Training Circuit-based Quantum Classifiers through Memetic Algorithms

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Among the ready-to-implement quantum algorithms, Variational Quantum Circuits (VQCs) play a key role in several applications, including machine learning. Their strength lies in the use of a parameterized quantum circuit that is trained by means of an optimization algorithm run on a classical computer. In such a scenario, there is a strong need to design appropriate classical optimization schemes that deal efficiently with VQCs and pave the way for quantum advantage in machine learning. Among possible optimization schemes, those based on evolutionary computation are finding increasing interest, given the unconventional and nonanalytical nature of the problem to be solved. Our published paper [1] proposes to apply memetic algorithms (MAs) to train VQCs used as quantum classifiers and shows the benefits of exploiting this evolutionary optimization technique through a comparative experimental session. The proposed MA is a hybridization of a genetic algortihm (GA) and a stochastic hill climbing (HC) technique. The new method has been compared against the two components, GA and HC, and a standard gradient descent technique in terms of optimization performance and model accuracy by considering eight binary classification problems for the benchmark datasets Iris, Wine, Cancer and Sonar. As shown in the experimental results in [1], the overall performance of MA is better than all the compared algorithms for both considered metrics. In detail, MA is characterized by a better optimization performance in six out of eight considered binary problems and higher balanced accuracy values on testing data in five out of eight binary problems.

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[1] Acampora, G., Chiatto, A., Vitiello, A. (2023). Training circuit-based quantum classifiers through memetic algorithms. Pattern Recognition Letters, 170, 32-38.

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