

# Mushrafi Munim Sushmit

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## PERSONAL STATEMENT

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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

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### Adapting Physics-Informed Neural Networks for Quantum Computing

Dhaka, Bangladesh

*Master's Thesis*

*Mar 2024 – Present*

- Conducting research under the mentorship of Dr. Golam Dastagir 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.
- Published the findings in a Q1 journal with an impact factor of 7.8

### 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

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- [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

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### University of Dhaka

*Master of Science in Physics*

Dhaka 1000, Bangladesh

*Mar 2024 – Present*

### University of Dhaka

*Bachelor of Science in Physics*

Dhaka 1000, Bangladesh

*Jan 2019 – Feb 2024*

**CGPA : 3.68/4.00(77.6%)**

- 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.

## AWARDS & ACHIEVEMENTS

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**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

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### Physics-Informed Neural Networks for Quantum Dynamics | [GitHub](#)

*Feb 2024*

- 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.

### Disease Spread Simulation | [GitHub](#)

*Dec 2023*

- 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.

### Automatic Speech Recognition System for Bengali Language | [GitHub](#)

*Dec 2022*

- 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.

### Julia set and Fractals | [GitHub](#)

*Jun 2020*

- Utilized Python and CUDA to create a visually engaging animation that showcases the intricate beauty of fractals and Julia sets.

## SKILLS

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**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

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- 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

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**Quantum Mechanics & Quantum Computing [Part-1](#) & [Part-2](#)** *Sep 2022*

*Quantum Computing theory, Comsol Simulation of Quantum Mechanical Systems, IBM Qiskit Learning*

**Neural Networks & Deep Learning [Certificate](#)** *Aug 2021*

*Foundational concepts of neural networks, Deep learning architectures*

**Bayesian Methods for Machine Learning [Certificate](#)** *Aug 2020*

*Bayesian Networks, Markov Chain Monte Carlo, Bayesian Inference*

**Data Driven Astronomy [Certificate](#)** *Jun 2020*

*Python Programming, Machine Learning, Applied Machine Learning, SQL*

## REFERENCES

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**Dr. Golam Dastegir Al Quaderi**

*Professor*

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