Karen Medlin

Ph.D. Candidate in Applied Mathematics

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Summary

- Applied Math Ph.D. Candidate applying optimization, statistics, and numerical methods in the development of novel ML/AI algorithms for handling imbalanced datasets. Expected graduation in May 2025.
- Experience deploying mathematical models for real-world problems, with specific investigation into airborne viruses inside the human respiratory tract.
- Proficient in Python (including PyTorch, TensorFlow, sci-kit learn, pandas, NumPy), Java and R; Bash and Vim for HPC environments; and Git version control.
- Versatile cross-disciplinary collaborator with experience at an R1 research university, national lab, and globally recognized arts organization, demonstrating adaptability and teamwork in complex environments.
- Recognized with fellowships from the National Science Foundation, UNC's Graduate School, and the U.S. Department of Energy for contributions to AI research and machine learning methodologies.

Education

University of North Carolina at Chapel Hill, Chapel Hill, NC
Ph.D. Applied Mathematics (M.S. in Mathematics, 2022) 2019 - 2025 (expected)
Co-advisors: Greg Forest, Sven Leyffer[1]

- Dissertation research: Developed novel deep learning algorithms to address class imbalance in AI models using bilevel optimization. By introducing novel sampling techniques while employing standard deep neural networks for training and testing, my research enhances the predictive accuracy for underrepresented classes of data. First-author publications being submitted to AAAI, ICML, and NeurIPS.
- Master's Project: Deployed a numerical model to simulate virus dynamics in human airways using Python and high-performance computing.
- Relevant Coursework: Data Structures, Machine Learning, Numerical Analysis, Optimization, Probability, Scientific Computing, and Statistical Modeling.

IBM Research, Almaden, CA
Mathematical Sciences Research Institute's (MSRI) summer school: "Mathematics of Data: Sketching and Tensor Algebra" Summer 2023

University of Washington, Seattle, WA
Masters coursework in mathematics 2018 - 2019

City University of New York, New York, NY
Post-baccalaureate coursework in mathematics, programming and statistics 2014 - 2018

1 Senior Computational Mathematician Dr. Sven Leyffer is the deputy division director of the Mathematics and Computer Sciences Division at Argonne National Laboratory.

Research & Publications

Karen Medlin, Sven Leyffer and Krishnan Raghavan. Sampling Imbalanced Data with Multi-objective Bilevel Optimization, 2025. (submitted to ICML)

Karen Medlin, Sven Leyffer and Krishnan Raghavan. A Bilevel Optimization Framework for Imbalanced Data Classification. *arXiv CoRR, abs/2410.11171v2*, 2024.

Leyi Zhang, Karen Medlin, Greg Forest, et al. Computational Modeling Insights into Extreme Heterogeneity in COVID-19 Nasal Swab Data. *Viruses*, 16(1): 69, 2024.

Nathan Davidov, Karen Medlin, et al. Maximum Covering Subtrees for Phylogenetic Networks. *IEEE/ACM Transactions on Computational Biology and Bioinformatics*, 18(6): 2823-2827, 2021.

Awards & Certificates

UNC Dissertation Completion Fellowship 2024 - 2025

U.S. Department of Energy Office of Science SCGSR Fellowship 2023 - 2024

National Science Foundation Math Sciences Graduate Internship 2022, 2023

UNC ARPA Graduate Degree Completion Grant (Master's degree) 2021 - 2022

Introduction to High Performance Computing (HPC) Certificate Nov. 2022
Super Computing Conference (SC22)

Work Experience

UNC Graduate Research Fellow 2019 - present
UNC Chapel Hill Mathematics Department, Chapel Hill, NC

U.S. Department of Energy Graduate Fellow 2022 - 2024
Argonne National Laboratory, Darien, IL

- Working on team led by Sven Leyffer and Krishnan Raghavan,developed a novel algorithm and its theoretical underpinnings featured in my first first-author paper.
- Began what became my dissertation while working in the Laboratory for Applied Mathematics, Numerical Software and Statistics (LANS) group as a NSF MSGI summer intern.

Senior Grants Manager 2012 - 2017
The Joyce Theater Foundation, Inc., New York, NY

- Exceeded fundraising targets year over year for an operational budget of $10+ million. Increased annual contributed income by $1 million (50%) over five years.

Teaching Experience

Recitation Leader

- Math 233: Calculus III, UNC Chapel Hill Fall 2023
- Math 232: Calculus II, UNC Chapel Hill Spring 2023
- Math 125: Calculus with Analytic Geometry II, Univ. of Washington Fall 2018, Winter 2019, Spring 2019

Assistant

- Math 347: Linear Algebra for Applications, UNC Chapel Hill Fall 2020, 2021, 2022
- Math 383: First Course in Differential Equations, UNC Chapel Hill Fall 2021, 2022
- Math 566: Introduction to Numerical Analysis, UNC Chapel Hill Fall 2020
- Math 381: Discrete Mathematics, UNC Chapel Hill Spring 2019

Conferences, Talks & Posters

SIAM Conference on the Mathematics of Data Science (MDS24) Oct. 2024
Atlanta
Minisymposium: Towards a Notion of Model Correctness for Deep Learning
Poster: Classifying Imbalanced Data

National Science Foundation's MSGI Symposium Aug.2023
Talk: Classifying Imbalanced Data

Triangle Computational and Applied Mathematics Symposium Sept. 2022
North Carolina State University
Lightning Talk and Poster: To Classify Imbalanced Data Correctly, Find the Best ~~Model~~ Data

Underrepresented Students in Topology and Algebra Research Symposium (USTARS) Apr. 2018
Reed College
Poster: Neural Networks and the Shape of Data

BMCC/CUNY Annual Research Symposium May 2017
Borough of Manhattan Community College
Talk: The Perceptron: An Introduction to Machine Learning

Joint Mathematics Meeting Jan. 2017
Poster: The Perceptron: An Introduction to Machine Learning

Community Service

Graduate Mathematics Association (GMA) 2019 - present
UNC Chapel Hill Mathematics Department
- Treasurer (2021-2022): Managed departmental funds for graduate student activities, facilitated budget proposals, and coordinated financial planning for events.

Anti-Racism Community Group (ARC) 2020 - 2022
UNC Chapel Hill Mathematics Department
- Founder and Organizer: Established ARC to address issues of diversity, equity, and inclusion within the department. Organized speaker events, facilitated workshops, and led initiatives to promote anti-racism education among faculty and students.

UNC Chapel Hill Mathematics Department 2020 - 2023
Invited Speaker and Workshop Facilitator
- Facilitated unconscious bias workshops during the Graduate Student Teaching Seminar, providing practical tools for addressing bias in academic environments.
- Delivered presentations on the impact of ARC initiatives to prospective graduate students as part of departmental outreach efforts.

Professional Affiliations

Association for Computing Machinery/IEEE Computer Society 2022 - present
- Supercomputing Conferences Student Volunteer, SC22-SC23

Society for Industrial and Applied Mathematics (SIAM) 2019 - present
- National Math Festival Student Volunteer, April 2021

Association for Women in Mathematics (AWM) 2018 - present
- Local UNC chapter Treasurer, 2021-2022