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A GMRES-Power algorithm for computing PageRank problems*

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Abstract: The PageRank algorithm for determining the importance of Web pages has become a central technique in Web search. we propose a new method to speed up the convergence performance for computing PageRank when the damping factor is close to one, called as GMRES-Power, which is based on a periodic combination of the power method with the GMRES algorithm. The description and convergence analysis of the new algorithm are discussed in detail. Numerical results are reported to confirm the efficiency of the new algorithm.

Keywords: PageRank; GMRES algorithm; Power method; GMRES-Power

Introduction

With the rapid development of the internet, web search engines have become the most important internet tools for information retrieval. Google is one of the most popular and successful search engines in recent years, due to its simple and elegant algorithm PageRank [1].

The PageRank problem is to compute the dominant eigenvector of the Google matrix A defined by

$$A = \alpha P + (1-\alpha)ve^T, \tag{1.1}$$

where P is a column-stochastic matrix (i.e., the dangling nodes are already replaced by columns with $1/n$), $\alpha \in (0,1)$ is the damping factor, $e = (1,1,\ldots,1)^T \in \mathbb{R}^n$, $v = e/n$, more details can be found in [3], and n is the dimension of P. The PageRank vector x satisfies

$$x = Ax, \tag{1.2}$$

where A is defined as in (1.1).

The PageRank problem can be regard as either the solution of the largest eigenvalues of the matrix corresponding to eigenvectors or an equivalent form, a homogeneous linear system. The Power method [1, 2] was firstly considered for PageRank computation by Page and Brin. However, the Power method cost more and converges very slowly, especially when the damping factor is close to 1. On the other hand, the closer the damping factor is to 1, the closer the Google matrix is to the original web link graph.

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