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A Levenberg-Marquardt method for solving semi-symmetric tensor equations

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Abstract: In this paper, we propose a Levenberg-Marquardt (LM) method for solving tensor equations with semi-symmetric coefficient tensor and prove its global convergence and local quadratic convergence under the local error bound condition, which is weaker than non-singularity. As application, we solve H-eigenvalue of real semi-symmetric tensor by the LM method. At last, some numerical examples are provided to illustrate the efficiency and validity of these methods proposed.

Keywords: Tensor equation; LM method; H-eigenvalue; semi-symmetric tensor; convergence analysis.

1 Introduction

Tensors have wide applications in the practical fields such as medical engineering, documents analysis, higher-order web link analysis and partial differential equation. The study in tensor and tensor computation has made great progress[1-16, 22-42]. Solving multi-linear systems is always an important problem in engineering and scientific computing. Firstly, we introduce two examples of tensor equations. The related mathematical concepts in this section will be given in Section 2.

One example of tensor equations is information retival [9]. Suppose $\mathscr{A}_1, \mathscr{A}_2, \mathscr{A}_3$ be hubs, authorities and relation probability tensor respectively, we compute non-negative vectors u, v, w that satisfy the following tensor equation.

$$\begin{cases} u = (a-\alpha)\mathscr{A}_{1\times}vw + \alpha z_1, \\ v = (a-\beta)\mathscr{A}_{2\times}uw + \beta z_2, \\ w = (a-\gamma)\mathscr{A}_{3\times}uv + \gamma z_3, \end{cases} \tag{1.1}$$