MTH 655, Winter 2013, LAB6

The goal of this assignment is to get acquainted with non-stationary iterative methods.
Turn in 1 and one of 2 or 3 (or both for extra credit).

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1. Repeat class example for SD, CG, GMRES with matrix $A = [2, 1; 1, 2]$, and $b = [-1, 1]^T$. Plot contours of the functions minimized by SD, CG, GMRES, compute (by hand) the iterates x_1 and x_2 for each of the method, and mark them on the graph. How many iterations of SD do you need to get close to the true solution within the tolerance $1e-2$?

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2. Use `pcg` in MATLAB and explore the benefits of preconditioning. For the matrix A use `gallery('wathen',12,12)` (should be sparse spd). Let the true x be a vector of 'ones' of appropriate dimension; compute $b = Ax$ accordingly.

You can use `rand('seed',your_osu_id);` or something like that to de-randomize your choices when exploring.

(i) Experiment with the M=diagonal preconditioner. Discuss the computational cost as well as condition number of $M^{-1}A$ as compared to A, and other factors that may be relevant. Choose different sizes, tolerances etc.; compare the quality of the solution to that obtained with the direct solver (backslash).

(ii) Next, code a function `mfun` to replace M. [Show me your code] (test with diagonal preconditioner first). Test performance as in (i). In `mfun`, test the performance of at least one preconditioner of your choice, e.g., `cholinc`, or a few iterations of the solvers Jacobi, SOR matrix, Richardson's iteration $G_{RICH} = I - \alpha A$ for an appropriately chosen α.

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3. Do 2 with GMRES or BiCGstab instead (use a non-symmetric matrix).