Mr. Matthew Broussard

Curriculum Vitae

Matthew.broussard@wsu.edu (503)715-7858 U.S. Citizen

DOCTORAL RESEARCH

"Multi-Commodity Max-Flow Min-Cut"

My research establishes a gap-free duality result between maximum flows and minimum cuts for the multi-commodity flow problem. Beginning with definitions to generalize relevant network-theoretic concepts to work with multiple commodities I determine the cause of a duality gap in previous work in the field, establish a method to resolve it, and create algorithms to determine the space of feasible flows and the maximum flow of a given ratio of commodities through the network.

RESEARCH EXPERIENCE

CURRENT, FROM JAN 2018 (FT)

Washington State University
Research Assistant

- Theoretical research in topology and network flows
- Applications of topological data analysis in machine learning and criminal justice
- Communication of results to audiences of non-specialists
- Contributed to manuscripts submitted for publication, gave talks over results, wrote PhD thesis.

SUMMER 2019 (FT)

Air Force Research Labs, Dayton OH
Summer of TDA Intern

- Constructed neural network architecture based on topological data analysis of MNIST data
- Designed and implemented experiments to test vulnerability of constructed network to adversarial attacks
- Determined constructed network was significantly more resistant to adversarial attacks than standard architectures, up to 600% classification improvement over some standard models

SUMMER 2018 (FT)

Air Force Research Labs, Dayton OH
Summer of TDA Intern

- Performed topological data analysis on activation data for deep neural networks
- Determined areas of weakness in neural networks classification methods
- Implemented method which locally outperformed state-of-the-art neural network's classification

TEACHING EXPERIENCE

AUG 2015–JAN 2018 (FT)

Washington State University
Teaching Assistant

- **TA Instructor**: Taught Introductory Algebra, Linear Algebra as instructor
- **Grader**: Graded for Calculus 3, Introduction to Proofs, and Differential Equationss
- **Lab Instructor**: Taught labs for Calculus 1, Calculus for Life Sciences

EDUCATION

2015 – CURRENT **Doctor of Philosophy**
Mathematics
Washington State University

2014-2015 **Non-Degree Seeking**
Mathematics
Portland State University

2009 – 2013 **Bachelor of Arts**
CUM LAUDE
Mathematics/Creative Writing
Linfield College

REFERENCES

Dr. Bala Krishnamoorthy

POSITION Professor
EMPLOYER Department of Mathematics
Washington State University

EMAIL kbala@wsu.edu
MOBILE +1 (410)349-7655

Dr. Ryan Kramer

POSITION Research Scientist
EMPLOYER Air Force Research Laboratories

EMAIL ryan.kramer.3@us.af.mil
MOBILE 937-608-1835

AWARDS

2018-19 **Nancy J. Robertson Graduate Research Fellowship in Mathematics**
Washington State University

COMMUNICATION SKILLS

PRESENTATIONS "Steinhaus Filtrations and Stable Paths in the Mapper"
JMM –2021

"The Mapper Algorithm With Introduction to Statistical Mapper"
GT Reading Group – 2020

Oral Presentation of Internship Achievements
AFRL – 2019

"Exploring Artificial Intelligence through Topological Data Analysis"
Seminar Presentation – 2018

Oral Presentation of Internship Achievements
AFRL – 2018

POSTERS "Detecting Evasion Paths in Sensor Networks"
AMS Poster Session – 2017

PUBLICATIONS

Broussard, M., Krishnamoorthy B., Makin, D., Willits, D. (Undergoing Revisions). "Extracting Insights on Use of Force by Police in Encounters through Topological Data Analysis of Body-Worn Camera Video Datasets". *Preprint*.

Arendt, D., **Broussard, M.**, Krishnamoorthy, B., Saul,N. (2019). Steinhaus Filtration and Stable Paths in the Mapper. *arXiv:1906.08256v2*,

CONFERENCES ATTENDED

CONFERENCES	Joint Mathematics Meeting E-Meeting –2021
	PNW MAA Meeting Portland, OR –2019
	Western Sectional Meeting Pullman, WA – 2017

SKILLS

Research Design

I am skilled at designing research projects which explore research goals, finish within a desired timeframe, and produce actionable results.

Big Data

Research at the Air Force Research Laboratories has given me expertise in gathering large data sets, keeping them in well-documented tables, and analyzing them with statistical and topological techniques.

Algorithm Development

My thesis research has taught me to develop algorithms to solve difficult problems. I can build up the required background results, build the algorithm, and prove its correctness.