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BREAST CANCER DETECTION USING QUANTUM ML AND QUANTUM DL AND COMPARISON WITH ML AND DL

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ABSTRACT

Breast cancer is a common disease that requires early detection in order to be treated effectively. Using the Wisconsin Breast Cancer dataset, this study compares the performance of conventional machine learning and deep learning algorithms with quantum machine learning and deep learning algorithms for breast cancer detection. The results show that the Support Vector Classifier (SVC) achieved 97.3% accuracy in 0.008 seconds, while the Quantum Support Vector Classifier (QSVC) achieved 93.8% accuracy in 893.55 seconds. An accuracy of 81% was achieved by Variational Quantum Classifier (VQC), another QML algorithm. For deep learning, CNN achieved an accuracy of 96.4% while QCNN achieved an accuracy of 64.04%. Although current hardware limitations may limit the quantum advantage, better results can be expected in the future as quantum hardware advances. These results imply that quantum machine learning has the ability to improve breast cancer diagnosis accuracy. Overall, this study demonstrates the utility of quantum machine learning and deep learning in medical fields such as breast cancer detection.

INTRODUCTION

Breast cancer is a major global health concern and early detection plays a critical role in effective treatment. Machine learning and deep learning have shown considerable improvement in the accuracy and efficiency of breast cancer diagnosis. While conventional algorithms have yielded encouraging results, the advent of quantum computing has opened up new avenues for even greater precision and efficiency. Using quantum computing techniques like superposition, entanglement, quantum parallelism etc, quantum machine learning and deep learning have the potential to substantially improve data processing and analysis. The efficacy of conventional and quantum machine learning and deep learning approaches for breast cancer diagnosis is compared in this study. The study aims to identify the strengths and limitations of each approach and provide insights into the potential of quantum computing for improving breast cancer diagnosis by analysing the available datasets.

METHODOLOGY

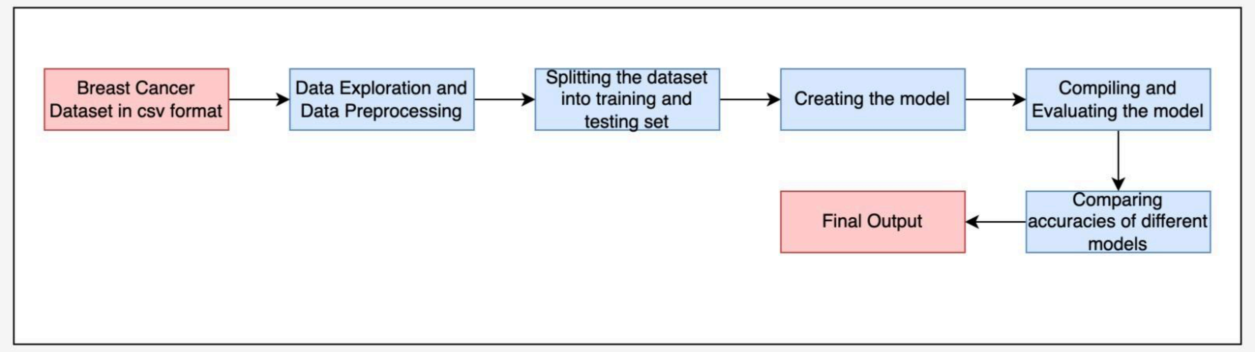

Fig.1 - Block diagram illustrating the process of machine learning and deep learning

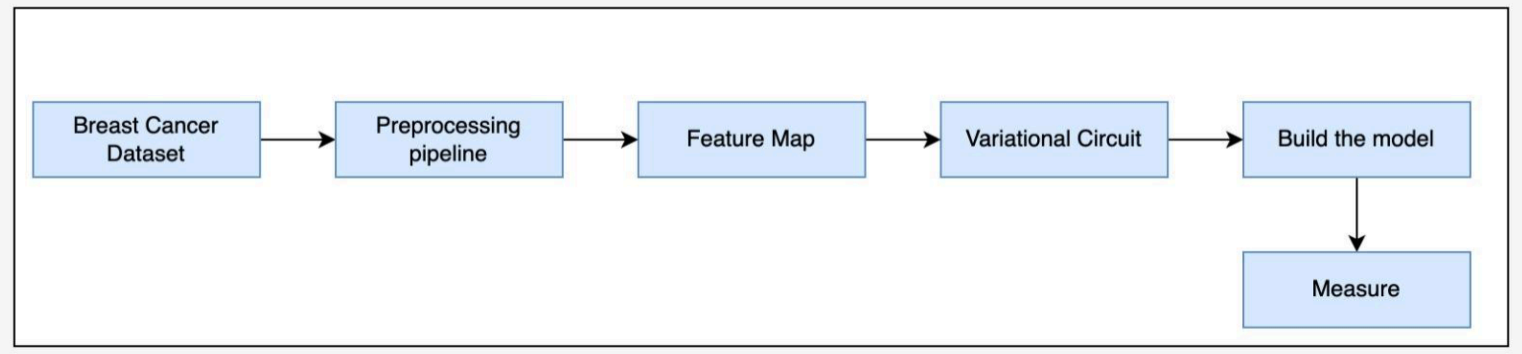

Fig. 2 - Block diagram illustrating the process of VQC algorithm

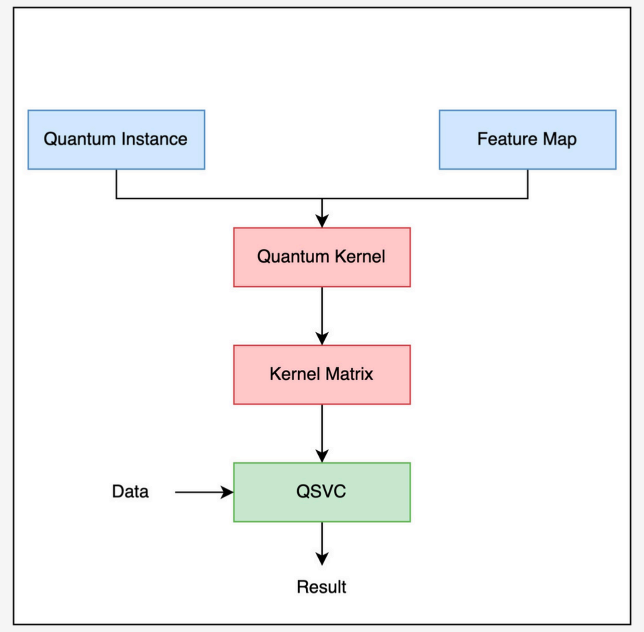

Fig. 3 - Block diagram illustrating the process of QSVC algorithm

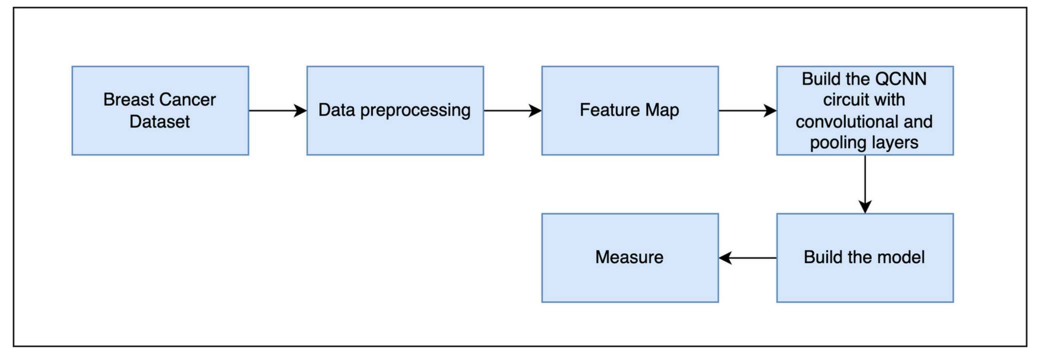

Fig. 4 - Block diagram illustrating the process Quantum CNN

FIGURES

	Conventional SVC	QSVC
Data mapping	High-dimensional space	Quantum kernel function
Computational architecture	Classical bits	Quantum bits (qubits)
Hyperplane determination	Greatest margin between classes	Unknown
Performance advantage	Limited by classical computing	Potential advantage from quantum parallelism
Features Used	30	4
Train-Test split	80-20	80-20
Accuracy Achieved	97.3%	93.8%

	CNN	QCNN
Model architecture	Convolutional	Quantum Convolutional
Hyperparameters	Adjustable	Adjustable
Accuracy achieved	High - 96.4%	64.04% Low, but potential for improvement with more qubits and improved techniques
Data type used	Classical	Quantum - 4 qubits
Concepts Used		Quantum entanglement, superposition, interference, tunnelling, energy quantization, diffraction, Bell states, quantum gates, quantum supremacy, quantum parallelism, Bloch sphere, ket and bra notation
Performance	Depends on hardware and data size	Depends on hardware, number of qubits, and data size
Features Used	30	4

RESULTS AND DISCUSSION

The performance of conventional machine learning, deep learning, and quantum computing models for breast cancer detection was evaluated using the Wisconsin Breast Cancer dataset. Random Forest and SVC achieved the best results for conventional machine learning, with SVC achieving an accuracy of 97.4%. CNN achieved an accuracy of 96.4% for deep learning. For quantum computing, QSVC achieved an accuracy of 93.8% but with a long computation time of 896 seconds. VQC achieved an accuracy of 81% in 635 seconds. SVC with rbf or polynomial kernels performed the best, while quantum methods showed promising potential. QCNN achieved an accuracy of 64.04%, compared to 96.4% for its classical counterpart.Continued development in the field of quantum computing could lead to more advanced and accurate breast cancer detection methods. Quantum machine learning methods have shown comparable accuracy to conventional methods on the Wisconsin Breast Cancer dataset, and quantum neural networks have the potential to outperform classical methods with further advancements in technology. This could lead to better patient outcomes and a better understanding of complex diseases like cancer in the future.