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Quantum Cellular Automata for the Density Classification Problem via Evolutionary Search

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We investigate the density classification task DCT—determining the majority bit in a one-dimensional binary lattice—within the quantum cellular automata framework. While classical cellular automata constrained by locality, homogeneity, and irreversible rules, cannot solve the DCT perfectly, we explore whether a unitary quantum model can succeed. Specifically, we employ the Partitioned Unitary Quantum Cellular Automaton (PUQCA), a number-conserving QCA framework, and reformulate the consensus condition regarding measurement probabilities rather than convergence to fixed-point configurations. Additionally, we identify a classically simulable regime for PUQCA, where rules that solve the DCT for fixed sizes can still be found.

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