Hybrid Classical–Quantum Learning for Job Failure Prediction in Distributed Cloud Systems

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***Abstract*—These Accurate job failure predictions in distributed cloud environments are vital for improving reliability, scheduling efficiency, and cost-effectiveness. Moreover, the dynamic variability and scale of production workloads make failure prediction a challenge to overcome. Although classical machine learning (ML) models, particularly Random Forests (RF) provide strong predictive performance, they can be computationally demanding under frequent retraining. Contrarily, Quantum Machine Learning (QML) methods leverage quantum-enhanced kernels to capture complex patterns, but standalone quantum models continue to have hardware limitations related and depict significant computational overhead. In this paper, we examine a hybrid classical-quantum ML framework for job failure prediction in large-scale distributed systems. A Hybrid Quantum Support Vector Machine (QSVM) is employed, blending classical RBF and quantum kernels, and benchmarked against RF. Experimental results show that RF attains high predictive accuracy (Acc ≈ 0.98 − 0.99, ROC AUC ≈ 0.99, AP ≈ 0.98), while hybrid QSVM achieves moderate accuracy (≈ 0.80 − 0.82), but they exhibit distinct timing behavior. While the quantum kernel evaluation is computationally expensive, the fitting is faster when the kernels are precomputed. This aspect offers potential advantages in cloud environments where rapid retraining is needed under evolving workloads. Furthermore, our results emphasize that classical and quantum models are not competing but rather complementing each other. While classical models offer high accuracy, the hybrid quantum approaches provide efficiency trade-offs for large-scale, time-sensitive prediction tasks.**

***Keyword*— classical machine learning, distributed cloud systems , job failure prediction, quantum machine learning**

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