

Frederick “Forrest” Isadore Miller (he/him)
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EDUCATION

Northeastern University (NEU), Boston, MA

Fall 2023 - Present

PhD in Mathematics

partially funded by National Science Foundation Graduate Research Fellowship

Worcester Polytechnic Institute (WPI), Worcester, MA

May 2023

Bachelor of Science, Mathematical Sciences: GPA: 3.92

Bachelor of Science, Data Science; GPA: 3.92

Major Quality Project (Honors Thesis): *Deep Learning for Reflected Backwards Stochastic Differential Equations*¹, Advisor: Professor Stephan Sturm (WPI). Awarded MQP Departmental Honorable Mention

Relevant Coursework

As a PhD Student At Northeastern

Mathematics: Optimization, Probability and Measure, Compressed Sensing and Random Matrix Theory (Readings Course), Geometry and Applications of Tensors

As an undergraduate at WPI

Computer Science - Accelerated Introduction to Program Design, Object Oriented Design Concepts, Database Systems I, Analysis of Algorithms, Machine Learning

Mathematics - Matrices and Linear Algebra II, Combinatorics, Linear Programming, Applied Statistics I & II, Probability Theory, Convex Optimization, Top Algorithms in Applied Mathematics, Numerical Methods for Linear and Nonlinear Systems, Data Analytics and Statistical Learning, Computational Optimization, Portfolio Valuation and Risk Management (Graduate), Lebesgue Measure and Integration (Graduate), Linear Algebra (Graduate)

Data Science - Introduction to Data Science, Data Science II: Modeling and Data Analysis, Data III: Computational Data Intelligence, Advanced Prescriptive Analytics

2022 Gene Golub SIAM Summer School, L'Aquila - Italy

August 2022

Topics: Quantitative Risk Management in Finance, Energy and Commodities Markets, Machine Learning and Financial Technology, Mean Field Games.

- Selected among competitive pool of applicants to be funded to attend the program

RESEARCH EXPERIENCE:

Graduate Research Assistant, Northeastern University (July 2023 - Present)

Advisor: Professor David Rosen (NEU)

- Member of Northeastern University Robust Autonomy Lab (NEU-RAL)
- Developing novel semialgebraic optimization techniques for high dimensional optimization of semidefinite programs (SDPs) for certifiable estimation problems arising in machine intelligence

Undergraduate Researcher, WPI (November 2021 - May 2023)

Advisor: Professor Andrew Trapp (WPI)

Project title: Optimizing the Benefit-to-Cost Ratio for Deployment of New York City Shelter Resources REU

¹Link: https://digital.wpi.edu/concern/student_works/js956j933?locale=en

- Using Python, Gurobi, and high performance computing to maximize the benefit to cost ratio for resource allocation for New York City runaway and homeless youth
- Applying techniques from fractional programming, mixed integer optimization, and data engineering to develop the optimization model

Advisor: Professor Stephan Sturm (WPI), Professor Rohini Kumar (Wayne State University), Dr. Hussein Nasrallah (University of Michigan - Dearborn)

Project title: Deep Learning to approximate RBSDEs to price American Options

- Applying neural networks to approximate solutions to reflected backwards stochastic differential equations (RBSDEs).
- Performing parameter selection for the neural network and RBSDEs to generate smile curves of the American Put Options and verify solutions are consistent with theory
- Reporting the solutions to be written for scientific publication

NSF REU Student, University of Wisconsin - La Crosse (UWL) (June 2021 - August 2021)

Advisors: Dr. Wako Bungula (UWL), Dr. Danelle Larson (United States Geological Survey)

Project title: Topological Data Analysis (TDA) of Upper Mississippi River System

- Utilized R and Python libraries to apply the TDA mapper algorithm to generate a large simplicial complex from the dataset
- Apply density algorithms to topologically define different ecological states within the data.
- Presented weekly progress updates to all the REU students and created a research poster to bring to conferences (a research poster that was accepted at JMM 2022)

Research Assistant Intern, Yale School of Medicine (June 2020 - August 2020)

Advisors: Dr. Steven Kleinstein, Dr. Kenneth Hoehn

Project title: B Cell Repertoire data set curation

- Developed parts of a data pipeline for analysis of longitudinal studies in the Observed Antibody Space and the iReceptor data sets
- Performed analysis on gene sequence data to find evidence of somatic hyper evolution
- Publication in eLife Sciences

PUBLICATIONS

1. Larson DM, Bungula W, Stockdill A, McKean C, Lee A, **Miller F. I.**, and Davis K. (June 2023) *Quantifying ecosystem states and state transitions of the Upper Mississippi River using topological data analysis*. PLOS Computational Biology. <https://doi.org/10.1371/journal.pcbi.1011147>
2. Larson, D.M., Bungula, W., Lee, A., Stockdill, A., McKean, C., **Miller F. I.**, Davis, K., Erickson, R.A. and Hlavacek, E. (May 2023), *Reconstructing missing data by comparing interpolation techniques: Applications for long-term water quality data*. Limnology and Oceanography: Methods. <https://doi.org/10.1002/lom3.10556>
3. **Miller, F. I.**, Y. Kaya, G. L. Dimas, R. Konrad, K. L. Maass, A. C. Trapp, *Optimizing the Benefit to Cost Ratio for Public Sector Decision Making*, (April 2023) <https://arxiv.org/abs/2212.04534>.
4. Hoehn, K. B., Turner, J. S., **Miller, F. I.**, Jiang, R., Pybus, O. G., Ellebedy, A. H., & Kleinstein, S. H. (2021). *Human B cell lineages associated with germinal centers*

following influenza vaccination are measurably evolving. ELife, 10, e70873.
<https://doi.org/10.7554/eLife.70873>

PROJECTS

1. MA 574 Portfolio Valuation and Risk Management Project: *Markowitz Portfolio Optimization*. Applied Markowitz Portfolio theory to trade assets throughout the semester. Produced report on the success of the account with weekly rebalances.
2. MA 4635 Data Analytics and Statistical Learning Final Project: Applied several statistical learning algorithms to best predict weather using a Kaggle dataset.
3. MA 3231 Linear Programming Final Project: *L¹ Regression Analysis*: Presented a theoretical study of L1 regression and its interpretation as a linear programming problem.

HONORS AND AWARDS:

- National Science Foundation Graduate Research Fellowship (NSF GRFP) Awardee, 2024
 - Provides Three full years of funding for my doctoral research
- WPI Peer Learning Assistant of the Year 2023
 - Also awarded Peer Learning Assistant of the year within the Mathematical Sciences Department
- WPI MQP Award Departmental Honorable Mention for MQP
- WPI Senior Math Award 2023
 - Awarded for outstanding performance and making valuable contributions to the WPI Community
- INFORMS Scholarship Award: Funding to travel and present at the INFORMS Annual Meeting, 2022
- Full funding to attend SIAM Summer School on Financial Analytics in L'Aquila, Italy
- WPI Presidential Scholarship (2019- 2023)
- Dean's List, WPI

TEACHING EXPERIENCE

REU Mentor, Northeastern University Math Department (May 2024 - July 2024)

- Mentoring two undergraduate students on a research project in support of the NEU-RAL.
- Assisting in writing and design of large scale eigenvalue computational tools
- Students are funded by NSF grant

Peer Learning Assistant (PLA), WPI Math Department (August 2020 - Present)

- Manage a section of 20 to 35 students in mathematical sciences courses at WPI
- Run a weekly discussion section reviewing lecture content.
- Grade Homework & exams for the section working with a Professor and other PLAs and Teaching Assistants.

Courses Taught:

MA 3231 - Linear Programming, A Term 2022

MA 2621 - Probability for Applications, C Term 2022, D Term 2023

MA 2071 - Matrices & Linear Algebra I - B Term 2020, D Term 2021

MA 2072 - Accelerated Matrices & Linear Algebra I - C Term 2023

MA 1023 - Calculus III, A Term 2020, A Term 2021, D Term 2022, B Term 2022

CONFERENCES / TALKS

- Graduate Student Seminar, Northeastern University
 - Certifiable Estimation Through Semidefinite Programming, February 2024
 - An Introduction to Mathematical Finance, September 2023
- Mathematical Finance and Stochastic Analysis Seminar @ WPI, April 2023
 - Risk Indifference Pricing for American Put Options
- WPI PhD Student Seminar, January 2023
 - Modern Portfolio Theory from Scratch
- 2023 Joint Mathematics Meeting, January 2023
 - Optimizing the Benefit-to-Cost Ratio for Public Sector Decision Making
- 2022 INFORMS Annual Meeting, October 2022
 - Optimizing The Benefit-to-Cost Ratio For Effective Capacity Deployment For New York City's Homeless Youth Shelter System
 - Awarded INFORMS Scholarship to be funded and attend the conference and attend special sessions
- WPI PhD Student Seminar @ WPI, February 2022
 - A brief survey of operations research and optimization
- Math REU Poster Session @ University of Wisconsin - La Crosse (UWL), August 2021
 - Research poster to members of UWL Math & Biology Departments
- WPI Math Club Sunday Night Seminar - April 2020
 - Introductory combinatorics to members of WPI Math club
- WPI Math Department Open House - April 2021, October 2021, April 2022
 - Mathematical Sciences undergraduate program at WPI with prospective students

LEADERSHIP / SERVICE

Organizer, NEU-RAL Group Meetings (August 2023 - August 2024)

Organize lab meetings for members to present current research and solicit feedback before major presentations.

President, WPI Math Club (April 2020 - March 2023)

Prepare meetings for WPI's math club by finding an activity for our weekly math hour. Normally this consists of a fun puzzle with a mathematical bend that the club discusses and tries to solve.

President, WPI Pi Mu Epsilon Massachusetts Alpha Math Honors Society (May 2022 - May 2023), Vice President January 2022 - May 2022, Member April 2021 - January 2022

SKILLS

Programming Languages: Julia, MATLAB, Python, SQL, R, Java

Applications: Microsoft Office, Google Suite, LaTeX, Bloomberg Market Concepts (Certified)

Docker, Github, slurm, Overleaf

Python libraries: pandas, numpy, scikit, tensorflow, pytorch, matplotlib, cvxpy

Julia Libraries: JuMP, LinearAlgebra, SparseArrays, Plots

Solvers: Gurobi, Mosek, COSMO, Clarabel, SCS

Interpersonal Skills: Leadership, Teamwork, Public speaking, Conflict resolution