#Q1

For a 16 by 16 matrix (change **`#define N 16`**in the code), measure the execution time of rank 0 and rank 1 for 1, 2, 4, 8, 16 processes respectively (the method of measurement is described in the skeleton code). Do it 3 times and report the average execution time. Oversubscribe if you have not enough number of physical cores.

<Results>

Attempt 1

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.000603	X	4.712977
2	0.000127	0.000833	4.712977
4	0.000690	0.000140	4.712977
8 (oversubscribed)	0.001054	0.000801	4.712977
16 (oversubscribed)	0.001260	0.000754	4.712977

Attempt 2

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.000777	X	4.712977
2	0.000567	0.000122	4.712977
4	0.001373	0.000202	4.712977
8 (oversubscribed)	0.001335	0.000584	4.712977
16 (oversubscribed)	0.003596	0.002444	4.712977

Attempt 3

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.000527	X	4.712977
2	0.001122	0.000205	4.712977
4	0.000395	0.001415	4.712977
8 (oversubscribed)	0.001156	0.000615	4.712977
16 (oversubscribed)	0.003049	0.002339	4.712977

Average Elapsed Time for Rank 0

	Elapsed Time for Rank 0				
Number of Processes	**1**	**2**	**4**	**8**	**16**
Attempt 1	0.000603	0.000127	0.00069	0.001054	0.00126
Attempt 2	0.000777	0.000567	0.001373	0.001335	0.003596
Attempt 3	0.000527	0.001122	0.000395	0.001156	0.003049
Average	0.000636	0.000605	0.000819	0.001182	0.002635

Average Elapsed Time for Rank 1

	Elapsed Time for Rank 1				
Number of Processes	**1**	**2**	**4**	**8**	**16**
Attempt 1		0.000833	0.00014	0.000801	0.000754
Attempt 2		0.000122	0.000202	0.000584	0.002444
Attempt 3		0.000205	0.001415	0.000615	0.002339
Average		0.000387	0.000586	0.000667	0.001846

#Q2

For a 1024 by 1024 matrix (change **`#define N 1024`** in the code), measure the execution time of rank 0 and rank 1 for 1, 2, 4, 8, 16 processes respectively. Do it 3 times and report the average execution time. Oversubscribe if you have not enough number of physical cores.

<Results>

Attempt 1

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.005644		268.994916
2	0.004973	0.004586	268.994916
4	0.004530	0.003751	268.994916
8 (oversubscribed)	0.006475	0.007123	268.994916
16 (oversubscribed)	0.006464	0.005452	268.994916

Attempt 2

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.005426		268.994916
2	0.006373	0.005628	268.994916
4	0.004085	0.005017	268.994916
8 (oversubscribed)	0.006692	0.008297	268.994916
16 (oversubscribed)	0.005989	0.007147	268.994916

Attempt 3

Number of Processes	Elapsed time for rank 0	Elapsed time for rank 1	Max
1	0.006542		268.994916
2	0.007112	0.006675	268.994916
4	0.004494	0.005083	268.994916
8 (oversubscribed)	0.006677	0.008156	268.994916
16 (oversubscribed)	0.006256	0.00514	268.994916

Average Elapsed Time for Rank 0

	Elapsed Time for Rank 0				
Number of Processes	1	2	4	8	16
Attempt 1	0.005644	0.004973	0.004530	0.006475	0.006464
Attempt 2	0.005426	0.006373	0.004085	0.006692	0.005989
Attempt 3	0.006542	0.007112	0.004494	0.006677	0.006256
Average	0.005871	0.006153	0.004370	0.006615	0.006236

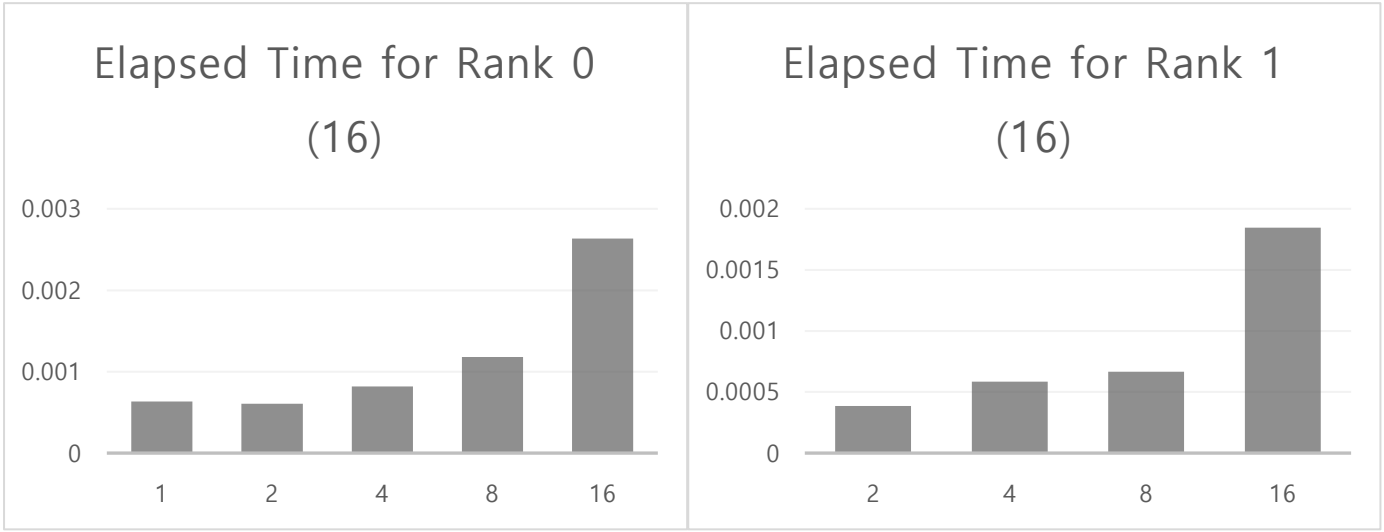
Average Elapsed Time for Rank 1

	Elapsed Time for Rank 1				
Number of Processes	1	2	4	8	16
Attempt 1		0.004586	0.003751	0.007123	0.005452
Attempt 2		0.005628	0.005017	0.008297	0.007147
Attempt 3		0.006675	0.005083	0.008156	0.005140
Average		0.005630	0.004617	0.007859	0.005913

#Q3

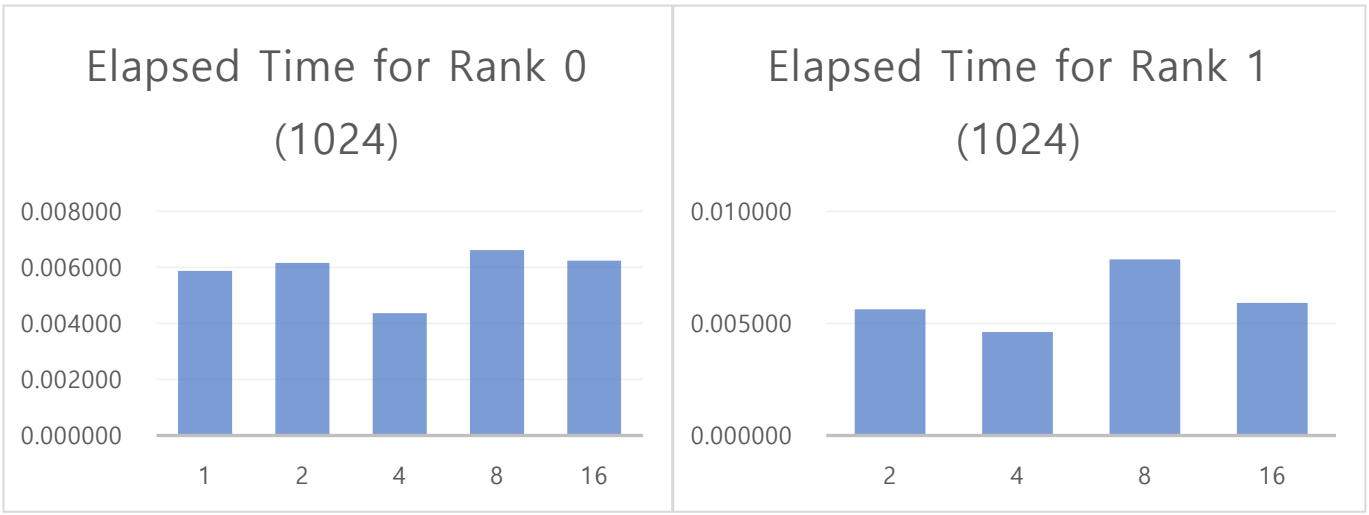
Analyze the execution time results.

- 16.txt 의 실행 결과, 그래프와 같이 rank 0과 rank 1일 때 모두 전반적으로 프로세스의 개수가 증가할수록, elapsed time이 증가한다.



- 1024.txt의 실행 결과, 프로세스가 늘어날수록 rank 0일 때, elapsed time은 증가하다가, 프로세스의 개수가 4개일 때, elapsed time이 감소한다. 프로세스가 8개일때부터는 elapsed time이 다시 감소한다.

- Rank 1일 때, elapsed time은 프로세스가 4개일 때까지 감소하다가, 8부터 다시 증가한 후, 또다시 감소하는 경향을 보인다.



결과적으로, 다뤄야할 데이터의 개수가 적을 때는 프로세스가 증가할 때 elapsed time도 같이 증가하지만, 다뤄야할 데이터의 개수가 많아질수록 elapsed time이 똑같이 증가하는 것이 아님을 알 수 있다. 가장 짧은 시간이 걸리는 프로세스의 개수가 달라지므로, 프로세스의 개수와 elapsed time은 비례관계가 아니다.