TT-Decomposition of Tensors with Application to High-Dimensional Problems and Data Compression

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Tensor Train (TT) decomposition of multidimensional arrays (tensors) presents an alternative to the widely used canonical representation. The number of parameters is linear in d, but TT decomposition can be computed via standard tools (QR and SVD), and the canonical decomposition can not. Moreover, TT decomposition is stable and best approximation with fixed ranks always exists. All basic linear algebra algorithms are implemented and available online as a TT Toolbox at `http://spring.inm.ras.ru/osel`, several successful applications to the solution of high-dimensional problems are presented. Since TT decomposition is based on a sequence of matrix decomposition, it is possible to present a generalization of the skeleton decomposition to d dimensions, which gives an exact interpolation for rank-r array on O(dnr2) elements of it, and allows truly black-box reconstruction. Usually, the data come as small-dimensional arrays, may be even vectors. We propose to introduce "virtual dimensions": a vector of length 2^d is treated as d-dimensional array and TT-decomposition is computed, giving in many cases large compression. The approach was applied to image compression and to signal denoising.

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