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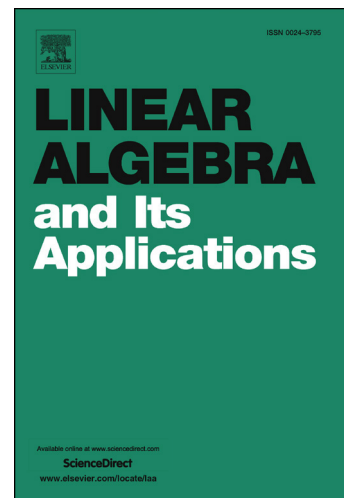
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Rectangular maximum-volume submatrices and their applications

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Abstract

We introduce a definition of the volume of a general rectangular matrix, which is equivalent to an absolute value of the determinant for square matrices. We generalize results of square maximum-volume submatrices to the rectangular case, show a connection of the rectangular volume with an optimal experimental design and provide estimates for a growth of coefficients and an approximation error in spectral and Chebyshev norms. Three promising applications of such submatrices are presented: recommender systems, finding maximal elements in low-rank matrices and preconditioning of overdetermined linear systems. The code is available online.

Keywords: maximum volume submatrices, pseudo-skeleton approximations, CGR-approximations, recommender systems, preconditioning, optimal experimental design

2000 MSC: 15A15,41A45,65F20

1. Introduction

How to define the volume of a rectangular matrix, and how to compute a submatrix with the maximal volume in a given matrix? A standard definition of the volume of a square matrix is an absolute value of its determinant. Maximum-volume submatrices play an important role in low-rank approximations [1, 2], recommender systems [3], wireless communications [4], preconditioning of overdetermined systems [5], tensor decompositions [6]. How to compute a submatrix of exactly maximal volume is a NP-hard problem [7]. However, in many applications, a submatrix of a sufficiently large volume is enough, and it

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