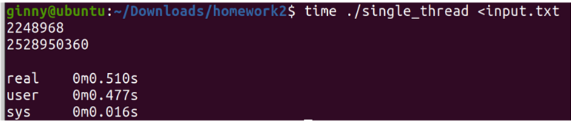
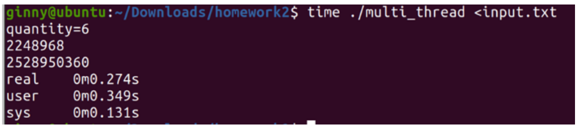
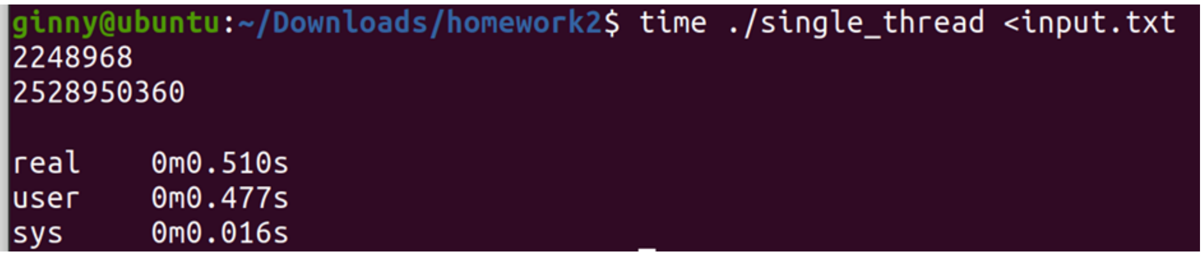
2022 NYCU OS HW2 report

Question	Answer
Q1. (5pts) Briefly describe your design for the add, multiple function of matrix, the thread management. Also, describe the number of threads in the Multi-thread program.	Add: Instead of calculating matC, just simply add each item of matA and matB to sum array in each thread computation. Summing up the sum array gets the result of matA+matB. Multiply: Compute matD within each thread operation. Equally distribute the row of matA to each thread, each of the threads contain subsize=MAX/quantity row of matA. Then calculate each item matD[i][j] by multiplying matA[i][0->499] and matB[0→499][j]. Store each value of matD[i][j] to sumD, by summing up sumD we can get the sum of matD which is multiplied by matA and matB. Since MAX is not divisible by every quantity from 2 to 20, store the remaining rows of matA to the last calculated thread. Thread management: Create and join threads for Add and Multiply function respectively. The number of threads equals the global variable quantity, so that it each much more easier to modify.
Q2. (15pts) Try at least 3 kinds of number of threads, and compare the difference in time.(Take screenshots of the time of each case) Also, explain the results.	The screenshots of thread quantity from 2 to 20 are listed below following the order of the quantities. We can see that the best case is when quantity=6 and has runtime 0m0.274s, speeduprate~=1.86. Where on the other hand, the worst case is when quantity= 16 and has runtime 0m0.354s, speedup rate~=1.44. Most of the runtime is within the range 0m0.300s+-0m0.015s. However, once the quantity gets pass 15, the runtime will exceed 0m0.315s and grows greater. This indicates that the more threads used does not always have better performance than less threads used, it has a limitation of speedup rate.

	Also, looking into quantity=3&4, it shows that if the number of threads is not big enough, though it is faster than single thread, it still has space for improvement. Thus, the quantity we choose must be big enough but not too big that causes burden on the processor.
Q3. (10pts) Show the best speedup between multi-thread and single-thread. (Take screenshots of the time of single-thread and multi-thread) Also, explain why multi-thread is faster.	Result of single-thread:  ginny@ubuntu:~/Downloads/homework2$ time ./single_thread <input.txt 2248968 2528950360 real 0m0.510s user 0m0.477s sys 0m0.016s Result of multi-thread:  ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt quantity=6 2248968 2528950360 real 0m0.274s user 0m0.349s sys 0m0.131s The best speedup=0.510/0.274~=1.86. Multi thread allows the whole process be separate into several smaller threads and run on different processor parallelly. Compare to single thread can only run one step at a time, while multi thread can run more steps(the quantity of the threads) at within the same time. Which makes multi thread much faster than single thread.

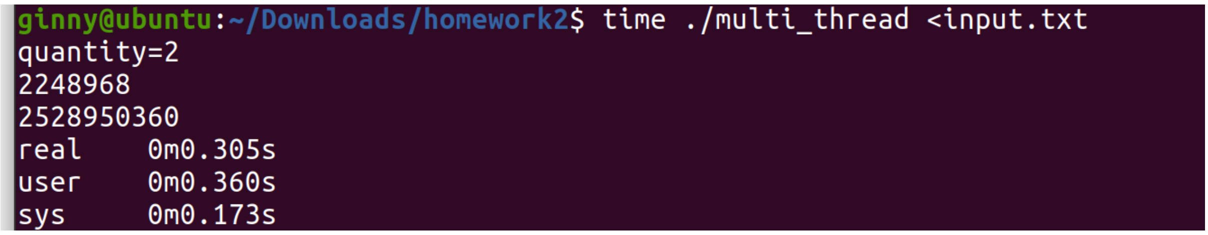
Result of single-thread:



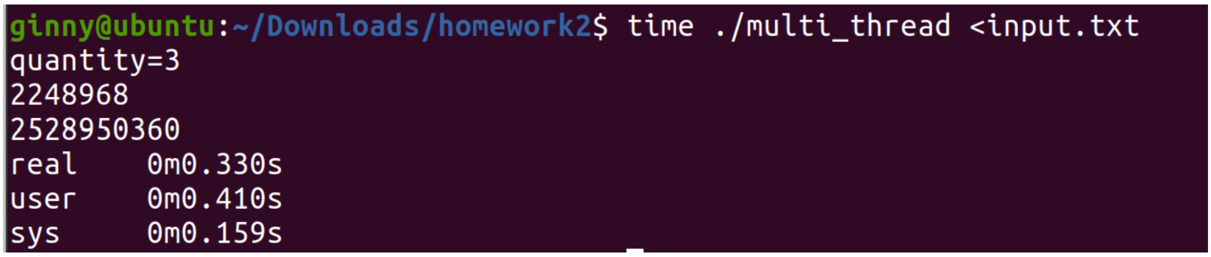
```
ginny@ubuntu:~/Downloads/homework2$ time ./single_thread <input.txt
2248968
2528950360

real    0m0.510s
user    0m0.477s
sys     0m0.016s
```

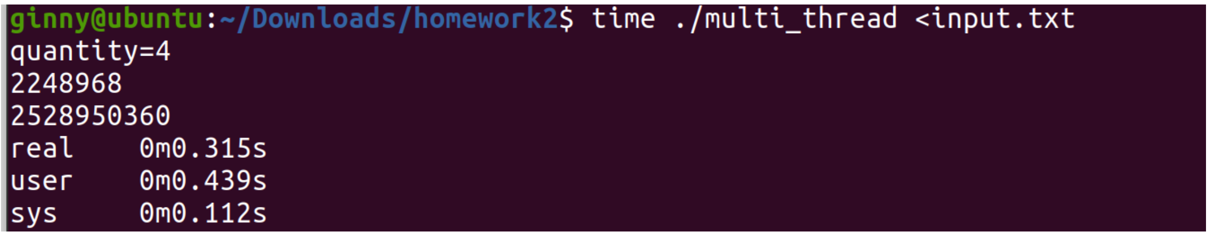
Result of multi-thread with different quantities:



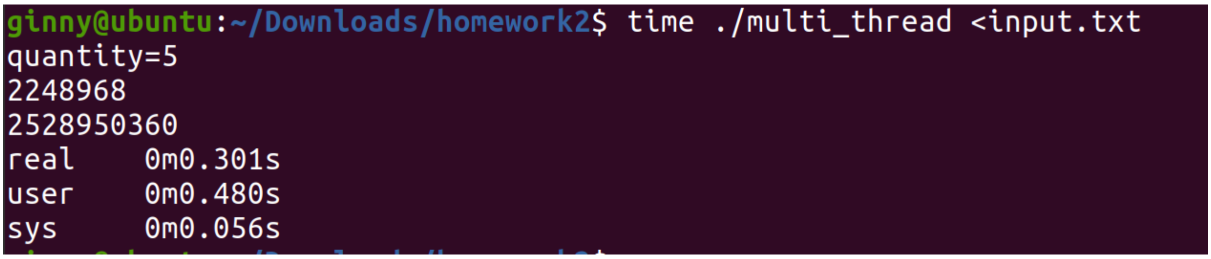
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=2
2248968
2528950360
real	0m0.305s
user	0m0.360s
sys	0m0.173s
```



```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=3
2248968
2528950360
real	0m0.330s
user	0m0.410s
sys	0m0.159s
```

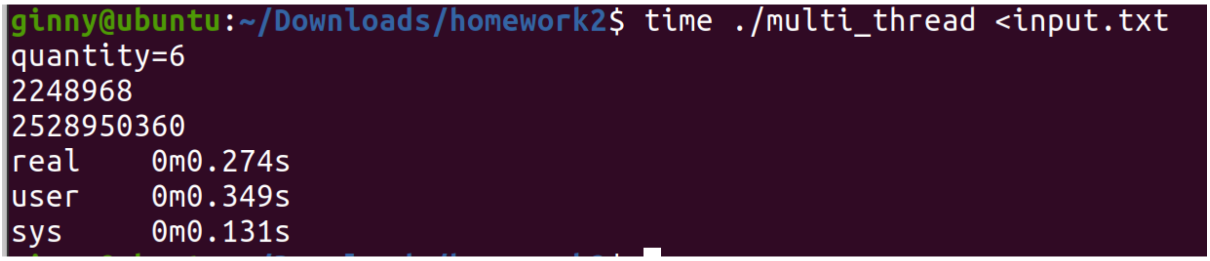


```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=4
2248968
2528950360
real	0m0.315s
user	0m0.439s
sys	0m0.112s
```

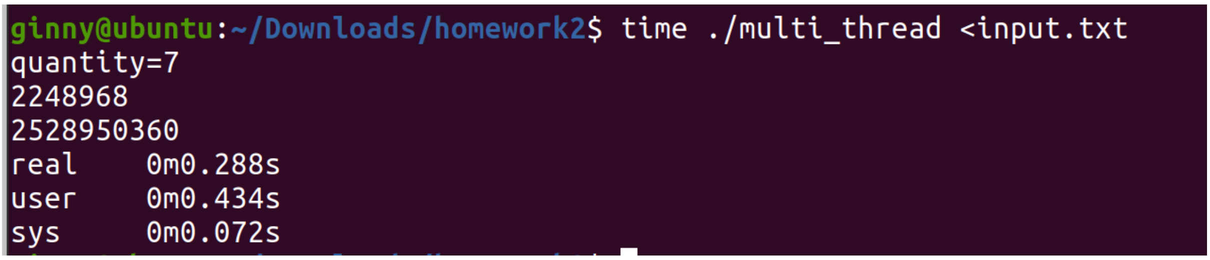


```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=5
2248968
2528950360
real	0m0.301s
user	0m0.480s
sys	0m0.056s
```

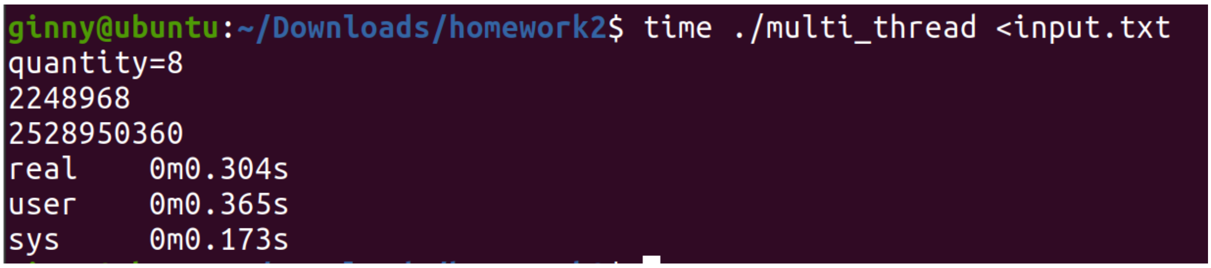
Best case:



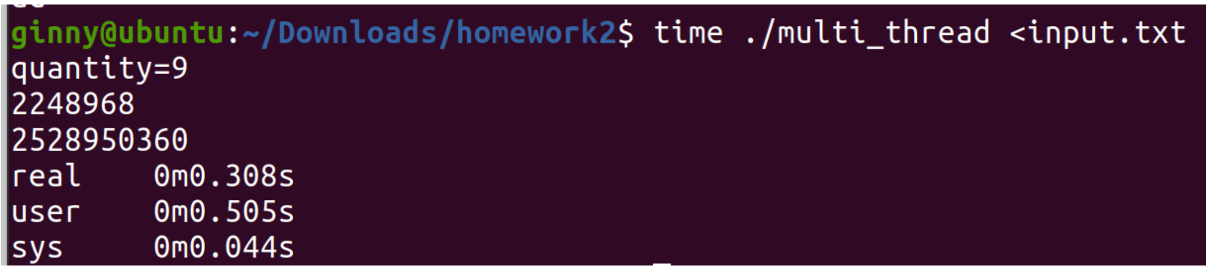
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=6
2248968
2528950360
real	0m0.274s
user	0m0.349s
sys	0m0.131s
```



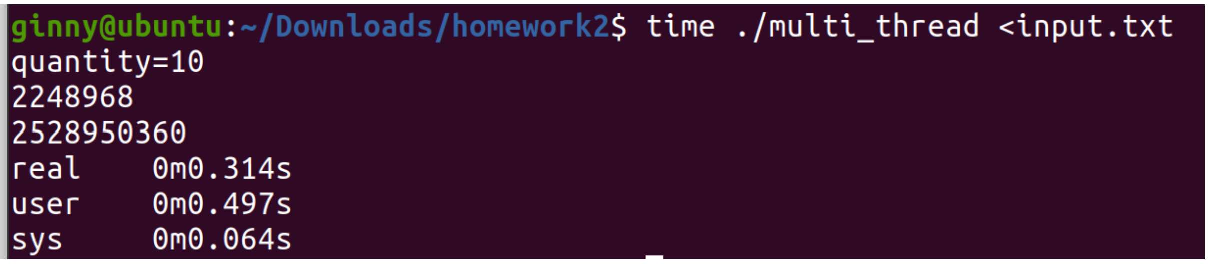
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=7
2248968
2528950360
real	0m0.288s
user	0m0.434s
sys	0m0.072s
```



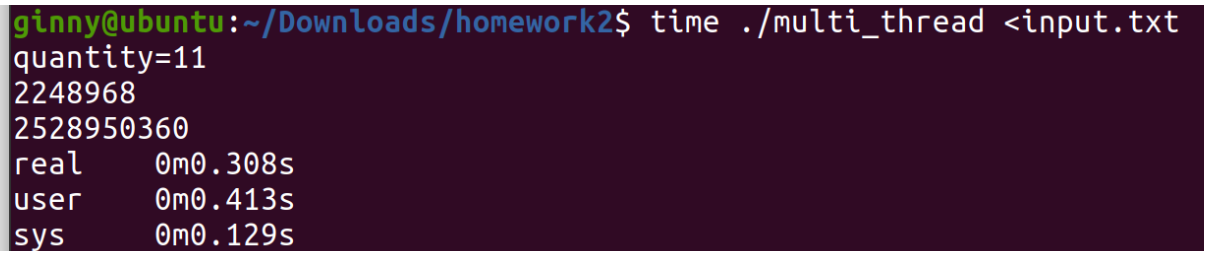
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=8
2248968
2528950360
real	0m0.304s
user	0m0.365s
sys	0m0.173s
```



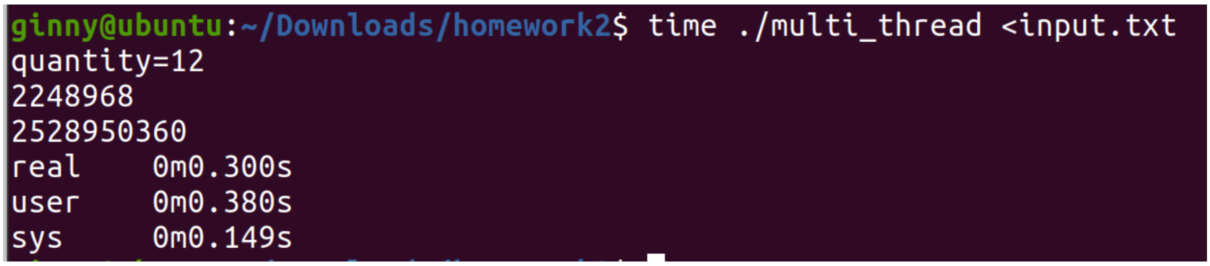
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=9
2248968
2528950360
real	0m0.308s
user	0m0.505s
sys	0m0.044s
```



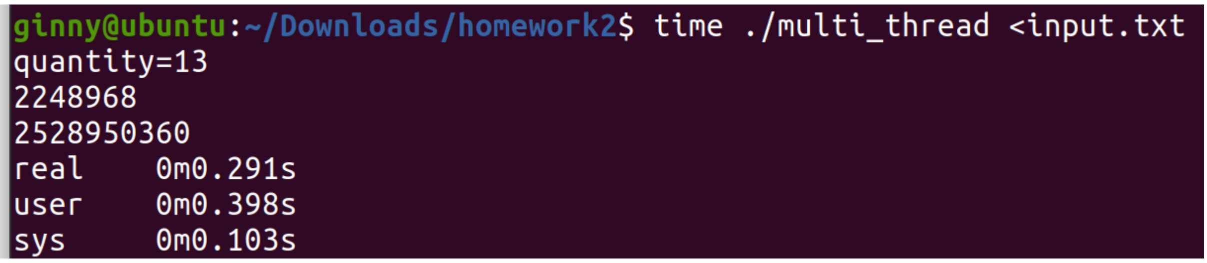
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=10
2248968
2528950360
real	0m0.314s
user	0m0.497s
sys	0m0.064s
```



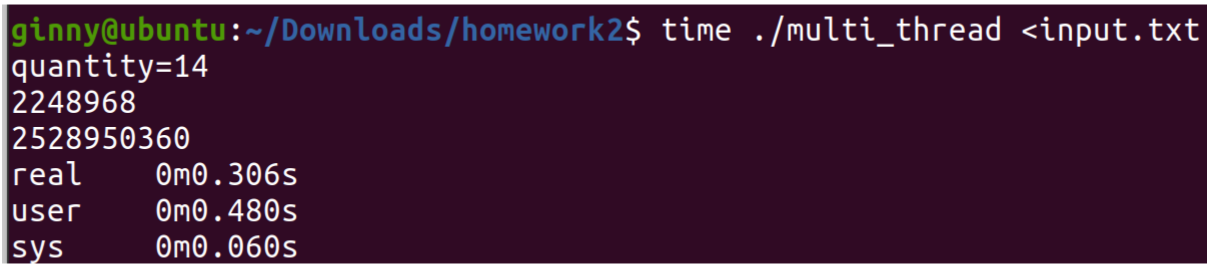
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=11
2248968
2528950360
real	0m0.308s
user	0m0.413s
sys	0m0.129s
```



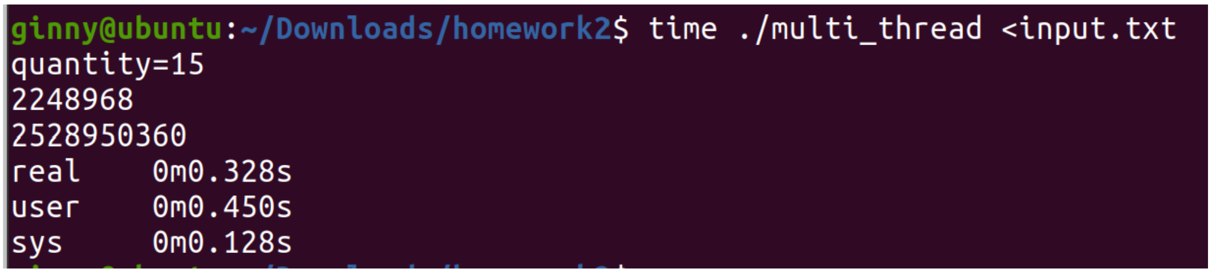
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=12
2248968
2528950360
real	0m0.300s
user	0m0.380s
sys	0m0.149s
```



```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=13
2248968
2528950360
real	0m0.291s
user	0m0.398s
sys	0m0.103s
```

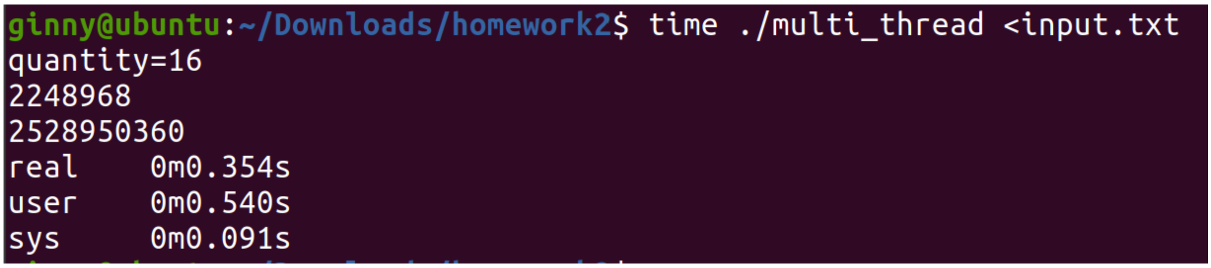


```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=14
2248968
2528950360
real	0m0.306s
user	0m0.480s
sys	0m0.060s
```

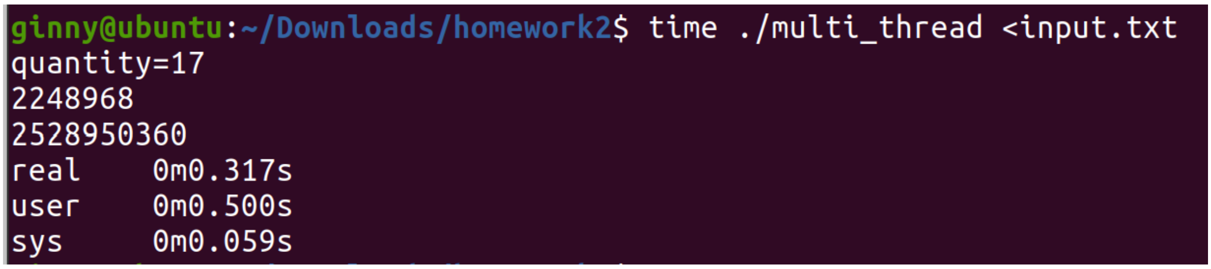


```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=15
2248968
2528950360
real	0m0.328s
user	0m0.450s
sys	0m0.128s
```

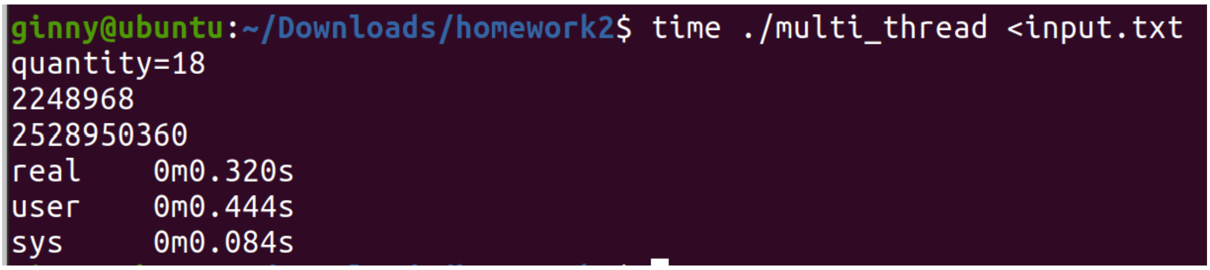
Worst case:



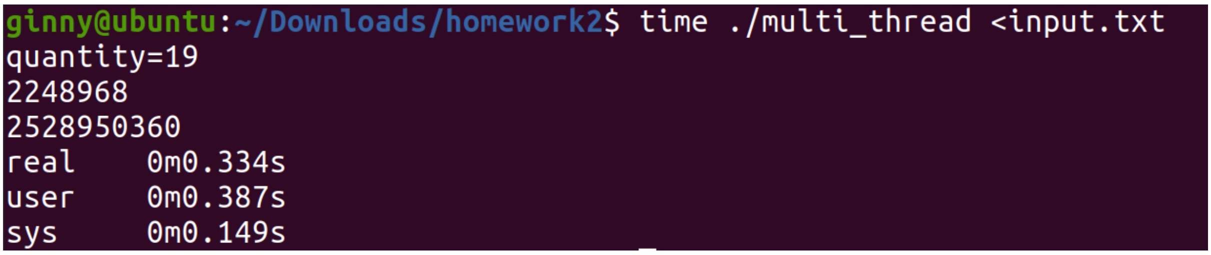
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=16
2248968
2528950360
real	0m0.354s
user	0m0.540s
sys	0m0.091s
```



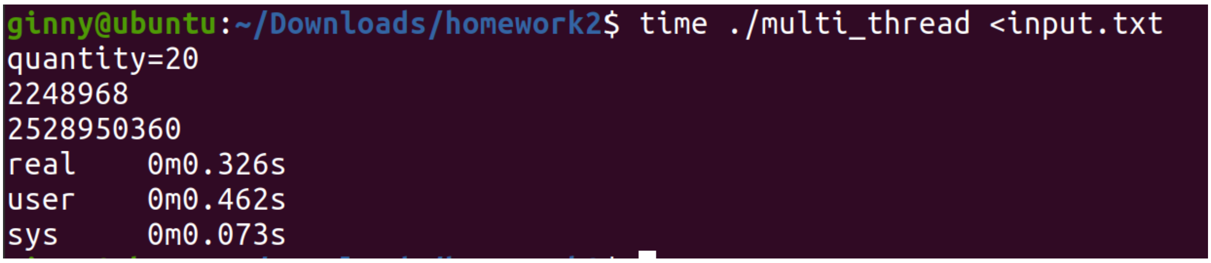
```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=17
2248968
2528950360
real	0m0.317s
user	0m0.500s
sys	0m0.059s
```



```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=18
2248968
2528950360
real	0m0.320s
user	0m0.444s
sys	0m0.084s
```



```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=19
2248968
2528950360
real	0m0.334s
user	0m0.387s
sys	0m0.149s
```



```
ginny@ubuntu:~/Downloads/homework2$ time ./multi_thread <input.txt
quantity=20
2248968
2528950360
real	0m0.326s
user	0m0.462s
sys	0m0.073s
```