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Farjana Siddiqua

Passionate and innovative PhD candidate of Mathematics with a background in Numerical Analysis, Scientific Computing, Machine Learning, Programming Language, and Quantitative Research.

Skills

Tools and Languages	MATLAB, R, Python, FEniCS, FreeFEM++, SQL, Maple, Mathematica, C++, FORTRAN, LaTeX.
Quantitative Research	Numerical Analysis, Scientific Computing, Mathematics of Finance, Optimization, Mathematical & Stochastic Modeling, Finite Element, Machine Learning, Iterative Methods, Operations Research.

Technical Experience

Scientific Computing **Fall 2015 - Present**

- Active researcher in Applied Mathematics. Worked on several real-life problems which resulted in multiple publications.
- Accomplished numerous coursework related to Scientific Computing such as Machine learning, Computational Fluid Dynamics, Dynamical Systems, Operations Research, etc.
- Strong Programming skills are demonstrated throughout my research journey as it is a vital part of the accomplished projects to validate the claimed theoretical results.
- I worked as a Graduate Research Assistant of Dr. William J. Layton on the projects titled “Accurate Prediction of Fluid Motion” and “Time Accurate Prediction of Fluid Motion”. Both projects are funded by NSF (DMS 1817542) and NSF (DMS 2110379).
- Certified for "Data Basics Workshop (Python)", Research Computing Education (RCE), University of Pittsburgh.
- Workshop on Small scale dynamics in incompressible fluid flows, American Institute of Mathematics, CA.

Machine Learning Research, University of Pittsburgh, Pittsburgh, PA **Fall 2021**

- Machine learning techniques applied to multi-objective optimization problems (Used RStudio) where true data were provided from high-fidelity physics simulations of an important manufacturing process.
- Trained Non-Bayesian linear models, regularized models with elastic net, neural networks, random forest, gradient boosted tree, support vector machines, and partial least squares.
- Identified the best models for each output and used best models to identify the input values that minimize the continuous output (response) and minimize the probability that the binary output (outcome) equals the event.

Mentorship Experience

Graduate Teaching Assistant, University of Pittsburgh **Fall 2018-Spring 2023**
Adjunct Faculty, Florida International University & Miami Dade College **Fall 2017-Summer 2018**
Graduate Teaching Assistant, Florida International University **Fall 2015-Spring 2017**
Lecturer, International University of Business Agriculture & Technology **Fall 2017-Summer 2018**

Education

PhD in Applied Mathematics, University of Pittsburgh, Pittsburgh, PA, USA **Fall 2018 – Spring 2024 (Expected)**
Research Concentration: Numerical Analysis and Scientific Computing

- Andrew W. Mellon Predoctoral Fellow for 2022-2023 academic year.
- Related courses: Machine Learning, Numerical Methods in Scientific Computing 1 & 2, Advanced Scientific Computing, 3, & 4, Mathematics of Finance 1 & 2, Finite Element Method, Iterative Methods, Numerical Solution to ODE & PDE, etc.
- Advisors: **Dr. William J. Layton**, **Dr. Catalin Trenchea**

MS in Mathematics, Florida International University, Miami, Florida, USA **Fall 2015 – Spring 2017**

- Related courses: Method of Applied Analysis, Fourier Analysis, Complex Analysis, Dynamical Systems & Chaos Theory, etc.
- Advisor: **Dr. Zhongming Wang**

MS in Applied Mathematics, University of Dhaka, Dhaka, Bangladesh **2013 – 2014**

- Related courses: Operations Research, Fluid Dynamics, Magnetohydrodynamics, Mathematical Hydrology etc.
- Advisor: **Dr. Mohammad Ferdows**

BS in Mathematics, University of Dhaka, Dhaka, Bangladesh **2008 – 2012**

- Related courses: Statistics, C++, FORTRAN programming, Mathematical Modeling in Finance & Business Management etc.
- Advisor: **Sarker Md. Sohel Rana**

Fellowships

- **Andrew W. Mellon Predoctoral Fellowship**, University of Pittsburgh, Fall 2023 - Spring 2024
- National Science Foundation Fellowship, Each Summer of 2019 - 2023
- Arts and Science Graduate Fellowship, University of Pittsburgh, Spring 2019

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Research and Publication

A second-order symplectic method for an advection-diffusion-reaction problem in Bioseparation
*(Authors: **F. Siddiqua**, C. Trenchea)* *Technical Report, TR-MATH 22-03, University of Pittsburgh, 2022*

- The considered problem with non-homogeneous boundary conditions models the chromatography process in bioseparation. Stability and error estimates are proved after using the Finite Element method for spatial discretization & the midpoint method for time discretization. Algorithms are conducted in FreeFEM++ and simulation data are visualized in MATLAB.

Numerical Analysis of a Corrected Smagorinsky Model
*(Authors: **F. Siddiqua**, X. Xie)* *Published in Journal of Numerical Methods for Partial Differential Equations, 2022*

- The considered problem with non-homogeneous boundary conditions models the chromatography process in bioseparation. Stability and error estimates are proved after using Finite Element method for spatial discretization & the midpoint method for time discretization. Algorithms are conducted in FreeFEM++, and simulation data are visualized in MATLAB.

Similarity Solution & Numerical analysis of the steady nanofluid layer induced by gyrotactic microorganisms containing wall temperature variations
*(Authors: M. Ferdows, N. I. Nima, **F. Siddiqua**)* *Published in Journal of Computational Mathematics and Modeling, 2020*

- To introduce the governing equations (boundary layer equations for describing the flow problem), a water-based nanofluid containing gyrotactic microorganisms is considered. Some dimensionless quantities such as the exponent of the temperature, the nanoparticle volume fraction, and the density of motile microorganisms are used to have the desired governing equation. The influences of considering these quantities are shown graphically by using the software Maple.

A Modified Poisson–Nernst–Planck Model with Excluded Volume Effect: Theory & Numerical Implementation
*(Authors: **F. Siddiqua**, Z. Wang, S. Zhou)* *Published in Journal of Communications in Mathematical Sciences, 2018*

- An effective Modified Poisson–Nernst–Planck (MPNP) model is developed by incorporating the excluded volume effect which is useful in many technological applications and biological processes such as electrochemical energy devices, membrane ion channels, drug designing, etc. A conservative and energy dissipative finite difference method is developed for the newly derived MPNP equations. The second-order accuracy of the method and the impacts of the effect of volume exclusion are shown through numerical experiments using MATLAB.

Variable Time Step Method of Dahlquist, Liniger and Nevanlinna (DLN) for a Corrected Smagorinsky Model (CSM)
*(Authors: **F. Siddiqua**, W. Pei)* *Preprint, 2023*

- Unconditionally, a long-time, nonlinearly stable scheme named DLN is implemented to CSM since it has greater accuracy and allows larger timesteps. The method's second-order accuracy and error estimates are demonstrated in addition to proving the kinetic energy is bounded for various time steps. Theoretical results are illustrated by several numerical tests using reeFEM++ and MATLAB and it's observed that adapting the time step produces a significant difference in the solution.

Stability and Accuracy analysis of the θ Method and 3-Point Time filter
*(Authors: N. Hurl, **F. Siddiqua**, S. Xu)* *Preprint, 2023*

- A θ method with 3-point time filter is analyzed which adds one additional line of code to the existing source code of θ method. The method's 0-stability, accuracy, and A-stability for both constant time step and variable time step are proved while validating them by several numerical tests.

Research Talks

- SIAM Conference on Optimization (OP23), Seattle, WA — Summer 2023
- Finite Element Circus, Carnegie Mellon University, Pittsburgh, PA — Fall 2022
- Sayas Numerics Day, University of Maryland, Baltimore County, MD — Fall 2022
- SIAM Annual Meeting, Pittsburgh, PA — Summer 2022
- AWM Research Symposium, University of Minnesota, MN — Summer 2022
- Finite Element Circus, Penn State University, PA — Fall 2021

Leadership Roles

- President, University of Pittsburgh Chapter of Association for Women in Mathematics (AWM) — January 2021 - Present
- Appointed to Central AWM Membership and Community Portfolio Committee — February 2023 - Present
- Treasurer, University of Pittsburgh Chapter of the Society for Industrial and Applied Mathematics — August 2021 - Present
- Executive Member, Mathematics Graduate Student Organization — August 2021 - Present
- President, Krishnachura: Bangladeshi Student Association of Pittsburgh — August 2021 - August 2023