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Combining Tensor Networks with Monte Carlo: Applications to the MERA ANDY FERRIS, Université de Sherbrooke, GUIFRE VIDAL, Perimeter Institute for Theoretical Physics — Our recent understanding of the entanglement properties of ground states of many-body quantum systems has led to the development of a variety of variational wavefunctions based on tensor networks. The so-called *bond dimension* of the tensor network, χ, sets both the limit to the amount of entanglement allowed in the ansatz as well as the required computational power to contract the tensor network. Because the cost scales very strongly with χ in higher dimensions, these approaches are currently challenging in 2D and currently unusable in 3D. We present our efforts in combining Monte Carlo techniques with tensor networks to ease the computational bottleneck. Classical Monte Carlo sampling can be used to estimate the contracted value of the network, allowing one to sample expectation values and vary parameters to optimize ground states. In particular, we show a perfect sampling scheme can be efficient for tensor networks which are also unitary quantum circuits. We apply this to the Multi-scale Entanglement Renormalization Ansatz (MERA) in 1D, formally reducing the cost from $O(\chi^9)$ to $O(\chi^5)$ per sample, and demonstrate that we can optimize wavefunctions. We expect the advantages from Monte Carlo sampling will be stronger in 2D and 3D systems.

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