

Introduction to Tensor Network

Pochung Chen
National Tsing Hua University

Tensor networks have emerged as an essential ingredient in various fields of science. In this work I will introduce the basic idea of the tensor network, emphasizing the connection between “analytical express”, “tensor network diagram”, and “computer code”. I will use statistical mechanics as an example to demonstrate how a tensor network provides a new perspective, which can smoothly connect the analytical expressions and numerical simulations. Furthermore, the renormalization of tensor networks can be viewed as a generalization of real-space renormalization, with the advantage that systematic improvement is possible. Starting with the tensor network representation of the partition function, we show how to express physical quantities such as correlation length, magnetization, specific heat in terms of tensor network. This allows one to evaluate these quantities directly in the thermodynamic limit. Next, we show how to port the finite-size scaling analysis to tensor network framework. We show that by combining tensor network renormalization methods one can determine accurately the critical temperature and critical exponents of statistical mechanics models. Finally, we show how a tensor network can be used to extract the underlying conformal field theory at the critical temperature.