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Emergence of geometry in quantum states KATHARINE HYATT, University of California Santa Barbara, JAMES GARRISON, Joint Quantum Institute, University of Maryland, BELA BAUER, Station Q, Microsoft Research —
Tensor networks impose a notion of geometry on the entanglement of a quantum system. In some cases, this geometry is found to reproduce key properties of holographic dualities, and subsequently much work has focused on using tensor networks as tractable models for holographic dualities. Conventionally, the structure of the network – and hence the geometry – is largely fixed a priori by the choice of tensor network ansatz. Here, we evade this restriction and describe an unbiased approach that allows us to extract the appropriate geometry from a given quantum state. This is based on an algorithm to iteratively find a unitary circuit that transforms a given quantum state into an unentangled state. We then analyze the structure of the resulting unitary circuits. In the case of critical systems in one dimension, we recover signatures of scale-invariance in the unitary network, and show that appropriately defined geodesic paths between physical degrees of freedom exhibit properties of a hyperbolic geometry.

Katharine Hyatt
University of California Santa Barbara

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