

EC527 Lab1

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Part 1

1a.

1048576 bytes of memory give the highest bandwidth. \
Besides, **262144** bytes gives a very similiar bandwidth.

1b.

67108864 gives the lowest. \
The ratio between the highest and the lowest is 1.19

1c.

16 Tasks with 262144 Bytes give the highest total bandwidth. \
16 Tasks with 1048576 Bytes gives a similliar bandwidth.

1d.

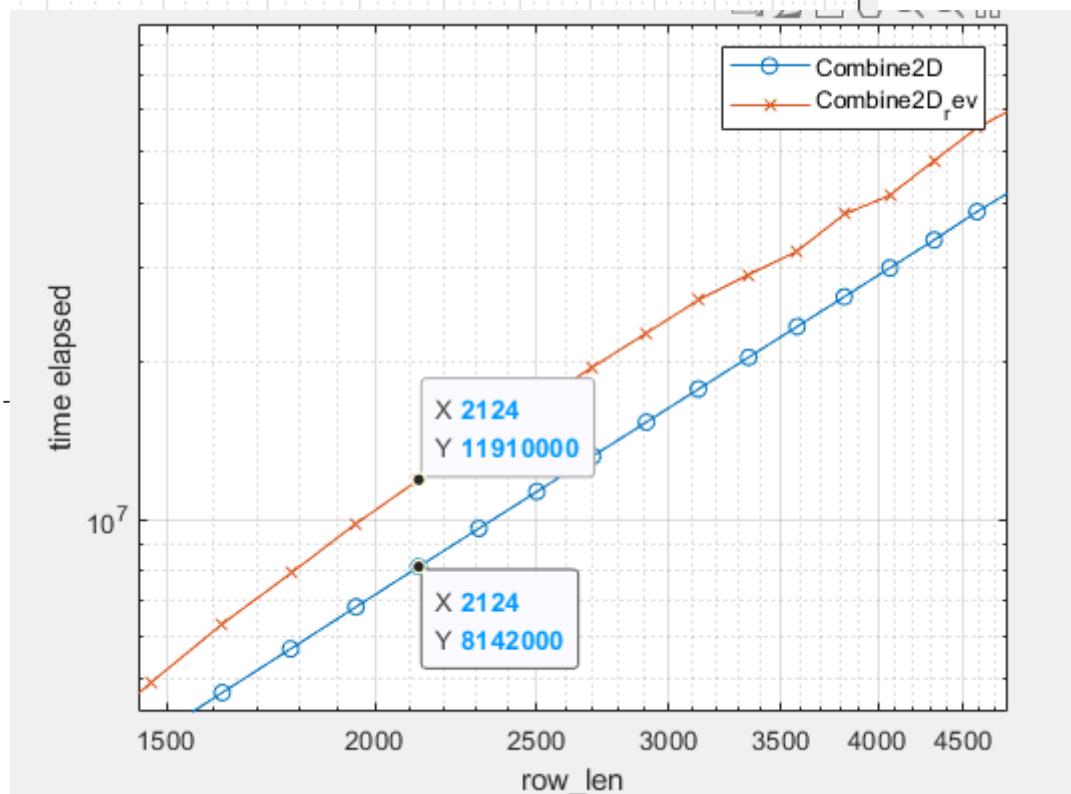
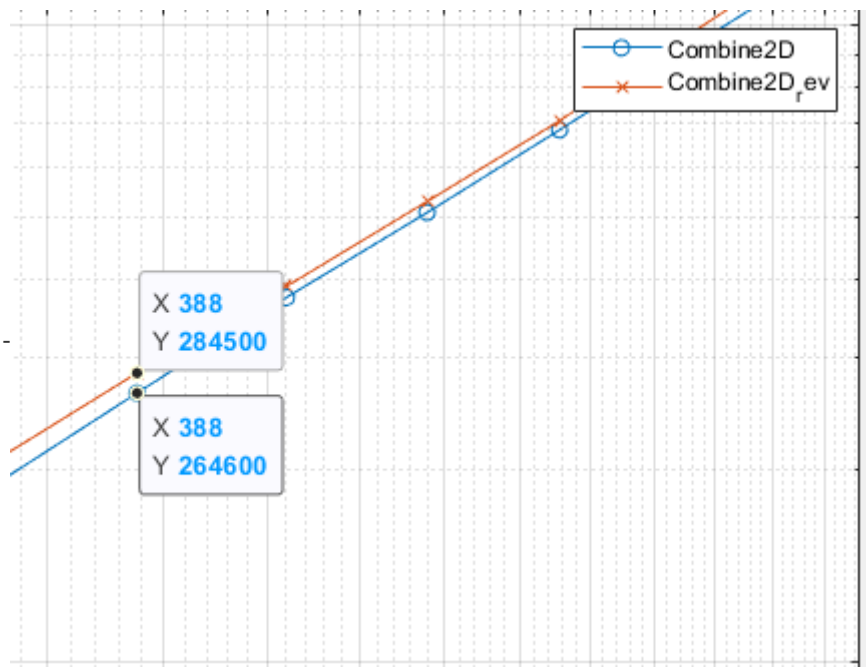
The bandwidth achieved when running just one task with largest memory size is $3.069e+10$. With restricted memory size and bandwidth per task, there can be only one task.

If the BW/task is not restricted, the bandwidth per task achieved **closest** to this bandwidth when running 2 tasks is **$1.81e+10$** .

Part2

2a.

- Around the size of 50000 x 50000, the test starts to run incredibly slow.
- At first it Combine2D() is 7.5% faster than Combine2D_Rev(), after the row length passes 1800, the difference becomes more than 50%.



- Starting from row_len 1164, the ratio drastically increased.

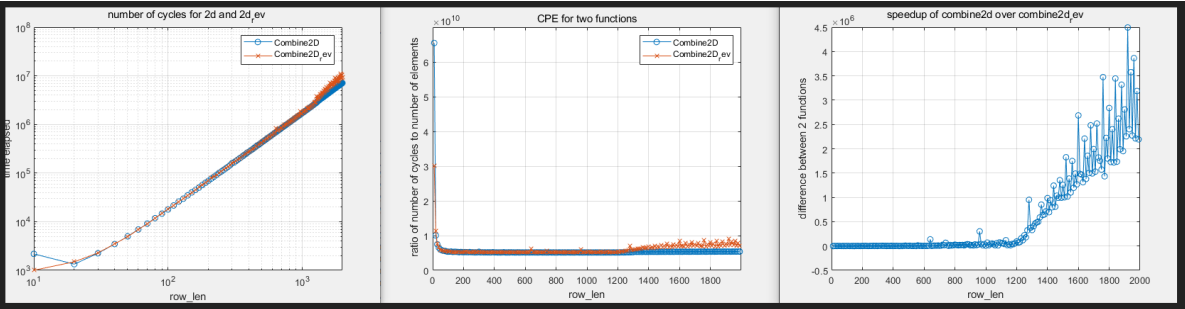
2b.

cycle time: 3.33×10^{-10}

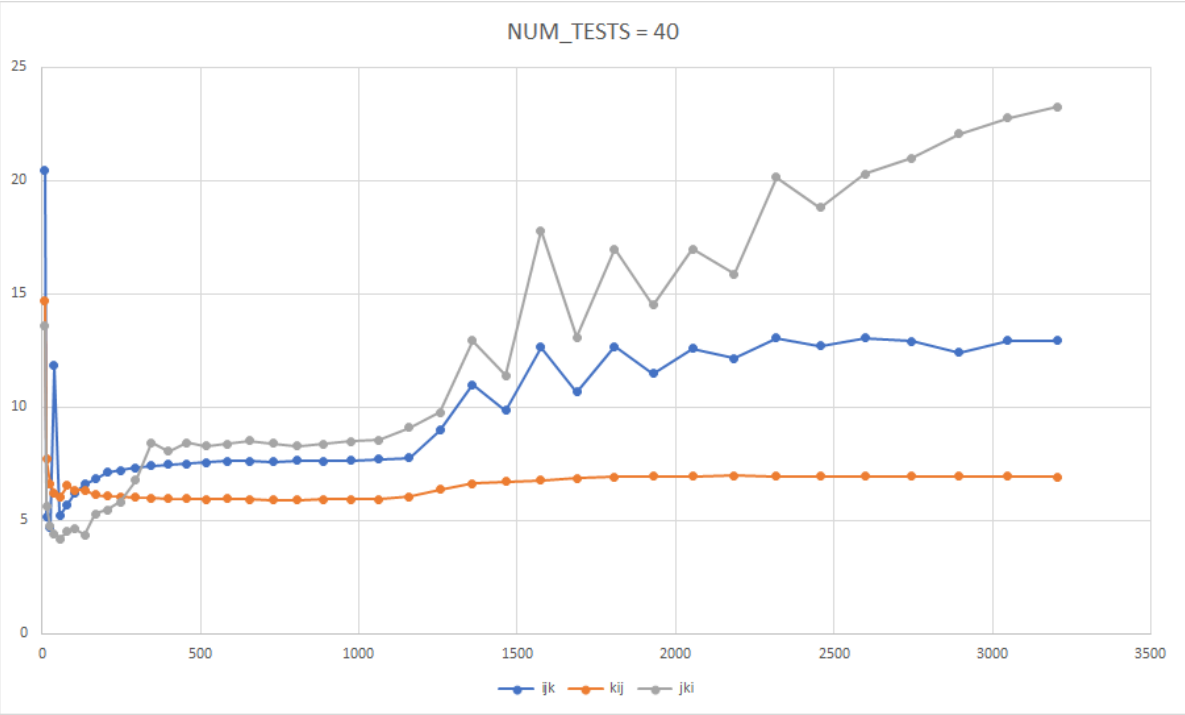
	CPE for range 100-442	CPE for range 10000- 10342
Combine2D	5.44e+09 - 5.14e+09	5.44e+09 - 5.45e+09
Combine2D_rev	5.36e+09 - 5.13e+09	9.64e+09 - 8.51e+09
Because of the cache, when doing matrix operation row-majorly, the miss rate will be extremely high. That is why the 2D_rev is much slower than 2D.		

2c.

The U shape starts at the very beginning of two charts.
Here is the zoom-in from 0 to 2000 row length.



Part3



3a ijk

- How many plateaus are there?

2

- For each plateau, what is the number of cycles per innermost loop iteration (as defined above)?

First is around 7.6; the second one is around 12.7

- Between plateaus are the "transitions". Expressing your answer in terms of the matrix sizes (horizontal axis), where do the transitions occur?

The matrix size is around $1358^2 = 1844164$

3b jki

- How many plateaus are there?

2

- For each plateau, what is the number of cycles per innermost loop iteration (as defined above)?

First is around 8.39; the second one is around 23.26

- Between plateaus are the "transitions". Expressing your answer in terms of the matrix sizes (horizontal axis), where do the transitions occur?

The matrix size is around 1806^2

3c kij

- How many plateaus are there?

2

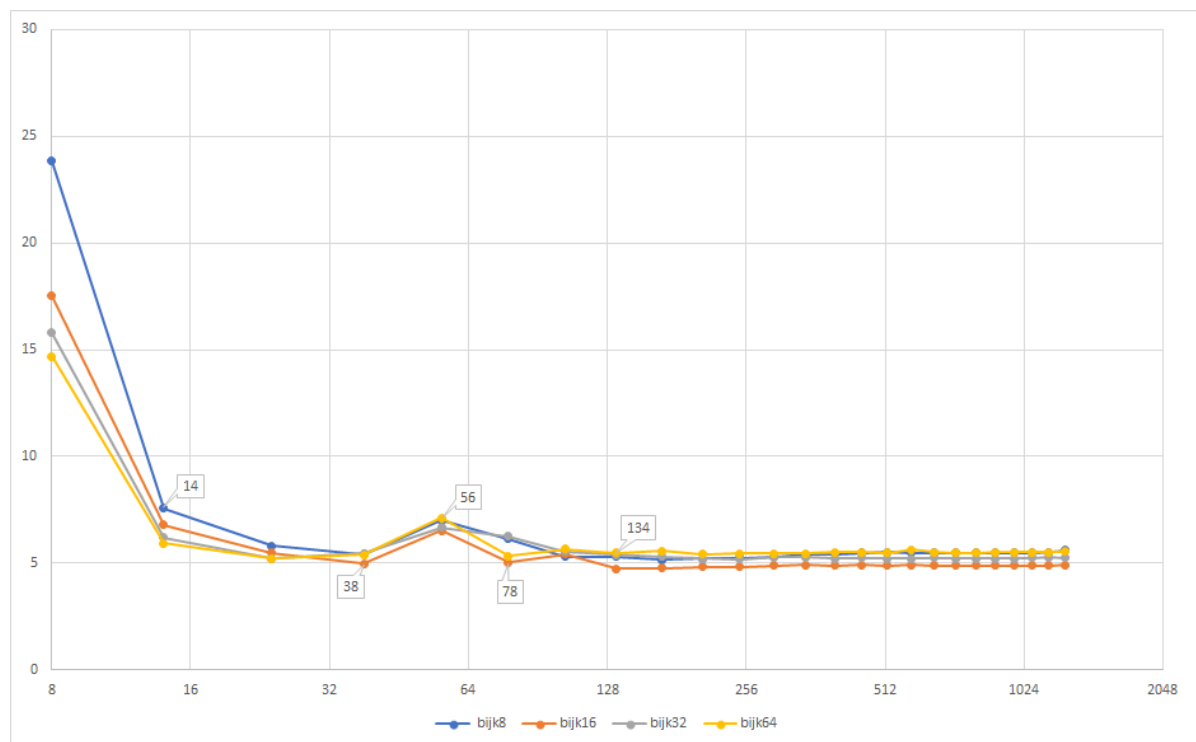
- For each plateau, what is the number of cycles per innermost loop iteration (as defined above)?

First is around 6.0; the second one is around 7.0

- Between plateaus are the "transitions". Expressing your answer in terms of the matrix sizes (horizontal axis), where do the transitions occur?

The matrix size is around 1256^2

Part 4



a

The benefit of blocking as a function of matrix size

$$HitRate(n) = \frac{2n^3}{\text{cache block size} \times \text{block size}}$$

b

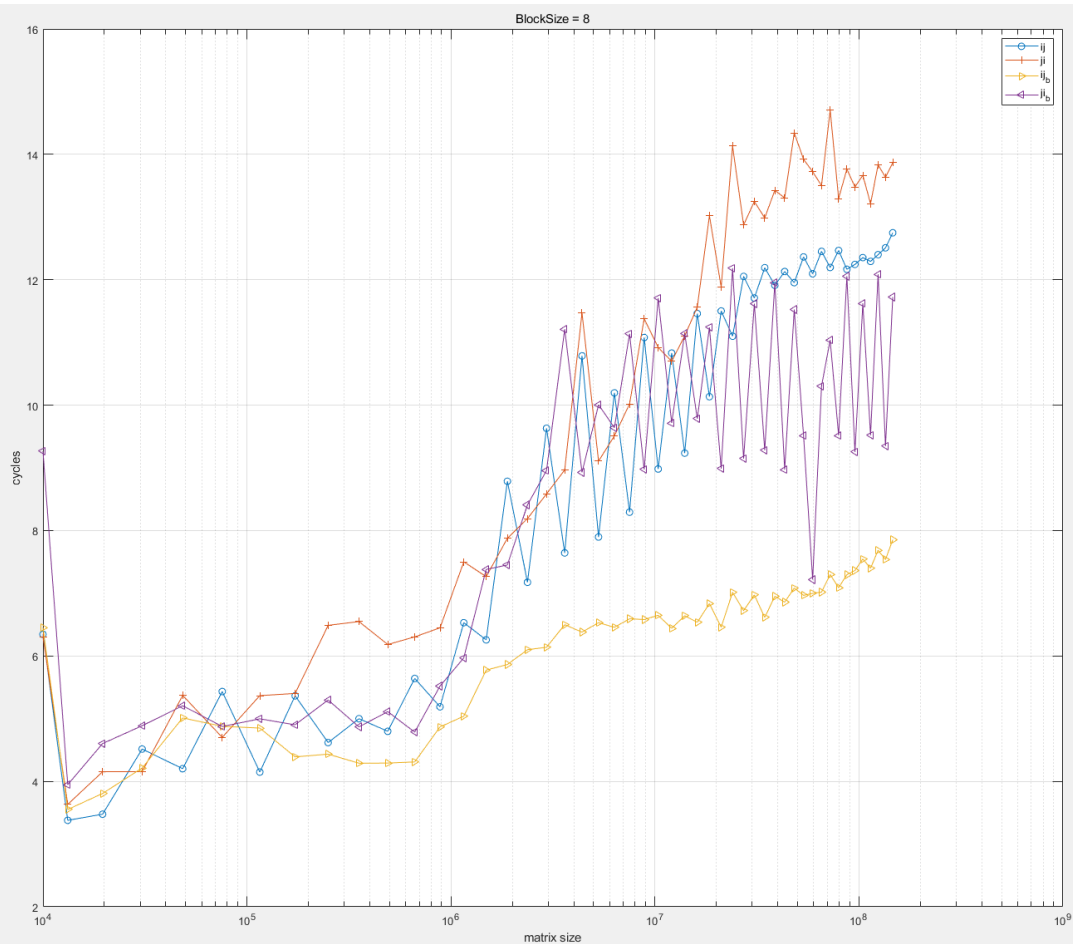
The optimal block size as a function of matrix size.

According to the graph, it should be 16

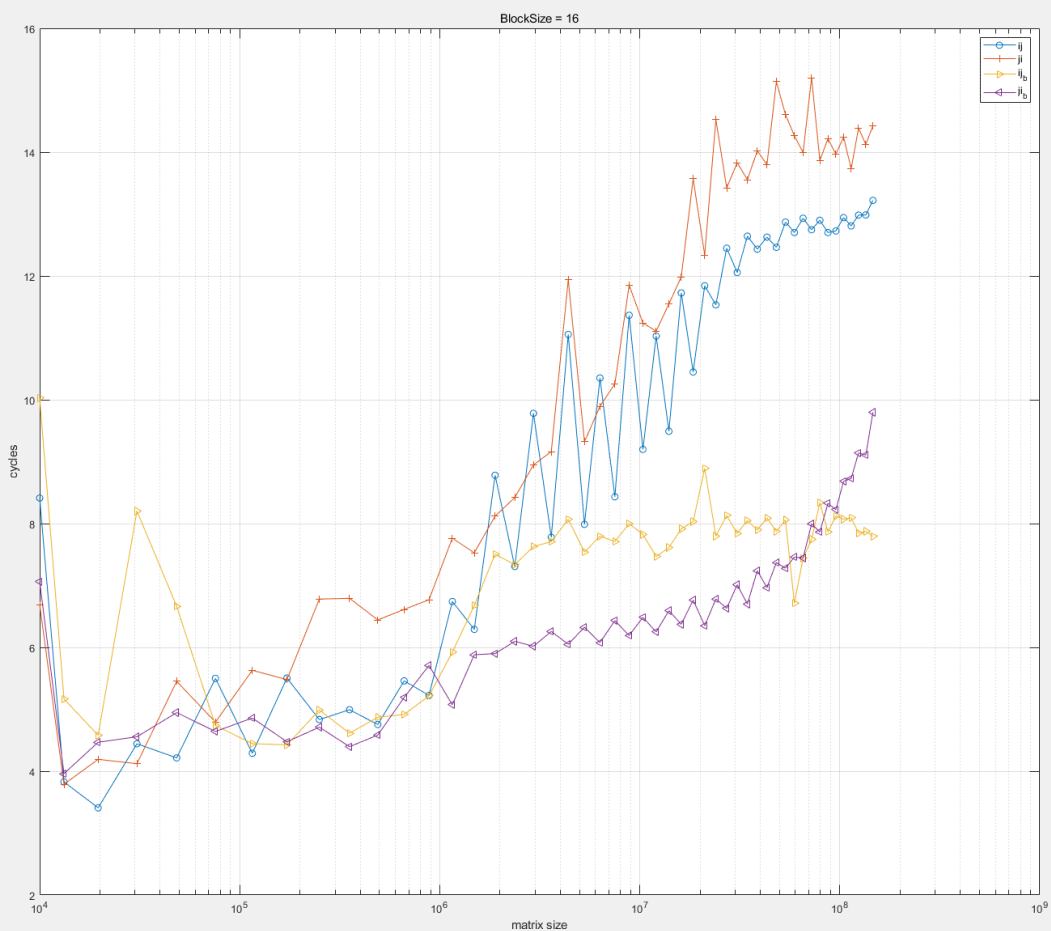
Part 5

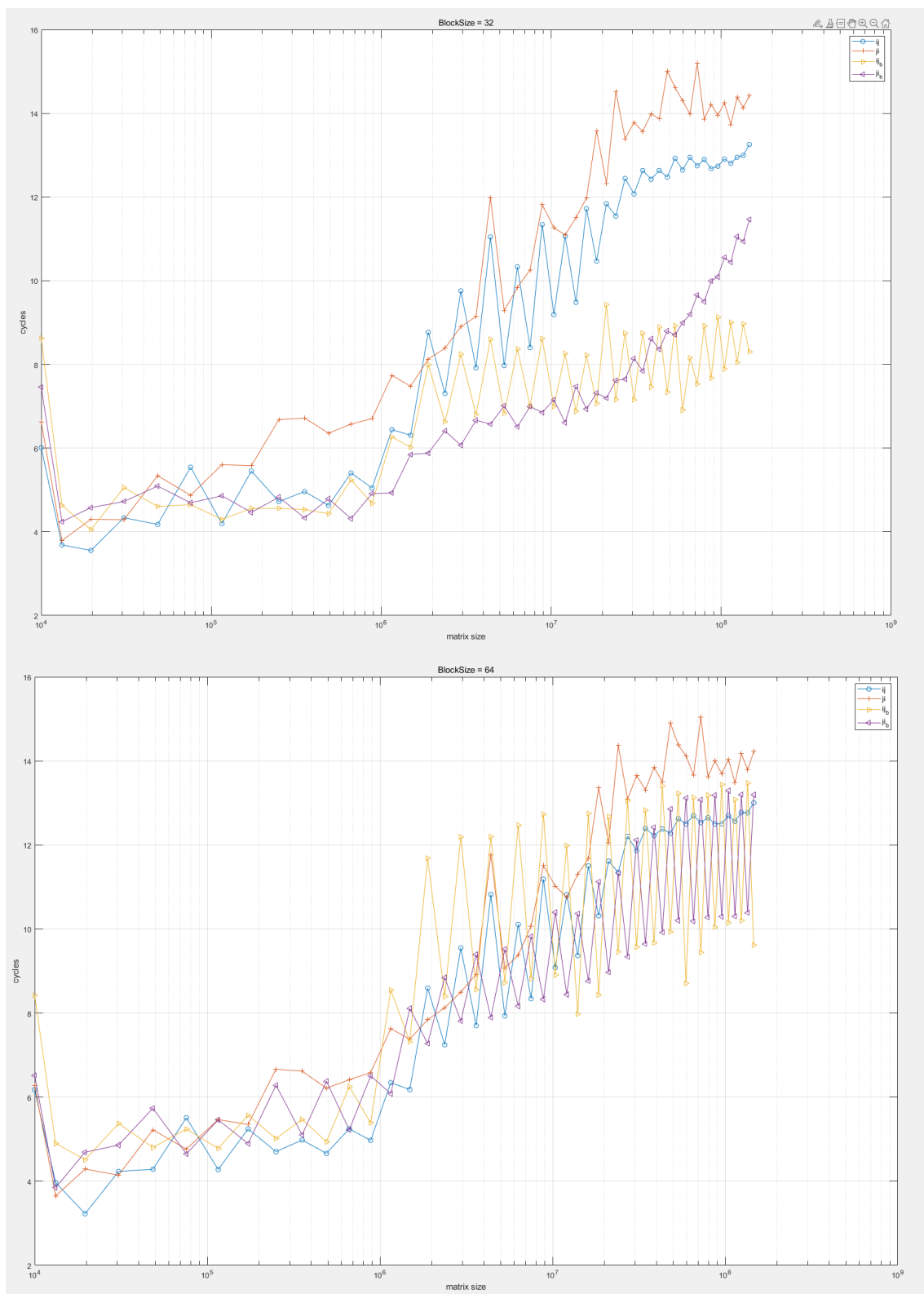
- please see the following pictures.

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a

Please see code.

b

I tested a range over 10000 elements to 1.4×10^8

C

I block the code by adding a for loop outside of the i j loop.

This should make the writing process more efficient. Since if we are reading column major in the original matrix, we have to write row major in the target matrix which is inefficient. If we block the code to prevent it from infinitely adding unaccessible memory to cache, more cache hit can be made even it is reading/writing row-wise. It seems that when block size is 16, it is helping both the ij and ji. However, if the block size is too big, it is not helping at all.

Part 6

How long did it take?

8+ hours

Did any part take an "unreasonable" amount of time for what it is trying to accomplish?

Part 1 question d, because there is no way, as shown on the data, that you can obtain almost the same BW/task when using that amount of memory

Are you missing skills needed to carry out this assignment?

Knowledge about blocking technique needs to be solidified.

Are there problems with the lab?

Instructions not very clear, often cause confusion (what questions need to be done, what only requires some thinking, what needs to be hand in).