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Mini-Course

Matrix Algebra for Better Understanding and Dealing with Tensors

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Abstract

We consider two principal tensor decompositions that are now most widely used. The first is the classical, known for decades, Canonical Polyadic Decomposition and the second is Tensor Train Decomposition, appeared in numerical analysis in 2009.

The former looks like a natural extension of the dyadic (rank, skeleton) decompositions of matrices, but does not possess in the least the nice properties of the matrix decomposition. From the negative part, it requires a several levels higher mathematical background that goes far beyond just linear algebra. From the positive part, when the number of dimensions is three or more, it possesses the uniqueness property (under very mild assumptions), which we never have for the dyadic decomposition of matrices. However, some pretty classical linear algebra is behind the proofs of uniqueness. We discuss some proofs and demonstrate how and what linear algebra works therein.

The latter decomposition is inspired by the wish to completely reduce our tensors to matrices. Thank to such a reduction, we are able to apply all nice algorithms of matrix algebra such as SVD etc. We discuss some principal algorithms such as TT-SVD and TT-rounding. It should be emphasized that that the complexity of these algorithms depend on the number of dimensions just linearly, however it is crucially effected by some intrinsic structure, kind of hidden structure in the tensors. Despite the fact that not every tensor manifests this structure, the class of "good tensors" is fairly vast and easily described in the terms of classical ranks of some matrices associated with a given tensor. If time permits, we would also mention some recent applications of Tensor Trains, in particular for solving difficult optimization problems.

Date :	January 16, 2017 (Monday)
	January 18, 2017 (Wednesday)
	January 25, 2017 (Wednesday)
Time :	7:30pm – 9:30pm
Venue :	Room 222, Lady Shaw Building
	The Chinese University of Hong Kong

All are Welcome