

CS211 hw2 Zi Yang Report
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Git:<https://github.com/UCR-HPC/cs211-hw2-solving-large-linear-system-ZiYang-ucr>

Q 1. Since $a[i, i] = 1$, all elements below $a[i, i]$ need to be divided by $a[i, i]$.

So, the matrix A becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ \frac{4}{1} & 13 & 18 \\ \frac{7}{1} & 54 & 78 \end{bmatrix}$$

Next, update $a[2, 2]$ as follows:

$$a[2, 2] = a[2, 2] - a[2, 1] \times a[1, 2] = 5$$

So, the matrix A becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 18 \\ 7 & 54 & 78 \end{bmatrix}$$

Similarly, update $a[3, 2]$:

$$a[3, 2] = a[3, 2] - a[3, 1] \times a[1, 2] = 40$$

Now, divide $a[3, 2]$ by $a[2, 2]$:

$$\frac{40}{5} = 8$$

So the matrix becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 18 \\ 7 & 8 & 78 \end{bmatrix}$$

update $a[2, 3]$:

$$a[2, 3] = a[2, 3] - a[1, 3] \times a[2, 1] = 6$$

So the matrix becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 78 \end{bmatrix}$$

the last $a[3, 3]$:

$$a[3, 3] = a[3, 3] - (a[1, 3] \times a[3, 1] + a[2, 3] \times a[3, 2]) = 9$$

the final matrix becomes :

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

so the $L =$

$$L = \begin{bmatrix} 1 & 0 & 0 \\ 4 & 1 & 0 \\ 7 & 8 & 1 \end{bmatrix}$$

so the $U =$

$$U = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 5 & 6 \\ 0 & 0 & 9 \end{bmatrix}$$

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[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$ python3 starter.py
make: 'main' is up to date.
n=1000, pad=1
time=0.133985s
[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$ python3 starter.py
make: 'main' is up to date.
n=2000, pad=1
time=1.285116s
[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$ python3 starter.py
make: 'main' is up to date.
n=3000, pad=1
time=5.610805s
[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$ python3 starter.py
make: 'main' is up to date.
n=5000, pad=1
time=28.703882s
[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$ python3 starter.py
make: 'main' is up to date.
n=4000, pad=1
time=14.194812s
[zyang253@cluster-001-login-node cs211-hw2-solving-large-linear-system-ZiYang-ucr]$

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Figure 2: my execute time

$$\text{Gflops} = \frac{\text{flops} (2 \times n^3)}{\text{Execution Time} \times 10^9}$$

so the Lappack Gflop is :

n	Execution Time (s)	Gflops
1000	0.038398	52.096
2000	0.203500	78.615
3000	0.640567	84.312
4000	1.304248	98.154
5000	2.620849	95.378

Table 1: LAPACK Performance: Execution Time and Gflops for different n values

And the mydtrsv and mydgetrf Glop is :

Matrix Size (n)	Execution Time (s)	Gflops
1000	0.133985	14.93
2000	1.285116	12.45
3000	5.610805	9.625
4000	14.194812	9.017
5000	28.703882	8.710

Table 2: My Performance: Execution Time and Gflops

Q 3.

Since the block size is 2, we first compute the first two columns. Starting with $a[1,1] = a_{1,1}$, all elements below $a_{1,1}$ in the first column need to be divided by $a_{1,1}$.

So the matrix A becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 9 & 12 & 15 \\ 3 & 26 & 41 & 49 \\ 4 & 40 & 107 & 135 \end{bmatrix}$$

Next, we compute $a[2, 2]$ by subtracting the product of $a[1, 2] \times a[2, 1]$ from $a[2, 2]$:

$$a[2, 2] = a_{2,2} - a_{1,2} \times a_{2,1} = 5$$

Similarly, for the third and fourth rows:

$$a[3, 2] = a_{3,2} - a_{1,2} \times a_{3,1} = 20$$

$$a[4, 2] = a_{4,2} - a_{1,2} \times a_{4,1} = 30$$

Thus, the updated matrix A becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 12 & 15 \\ 3 & 20 & 41 & 49 \\ 4 & 30 & 107 & 135 \end{bmatrix}$$

Next, the elements below $a[2, 2]$ in the second column are divided by $a[2, 2]$. So the matrix becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 12 & 15 \\ 3 & 4 & 41 & 49 \\ 4 & 6 & 107 & 135 \end{bmatrix}$$

by updating $a[2, 3]$ using the formula $a[2, 3] = a[2, 3] - a[1, 3] \times a[2, 1] = 6$. Similarly, we compute $a[2, 4]$:

$$a[2, 4] = a[2, 4] - a[1, 4] \times a[2, 1] = 7$$

Now we move on to compute the final block:

$$a[3, 3] = a[3, 3] - (a[1, 3] \times a[3, 1] + a[2, 3] \times a[3, 2]) = 8$$

Similarly, for $a[3, 4]$:

$$a[3, 4] = a[3, 4] - (a[1, 4] \times a[3, 1] + a[2, 4] \times a[3, 2]) = 9$$

At this point, the matrix A becomes:

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 6 & 7 \\ 3 & 4 & 8 & 9 \\ 5 & 6 & 107 & 135 \end{bmatrix}$$

Finally, we update $a[4, 3]$ and $a[4, 4]$:

$$\begin{aligned} a[4, 3] &= a[4, 3] - (a[1, 3] \times a[4, 1] + a[2, 3] \times a[4, 2]) = 7 \\ a[4, 4] &= a[4, 4] - (a[1, 4] \times a[4, 1] + a[2, 4] \times a[4, 2] + a[3, 4] \times a[3, 4]) = 10 \end{aligned}$$

final A =

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 5 & 6 & 7 \\ 3 & 4 & 8 & 9 \\ 5 & 6 & 7 & 10 \end{bmatrix}$$

so L =

$$A = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 2 & 1 & 0 & 0 \\ 3 & 4 & 1 & 0 \\ 5 & 6 & 7 & 1 \end{bmatrix}$$

U =

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & 5 & 6 & 7 \\ 0 & 0 & 8 & 9 \\ 0 & 0 & 0 & 10 \end{bmatrix}$$