Sparsity preserving preconditioning of normal matrices in interior point methods

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Solving systems of linear equations with matrices of the form A D2 AT is a key ingredient in the computation of search directions for interior-point methods. It has been shown by Monteiro, O'Neal and Tsuchiya [1] that a well-known basis preconditioner for such systems of linear equations produces scaled matrices with uniformly bounded condition numbers as D varies over the set of all positive diagonal matrices, under the condition that the scaling factors are in the decreasing ordering. However, this might lead to a considerable fill-in of the resulting matrix. We propose a strategy which balances stability and sparsity preserving requirements. In particular, by extending the arguments in [2] we show that the scaling factors can be partitioned by magnitude into groups, in which the ordering is irrelevant and can be chosen subject to minimal fill-in. The condition number of the resulting matrix depends on the ratios of maximal and minimal scaling factors within each group.

References

[1] R. D. C. Monteiro, J. W. O'Neal and T. Tsuchiya, *Uniform boundedness of a preconditioned normal matrix used in interior-point methods*. SIAM Journal on Optimization, 15 (2005) 96-100.

[2] V. V. Kovacevic-Vujcic and M. D. Asic, *Stabilization of interior-point methods for linear programming*, Computational Optimization and Applications, 13 (1999) 331-346.