

Mushrafi Munim Sushmit

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PERSONAL STATEMENT

I am a highly motivated and passionate researcher in the field of physics and quantum computing. With a strong background in physics and mathematics, I have dedicated my academic journey to exploring the intersection of quantum mechanics and machine learning. My goal is to leverage the power of quantum machine learning to solve complex real-world problems.

Key Skills: Quantum Computing, Machine Learning, Quantum Machine Learning, Research, Mathematical Modeling.

RESEARCH EXPERIENCE

Adapting Physics-Informed Neural Networks for Quantum Computing

Dhaka, Bangladesh

Master's Thesis

Mar 2024 – Present

- Conducting research under the mentorship of Dr. Golam Dastegir Al Quaderi in the field of quantum computing, specifically focusing on the adaptation of physics-informed neural networks (PINNs) to quantum computational frameworks.
- Successfully developed multiple models that integrate classical physics equations with PINN, including the coupling of differential equations like the Lotka-Volterra model, high-dimensional coupled Higgs equation, and nonlinear Schrödinger equations
- Currently transitioning towards quantum machine learning-based implementations, aiming to bridge the gap between classical physics-informed modeling and quantum computing capabilities.
- Utilizing a combination of Python, PyTorch, PennyLane, and Qiskit to construct and validate quantum-enhanced versions of physics-informed neural networks
- This ambitious project, serving as my master's thesis, aims to pioneer the integration of PINNs within quantum computing, potentially revolutionizing how we approach and solve physics-based problems through computational means.

Vaccination Decisions in a Dual Strain Disease Dynamics

Dhaka, Bangladesh

Research Assistant

Aug 2023 – Feb 2024

- Worked under the guidance of Dr. Muntasir Alam from Department of Applied Mathematics, University of Dhaka to analyze the impact of vaccination considering behavioral, socio-economic factors on the dynamics of a second disease strain.
- Integrated randomness, game theory principles, and network analysis to create a comprehensive model for disease spread in the given scenario.
- Utilized Python, Mesa and Julia to implement multi agent based models and conducted rigorous testing.
- Developed three distinct models to enhance the understanding of disease spread dynamics: a scale-free model where agents utilize a random scale-free graph to make vaccination decisions, a complete graph model reflecting uniform decision-making among all agents, and a stochastic model for validating our findings.
- The comprehensive study is currently under review at the Chaos, Solitons & Fractals journal

Quantum Machine Learning for Solar Irradiance Forecasting

Dhaka, Bangladesh

Research Assistant

Mar 2023 – May 2023

- Worked under the supervision of Dr. Mohammed Mahbubul Islam from Institute of Energy Engineering, Dhaka University of Engineering & Technology to develop and validate hybrid classical-quantum machine learning models for solar irradiance prediction.
- Conceptualized and initiated the project, proposing the integration of quantum layers within feedforward neural networks.
- Utilized Python, PennyLane, Qiskit, and PyTorch to implement the models and conducted rigorous testing.
- Engineered a novel fully connected parameterized quantum circuit tailored for solar irradiance forecasting.
- Led the technical aspects of the project, encompassing model design, implementation, model validation and, performance evaluation.
- Published the findings in a Q1 journal with an impact factor of 10.4

PUBLICATION

[1] M. M. Sushmit, R. H. Leon, and M. Alam. “Dynamic vaccination strategies in dual-strain epidemics: A multi-agent-based game-theoretic approach on scale-free hybrid networks”. In: *Chaos, Solitons & Fractals* 185 (Aug. 2024), p. 115067. ISSN: 0960-0779. DOI: [10.1016/j.chaos.2024.115067](https://doi.org/10.1016/j.chaos.2024.115067). URL: <http://dx.doi.org/10.1016/j.chaos.2024.115067>.

[2] M. M. Sushmit and I. M. Mahbubul. “Forecasting solar irradiance with hybrid classical–quantum models: A comprehensive evaluation of deep learning and quantum-enhanced techniques”. In: *Energy Conversion and Management* 294 (Oct. 2023), p. 117555. DOI: [10.1016/j.enconman.2023.117555](https://doi.org/10.1016/j.enconman.2023.117555). URL: <https://doi.org/10.1016/j.enconman.2023.117555>.

EDUCATION

University of Dhaka <i>Master of Science in Physics</i>	Dhaka 1000, Bangladesh <i>Mar 2024 – Present</i>
University of Dhaka <i>Bachelor of Science in Physics</i> CGPA : 3.68/4.00(77.6%) <ul style="list-style-type: none">• Top 2% achiever of the cohort• Fourth-year GPA of 3.71• Third-year GPA of 3.58• Second-year GPA of 3.78• First-year GPA of 3.66 Relevant Coursework: Differential Calculus-I, Differential Calculus-II, Ordinary Differential Equation, Principles of Statistics, Mathematical Physics, Classical Mechanics and Relativity, Statistical Mechanics, Quantum Mechanics-I, Quantum Mechanics-II, Classical Electrodynamics, Lasers and Photonics, Solid State Physics-I, Solid State Physics-II, Nuclear and Particle Physics.	Dhaka 1000, Bangladesh <i>Jan 2019 – Feb 2024</i>

AWARDS & ACHIEVEMENTS

Fourth Place in Deep Learning Competition: Achieved 4th place in the inaugural Deep Learning Sprint (DLSprint) competition organized by Bangladesh University of Engineering and Technology (BUET). Developed the first-ever Bengali Automatic Speech Recognition (ASR) system, showcasing expertise in deep learning techniques.

CODING PROJECTS

Physics-Informed Neural Networks for Quantum Dynamics GitHub <ul style="list-style-type: none">• Implemented a novel approach with Physics-Informed Neural Networks (PINNs) for quantum dynamics problems, using PyTorch, NumPy, and SciPy for development and computations.• Showcased PINNs’ ability to decode complex quantum phenomena, merging deep learning with physical laws for advanced physics solutions.	<i>Feb 2024</i>
Disease Spread Simulation GitHub <ul style="list-style-type: none">• Developed a simulation model to understand the dynamics of disease spread within populations, leveraging the Python programming language and the Mesa framework to create agent-based models that simulate the spread of diseases• Incorporated realistic epidemiological parameters into the model to simulate various scenarios and assess the impact of public health interventions, providing valuable insights for decision-making in public health policy.	<i>Dec 2023</i>
Automatic Speech Recognition System for Bengali Language GitHub <ul style="list-style-type: none">• Designed and developed an Automatic Speech Recognition (ASR) system for the Bengali language using advanced deep learning techniques.• Implemented state-of-the-art models including Wav2Vec2-XLSR, T5, and ARPA models to achieve accurate speech recognition and transcription.	<i>Dec 2022</i>
Julia set and Fractals GitHub <ul style="list-style-type: none">• Utilized Python and CUDA to create a visually engaging animation that showcases the intricate beauty of fractals and Julia sets.	<i>Jun 2020</i>

SKILLS

Programming: C++, Python, Julia, BASH

Technologies: Git, Docker, Nix, PyTorch, Qiskit, Comsol, Pandas, OpenCV

Operating System: Linux, Windows

Languages: Bengali (Native), English (Professional, TOEFL Score: Reading 24/30, Listening 28/30, Speaking 25/30, Writing 23/30)

TEACHING EXPERIENCE

- Extensively tutored students for over 4 years at various academic levels, including O level, A level, National Curriculum high school, and first-year university students.
- Delivered instruction in High School Level Mathematics, Physics, and Programming, covering topics such as Calculus, Trigonometry, Probability and Statistics, Newtonian Mechanics, Electricity and Magnetism, and more.

CERTIFICATES

Quantum Mechanics & Quantum Computing Part-1 & Part-2	<i>Sep 2022</i>
<i>Quantum Computing theory, Comsol Simulation of Quantum Mechanical Systems, IBM Qiskit Learning</i>	
Neural Networks & Deep Learning Certificate	<i>Aug 2021</i>
<i>Foundational concepts of neural networks, Deep learning architectures</i>	
Bayesian Methods for Machine Learning Certificate	<i>Aug 2020</i>
<i>Bayesian Networks, Markov Chain Monte Carlo, Bayesian Inference</i>	
Data Driven Astronomy Certificate	<i>Jun 2020</i>
<i>Python Programming, Machine Learning, Applied Machine Learning, SQL</i>	

REFERENCES

Dr. Golam Dastegir Al Quaderi

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