Seeking advantage in Quantum-Classical Machine Learning with trapped ion system

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Quantum technologies, specifically Quantum Computing (QC), represent a paradigm shift in computational power. However, the roadmap to utility is hindered by the inherent fragility of quantum states —a hurdle that makes scaling the industry's greatest challenge. To address this, we have developed a quantum-classical hybrid framework designed to push the boundaries of Quantum Machine Learning (QML). By leveraging the trapped-ion platform—noted for its superior coherence times and high gate fidelities—we have demonstrated that quantum classifiers can achieve over 98 % fidelity in supervised learning tasks using real-world datasets. While achieving parity with classical systems is a significant milestone, our current research pivots toward the ultimate goal: identifying the specific parameters and architectures where QML provides a definitive advantage over classical counterparts. Here, we will discuss detail of our findings across varied application contexts, highlighting the conditions under which quantum enhancement becomes a reality.

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