DeepQSVM: A 1D-CNN Feature Extractor with Adaptive Quantum Kernel Selection for Chronic Kidney Disease Diagnosis

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Abstract:

Chronic Kidney Disease (CKD) silently erodes kidney function in roughly one adult in ten worldwide. Because symptoms rarely surface until the disease is advanced, early and accurate diagnosis is a clinical necessity. Machine learning classifiers have achieved strong benchmark results on CKD data. Quantum classifiers, however, have consistently underperformed when paired with linear preprocessing pipelines such as PCA. We present DeepQSVM to address this gap. The system trains a 1D Convolutional Neural Network (1D-CNN) in a supervised manner to extract compact, nonlinear feature embeddings from raw clinical records. These embeddings feed a Quantum Support Vector Machine (QSVM).These embeddings are fed to a Quantum Support Vector Machine (QSVM). An Adaptive Quantum Kernel Selection (AQKS) module selects between ZZFeatureMap and PauliFeatureMap at each cross validation fold - Shannon entropy is used for the selection. No fixed kernel is used for the whole experiment. On the UCI CKD benchmark 400 records, 24 features, five-fold stratified cross validation DeepQSVM gives 98.50% accuracy, and 100% specificity. Positive results were not recorded in any fold. Under controlled Gaussian noise, at $\sigma = 0.20$, the framework degrades 2.75 percentage points lesser compared to a PCA-based quantum baseline.

Keywords:

Chronic Kidney Disease (CKD), Quantum Support Vector Machine (QSVM), Deep Learning, Adaptive Quantum Kernel Selection, 1D Convolutional Neural Network (1D-CNN), Medical Diagnosis.