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Computing Eigenpairs in Augmented Krylov Subspace Produced by Jacobi-Davidson Correction Equation

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Abstract

In this paper, we present an augmented Krylov subspace method for computing some extreme eigenvalues and corresponding eigenvectors of Hermitian matrices. The augmented Krylov subspace, which is a union of the standard Krylov subspace and another low-dimension subspace used to extract the approximations to the desired eigenpairs, is essentially different from the projection subspace involved in the Jacobi-Davidson iteration method. The augmented Krylov subspace method converges globally and attains cubic convergence rate locally. Some numerical experiments are carried out to demonstrate the convergence property and the competitiveness of this method.

Keywords: Hermitian eigen-problem, augmented Krylov subspace, Jacobi-Davidson

AMS(MOS) Subject Classifications: 65F15, 65N25.

1 Introduction

Consider the computation of a few extreme eigenpairs of the standard eigen-problem

$$Ax = \lambda x, \quad \text{with} \quad \|x\| = 1, \tag{1.1}$$

where $A \in \mathbb{C}^{n\times n}$ is a large sparse Hermitian matrix, $\lambda \in \mathbb{R}$ is an eigenvalue and $x \in \mathbb{C}^n$ is the corresponding eigenvector of the matrix A. We use $\|\cdot\|$ to denote the Euclidean norm of a vector. Many iterative methods have been developed, such as the Krylov subspace methods [11, 14], the locally optimal block preconditioned conjugate gradient method [7], the Davidson method [3] and the Jacobi-Davidson iteration method [15], etc. The eigen-problem (1.1) can also be transformed into the Newton method as well as its variants. For more details, we refer to [4, 16, 17] and the references therein.

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