Research on truncated singular value method for ill-conditioned least squares problem.

(Chinese. English summary) Zbl 07448765

Summary: In this paper, a two-step method is proposed to select the optimal truncation threshold in the singular value truncation method. The theory basis of the existing methods to determine the optimal solution is firstly discussed and the possible shortcomings are analyzed. The reason may be that the residual norm is always considered as the main aspect in the process of determining the truncation threshold, which is not very consistent with the characteristics of the optimal solution. On this basis, a two-step method is proposed to determine the optimal truncation threshold. The norm of each level solution and the corresponding residual norm are considered step by step. In the first step, only the residual norm is considered. The residual limit value is calculated firstly and then those solutions whose residual norm is greater than the limit value are excluded. As a result, a small range alternative set of optimal solutions can be obtained. In the second step, only the norm of each solution in the alternative set is considered. The cut-off threshold of the optimal solution is determined by the stability of the solution norm. The solution whose stability index is the smallest is the optimal solution. Two numerical examples are used to illustrate the proposed method. The results show that the proposed method is reasonable and feasible.

MSC:

65F22 Ill-posedness and regularization problems in numerical linear algebra
65F35 Numerical computation of matrix norms, conditioning, scaling

Keywords:
ill-conditioned least squares problem; singular value decomposition; truncation threshold; 2-norm