

## Array Sum

	Sequential	1 thread	2 threads	5 threads	7 threads	9 threads
Time	1.066					
Pthread		1.354	0.997	0.982	0.873	0.835
OpenMP		0.704	0.581	0.500	0.536	0.507

## Matrix Multiplication

	Sequential	1 thread	2 threads	5 threads	7 threads	9 threads
Time	5.181					
Pthread		2.606	1.713	0.952	0.769	0.801
OpenMP		4.735	3.640	2.269	2.094	2.145

## Trapezoidal Rule Integration

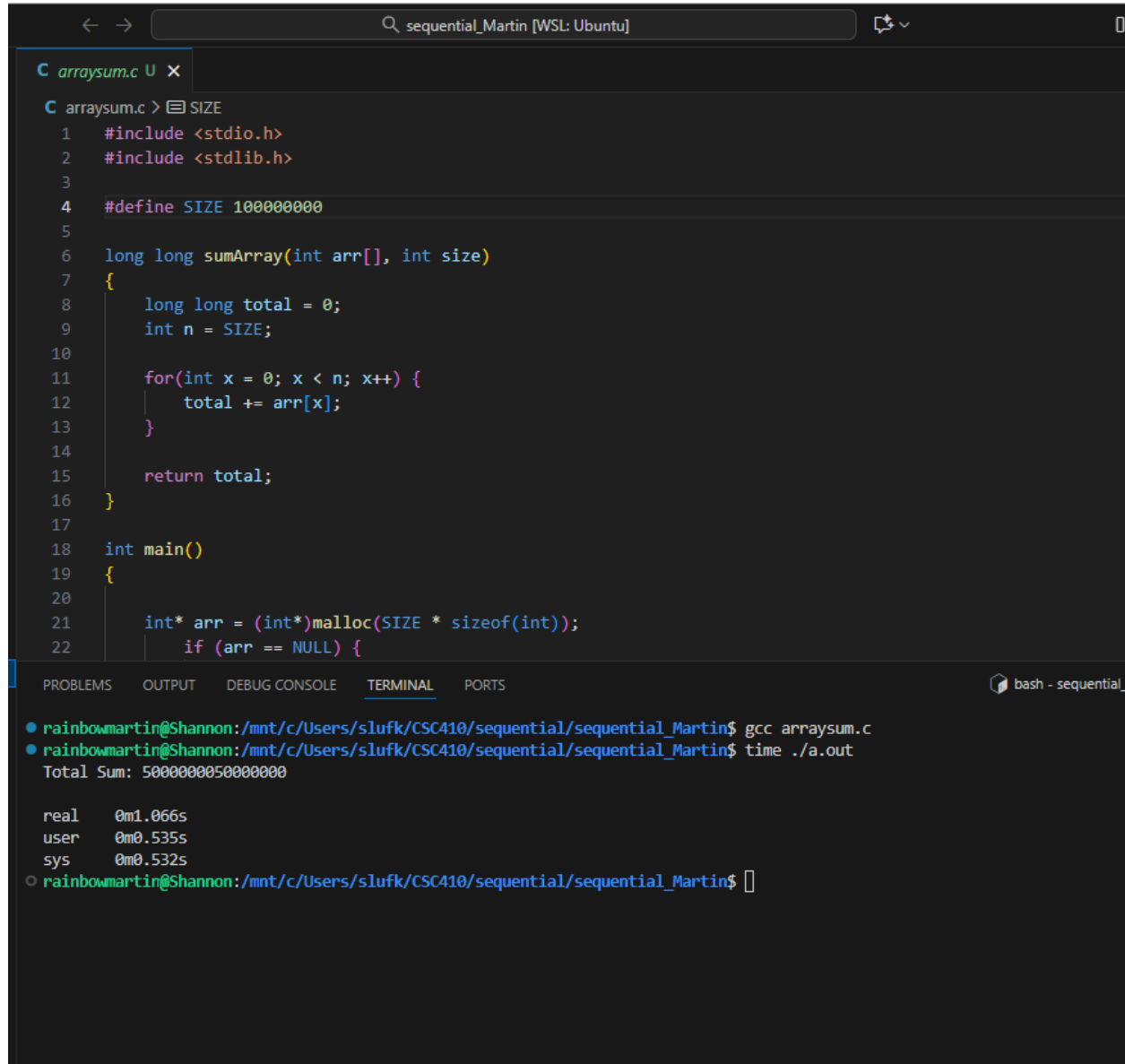
	Sequential	1 thread	2 threads	5 threads	7 threads	9 threads
Time	2.781					
Pthread		2.534	1.654	0.960	0.792	0.828
OpenMP		2.726	1.823	1.057	0.922	0.945

## N Queens

	Sequential	1 thread	2 threads	5 threads	7 threads	9 threads
Time	2m15.690					
Pthread		48.580	31.661	15.069	13.172	13.312
OpenMP		50.524	31.670	19.314	15.970	13.060

# Array Sum

## Sequential



The image shows a Visual Studio Code editor window with a C program named `arraysum.c` and a terminal window below it. The C program calculates the sum of an array of 10,000,000 integers sequentially. The terminal shows the compilation and execution of the program, displaying the total sum and execution time.

```
C arraysum.c U x
C arraysum.c > SIZE
1  #include <stdio.h>
2  #include <stdlib.h>
3
4  #define SIZE 100000000
5
6  long long sumArray(int arr[], int size)
7  {
8      long long total = 0;
9      int n = SIZE;
10
11     for(int x = 0; x < n; x++) {
12         total += arr[x];
13     }
14
15     return total;
16 }
17
18 int main()
19 {
20
21     int* arr = (int*)malloc(SIZE * sizeof(int));
22     if (arr == NULL) {
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS bash - sequential\_

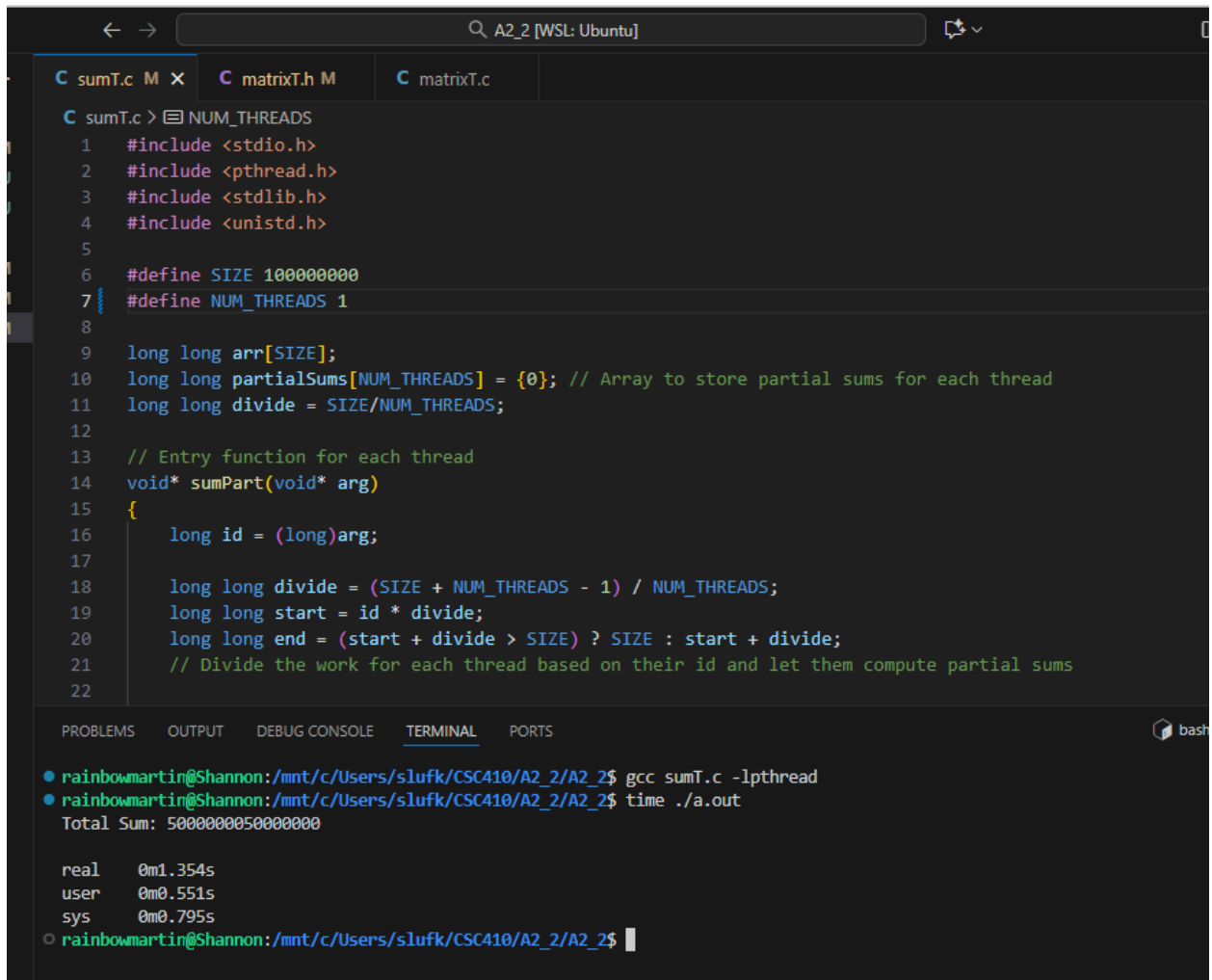
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential\_Martin\$ gcc arraysum.c
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential\_Martin\$ time ./a.out

Total Sum: 5000000050000000

real 0m1.066s  
user 0m0.535s  
sys 0m0.532s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential\_Martin\$

## Pthread – 1 thread



```
← → A2_2 [WSL: Ubuntu]
C sumT.c M X C matrixT.h M C matrixT.c
C sumT.c > NUM_THREADS
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 100000000
7  #define NUM_THREADS 1
8
9  long long arr[SIZE];
10 long long partialSums[NUM_THREADS] = {0}; // Array to store partial sums for each thread
11 long long divide = SIZE/NUM_THREADS;
12
13 // Entry function for each thread
14 void* sumPart(void* arg)
15 {
16     long id = (long)arg;
17
18     long long divide = (SIZE + NUM_THREADS - 1) / NUM_THREADS;
19     long long start = id * divide;
20     long long end = (start + divide > SIZE) ? SIZE : start + divide;
21     // Divide the work for each thread based on their id and let them compute partial sums
22
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS bash
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ gcc sumT.c -lpthread
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ time ./a.out
Total Sum: 5000000050000000

real    0m1.354s
user    0m0.551s
sys     0m0.795s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$
```

## Pthread – 2 threads

```
sumT.c M X  matrixT.h M  matrixT.c
C sumT.c > NUM_THREADS
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 100000000
7  #define NUM_THREADS 2
8
9  long long arr[SIZE];
10 long long partialSums[NUM_THREADS] = {0}; // Array to store partial sums for each thread
11 long long divide = SIZE/NUM_THREADS;
12
13 // Entry function for each thread
14 void* sumPart(void* arg)
15 {
16     long id = (long)arg;
17
18     long long divide = (SIZE + NUM_THREADS - 1) / NUM_THREADS;
19     long long start = id * divide;
20     long long end = (start + divide > SIZE) ? SIZE : start + divide;
21     // Divide the work for each thread based on their id and let them compute partial sums
22
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS  bash
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ gcc sumT.c -lpthread
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ time ./a.out
Total Sum: 5000000050000000

real    0m0.997s
user    0m0.719s
sys     0m0.512s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$
```

## Pthread – 5 threads

```
sumT.c M X  matrixT.h M  matrixT.c
sumT.c > NUM_THREADS
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 100000000
7  #define NUM_THREADS 5
8
9  long long arr[SIZE];
10 long long partialSums[NUM_THREADS] = {0}; // Array to store partial sums for each thread
11 long long divide = SIZE/NUM_THREADS;
12
13 // Entry function for each thread
14 void* sumPart(void* arg)
15 {
16     long id = (long)arg;
17
18     long long divide = (SIZE + NUM_THREADS - 1) / NUM_THREADS;
19     long long start = id * divide;
20     long long end = (start + divide > SIZE) ? SIZE : start + divide;
21     // Divide the work for each thread based on their id and let them compute partial sums
22
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS  bas
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ gcc sumT.c -lpthread
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ time ./a.out
Total Sum: 5000000050000000

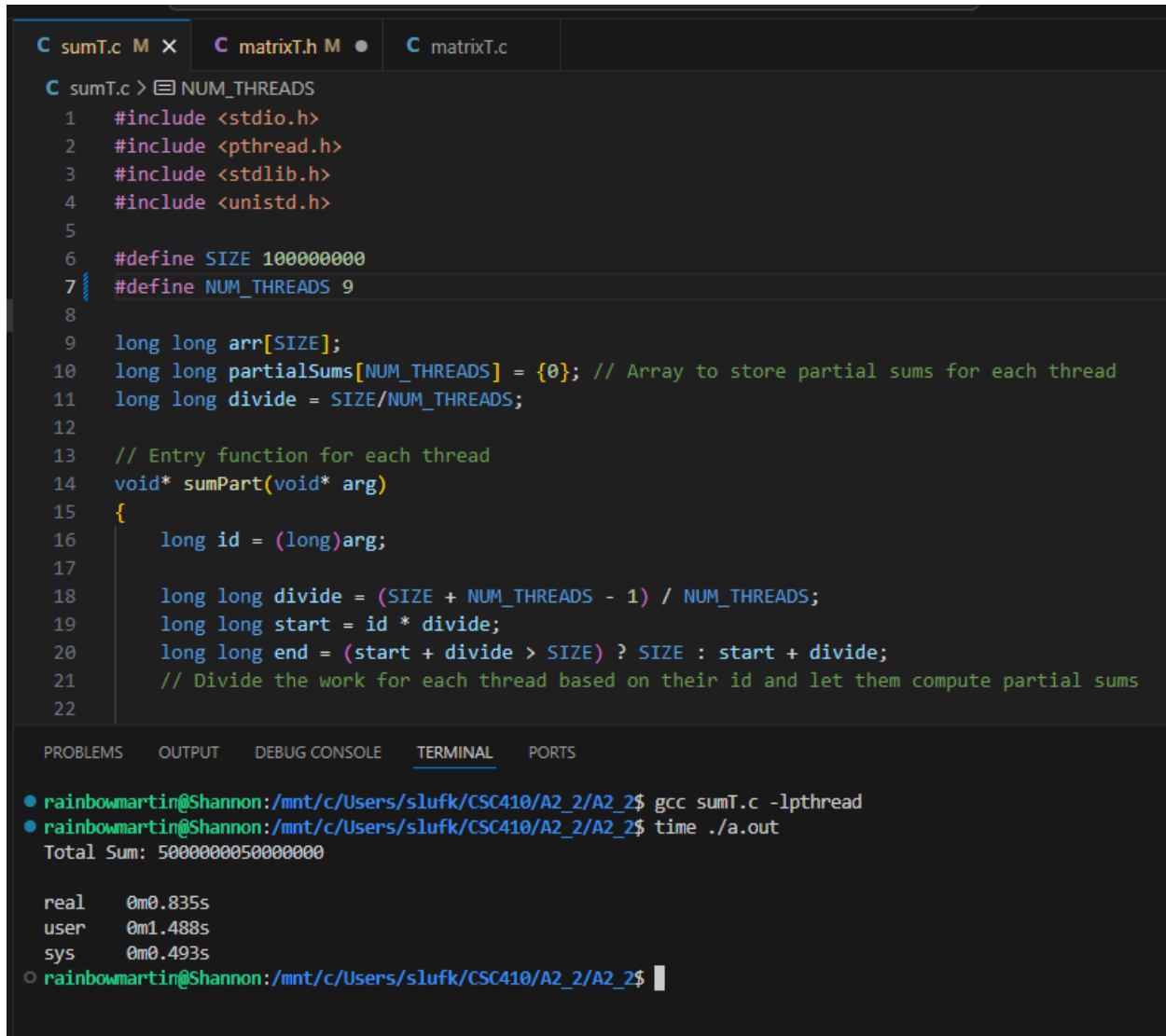
real    0m0.982s
user    0m1.097s
sys      0m0.577s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$
```

## Pthread – 7 threads

```
sumT.c M x  matrixT.h M  matrixT.c
C sumT.c > NUM_THREADS
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 100000000
7  #define NUM_THREADS 7
8
9  long long arr[SIZE];
10 long long partialSums[NUM_THREADS] = {0}; // Array to store partial sums for each thread
11 long long divide = SIZE/NUM_THREADS;
12
13 // Entry function for each thread
14 void* sumPart(void* arg)
15 {
16     long id = (long)arg;
17
18     long long divide = (SIZE + NUM_THREADS - 1) / NUM_THREADS;
19     long long start = id * divide;
20     long long end = (start + divide > SIZE) ? SIZE : start + divide;
21     // Divide the work for each thread based on their id and let them compute partial sums
22
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS  bash - A2_2 +
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ gcc sumT.c -lpthread
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$ time ./a.out
Total Sum: 5000000050000000

real    0m0.873s
user    0m1.534s
sys     0m0.504s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$
```

## Pthread – 9 threads



The image shows a code editor with three tabs: `sumT.c`, `matrixT.h`, and `matrixT.c`. The `sumT.c` tab is active, displaying a C program that uses 9 threads to calculate the sum of a large array. The code defines a constant `SIZE` of 100000000 and `NUM_THREADS` of 9. It creates an array `arr` of size `SIZE` and an array `partialSums` of size `NUM_THREADS`. The `sumPart` function is the entry point for each thread, which calculates a partial sum of the array based on its ID. The terminal output shows the compilation and execution of the program, resulting in a total sum of 5000000050000000 and execution times for real, user, and system.

```
C sumT.c M X C matrixT.h M C matrixT.c
C sumT.c > NUM_THREADS
1  #include <stdio.h>
2  #include <pthread.h>
3  #include <stdlib.h>
4  #include <unistd.h>
5
6  #define SIZE 100000000
7  #define NUM_THREADS 9
8
9  long long arr[SIZE];
10 long long partialSums[NUM_THREADS] = {0}; // Array to store partial sums for each thread
11 long long divide = SIZE/NUM_THREADS;
12
13 // Entry function for each thread
14 void* sumPart(void* arg)
15 {
16     long id = (long)arg;
17
18     long long divide = (SIZE + NUM_THREADS - 1) / NUM_THREADS;
19     long long start = id * divide;
20     long long end = (start + divide > SIZE) ? SIZE : start + divide;
21     // Divide the work for each thread based on their id and let them compute partial sums
22 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2\_2/A2\_2\$ gcc sumT.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2\_2/A2\_2\$ time ./a.out

Total Sum: 5000000050000000

real 0m0.835s  
user 0m1.488s  
sys 0m0.493s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2\_2/A2\_2\$

Omp – 1 thread

```
C arraysum.c M X
C arraysum.c > main()
5  #define SIZE 100000000
6
7  int main()
8  {
9      // Set number of threads
10     omp_set_num_threads (1);
11
12     // Initialize array
13     int* arr = (int*)malloc(SIZE * sizeof(int));
14     if (arr == NULL) {
15         printf("Memory allocation failed!\n");
16         return 1;
17     }
18
19     for (int i = 0; i < SIZE; i++) {
20         arr[i] = i + 1;
21     }
22
23     // Shared variables
24     long long total = 0;
25     int n = SIZE;
26     long long thisTotal = 0;
27
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc arraysum.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Total Sum: 5000000050000000

real    0m0.704s
user    0m0.449s
sys     0m0.252s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```



## Omp – 2 threads

```
C arraysum.c M ●
C arraysum.c > main()

5  #define SIZE 100000000
6
7  int main()
8  {
9      // Set number of threads
10     omp_set_num_threads (2);
11
12     // Initialize array
13     int* arr = (int*)malloc(SIZE * sizeof(int));
14     if (arr == NULL) {
15         printf("Memory allocation failed!\n");
16         return 1;
17     }
18
19     for (int i = 0; i < SIZE; i++) {
20         arr[i] = i + 1;
21     }
22
23     // Shared variables
24     long long total = 0;
25     int n = SIZE;
26     long long thisTotal = 0;
27
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc arraysum.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Total Sum: 5000000050000000

real    0m0.581s
user    0m0.446s
sys     0m0.261s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```

Omp – 5 threads

```
C arraysum.c M X
C arraysum.c > main()
5  #define SIZE 100000000
6
7  int main()
8  {
9      // Set number of threads
10     omp_set_num_threads (5);
11
12     // Initialize array
13     int* arr = (int*)malloc(SIZE * sizeof(int));
14     if (arr == NULL) {
15         printf("Memory allocation failed!\n");
16         return 1;
17     }
18
19     for (int i = 0; i < SIZE; i++) {
20         arr[i] = i + 1;
21     }
22
23     // Shared variables
24     long long total = 0;
25     int n = SIZE;
26     long long thisTotal = 0;
27
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc arraysum.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Total Sum: 5000000050000000

real    0m0.500s
user    0m0.551s
sys     0m0.224s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```

Omp – 7 threads

```
C arraysum.c M X
C arraysum.c > main()
5  #define SIZE 100000000
6
7  int main()
8  {
9      // Set number of threads
10     omp_set_num_threads (7);
11
12     // Initialize array
13     int* arr = (int*)malloc(SIZE * sizeof(int));
14     if (arr == NULL) {
15         printf("Memory allocation failed!\n");
16         return 1;
17     }
18
19     for (int i = 0; i < SIZE; i++) {
20         arr[i] = i + 1;
21     }
22
23     // Shared variables
24     long long total = 0;
25     int n = SIZE;
26     long long thisTotal = 0;
27
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc arraysum.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Total Sum: 5000000050000000

real    0m0.536s
user    0m0.741s
sys     0m0.269s
```

## Omp – 9 threads

```
C arraysum.c X
C arraysum.c > main()
5  #define SIZE 100000000
6
7  int main()
8  {
9      // Set number of threads
10     omp_set_num_threads (9);
11
12     // Initialize array
13     int* arr = (int*)malloc(SIZE * sizeof(int));
14     if (arr == NULL) {
15         printf("Memory allocation failed!\n");
16         return 1;
17     }
18
19     for (int i = 0; i < SIZE; i++) {
20         arr[i] = i + 1;
21     }
22
23     // Shared variables
24     long long total = 0;
25     int n = SIZE;
26     long long thisTotal = 0;
27
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc arraysum.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Total Sum: 5000000050000000

real    0m0.507s
user    0m0.477s
sys     0m0.275s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```

# Matrix Multiplication

## Sequential

```
C matrixMul.h U x
matrixMul > C matrixMul.h > N
1  #include <stdio.h>
2  #include <stdlib.h> // For malloc() and free()
3
4  #define N 1000 // Adjust this to test larger matrix sizes
5
6  void displayMatrix(int** matrix, int n)
7  {
8      for (int i = 0; i < n; ++i) {
9          for (int j = 0; j < n; ++j) {
10             printf("%d ", matrix[i][j]);
11         }
12         printf("\n");
13     }
14 }
15
16 void matrixMultiply(int** A, int** B, int** C, int n)
17 {
18     //Loop through rows of C and A
19     for (int i = 0; i < n; i++){
20         //Loop through columns of C and B
21         for (int j = 0; j < n; j++){
22             //Loop through columns of row i for A and row of column j of B
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Pthread – 1 thread

```
C sumT.c M    C matrixT.h X    C matrixT.c

C matrixT.h > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4
5  #define N 1000 // Size of the matrix
6  #define NUM_THREADS 1 // Number of threads
7
8  int **A, **B, **C; // Global matrices
9
10 // Structure to hold information for each thread
11 typedef struct
12 {
13     int thread_id;
14     int num_rows; // Number of rows each thread will handle
15 } thread_data_t;
16
17 // Function for each thread to perform matrix multiplication
18 void* matrixMultiplyThread(void* arg)
19 {
20     long id = (long)arg;
21     // Divide the task (rows) of each thread based on thread id
22     // compute a portion of the matrix multiplication
23
24     // ... (rest of the function code) ...
25
26     return C;
27 }
28
29 int main()
30 {
31     // ... (main function code) ...
32
33     return 0;
34 }

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

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sys     0m0.077s

rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A2_2/A2_2$
```

## Pthread – 2 threads

[illegible]

### Pthread – 5 threads

[illegible]



Pthread – 7 threads

[illegible]

Pthread – 9 threads

[illegible]

Omp – 1 thread

```
C arrays.c M C mainM.c C matrixMul.h X
matrixMul > C matrixMul.h > matrixMultiply(int **, int **, int **, int)
7 void displayMatrix(int** matrix, int n)
15 }
16
17 void matrixMultiply(int** A, int** B, int** C, int n)
18 {
19     // Set number of threads
20     omp_set_num_threads(1);
21
22
23     //Loop through rows of C and A
24     #pragma omp parallel for
25     for (int i = 0; i < n; i++){
26         //Loop through columns of C and B
27         for (int j = 0; j < n; j++){
28             //Loop through columns of row i for A and row of column j of B
29             for (int m = 0; m < n; m++){
30                 C[i][j] += A[i][m] * B[m][j];
31             }
32         }
33     }
34 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
00 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1
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00 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1
0 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 10
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000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
00 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1
0 1000 1000 1000

real    0m4.735s
user    0m3.937s
sys     0m0.080s
```

Omp – 2 threads

[illegible]

Omp – 5 threads

[illegible]

Omp – 7 threads

```
C arraysum.c M      C mainM.c      C matrixMul.h X
matrixMul > C matrixMul.h > matrixMultiply(int **, int **, int **, int)
7  void displayMatrix(int** matrix, int n)
15 }
16
17 void matrixMultiply(int** A, int** B, int** C, int n)
18 {
19     // Set number of threads
20     omp_set_num_threads(7);
21
22
23     //Loop through rows of C and A
24     #pragma omp parallel for
25     for (int i = 0; i < n; i++){
26         //Loop through columns of C and B
27         for (int j = 0; j < n; j++){
28             //Loop through columns of row i for A and row of column j of B
29             for (int m = 0; m < n; m++){
30                 C[i][j] += A[i][m] * B[m][j];
31             }
32         }
33     }
34 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
00 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
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1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
00 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000
0 1000 1000 1000
```

real 0m2.094s  
user 0m8.842s  
sys 0m0.086s



Omp – 9 threads

[illegible]

# Trapezoidal Rule Integration

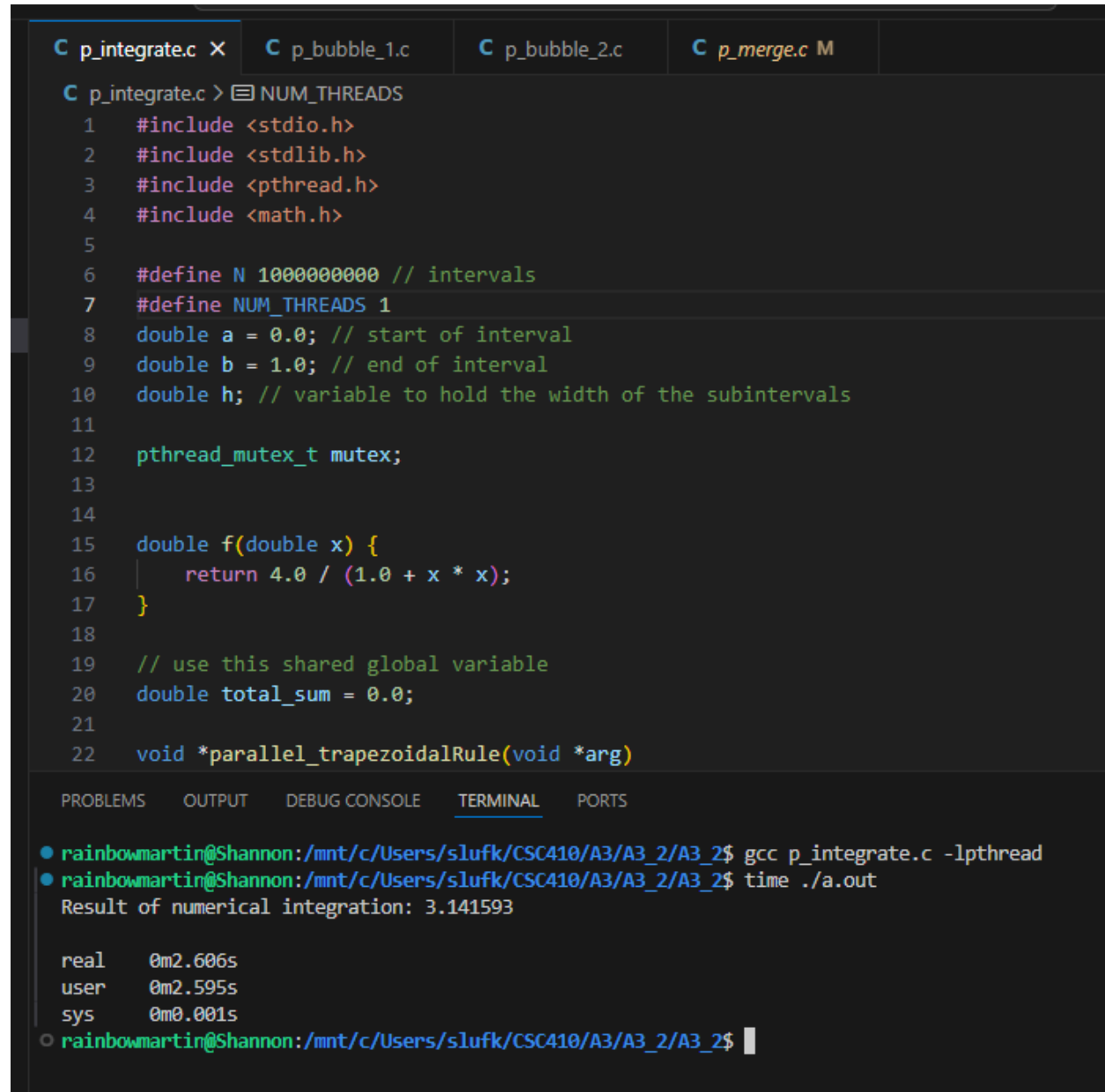
Sequential

```
C numIntegrate.c U x
C numIntegrate.c > N
1  #include <stdio.h>
2
3  #define N 1000000000 // intervals
4
5  double f(double x) {
6      return 4.0 / (1.0 + x * x); // Function to integrate
7  }
8
9  double trapezoidalRule()
10 {
11     // Upper limit and lower limit
12     double start = 0.0;
13     double end = 1.0;
14
15     // Width of each trapezoid
16     double trapWidth = end / N;
17     // Total of trapezoid areas
18     double total = 0.0;
19
20     // First point contributes half
21     total += f(start) / 2;
22
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential_Martin$ gcc numIntegrate.c
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential_Martin$ time ./a.out
Estimated value of  $\pi$ : 3.141593

real    0m2.781s
user    0m2.772s
sys     0m0.001s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/sequential/sequential_Martin$
```



## Pthread – 1 thread



```
C p_integrate.c X C p_bubble_1.c C p_bubble_2.c C p_merge.c M
C p_integrate.c > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4  #include <math.h>
5
6  #define N 1000000000 // intervals
7  #define NUM_THREADS 1
8  double a = 0.0; // start of interval
9  double b = 1.0; // end of interval
10 double h; // variable to hold the width of the subintervals
11
12 pthread_mutex_t mutex;
13
14
15 double f(double x) {
16     return 4.0 / (1.0 + x * x);
17 }
18
19 // use this shared global variable
20 double total_sum = 0.0;
21
22 void *parallel_trapezoidalRule(void *arg)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ gcc p\_integrate.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ time ./a.out

Result of numerical integration: 3.141593

real 0m2.606s  
user 0m2.595s  
sys 0m0.001s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$

## Pthread – 2 threads

```
C p_integrate.c M X C p_bubble_1.c C p_bubble_2.c C p_merge.c M
C p_integrate.c > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4  #include <math.h>
5
6  #define N 1000000000 // intervals
7  #define NUM_THREADS 2
8  double a = 0.0; // start of interval
9  double b = 1.0; // end of interval
10 double h; // variable to hold the width of the subintervals
11
12 pthread_mutex_t mutex;
13
14
15 double f(double x) {
16     return 4.0 / (1.0 + x * x);
17 }
18
19 // use this shared global variable
20 double total_sum = 0.0;
21
22 void *parallel_trapezoidalRule(void *arg)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ gcc p\_integrate.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ time ./a.out

Result of numerical integration: 3.141593

```
real    0m1.713s
user    0m3.394s
sys     0m0.001s
```

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$

## Pthread – 5 threads

```
C p_integrate.c M X C p_bubble_1.c C p_bubble_2.c C p_merge.c M
C p_integrate.c > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4  #include <math.h>
5
6  #define N 1000000000 // intervals
7  #define NUM_THREADS 5
8  double a = 0.0; // start of interval
9  double b = 1.0; // end of interval
10 double h; // variable to hold the width of the subintervals
11
12 pthread_mutex_t mutex;
13
14
15 double f(double x) {
16     return 4.0 / (1.0 + x * x);
17 }
18
19 // use this shared global variable
20 double total_sum = 0.0;
21
22 void *parallel_trapezoidalRule(void *arg)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ gcc p\_integrate.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ time ./a.out

Result of numerical integration: 3.141593

real 0m0.952s  
user 0m4.531s  
sys 0m0.001s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$

## Pthread - 7 threads

```
C p_integrate.c M X C p_bubble_1.c C p_bubble_2.c C p_merge.c M
C p_integrate.c > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4  #include <math.h>
5
6  #define N 1000000000 // intervals
7  #define NUM_THREADS 7
8  double a = 0.0; // start of interval
9  double b = 1.0; // end of interval
10 double h; // variable to hold the width of the subintervals
11
12 pthread_mutex_t mutex;
13
14
15 double f(double x) {
16     return 4.0 / (1.0 + x * x);
17 }
18
19 // use this shared global variable
20 double total_sum = 0.0;
21
22 void *parallel_trapezoidalRule(void *arg)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ gcc p\_integrate.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ time ./a.out

Result of numerical integration: 3.141593

```
real    0m0.769s
user    0m5.172s
sys     0m0.000s
rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3_2/A3_2$
```

## Pthread - 9 threads

```
C p_integrate.c M X C p_bubble_1.c C p_bubble_2.c C p_merge.c M
C p_integrate.c > NUM_THREADS
1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <pthread.h>
4  #include <math.h>
5
6  #define N 1000000000 // intervals
7  #define NUM_THREADS 9
8  double a = 0.0; // start of interval
9  double b = 1.0; // end of interval
10 double h; // variable to hold the width of the subintervals
11
12 pthread_mutex_t mutex;
13
14
15 double f(double x) {
16     return 4.0 / (1.0 + x * x);
17 }
18
19 // use this shared global variable
20 double total_sum = 0.0;
21
22 void *parallel_trapezoidalRule(void *arg)
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

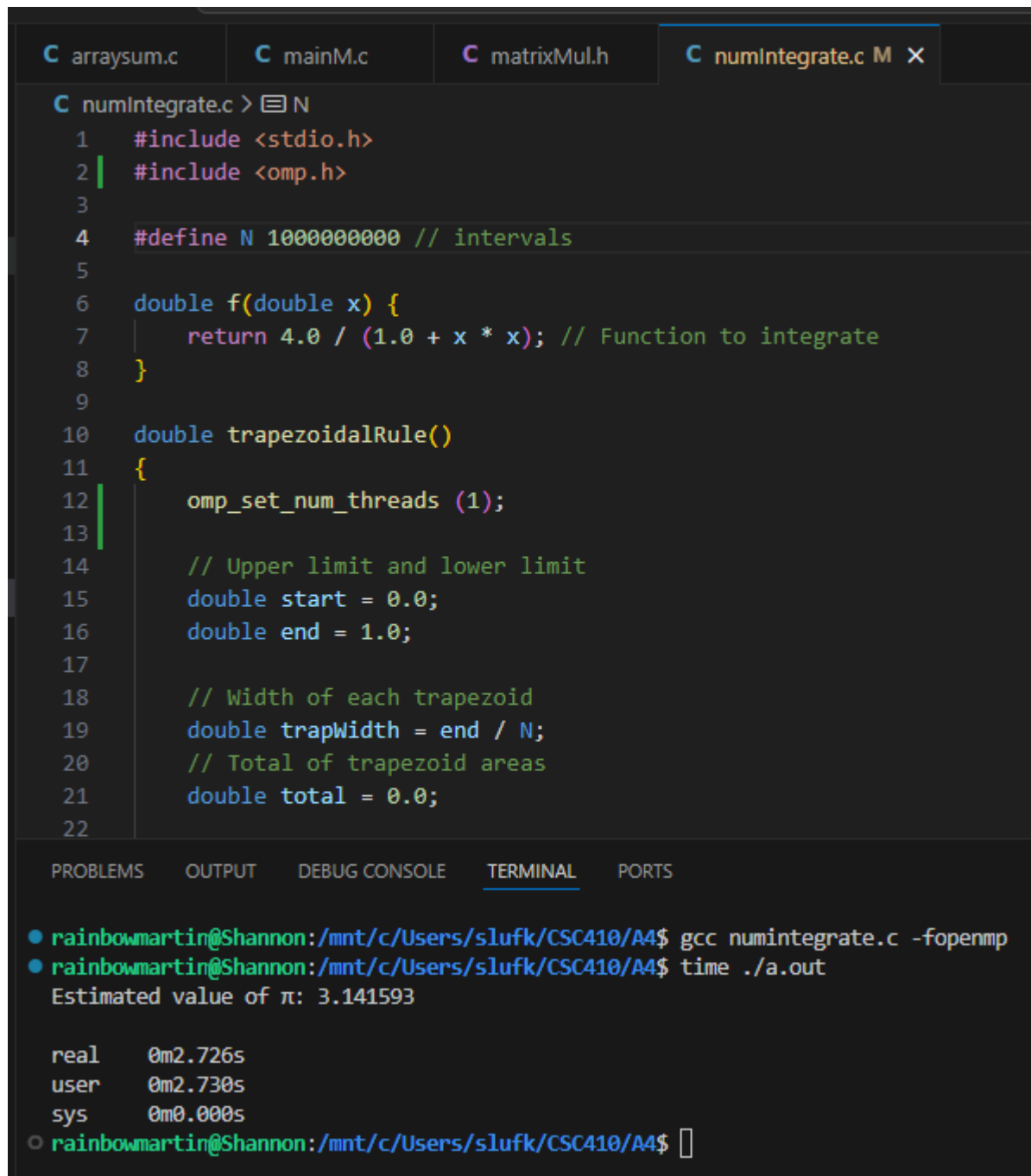
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ gcc p\_integrate.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$ time ./a.out

Result of numerical integration: 3.141593

real 0m0.801s  
user 0m5.691s  
sys 0m0.025s

rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A3/A3\_2/A3\_2\$

Omp – 1 thread



```
C arraysum.c C mainM.c C matrixMul.h C numIntegrate.c M X
C numIntegrate.c > N
1  #include <stdio.h>
2  #include <omp.h>
3
4  #define N 1000000000 // intervals
5
6  double f(double x) {
7      return 4.0 / (1.0 + x * x); // Function to integrate
8  }
9
10 double trapezoidalRule()
11 {
12     omp_set_num_threads (1);
13
14     // Upper limit and lower limit
15     double start = 0.0;
16     double end = 1.0;
17
18     // Width of each trapezoid
19     double trapWidth = end / N;
20     // Total of trapezoid areas
21     double total = 0.0;
22
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc numintegrate.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Estimated value of  $\pi$ : 3.141593

real    0m2.726s
user    0m2.730s
sys      0m0.000s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```

Omp – 2 threads

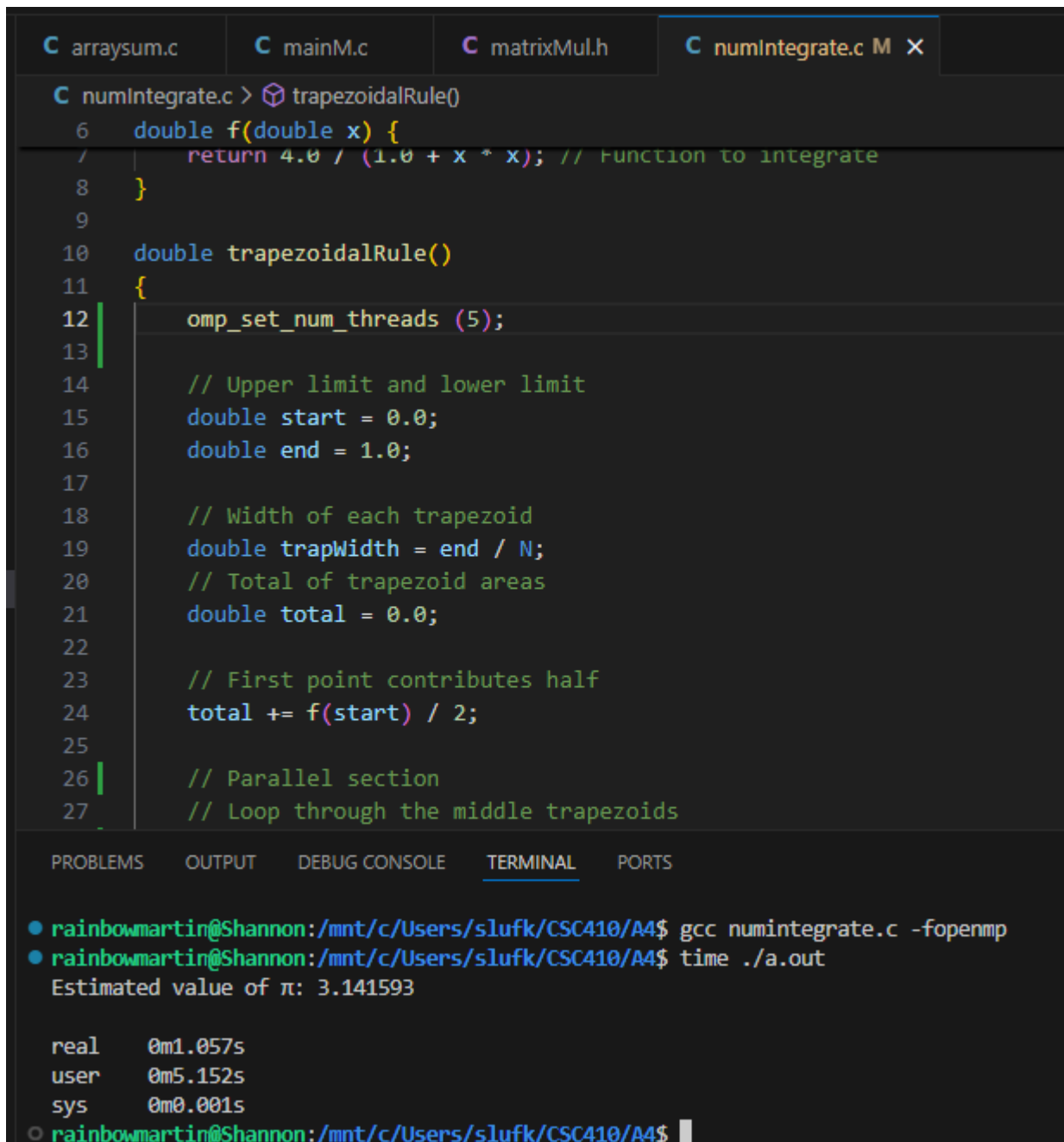
```
C arraysum.c  C mainM.c  C matrixMul.h  C numIntegrate.c M X
C numIntegrate.c > trapezoidalRule()
6  double f(double x) {
7      return 4.0 / (1.0 + x * x); // Function to integrate
8  }
9
10 double trapezoidalRule()
11 {
12     omp_set_num_threads (2);
13
14     // Upper limit and lower limit
15     double start = 0.0;
16     double end = 1.0;
17
18     // Width of each trapezoid
19     double trapWidth = end / N;
20     // Total of trapezoid areas
21     double total = 0.0;
22
23     // First point contributes half
24     total += f(start) / 2;
25
26     // Parallel section
27     // Loop through the middle trapezoids
28
29     // Last point contributes half
30     total += f(end) / 2;
31
32     return total;
33 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc numintegrate.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Estimated value of pi: 3.141593

real    0m1.823s
user    0m3.632s
sys     0m0.001s
```

Omp – 5 threads

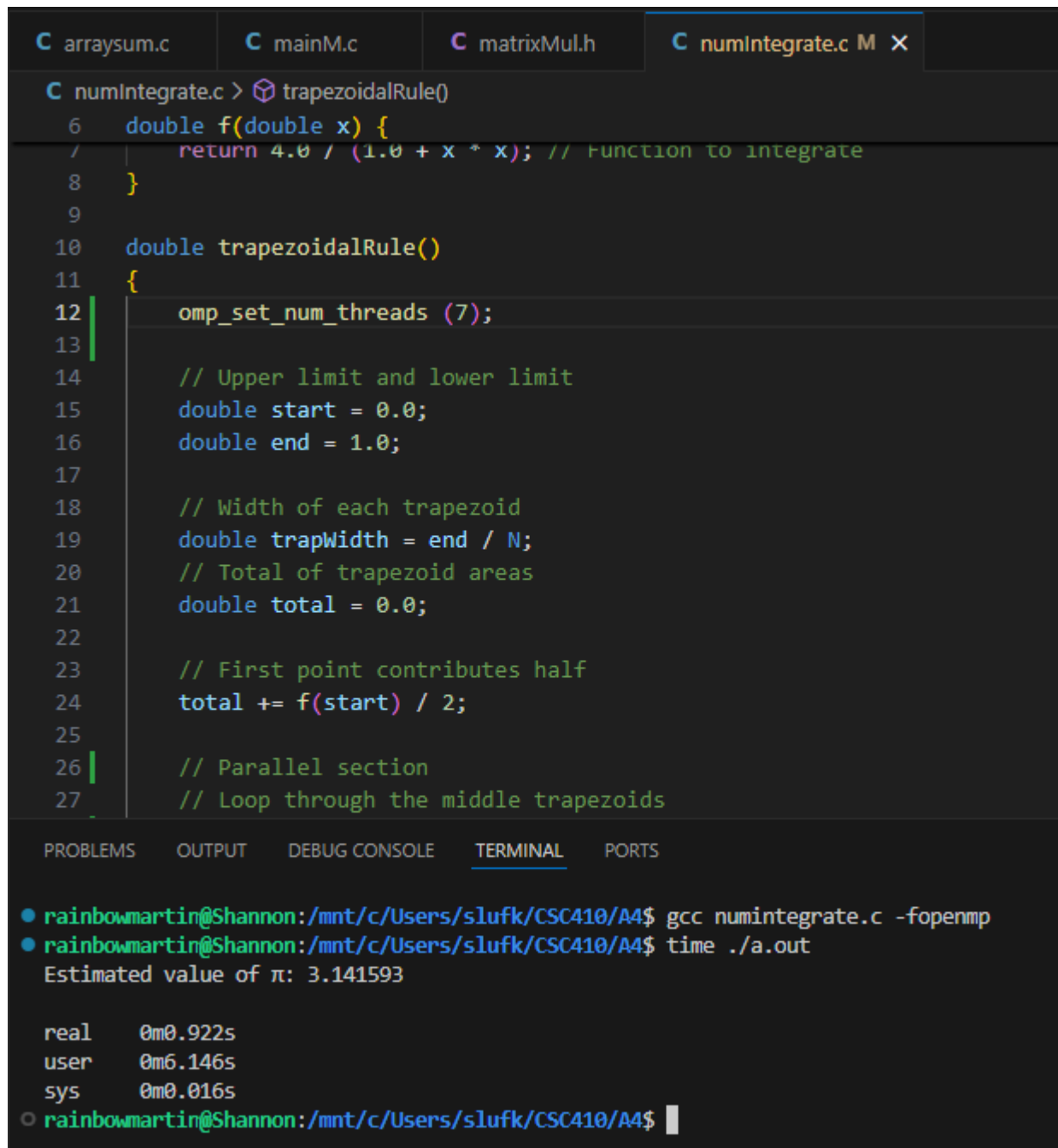


```
C arrays.c  C mainM.c  C matrixMul.h  C numIntegrate.c M X
C numIntegrate.c > trapezoidalRule()
6  double f(double x) {
/   return 4.0 / (1.0 + x * x); // Function to integrate
8  }
9
10 double trapezoidalRule()
11 {
12     omp_set_num_threads (5);
13
14     // Upper limit and lower limit
15     double start = 0.0;
16     double end = 1.0;
17
18     // Width of each trapezoid
19     double trapWidth = end / N;
20     // Total of trapezoid areas
21     double total = 0.0;
22
23     // First point contributes half
24     total += f(start) / 2;
25
26     // Parallel section
27     // Loop through the middle trapezoids
28
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ gcc numintegrate.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$ time ./a.out
Estimated value of π: 3.141593

real    0m1.057s
user    0m5.152s
sys     0m0.001s
○ rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4$
```



Omp – 7 threads



```
C arrays.c C mainM.c C matrixMul.h C numIntegrate.c M X
C numIntegrate.c > trapezoidalRule()
6 double f(double x) {
7     return 4.0 / (1.0 + x * x); // Function to integrate
8 }
9
10 double trapezoidalRule()
11 {
12     omp_set_num_threads (7);
13
14     // Upper limit and lower limit
15     double start = 0.0;
16     double end = 1.0;
17
18     // Width of each trapezoid
19     double trapWidth = end / N;
20     // Total of trapezoid areas
21     double total = 0.0;
22
23     // First point contributes half
24     total += f(start) / 2;
25
26     // Parallel section
27     // Loop through the middle trapezoids
28 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$ gcc numintegrate.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$ time ./a.out

Estimated value of  $\pi$ : 3.141593

real 0m0.922s  
user 0m6.146s  
sys 0m0.016s

rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$

Omp – 9 threads

```
arraysum.c  mainM.c  matrixMul.h  numIntegrate.c M x
numIntegrate.c > trapezoidalRule()
6  double f(double x) {
   /   return 4.0 / (1.0 + x * x); // Function to integrate
8  }
9
10 double trapezoidalRule()
11 {
12     omp_set_num_threads (9);
13
14     // Upper limit and lower limit
15     double start = 0.0;
16     double end = 1.0;
17
18     // Width of each trapezoid
19     double trapWidth = end / N;
20     // Total of trapezoid areas
21     double total = 0.0;
22
23     // First point contributes half
24     total += f(start) / 2;
25
26     // Parallel section
27     // Loop through the middle trapezoids
28
29     // Loop through the middle trapezoids
30     for (int i = 1; i < N; i++)
31     {
32         double x1 = start + i * trapWidth;
33         double x2 = x1 + trapWidth;
34         double f1 = f(x1);
35         double f2 = f(x2);
36         total += (f1 + f2) * trapWidth;
37     }
38     return total;
39 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$ gcc numintegrate.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$ time ./a.out

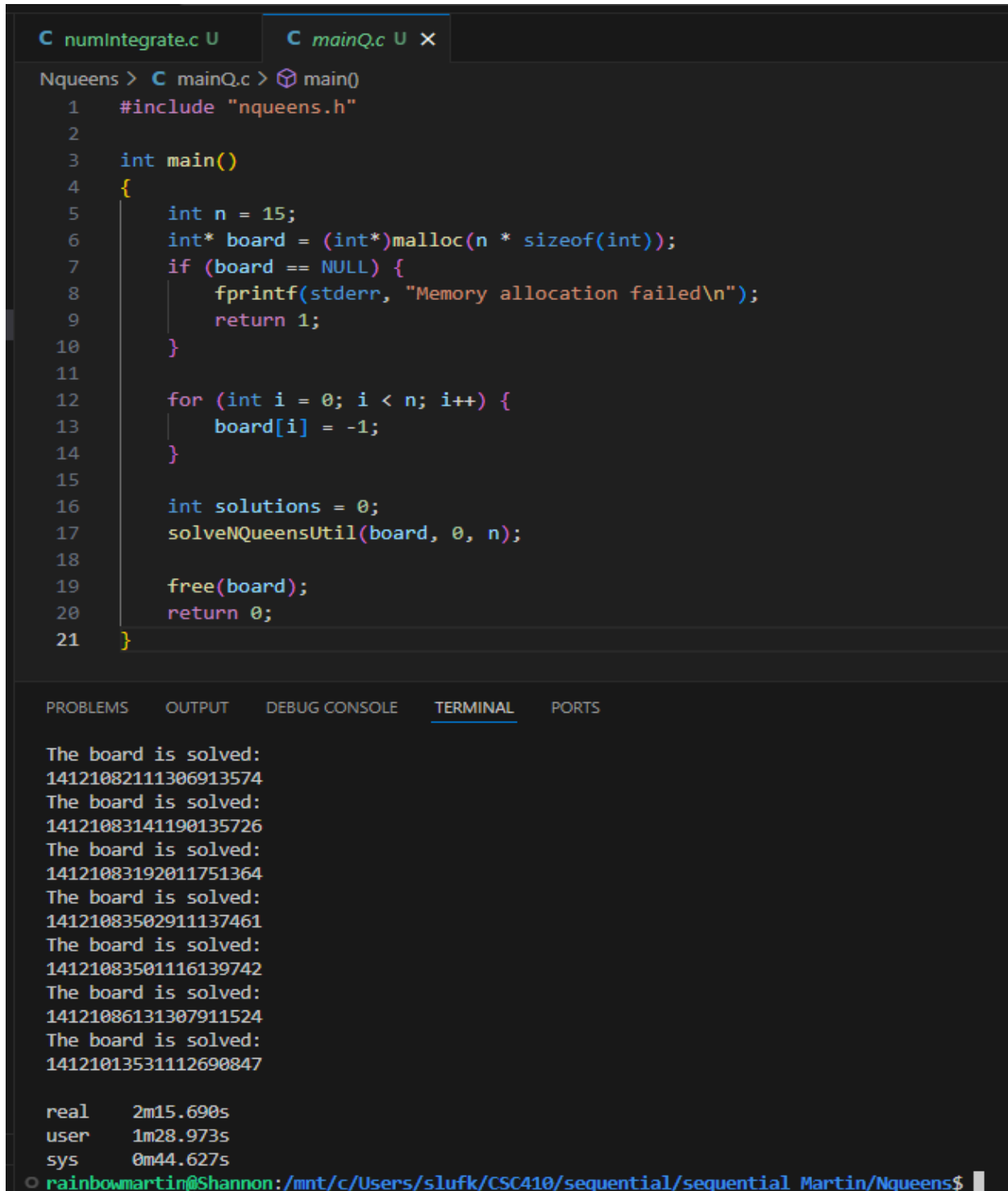
Estimated value of  $\pi$ : 3.141593

real 0m0.945s  
user 0m6.732s  
sys 0m0.033s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4\$

# N Queens

Sequential



```
C numIntegrate.c U C mainQ.c U X
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2
3  int main()
4  {
5      int n = 15;
6      int* board = (int*)malloc(n * sizeof(int));
7      if (board == NULL) {
8          fprintf(stderr, "Memory allocation failed\n");
9          return 1;
10     }
11
12     for (int i = 0; i < n; i++) {
13         board[i] = -1;
14     }
15
16     int solutions = 0;
17     solveNQueensUtil(board, 0, n);
18
19     free(board);
20     return 0;
21 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

The board is solved:  
14121082111306913574  
The board is solved:  
14121083141190135726  
The board is solved:  
14121083192011751364  
The board is solved:  
14121083502911137461  
The board is solved:  
14121083501116139742  
The board is solved:  
14121086131307911524  
The board is solved:  
14121013531112690847

real 2m15.690s  
user 1m28.973s  
sys 0m44.627s

rainbowmartin@Shannon: /mnt/c/Users/slufk/CSC410/sequential/sequential\_Martin/Nqueens\$

## Pthread – 1 thread

```
C nqueens.c M X
C nqueens.c > Max_Threads
1 // Parallelize N queens with pthreads!
2
3 #include <stdio.h>
4 #include <stdbool.h>
5 #include <stdlib.h>
6 #include <pthread.h>
7
8 #define N 15 // Board size
9 #define K 2 // Number of rows explored per thread
10 #define Max_Threads 1 // Number of threads
11
12 // Create structure of partial boards for threads
13 typedef struct {
14     int thisBoard[K];
15 } perThread;
16
17 perThread queue[10000];
18 int task = 0;
19 int taskQueue = 0;
20
21 int total_solutions = 0;
22 pthread_mutex_t lock;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ gcc nqueens.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ time ./a.out

Total solutions for N=15: 2279184

real 0m48.580s  
user 0m48.548s  
sys 0m0.008s

rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$

## Pthread – 2 threads

```
C nqueens.c M X
C nqueens.c > Max_Threads
1 // Parallelize N queens with pthreads!
2
3 #include <stdio.h>
4 #include <stdbool.h>
5 #include <stdlib.h>
6 #include <pthread.h>
7
8 #define N 15 // Board size
9 #define K 2 // Number of rows explored per thread
10 #define Max_Threads 2 // Number of threads
11
12 // Create structure of partial boards for threads
13 typedef struct {
14     int thisBoard[K];
15 } perThread;
16
17 perThread queue[10000];
18 int task = 0;
19 int taskQueue = 0;
20
21 int total_solutions = 0;
22 pthread_mutex_t lock;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ gcc nqueens.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ time ./a.out

Total solutions for N=15: 2279184

real 0m31.661s  
user 1m3.395s  
sys 0m0.000s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$

pthread – 5 threads

```
C nqueens.c M X
C nqueens.c > Max_Threads
1 // Parallelize N queens with pthreads!
2
3 #include <stdio.h>
4 #include <stdbool.h>
5 #include <stdlib.h>
6 #include <pthread.h>
7
8 #define N 15 // Board size
9 #define K 2 // Number of rows explored per thread
10 #define Max_Threads 5 // Number of threads
11
12 // Create structure of partial boards for threads
13 typedef struct {
14     int thisBoard[K];
15 } perThread;
16
17 perThread queue[10000];
18 int task = 0;
19 int taskQueue = 0;
20
21 int total_solutions = 0;
22 pthread_mutex_t lock;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ gcc nqueens.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ time ./a.out

Total solutions for N=15: 2279184

real 0m15.069s  
user 1m15.143s  
sys 0m0.005s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$

## Pthread - 7 threads

C nqueens.c M X

C nqueens.c > Max\_Threads

```
1 // Parallelize N queens with pthreads!
2
3 #include <stdio.h>
4 #include <stdbool.h>
5 #include <stdlib.h>
6 #include <pthread.h>
7
8 #define N 15 // Board size
9 #define K 2 // Number of rows explored per thread
10 #define Max_Threads 7 // Number of threads
11
12 // Create structure of partial boards for threads
13 typedef struct {
14     int thisBoard[K];
15 } perThread;
16
17 perThread queue[10000];
18 int task = 0;
19 int taskQueue = 0;
20
21 int total_solutions = 0;
22 pthread_mutex_t lock;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ gcc nqueens.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ time ./a.out  
Total solutions for N=15: 2279184  
  
real 0m13.172s  
user 1m30.657s  
sys 0m0.029s
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$

## Pthread - 9 threads

```
C nqueens.c M X
C nqueens.c > Max_Threads
1 // Parallelize N queens with pthreads!
2
3 #include <stdio.h>
4 #include <stdbool.h>
5 #include <stdlib.h>
6 #include <pthread.h>
7
8 #define N 15 // Board size
9 #define K 2 // Number of rows explored per thread
10 #define Max_Threads 9 // Number of threads
11
12 // Create structure of partial boards for threads
13 typedef struct {
14     int thisBoard[K];
15 } perThread;
16
17 perThread queue[10000];
18 int task = 0;
19 int taskQueue = 0;
20
21 int total_solutions = 0;
22 pthread_mutex_t lock;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ gcc nqueens.c -lpthread
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$ time ./a.out

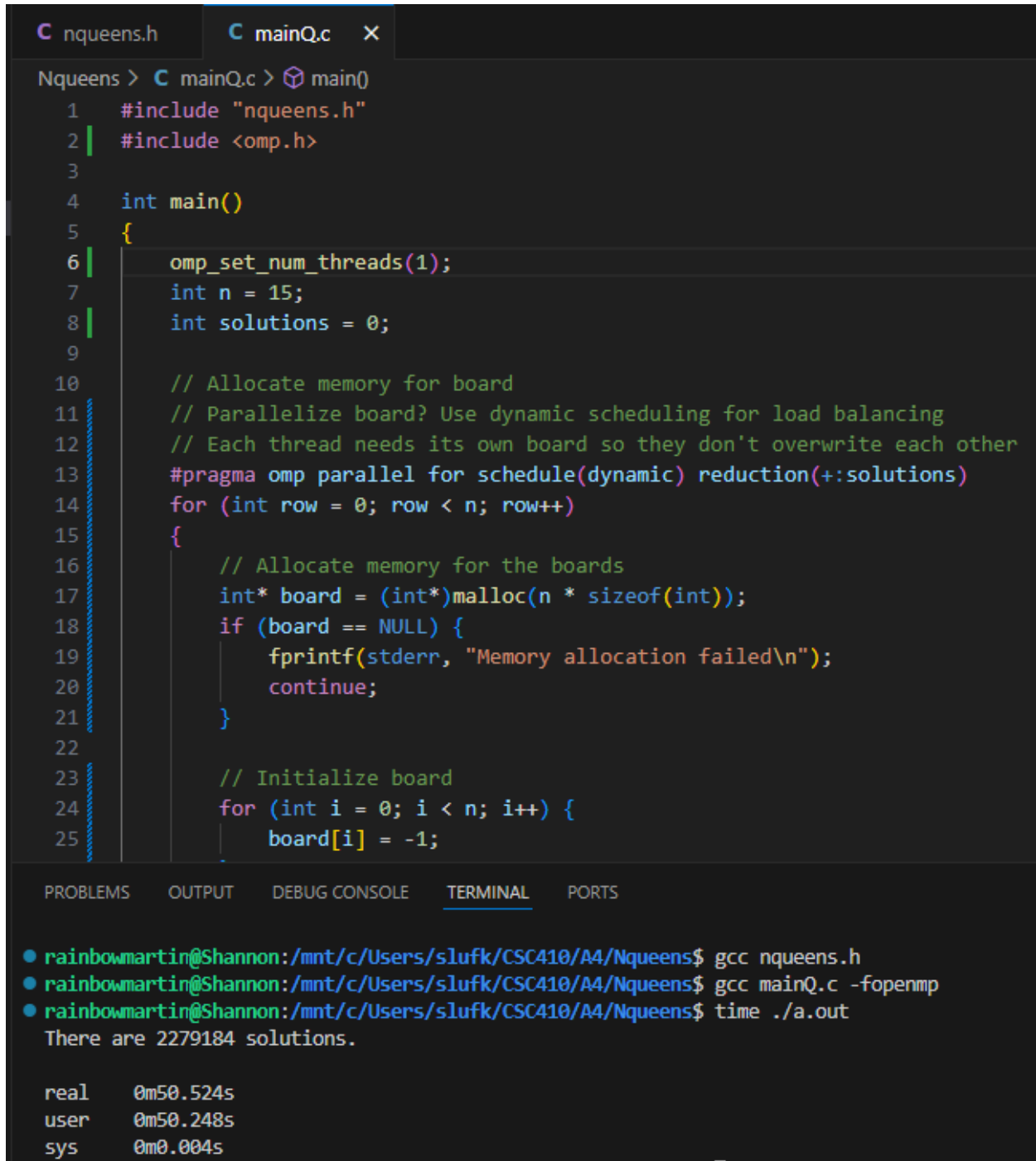
Total solutions for N=15: 2279184

real 0m13.312s  
user 1m44.562s  
sys 0m0.118s

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/Midterm\$



## Omp – 1 thread



```
nqueens.h  mainQ.c x
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2  #include <omp.h>
3
4  int main()
5  {
6      omp_set_num_threads(1);
7      int n = 15;
8      int solutions = 0;
9
10     // Allocate memory for board
11     // Parallelize board? Use dynamic scheduling for load balancing
12     // Each thread needs its own board so they don't overwrite each other
13     #pragma omp parallel for schedule(dynamic) reduction(+:solutions)
14     for (int row = 0; row < n; row++)
15     {
16         // Allocate memory for the boards
17         int* board = (int*)malloc(n * sizeof(int));
18         if (board == NULL) {
19             fprintf(stderr, "Memory allocation failed\n");
20             continue;
21         }
22
23         // Initialize board
24         for (int i = 0; i < n; i++) {
25             board[i] = -1;
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc nqueens.h
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc mainQ.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ time ./a.out

There are 2279184 solutions.

real 0m50.524s  
user 0m50.248s  
sys 0m0.004s

## Omp – 2 threads

```

C nqueens.h  C mainQ.c  X
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2  #include <omp.h>
3
4  int main()
5  {
6      omp_set_num_threads(2);
7      int n = 15;
8      int solutions = 0;
9
10     // Allocate memory for board
11     // Parallelize board? Use dynamic scheduling for load balancing
12     // Each thread needs its own board so they don't overwrite each other
13     #pragma omp parallel for schedule(dynamic) reduction(+:solutions)
14     for (int row = 0; row < n; row++)
15     {
16         // Allocate memory for the boards
17         int* board = (int*)malloc(n * sizeof(int));
18         if (board == NULL) {
19             fprintf(stderr, "Memory allocation failed\n");
20             continue;
21         }
22
23         // Initialize board
24         for (int i = 0; i < n; i++) {
25             board[i] = -1;

```

PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL   PORTS

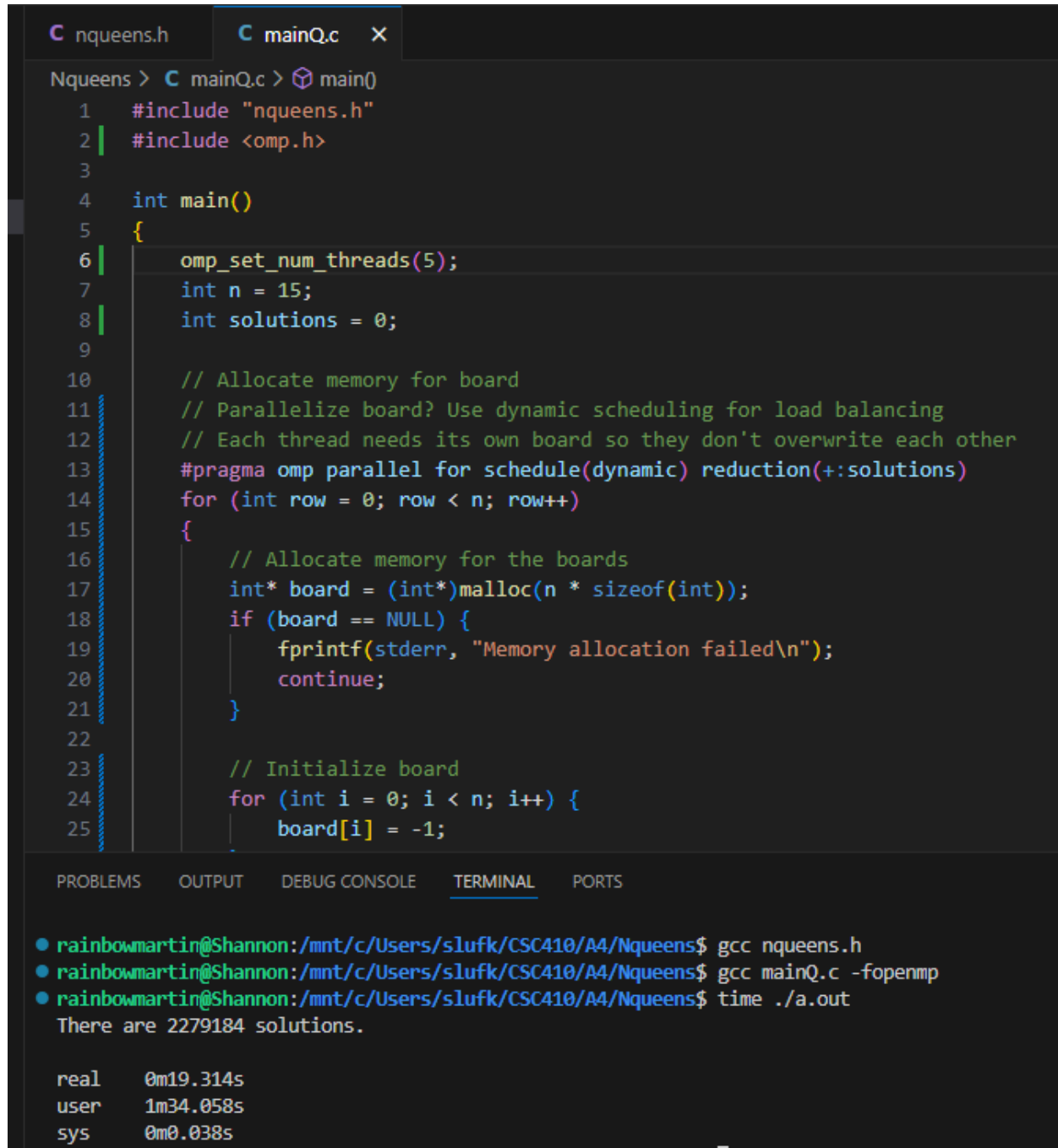
```

● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens$ gcc nqueens.h
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens$ gcc mainQ.c -fopenmp
● rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens$ time ./a.out
There are 2279184 solutions.

real    0m31.670s
user    1m1.185s
sys     0m0.000s

```

## Omp – 5 threads



```

C nqueens.h  C mainQ.c  X
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2  #include <omp.h>
3
4  int main()
5  {
6      omp_set_num_threads(5);
7      int n = 15;
8      int solutions = 0;
9
10     // Allocate memory for board
11     // Parallelize board? Use dynamic scheduling for load balancing
12     // Each thread needs its own board so they don't overwrite each other
13     #pragma omp parallel for schedule(dynamic) reduction(+:solutions)
14     for (int row = 0; row < n; row++)
15     {
16         // Allocate memory for the boards
17         int* board = (int*)malloc(n * sizeof(int));
18         if (board == NULL) {
19             fprintf(stderr, "Memory allocation failed\n");
20             continue;
21         }
22
23         // Initialize board
24         for (int i = 0; i < n; i++) {
25             board[i] = -1;

```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc nqueens.h
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc mainQ.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ time ./a.out

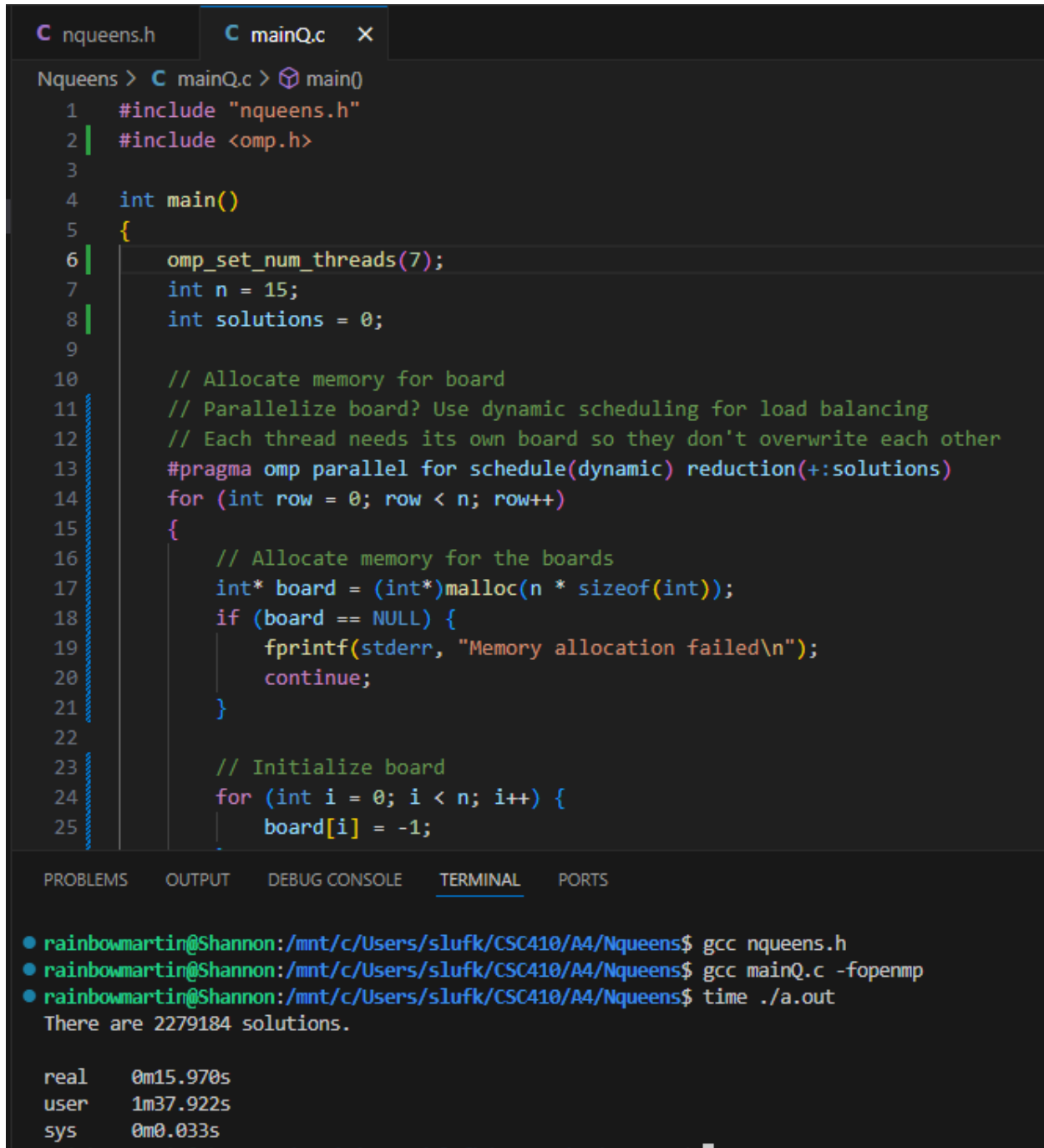
There are 2279184 solutions.

```

real    0m19.314s
user    1m34.058s
sys     0m0.038s

```

## Omp – 7 threads



```
C nqueens.h C mainQ.c X
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2  #include <omp.h>
3
4  int main()
5  {
6      omp_set_num_threads(7);
7      int n = 15;
8      int solutions = 0;
9
10     // Allocate memory for board
11     // Parallelize board? Use dynamic scheduling for load balancing
12     // Each thread needs its own board so they don't overwrite each other
13     #pragma omp parallel for schedule(dynamic) reduction(+:solutions)
14     for (int row = 0; row < n; row++)
15     {
16         // Allocate memory for the boards
17         int* board = (int*)malloc(n * sizeof(int));
18         if (board == NULL) {
19             fprintf(stderr, "Memory allocation failed\n");
20             continue;
21         }
22
23         // Initialize board
24         for (int i = 0; i < n; i++) {
25             board[i] = -1;
```

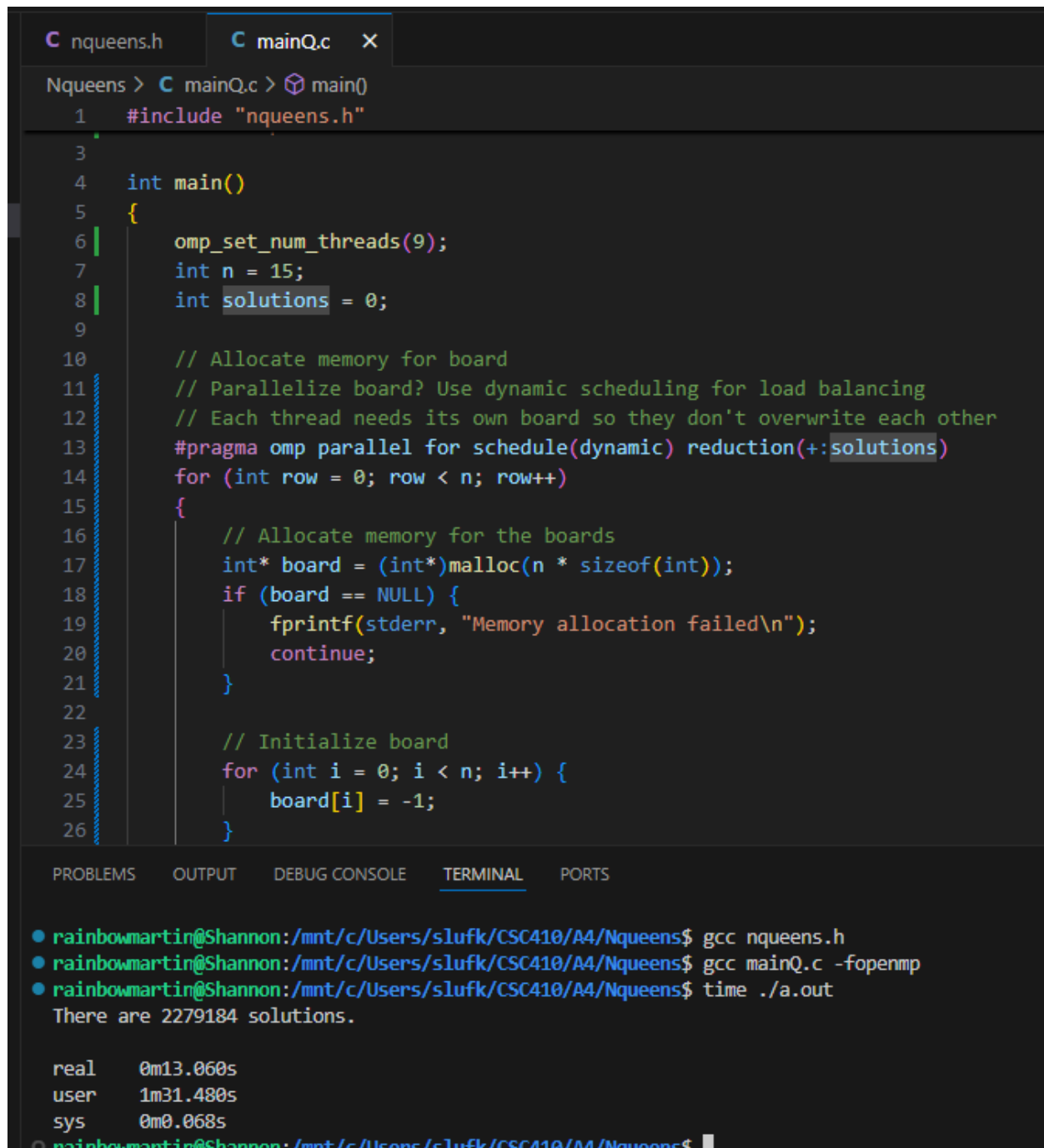
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc nqueens.h
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc mainQ.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ time ./a.out

There are 2279184 solutions.

```
real    0m15.970s
user    1m37.922s
sys     0m0.033s
```

## Omp – 9 threads



```
nqueens.h  mainQ.c X
Nqueens > C mainQ.c > main()
1  #include "nqueens.h"
2
3
4  int main()
5  {
6      omp_set_num_threads(9);
7      int n = 15;
8      int solutions = 0;
9
10     // Allocate memory for board
11     // Parallelize board? Use dynamic scheduling for load balancing
12     // Each thread needs its own board so they don't overwrite each other
13     #pragma omp parallel for schedule(dynamic) reduction(+:solutions)
14     for (int row = 0; row < n; row++)
15     {
16         // Allocate memory for the boards
17         int* board = (int*)malloc(n * sizeof(int));
18         if (board == NULL) {
19             fprintf(stderr, "Memory allocation failed\n");
20             continue;
21         }
22
23         // Initialize board
24         for (int i = 0; i < n; i++) {
25             board[i] = -1;
26         }
27     }
28 }
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc nqueens.h
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ gcc mainQ.c -fopenmp
- rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$ time ./a.out

There are 2279184 solutions.

real 0m13.060s  
user 1m31.480s  
sys 0m0.068s

rainbowmartin@Shannon:/mnt/c/Users/slufk/CSC410/A4/Nqueens\$