Tikhonov regularization and matrix function evaluation

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We present a novel approach for solving ill-conditioned linear systems $Ax = b$ based on the computation of matrix functions. Starting from the Tikhonov regularized solution

$$x_\lambda = \arg\min_x \left(\|Ax - b\| + \lambda \|Hx\| \right)$$

where $\lambda > 0$ and H is the regularization matrix, we consider the relationship between x_λ and the exact solution of the system, that can be stated in terms of a suitable matrix function times a vector. We employ the standard Arnoldi method to compute this operation. The arising Krylov method seems to be competitive with the most powerful iterative solvers in terms of speed and accuracy, and the dependence on the regularization parameter λ is heavily reduced.

Numerical experiments on classical test problems and image restoration are presented.