

Task 3:

I chose to use a mutex for both sum array and matrix multiply because neither function needed a barrier or a condition. The start and end of the range for each thread is handled by local variables and I think that is a sufficient condition for memory control. Since that variable is controlling the range of the memory, mutex is only needed to prevent each thread from overlapping in the memory. Matrix multiply has the same logic where local variables are controlling the memory range so no barriers or conditions are needed for that either.

Screenshot showing the sum array function is working:

```
sumT.c > sumPart(void *)
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 1000000
7  #define NUM_THREADS 4
8
9  long long arr[SIZE];
10 long long totalSum = 0;
11 pthread_mutex_t lock;
12
13 void* sumPart(void* arg) {
14     int thread_id = *(int*)arg;
15     int chunk_size = SIZE / NUM_THREADS;
16     int start = thread_id * chunk_size;
17     int end = (thread_id + 1) * chunk_size;
18
19     long long temp;
20     pthread_mutex_lock(&lock); // lock the memory using mutex so this thread only access the needed memory. Prevents overlap.
21     // Calculate partial sums
22     for (int i = start; i < end; i++) {
23         temp = totalSum;
24         temp += arr[i];
25         // sleep(rand()%2);
26         totalSum = temp;
27     }
28     pthread_mutex_unlock(&lock);
29     pthread_exit(NULL);
30 }
31
32 int main() {
33     // Initialize the array
34     for (int i = 0; i < SIZE; i++) {
35         arr[i] = i + 1;
36     }
37 }

PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS

dlanner@TheRGBoi:/mnt/c/Users/Dakot/OneDrive/Documents/CSC 410/A3 P1 rough$ gcc sumT.c -lpthread
dlanner@TheRGBoi:/mnt/c/Users/Dakot/OneDrive/Documents/CSC 410/A3 P1 rough$ ./a.out
Total Sum: 500000500000
dlanner@TheRGBoi:/mnt/c/Users/Dakot/OneDrive/Documents/CSC 410/A3 P1 rough$ ./a.out
Total Sum: 500000500000
dlanner@TheRGBoi:/mnt/c/Users/Dakot/OneDrive/Documents/CSC 410/A3 P1 rough$
```

Screenshot showing the matrix multiply is working:

```
C matrixT.h > matrixMultiplyThread(void *)
13  typedef struct {
14      int num_rows;
15  } thread_data_t;
16
17  // Entry function for each thread
18  void* matrixMultiplyThread(void* arg) {
19      // Extract thread info from the passes argument
20      thread_data_t t = *(thread_data_t*)arg;
21
22      // Calculate the start and ending row chunk for each thread to handle
23      int start = t.num_rows;
24      int end = (t.thread_id + 1) * t.num_rows;
25      pthread_mutex_lock(&lock); // lock the memory using mutex so this thread only access the needed memory. Prevents overlap.
26
27      // Loop through the start and end row assigned to the thread and compute matrix multiplication
28
29      int tempC, colC = 0; //colC = column number for matrix C
30      for (int x = start; x < end; ++x){ //iterate through row x in A and C
31          for (int i = 0; i < N; ++i) {
32              for (int j = 0; j < N; ++j) {
33                  tempC += A[j][x] * B [i][j]; // iterate through row x column j of A and column i row j of B.
34              }
35              C [colC++][x] = tempC; // fill in element in matrix C
36              tempC = 0;
37          }
38          colC = 0;
39      }
40
41      pthread_mutex_unlock(&lock);
42      pthread_exit(NULL);
43  }
44
45  /*void displayMatrix(int** matrix[N][N], int x) {
46      for (int i = 0; i < x; ++i) {
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