Unitary network: Tensor network unitaries with local unitarity

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We introduce unitary network, an oriented architecture for tensor network unitaries [1]. Compared to existing architectures, in a unitary network each local tensor is required to be a unitary matrix upon suitable reshaping. Global unitarity is ensured when the network obeys a suitable ordering property. Unitary operators represented by unitary networks need not preserve locality. In particular, we show that the class of unitary networks encompasses global unitaries which preserve locality up to exponentially suppressed tails, as in those that naturally arise from the finite-time evolution of local Hamiltonians. Non-invertible symmetries, as exemplified by the non-local Kramers-Wannier duality in one dimension, can also be represented using unitary networks. We also show that information flow in a unitary network can be characterized by a flow index, which matches the known index for quantum cellular automata as a special case.

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[1] W. Xie, S. Ono, and H. C. Po, arXiv: 2508.16890 (2025)