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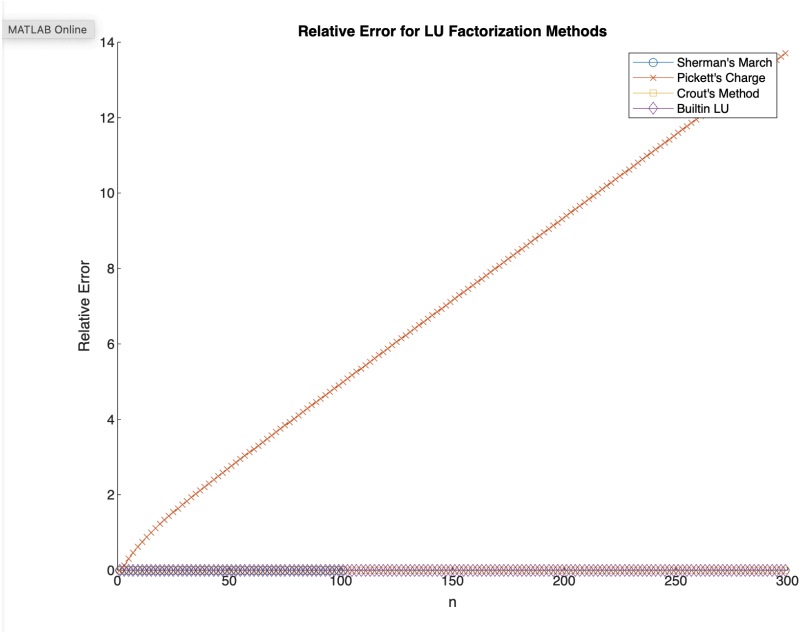
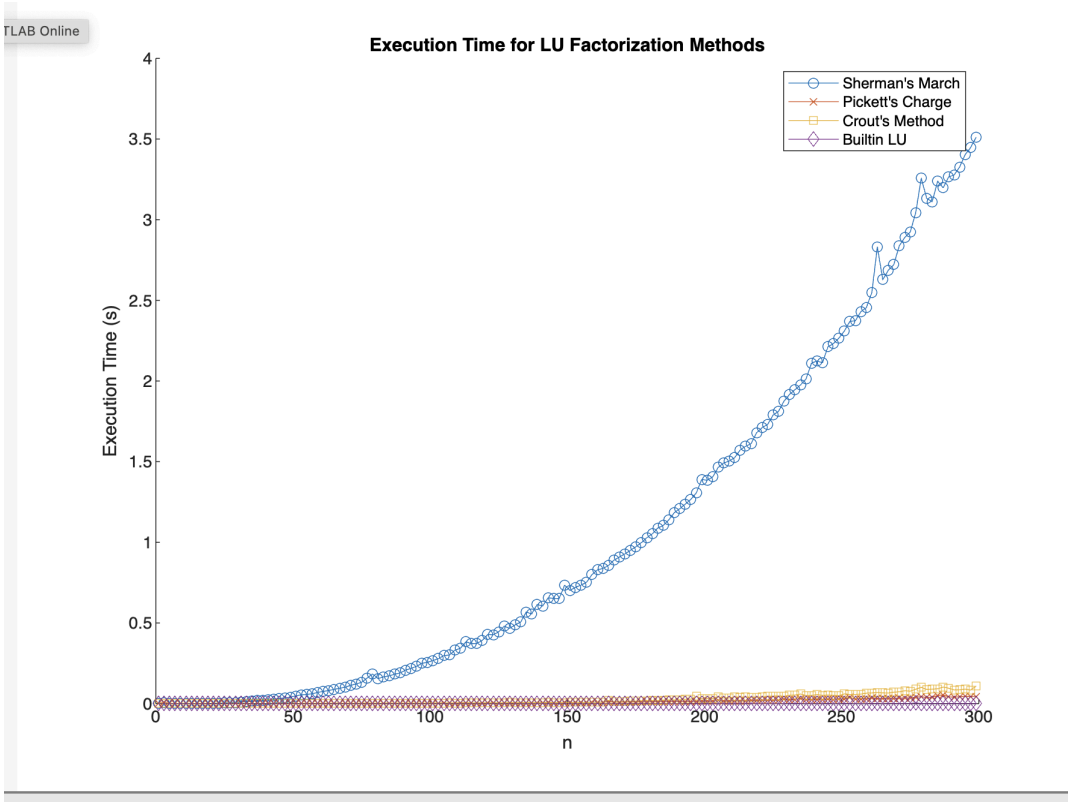
CENG371 HW2

Question 2

1) The relative error plot shows that Pickett's Charge exhibits a steadily increasing error as the matrix size n grows, reaching extremely high values (up to 14 for n=300), making it numerically unstable and unsuitable for large matrices. In contrast, Sherman's March, Crout's Method, and MATLAB's Built-in LU maintain consistently low relative errors near zero, indicating strong numerical stability and accuracy regardless of matrix size. This demonstrates that Pickett's Charge is unreliable for ill-conditioned matrices like the Hilbert matrix, while the other methods, especially MATLAB's LU and Crout's Method, are robust and stable.



The execution time plot reveals that Sherman's March is significantly slower than the other methods, with its runtime increasing exponentially as the matrix size nn grows, surpassing 3.5 seconds for n=300, making it impractical for large matrices. In comparison, Pickett's Charge, Crout's Method, and MATLAB's Built-in LU have much shorter and more manageable runtimes, with MATLAB's LU function being the fastest due to its optimized implementation. Crout's Method follows closely, offering a good balance between speed and accuracy, while Pickett's Charge, despite being computationally efficient, is undermined by its poor accuracy as shown in the relative error plot.



2) When comparing speed, MATLAB's built-in LU function was the fastest because it is highly optimized. Crout's Method was also very efficient and close to MATLAB's speed, making it a good custom option. Pickett's Charge was slower than MATLAB and Crout's Method but still faster than Sherman's March. Sherman's March was the slowest, with its execution time increasing a lot as the matrix size grew, making it unsuitable for large matrices.

   In terms of accuracy, MATLAB's LU function and Crout's Method were the most reliable, with very low relative errors even for large matrices. Sherman's March also had low errors, but its slow speed makes it less practical. Pickett's Charge, however, struggled with accuracy, as its error increased a lot for larger matrices. This shows that Pickett's Charge is unstable and not suitable for large or complex problems like the Hilbert matrix.

   Overall, MATLAB's built-in LU function was the best in both speed and accuracy, making it the best choice for practical use. Crout's Method is a good alternative if you need to use your own code. Sherman's March works fine for small matrices but is too slow for larger ones, and Pickett's Charge is not reliable because of its high errors. This shows that efficient and stable methods like MATLAB's LU and Crout's Method are the best options for LU factorization.