Quantum Machine Learning for Drowsiness Detection with Electroencephalogram Signals

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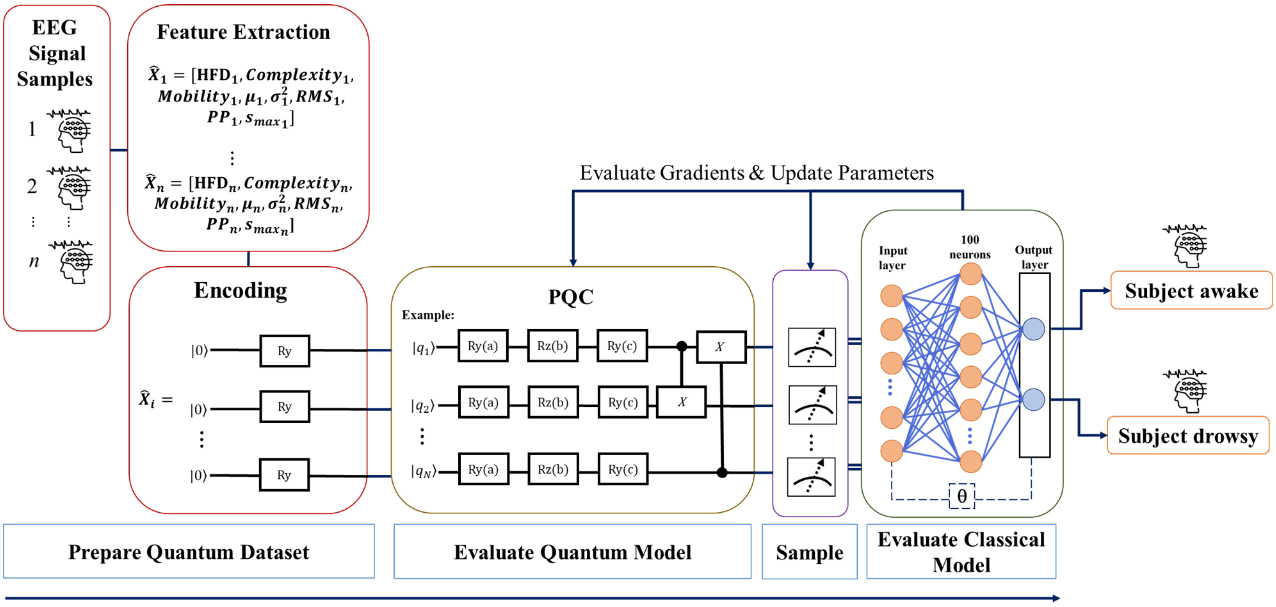
Abstract

By reducing focus and impairing decision-making, drowsiness significantly impacts various industries, increasing accident and injury risks. Electroencephalogram (EEG) is a valuable method for recording brain activity and understanding cognitive functions, and it allows for the identification of brain patterns related to drowsiness, which is useful for developing predictive models which can be deployed as real-time drowsiness detectors. However, EEG analysis is complex due to the data's high dimensionality and the brain's intricate dynamics. This work explores the application of Quantum Machine Learning (QML) for detecting drowsiness, using the EEG signals from the DROZY dataset [2], which consists of a time series for 13 subjects, 5 of which were used in the analysis. The core innovation of this study is the use of Quantum Neural Networks to classify EEG signals between drowsy and alert states. We implemented 12 different Parametrized Quantum Classifier (PQC) architectures, varying the types of gates and/or the number of layers, as it is schematically shown in the figure below. The results, achieved via noiseless simulations of the quantum hardware, yield promising outcomes that highlight QML's potential utility in neurophysiological settings.



The quantum models were benchmarked against traditional Multilayer Perceptron models, revealing that while classical methods showed better results for 1 out of 5 subjects, quantum models excelled or matched performance in other instances. This highlights QML's potential to handle complex patterns in neurological data more effectively than some classical approaches.

This work was published in [1].

References

[1] Isis Didier Lins, Lavínia Maria Mendes Araújo, Caio Bezerra Souto Maior, Plínio Márcio da Silva Ramos, Márcio José das Chagas Moura, André Juan Ferreira-Martins, Rafael Chaves, and Askery Canabarro. Quantum machine learning for drowsiness detection with eeg signals. *Process Safety and Environmental Protection*, 2024.

[2] University of Liège. ULg Multimodality Sleepiness Database (DROZY). Available from the University of Liège's Laboratory of Sleep Research, 2024. Accessed: 2024-04-18.