Improving Quantum Support Vector Classifiers and Quantum Neural Networks for Biomedical Data Classification

Aninda Astuti¹

Department of Bioinformatics and Medical Engineering, Asia University, Taiwan <u>112225005@live.asia.edu.tw</u>

Ka-Lok Ng #1,2,3

¹ Department of Bioinformatics and Medical Engineering, Asia University, Taiwan; <u>klng@asia,edu.tw; ppiddi@gmail.com</u>

² Quantum Computing Research and Development Center, Asia University, Taiwan,

³ Department of Medical Research, China Medical University Hospital, China Medical University, Taiwan

[#] corresponding author

Abstract

The combination of quantum computing and machine learning, termed Quantum Machine Learning (QML), holds promise for tackling complex computational challenges. This work investigates the potential of QML in the context of identifying gene expression biomarkers associated with the metastatic behavior of clear cell renal cell carcinoma (ccRCC). ccRCC, the most prevalent form of kidney cancer, is characterized by a high mortality rate, largely due to the intricacies of its metastatic progression. A comprehensive understanding of the mechanisms driving cancer cell spread and colonization of distant sites remains a significant challenge, despite ongoing research efforts. The identification of reliable metastasis biomarkers presents a formidable task within the framework of traditional machine learning.

Our research focuses on enhancing the performance of Quantum Support Vector Classifier (QSVC) and Quantum Neural Network (QNN) algorithms for binary classification tasks, specifically addressing the limitations in classification accuracy observed in the current QML algorithms, Qunatum Support Vector Classifier (QSVC) and Qunatum Neural Network (QNN). Inspired by the Neural Quantum Embedding (NQE) methodology, we introduce a novel two-stage framework designed for binary classification. The central objective of this study is to evaluate the performance gains achieved by integrating NQE with QSVC and QNN, compared to the integration of NQE with SVC and NN. We conduct a comparative analysis across two biomedical datasets to demonstrate the efficacy and broader applicability of our proposed approach.

Keywords: quantum machine learning; quantum support vector classifier; quantum neural network classifier; metastasis; renal cancer