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Tensor Networks with respect to connected graphs

We extend the known tensor decompositions for discrete tensors, as: Canonical Polyadic, Tucker, Tensor Train, Tensor Chain (MPS), Hierarchical, PEPS, etc. to a general decomposition scheme called here *tensor network graph decomposition*. For a given connected graph G with n nodes and d open edges, we can decompose a given d-order tensor $calT \in \mathbb{R}^{n_1 \times \cdots \times n_d}$ as contractions of n component tensors of smaller dimensions, which contract along the common indices indicated by the common edges of G. The main tools for such representations are the singular value decomposition (for general tensor) and non-negative matrix factorization (for non-negative tensors). We present an improvement of the Tensor Train decomposition, which is also implemented in the general tensor network decomposition. Another approach for such general decomposition is also introduced, based on the alternating least squares method. We present algorithms for such general decomposition and discuss with examples some of its advantages and disadvantages.

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