Variable Star Classification Using Light Curve Analysis and Hybrid Quantum Algorithms

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Variable stars are important cosmic distance indicators and they help us find key parameters like the Hubble constant, the rate of expansion of the Universe. Compared to periodic variables like Cepheids (which are used to estimate the Hubble constant), RR Lyrae are more abundant and have longer lifetimes. RR Lyrae (especially RRab type) are used in determining distances to globular clusters, due to their period-luminosity dependence. However, RR Lyrae are somewhat faint periodic variables, and their periods and amplitudes overlap with eclipsing binaries. As a result, we need to classify between eclipsing binaries and RR Lyrae. While classification tasks which deal with datasets that can get huge (like RR Lyrae, and other astronomical datasets) can be addressed with machine learning techniques, quantum computing can potentially boost the effectiveness of such techniques. Although variable star classification has been performed with neural networks and support vector machines, this research is the first to attempt a quantum algorithm (a quantum CNN) to classify light curves of RR Lyrae and eclipsing binaries. This research transforms the raw light curves obtained from the ASAS-SN database and after pre-processing provides a 2-dimensional dm-dt mapping. This mapping is then fed to a CNN for classification. Through amplitude embedding, dm-dt mappings are also fed into multi-layered hybrid quantum CNN. During iterations, by modifying parameters, depth, and other features of the QCNN, we were able to achieve classification accuracies in the range of 80-88%. This research is an early implementation of quantum algorithms in astronomy classification.