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Quantum Support Vector Machines for Continuum Suppression in B Meson Decays

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Quantum computers have the potential for significant speed-ups of certain computational tasks. A possibility this opens up within the field of machine learning is the use of quantum features that would be inefficient to calculate classically. Machine learning algorithms are ubiquitous in particle physics and as advances are made in quantum machine learning technology, there may be a similar adoption of these quantum techniques.
In this work a quantum support vector machine (QSVM) is implemented for signal-background classification. We investigate the effect of different quantum encoding circuits, the process that transforms classical data into a quantum state, on the final classification performance. We show an encoding approach that achieves an Area Under Receiver Operating Characteristic Curve (AUC) of 0.877 determined using quantum circuit simulations. For this same dataset the best classical method, a classical Support Vector Machine (SVM) using the Radial Basis Function (RBF) Kernel achieved an AUC of 0.865. Using a reduced dataset we then ran the algorithm on the IBM Quantum ibmq_casablanca device achieving an average AUC of 0.703. As further improvements to the error rates and availability of quantum computers materialise, they could form a new approach for data analysis in high energy physics.

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