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 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](). URL: [https://doi.org/10.1016/j.enconman.2023.117555]().

Education

University of Dhaka Dhaka 1000, Bangladesh
Master of Science in Physics *Mar 2024 – Present*

University of Dhaka Dhaka 1000, Bangladesh
Bachelor of Science in Physics *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 Phsyics-II, Nuclear and Particle Physics.

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* *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

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   *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

Dr. Golam Dastegir Al Quaderi	**Department of Physics**
Professor	*University of Dhaka*
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Dr. Kazi Hanium Maria	**Department of Physics**
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Dr. Ratan Chandra Gosh	**Department Of Physics**
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