# Lakshika Rathi

Curriculum Vitae

# Research Interests

Quantum Architecture, Machine Learning for Quantum, Quantum Machine Learning

#### Education

- 2023 2025 **University of Wisconsin-Madison** *Master's* Masters in Computer Sciences (GPA - 4/4) Research Advisor: Prof. Swamit Tannu
- 2019 2023 Indian Institute of Technology Delhi Bachelor's of Technology BTech in Electrical Engineering with a Minor in Computer Science (GPA - 9.23/10.00) Research Advisor: Prof. Saurabh Gandhi

## Publications

- Papers (1) L. Rathi, S. Diadamo, A. Shabani, "Quantum Autoencoders for Learning Quantum Channel Codes" 16th International Conference on COMmunication Systems & NETworkS (COMSNETS) 2024
  - (2) L. Rathi, et al., "Cycle-GANs generated difference maps to interpret race prediction from medical images" *FAIMI: The MICCAI 2024 Workshop on Fairness of AI in Medical Imaging*
  - (3) L. Rathi, E. Tretschk, C. Theobalt, R. Dabral, V. Golyanik, "Fully Quantum Auto-Encoding of 3D Shapes" British Machine Vision Conference (BMVC) 2023

# Research Experience and Internships

#### Current Qubit Readout for Neutral-atom systems using ML

University of Wisconsin-Madison. Guide: Prof. Swamit Tannu

- (a) Pruning convolutional neural network (CNN) models to process the readout of neutral-atom-based systems on a field-programmable gate array (FPGA)
- (b) Characterizing the background noise and crosstalk in the EMCCD based readout mechanism

#### 2024 Quantum Capability Learning with Physics-aware Neural Networks

Quantum Performance Laboratory - Sandia National Laboratories. Guide: Dr. Timothy Proctor

(a) Studying the usage of physics-aware neural networks to accurately learn a quantum computer's capability by predicting the circuit fidelities of complex systems subject to Markovian errors

#### 2023-24 Classical Parallelism and Compiler Optimization for Neutral Atom Architectures

University of Wisconsin-Madison. Guide: Prof. Swamit Tannu

- (a) Evaluated existing compilers such as SABRE (utilizing heuristic search and circuit reversal techniques) and other SAT/SMT-based compilers to assess the effectiveness of long-range interactions in neutral-atom systems, along with testing newer tools for reconfigurable neutral-atom systems
- (b) Studied the trade-offs in utilizing classical parallelism on NISQ hardware, specifically focusing on the optimal speedup achievable when mapping k-copies of a quantum circuit on a neutral-atom grid

#### 2023 **Quantum Network Protocols Simulation, Quantum Auto-encoders for learning channel codes** *Cisco Quantum Research. Guide: Dr. Stephen DiAdamo.*

- (a) Software: Implemented Quantum Network Protocols like multi-node entanglement swap, QKD and quantum teleportation using QuNetSim, NetSquid and Squanch in the backend framework of Cisco Networks platform - QNet Lab
- (b) Research: Developed a Machine Learning framework for generating quantum channel codes to evaluate them in classical, entanglement-assisted and quantum communication scenarios

#### 2022 Quantum Point-Cloud Auto-encoders 🖓 🌐

Max-Planck-Institut für Informatik, Germany. Guide: Dr. Vlad Golyanik.

- (a) Investigated **hybrid quantum-classical auto-encoder models** in the context of 3D representations; trained such hybrid models using a specialized back-propagation algorithm in the Qiskit and Pennylane frameworks
- (b) Analyzed ways to mitigate barren plateaus for auto-encoding point clouds and devised a normalisation scheme for encoding

#### 2021-22 Quantitative Translational Imaging - Race Analysis Project

QTIM Lab Martinos Center, affiliated with Harvard. Guide: Jayashree Kalpathy-Cramer.

- (a) Researched the underlying mechanism by which AI models can recognize race in medical images; examined the extent to which race-predicting models rely on confounds by using **Cycle Generative Adversarial Networks**
- (b) Worked on building occlusion maps to help identify the prominent regions responsible for predicting a particular race

#### 2020-21 Expressibility and Trainability of Quantum Machine Learning Models 🗘

- University of Edinburgh, UK. Guide: Prof. Elham Kashefi, Dr. Niraj Kumar.
- (a) Worked under Professor Elham Kashefi to analyze the expressibility of Quantum Models, primarily parametrized quantum circuits, through tools in Information theory like Fisher Information Metric and Effective Dimension
- (b) Explored the concepts of multiple data re-uploading in quantum circuits to enhance the model's capacity and expressibility

#### 2022 Mesoscale Modeling of the Mouse Brain in different states of consciousness 🖓 🏂

Indian Institute of Technology Delhi. Guide: Prof. Saurabh Gandhi

- (a) Investigated the mechanism of how information flow differs between an awake and an anesthetized mouse to help understand the mechanisms of anaesthesia and improve our ability to monitor anaesthesia
- (b) Modeled brain connections using data-constrained recurrent neural network (RNN) models incorporating multiple regions, and applied the current-based decomposition (CURBD) technique to analyze spiking data from mouse brain

#### 2021 Personalized Intelligent Teaching Assistant (PITA)

Infosys Summer Program. Guide: Kajari Ghoshdastidar

(a) Designed and implemented a mobile AI-powered software engine with the primary aim of reducing the workload on Teaching Assistants, leveraging automation to handle routine queries, thus enhancing overall efficiency in academic support

#### 2020 Analyzing Climate Factors to predict the spread of Covid-19

Indian Institute of Technology Delhi. Guide: Prof. Jay Dhariwal

- (a) Performed a **statistical analysis** of climatic data from the major cities in 165 countries around the world, taking into account the number of COVID-19 cases from January to June 2020
- (b) Implemented **supervised Machine Learning** techniques with Python to predict the spatial spread and seasonality

### Course Projects

#### Spring 2024 Studying spatial and temporal effects of running ML workloads

Big Data Systems. Guide: Prof. Shivaram Venkataraman.

Temporally co-located workloads across nodes to analyze power, frequency and temperature and study the effects of thermal throttling and different cooldown periods.

#### Fall 2023 LLMs for Quantum Circuit Compilation

Foundation Models & the Future of Machine Learning. Guide: Prof. Fred Sala. Explored the usage of LLMs as an ensemble of quantum compilers, assisting in determining the most suitable compiler for a given problem and provide a tailored solution accordingly.

#### Fall 2022 Impact of Non-IID distribution and label noise on Federated Semi-Supervised Learning

Special Topics in ML - Computer Vision. Guide: Prof. Anurag Mittal. Studied the impact of data distribution (IID v/s non-IID) on the FedAvg algorithm along with the impact of label noise on federated training.

# Spring 2022 Network Analysis of the Indian Stock Market O Special Topics in Computer Applications - Social Computing. Guide: Prof. Abhijnan Chakraborty. Constructed and analyzed a network of Indian stock market returns using correlation, community detection techniques, and Gephi visualizations to identify key market segments and behaviors during crises.

#### Spring 2021 Gesture Recognition

Digital Signal Processing. Guide: Prof. Lalan Kumar.

Implemented the Research Paper- "High Density Surface EMG-based Gesture Recognition using a 3D Convolutional Neural Network" using Matlab, Keras and TensorFlow frameworks

# Fellowships and Hackathons

#### 2024 iQuHack Hackathon by MIT-CQE, Boston 🖓 🌐

• Attended MIT's annual Hacakthon, working on the portfolio optimization problem given by Moody's

#### 2023 BigQ Hackathon by CQE and QuantX, Chicago

• Attended the BigQ Hackathon, a four-day quantum competition, selected among the top 5 teams out of 9, working on a predictive maintenance problem given by United Airlines

#### 2023 NYUAD International Hackathon for Social Good, Abu Dhabi

 Secured 2nd place among 16 International teams, working on designing an eco-friendly water distribution network based on Adiabatic Quantum Computing and Quantum ML

#### 2023 ICTP-Quantinuum Quantum Hackathon, Trieste, Italy

 Secured 2nd place among the 18 International teams, working on the Merck Gruppe/Merck Healthcare QNLP challenge, designing a classifier to detect adverse drug events using Lambeq

#### 2020-22 Google Women Techmakers Engineering Fellow

- Selected among the **top 126 candidates** out of 15,000 girls for a two-year experiential Program (WTEF) to become a professional coder; mentored by senior engineers at **Google and TalentSprint**
- Created a standard simulation for Quantum Key Distribution BB84 Protocol, using Qiskit

# Summer Schools and Workshops

# 2024 LLNL QuDIT Testbed Workshop, CA, USA

Workshop jointly hosted by San Jose State University and Lawrence Livermore National Lab, featuring research talks and hands-on training on LLNL's innovative QuDiT testbed

- 2024 Workshop on Quantum Communication and Computing, COMSNETS 2024, Bangalore, India Presented the Poster - "Quantum Autoencoders for learning Quantum Channel Codes"
- 2019 Harry Messel International Science School, University of Sydney, Australia Selected among top 5 candidates to represent India at the Summer school along with 140 students across 7 countries; Attended the residential programme of talks by world-renowned scientists, lab tours and social events around Sydney

# Honors and awards

- Sep 2022 Received the Endowment Merit Scholarship, ranking among top 15 female students at IIT Delhi
- Jun 2021 Selected as the Semi-Finalist in the Cargill Global Scholars Program, an initiative by Cargill and IIE
- Jan 2021 Achieved **Rank 1** & won the Best Education Hack award at GirlHacks, organized by the New Jersey Institute of Technology for building Learn Aid, a mobile app designed to assist hearing-impaired or visually-impaired students
- Mar 2018 Recipient of the **Kishore Vaigyanik Protsahan Yojana**, a coveted fellowship by the Department of Science and Technology, Government of India awarded to the top 1% students across the country
- May 2017 Awarded the NTSE Scholarship after a two-tier merit-based procedure by NCERT, Government of India

# Positions of Responsibility

- 2024 **Research Mentorship** | Quantum Sensing, University of Wisconsin-Madison Mentored Yining Wang, a Junior Undergrad in implementing the Research paper - Adaptive Circuit Learning in Quantum Metrology
- 2023-24 **Teaching Assistant** | CS400, University of Wisconsin-Madison Responsible for conducting office hours and grading assignments on **industry-level Java code**
- 2020-21 **Core Team Member** | CovEd India Worked as Core Team Member responsible for Data Handling to help school students during COVID-19
  - 2020 Academic Mentorship | PYL100, IIT Delhi Responsible for guiding a group of 170 freshmen for the course "Electromagnetics and Quantum Mechanics"

# **Technical Skills**

# Programming<br/>LanguagesC++, Python, Haskell, Java, HTML, CSS, Git, JavaScript, Shell, Bash<br/>LanguagesSoftware<br/>ToolsLATEX, Qiskit, GitHub, Autodesk Inventor, Arduino, Pygame, Graphviz, Pennylane, QuTip

Data Science Matplotlib, MATLAB, PyTorch, SciPy, Pandas, Keras, Tensorflow, OpenCV