Symmetrization Techniques in Image Deblurring

This talk focuses on preconditioning techniques that enhance the performance of iterative regularization methods in image deblurring. The preconditioners are applied to problems with different point spread functions (PSFs) and boundary conditions [1]. More precisely, we first consider the anti-identity preconditioner [3], which symmetrizes the coefficient matrix associated to problems with zero boundary conditions, allowing the use of MINRES as a regularization method. When considering more sophisticated boundary conditions and strongly nonsymmetric PSFs, the anti-identity preconditioner improves the performance of GMRES. We present both stationary and iteration-dependent regularizing circulant preconditioners that speed up the iterations when applied in connection with the anti-identity matrix and flexible Krylov subspaces [2]. A theoretical result about the clustering of the eigenvalues of the preconditioned matrices is proved in a special case [1]. The results of many numerical experiments are illustrated to show the effectiveness of the new preconditiong techniques, including when considering the deblurring of sparse images.

[1] M. Donatelli, P. Ferrari, S. Gazzola, *Symmetrization Techniques in Image Deblurring*, https://arxiv.org/abs/2212.05879

[2] S. Gazzola, J. G. Nagy, M. Sabaté Landman, *Iteratively reweighted FGMRES and FLSQR for sparse reconstruction*, SIAM J. Sci. Comput., 2021.

[3] A. J. Wathen, J. Pestana, *A preconditioned MINRES method for nonsymmetric Toeplitz matrices*, SIAM J. Matrix Anal. Appl., 2015.

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