile — Summer 2002

Taught math and English, in Spanish and English, at a secondary school.

Ross Mathematics Program, Columbus, Ohio — Summer 2001

Mentored high school students in a challenging number theory program.

Coding

Python, R, LaTeX, Scheme; highly motivated to build skills in scalable, distributed computing.

Referee

Geometria Dedicata, Journal of Differential Geometry, Journal of Geometric Analysis, Pacific Journal of Mathematics, Quantum Topology, Advances in Mathematics

Seminars

Co-founder of Stat Math Reading Club (SMRC), Broad Institute — Fall 2014 - present
Co-organizer of Geometry and Topology Seminar, MIT — Fall 2011 - Spring 2013
Organizer of weekly graduate seminar, MSRI — Spring 2011

MOOCs

Completed all work for the following Coursera and edX courses since 2013:
JHU: Computing for Data Analysis
UCSD: Bioinformatics Algorithms - Part 1
MIT 7.00x: Introduction to Biology - The Secret of Life
MIT 6.00x: Introduction to Computer Science and Programming
Harvard PH207x: Quantitative Methods in Clinical and Public Health Research

Public Workshops

Knots for novices. 2012 Cambridge Science Festival, MIT Museum of Science — April 22, 2012
It's knot (all) theory! MIT150: Under the Dome, MIT — May 8, 2011
No loose ends. 2011 Cambridge Science Festival, MIT Museum of Science — April 30, 2011

Consultant

Law and Order SVU, *Hothouse* (Episode 1012) — December 5, 2008
Created math visuals and coached actor playing math prodigy/murder suspect in NBC drama.
Clip available at: `http://math.mit.edu/~jbloom/blackboards.mov`

Invited Talks

OCW Educator Roundtable, MIT — April 7, 2015
AMS Special Session on Statistics Education, 2015 Joint Meetings — Jan 12, 2015
DSDE Meetup, Broad Institute — Dec 4, 2015
Undergraduate Math Club, UConn — Nov 5, 2014
Math Education Forum, UConn — Nov 5, 2014

Scheller Teacher Education Program, MIT	Jun 23, 2014
HHMI - MIT Biology Education Group Seminar `http://educationgroup.mit.edu/HHMIEducationGroup/?p=4372`	April 7, 2014
MIT-Haiti Initiative, Statistics Education Workshop, Port-au-Prince	March 24-27, 2014
Topological Data Analysis talk to Broad Institute study group	March 7, 2014
Caltech/UCLA/USC Joint Topology Seminar	February 24, 2014
Altshuler group meeting, Broad Institute (with Amit Mijithia)	January 27, 2014
Joint Meetings of the American Mathematical Society	January 18, 2014
MIT Symplectic Coffee Seminar	April 18, 2013
Workshop 13w5037, Banff International Research Station `https://www.youtube.com/watch?v=9-echU1zIfI`	March 26, 2013
UC Berkeley Topology Seminar	November 21, 2012
Contact and Symplectic Geometry Summer School, Budapest	July 13, 2012
Nineteenth Gökova Geometry / Topology Conference	May 28 and June 1, 2012
Princeton Topology Seminar	October 25 and 27, 2011
Notre Dame Felix Klein Seminar	October 13, 2011
Michigan State Topology Seminar	October 10, 2011
Harvard Gauge Theory and Topology Seminar	September 16, 2011
MIT Geometry and Topology Seminar	September 12, 2011
AMS 2011 Fall Eastern Sectional Meeting, Cornell University	September 10, 2011
MIT QFT Seminar	August 2, 2011
USC Geometry and Topology Seminar	March 7, 2011
Dartmouth Geometry and Topology Seminar	January 11, 2011
Moscow State Knots and Representation Theory Seminar	December 14, 2010
MSRI Graduate Seminar	April 16 and 23, 2010
UCLA Geometry Seminar	March 5, 2010
Distinguished Student Talk, Knots in Washington XXIX	December 6, 2009
MIT Geometry and Topology Seminar	November 23, 2009
Boston College Geometry and Topology Seminar	November 19, 2009
Ohio State Topology Seminar	November 9, 2009
UT Austin Geometry Seminar	November 5, 2009
Princeton Topology Seminar	October 29, 2009
Columbia Undergraduate Math Society Seminar	October 21, 2009
Columbia Geometric Topology Seminar	January 30, 2009
Harvard Undergraduate Mathematics Colloquium *This talk earned the Robert Fletcher Rogers Prize.*	April 27, 2004

Conferences and Workshops

Joint Meetings of the American Mathematical Society San Antonio, Texas	January 10-13, 2015
MIT-Haiti Initiative, co-organizer of Statistics Education Workshop Port-au-Prince, Haiti	March 24-27, 2014
Joint Meetings of the American Mathematical Society Baltimore, Maryland	January 15-18, 2014
AMS Short Course: Geometry and Topology in Statistical Inference Baltimore, Maryland	January 13-14, 2014

BIRS Workshop 13w5037 — March 24-29, 2013
Banff International Research Station, Alberta, Canada

Contact and Symplectic Geometry Summer School and Conference — July 9-20, 2012
Alfrd Rényi Institute of Mathematics, Budapest, Hungary

Nineteenth Gökova Geometry / Topology Conference — May 28 - June 2, 2012
Gökova, Turkey

AMS 2011 Fall Eastern Sectional Meeting — September 10-11, 2011
Cornell University, Ithaca, NY

Homological Invariants in Low-Dimensional Topology Workshop — June 13-16, 2011
Simons Center for Geometry and Physics, Stony Brook, NY

Geometric and Algebraic Structures in Mathematics — May 26-29, 2011
Simons Center for Geometry and Physics, Stony Brook, NY

William Rowan Hamilton Geometry and Topology Workshop — September 2-4, 2010
Trinity College, Dublin, Ireland

Workshop on Symplectic Geometry and Mirror Symmetry — July 19-23, 2010
Massachusetts Institute of Technology, Cambridge, MA

Low-Dimensional Topology and Categorification — June 21-25, 2010
State University of New York, Stony Brook, NY

Homology Theories of Knots and Links — January - May, 2010
Mathematical Sciences Research Institute, Berkeley, CA

AMS Joint Mathematics Meetings 2010 — January 13-16, 2010
San Francisco, CA

Knots in Washington XXIX — December 4-6 2009
George Washington University, Washington D.C.

Georgia International Topology Conference — May 18-29, 2009
University of Georgia, Athens, GA

Holomorphic Curves: Algebraic Structures and Geometric Applications — August 18-29, 2008
Stanford University, Palo Alto, CA

Low Dimensional Topology — August 11-15, 2008
Mathematical Sciences Research Institute, Berkeley, CA

XVI Oporto Meeting on Geometry, Topology, and Physics — July 5-8, 2007
Universidade do Algarve, Faro, Portugal

New Perspectives and Challenges in Symplectic Field Theory — June 25-29, 2007
Stanford University, Palo Alto, CA

Georgia Topology Conference — May 14-18, 2007
University of Georgia, Athens, GA

Park City Mathematics Institute: Low Dimensional Topology — June 25 - July 15, 2006
Park City, UT