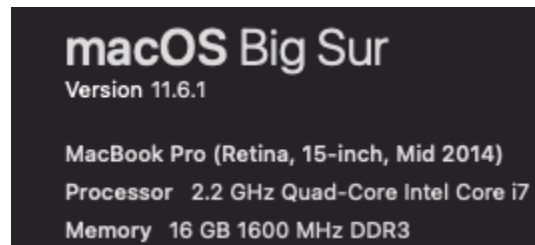


Homework 1 Report

1. System Configuration:



- a.

The main steps to enabling the QEMU VM was to first install qemu via homebrew. I first needed to run brew update since running brew install qemu first failed. This allowed other dependencies to be installed. After it was done installing, I followed the steps in the pdf file to start up the QEMU VM.

 - a. `sudo qemu-img create ubuntu.img 10G`

However, this did not work with Ubuntu version 20 that was downloaded. I had to redownload an older version of Ubuntu (16.04) which resolved my issues with starting up the VM. Then I ran the following command:
 - b. `sudo qemu-system-x86_64 -hda ubuntu.img -cdrom ubuntu-16.04.7.server-amd64.iso -m 2046 -boot strict=on`

This then stated the VM installation process which took about an hour in total. The arguments specified are to set the memory to 2GB, boot from the ubuntu iso that I downloaded, and the boot strict on makes it so qemu will only attempt to boot from those devices that have a specific boot order.
3. The main steps to enable the docker container was to first install docker from the provided link: <https://docs.docker.com/desktop/mac/install/> and click the Mac with Intel chip. After the download and setup was done, I needed to install the sysbench image from: <https://hub.docker.com/r/csminpp/ubuntu-sysbench>. This image has sysbench installed so I can compare the difference between the container vs the VM. In this case, both the VM and the containers are running version 0.4.12 of sysbench.
 - a. Note that in the second link, you need to copy the git repo that has sysbench installed. I took this command and put it in the CLI of the docker program that was installed in the first link to generate the image and was able to run it.
4. Images of both QEMU and Docker Container with tests:
 - a. QEMU
 - i. File IO:
 1. 1st run:
 - a. Min: 0.02ms
 - b. Max: 41.93ms
 - c. Average: 1.52ms

d. Std: 951.57

```
Operations performed: 6080 Read, 4052 Write, 12800 Other = 22932 Total
Read 95Mb Written 63.312Mb Total transferred 158.31Mb (25.045Mb/sec)
1602.91 Requests/sec executed

Test execution summary:
  total time:                6.3210s
  total number of events:    10132
  total time taken by event execution: 15.4317
  per-request statistics:
    min:                      0.02ms
    avg:                      1.52ms
    max:                      41.93ms
    approx. 95 percentile:    7.28ms

Threads fairness:
  events (avg/stddev):       633.2500/951.57
  execution time (avg/stddev): 0.9645/0.69
```

e.

2. 2nd run:

- a. Min: 0.02
- b. Max: 72.52
- c. Average: 3.73
- d. Std: 30.71

```
Test execution summary:
  total time:                6.0405s
  total number of events:    10212
  total time taken by event execution: 38.1248
  per-request statistics:
    min:                      0.02ms
    avg:                      3.73ms
    max:                      72.52ms
    approx. 95 percentile:    13.85ms

Threads fairness:
  events (avg/stddev):       638.2500/30.71
  execution time (avg/stddev): 2.3828/0.06
```

e.

3. 3rd run:

- a. Min: 0.02ms
- b. Max: 81.98ms
- c. Average: 3.86 ms
- d. Std: 18.67

```

Test execution summary:
  total time:                      6.1167s
  total number of events:          10056
  total time taken by event execution: 38.8167
  per-request statistics:
    min:                           0.02ms
    avg:                           3.86ms
    max:                           81.98ms
    approx. 95 percentile:         14.41ms

Threads fairness:
  events (avg/stddev):             628.5000/18.67
  execution time (avg/stddev):     2.4260/0.06

```

e.

4. 4th run:

- a. Min: 0.02ms
- b. Max: 44.29ms
- c. Average: 1.95ms
- d. Std: 549.71

```

Test execution summary:
  total time:                      5.5474s
  total number of events:          10053
  total time taken by event execution: 19.6426
  per-request statistics:
    min:                           0.02ms
    avg:                           1.95ms
    max:                           44.29ms
    approx. 95 percentile:         7.53ms

Threads fairness:
  events (avg/stddev):             628.3125/549.71
  execution time (avg/stddev):     1.2277/0.80

```

e.

5. 5th run:

- a. Min: 0.02ms
- b. Max: 139.93ms
- c. Average: 10.8ms
- d. Std: 22.09

```

Test execution summary:
  total time:                11.2428s
  total number of events:    10150
  total time taken by event execution: 109.6486
  per-request statistics:
    min:                     0.02ms
    avg:                     10.80ms
    max:                     139.93ms
    approx. 95 percentile:   48.84ms

Threads fairness:
  events (avg/stddev):       634.3750/22.09
  execution time (avg/stddev): 6.8530/0.13

```

- e.
- ii. CPU Max Prime (ran with 20000)
 1. Run 1:
 - a. Min: 4.81ms
 - b. Max: 18.91ms
 - c. Average: 5.35ms
 - d. Std: 0 ??

```

Test execution summary:
  total time:                53.4957s
  total number of events:    10000
  total time taken by event execution: 53.4651
  per-request statistics:
    min:                     4.81ms
    avg:                     5.35ms
    max:                     18.91ms
    approx. 95 percentile:   6.00ms

Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 53.4651/0.00

```

- e.
2. Run 2:
 - a. Min: 4.82ms
 - b. Max: 89.41 ms
 - c. Average: 5.4ms
 - d. Std: 0.0?

```

Test execution summary:
  total time:                    54.0801s
  total number of events:        10000
  total time taken by event execution: 54.0367
  per-request statistics:
    min:                        4.82ms
    avg:                        5.40ms
    max:                        89.41ms
    approx. 95 percentile:      6.06ms

Threads fairness:
  events (avg/stddev):           10000.0000/0.00
  execution time (avg/stddev):   54.0367/0.00

```

e.

3. Run 3:

- a. Min: 4.82 ms
- b. Max: 15.85ms
- c. Average: 5.37ms
- d. Std: 0?

```

Test execution summary:
  total time:                    53.7146s
  total number of events:        10000
  total time taken by event execution: 53.6845
  per-request statistics:
    min:                        4.82ms
    avg:                        5.37ms
    max:                        15.85ms
    approx. 95 percentile:      6.10ms

Threads fairness:
  events (avg/stddev):           10000.0000/0.00
  execution time (avg/stddev):   53.6845/0.00

```

e.

4. Run 4:

- a. Min: 4.81 ms
- b. Max: 16.46 ms
- c. Average: 5.49 ms
- d. Std: 0

```

Test execution summary:
  total time:                    54.9263s
  total number of events:        10000
  total time taken by event execution: 54.8883
  per-request statistics:
    min:                        4.81ms
    avg:                        5.49ms
    max:                        16.46ms
    approx. 95 percentile:      6.36ms

Threads fairness:
  events (avg/stddev):          10000.0000/0.00
  execution time (avg/stddev):  54.8883/0.00

```

e.

5. Run 5:

- a. Min: 4.81 ms
- b. Max: 19.65 ms
- c. Average: 5.37ms
- d. Std: 0

```

Test execution summary:
  total time:                    53.7133s
  total number of events:        10000
  total time taken by event execution: 53.6827
  per-request statistics:
    min:                        4.81ms
    avg:                        5.37ms
    max:                        19.65ms
    approx. 95 percentile:      5.93ms

Threads fairness:
  events (avg/stddev):          10000.0000/0.00
  execution time (avg/stddev):  53.6827/0.00

```

e.

b. Docker:

i. File IO

1. Run 1:

- a. Min: 0.0ms
- b. Max: 10.01ms
- c. Average: 1.4ms
- d. Std: 29

```

Test execution summary:
  total time:                1.7745s
  total number of events:    10040
  total time taken by event execution: 14.1083
  per-request statistics:
    min:                     0.00ms
    avg:                     1.41ms
    max:                     10.01ms
    approx. 95 percentile:   3.64ms

Threads fairness:
  events (avg/stddev):       627.5000/29.00
  execution time (avg/stddev): 0.8818/0.02

```

e.

2. Run 2:

- a. Min: 0.0ms
- b. Max: 10.6ms
- c. Average: 1.37ms
- d. Std: 35.49

```

Test execution summary:
  total time:                1.6898s
  total number of events:    10011
  total time taken by event execution: 13.7063
  per-request statistics:
    min:                     0.00ms
    avg:                     1.37ms
    max:                     10.60ms
    approx. 95 percentile:   3.62ms

Threads fairness:
  events (avg/stddev):       625.6875/35.49
  execution time (avg/stddev): 0.8566/0.02

```

3. Run 3:

- a. Min: 0.00ms
- b. Max: 7.97ms
- c. Average: 1.52ms
- d. Std: 26.04

```

Test execution summary:
  total time:                1.8217s
  total number of events:    10014
  total time taken by event execution: 15.2382
  per-request statistics:
    min:                     0.00ms
    avg:                     1.52ms
    max:                     7.97ms
    approx. 95 percentile:   3.88ms

Threads fairness:
  events (avg/stddev):       625.8750/26.04
  execution time (avg/stddev): 0.9524/0.02

```

4. Run 4:

- a. Min: 0.00ms
- b. Max: 15.94ms

- c. Average: 1.57ms
- d. Std: 25.88

```
Test execution summary:
total time: 1.8525s
total number of events: 10011
total time taken by event execution: 15.6922
per-request statistics:
  min: 0.00ms
  avg: 1.57ms
  max: 15.94ms
  approx. 95 percentile: 3.96ms

Threads fairness:
  events (avg/stddev): 625.6875/25.88
  execution time (avg/stddev): 0.9808/0.02
```

- 5. Run 5:
 - a. Min: 0.0ms
 - b. Max: 34.83 ms
 - c. Average: 1.8ms
 - d. Std: 23.87

```
Test execution summary:
total time: 2.0327s
total number of events: 10008
total time taken by event execution: 18.0497
per-request statistics:
  min: 0.00ms
  avg: 1.80ms
  max: 34.83ms
  approx. 95 percentile: 4.39ms

Threads fairness:
  events (avg/stddev): 625.5000/23.87
  execution time (avg/stddev): 1.1281/0.02
```

- ii. CPU Max prime (20000)
 - 1. Run 1:
 - a. Min: 2.41 ms
 - b. Max: operation time is greater warning
 - c. average : 2.67 ms
 - d. Std: 0


```

Threads started!
WARNING: Operation time (18446744073690634240.000000) is greater than
000000
WARNING: Percentile statistics will be inaccurate
Done.

Maximum prime number checked in CPU test: 20000

Test execution summary:
total time: 26.6683s
total number of events: 10000
total time taken by event execution: 26.6650
per-request statistics:
  min: 2.41ms
  avg: 2.67ms
  max: 18446744073690.70ms
  approx. 95 percentile: 3.07ms

Threads fairness:
  events (avg/stddev): 10000.0000/0.00
  execution time (avg/stddev): 26.6650/0.00

```

e.

2. Run 2:

- a. Min: 2.41 ms
- b. Max: operation time is greater warning.
- c. Average: 2.68 ms
- d. Std: 0

```

Test execution summary:
total time: 26.8175s
total number of events: 10000
total time taken by event execution: 26.8142
per-request statistics:
  min: 2.41ms
  avg: 2.68ms
  max: 18446744073690.13ms
  approx. 95 percentile: 3.07ms

Threads fairness:
  events (avg/stddev): 10000.0000/0.00
  execution time (avg/stddev): 26.8142/0.00

```

e.

3. Run 3:

- a. Min: 2.43ms
- b. Max: operation time is greater warning
- c. Average: 2.66ms
- d. Std: 0

```

Test execution summary:
  total time:                26.6494s
  total number of events:    10000
  total time taken by event execution: 26.6462
  per-request statistics:
    min:                      2.43ms
    avg:                      2.66ms
    max:                      18446744073690.18ms
    approx. 95 percentile:    3.10ms

Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 26.6462/0.00

```

e.

4. Run 4:

- a. Min: 2.42 ms
- b. Max: operation time is greater warning
- c. Average: 2.68 ms
- d. Std: 0

```

Test execution summary:
  total time:                26.8311s
  total number of events:    10000
  total time taken by event execution: 26.8279
  per-request statistics:
    min:                      2.42ms
    avg:                      2.68ms
    max:                      18446744073691.40ms
    approx. 95 percentile:    3.09ms

Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 26.8279/0.00

```

e.

5. Run 5:

- a. Min: 2.41 ms
- b. Max: operation time is greater warning
- c. Average: 2.64 ms
- d. Std: 0

```

Test execution summary:
  total time:                26.3622s
  total number of events:    10000
  total time taken by event execution: 26.3592
  per-request statistics:
    min:                      2.41ms
    avg:                      2.64ms
    max:                      18446744073690.41ms
    approx. 95 percentile:    2.99ms

Threads fairness:
  events (avg/stddev):       10000.0000/0.00
  execution time (avg/stddev): 26.3592/0.00

```

e.

5. These measurements were conducted by running each test 5 times (cpu max prime and fileio). I then recorded each of the 5 run's min, max, average time and standard deviation.

6. Shell scripts (same for both):

[illegible]

7. Present how you use performance tools to collect performance data.
 - a. In the docker container, I ran the above shell script and ran top to view the user and system usage.

```
Tasks:   6 total,   1 running,   5 sleeping,   0 stopped,   0 zombie
%Cpu(s): 25.0 us,  0.1 sy,  0.0 ni, 74.9 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem: 2033396 total,  908012 used, 1125384 free,   35548 buffers
KiB Swap: 1048572 total,   53560 used,  995012 free.  510596 cached Mem
```

1. Which indicates 25s user usage and 0.1s kernel usage.
8. Presentation and analysis of the performance data
 - a. For both Docker and QEMU VM,
 - i. I chose to run with cpu max prime of 20000. In the docker container, it took about 30 seconds to run, while in the VM, it took 60 seconds. The reason why I chose this was because if I were to choose less, the container would run too fast, so I settled on this as a middle ground.
 - ii. For fileio, i ran the test initially with file size 3G, but both completed in less than 6 seconds. I increased the values to 6 GB which did help increase the run time, but they did complete very fast (even after clearing the cache for both the VM and Docker).
9. Github repo:
 - a. <https://github.com/alexte1/COEN241-HW1>