NIRAJ KUMAR

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CAREER OBJECTIVE

I am a post-doctoral senior researcher at the University of Edinburgh actively working in the field of quantum machine learning, benchmarking/verification of near term quantum devices and secure communications. Currently holding 5+ years of research experience in theoretical and experimental quantum computation, I am eager to join industrial research leading to building, applicability and improved understanding of quantum computers.

RECOGNITION AND AWARDS

- Wired magazine and Quanta magazine news coverage on the work "Milestone Experiment Proves Quantum Communication Really Is Faster".
- 2Physics.com magazine news coverage on the work "Non-locality and conflicting interest games".
- Recipient of EDITE scholarship by the French government for P.hD. in Télécom Paris-tech.
- Granted SURGE fellowship by Indian Institute of Technology, Kanpur for research internship.

EDUCATION

Télécom Paris-Tech, France — Doctorate — 2015 - 2018

Topic: Design, analysis and implementation of advanced quantum communication protocols. Thesis can be found here.

Indian Institute of Technology, Kanpur — Integrated Bachelors & Masters — 2009 - 2014

Integrated Bachelors & Masters in Physics — GPA: 8.1/10

RESEARCH EXPERIENCE

Post-Doctoral Research — 2019-Present
Affiliation: School of Informatics, University of Edinburgh
Employer: Dr. Elham Kashefi

- **Quantum Machine Learning.**
  a. Joint project with Rigetti computing company on using quantum generative algorithms such as Born machines for finance. Specifically on generation of synthetic market data.
  b. Variational quantum algorithms for approximate quantum state cloning and estimation attacks for cryptanalysis on quantum secure systems.
- **Certification and Benchmarking.**
  a. Technique to benchmark of quantum computation with classical verification based on quantum hardware secure tokens.
  b. Collaboration with UK Quantum Computation and Simulation hub to deliver verification across a quantum network.
- **Cryptography and secure communication.**
  a. Developed quantum device authentication schemes with quantum hardware secure tokens.
  b. Efficient construction of quantum cryptographic primitives with unitary t-designs.

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Tencent Research, HongKong Feb'2019

Collaborator: Dr. Shengyu Zhang

Proposed a blueprint to implement quantum random access memory (QRAM), an integral part in quantum machine learning algorithms, in photonics platform.

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PhD research 2015-2018

Affiliation: Télécom Paris-Tech, France

Supervisors: Dr. Eleni Diamanti and Dr. Iordanis Kerenidis

- Proposed and demonstrated various communication and cryptographic tasks for which a quantum system outperforms any classical computing system in terms of resource efficiency.
- Other PhD highlights: Experiments on photonics systems; use of electronic systems (FPGA, National Instruments cards); data analysis using Python, C, and Matlab.

Master's Research 2013-2014

Affiliation: Indian Institute of Technology, Kanpur

Supervisor: Dr. Rajat Mittal

Topic: Investigation of constraint satisfaction problems. Modelling it into non-local games to look for game structures that permit quantum advantage.

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Paris Research Internship 2013

Affiliation: Université Paris Diderot- Paris 7.

Supervisors: Dr. Eleni Diamanti and Dr. Iordanis Kerenidis

Topic: Design, analysis and photonic implementation of non-cooperative bayesian games which admits a higher payoff using quantum resources.

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SURGE Research Internship 2012

Affiliation: Indian Institute of Technology, Kanpur

Supervisors: Dr. Debabrata Goswami

Topic: Design of a quantum genetic algorithm to solve an exponential size maze in polynomial steps.

JOURNAL PUBLICATIONS

Published research works in esteemed journals such as Nature Communications, Physics Review Letters and Physics Review Applied with a total citation count 94.

1. **Quantum versus Classical Generative Modelling in Finance** **2020**
Authors: Brian Coyle, Maxwell Henderson, Justin Chan Jin Le, Niraj Kumar, Marco Paini, Elham Kashefi. Journal: arXiv preprint arXiv:2008.00691

2. **Optimal quantum-programmable projective measurements with coherent states** **2020**
Authors: Niraj Kumar, Ulysse Chabaud, Elham Kashefi, Damian Markham, Eleni Diamanti. Journal: arXiv preprint arXiv: arXiv:2009.13201

3. **Experimental demonstration of quantum advantage for NP verification** **2020**
Authors: Federico Centrone, Niraj Kumar, Eleni Diamanti, Iordanis Kerenidis. Journal: arXiv preprint arXiv:2007.15876

4. **Client-Server Identification Protocols with Quantum PUF** **2020**
Authors: Mina Doosti, Niraj Kumar, Mahshid Delavar, Elham Kashefi. Journal: arXiv preprint arXiv:2006.04522

5. **Practically feasible robust quantum money with classical verification** **2019**
Authors: Niraj Kumar. Journal: Cryptography 2019, 3(4), 26

6. **Experimental demonstration of quantum advantage for one-way communication complexity surpassing best-known classical protocol** **2019**
Authors: Niraj Kumar, Iordanis Kerenidis, Eleni Diamanti. Journal: Nature Communications volume 10, Article number: 4152 (2019)

7. **Efficient quantum communications with coherent state fingerprints over multiple channels** **2017**
Authors: Niraj Kumar, Eleni Diamanti, Iordanis Kerenidis. Journal: Phys. Rev. A 95, 032337

8. **Nonlocality and conflicting interest games** **2015**
Authors: Anna Pappa, Niraj Kumar, Thomas Lawson, Miklos Santha, Shengyu Zhang, Eleni Diamanti, Iordanis Kerenidis. Journal: Phys. Rev. Lett. 114, 020401

9. **Quantum algorithm to solve a maze** **2013**
Authors: Niraj Kumar, Debabrata Goswami. Journal: arXiv preprint arXiv:1312.4116

Detailed publications can be found in my google scholar.

SKILL-SET

- Tools: Semi-definite programming, Linear optimisation.
- Languages: C, C++, Python, Matlab, R.
- Fiber optics, Interfacing optics with electronics, Signal synchronisation.
- Autodesk Inventor, Blender.

LANGUAGES

English: fluent; French: intermediate; Hindi: native.

OTHER INTERESTS

- Robotics: Automated Bots, Drones, Swarm Bots.
- Cryptocurrency and Blockchain.
- Sports: Lawn tennis and Badminton.