Modular Quantum Extreme Reservoir Computing

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The connectivity between qubits plays a crucial role in the performance of quantum extreme reservoir computing (QERC), particularly regarding long-range and inter-modular connections. We demonstrate that sufficiently long-range connections within a single module can achieve performance comparable to fully connected networks in supervised learning tasks. Further analysis of inter-modular connection schemes -- such as boundary, parallel, and arbitrary links -- shows that even a small number of well-placed connections can significantly enhance QERC performance. These findings suggest that modular QERC architectures, which could be more easily implemented on two-dimensional quantum chips or through the integration of small quantum systems, provide an effective approach for machine learning tasks.

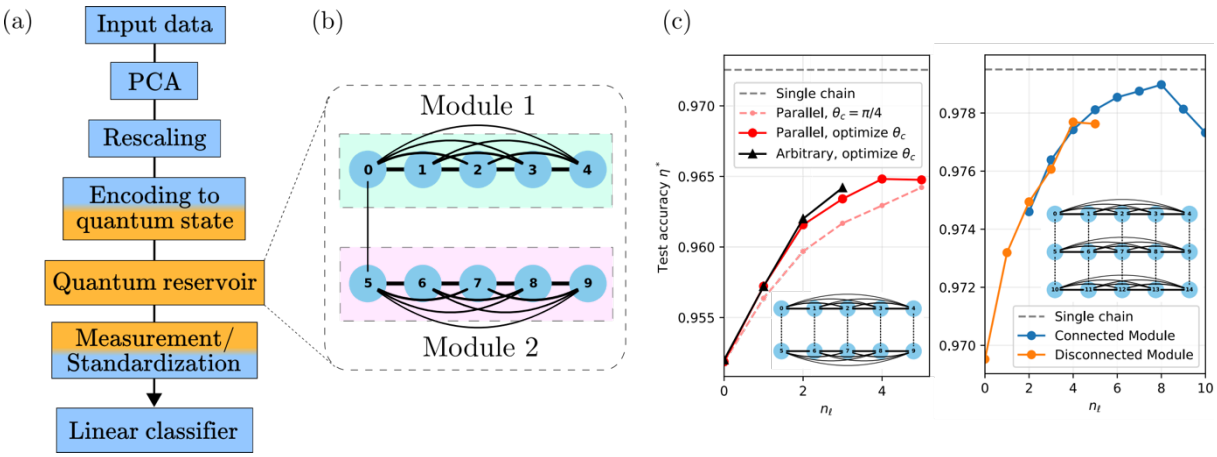

FIG. 1 (a) Architecture of the Modular QERC scheme. The quantum reservoir consists of modular-level reservoir action, interconnections, and single-qubit rotation in sequence. (b) Illustration of parallel modular reservoirs. (c) Improvement in test accuracy on MNIST data vs number of links with different configurations.