Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Exact Machine Learning Topological States[1] DONG-LING DENG, XIAOPENG LI, Condensed Matter Theory Center and Joint Quantum Institute, Department of Physics, University of Maryland, College Park, MD 20742-4111, USA — Artificial neural networks play a prominent role in the rapidly growing field of machine learning and are recently introduced to quantum many-body systems to tackle complex problems. Here, we show that even topological states with long-range quantum entanglement can be represented with classical artificial neural networks. This is demonstrated by using two concrete spin systems, the one-dimensional (1D) symmetry-protected topological cluster state and the 2D toric code state with an intrinsic topological order. For both cases we show rigorously that the topological ground states can be represented by short-range neural networks in an *exact* fashion. This neural network representation, in addition to being exact, is surprisingly *efficient* as the required number of hidden neurons is as small as the number of physical spins. Our results demonstrate explicitly the exceptional power of neural networks in describing exotic quantum states, and at the same time provides valuable guidances to supervise machine learning topological quantum orders in generic lattice models.

[1]We thank Y.-L. Wu for helpful discussions. This work is supported by JQI- NSF-PFC and LPS-MPO-CMTC.

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Date submitted: 08 Nov 2016 Electronic form version 1.4