Reinforcement Learning Generation of 4-Qubits Entangled States

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Abstract

Artificial intelligence algorithm with machine reinforcement learning (Q-learning) to construct remarkable entangled states with 4 qubits. The algorithm is able to generate representative states for some of the 49 true SLOCC classes of the four-qubit entanglement states. It is possible to reach at least one true SLOCC class for each of the nine entanglement families. The quantum circuits synthesized by the algorithm may be useful for the experimental realization of these important classes of entangled states. We introduce a graphical tool called the state-link graph (SLG) to represent the construction of the Quality matrix (Q-matrix) used by the algorithm to build a given objective state belonging to the corresponding entanglement class. This allows us to discover the necessary connections between specific entanglement features and the role of certain quantum gates, which the algorithm needs to include in the quantum gate set of actions. The quantum circuits found are optimal in the number of gates by construction with respect to the quantum gate-set chosen. These SLGs make the algorithm simple, intuitive and a useful resource for the automated construction of entangled states with a low number of qubits.

References

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Figures

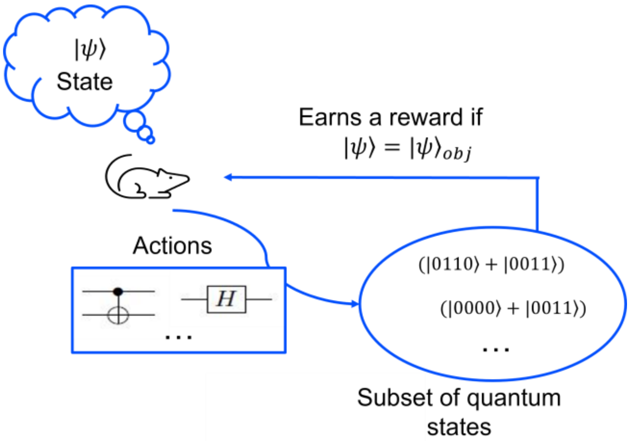

Figure 1: Exploration part of the reinforcement learning algorithm: assigns a reward to the agent to teach it the best action to take in every state, to reach the objective one.

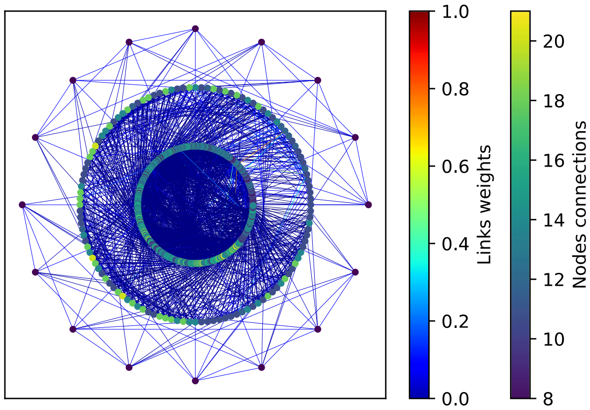

Figure 2: Example of SLG graph after the exploration: the nodes are the quantum states while the links are the rewarded applications of gates.