Adiabatic and Evolutionary Algorithms for training Variational Quantum Algorithms

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Abstract

Variational Quantum Algorithms (VQA) are some of the most commonly used models in supervised quantum machine learning. Gradient-based classical optimization techniques are frequently used to find the best values of their free parameters. However, these mechanisms make them not fully operative when facing vanishing gradient issues, better known as the barren plateau effect, which causes the optimization algorithm to fail to find the correct slope direction towards the minimization of the defined cost function. Some gradient-free classical approaches have been proposed to overcome this effect. In particular, Evolutionary Algorithms have been recently proposed to train VQAs with very promising results[1][2]. In this work, we propose to use adiabatic quantum models to train VQAs.

This paper presents a hybrid quantum-classical model composed of three elements: a classical computer in charge of data preparation and interpretation; a gate-based quantum computer running the VQA; and an adiabatic quantum computer where the optimization function is executed to find the best parameters for the VQA.

The paper compares the results obtained by three different optimization methods: gradient-based classical algorithms, evolutionary algorithms and the proposed adiabatic optimizers, using biological datasets as a relevant landscape for potential practical application of the proposed techniques.

We show the feasibility of integration for gate-based and adiabatic quantum computing models, avoiding the barren plateau effect and opening the door to modern hybrid quantum machine learning approaches for High Performance Computing (HPC).

Keywords: Quantum Machine Learning, Variational Quantum Algorithm, Evolutionary Computation, Quantum Annealing.

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