Anantha Krishnan

Project Associate at Indian Institute of Science Education and Research Thiruvananthapuram
Integrated BS-MS dual degree Physics graduate | 2023 Chanakya Research Fellow

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Education

IISER Thiruvananthapuram Jul 2018 – Jul 2023
Integrated BS-MS Dual Degree in Physical Sciences & Minor in Data Sciences

- CGPA: 8.34/10.0
- **Coursework:** Quantum information theory, Quantum foundations, Non-linear dynamics, Machine learning algorithms for quantum systems, Quantum field theories, and Quantum many-body theories.

I-HUB QTF, Chanakya Research Fellow Jul 2022 – Dec 2023

- Was awarded the Chanakya PG Fellowship (I-HUB QTF) under the Department of Science and Technology, Govt. of India
- **Professional Development:** Quantum multipartite networks, Non-classicality, Quantum causal structures, Learning algorithms.
- **Publication/Projects**: *Is Genuine nonlocality in the triangle network exclusive to pure states*

TOEFL iBT Score - 101

Experience

Project Associate I: *IISER TVM, India*
Quantum information processing from distinguishability of physical processes: *Jan 2024 - Ongoing*
jointly advised by Dr. Debashis Saha & Prof. Anil Shaji Award Letter

- Work presented in multiple international conferences QCMC24, QM100.
- **Professional Development**: Learning algorithms for quantum foundations, Quantum resources, Quantum learning theory, Quantum algorithms, Quantum machine learning, SDP.
- **Projects**: *A neural network framework for quantum networks*, *Machine learning non-local correlations for loophole-free Bell experiment*

Research & Projects

Chanakya Research Fellow | **Masters Thesis:** *I-HUB QTF & IISER TVM, India*
Genuine network nonlocality through LHV k-rank neural network oracle: jointly *July 2023 - Dec 2023*
advised by Dr. Debashis Saha & Prof. Anil Shaji GitHub

- We uncovered that Genuine Network nonlocality is exclusive to pure states in the triangle network, with extreme discrete noise robustness unlike the standard bell scenario. Publication Preprint
- Developed a new model for distinguishing local distributions for separable network states with rank-k.
- This work was awarded the Chanakya Fellowship (I-HUB QTF) and was also presented at 24th QCMC International Conference.
- Tools used: Python, tensorflow, HPC-slurm.

Project Associate I:
A causal-informed neural network proof for quantum multipartite networks: *Ongoing* GitHub
jointly advised by Dr. Debashis Saha & Prof. Anil Shaji

- Currently exploring the case of genuine network nonlocality (GNN) in Bilocality networks and Elegant joint measurements. Building a scalable LHV-rank model for Quantum Causal Structures
- Expanding the work to all quantum causal structures, re-framing GNN and its resources.

A machine learning proof for the loophole-free Bell test: jointly advised by Dr. *Ongoing* GitHub
Debashis Saha & Prof. Anil Shaji

- We are developing a learning model to build a noise-robust proof for loophole-free Bell experiment, where we take into account the role of detector efficiency.

Minor Thesis: *IISER TVM, India*
Superadditivity of Coherent Information in Noisy Quantum Channels: advised by Dr. Nagaiah Chamakuri *Jul 2022 - Dec 2022*
GitHub

- Using Restricted Boltzmann Machines identified Quantum states demonstrating Superadditivity of coherent information, applying GAs and PSOs (Evolutionary algorithms) over gradient descent for global optimization.
- Tools used: Restricted Bolztmann Machine (RBM), Metaheursitic Algorithms (Genetic Algorithms), QuTip.

Research Collaboration: *IISER TVM India*
Foundations of Quantum Mechanics from Bell Experiment to Random number verification & Multipartite Causal Structures: advised by Dr. Manik Banik *Jul 2020 - Dec 2020*

- Presented the Bohr-Einstein Debate to its consequence in Random no. generation & debated the case of the Bell experiment and Multipartite Causal structures.

Research Internship: *IISER TVM, India*
Variational principles for finding quantum bound states: advised by Prof. Anil Shaji *May 2019 - July 2019*

Quantum Machine Learning:

- Experienced in designing quantum circuits and quantum machine learning algorithms (qNNs, qGANs, qSVM/Qiskit). Tensor Network Circuits such as MPS and Tree Tensor Quantum Circuit.
- Experienced with Pennylane, Qiskit, tensorflow quantum, etc.

Quantum Complexity and Quantum Resource Theory:

- From lectures of Scott Aaronson on Quantum Complexity Theory from MIT OpenCourseWare and predominantly his book "Quantum Computing since Democritus"

Publications

Is genuine nonlocality in the traingle network exclusive to pure states 2024
Anantha K Sunilkumar, Anil Shaji, Debashis Saha
Preprint QCMC24 Conference Paper

A domain-informed neural network framework for causal networks, Resources for genuine nonlocality in quantum networks Ongoing
Anantha K Sunilkumar, Anil Shaji, Debashis Saha
Manuscript: under preparation

Conferences & Workshops

- Presented my work at the 24th International Conference on Quantum Communication, Measurement and Computing (QCMC24) at IIT Madras, Chennai.
- Been selected for the International conference on Foundations of Quantum Mechanics (QM100) on occasion of a century of Quantum Mechanics at IISER Kolkata.
- 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

Skills & Expertise

Machine Learning & Programming

- Machine Learning Algorithms - Neural Networks, SVMs, Random Forest
- Languages - Python, JS, C.
- Statistical analysis & Optimisation - Gradient descent, Metaheuristic algorithms (PSO, GA), Bayesian optimisation.

Quantum Software and Scientific computing

- Qiskit, Pennylane, tensorflow quantum, Cirq.
- Quantum Machine Learning: qNNs, qCNNs.
- Scientific packages & techniques - TensorFlow, MatLab, Mathematica, R
- QuTip Quantum Channels and Density States
- Perturbation theory, Variational methods, Adiabatic Approximation, DFT, Path Integral Formulation, Quantum MonteCarlo Methods

Semi-Definite Programming

- Experienced with using SDP, SOS approach for POPs.
- Tools Used: cvxp package for SDP, NCSOStools and NCAlgebra for Non-commutative polynomial optimization.

Others

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

Communication & Teamwork

- Clear and concise scientific writing
- Active member of the Journal Club
- Co-organized the 23rd NCAMP conference school in IISER TVM
- Experience working in research teams or in collaborative projects like with BCL, IISc Bangalore 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.
- Physics Tutor on the online tutoring platforms Chegg and CourseHero.
- Continual learning and participation in workshops, conferences, and training programs.

Referees

Prof. Anil Shaji Professor (Physics) — *IISER Thiruvananthapuram, India*
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