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Math128B: Numerical Analysis

Programming Assignment #3, Due April 12

In this project, we reduce a real $n \times n$ non-symmetric matrix into upper Hessenberg form. Your program should include:

1. A function that computes the Householder transformation. Note that you should only save the Householder vector, not the matrix.

2. A function that does the reduction to upper Hessenberg form based on the Householder transformation. Your program should utilize the Householder vectors for fast computations, instead of treating the Householder transformation as a dense matrix in your computations.

As (imperfect) accuracy tests, you should perform the following experiments.

1. On random matrices with dimension $n = 20, 200, 2000$, compare your upper Hessenberg matrix with the matrix you obtain from the built-in matlab function `hess`. Also use the `eig` function to compare the eigenvalues of the original matrix with those of your upper Hessenberg matrix. In both cases, you should expect the differences to be relatively negligible for small-sized matrices but potentially significant for large n.

2. Generate random *symmetric* matrices with dimension $n = 20, 200, 2000$. Run your program to reduce them to upper Hessenberg matrices. Compute the 2-norm of the part of the upper Hessenberg matrices above the first super-diagonal. Such norms should always be of the same order as machine precision.

Write a report to summarize your results, and email both your report and your matlab code to Alan by 11:59PM, April 12.