Results for **part A1 and A2** (both in same terminal output)

A screen shot of a computer

Description automatically generated

Results for **part B3**

A computer screen with white text

Description automatically generated

Results for **part B4**

A computer screen shot of a black screen

Description automatically generated

**Part C. Observations (10 points)**

**5.** Was there a difference in your runtimes between Part B.3 and Part B.4? Why or why not? You need to explain for credit.

While I didn’t measure the run times for them, I saw mostly no difference aside from the fact that the multithreaded version would run maybe a second or even a few seconds slower than the single threaded occasionally after some testing. This might be from some sort of thread creation overhead or just from random high CPU, I/O, or RAM usage from using my computer.

In general, these tasks are most likely I/O bound, so there’s not much that can be done if that is the case. But generally speaking, there was no difference.

**6.** Was there a difference in your output between Part B.3 and Part B.4? Why or why not? You need to explain for credit.

There was definitely a significant difference between Part B3 and B4. The single threaded version was roughly about 43 to 55 seconds when I tested it multiple times, while the multi-threaded version was roughly anywhere from 8 seconds to 55 seconds.

This makes sense, as each thread works on an individual file. Each thread has an overhead and other related issues that could potentially cause it to be very fast or very slow. In the faster cases, this would be the overhead of creating + joining threads and however long the actual execution takes for all the threads to finish. However, this was very frustrating, and I was not able to get any consistency. I used multiple computers and a VM Linux OS as well.

This may be a potential synchronization error or just a small bug or something else, but I gave up after a whole week of trying to fix it.

**Example screenshots below**

Example: I run the code twice in a row with no changes and it runs 42 seconds and then 15 seconds?

A computer screen with white text

Description automatically generated

Another example of running the same code (named two different files because I was lazy) and getting significantly different multithread times from the same code.

A screenshot of a computer

Description automatically generated