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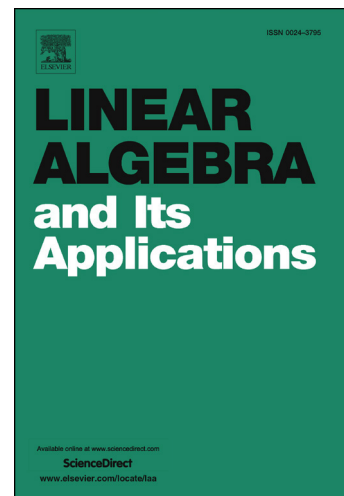
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# Spectral Radius of $\{0, 1\}$ -Tensor with Prescribed Number of Ones

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## Abstract

For any  $r$ -order  $\{0, 1\}$ -tensor  $A$  with  $e$  ones, we prove that the spectral radius of  $A$  is at most  $e^{\frac{r-1}{r}}$  with the equality holds if and only if  $e = k^r$  for some integer  $k$  and all ones forms a principal sub-tensor  $\mathbf{1}_{k \times \dots \times k}$ . We also prove a stability result for general tensor  $A$  with  $e$  ones where  $e = k^r + l$  with relatively small  $l$ . Using the stability result, we completely characterized the tensors achieving the maximum spectral radius among all  $r$ -order  $\{0, 1\}$ -tensor  $A$  with  $k^r + l$  ones, for  $-r - 1 \leq l \leq r$ , and  $k$  sufficiently large.

MSC: 05C50; 05C35

keywords: Spectral radius, nonnegative tensor, 0, 1-tensor, maximum tensor

## 1 Introduction

For a real nonnegative square matrix  $A$  the spectral radius  $\rho(A)$  is the largest eigenvalue of  $A$  in modulus, which is real as guaranteed by the Perron-Frobenius theorem. The problem of finding the maximal spectral radius for all  $\{0, 1\}$ -matrices with prescribed number of ones was introduced by Brualdi and Hoffman [1] in 1985. Let  $g(e)$  be the maximal spectral radius of  $A$  among all  $\{0, 1\}$ -matrices  $A$  with  $e$  ones. They proved that for each positive integer  $k$ ,  $g(k^2) = g(k^2 + 1) = k$ . When  $e = k^2$ , the equality holds if  $A$  is essentially a  $k \times k$  all-1-matrix (inserted by possibly extra rows/columns of 0's). When  $e = k^2 + 1$  and  $k \geq 3$ , the equality is attained for only when a useless additional 1 is put at any place else to a  $k \times k$  all-1-matrix. (But for  $k = 1$ , or 2, there is another  $A$  with  $\rho(A) = k$ .) Friedland [5] solved another cases when  $e = k^2 - 1$ ,  $e = k^2 - 4$ , or  $e = k^2 + l$  for a fixed  $l$  and  $k$  sufficiently large. In all cases, the matrices with maximum spectral radius are characterized.

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