Tensor product methods and entanglement optimization for models with long range interactions

Ors Legeza

April 26, 2017

Abstract

Hierarchical Tucker tensor (HT) format and Tensor Trains (TT) have been introduced recently for low rank tensor product approximation. TT representation, also known as Matrix Product States (MPS), and HT representation, apparent in tensor network states (TNS), have been used in quantum physics for several years. Hierarchical tensor decompositions are based on subspace approximation by extending Tucker decomposition into a multilevel framework. Therefore, they inherit the favorable properties of Tucker tensors, i.e., they offer a stable and robust approximation, but still enabling low order scaling with respect to the dimensions. For many high dimensional problems, hard to treat so far, this approach may offer a novel strategy to circumvent the curse of dimensionality. In this contribution, we overview tensor network states techniques that can be used for the treatment of high-dimensional optimization tasks used in many-body quantum physics with long range interactions and ab initio quantum chemistry. Among the various optimization tasks, we will discuss those which are connected to a controlled manipulation of entanglement, which is in fact the key ingredient of such methods.