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Detection of phase transition in transverse-field Ising model by neural network

We detect the quantum phase transition in the transverse-field Ising model on the one-dimensional chain by using a different way from the standard estimation of the order parameters. We employ a technique of the unsupervised machine learning. The used data for learning is generated by the quantum Monte-Carlo simulation by mapping the original transverse-field Ising model on the one-dimensional chain onto the two-dimensional classical Ising model via the Suzuki-Trotter decomposition.

We construct a simple feed-forward neural network which learns the feature of the ordered phase of the transeverse-field Ising model and the disordered one only from the spin configurations without any prior information of the detailed form of the Hamiltonian.

In the previous study [1], the similar type of the neural network can detect the critical point of the classical Ising model on the square lattice from the fed data of the spin configuration.

In the present study [2], following the previous study, we elucidate a new quantity corresponding to the order parameter via the procedure of the machine learning and it shows a fairly good estimation of the location of the critical point of the transeverse-field Ising model. The present study demonstrates the potential of the technique of the machine learning, which can predict nontrivial behavior of quantum spin systems.

This work is collaboration with Masayuki Ohzeki (Tohoku University).

[1] A. Tanaka and A. Tomiya: arxiv/1609.09087

[2] S. Arai and M. Ohzeki: to appear soon