Journal club report

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The main contribution of this paper is:

1. introduce tensor train decomposition and apply tensor rank to solve tensor completion.
2. Introduce two algorithm based on TT rank.
3. Introduce a new technique called KA to extend tensor dimension.

Main discussion:

1. tensor train decomposition

$$\mathcal{A}_{[k]} = \text{reshape}(\mathcal{A}, \prod_{s=1}^{k} n_s, \prod_{s=k+1}^{d} n_s) \tag{1}$$

   The difference between tucker decomposition and tensor train decomposition is that tucker decomposition is just mode-k matricization but tensor train decomposition is mode-$(1, 2, , k)$ matricization.

2. how to prove the tensor train decomposition is balanced? In this paper, via von neuman entropy, we obtain that

$$S = \log_2 r_k \tag{2}$$

   Because the bigger the S, the stronger the correlation between subsystem A and B. S is bounded by r_k , r_k is bounded by $m = I_k$. It just prove that tucker decomposition is unbalanced. And r_k should be as large as possible. So tensor train decomposition can be a solution.

3. Algorithm The two algorithms in this paper is easy to understand, the main difference is the step unfold the tensor $\mathcal{A}$ to get $\mathbf{A}_k$ (TT decomposition). TMac-TT is a good algorithm due to its multilinear matrix factorization model.

4. KA Ket augmentation(KA) is a technique to represent a lower-order tensor by a high-order one. The expansion method here is hard to imagine how the elements in the new tensor are arranged.

5. Balance Compared with tucker decomposition, the tensor train decompositin is more banlanced. Due to

$$\mathcal{A}_{[k]} = \text{reshape}(\mathcal{A}, \prod_{s=1}^{k} n_s, \prod_{s=k+1}^{d} n_s) \tag{3}$$

   , to some extent, k is closer to $d/2$, $\mathbf{A}_k$ is more balanced.

6. the possible future work
   1.due to the balance problem, we think that block+multilinear low-rank which we didnt finished last time is likely to succeed.
   2.TMac algorithm in this paper perform better than others, maybe we can use other matrix factorization method to have a try. Or use it to other application.