Given an matrix A and a vector , we find and use QR and LU (GE) factorizations to find . ranging from , with a step of 100 at 5 trials each, was chosen to show times and errors in detail for large matrices. The mean absolute errors is represented both as a scatter plot and with linear interpolation for preference.

Fig. 1b -QR vs GE Actual - 
Mean Absolute Errors 
10-8 
10-9 
10 10 
1011 
10 12 
10 13 
10 14 
1000 
2000 
3000 
4000 
5000 
6000 
7000 
8000 
9000 
10000 10-8 
10-9 
10 10 
1011 
10 12 
10 13 
10 14 
Fig. 1b - QR vs GE Actual - Mean Absolute Errors 
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 Fig. la - 
Mean QR vs GE times 
102 
101 
100 
10-1 
— 10-2 
10-3 
104 
1000 
2000 
3000 
4000 
5000 
6000 
7000 
8000 
9000 
10000 

**Efficiency**

As expected and seen in fig. 1a, QR was roughly twice as slow as LU given that QR has an estimated run time of while LU has . Both algorithms have a stable run time as N increases.

**Robustness**

QR factorization, with Q being orthogonal, has and therefore . R on the other hand maintains the inherent error of the original problem from A. The QR factorization is robust, and relies on A being a well conditioned matrix.

On the other hand, LU factorization decomposes A, which may be well conditioned, into two easier problems ( and ) which may end up amplifying the inherent error due to its nature.

Fig. lc - 
Condition of A vs QR vs LU 
O 
1012 
1010 
108 
106 
104 
102 
1000 
2000 
3000 
4000 
5000 
6000 
7000 
8000 
9000 
10000 As seen in fig. 1b, QR has significantly less error, and is generally more stable as LU depends on getting a well conditioned LU factorization. The condition of the two algorithms versus their initial matrix A can be seen in fig. 1c. The condition of QR factorization is the same as A, while the condition of the LU factorization is higher