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My name is Anantha Krishnan, and I hold a Bachelor's and Master's integrated dual degree from the Indian Institute of Science Education and Research (IISER) Thiruvananthapuram, with a strong specialization in Quantum Information Theory and Machine Learning. Currently, I am a Project Associate at IISER, where my research focuses on learning quantum resources through both analytical and numerical algorithms, and reciprocally I aim to improve these algorithms using these physical resources. My research aims to bridge quantum computing with foundations of quantum mechanics, bringing together quantum information, math and machines to discover new facets of complex physical systems.

My current work centers on developing a measure for nonclassical correlations in complex multipartite quantum networks, and the foundational nature of these systems advised by Prof. Anil Shaji and Dr. Debashis Saha. Presently, I have worked on Genuine network nonlocality, where I use a classical neural network algorithm to learn quantum distributions and in the process distinguish genuine network nonlocal distributions, effectively making a noise robust proof for multipartite network systems. This revealed a striking result that these set of correlations are exclusive to pure states in the triangle scenario, with a discrete sensitivity to noise, vanishing as soon as the slightest noise is added. Thus, making these correlations much more unique than the standard bell nonlocal scenarios. I am currently in the process of finishing my research manuscript, which can be accessed *here*.

My research interests revolve around three key areas:

1. How foundational resources can bring quantum advantage to machines, like contextuality in MBQC, magic states in universal computation.
2. How we can use these resources with quantum learning theory to build machine learning algorithms, allowing cross-fertilization of ideas from quantum foundations and computing.
3. And, finally how we can use such intelligent learning algorithms to understand complex systems both quantum and classical.

My current experience is in using classical learning algorithms in understanding nonclassical correlations. This project stems from a broader interest in learning quantum resources, and I aim to explore how quantum resources themselves can enhance learning algorithms to address more complex systems. Now as a project associate I am building Local Hidden Variable (LHV-rank) Neural network oracle for Generic Multipartite Quantum networks, which is nearing completion. One other project I am working on is loophole-free Bell experiment, where I have adapted a machine learning model to capture Bell violation effectively accounting detector efficiency.

At IISER, I studied Quantum Foundations under Dr. Manik Banik, where we also did a project on the Bohr-Einstein debate's role in the applications of quantum nature of reality including random number generation. My minor thesis in Data Sciences, under Dr. Nagaiah Chamakuri, investigated the superadditivity of coherent information in noisy quantum channels, utilizing metaheuristic algorithms and RBM architecture to navigate computational challenges in machine optimization.

I have also completed several short projects involving quantum algorithms through workshops and personal exploration, gaining strong expertise in quantum software such as Qiskit and Pennylane. This experience has equipped me with essential knowledge for building learning algorithms and understanding complex systems. My foundational understanding of computational complexity is deeply influenced by Scott Aaronson's lectures, and I am keen to integrate physical sciences with computational theory within a PhD framework.

My academic journey at IISER Thiruvananthapuram has provided me with a robust foundation in Quantum Information Theory, Quantum Foundations, and Machine Learning. Throughout my studies, I have excelled in courses such as Quantum Information Theory, Quantum Foundations, and Quantum Many-Body Physics, laying a strong foundation for advanced research in these interdisciplinary fields. My research on Nonlocality in Quantum Networks, recognized with the prestigious Chanakya Fellowship from I-HUB QTF National Mission on Interdisciplinary Cyber Physical Systems, exemplifies my commitment to advancing Quantum Technologies. My studies in quantum causal structures and machine learning techniques have yielded valuable insights into Quantum Network Nonlocality, including the exclusiveness property of genuine network nonlocality (GNN) in triangle networks and the LHV-rank neural network model for multipartite quantum networks. This work has been *presented* at the 24th International Conference on Quantum Communication, Measurement and Computation (IIT Madras) and the Frontier Symposium of Physics at IISER TVM and has been selected for presentation at both the QM100 International Conference celebrating 100 years in Foundations of Quantum Mechanics (IISER Kolkata).

Sincerely,

Anantha Krishnan Sunilkumar