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Quantum Machine Learning for Liver Disease Prediction

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The liver is the body's largest gland, crucial for many vital functions such as processing nutrients, filtering toxins from the bloodstream, and supporting immune defense. Exposure to viruses or harmful chemicals can cause liver damage, which may lead to liver disease—a serious condition that can impair liver function and require immediate medical care. This study explores the early prediction of liver diseases using Quantum Machine Learning (QML), an emerging interdisciplinary field that merges quantum physics with machine learning techniques. Specifically, hybrid QML models combine classical neural networks with quantum layers, utilizing the unique properties of quantum mechanics, such as superposition and entanglement, to enhance data processing and representation. This allows the model to capture complex patterns in the data, potentially improving performance in classification and regression tasks compared to traditional methods. Furthermore, QML has demonstrated higher computational efficiency and performance.

The dataset used for this study, sourced from UC Irvine Machine Learning, contains 583 patient records from India, where 416 cases are diagnosed with liver disease, and 167 are not—resulting in a highly imbalanced dataset. Each record includes 11 attributes, such as patient gender, liver function tests, and a classification label indicating the presence of liver disease.

In this work, we have proposed the 'QML-Liver' model, a hybrid architecture that combines two classical layers (with 2 and 1 neurons, respectively) and a quantum layer containing one qubit. To evaluate its performance, we utilized four key metrics: accuracy, precision, recall, and F1-score. Our QML-Liver model has demonstrated remarkable performance in predicting liver diseases, achieving an accuracy of 82%, a precision of 81%, a recall of 99%, and an F1-score of 89%. Compared to state-of-the-art models, our model improves these metrics using a simpler architecture and an imbalanced dataset. This approach, which integrates quantum mechanics techniques with classical neural networks, highlights its potential in liver disease prediction by allowing better generalization and handling of data variability.