Melissa R. McGuirl | Ph.D. Candidate

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Research Interests

Computational and applied topology, topological data analysis, dynamical systems, pattern formation, mathematical biology, machine learning applications, and genomics.

Education

Doctor of Philosophy, Applied Mathematics — **Providence, RI**
Brown University — *2015–2020*

Master of Science, Applied Mathematics — **Providence, RI**
Brown University — *2015-2016*

Bachelor of Arts In Cursu Honoris, Mathematics — **Worcester, MA**
College of the Holy Cross Rank: 3/724 — *2011–2015*

Work Experience

Machine Learning Engineer II — **Spotify**
Machine learning engineer for Spotify — *May 2020-Present*

Machine Learning Engineer, PhD Intern — **Spotify**
Machine learning engineer for New York City Summer Internship Program at Spotify. — *Summer 2019*

Recent Academic Research

Doctoral Research on Topological Data Analysis and Dynamical Systems — **Brown University**
Advised by Björn Sandstede; Co-advised by Andrew Blumberg. — *2016-2020*
Analyzing spatio-temporal pattern formation using topological data analysis and machine learning.

Collaborative Doctoral Research on Genetics and Machine Learning — **Brown University**
Advised by Björn Sandstede and Sohini Ramachandran. — *2016-2020*
Cluster gene-level association statistics to differentiate genetic architecture between phenotypes. *In collaboration with Samuel Smith.*

Collaborative Research on Music Information Retrieval — **ICERM**
Advised by Katherine Kinnaird; Advisees for Erin Bugbee and Claire Savard. — *2017-2020*
Develop topological data analysis inspired methods for completing tasks in music information retrieval.

Collaborative Doctoral Research on Topological Data Analysis and Genetics — **UT Austin**
Advised by Andrew Blumberg. — *2016-2018*
Applying topological tools to predict recombination rate from genomic data. *In collaboration with Devon Humphreys and Michael Miyagi.*

Summer@ICERM: Topological Data Analysis — **ICERM**
Advised by Katherine Kinnaird; Advisees for Erin Bugbee and Claire Savard. — *2017-2018*
Develop an efficient and accurate method for the cover song task using methods inspired from topological data analysis.

Awards and Honors

Stella Dafermos Award — **Brown University**
Award in honor and memory of Stella Dafermos for outstanding graduate students — *2020*

Sigma Xi Award — **Brown University**
Award for excellence in research and high potential for future contributions. — *2019*

SIAM Student Chapter Certificate of Recognition — **Brown University**
Award for outstanding service and contributions to the Brown Student Chapter of SIAM. — *2019*

Reginald D. Archambault Award for Teaching Excellence — **Brown University**
Dual first prize for excellence in summer session education. — *2018*

The Gertrude McBrien Mathematics Prize — **College of the Holy Cross**
Award for outstanding performance as a mathematics major. — *2015*

Mathematics High Honors — **College of the Holy Cross**
Award for high GPA in mathematics classes and thesis research. — *2015*

College Honors Program — **College of the Holy Cross**
Highly selective and challenging interdisciplinary honors program. — *2013-2015*

Publications and Preprints

1. **M. R. McGuirl**, A. Volkening, B. Sandstede, Topological data analysis of zebrafish patterns (2020) Proceedings of the National Academy of Sciences 117 (10) 5113-5124 **(Available here).**

2. **M. R. McGuirl**, S. P. Smith, B. Sandstede, S. Ramachandran. Hierarchical clustering of gene-level association statistics reveals shared and differential genetic architecture among traits in the UK Biobank (2020) GENETICS. Accepted. **(Available here).**

3. D. P. Humphreys, **M. R. McGuirl**, M. Miyagi, A. J. Blumberg. Fast Estimation of Recombination Rates Using Topological Data Analysis (2019) GENETICS 211 (4) 1191-1204 **(Available here).**

4. **M. R. McGuirl**, K. M. Kinnaird, C. Savard, and E. Bugbee. SE and $S_N L$ diagrams: Flexible data structures for MIR (2018) Proceedings of the 19th ISMIR conference.**(Available here.)**

5. D B. Damiano and **M R. McGuirl.** A Topological Analysis of Targeted In-111 Uptake in SPECT Images of Murine Tumors. Journal of Mathematical Biology (2017) 1432-1416 **(Available here.)**

6. C Xia, C Cochrane, J DeGuire, G Fan, E Holmes, **M McGuirl**, P Murphy, J Palmer, P Carter, L Slivinski, and B Sandstede. Assimilating Eulerian and Lagrangian data in traffic-flow models. Physica D 346 (2017) 59-72 **(Available here.)**

Fellowships and Grants

NSF Graduate Research Fellowship Program — **National Science Foundation**
Grant for outstanding graduate students in science. — *2016-Present*

Charles. A Dana Scholarship — **College of the Holy Cross**
Scholarship for students with strong academics and exceptional leadership. — *2013-2015*

Leadership and Service

Leadership

Applied Mathematical Modeling with Topological Techniques at ICERM **Providence, RI**
Research group facilitator on Modeling Gun Violence with Topological Techniques. *2019*

Webmaster **Providence, RI**
Brown University Student Chapter of SIAM *2018-2019*

TRIPODS Summer Bootcamp: Topology and Machine Learning at ICERM **Providence, RI**
Co-organized boot-camp of tutorials and a mini-conference on topology and machine learning. *2018*

Brown University Applied Topology and Geometry Seminar **Providence, RI**
Co-organized a bi-weekly research seminar. *2017-2018*

Are we putting too much faith in Math? Brown University Reading Group **Providence, RI**
Co-organized reading group that focused on the social impact of math and machine learning. *2017-2018*

President **Providence, RI**
Brown University Student Chapter of SIAM *2017-2018*

Annual Applied Math Graduate Student Retreat at Brown University **Providence, RI**
Co-organized the annual student retreat to discuss research ideas and build camaraderie. *2016-2018*

Members of Historically Underrepresented Groups in Mathematics Panel **Providence, RI**
Co-organized a panel on being a minority in mathematics. *2017*

Women in Mathematics Panel **Providence, RI**
Co-organized a panel on being a woman in mathematics. *2017*

Treasurer **Providence, RI**
Brown University Student Chapter of SIAM *2016-2017*

Secretary **Providence, RI**
Brown University Student Chapter of SIAM *2015-2016*

Secretary **Worcester, MA**
Holy Cross Chapter of Pi Mu Epsilon *2014-2015*

Treasurer **Worcester, MA**
Holy Cross Mathematics and Computer Science Club *2013-2014*

Service

IEEE International Conference on Machine Learning and Applications **Boca Raton, FL**
Program committee member for Topological Data Analysis in Machine Learning *2019*

Math CoOp Outreach Center at Brown University **Providence, RI**
A math outreach group that presents different areas of math to students of all grade levels. *2016-Present*

Reviewer for the Women In Machine Learning Workshop **Montreal, Quebec**
Reviewed submitted abstracts for the Women In Machine Learning Workshop. *2018*

Faculty Graduate Student Liaison at Brown University **Providence, RI**
Orchestrated faculty-grad interactions and communicate any concerns or questions. *2016-2018*

Reviewer for the Women In Machine Learning Workshop **Long Beach, CA**
Reviewed submitted abstracts for the Women In Machine Learning Workshop. *2017*

Teaching and Mentoring Experiences

Teaching Experiences

Instructor — **Brown University**
APMA 0350: Applied Ordinary Differential Equations — *Summer 2018*

Teaching Assistant — **ICERM**
Summer at ICERM: Topological Data Analysis — *Summer 2017*

Teaching Assistant — **Brown University**
APMA 0350: Applied Ordinary Differential Equations — *Spring 2017*

Teaching Assistant — **Brown University**
APMA 0350: Applied Ordinary Differential Equations — *Fall 2016*

Tutor — **College of the Holy Cross**
Calculus Workshop — *2012-2015*

Grader — **College of the Holy Cross**
MATH 2410: Multivariable Calculus — *Fall 2012*

High School Summer Teacher — **Nativity School of Worcester**
Noyce Scholar — *Summer 2012*

Pedagogy Training

Course Design Seminar — **Brown University**
The Harriet W. Sheridan Center for Teaching and Learning — *2018*
Explored integrated course design principles and developed syllabi, assignments, and activities. Learned methods for inclusive teaching, engaged student learning, backward course design, and interdisciplinary communication.

Teaching Consultant Program — **Brown University**
The Harriet W. Sheridan Center for Teaching and Learning — *2017-2018*
Developed and refined skills in peer observation and feedback, leadership, and discussion facilitation. Developed and articulated a teaching philosophy and created a teaching portfolio.

Teaching Seminar on Reflective Teaching — **Brown University**
The Harriet W. Sheridan Center for Teaching and Learning — *2016-2017*
Developed and refined fundamental teaching and assessment strategies. Learned diverse communication skills based on how students learn.

Mentoring Experience

Academic Buddy Program — **Brown University**
Division of Applied Math — *2017-2018*
Provide guidance to an incoming graduate student as they begin their doctoral studies in the Division of Applied Mathematics.

Undergrad/Grad Mentoring Program — **Brown University**
Division of Applied Math — *2016-2018*
Mentor six undergraduate students interested in applied mathematics. Meet regularly to discuss classes, graduate school, and applying to REUs.

Undergraduate Research Mentor — **ICERM**
Summer@ICERM: Topological Data Analysis — *2017*
Mentored and advised a group of undergraduate students from different colleges across the US on a research project on music information retrieval and data analysis.

Research Presentations

Invited Talks

A Topological Toolbox for Quantifying Zebrafish Patterns — **Cincinnati, Ohio**
SIAM Conference on Mathematics of Data Science — *2020 (postponed)*

Quantifying Zebrafish Patterns — **Leiden, The Netherlands**
Equadiff Conference — *2019*

A Topological Study of Spatio-Temporal Pattern Formation — **Snowbird, UT**
SIAM Conference on Applications of Dynamical Systems — *2019*

A Topological Study of Spatio-temporal Pattern Formation — **San Marcos, TX**
The Topology Seminar at Texas State University — *2018*

A Topological Approach to Spatio-temporal Pattern Formation — **Norman, OK**
The 4th Annual Meeting of SIAM Central States Section — *2018*

Contributed Talks

Topological Data Analysis and Applications — **Providence, RI**
Brown Math Slam — *2018*

A Topological Analysis of Model Sensitivity and Classification for Zebrafish — **Worcester, MA**
Advancing Women's Impact in Mathematics Symposium — *2018*

Data Science and Music Information Research at Brown — **Providence, RI**
North East Music Information Special Interest Group Conference — *2018*

A Topological Analysis of Model Sensitivity for Pattern Formation on Zebrafish — **Boston, MA**
Brown-BU Dynamics and PDE seminar at Boston University — *2017*

A Topological Analysis of Model Sensitivity for Pattern Formation on Zebrafish — **Providence, RI**
Brown University Applied Math Graduate Seminar — *2017*

A Topological Analysis of Targeted In-111 Uptake in SPECT Images of Murine Tumors — **Seattle, WA**
MAA/AMS Joint Mathematics Meeting: AMS Session on Mathematical Biology — *2016*

The Topological Microstructure of Murine Tumors — **San Antonio, TX**
MAA/AMS Joint Mathematics Meeting: AMS Session on Mathematical Biology — *2015*

The Topological Microstructure of Murine Tumors — **Northampton, MA**
Women in Mathematics in New England Conference: Medicine Short Talks Session — *2013*

The Topological Microstructure of Murine Tumors — **Boston, MA**
Invicro, LLC Image Analysts — *2013*

Poster Presentations

Hierarchical Clustering of Gene-Level Association Statistics — **Montreal, Quebec**
Women in Machine Learning Workshop — *2018*

Thresholded Hierarchical Clustering of Gene-Level Association Statistics — **Santa Clara, CA**
NSF Tripods PI workshop — *2018*

Classifying Zebrafish Stripe Patterns using TDA and Multi-class SVMs — **Providence, RI**
TRIPODS Summer Boot-camp: Topology and Machine Learning — *2018*

Classifying Zebrafish Stripe Patterns using TDA and Multi-class SVMs — **Long Beach, CA**
Women in Machine Learning Workshop — *2017*

Modeling Microscopic and Macroscopic Traffic Flow — **San Antonio, TX**
MAA/AMS Joint Mathematics Meeting — *2015*

Modeling Microscopic and Macroscopic Traffic Flow — **Worcester, MA**
Holy Cross Summer Research Symposium — *2014*

The Topological Microstructure of Murine Tumors — **Baltimore, MD**
MAA/AMS Joint Mathematics Meeting — *2014*

The Topological Microstructure of Murine Tumors — **Worcester, MA**
Holy Cross Summer Research Symposium — *2013*

Travel Grants

SIAM Student Travel Award — **Cincinnati, Ohio**
Award to attend 2020 SIAM Conference on Mathematics of Data Science — *2020*

Brown University Travel Award — **Leiden, The Netherlands**
Award to attend Equadiff 2019 — *2019*

SIAM Student Travel Award — **Snowbird, Utah**
Award to attend 2019 SIAM Conference on Applications of Dynamical Systems — *2019*

Women in Machine Learning Travel Award — **Montreal, Quebec**
Award to attend and present at WiML — *2018*

NSF Tripods Travel Award — **Santa Clara, CA**
Award to attend and present at the NSF Tripods PI workshop — *2018*

SIAM CSS Travel Award — **Norman, OK**
Award to attend and present at SIAM Central States Conference — *2018*

Women in Machine Learning Travel Award — **Long Beach, CA**
Award to attend and present at WiML — *2017*

Brown Graduate Research Travel Grant — **Austin, TX**
Award to attend the NSF-CBMS Regional Conference on TDA — *2016*

Workshops and Short Courses

Applied Mathematical Modeling with Topological Techniques — **Providence, RI**
ICERM — *2019*

Collaborate@ICERM: Topological Data Analysis and Music Information Retrieval — **Providence, RI**
ICERM — *2019*

Tutorial on Multiparameter Persistence, Computation, and Application — **Minneapolis, MN**
Institute for Mathematics and its Applications — *2018*

Geometry and Topology of Data — **Providence, RI**
ICERM — *2017*

Synergies in Geometric Data Analysis — **Long Beach, CA**
Neural Information Processing Systems — *2017*

Mathworks: Hands-on Parallel Computing — **Boston, MA**
Harvard University — *2017*

Women in Data Science and Mathematics Research Collaboration — **Providence, RI**
ICERM — *2017*

Brown-ICERM-Kobe Simulation Summer School — **Providence, RI and Kobe, Japan**
Brown Unvierstiy and Kobe University — *2016*

Geometry and Topology in Statistical Inference — **Baltimore, MD**
AMS Short Course — *2014*

Conferences Attended

Equadiff — **Leiden, The Netherlands**
Leiden University — *2019*

SIAM Conference on Applications of Dynamical Systems — **Snowbird, UT**
SIAM — *2019*

Women In Machine Learning Workshop — **Montreal, Quebec**
Women In Machine Learning — *2018*

NSF Tripods PI workshop — **Santa Clara, CA**
The University of California, Santa Cruz — *2018*

The 4th Annual Meeting of SIAM Central States Section — **Norman, OK**
University of Oklahoma — *2018*

Advancing Women's Impact in Mathematics Symposium — **Worcester, MA**
Worcester Polytechnic Institute — *2018*

Neural Information Processing Systems Conference — **Long Beach, CA**
NIPS Foundation — *2017*

Women In Machine Learning Workshop — **Long Beach, CA**
Women In Machine Learning — *2017*

Union College Mathematics Conference — **Schenectady, NY**
Union College — *2016*

NSF-CBMS Regional Conference on Topological Data Analysis — **Austin, TX**
University of Texas at Austin — *2016*

Joint Mathematics Meeting — **Seattle, WA**
The American Mathematical Society and the Mathematical Association of America — *2016*

Joint Mathematics Meeting — **San Antonio, TX**
The American Mathematical Society and the Mathematical Association of America — *2015*

Joint Mathematics Meeting — **Baltimore, MD**
The American Mathematical Society and the Mathematical Association of America — *2014*

Women in Mathematics in New England Conference — **Northampton, MA**
Smith College — *2013*

Professional Societies

- Institute for the Quantitative Study of Inclusion, Diversity, and Equity (QSIDE)
- Association of Women in Mathematics
- The Rose Whelan Society
- Society for Industrial and Applied Mathematics