Natansh **Mathur**

Quantum Machine Learning Researcher

Residency: French | Nationality: Indian

natansh.mathur@qcware.com | nashmathur | natanshmathur

Education

QC Ware & IRIF, CNRS
Paris, France

Doctorate in Computer Science — *2022 - 2026 (Expected)*

- Industrial PhD in Quantum Machine Learning

Université Paris Cité (University of Paris City)
Paris, France

Parisian Master of Research in Computer Science (MPRI) — *2021 - 2022*

- Mention: Magna Cum Laude

Indian Institute of Technology, Roorkee
Roorkee, India

Bachelor of Technology in Computer Science and Engineering — *2017 - 2021*

- CGPA: 9.538/10

Experience

QC Ware Corp.
Paris, France

Quantum Researcher (Asso. Staff Scientist) — *August, 2020 - Present*

- Researcher under the guidance of Prof. Iordanis Kerenidis.
- Provided QML research consultancy and services to various client firms.

IRIF, CNRS and Université Paris Cité
Paris, France

Master's Research Internship — *April, 2022 - August, 2022*

- Research Internship for M2 of the Masters (MPRI).
- Guided and supervised by Prof. Iordanis Kerenidis.

Quantum Open Source Foundation
Online

Mentor — *September, 2021 - January, 2022*

- Mentored a candidate to contribute to the Quantum Protocol Zoo.

IRIF, CNRS and Université Paris Cité
Paris, France (Remote)

Research Internship — *August, 2020 - December, 2020*

- Research Internship for completion of Bachelor's Thesis Project.
- Guided and supervised by Prof. Iordanis Kerenidis.

Institute for Quantum Computing, University of Waterloo
Waterloo, Canada (Remote)

Undergraduate Research Assistant — *April, 2020 - July, 2020*

- Research Assistant under the guidance of Prof. Norbert Lütkenhaus.
- Associated with Optical Quantum Communication Theory Group.

LIP6, CNRS and Sorbonne Université
Paris, France

Research Internship — *May, 2019 - July, 2019*

- Summer Research Internship under the guidance of Prof. Elham Kashefi.
- Part of the Quantum Internet Alliance team at CNRS.
- Associated with Paris Centre for Quantum Computing.

Information Management Group, IIT Roorkee
Roorkee, India

Chief of Research and Development — *January, 2018 - June, 2021*

- Working with a team of around 50 tech enthusiasts to develop software solutions for the college campus community.
- Maintain the IIT Roorkee official website with up-to-date technology stack.

Publications and Posters

Improved Financial Forecasting via Quantum Machine Learning

Sohum Thakkar, Skander Kazdaghli, **NM**, Iordanis Kerenidis, André J Ferreira-Martins, Samurai Brito

- https://arxiv.org/abs/2306.12965

Quantum Fourier Networks for Solving Parametric PDEs

Nishant Jain, Jonas Landman, **NM**, Iordanis Kerenidis

- https://arxiv.org/abs/2306.15415
- Long Talk at **QTML, 2023** in CERN, Geneva, Switzerland

Quantum Vision Transformers

El Amine Cherrat, Iordanis Kerenidis, **NM**, Jonas Landman, Martin Strahm, Yun Yvonna Li

- https://arxiv.org/abs/2209.08167
- Poster presented at **QCTiP, 2023** in Cambridge, UK

Quantum Methods for Neural Networks and Application to Medical Image Classification

Jonas Landman, **NM**, Yun Yvonna Li, Martin Strahm, Skander Kazdaghli, Anupam Prakash, Iordanis Kerenidis

- https://quantum-journal.org/papers/q-2022-12-22-881/
- Poster presented at **QIP, 2023** in Ghent, Belgium
- Poster presented at **QTML, 2022** in Naples, Italy

Classical and Quantum Algorithms for Orthogonal Neural Networks

Iordanis Kerenidis, Jonas Landman, **NM**

- **US Patent** number: US 11,829,877 B2
- Poster presented at **ECML PKDD, 2022** in Grenoble, France

Towards an Open-source Software Platform for Numerical Key Rate Calculation of General Quantum Key Distribution Protocols

Jie Lin, Ian George, Kai-Hong Li, Kun Fang, Twesh Upadhyaya, **NM**, Max Chemtov, Shlok A Nahar, Shahabeddin M Aslmarand, Thomas Van Himbeeck, Yanbao Zhang, Christopher Boehm, Patrick Coles, Adam Winick, Wenyuan Wang, Norbert Lütkenhaus

- The poster is available at https://2020.qcrypt.net/posters/QCrypt2020Poster139Wang.pdf
- Poster presented at **QCrypt, 2020** in Amsterdam, Netherlands

Towards a Unified Quantum Protocol Framework: Classification, Implementation, and Use Cases

Shraddha Singh, Mina Doosti, **NM**, Mahshid Delavar, Atul Mantri, Harold Ollivier, Elham Kashefi

- https://arxiv.org/abs/2310.12780
- Talk at **QTech, 2020** in Barcelona, Spain

Projects

Quantum Machine Learning for Enhancing MRI Screening

Joint work with **Harvard Medical School** and **F. Hoffmann-La Roche AG** *September, 2023 - PRESENT*

- Part of Wellcome Leap: Quantum for Bio Challenge.
- Applying various quantum machine learning techniques to improve MRI acquisition.

Quantum Bayesian Neural Networks for Anomaly Detection

Joint work with **BMW** *November, 2023 - PRESENT*

- Applied Bayesian learning to Quantum Orthogonal Neural Networks for segmenting the faults in 3D car parts.
- Used FNNs and 3D CNNs along with their different Bayesian versions to find the optimal solution.

Quantum Neural Networks for Credit Risk Assessment

Joint work with **Itaú Unibanco** *September, 2022 - March, 2023*

- Designed Neural Networks for predicting credit risk from the bank's customer data.
- Matched classical performance with significantly fewer parameters using quantum neural networks.

Quantum Autoencoders for Anomaly Detection

Joint work with **BMW** *September, 2022 - March, 2023*

- Designed autoencoders using quantum orthogonal neural networks to detect anomalies in satellite images of ship routes.

Quantum Vision Transformers for Medical Image Classification

Joint work with **F. Hoffmann-La Roche AG** *April, 2022 - August, 2022*

- Developed both a quantum analogue and a quantum native variant of the vision transformer.
- Used the developed techniques to classify Medical MNIST images.
- Perform real hardware experiments to benchmark performance.

Quantum Convolutional Neural Networks for Surface Crack Detection

Joint work with **BMW** *August, 2020 - June, 2021*

- Designed a convolutional neural network based on quantum orthogonal neural networks.
- Used the developed techniques to segment cracks on surface images.

Quantum Orthogonal Neural Networks for Medical Image Classification

Joint work with **F. Hoffmann-La Roche AG** *August, 2020 - June, 2021*

- Designed an orthogonal neural network architecture using quantum gates.
- Designed efficient learning algorithm to train the perfectly orthogonal neural networks.
- Extended it further to actual quantum architecture and benchmark its performance.
- Used the developed techniques to classify Medical MNIST images.

Numerical key rate calculator for QKD Protocols

Part of Research Assistantship at IQC, UWaterloo *April, 2020 - July, 2020*

- Contributed to the development of the software architecture and wrote protocols fitting into it.
- Wrote unified algorithms to perform parameter optimisation for various QKD Protocols using numerical methods and optimisation techniques.
- Used High-Performance super-computing clusters of ComputeCanada to evaluate various QKD protocols' key rates for different parameters.
- Software available in the public domain at *https://openqkdsecurity.wordpress.com/*

Quantum Protocol Zoo

Part of Research Internship at LIP6, Paris *December, 2018 - July, 2019*

- Added various protocols to the online encyclopedia of Quantum Internet Protocols and reviewed many others.
- Analysed and identified the resource requirements for performing each protocol.
- Developed the 'Knowledge Graphs' - a unified, interactive and user-friendly tool for resource visualisation.
- Available online at *wiki.veriqloud.fr*.

Linear Cryptanalysis of Substitution-Permutation Network

Summer Project *May, 2018 - June, 2018*

- Learning project under Prof. Sugata Gangopadhyay, Dept. of CSE, IIT Roorkee.
- Implemented a Substitution-Permutation Network based Block Cipher model.
- Implemented a linear cryptanalytic attack on the developed cryptosystem for retrieval of certain key bits.

Honours & Achievements

2021 **USEQIP,** Selected among top 30 individuals from the world by IQC, UWaterloo consecutively twice
2020 **USEQIP & URA,** Selected among top 30 individuals from the world by IQC, UWaterloo
2017 **Aditya Birla Scholarship Programme,** Shortlisted among 30 students from various IITs for 2017-18 Awards
2017 **All India Rank - 348,** JEE Advanced, administered by Indian Institutes of Technology
2017 **All India Rank - 231,** JEE Main, taken by more than a million students.
2017 **All India Rank - 114,** KVPY, administered by Indian Institute of Science.

Grants, Fundings, Fellowships

2022 **EUR QuanTech Fellowship,** Fellowship for M2 internship by Université Paris Cité
2020 **Unitary Fund,** Granted funding for developing open source Quantum Machine Learning teaching material.

Extracurriculars

Quantum Computing Group, IIT Roorkee

Roorkee, India

Founder, Core Member, Secretary for the term 2020-21

2020 - 2021

- Established the Quantum Computing research and discussion group under ACM Student Chapter, IIT Roorkee.
- Conducted QC discussions on various topics from the basics to the advanced.
- Mentored beginners in the field to explore the various topics systematically.

Geek Gazette

Roorkee, India

Editor and President for the term 2019-20

2017 - 2021

- Official Tech Magazine based in IIT Roorkee.
- Managed a group of 80 students divided into four diversely functional cells - Editorial, Design, Finance and Web.
- Written and edited articles and interviews for 6 issues of the magazine and the *website*.

Student Mentorship Programme

Roorkee, India

Mentor

2019 - 2020

- Personally mentored five freshmen from the CS Department.
- Individually guided them through personal and academic problems for the entire year.

Dramatics Section, IIT Roorkee

Roorkee, India

Dramatist

2017 - 2018

- Performed one Stage Play and acted as non cast member for three stage and street plays.

Programming and Algorithms Group

Roorkee, India

Programmer

2017 - 2018

- Member of the Competitive Coding club based in IIT Roorkee.