Natansh **Mathur**

QUANTUM MACHINE LEARNING RESEARCHER

Residency: French | Nationality: Indian

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Edu**cation**

QC Ware, France & IRIF, CNRS, Université Paris Cité
Paris, France

DOCTORATE IN COMPUTER SCIENCE   *2022 - 2025 (Expected)*

- Industrial PhD (CIFRE) in Quantum Machine Learning
- Supervisor: Prof. Iordanis Kerenidis

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

PARISIAN MASTER OF RESEARCH IN COMPUTER SCIENCE (MPRI)   *2021 - 2022*

- Honour: Magna Cum Laude

Indian Institute of Technology, Roorkee
Roorkee, India

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING   *2017 - 2021*

- CGPA: 9.538/10

Exp**erience**

QC Ware Corp.
Paris, France

QUANTUM RESEARCHER (ASSOCIATE STAFF SCIENTIST)   *August, 2020 - Present*

- Solve industrial use cases with Quantum Machine Learning solutions
- Clients include top firms across pharmaceuticals, finance, and automotives
- Developed software to run the machine learning solutions on client use case
- Performed several QML hardware experiments on various quantum devices

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

CHIEF OF RESEARCH AND DEVELOPMENT

Roorkee, India

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

Bayesian Quantum Orthogonal Neural Networks for Anomaly Detection

IEEE QCE 2025

NM, BRIAN COYLE, NISHANT JAIN, SNEHAL RAJ, AKSHAT TANDON, JASPER SIMON KRAUSER, RAINER STOESSEL

- https://arxiv.org/abs/2504.18103
- To be presented as a talk at **QTML, 2025** in Singapore
- Talk at **IEEE Quantum Week, 2025** in Albuquerque, USA
- Poster presented at **QCTiP, 2025** in Berlin, Germany

Training-Efficient Density Quantum Machine Learning

arXiv

BRIAN COYLE, EL AMINE CHERRAT, NISHANT JAIN, **NM**, SNEHAL RAJ, SKANDER KAZDAGHLI, IORDANIS KERENIDIS

- https://arxiv.org/abs/2405.20237
- Long Talk at **QTML, 2024** in Melbourne, Australia
- Talk at **QCTiP, 2024** in Edinburgh, UK

Improved Financial Forecasting via Quantum Machine Learning

Quantum Machine Intelligence

SOHUM THAKKAR, SKANDER KAZDAGHLI, **NM**, IORDANIS KERENIDIS, ANDRÉ J FERREIRA-MARTINS, SAMURAI BRITO

- https://link.springer.com/article/10.1007/s42484-024-00157-0
- Poster presented at **QCTiP, 2024** in Edinburgh, UK

Quantum Fourier Networks for Solving Parametric PDEs

Quantum Science & Technology

NISHANT JAIN, JONAS LANDMAN, **NM**, IORDANIS KERENIDIS

- https://iopscience.iop.org/article/10.1088/2058-9565/ad42ce
- Long Talk at **QTML, 2023** in CERN, Geneva, Switzerland
- Poster presented at **QCTiP, 2024** in Edinburgh, UK

Quantum Vision Transformers

Quantum

EL AMINE CHERRAT, IORDANIS KERENIDIS, **NM**, JONAS LANDMAN, MARTIN STRAHM, YUN YVONNA LI

- https://quantum-journal.org/papers/q-2024-02-22-1265/
- Poster presented at **QTML, 2023** in CERN, Geneva, Switzerland
- Poster presented at **QCTiP, 2023** in Cambridge, UK

Quantum Methods for Neural Networks and Application to Medical Image Classification

Quantum

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

US Patent

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

Pro**jects**

Quantum Machine Learning for Enhancing MRI Screening

JOINT WORK WITH **HARVARD MEDICAL SCHOOL** AND **F. HOFFMANN-LA ROCHE AG**   *September, 2023 - August, 2024*

- Part of Wellcome Leap: Quantum for Bio Challenge - Phase 1
- Applied various quantum machine learning techniques to improve MRI acquisition

Quantum Bayesian Neural Networks for Anomaly Detection

JOINT WORK WITH **AIRBUS**   *November, 2023 - August, 2024*

- 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
- Perform real hardware experiments to benchmark performance

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 hybrid classical-quantum neural networks
- Perform real hardware experiments to benchmark performance

Quantum Autoencoders for Anomaly Detection

JOINT WORK WITH **AIRBUS**   *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

- 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

Skills

Programming Languages	Python, C++, MATLAB, JAVA, C
Packages and Environments	Qiskit, Numpy, PyTorch, IBMQ Experience, JAX
Utilities	Git, LaTeX, Linux Shell, Vim, Jupyter

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.