# ITCS 6144/8144 Assignment - Pthread Lock

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**Test platform:**

- Processor: Intel(R) Xeon(R) CPU E5-2620 2.00GHz (12 Core)
- Linux version: 5.0.0-27-generic
- GCC version: 7.4.0 (Ubuntu 7.4.0-1ubuntu1~18.04.1)

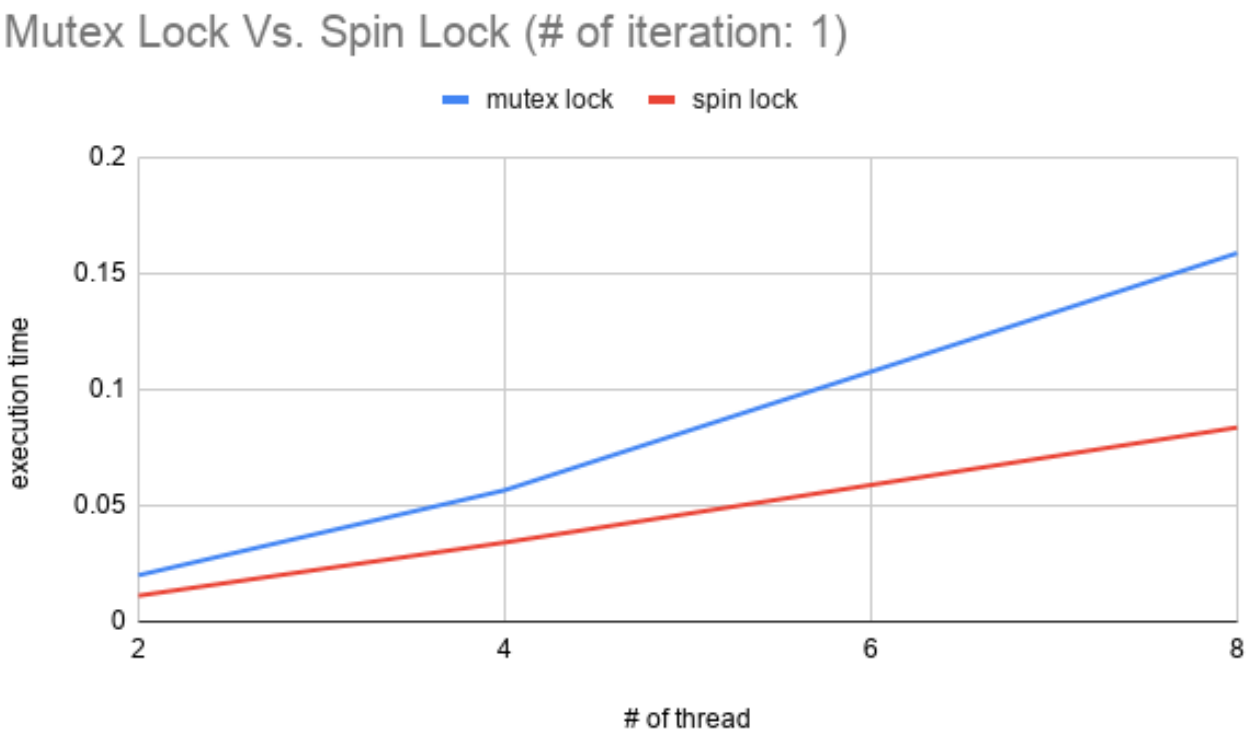
## Program 1: Mutex Lock and Spin Lock

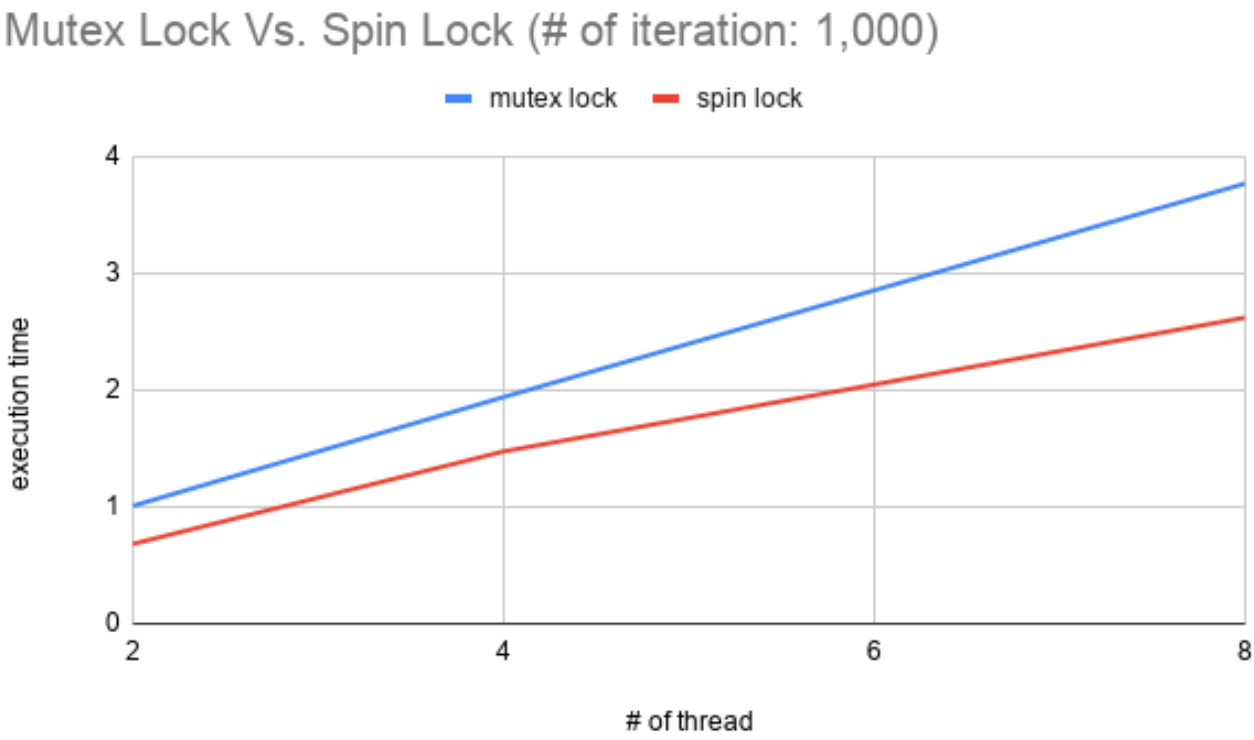
For this problem, I prepared two programs using both pthread Mutex Lock and Spin Lock. The execution time is showing bellow:

```
$ ./build/p1_mutex_lock 2
[Mutex Lock] 2 threads with iteration 1 took: 0.020013
[Mutex Lock] 2 threads with iteration 1000 took: 1.009162
[Mutex Lock] 2 threads with iteration 1000000 took: 820.893171

$ ./build/p1_mutex_lock 4
[Mutex Lock] 4 threads with iteration 1 took: 0.056631
[Mutex Lock] 4 threads with iteration 1000 took: 1.940355
[Mutex Lock] 4 threads with iteration 1000000 took: 1855.090460

$ ./build/p1_mutex_lock 8
[Mutex Lock] 8 threads with iteration 1 took: 0.158721
[Mutex Lock] 8 threads with iteration 1000 took: 3.768429
[Mutex Lock] 8 threads with iteration 1000000 took: 3687.262856
```

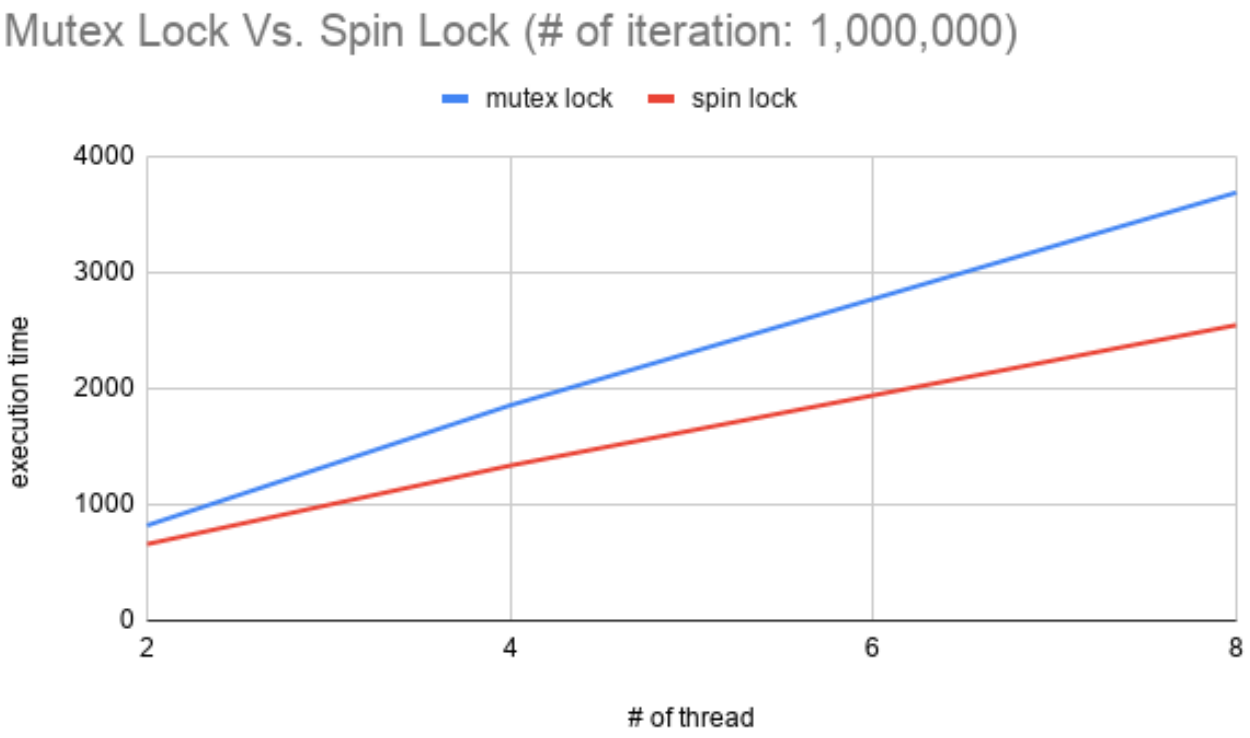
```
$ ./build/p1_spin_lock 2
[Spin Lock] 2 threads with iteration 1 took: 0.011201
[Spin Lock] 2 threads with iteration 1000 took: 0.683132
[Spin Lock] 2 threads with iteration 1000000 took: 659.433738

$ ./build/p1_spin_lock 4
[Spin Lock] 4 threads with iteration 1 took: 0.034115
[Spin Lock] 4 threads with iteration 1000 took: 1.475001
[Spin Lock] 4 threads with iteration 1000000 took: 1336.079932

$ ./build/p1_spin_lock 8
[Spin Lock] 8 threads with iteration 1 took: 0.083648
[Spin Lock] 8 threads with iteration 1000 took: 2.620485
[Spin Lock] 8 threads with iteration 1000000 took: 2546.134466
```

The following three diagrams will show the comparison graph:


Mutex Lock Vs. Spin Lock (# of iteration: 1)
mutex lock
spin lock
0.2
0.15
0.1
0.05
0
execution time
2
4
6
8
# of thread


Mutex Lock Vs. Spin Lock (# of iteration: 1,000)
mutex lock
spin lock
4
3
2
1
0
execution time
2
4
6
8
# of thread

**Result analysis:** It is clearly visible that spin lock outperform mutex lock. This happens because, in mutex lock it is taking too much time sending a thread to sleep and waking it up again, than, the spinlock's busy waiting of the thread for the shared resource.




## Program 2: Condition Variable

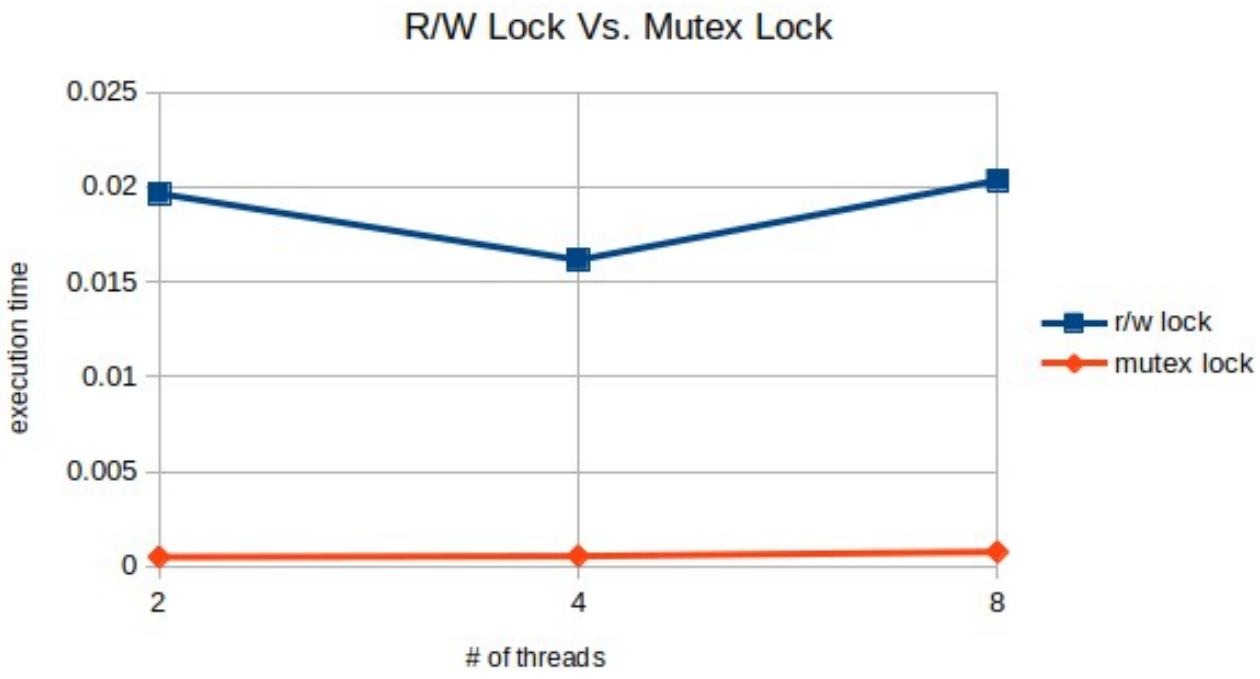
For this problem, I develop a program using pthread Condition Variable. The program takes n as the input parameter to denote how many threads will be created. n will be in range of [2, 4, 8]. n-1 threads randomly add 1 to a shared variable k in an interval of 100 ms. One thread wait until that shared variable reaches 100 and print "Reached to 100!".

## Program 3: Reader/Writer Lock

For this problem, I prepared two programs using both pthread Reader Writer Lock and Mutex Lock. The execution time is showing bellow:

```
$ ./build/p3_rw_lock 2
[Reader/Writer Lock] 2 reader threads took: 0.019652

$ ./build/p3_rw_lock 4
[Reader/Writer Lock] 4 reader threads took: 0.016154

$ ./build/p3_rw_lock 8
[Reader/Writer Lock] 8 reader threads took: 0.020346
```

```
$ ./build/p3_rw_lock_mutex 2
[R/W Mutex Lock] 2 reader thread took: 0.000484

$ ./build/p3_rw_lock_mutex 4
[R/W Mutex Lock] 4 reader thread took: 0.000534

$ ./build/p3_rw_lock_mutex 8
[R/W Mutex Lock] 8 reader thread took: 0.000756
```




**Note:** As I have noticed a huge fluctuation in the execution time, I run each of the programs 100 times and then take the average.

**Result analysis:** In this implementation, mutex lock can have only one reader or writer at a time. On the other hand rw lock can have one writer or multiple reader at a time. But still the mutex lock outperform rw lock.

This is because, rw lock requires its contents to be Sync and mutex lock only requires Send. In rw lock, multiple threads may access the shared resource simultaneously. But in mutex lock, it sends data to the thread who owns the lock and after unlocking it, it will be send to another thread.