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ENHANCING CREDIT SCORING WITH HYBRID QUANTUM MACHINE LEARNING ARCHITECTURES

Credit scoring remains an essential mechanism in financial risk assessment and lending. Traditional machine learning (ML) models, while robust, face limitations when handling imbalanced datasets and complex nonlinear patterns common in small and medium-sized enterprise (SME) credit data. Quantum machine learning (QML) offers a promising direction due to its potential for enhanced representation capacity and reduced training times. Recent work [1-5] introduces a hybrid quantum–classical neural network architecture aimed at achieving practical improvements in credit scoring performance using quantum computing simulators.

The proposed architecture combines three components: a classical neural network front-end, a variational quantum circuit (VC), and data re-uploading circuit (DRC) blocks. The classical layers reduce high-dimensional feature inputs (21 features) to a vector compatible with a limited number of qubits. Angle embedding is employed to load real-valued features into quantum states using rotation gates. The VC layer includes trainable rotation and entanglement gates, while DRC blocks reinject data to improve representational depth. This hybrid design leverages strengths of classical preprocessing and quantum expressivity.

Experimental results show that the proposed model achieves an ROC/AUC score of 0.75, outperforming the CCN model trained for the same number of epochs (AUC = 0.73). Interestingly, the CCN model required up to 3500 epochs to reach comparable performance, demonstrating a significant training-efficiency advantage for the hybrid architecture. The best performance occurred with 12 qubits and minimal data re-uploading, while further increases caused accuracy to decline—likely due to barren plateaus and over-parameterization effects in deeper quantum circuits. Execution time scaling analysis showed quadratic growth with qubit count and linear dependence on DRC depth, underscoring practical limitations for near-term devices.

The findings indicate that hybrid quantum–classical machine learning offers meaningful advantages for credit-risk classification, especially in

training-time efficiency. While accuracy gains remain modest, the proposed model demonstrates resilience to noisy financial data and presents a feasible pathway toward quantum-enhanced financial analytics. Limitations arise from qubit scalability, barren plateaus, and computational overhead. However, advancements in quantum hardware—projected to exceed 4000 qubits—combined with runtime optimization frameworks may enable substantial performance improvements in future applications.

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