BILKENT UNIVERSITY

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

CS342
Operating Systems

Project 2
INTEGER COUNTING WITH A THREAD SAFE HASH-TABLE

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Results of the Experiments

Effect of K on Execution Time for various T values

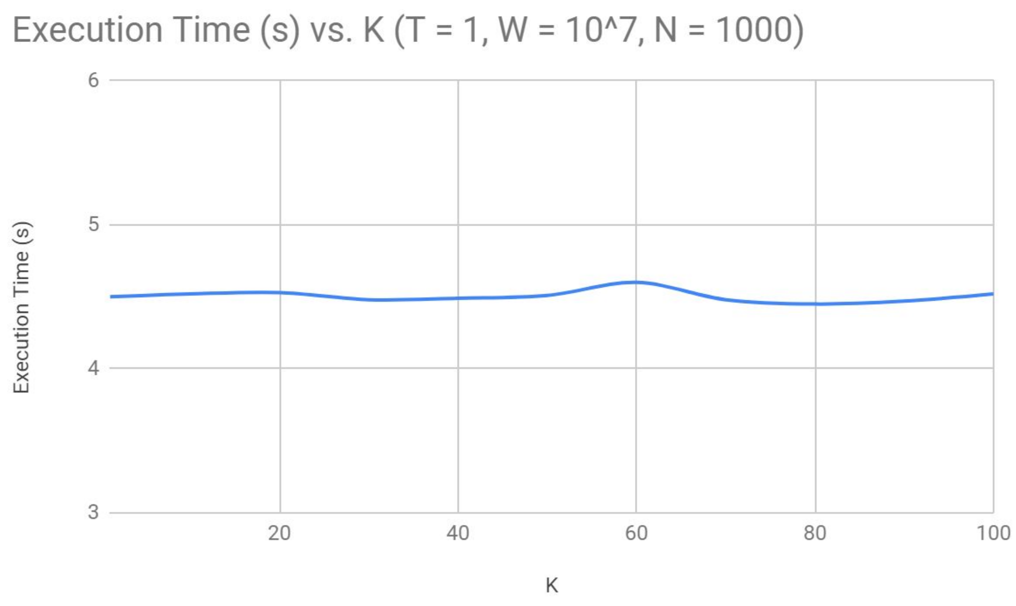

Figure 1 - Execution Time vs K (T=1)

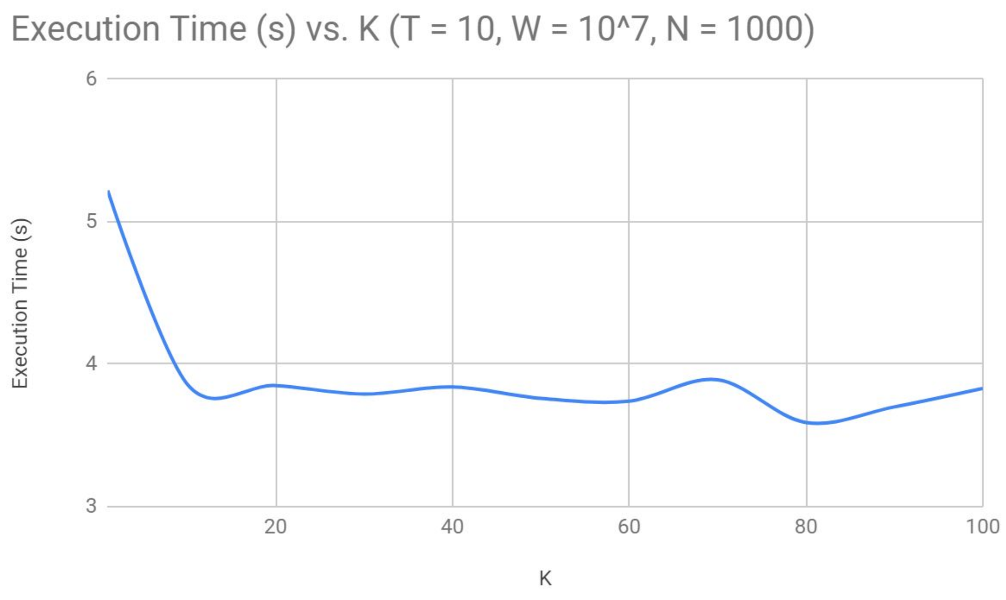

Figure 2 - Execution Time vs K (T=10)

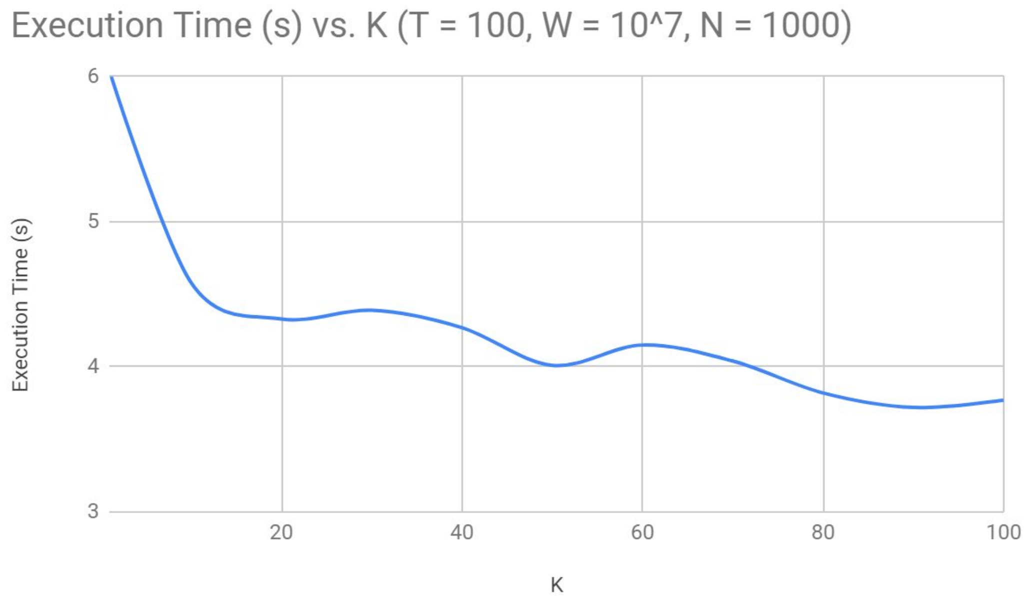

Figure 3 - Execution Time vs K (T=100)

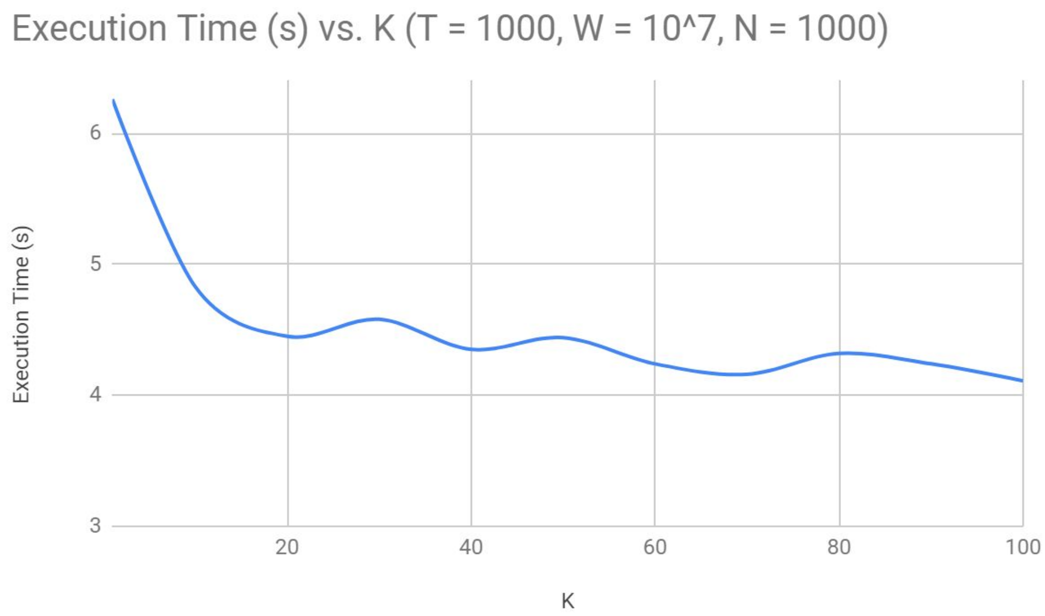

Figure 4 - Execution Time vs K (T=1000)

Effect of N on Execution Time

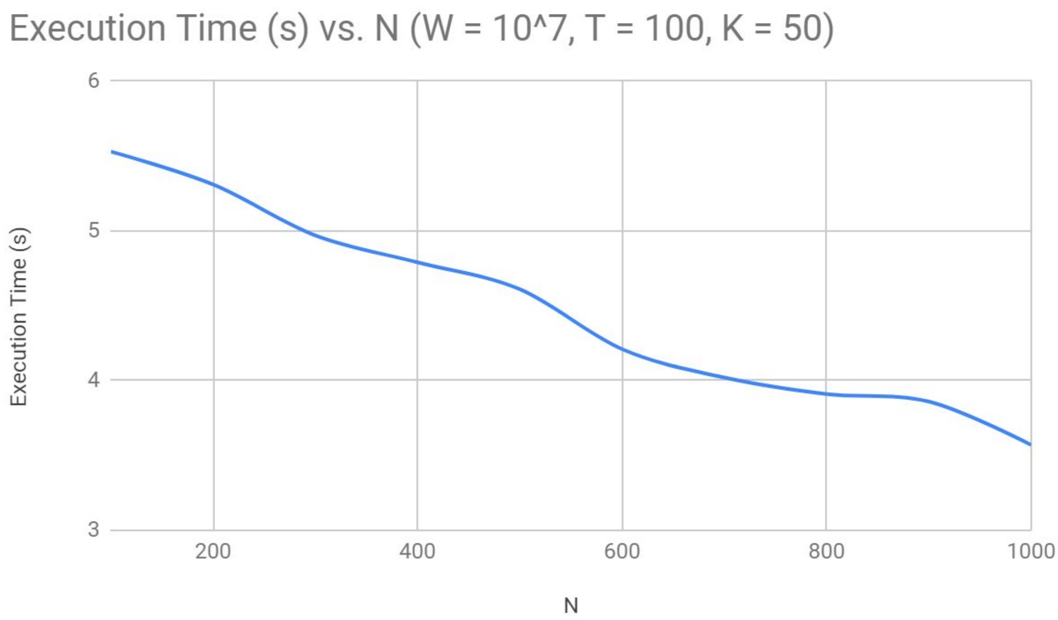

Figure 5 - Execution Time vs N

Effect of W on Execution Time

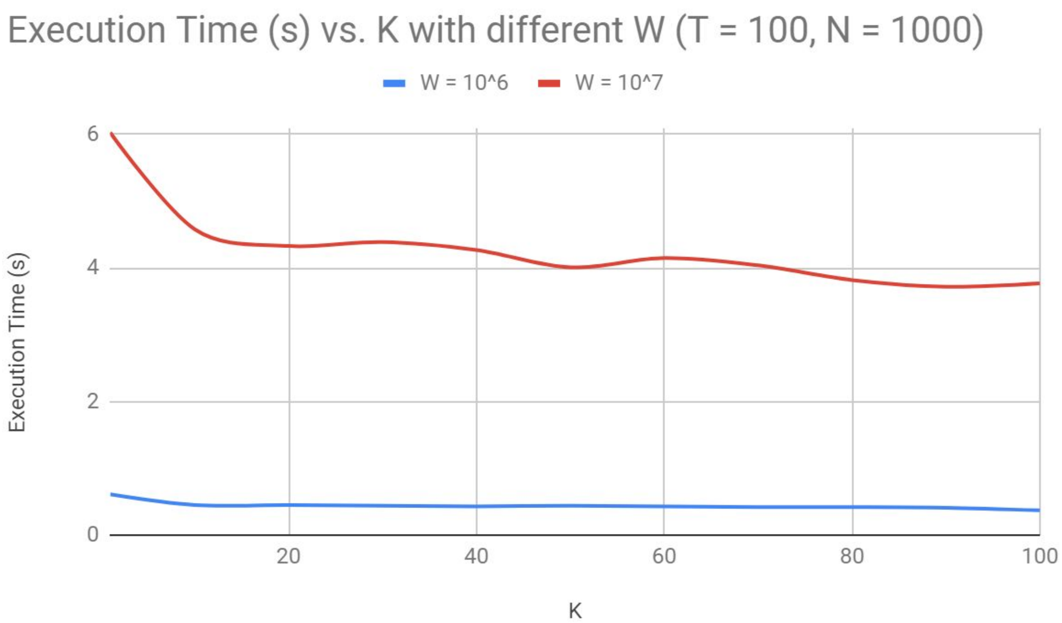

Figure 6 - Execution Time vs K with different W

Interpretation and Conclusion

As we were questioning the effect of different values for W, N, K, and T on the execution time which is respectively, the number of operations, buckets, locks, and threads, we have made a significant number of experiments. In our experiments we changed the value of K from 1 to 100, T from 1 to 100, W from 10^6 to 10^7 and N from 100 to 1000 and recorded the execution time for each case.

For the effect of K (number of locks) on the execution time, we have observed that when the value of K increases from 1 to 10 there is a rapid decrease in execution time. However, for the other values greater than 10, the rate of decrease is slower. Therefore, we concluded that as the number K increases, the execution time decreases. The most significant reason for this is that the contention is decreasing when we increase the number of locks. For example, an execution with 1 lock will make only allow a single thread to execute at a time no matter what the key value is so that other threads won't be able to acquire the lock. And because they can not acquire the lock, they will stay in a loop, which causes busy waiting and longer execution time. However, if the K value is larger, there is a greater chance that multiple threads will operate at the same time (obviously depending on the key values) as different locks will be protecting different regions. As a result, the execution time will be lower because of low contention. (Figure 1 to 4)

For the effect of N on execution time, we have found out that as long as N increases the execution time decreases. In our Execution Time vs N graph, it can be seen that as the number N goes from 100 to 1000 the execution time goes from 5.5s to 3.5s. The main reason for this is that as long as there are more buckets in the hash table, the hash table will be able to perform its operations in less time. For example let's say that there is only 1 bucket in the hash table, then every time we call a hash function we need to iterate a significant amount of nodes to perform our operation successfully and also there is a high possibility that multiple key values will be put to the same bucket which will cause high contention. However, if the number of buckets is high we are able to make a more precise distribution of key values which will result in having fewer values per bucket and therefore less contention and shorter execution time. (Figure 5)

Most importantly, for the effect of thread count on execution time, we observed that as the number of threads increases the execution times also increases. If we compare our values for W= 10^7, N=1000 with different T values of 10, 100 and 1000 we can see that T=10 has the shortest execution time of 5.22s. Then it is followed by T=100 having 6.03s and T=1000 having 6.26s of execution time. As the threads in our application are operating on the same hash table, the contention increases when we increase the number of threads. Execution of a blocked thread will cause the CPU to waste time because a blocked thread will spend its time in a while loop which is referred to as busy waiting. However, when the number of threads is low, it means that there will be fewer threads to wait and the execution will continue much faster as the time spent in a while loop waiting for other threads will decrease as well. (Figure 1 to 4)

Finally, as the number of W (operations) increases, the execution time also increases as expected. The execution time for W=10^6 is 0.4s on average, while the execution time for W=10^7 is 4s on average. (Figure 6)