Project 1: Multithreaded Programming and Synchronization

Part 1: This output of the program will not be using pthread synchronization. It is a simple multithreaded program. All of the threads will be randomly reading and writing the shared variables which will all end at random numbers. Unsynchronized will mean that all the final values will not share the same values at the end. It will just ultimately depend on your cpu scheduler to determine which threads are faster. The reason why the final values never hit 80 because each thread interrupts each other as it increments the global variable. For example, thread 1 increases the value up to 20 but thread 2 interrupts and starts increasing from 20...21...22. However, when thread 1 starts incrementing again its memory is still on 20 so the global variable value goes back to 20...21...22.

Part 2: The second part of this lab will be utilizing pthread mutex lock and pthread barrier for synchronization. The mutex lock's job is to get a constant value for the shared value between all the threads. Doing this will give exclusion to the shared variable for each thread. Now we get the final values as 80. The barrier will simply wait for all the threads to join together at the end to product the final outputs. The final values we get are 80 because of the mutex lock. Mutex lock ensures that one thread will finish incrementing up to 80 for the global variable first, then the other threads can start their task next.

The difference between unsynchronized and synchronized means the results will be random for unsync and ordered/same for synchronized. The first part will use multiple threads to process the same value while the second part of this project will utilize mutex lock to force only one thread can access the shared variable at a time. Then the mutex unlock will release it for the next thread to use.

Part 1: No synchronization

```
fiction@fiction-VirtualBox:~/Desktop/CECS 326$ ./lab1exe 4
More than one argument supplied
argv[1]: 4
2***thread 2 sees value 0
3***thread 3 sees value 1
3***thread 3 sees value 2
3***thread 3 sees value 3
2***thread 2 sees value 4
2***thread 2 sees value 5
1***thread 1 sees value 6
1***thread 1 sees value 7
0***thread 0 sees value 8
0***thread 0 sees value 9
3***thread 3 sees value 10
2***thread 2 sees value 11
1***thread 1 sees value 12
0***thread 0 sees value 13
3***thread 3 sees value 14
3***thread 3 sees value 15
2***thread 2 sees value 16
2***thread 2 sees value 17
2***thread 2 sees value 18
2***thread 2 sees value 19
1***thread 1 sees value 20
1***thread 1 sees value 21
1***thread 1 sees value 22
1***thread 1 sees value 23
1***thread 1 sees value 24
0***thread 0 sees value 25
0***thread 0 sees value 26
3***thread 3 sees value 27
2***thread 2 sees value 28
1***thread 1 sees value 29
1***thread 1 sees value 30
0***thread 0 sees value 31
3***thread 3 sees value 32
3***thread 3 sees value 33
2***thread 2 sees value 34
2***thread 2 sees value 35
1***thread 1 sees value 36
0***thread 0 sees value 37
3***thread 3 sees value 38
3***thread 3 sees value 39
```

```
3***thread 3 sees value 38
3***thread 3 sees value 39
2***thread 2 sees value 40
2***thread 2 sees value 41
2***thread 2 sees value 42
1***thread 1 sees value 43
0***thread 0 sees value 44
0***thread 0 sees value 45
2***thread 2 sees value 46
3***thread 3 sees value 47
3***thread 3 sees value 48
3***thread 3 sees value 49
1***thread 1 sees value 50
0***thread 0 sees value 51
0***thread 0 sees value 52
0***thread 0 sees value 53
0***thread 0 sees value 54
0***thread 0 sees value 55
0***thread 0 sees value 56
0***thread 0 sees value 57
3***thread 3 sees value 58
2***thread 2 sees value 59
1***thread 1 sees value 60
1***thread 1 sees value 61
0***thread 0 sees value 62
0***thread 0 sees value 63
2***thread 2 sees value 64
3***thread 3 sees value 65
1***thread 1 sees value 66
0***thread 0 sees value 67
0***thread 0 sees value 68
Thread 0 sees final value 69
3***thread 3 sees value 69
3***thread 3 sees value 70
2***thread 2 sees value 69
1***thread 1 sees value 70
2***thread 2 sees value 71
2***thread 2 sees value 72
Thread 2 sees final value 73
3***thread 3 sees value 71
1***thread 1 sees value 72
3***thread 3 sees value 73
Thread 3 sees final value 74
1***thread 1 sees value 74
1***thread 1 sees value 75
Thread 1 sees final value 76
fiction@fiction-VirtualBox:~/Desktop/CECS 326$
```

Part 2: With synchronization

```
More than one argument supplied
argv[1]: 4
2***thread 2 sees value 0
3***thread 3 sees value 1
3***thread 3 sees value 2
3***thread 3 sees value 3
2***thread 2 sees value 4
2***thread 2 sees value 5
1***thread 1 sees value 6
1***thread 1 sees value 7
0***thread 0 sees value 8
0***thread 0 sees value 9
3***thread 3 sees value 10
2***thread 2 sees value 11
1***thread 1 sees value 12
0***thread 0 sees value 13
3***thread 3 sees value 14
3***thread 3 sees value 15
2***thread 2 sees value 16
2***thread 2 sees value 17
2***thread 2 sees value 18
2***thread 2 sees value 19
1***thread 1 sees value 20
1***thread 1 sees value 21
1***thread 1 sees value 22
1***thread 1 sees value 23
1***thread 1 sees value 24
0***thread 0 sees value 25
0***thread 0 sees value 26
3***thread 3 sees value 27
2***thread 2 sees value 28
1***thread 1 sees value 29
1***thread 1 sees value 30
0***thread 0 sees value 31
3***thread 3 sees value 32
3***thread 3 sees value 33
2***thread 2 sees value 34
2***thread 2 sees value 35
1***thread 1 sees value 36
0***thread 0 sees value 37
3***thread 3 sees value 38
3***thread 3 sees value 39
2***thread 2 sees value 40
2***thread 2 sees value 41
2***thread 2 sees value 42
1***thread 1 sees value 43
0***thread 0 sees value 44
```

```
3***thread 3 sees value 38
3***thread 3 sees value 39
2***thread 2 sees value 40
2***thread 2 sees value 41
2***thread 2 sees value 42
1***thread 1 sees value 43
0***thread 0 sees value 44
0***thread 0 sees value 45
2***thread 2 sees value 46
3***thread 3 sees value 47
3***thread 3 sees value 48
3***thread 3 sees value 49
1***thread 1 sees value 50
0***thread 0 sees value 51
0***thread 0 sees value 52
0***thread 0 sees value 53
0***thread 0 sees value 54
0***thread 0 sees value 55
0***thread 0 sees value 56
0***thread 0 sees value 57
3***thread 3 sees value 58
2***thread 2 sees value 59
1***thread 1 sees value 60
1***thread 1 sees value 61
0***thread 0 sees value 62
0***thread 0 sees value 63
2***thread 2 sees value 64
3***thread 3 sees value 65
1***thread 1 sees value 66
0***thread 0 sees value 67
0***thread 0 sees value 68
3***thread 3 sees value 69
3***thread 3 sees value 70
2***thread 2 sees value 71
1***thread 1 sees value 72
2***thread 2 sees value 73
2***thread 2 sees value 74
3***thread 3 sees value 75
1***thread 1 sees value 76
3***thread 3 sees value 77
1***thread 1 sees value 78
1***thread 1 sees value 79
Thread 1 sees final value 80
Thread 2 sees final value 80
Thread 3 sees final value 80
Thread 0 sees final value 80
fiction@fiction-VirtualBox:~/Desktop/CECS 326$
```

ID: Sam Chen, 013502214
ID: Paul Nguon, 015782505
1:20 AM 9/27/20