

# Mr. Matthew Broussard

## Curriculum Vitae

Matthew.broussard@wsu.edu

(503)715-7858

U.S. Citizen

### DOCTORAL RESEARCH

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#### **“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

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Washington State University  
***Research Assistant***

CURRENT, FROM JAN 2018 (FT)

- 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.

Air Force Research Labs, Dayton OH  
***Summer of TDA Intern***

SUMMER 2019 (FT)

- 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

Air Force Research Labs, Dayton OH  
***Summer of TDA Intern***

SUMMER 2018 (FT)

- 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 Equations
- **Lab Instructor:** Taught labs for Calculus 1, Calculus for Life Sciences

## EDUCATION

## REFERENCES

2015 – CURRENT	<b>Doctor of Philosophy</b> Mathematics <i>Washington State University</i>	POSITION	<b>Dr. Bala Krishnamoorthy</b> Professor
		EMPLOYER	Department of Mathematics <i>Washington State University</i>
2014-2015	<b>Non-Degree Seeking</b> Mathematics <i>Portland State University</i>	EMAIL	kbala@wsu.edu
		MOBILE	+1 (410)349-7655
2009 – 2013	<b>Bachelor of Arts</b> CUM LAUDE Mathematics/Creative Writing <i>Linfield College</i>	POSITION	<b>Dr. Ryan Kramer</b> 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

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CONFERENCES    Joint Mathematics Meeting  
                         E-Meeting –2021

                         PNW MAA Meeting  
                         Portland, OR –2019

                         Western Sectional Meeting  
                         Pullman, WA – 2017

## SKILLS

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### *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.