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Simple quantum many-body dynamics reservoir for image classification

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Recently, quantum machine learning, particularly quantum reservoir computing, has attracted attention for directly utilizing the natural complex dynamics of quantum systems for information processing. It is believed that by utilizing the vast internal space (Hilbert space) of quantum systems, performance comparable to classical models can be achieved with only a few qubits. However, encoding classical information into a small number of qubits makes it challenging to apply quantum models to large inputs, such as image classification. In this context, in 2022, we proposed a new quantum model, quantum extreme reservoir computing (QERC), that combines classical lightweight compression techniques and achieves performance comparable to classical models within the same machine learning family. This talk presents the QERC model and the various quantum reservoir systems we have experimented with. These include a wide range of possibilities, from using natural Hamiltonian dynamics, as in the Ising model, to representing quantum circuits with random Clifford circuits. Furthermore, this talk will address how much one can simplify the reservoir and how much complexity is necessary, which is of interest to both the theory and implementation sides.

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