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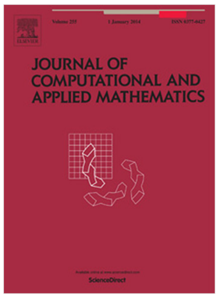

The inexact residual iteration method for quadratic eigenvalue problem and the analysis of convergence

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The inexact residual iteration method for quadratic eigenvalue problem and the analysis of convergence

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Abstract. The residual iteration method is a kind of direct projection methods commonly used for solving the quadratic eigenvalue problem. The convergence criteria of the residual iteration method was established, and the impact of shift point and the subspace expansion on the convergence of this method has been analyzed. In the process of expanding subspace, this method needs to solve a linear system at every step. For large scale problems in which the equations cannot be solved directly, an inner and outer iteration version of the residual iteration method was proposed. The new method uses the iterative method to solve the equations and uses the approximate solution to expand the subspace. Based on analysing the relationship between inner and outer iterations, a quantitative criterion for the inner iteration was established which can ensure the convergence of the outer iteration. Finally, the numerical experiments confirm the theory.

1 Introduction

The quadratic eigenvalue problem (QEP) is to find scalars λ and nonzero vectors x, y satisfying

$$Q(\lambda)x = (\lambda^2 M + \lambda C + K)x = 0, x \neq 0, \tag{1}$$

$$y^* Q(\lambda) = y^*(\lambda^2 M + \lambda C + K) = 0, y \neq 0, \tag{2}$$

where M, C, K are $n \times n$ complex matrices, x, y are the right and left eigenvectors, respectively, corresponding to the eigenvalue λ. In[1], Tisseur systematically summarized and reviewed the QEP.

There are two major classes of numerical methods to solve large QEPs. The first method is to linearize the QEP into an equivalent generalized eigenvalue problem (GEP) or an equivalent standard eigenvalue problem (SEP)(when M is reversible) such as

$$A \begin{bmatrix} \lambda x \\ x \end{bmatrix} = \lambda B \begin{bmatrix} \lambda x \\ x \end{bmatrix}, \quad B^{-1} A \begin{bmatrix} \lambda x \\ x \end{bmatrix} = \lambda \begin{bmatrix} \lambda x \\ x \end{bmatrix},$$