ANANTHA KRISHNAN

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Integrated **BS-MS** dual degree **Physics** graduate **Indian Institute of Science Education and Research Thiruvananthapuram**

EXPERIENCE

Research Fellow: Quantum Causal Multipartite Networks and LHV-Neural Networks

Ongoing | IISER TVM, Kerala, India

- With Prof. Anil Shaji and Prof. Debashis Saha, found the best measurement setting for Genuine network nonlocality with two-qubit sources(Masters).
- Developed a new model for distinguishing local distributions for separable network states with rank-k. Currently expanding the work to all quantum causal structures and reframing GNN and its resources(Fellow).
- Awarded the Chanakya Fellowship (I-HUB QTF) under the Department of Science and Technology, Govt. of India

Research Assistantship: Noisy Quantum Channels

Jan 2022 – Apr 2022 | IISER TVM, Kerala, India

- Under Prof. Nagaiagh Chamakuri(Data Science Minor), on identifying Quantum states (using RBM ansatz) demonstrating Superadditivity of coherent information, applying GAs and PSOs (Evolutionary algorithms) over gradient descent for global optimisation.

Project: Semi Definite Programming and POPs

- Experienced with using SDP, SOS approach for POPs and it Non Commutative counterpart with SOHS, solving them as a Semi Definite program. NCSOStools and NCAlgebra for SOHS check, trace min, eigen min, etc.
- SDP for Geometry, Dynamical System Theory and Max Cut (NP-Hard) Problems(cvxp package).

Project Contributor: Bell's Theorem, Random number certification, Quantum Causal Models.

Aug 2020 – Dec 2020 | IISER TVM, Kerala, India

- Did a presentation on **Bell's theorem** and the whole Bohr, Einstein debate, and its importance in random number generation with Prof. Manik Banik.
- Later, delved into Causal Box and Process Matrix frameworks for understanding Quantum Causal Networks.

Project: Quantum Circuits, Algorithms, and Computing

- Experienced with designing Quantum Circuits, Quantum Machine Learning (qNNs, qGANs, qSVM/Qiskit), Clifford Circuits & Gates.
- Tensor Network Circuits such as MPS and Tree Tensor Quantum Circuit for Ideal and Noisy Simulations
- Quantum Error Correction and Gate decompositions
- Experienced with Pennylane, Qiskit, tensorflow quantum, etc.

Research Assistant: Variational principles for finding quantum bound states

Aug 2019 – Dec 2019 | IISER TVM, Kerala, India

Group Project: Exploring dynamics of Chua's circuit

Jan 2022 – Apr 2022 | IISER TVM, Kerala, India

- Simulated Chua's circuit dynamics to understand its chaotic behavior. Learnt the significance of project management in research.

RESEARCH INTERESTS

I am interested in Quantum Information Science of importance to its foundation nature to emerging quantum technology, using theoretical and machine learning approaches.

I am also interested in Science communication, Interdisciplinary biology, and the Philosophy of science

EDUCATION & AWARDS

Integrated BS-MS Dual Degree
in Physics with Data Science Minor

IISER Thiruvananthapuram

July 2018 – July 2023

CGPA - 8.34/10

Research fellowship student

July 2023 – present (IISER Thiruvananthapuram)

TOEFL iBT Score

Total Score - 101

Chanakya PG Fellowship I-HUB QTF

July 2023 | NMICPS, Govt of India

Qiskit Quantum Excellence Award

2023 | IISER TVM, Kerala, India

MASTERY

Python | MatLab | Mathematica | R | HPC | Conda | MPI | Parallel Computing

Qiskit | QuTip | tensorflow and keras | Pennylane | SDP | Tensor Networks/MPS

COURSEWORK

- Courses on Classical, Statistical, and Quantum Mechanics, courses on Condensed matter physics, Electrodynamics with Special and General theories of relativity, Atomic and molecular physics, and High energy physics.
- Advanced courses on Quantum Information Theory, Quantum Foundations, Quantum Field Theory, and Quantum Many-Body Theories.
- Courses on Computational Techniques and Programming languages, Introduction to Machine Learning, Probability and Statistics, Advanced Mathematical methods, and Data and Statistical Models in Astronomy.

SKILLS & EXPERTISE

Machine Learning & Programming

- Machine Learning Algorithms - Neural Networks, SVMs, KNN, Random Forest.
- Languages - Python, JS, C.
- Statistical analysis - Regression Models, ANOVA, Chi squared tests, Bayesian Models.
- Optimisation - Gradient descent, Metaheuristic algorithms (PSO, GA), Bayesian optimisation.

Optimisation & mathematical rigour

- Semi Definite Programming: cvxp python package
- Nonconvex to convex polynomial optimisation: SOS relaxation & Lassiere's Heirarchy
- Non commutative polynonimal optimisation (SOHS)
- Solving PDEs (Shooting, Relaxation methods - Guass Seidel Algorithm)

Quantum Causal Models

- Quantum Box Formalism & Process Matrix Formalism

Tensor Networks/Matrix Product States

Scientific Computing for Quantum

- Scientific packages & techniques - TensorFlow, MatLab, Mathematica, R.
- Bell Inequalities and Causal probability relationships.
- QuTip Quantum Channels and Density States
- Neural Network Architecture - Restricted Bolztmann NN ansatz, Nonlocality witness.
- Perturbation theory, Variaotional methods, Adiabatic Approximation, DFT, Path Integral Formulation, Quantum MonteCarlo Methods

Quantum Softwares

- Qiskit, Pennylane, tensorflow quantum, Cirq.
- Quantum Circuits, Gates, Algorithms: VQE, QPE.
- Quantum Machine Learning: qNNs, qCNNs, qAutoEncoders.

Other Software skills

Adobe | Scientific Illustration:Blender (Design team) | Origin Pro | Data Visualisation | Web Dev: NodeJS

WORKSHOPS & CONFERENCES

- Presented my work on **Quantum Network Nonlocality using Machine learning** at the Frontier Symposium Physics 2024 in IISER Thiruvananthapuram.
- **Qiskit Global Summer School (QGSS) 2021, 2022, 2023** on **Quantum Machine Learning, Quantum Simulation and Algorithms, and Theory to Implementation**.
- Participated in Hackathon - **Datathon IndoML** 2023
- **Brain, Computation, and Learning (BCL)** 2023 workshop at IISc, Bangalore.
- Attended the Summer school on **Quantum Information and Quantum Technology (QIQT)** 2021
- Participated in 2021 **Build a Detector Workshop** organized by the **NewtonBhabha** and **LIGO India** partnership
- Attended the **Intel one API HPC Free Training & Workshop** at IISER Thiruvananthapuram
- Attended the **International Workshop on HPC in Science and Engineering 2021** at IISER TVM

RESEARCH ACHIEVEMENTS & MANUSCRIPTS

Master Thesis Defense "**Exploring Triangle Nonlocality using Machine Learning**"

May 3rd 2023 — IISER TVM, Kerala, India

PDF - check-here

Minor Thesis Defense "**Superadditivity of Coherent Information in Noisy Quantum Channels**"

July 20th 2022 — IISER TVM, Kerala, India

PDF - check-here

Genuine Quantum Network Nonlocality using X States

IISER TVM, Kerala, India

Soon to be peer-reviewed - check-here

COMMUNICATION & TEAMWORK

- Clear and concise **scientific writing**.
- Co-organized the **23rd NCAMP conference school** in **IISER TVM**
- Experience working in **research teams** or **collaborative projects** like with **NCAMP-23** and **Cloud Cuckoo Land, India**.
- **Mentored** undergraduate students and junior researchers at IISER TVM.
- **Ishya** & **IICM Cultural Fest** design coordinator and participant.
- **Humanities Collective** member.
- Continous learning and participation in workshops, conferences, and training programs.

REFEREES

Prof. Anil Shaji

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