

# ALEXANDER M. MERCIER

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## Education:

### Harvard School of Public Health

Program: Ph.D. in Population Health Sciences

Masters in Passing: Biostatistics

Primary Advisor: James M. Robins, M.D.

Expected Graduation: Spring 2027

Epidemiological Methods

### University of South Florida

Majors: Pure Mathematics B.A. & Microbiology B.S.

Minor: Russian

Graduated: Spring 2022

## Computer Languages

R, Julia, Python (TensorFlow & PyTorch)

## Research:

### Contagion-Preserving Network Sparsifiers

Primary Investigator: Dr. Christopher Moore

Researcher, Santa Fe Institute

Summer 2020 - Present

*This REU questioned what makes an edge important in a network-based conceptualization of contagion spread, attempting to remove all but important edges in a network. I examine contagion-preserving network sparsifiers (CPNS) which reduce the number of edges in a network while approximating average epidemic dynamics. I used a spectral sparsification algorithm utilizing effective resistance by Spielman and Srivastava to produce CPNS drawing parallels between the linear flow conceptualization of a network and contagion processes. A range of experiments on random and real-world networks was conducted using a variety of metrics, including Hamming distance and mutual information. A novel notion of epidemic edge importance was formed using self-created infection-spanning trees. It was found that CPNS can be utilized to remove 75% of the edges in some networks while approximately preserving the same average SI dynamics through time. Parts of this work to be published in Proceedings of the National Academy of Sciences.*

### Network Sparsification of Large Complex Networks

Primary Investigator: Dr. Andrew Kramer

Researcher, Kramer Ecology Lab

Fall 2019 - Present

*The purpose of the `simplifyNet` R package is to provide researchers with a suite of diverse network sparsification tools for various tasks. This R package is intended for any who use dense, complex network-based models or constructs to associate relational data. I wrote code in R for dimensionality reduction of large complex networks to be compiled into an R package. Specifically, combining various network sparsification techniques such as best path, iterative refitting, Lorelai Adaptive Sparsification (LAS), and spectral sparsification through effective resistance. Additionally, I am working to perform a comparative analysis of these various network dimensionally reduction techniques as they relate to various ecological networks, such as predator-prey interactions, food webs, contagion networks, and animal hierarchical social networks. The `simplifyNet` package can be located in CRAN [here](#).*

### Weather Influences the Spatial Transmission of White-Nose Syndrome in Little Brown Bats

Primary Investigator: Dr. Andrew Kramer

Research, Kramer Ecology Lab

Spring 2019 - Spring 2021

*Worked to build a generalized gravity model examining pairwise interactions between counties based on the density and distance of caves in a county. Analyzed data describing weather from high-resolution climatic data. Several combinations of dimensions were implemented, including the yearly length of winter, the yearly start of winter, average winter length, and bat species richness to uncover the predictive power of different combinations of variables. Tabulated AIC scores, implicating mechanics of WNS spread are driven by winter conditions which result in a variable risk of infection, with fitted data indicating that longer winters increase*

spread transmission risk. This work is being written for publication and will be presented at the National Conference on Undergraduate Research (NCUR).

### **Isolation of Bacteriophage through Plaque Assays**

Primary Investigator: Dr. Richard Pollenz

August 2018 - December 2018

Research Assistant, SEA PHAGES Program

*Collected, purified, amplified, and analyzed a strain of bacteriophage through pick-a-plaque and direct or enriched isolation later sent to Howard Hughes Medical Institute (HHMI). Prepared slide for a transmission electron microscope. Performed both DNA and protein electrophoresis.*

### **Publications:**

Kramer A., Mercier A., Maher S., Kumi-Ansu Y., Bowden S., and Drake J. 2023. Spatial spread of white-nose syndrome in North America, 2006-2018. *Journal of Animal Ecology*. [In-progress]

Mercier A, Scarpino S, Moore C (2022) Effective resistance against pandemics: Mobility network sparsification for high-fidelity epidemic simulations. *PLOS Computational Biology* 18(11): e1010650.

Mercier A. 2021. Contagion-preserving network sparsifiers: exploring epidemic edge importance utilizing effective resistance. arXiv:2101.11818

### **Presentations:**

#### **Goldwater Annual Graduate Student Council Research Symposium:**

#### **Producing Contagion Network Sparsifiers Via a Random Sampling Algorithm** Summer 2021

Mercier, A. Moore, C. Scarpino, S. Producing Contagion Network Sparsifiers Via a Random Sampling Algorithm. Paper session presented at: Goldwater Annual Graduate Student Council Research Symposium, 2021; 2021 August 7; Virtual.

*Accepted as a 2021 Goldwater Scholar to give a talk at the annual Goldwater Research Symposium. Presented on how the Spielman-Srivastava algorithm can be used to generate sparser networks that still maintain similar stochastic dynamics looking at real-world mobility networks of the United States using a continuous-time Susceptible-Infected-Recovered (SIR) model.*

#### **NCUR 2021:**

#### **Weather Influences the Spatial Transmission of White-Nose Syndrome in Bats** Spring 2021

Kramer A., Mercier A., and Basu S. Weather influences the spatial transmission of white-nose syndrome in little brown bats. Paper session presented at: National Conference on Undergraduate Research, 2021; 2021 April 12-14; Virtual.

*Accepted out of 4,000 abstracts to perform an oral presentation at the National Conference on Undergraduate Research (NCUR) 2021. Described generalized gravity model examining pairwise interactions between counties was formulated based on the density and distance of caves in a county.*

#### **NimBios 2020:**

#### **Contagion-preserving network sparsifiers: Preserving average epidemic dynamics utilizing effective resistance** Fall 2020

Mercier A. Contagion-Preserving Network Sparsifiers: Preserving Average Epidemic Dynamics Utilizing Effective Resistance. Paper session presented at: 12th Annual Undergraduate Research Conference at the Interface of Biology and Mathematics; 2020 October 31-November 1; Virtual.

*Accepted to give a talk on contagion-preserving network sparsifiers at NimBios 2020. Presented on how the Spielman-Srivastava algorithm can be used to generate sparser networks that still maintain similar stochastic dynamics.*

#### **NCUR 2020:**

**Weather Influences the Spatial Transmission of White-Nose Syndrome in Bats** Spring 2020  
Kramer A., Mercier A., and Basu S. Weather influences the spatial transmission of white-nose syndrome in little brown bats. Paper session presented at: National Conference on Undergraduate Research, 2020; 2020 March 26-28; Bozeman, Montana.

*Accepted out of 4,000 abstracts to perform an oral presentation at the National Conference on Undergraduate Research (NCUR) 2020. Described generalized gravity model examining pairwise interactions between counties was formulated based on the density and distance of caves in a county.*

**NECSI Winter School Week One Project** Fall 2019  
White B., M J., Mercier A., M C., and Aiello K. The emergence of the Pareto principle in scholarly journals. Paper session presented at: New England Complex Systems Institute Winter School 2020; 2020 January 6-10; Boston, Massachusetts.

*Performed network analysis and graph visualization on citation network mentioning the Pareto Principle and presented findings to the instructors and students of the NECSI Winter School.*

**L<sup>A</sup>T<sub>E</sub>X: Basics for Biologists** Fall 2019  
*Given to the Kramer Ecology Lab. Teaching the basics of L<sup>A</sup>T<sub>E</sub>X, including basic L<sup>A</sup>T<sub>E</sub>X syntax, equations, formatting, margin notes, tables, with added emphasis on the construction of relational diagrams for biologists.*

**Donuts and Competition Math** Fall 2019  
*Given to USF Math Club about what the MAA Putnam Competition is and how students can be involved.*

**Study Abroad in Russia** Fall 2019  
*Given jointly to the USF Institute on Russia and the USF Russian Club on study abroad experience in St. Petersburg, Russia, and the mechanics of how study abroad works at USF, encouraging other students to study internationally.*

### Awards:

Rhodes Scholarship Finalist	Fall 2021
Marshall Scholarship Finalist	Fall 2021
2021 Barry Goldwater Scholar	Spring 2021
Florida Epsilon Chapter, Pi Mu Epsilon 2021 Outstanding Scholar Award	Spring 2021
Sigma Xi Scientific Research Honor Society	Spring 2021 - Present
Abstract Acceptance, University of South Florida Undergraduate Research Conference	Spring 2021
Abstract Acceptance for Oral Presentation, NCUR 2021	Spring 2021
Abstract Acceptance for Oral Presentation, NimBios 2020	Fall 2020
Santa Fe Institute vUCR REU	Summer 2020
Abstract Acceptance for Oral Presentation, NCUR 2020	Spring 2019
The National Society of Leadership and Success	Fall 2019 - Present
CIEE Alumni	Fall 2019 - Present
Pi Mu Epsilon Honor Society	Spring 2019 - Present
Phi Kappa Phi Honor Society	Spring 2019 - Present
Golden Key Honor Society	Fall 2018 - Present
University of South Florida Dean's List	Fall 2018 - Present
University of South Florida Venture Scholar	Spring 2018 - Present
USF Green & Gold Presidential Award	Spring 2018 - Present
St. Petersburg College, Seminole Campus, Student Award for Philosophy	Spring 2018
Hispanic Scholarship Fund FedEx Scholarship Recipient	Fall 2018
Hispanic Scholarship Fund Member	Fall 2017-Present
National Hispanic Scholar	Spring 2017 - Present
Congressional Art Competition Winner, "No Greater Love"	2016

## **Extracurricular Activities:**

### **University of South Florida Mathematics Student Grader**

Spring 2020

*Paid student grader at University of South Florida for MAP 2302, Ordinary Differential Equations I. Worked under Dr. Manoug Manougian to grade three in-class exams and various quizzes given throughout the semester. During this term, the supervisor was Dr. Dmytro Savchuk.*

### **New England Complex Systems Institute Winter School 2020 Week 1**

January 2020

*Attended various lectures on complexity science topics given by Dr. Yaneer Bar-Yam, Dr. Justin Warfel, and Dr. Alfredo Morales, with guest speakers Dr. Alex 'Sandy' Pentland, Dr. Blake LeBaron, and Dr. Hyejin Youn. The topics included, but were not limited to, pattern formation, fractal patterns, spatial patterns, re-normalization groups, patterns in brain and mind (network patterns), complex system description (Shannon Information Theory), complexity profiles, power laws, dynamic patterns and chaos, neo-Darwinian theory, altruism and communication, dimensionality reduction, introduction to machine learning, and an introduction to artificial neural networks.*

### **USF Mathematical Association of America Chapter**

Fall 2019 - Present

*Current USF MAA Undergraduate Chapter president, responsible for the logistics and planning of club meetings, events, and talks, club finances and funding, and general direction of the club and its activities. Under presidency, began the USF Putnam Club, which allows undergraduate students to work collaboratively on unique problem sets. Participated in the 2018 MathFest Data Science Workshop.*

### **CIEE Summer Russian Language Program**

Summer 2019

*Studied in St. Petersburg, Russia, for eight weeks, focusing on Russian language study. At St. Petersburg State University's political science department, took 10 credit hours in language and culture. Language classes taken were Russian Phonetics, Russian Conversation (Intermediate II), and Russian Grammar (Intermediate II), determined by an onsite placement test.*

### **USF Russian Club**

Spring 2019 - Present

*Current USF Russian Club secretary, responsible for the club's social media presence, club meeting minutes, inter-club communications, and assisting in the planning of upcoming club events. Performed a section of Borodino by Mikhail Lermontov at the 2018 Russian Poetry Festival. Have helped to run the Russian Club booth at the USF International Festival. The booth was voted the best for the European and Eastern-European sections of the festival. Have helped to coordinate the Russian Maslenitsa festival, including coordinating Russian music and performing the Russian children's tale Teremok in Russian for an audience.*

### **Synergistic Activity with Kramer Ecology Lab**

Fall 2018 - Present

*Assist in various lab processes such as data collection and analysis. Also, participate in paper discussions and organization of lab presentations with the graduate students. Under Dr. Kramer, built a model of White Nose syndrome in bats, including, but not limited to, working with geospatial and climatic data, population dynamics, statistical analysis in R and figure creation in R. Currently, exploring the idea of network compression through sparsification through best path, iterative refitting, and Lorelai Adaptive Sparsification (LAS).*

### **University of South Florida Honors College**

Fall 2018 - Present

*A Honor's College student at the University of South Florida. Created the photo-realistic portrait entitled "Unfinished" of a homeless man which was accepted into the 2019 University of South Florida Honors College Off the Wall art show. The portrait is displayed in the Honors College building. For the honors course Compassionate Cities, created a short documentary on community response to the homeless in Tampa Bay entitled "Drop by Drop" which focused on a variety of different reactions to the*

*homeless population and how that weighs upon the heart. "Even in our sleep, pain which cannot forget falls drop by drop upon the heart until, in our own despair, against our will, comes wisdom through the awful grace of God." - Aeschylus*

**USF HHMI STEM Academy**

Fall 2018

*Member of the USF HHMI STEM Academy. Trained to prepare for research experiences as a first-year undergraduate.*

**Service:**

**Golden Key Honor Society**

Spring 2019

*Created handmade cards for the elderly on Valentines Day.*

**Trinity Cafe | Feeding Tampa Bay**

Fall 2018 - Present

*Serve our homeless neighbors a nutritious meal with dignity and respect. Have worked as a server, bringing food and drinks, a host, speaking with those in communion around the table, a dishwasher, and a table busser (approx. 2,600 persons served).*

**St. Petersburg College | Mathematics Tutor**

Fall 2017 - Spring 2018

*Volunteered to tutor college mathematics in the mathematics building of St. Petersburg College, Tarpon Springs Campus. Tutored remedial math, liberal arts math I& II, pre-calculus, statistics I& II, Calculus I, II, II, and ordinary differential equations.*

**St. Timothy Catholic Church**

Fall 2014 - Present

*Choir Performance of John Rutter's Requiem March, 2015. Approximately 400 persons attended. Serving as an introduction, a separate solo piano performance was given in which Rêverie by Claude Debussy was played (60 hours effort). Choir Performance of John Rutter's Gloria, December 2015 with separate solo piano performances during the show, including Rachmaninoff's Prelude in B minor, Op. 32 No. 10 and Frederic Chopin's Fantaisie Impromptu in C# minor, Op. 66. Approximately 900 persons attended (80 hours effort). Created food bags filled nutrient-rich food items to be shipped to Africa.*

**Graduate Courses:**

**Harvard University:**

- EPI201 Introduction to Epidemiology Methods I
- EPI202 Introduction to Epidemiology Methods II
- EPI289 Epidemiological Methods III: Methods for Causal Inference
- EPI203 Study Design in Epidemiologic Research
- EPI207 Advanced Epidemiologic Methods
- EPI247 Epidemiologic Methods Development
- PHS2000A Quantitative Research Methods in Population Health Sciences I
- PHS2000B Quantitative Research Methods in Population Health Sciences II
- BST222 Basics of Statistical Inference
- BST234 Data Structures and Algorithms
- BST241 Statistical Inference II [Spring 2024]

**Massachusetts Institute of Technology:**

- 18.675 Theory of Probability
- 18.337 Parallel Computing and Scientific Machine Learning
- 6.7920 Reinforcement Learning: Foundations and Methods
- 18.656 Mathematical Statistics: A Non-Asymptotic Approach [Spring 2024]
- 18.676 Stochastic Calculus [Spring 2024]

**Courses Taught as Teaching Fellow:**  
**University of South Florida:**

- MAP2302 Differential Equations
- MAC2312 Calculus II [Grader]

**Harvard University:**

- ID201 Core Principles of Biostatistics and Epidemiology for Public Health Practice