Identifiability of Nonnegative Tucker Decompositions: Algorithms and Applications

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Abstract

Tensor decompositions have become a central tool in data science, with applications in areas such as data analysis, signal processing, and machine learning. The Tucker decomposition (TD) is a central and widely used tensor decomposition model. However, it is in general not identifiable. We first introduce and motivate matrix and tensor decomposition models, with a focus on nonnegative matrix factorization (NMF) and nonnegative Tucker decomposition (NTD). [Saha,Barbarino,Gillis, arXiv:2505.12713, 2025] discuss conditions under which the NTD is identifiable, if it exists. In this talk, we would discuss algorithms for computing the unique NTD in the aforementioned settings. For order-2 tensors, that is, matrices, NTD is equivalent to a nonnegative tri-factorization model. We propose a fast algorithm (with convergence guarantees) to solve this problem based on the block majorization minimization framework with extrapolation steps (TITAN) [Hien et al, 2023]. Using this, we give fast algorithms for decomposition of order-3 tensors - we show that just one or two nonnegative matrix tri-factorization problems need to be solved in order to obtain an NTD. We also discuss how these results can be extended to higher order tensors and are computationally more efficient than existing optimization algorithms for computing an NTD (which often suffer from the curse of dimensionality).