All-Gaussian Quantum Neural Network

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Continuous-variable quantum computing (CV-QC) is a paradigm of quantum information processing that exploits the continuous nature of bosonic systems for analog computation [1]. In the upcoming era of noisy intermediate-scale devices, it is crucial to find experimentally feasible use cases for practical computation.

In the qubit regime, variational quantum circuits (VQCs) [2] are vigorously investigated as promising candidates for application. Although previous papers [3, 4] have partially extended this framework to CV-QC, these proposals raise numerous challenges experimentally and numerically. Here we present an experimentally feasible ansatz for CV quantum machine learning. As illustrated in Fig. 1, the VQC employed here consists only of Gaussian gates, enabling a straightforward implementation by a measurement-based quantum computation scheme using cluster states. The trick is to insert data-dependent layers into the quantum circuit, introducing a nonlinear transformation against input data that serves as an activation function of classical neural networks. As is shown in Fig. 2, this ansatz can be successfully trained for multiple tasks such as curve fitting and binary classification.

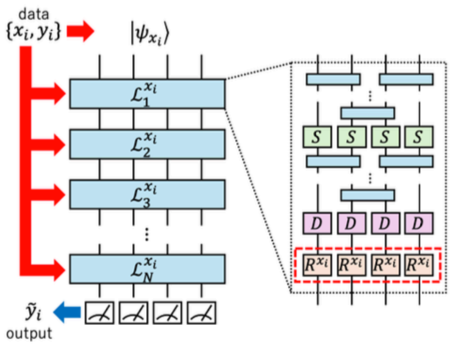

Fig. 1 All-gaussian VQC ansatz. Red dotted layer on the right denotes input-dependent gates.

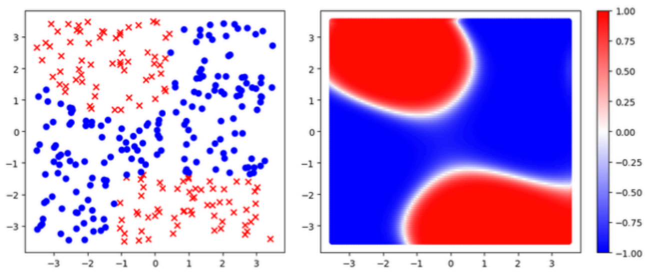

Fig. 2 Training data of binary classification on 2D plain (left) and training result on our VQC (right).

References

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