Quantum machine learning algorithms and its implementation in molecular qudits

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Quantum machine learning (QML) is recently gaining interest in both theory and experiment thanks to variational circuits implemented in the noisy intermediate-scale quantum computers (NISQs) [1]. Since we are in such an era, algorithms capable of being implemented in small circuits are of great interest. In pursuit of this objective, we explore QML algorithms that are implementable in circuits involving a single qudit, a system with d > 2 levels, instead of the traditional qubit (d = 2). Molecules with large electronic and/or nuclear spins provide a natural platform with multiple operational levels [2], being a suitable choice for implementing our qudits. Operations are driven by electromagnetic pulses resonant with the allowed transitions, which can be realized with EPR techniques or by coupling them to superconducting circuits [3]. It has been shown that this type of control in a single qudit is sufficient to implement any d-dimensional unitary operation [4], thus being an universal quantum processing unit. Specifically, we explore supervised learning [5] and classification problems of databases comprising more classes than levels are accessible in our qudit, forcing the development of tools to find maximally orthogonal states [6].

References

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Figures

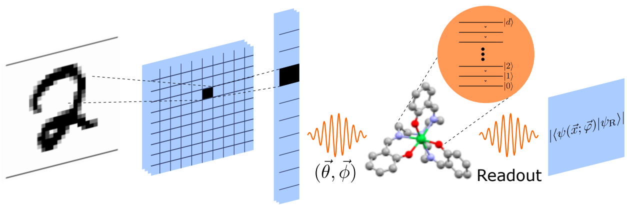

Figure 1: Sketch of a hybrid neural network combining the classical capabilities for pre-processing and optimization with the generation of quantum states in molecular qudits.