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Title: Frequency-Domain Analysis of Quantum Neural Networks: From Output Approximation to Interpretability Insights

Abstract: Quantum machine learning has recently attracted increasing attention as an interdisciplinary field at the intersection of quantum computing and machine learning. Quantum neural networks (QNNs), typically implemented using parameterized quantum circuits (PQCs), have been extensively studied through both theoretical analysis and numerical simulation to explore their potential and possible advantages over classical models and algorithms. Recent studies have shown that QNN outputs can be represented as Fourier series, providing a frequency-domain perspective for analyzing model expressivity, trainability, and phenomena such as barren plateaus. Inspired by these works, my recent work focuses on developing Fourier models of trained QNNs and investigates the gap between existing theoretical results and practical models. It further analyzes the decision boundaries and sensitive regions from a frequency-domain perspective, including contributions of different frequency components and input features, spectral changes during model optimization, and the sensitivity of key frequencies to different circuit regions. The work is expected to explore how frequency-domain information can improve the performance and interpretability of QNNs.