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, Quantum Field Theory, and Quantum Many-Body Theories.

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

- Was awarded the Chanakya Fellowship (I-HUB QTF) under the Department of Science and Technology, Govt. of India
- **Professional Development:** Quantum Multipartite networks, Nonclassicality, Quantum Causal Structures, Quantum Algorithms.
- **Publication/Projects**: *Is Genuine Network Nonlocality exclusive to Pure States*

TOEFL iBT Score - 101

Experience

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

- Work presented in multiple international conferences QCMC24, QM100.
- **Professional Development**: SDP, Quantum Foundations, Quantum Resources, Machine Learning for Quantum, Quantum Learning Theory, Quantum Algorithms, Quantum Machine Learning.
- **Projects**: A neural network oracle of generic quantum networks, Machine learning nonlocal correlations in loophole-free Bell experiment.

Research & Projects

Chanakya Research Fellow | Masters Thesis: *I-HUB QTF & IISER TVM, India*
Quantum Causal Networks through Ranked LHV-Neural Network Oracle: jointly advised by Dr. Debashis Saha & Prof. Anil Shaji *July 2022 - Dec 2023 (PDF)*

- Developed a new model for distinguishing local distributions for separable network states with rank-k. Expanding the work to all quantum causal structures and reframing GNN and its resources.
- We uncovered that Genuine Network nonlocality is exclusive to Pure states in the triangle network, with extreme discrete noise robustness unlike standard bell scenario. Publication GitHub
- This work was awarded the Chanakya Fellowship (I-HUB QTF) and was also presented at the 24th QCMC International Conference.
- Quantum causal structures, Nonclassical correlations, Machine Learning for Quantum, Bell inequalities.
- Tools Used: Python, tensorflow, HPC-slurm.

Project Associate I: ***A Neural Network Oracle for Quantum Multipartite Networks***: jointly advised by Dr. Debashis Saha & Prof. Anil Shaji *Ongoing GitHub*

- Currently exploring the case of genuine network nonlocality in Bilocality networks and Elegant joint measurements. Building a scalable LHV-rank model for Quantum Causal Structures

Project Associate I: ***Machine Learning model for distinguishing Loophole-free Bell violation***: jointly advised by Dr. Debashis Saha & Prof. Anil Shaji *Ongoing GitHub*

- Currently working on a learning model to build a noise robust proof for loophole-free Bell experiment.

Minor Thesis: *IISER TVM, India*
Superadditivity of Coherent Information in Noisy Quantum Channels: *Jan 2022 – Apr 2022*
advised by Dr. Nagaiah Chamakuri *PDF*

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

Research Collaboration: ***Foundations of Quantum Mechanics from Bell Experiment to Random no. verification & Multipartite Causal Structures***: advised by Dr. Manik Banik *IISER TVM India Aug 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: ***Variational principles for finding quantum bound states***: advised by Prof. Anil Shaji *IISER TVM, India Aug 2019 - Dec 2019*

Quantum Machine Learning for Classification

- Experienced with designing Quantum Circuits, 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"
- Contexutality for MBQC, Magic States for Universal Computation.

Publications

Is Genuine Network Nonlocality Exclusive to Pure States Ongoing

Anantha K Sunilkumar, Anil Shaji, Debashis Saha

Manuscript: soon to be published QCMC24 Conference Paper

A LHV Neural Network Oracle for Generic Quantum Networks Ongoing

Anantha K Sunilkumar, Anil Shaji, Debashis Saha

Manuscript: soon to be published

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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