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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 such physical resources. My research aims to cross-fertilize quantum computing with foundations of quantum mechanics, bringing together quantum information, math and machines to discover new facets of complex physical systems.

Currently my 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. 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. (Poster)

My research interests revolve around three key areas:

1. Learning quantum systems using classical and quantum learning algorithms to uncover complex quantum behavior in condensed matter physics, non-classical correlations in quantum foundations, and for understanding quantum models in quantum computing.[1][2][3]
2. What foundational resources can bring quantum advantage and what are the limitations imposed by no-go theorems for quantum learning.[4][5]
3. And, how can we use these resources with quantum learning theory to build better learning algorithms, cross-fertilizing ideas from quantum foundations and quantum computing.[6][7]

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 a Local Hidden Variable (LHV-rank) Neural Network Oracle for Generic Multipartite Quantum networks, which is nearing completion. One other project I am working is on Loophole-free Bell experiment, where I am adapting a machine learning model to capture Bell violation effectively accounting detector efficiency. My collective interest in quantum resources for quantum advantage and quantum learning algorithms takes into account their application in learning quantum phenomena in condensed matter physics and also their interdisciplinary with neuroscience experiments and social science.

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).

The rich exposure to academic and cultural events at the Indian Institute of Science Education and Research Thiruvananthapuram (IISER TVM) allowed me to develop important networking and leadership skills. I was part of coordinating the 23rd NCAMP conference school on Atomic and Molecular Physics and Quantum Technology in IISER TVM organized by Prof. Anil Shaji in IISER TVM. I have also organized and volunteered for debates and discussions as part of the Humanities collective of IISER TVM. I have taught students Physics through coaching websites such as Chegg and CourseHero, I also have experience teaching my undergraduate juniors Quantum Information Science and Foundations of Quantum Mechanics at IISER Trivandrum. I have attended several workshops and schools, which are outlined in my CV; including the Qiskit series Qiskit Global Summer School 2020,21,22,23 and the Qiskit Challenges through which I received the Qiskit Quantum Excellence Award.

Coming to outreach, I was part of the Humanities Collective and Cultural Society at IISER (TVM). Engaging in debates and organizing programs honed my communication skills and broadened my perspective on diverse social issues. These experiences highlighted the importance of mental health awareness and inclusivity, leading me to collaborate with Cloud Cuckoo Land, a Mental Health Organization in India. In this project, I am closely collaborating with mental health professionals such as Consultant Psychiatrist Dr. Sooryajith M and Clinical Psychologist Anjana. K for developing an Intent Recognition Chatbot Platform for Mental Health Applications and technology assisted therapy. This initiative aims to make mental health support more accessible, overcoming financial constraints. As a student mentor at IISER TVM, I have actively contributed to raising awareness about mental health help and providing academic support to junior students and local community members. These efforts have fostered a supportive and inclusive environment on campus, strengthening social clubs. My participation in community outreach activities, such as blood donation drives, sports programs in local schools, and environmental clean-up campaigns, has further deepened my commitment to social welfare and community engagement.

Sincerely,

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References

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