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The Tensor Splitting with Application to Solve Multi-linear Systems

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Abstract

In this paper, firstly, we introduce the variant tensor splittings, and present some equivalent conditions for a strong $\mathcal{M}$-tensor based on the tensor splitting. Secondly, the existence and uniqueness conditions of the solution for multi-linear systems are given. Thirdly, we propose some tensor splitting algorithms for solving multi-linear systems with coefficient tensor being a strong $\mathcal{M}$-tensor. As an application, a tensor splitting algorithm for solving the multi-linear model of higher order Markov chains is proposed. Numerical examples are given to demonstrate the efficiency of the proposed algorithms.

Key words. Inverse of a tensor, tensor splitting, strong $\mathcal{M}$-tensor, multi-linear systems, tensor splitting algorithms

MSC 15A69

1 Introduction

Recently, a study of tensors has become a hot topic because of some applications such as data analysis. In particular, tensors decomposition (e.g., see [11] and [12]) and tensor eigenvalue problems (e.g., see [1, 5, 6, 22, 29, 30]) are extensively studied. Some special tensors such as nonnegative tensors, $\mathcal{M}$-tensors et al have been discussed (e.g., see [7, 8, 32]). Some theoretical analysis and algorithms for solving the following multi-linear systems are also presented:

$$\mathcal{A}\mathbf{x}^{m-1} = \mathbf{b}, \tag{1.1}$$

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