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# OPERATING SYSTEMS PROJECT 2

I did this project without a partner. For the beginning of the project, I started with implementing a thread-safe heap structure as in the project document. I created the hash structure with implementing a bucket struct which has a pthread_mutex_t and a Node pointer. The Node struct has an integer key, a value as a void pointer, and a next struct pointer. Then I implemented the skeleton code. I added an extra function **void hash_print(HashTable *hp)** to create an output file for integer-count.c. The name of the output file is “output.txt”.

For implementation of the test.c, I made experiments around different number of threads ( T ), number of keys / operations ( W ), number of locks ( K ), and table size ( N ). Number of threads start from 1 to 1000, number of keys / operations stars from 1 to 10000, number of locks is stars from min 10 to 100, and table size start from 100 to 1000. In the experiment I found out all the combination of these parameters. The results of the experiment and graphs are given in the following. Moreover I saw that while the number of threads are increasing, the number of keys increase the performance of the hash table. The output of the test.c proves the performance increase in above.
Some examples like:

| | | | | |
|---|---|---|---|---|
| 16- Total time of T=1000, | W=10000, | K=10, | N=100 | 120.993248 seconds |
| 32- Total time of T=1000, | W=10000, | K=100, | N=1000 | 19.810075 seconds |
| And | | | | |
| 8- Total time of T=10, | W=10000, | K=10, | N=100 | 1.115695 seconds |
| 24- Total time of T=10, | W=10000, | K=100, | N=1000 | 0.221776 seconds |

The integer-count.c will run like

*./integer-count 3 input1.txt input2.txt input3.txt output.txt*

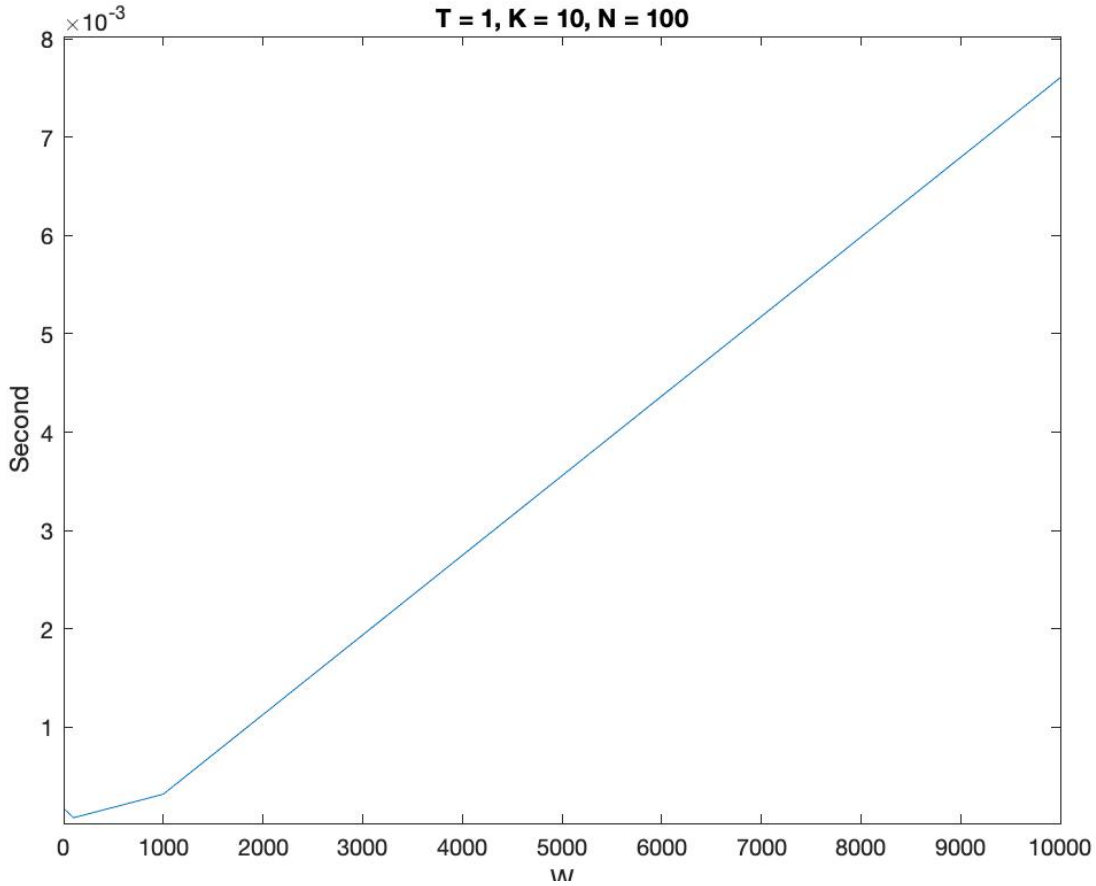
The test.c will run like

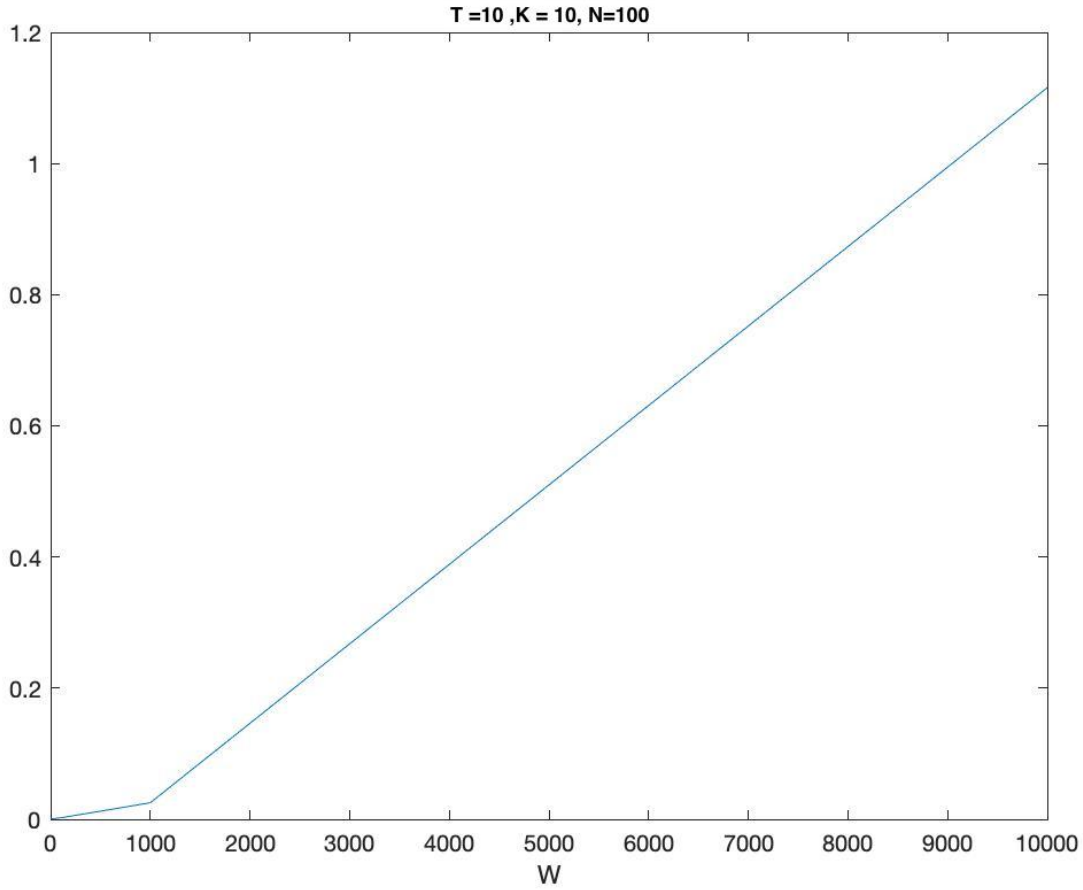
*./test*

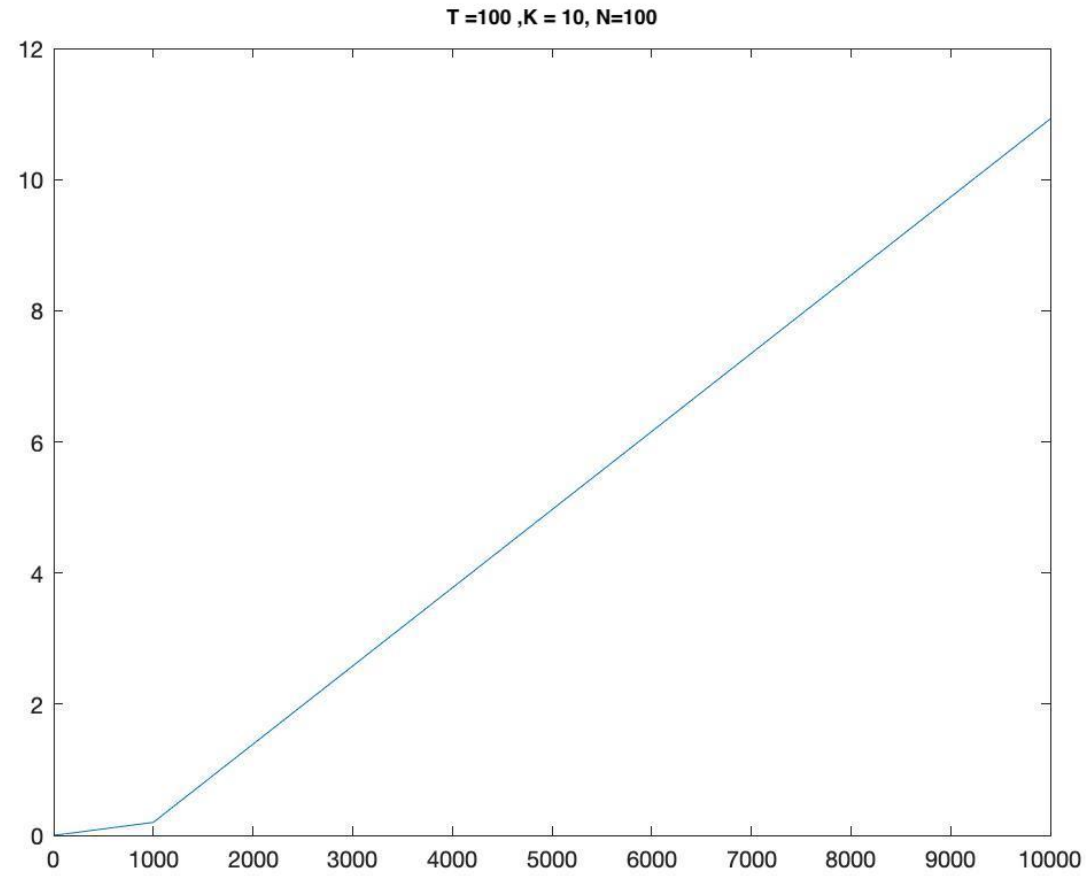
- **Outputs of test.c**

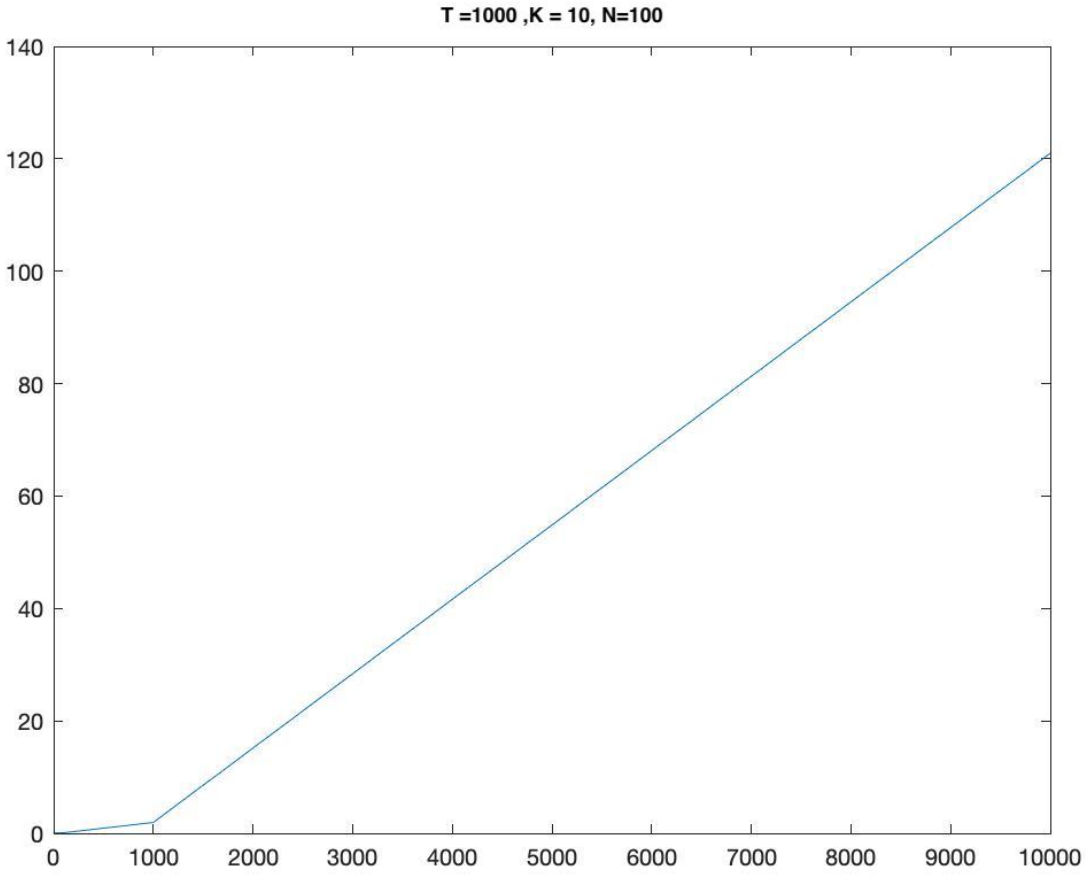
| | | | | | |
|---|---|---|---|---|---|
| 1- | Total time of T=1, | W=10, | K=10, | N=100 | 0.000165 seconds |
| 2- | Total time of T=1, | W=100, | K=10, | N=100 | 0.000080 seconds |
| 3- | Total time of T=1, | W=1000, | K=10, | N=100 | 0.000319 seconds |
| 4- | Total time of T=1, | W=10000, | K=10, | N=100 | 0.007603 seconds |
| 5- | Total time of T=10, | W=10, | K=10, | N=100 | 0.000729 seconds |
| 6- | Total time of T=10, | W=100, | K=10, | N=100 | 0.002181 seconds |
| 7- | Total time of T=10, | W=1000, | K=10, | N=100 | 0.025242 seconds |
| 8- | Total time of T=10, | W=10000, | K=10, | N=100 | 1.115695 seconds |
| 9- | Total time of T=100, | W=10, | K=10, | N=100 | 0.003659 seconds |
| 10- | Total time of T=100, | W=100, | K=10, | N=100 | 0.017538 seconds |
| 11- | Total time of T=100, | W=1000, | K=10, | N=100 | 0.197533 seconds |
| 12- | Total time of T=100, | W=10000, | K=10, | N=100 | 10.924585 seconds |
| 13- | Total time of T=1000, | W=10, | K=10, | N=100 | 0.056776 seconds |
| 14- | Total time of T=1000, | W=100, | K=10, | N=100 | 0.095833 seconds |
| 15- | Total time of T=1000, | W=1000, | K=10, | N=100 | 1.930807 seconds |
| 16- | Total time of T=1000, | W=10000, | K=10, | N=100 | 120.993248 seconds |
| 17- | Total time of T=1, | W=10, | K=100, | N=1000 | 0.000206 seconds |
| 18- | Total time of T=1, | W=100, | K=100, | N=1000 | 0.000162 seconds |
| 19- | Total time of T=1, | W=1000, | K=100, | N=1000 | 0.000503 seconds |
| 20- | Total time of T=1, | W=10000, | K=100, | N=1000 | 0.002000 seconds |
| 21- | Total time of T=10, | W=10, | K=100, | N=1000 | 0.000741 seconds |
| 22- | Total time of T=10, | W=100, | K=100, | N=1000 | 0.001131 seconds |
| 23- | Total time of T=10, | W=1000, | K=100, | N=1000 | 0.015998 seconds |
| 24- | Total time of T=10, | W=10000, | K=100, | N=1000 | 0.221776 seconds |
| 25- | Total time of T=100, | W=10, | K=100, | N=1000 | 0.003391 seconds |
| 26- | Total time of T=100, | W=100, | K=100, | N=1000 | 0.018419 seconds |
| 27- | Total time of T=100, | W=1000, | K=100, | N=1000 | 0.135352 seconds |
| 28- | Total time of T=100, | W=10000, | K=100, | N=1000 | 1.737109 seconds |
| 29- | Total time of T=1000, | W=10, | K=100, | N=1000 | 0.057939 seconds |
| 30- | Total time of T=1000, | W=100, | K=100, | N=1000 | 0.067882 seconds |
| 31- | Total time of T=1000, | W=1000, | K=100, | N=1000 | 1.256750 seconds |
| 32- | Total time of T=1000, | W=10000, | K=100, | N=1000 | 19.810075 seconds |

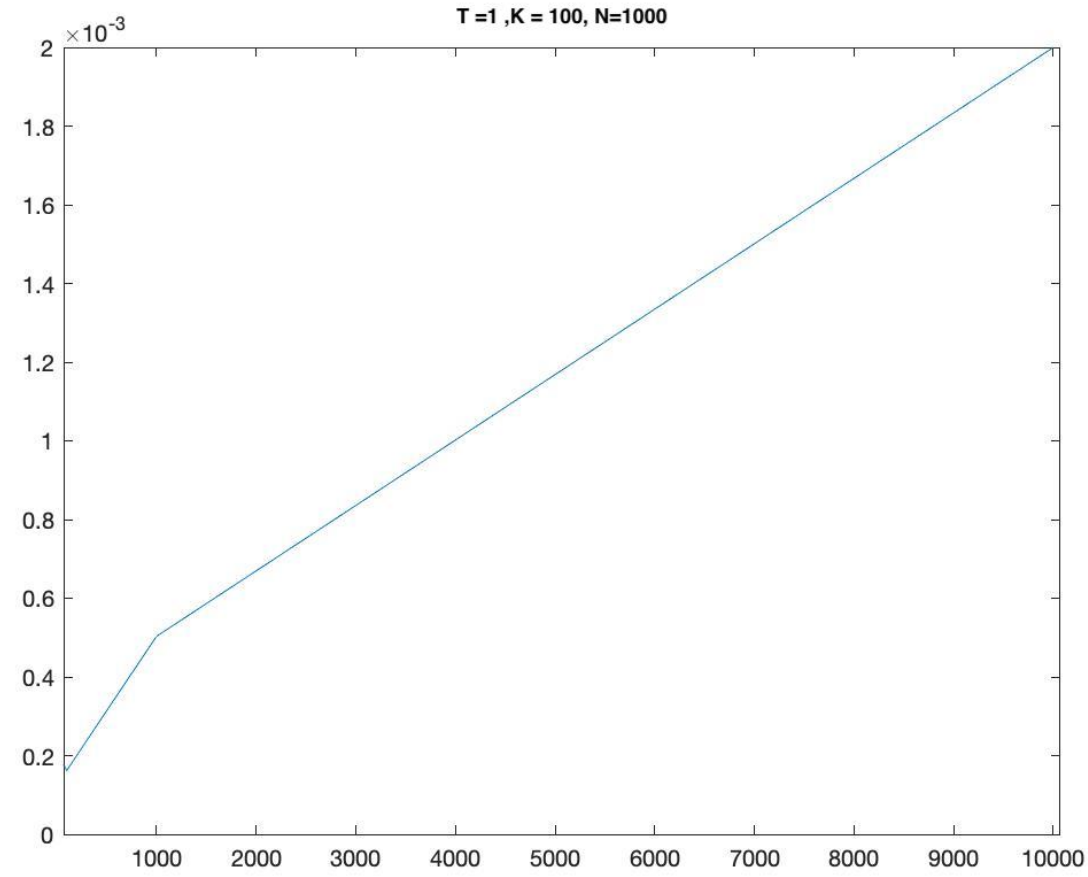
- **Graphs of the test.c is created with respect to T, K N, and W**

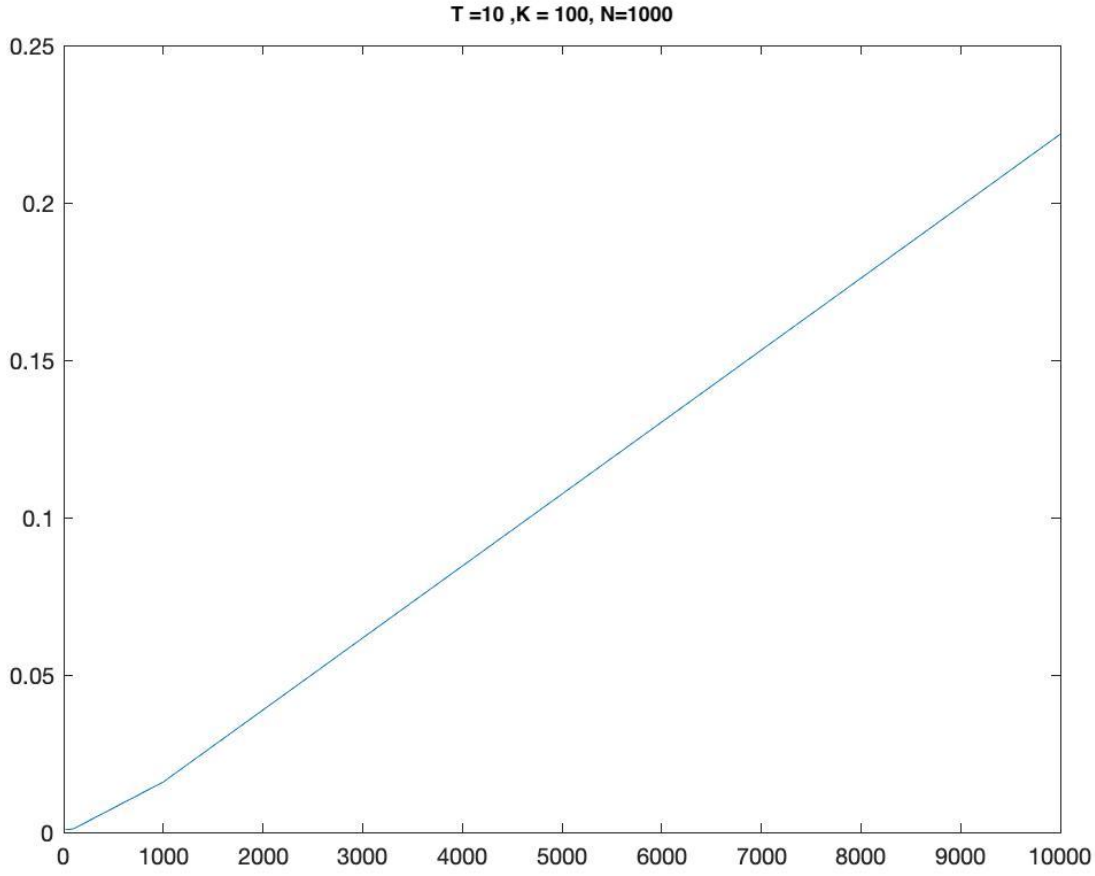


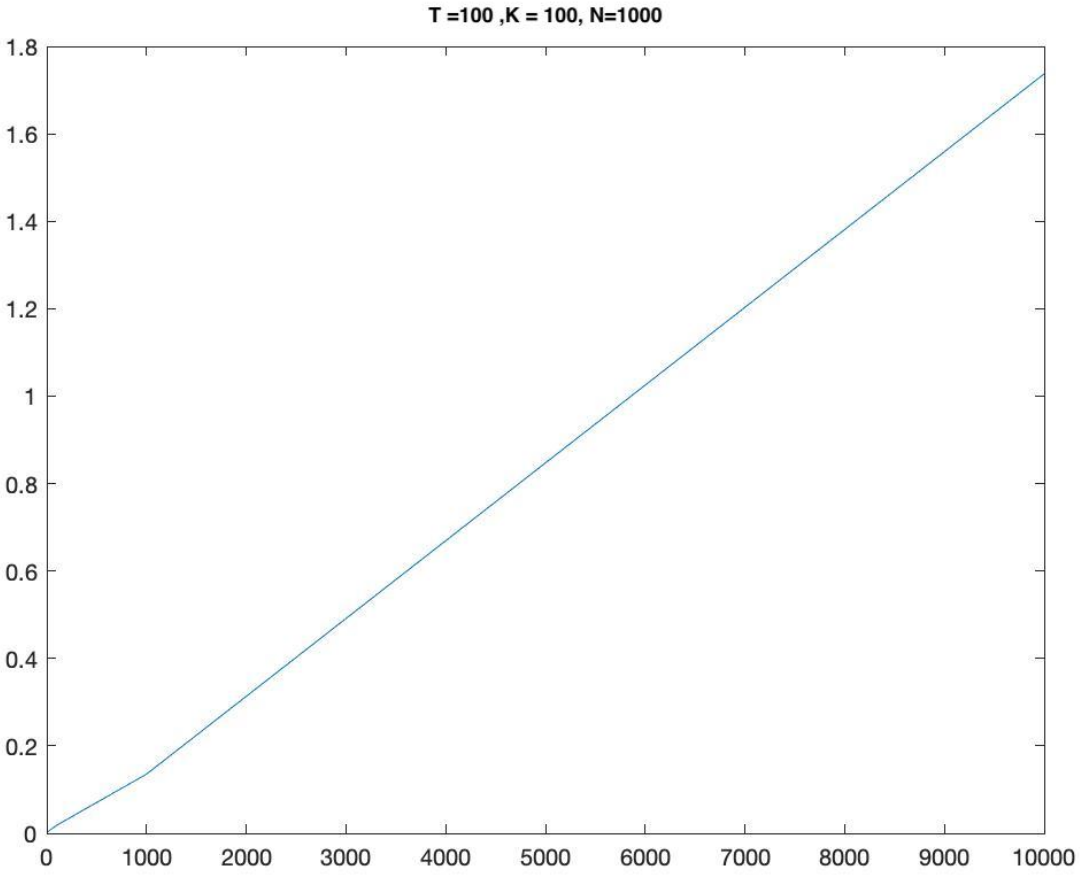



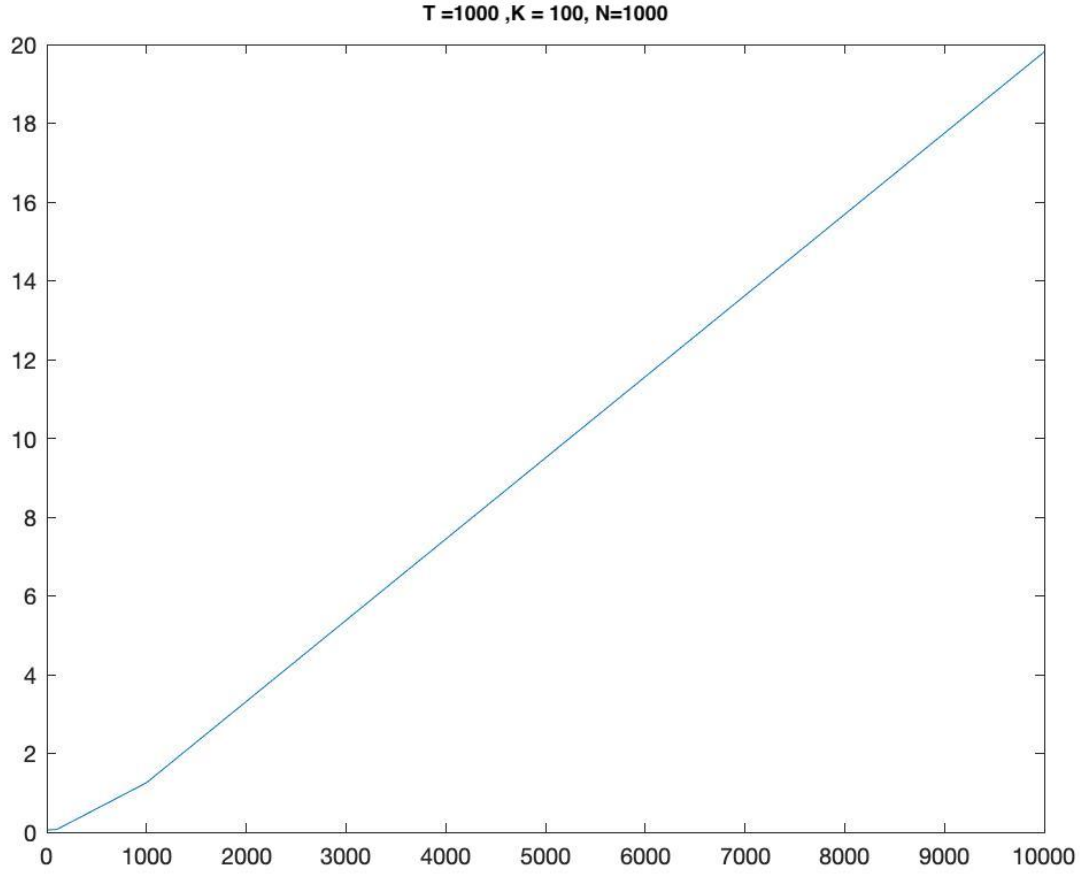

T =100 ,K = 10, N=100
12
10
8
6
4
2
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


T =1000 ,K = 10, N=100
140
120
100
80
60
40
20
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


T =1 ,K = 100, N=1000
×10^-3
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


T =10 ,K = 100, N=1000
0.25
0.2
0.15
0.1
0.05
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


T =100 ,K = 100, N=1000
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


T =1000 ,K = 100, N=1000
20
18
16
14
12
10
8
6
4
2
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000