Middle East Technical University | Department of Computer Engineering

CENG371

Scientific Computing

Fall 2023-2024

Homework 2

Due: November 25th, 2023

Question 1 (60 points)

Implement the following algorithms

a) **(20 pts)** LU factorization without pivoting (filename: `my_lu.m`, returns matrices L and U)

b) **(20 pts)** LU factorization with partial pivoting (filename: `my_lu_pp.m`, returns matrices L, U, and P)

c) **(20 pts)** LU factorization with complete pivoting (filename: `my_lu_cp.m`, returns matrices L, U, P and Q)

Uploading your `.m` files is enough for this part.

Question 2 (40 points)

Use each of the above algorithms to factorize $A_n = \texttt{hilb}\,(n)$ for $n \in \{2, \ldots, 300\}$.

a) **(30 pts)** Compare the algorithms in terms of their total run times and in terms of the plots of their relative errors *i.e.*, $\frac{\|A_n - L_n U_n\|_2}{\|A_n\|_2}$, $\frac{\|P_n A_n - L_n U_n\|_2}{\|P_n A_n\|_2}$, or $\frac{\|P_n A_n Q_n - L_n U_n\|_2}{\|P_n A_n Q_n\|_2}$.
Note: You can use `tic` & `toc` to measure the elapsed time. Use `semilogy(.)` together with the command `hold on` to display your relative error versus matrix size graphs.

b) **(10 pts)** Do the algorithms you have implemented successfully (up to numerical errors) factorize any square matrix? Explain.

(`hilb` is a MATLAB built-in function. It returns the $n \times n$ Hilbert matrix.)

Regulations

1. Your submission should include a single PDF and your `.m` files.
2. Submission will be done via odtuclass.
3. **Late Submission:** Accepted with a penalty of $-5 \times (day)^2$.