CSE 4001

PARALLEL AND DISTRIBUTED COMPUTING

Lab Assessment – 1

L27+L28 | PLBG04
Dr. Narayanan Prasanth

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by

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19BCE2105

Q1. Develop an OpenMP program to parallelize the matrix vector multiplication.

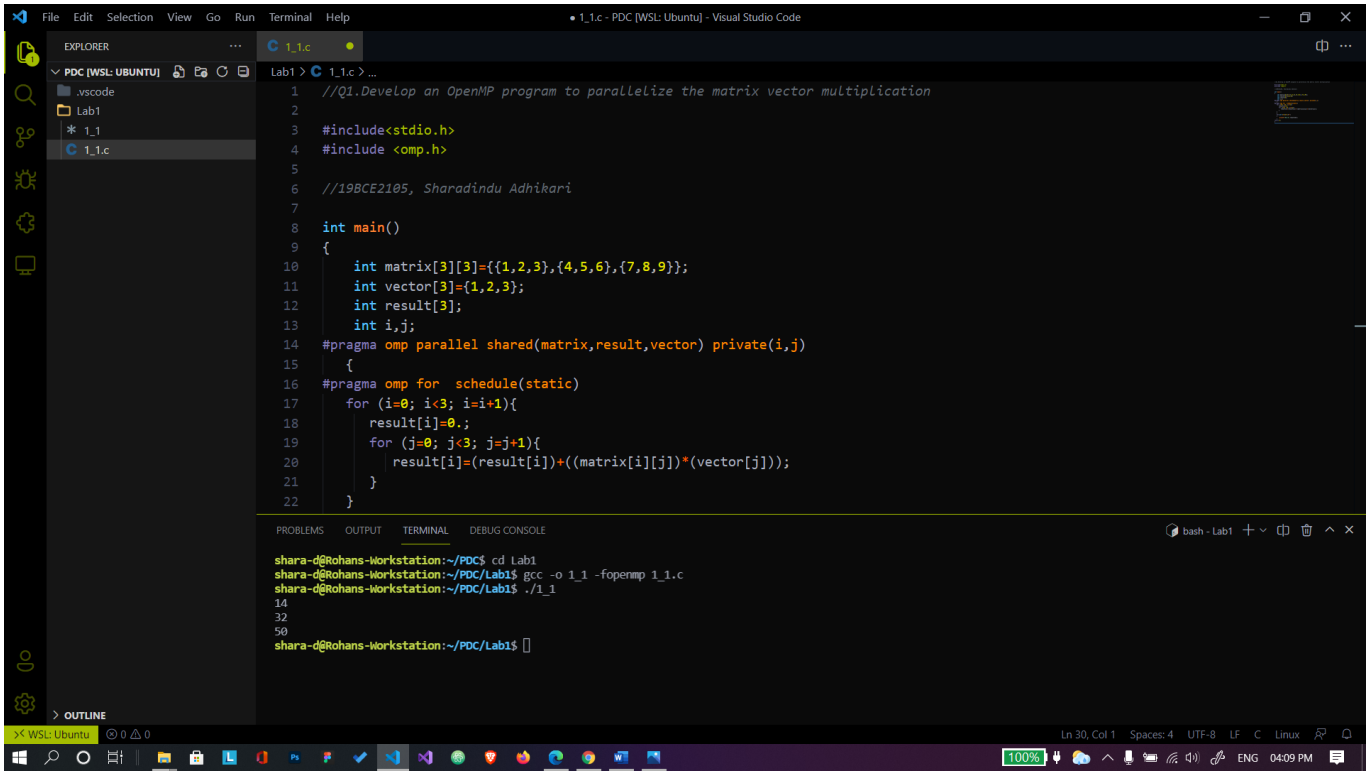
Code and Input:

```
//Q1. Develop an OpenMP program to parallelize the matrix vector multiplication

#include<stdio.h>
#include <omp.h>

//19BCE2105, Sharadindu Adhikari

int main()
{
    int matrix[3][3]={{1,2,3},{4,5,6},{7,8,9}};
    int vector[3]={1,2,3};
    int result[3];
    int i,j;
#pragma omp parallel shared(matrix,result,vector) private(i,j)
   {
#pragma omp for  schedule(static)
   for (i=0; i<3; i=i+1){
      result[i]=0.;
      for (j=0; j<3; j=j+1){
         result[i]=(result[i])+((matrix[i][j])*(vector[j]));
      }
   }
   }
   for(int k=0;k<3;k++)
   {
       printf("%d \n",result[k]);
   }
return 0;
}
```

Output:

```
shara-d@Rohans-Workstation:~/PDC$ cd Lab1
shara-d@Rohans-Workstation:~/PDC/Lab1$ gcc -o 1_1 -fopenmp 1_1.c
shara-d@Rohans-Workstation:~/PDC/Lab1$ ./1_1
14
32
50
```

Screenshot:



Q2. Develop an OpenMP program to find the occurrence of min and max element in the provided list. These operations have to be performed in different sections and thereby executed by different threads. Print the time taken by both the sections. List = {2,3,4,5,5,4,5,3,2,7,8,2}

Code and Input:

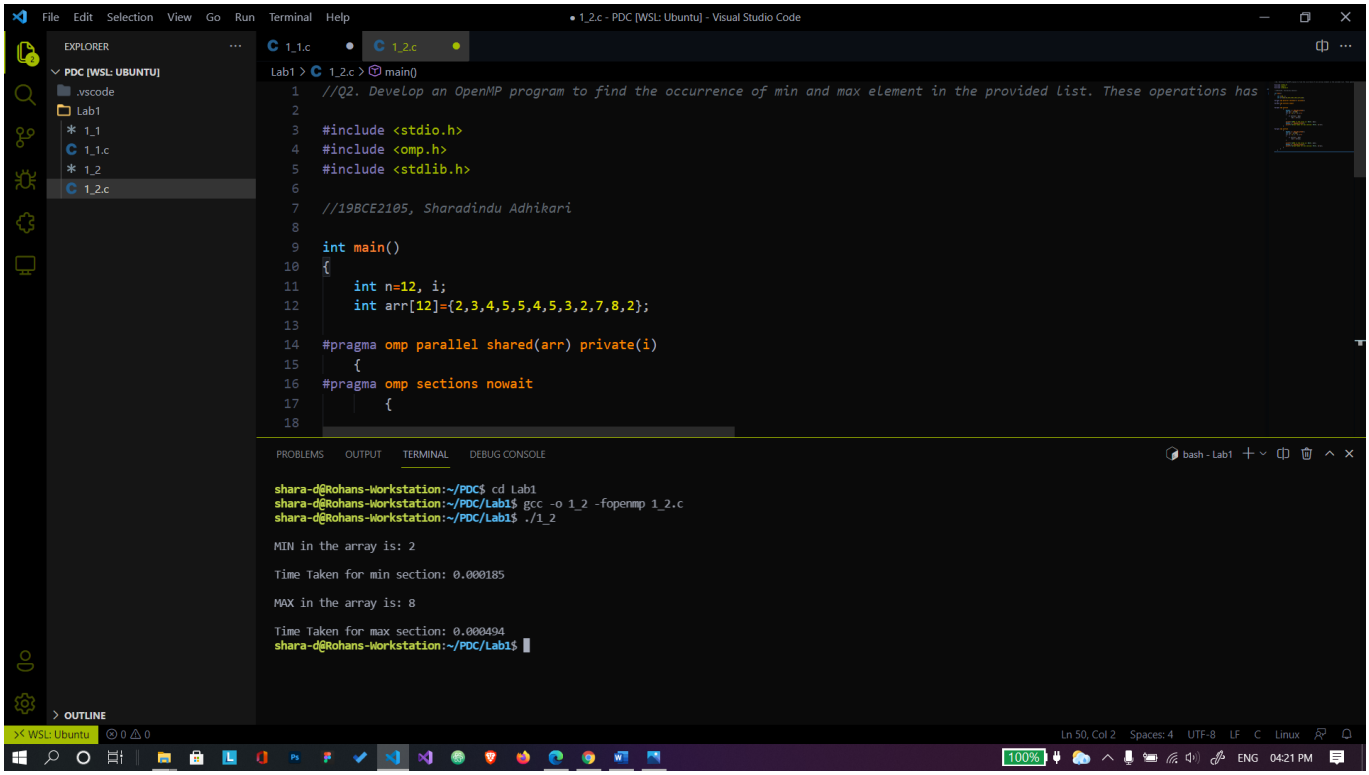
```
//Q2. Develop an OpenMP program to find the occurrence of min and max element in the provided list. These operations has to be performed in different sections and thereby executed by different threads. Print the time taken by both the sections. List = {2,3,4,5,5,4,5,3,2,7,8,2}

#include <stdio.h>
#include <omp.h>
#include <stdlib.h>

//19BCE2105, Sharadindu Adhikari

int main()
{
    int n=12, i;
    int arr[12]={2,3,4,5,5,4,5,3,2,7,8,2};

#pragma omp parallel shared(arr) private(i)
```

```
    {
#pragma omp sections nowait
        {
#pragma omp section
            {
                double x = omp_get_wtime();
                int max = arr[0];
                for (i = 1; i < n; i++)
                {
                    if (arr[i] > max)
                        max = arr[i];
                }
                printf("\nMAX in the array is: %d\n", max);
                double y = omp_get_wtime();
                printf("\nTime Taken for max section: %f\n", (y-x));
            }

#pragma omp section
            {
                double a = omp_get_wtime();
                int min = arr[0];
                for (i = 1; i < n; i++)
                {
                    if (arr[i] < min)
                        min = arr[i];
                }
                printf("\nMIN in the array is: %d\n", min);
                double b = omp_get_wtime();
                printf("\nTime Taken for min section: %f\n", (b-a));
            }
        }
    }
}
```

Output:

```
shara-d@Rohans-Workstation:~/PDC/Lab1$ gcc -o 1_2 -fopenmp 1_2.c
shara-d@Rohans-Workstation:~/PDC/Lab1$ ./1_2

MIN in the array is: 2
Time Taken for min section: 0.000185
MAX in the array is: 8
Time Taken for max section: 0.000494
```

Screenshot:



Q3. Develop a C program which counts the number of primes between 1 and N, use OpenMP to carry out the calculation in parallel. Display time taken for each computation of N successfully.

Code and Input:

```
//Develop a C program which counts the number of primes between 1 and N, use OpenMP to carry out the calculation in parallel. Display the time taken for each computation of N successfully.

# include <stdlib.h>
# include <stdio.h>
# include <omp.h>

//19BCE2105, Sharadindu Adhikari

int main ( int argc, char *argv[] );
void prime_number_sweep ( int n_lo, int n_hi, int n_factor );
int prime_number ( int n );

int main ( int argc, char *argv[] )
{
  int n_factor;
  int n_hi;
```

```
  int n_lo;

  printf ( "\n" );
  printf ( "PRIME_OPENMP\n" );

  printf ( "\n" );
  printf ( "  Number of processors available = %d\n", omp_get_num_procs ( ) );
  printf ( "  Number of threads =              %d\n", omp_get_max_threads ( ) );

  n_lo = 1;
  n_hi = 1000;
  n_factor = 2;

  prime_number_sweep ( n_lo, n_hi, n_factor );

  printf ( "\n" );
  printf ( "PRIME_OPENMP\n" );
  printf ( "  Normal end of execution.\n" );

  return 0;
}

//****************************************************************************

void prime_number_sweep ( int n_lo, int n_hi, int n_factor )

{
  int n;
  int primes;
  double wtime;

  printf ( "\n" );
  printf ( "  Call PRIME_NUMBER to count the primes from 1 to N.\n" );
  printf ( "\n" );
  printf ( "         N        Pi          Time\n" );
  printf ( "\n" );

  n = n_lo;
  while ( n <= n_hi )
  {
    wtime = omp_get_wtime ( );

    primes = prime_number ( n );
    wtime = omp_get_wtime ( ) - wtime;
```

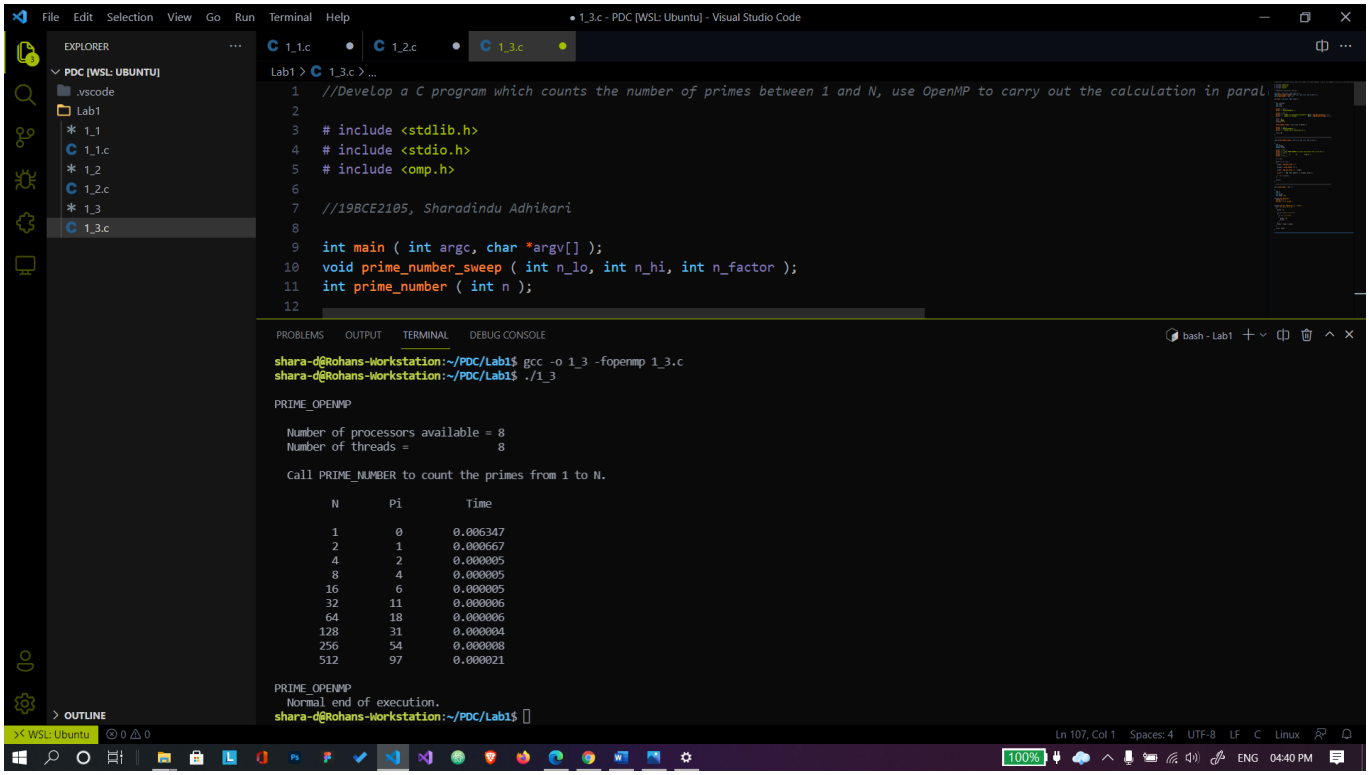
```
    printf ( "  %8d  %8d  %14f\n", n, primes, wtime );
    n = n * n_factor;
  }

  return;
}

//****************************************************************************

int prime_number ( int n )
{
  int i;
  int j;
  int prime;
  int total = 0;

#pragma omp parallel \
  shared ( n ) \
  private ( i, j, prime )

#pragma omp for reduction ( + : total )
  for ( i = 2; i <= n; i++ )
  {
    prime = 1;

    for ( j = 2; j < i; j++ )
    {
      if ( i % j == 0 )
      {
        prime = 0;
        break;
      }
    }
    total = total + prime;
  }

  return total;
}
```

Output:

```
shara-d@Rohans-Workstation:~/PDC/Lab1$ gcc -o 1_3 -fopenmp 1_3.c
shara-d@Rohans-Workstation:~/PDC/Lab1$ ./1_3
```

```
PRIME_OPENMP

  Number of processors available = 8
  Number of threads =              8

  Call PRIME_NUMBER to count the primes from 1 to N.

         N        Pi          Time

         1         0        0.006347
         2         1        0.000667
         4         2        0.000005
         8         4        0.000005
        16         6        0.000005
        32        11        0.000006
        64        18        0.000006
       128        31        0.000004
       256        54        0.000008
       512        97        0.000021

PRIME_OPENMP
  Normal end of execution.
```

Screenshot:



Q4. Write an OpenMP program to demonstrate the time effectiveness of static, dynamic and guided schedule.

Code and Input:

```
//Q4. Write an OpenMP program to demonstrate the time effectiveness of static, dynamic and guided schedule.

# include <stdlib.h>
# include <stdio.h>
# include <omp.h>

//19BCE2105, Sharadindu Adhikari

int main()
{
printf("\nTime effectiveness of Static Schedule\n");
#pragma omp parallel for schedule(static, 3)
for (int i = 0; i < 20; i++)
    {
        printf("Thread %d is running number %d\n", omp_get_thread_num(), i);
    }
printf("\nTime effectiveness of Dynamic Schedule\n");
#pragma omp parallel for schedule(dynamic, 1)
for (int i = 0; i < 20; i++)
    {
        printf("Thread %d is running number %d\n", omp_get_thread_num(), i);
    }
printf("\nTime effectiveness of Guided Schedule\n");
omp_set_num_threads(4);
#pragma omp parallel for schedule(guided, 3)
for (int i = 0; i < 20; i++)
    {
        printf("Thread %d is running number %d\n", omp_get_thread_num(), i);
    }
    return 0;
}
```

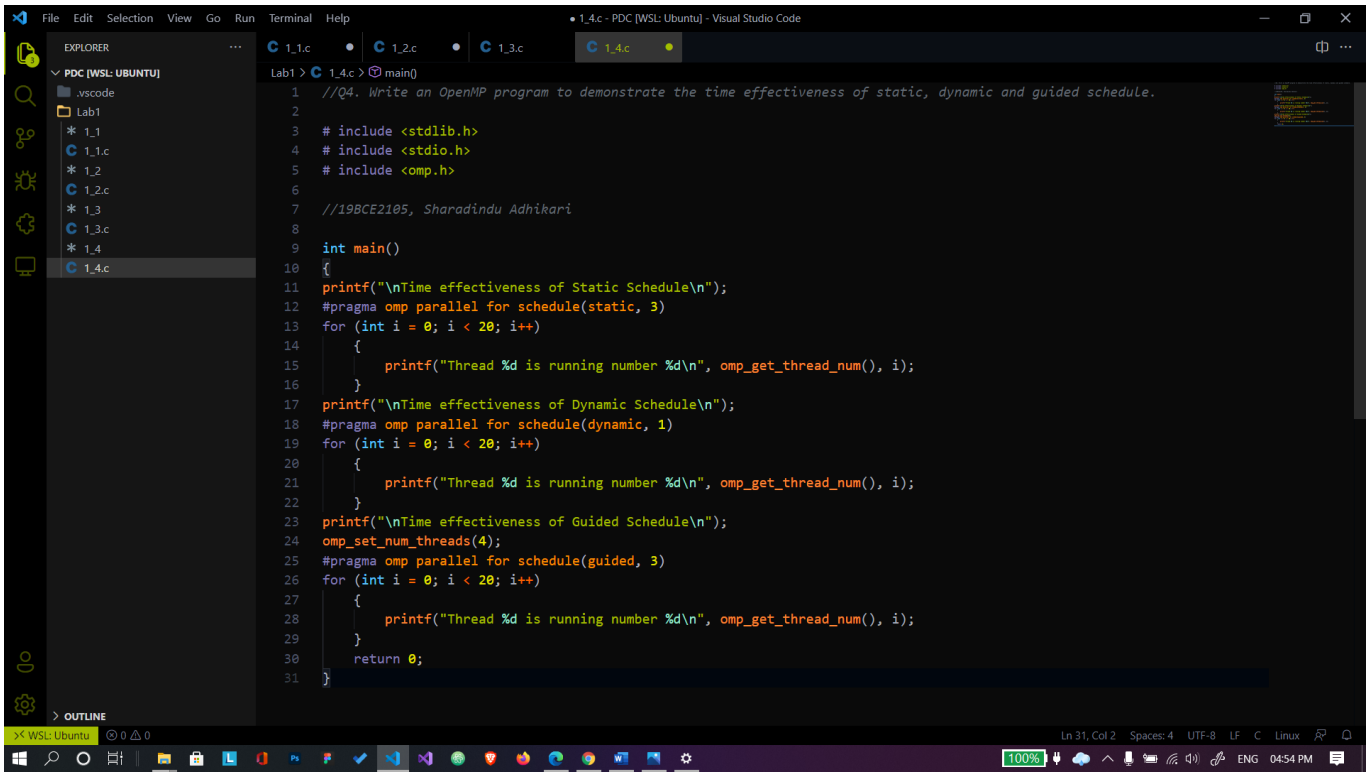
Output:

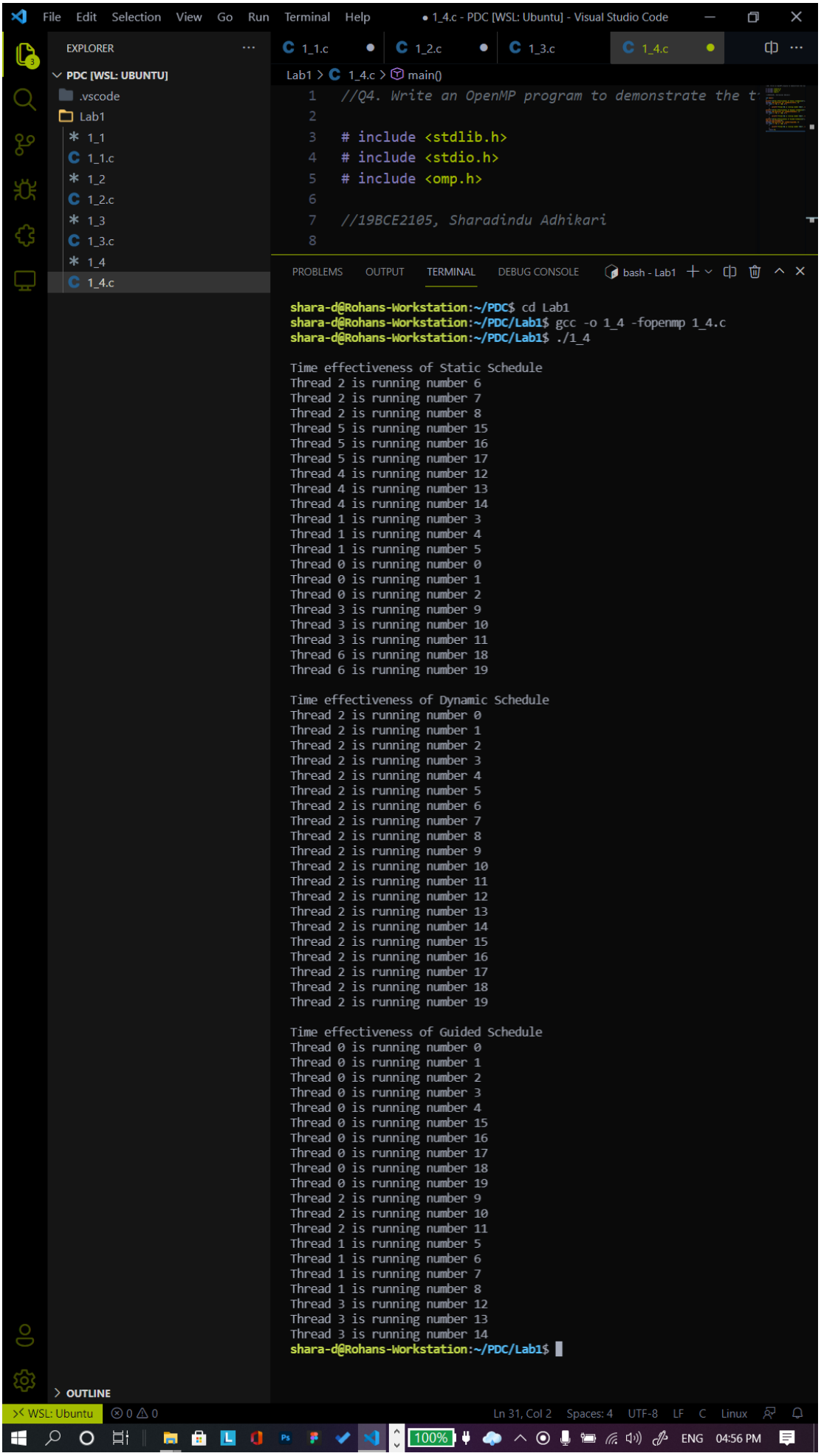
```
shara-d@Rohans-Workstation:~/PDC/Lab1$ gcc -o 1_4 -fopenmp 1_4.c
shara-d@Rohans-Workstation:~/PDC/Lab1$ ./1_4
```

```
Time effectiveness of Static Schedule
Thread 2 is running number 6
Thread 2 is running number 7
Thread 2 is running number 8
Thread 5 is running number 15
Thread 5 is running number 16
Thread 5 is running number 17
Thread 4 is running number 12
Thread 4 is running number 13
Thread 4 is running number 14
Thread 1 is running number 3
Thread 1 is running number 4
Thread 1 is running number 5
Thread 0 is running number 0
Thread 0 is running number 1
Thread 0 is running number 2
Thread 3 is running number 9
Thread 3 is running number 10
Thread 3 is running number 11
Thread 6 is running number 18
Thread 6 is running number 19

Time effectiveness of Dynamic Schedule
Thread 2 is running number 0
Thread 2 is running number 1
Thread 2 is running number 2
Thread 2 is running number 3
Thread 2 is running number 4
Thread 2 is running number 5
Thread 2 is running number 6
Thread 2 is running number 7
Thread 2 is running number 8
Thread 2 is running number 9
Thread 2 is running number 10
Thread 2 is running number 11
Thread 2 is running number 12
Thread 2 is running number 13
Thread 2 is running number 14
Thread 2 is running number 15
Thread 2 is running number 16
Thread 2 is running number 17
Thread 2 is running number 18
Thread 2 is running number 19
```

```
Time effectiveness of Guided Schedule
Thread 0 is running number 0
Thread 0 is running number 1
Thread 0 is running number 2
Thread 0 is running number 3
Thread 0 is running number 4
Thread 0 is running number 15
Thread 0 is running number 16
Thread 0 is running number 17
Thread 0 is running number 18
Thread 0 is running number 19
Thread 2 is running number 9
Thread 2 is running number 10
Thread 2 is running number 11
Thread 1 is running number 5
Thread 1 is running number 6
Thread 1 is running number 7
Thread 1 is running number 8
Thread 3 is running number 12
Thread 3 is running number 13
Thread 3 is running number 14
```

Screenshots:




File Edit Selection View Go Run Terminal Help
• 1_4.c - PDC [WSL: Ubuntu] - Visual Studio Code
EXPLORER
PDC [WSL: UBUNTU]
.vscode
Lab1
1_1
1_1.c
1_2
1_2.c
1_3
1_3.c
1_4
1_4.c
1_1.c
1_2.c
1_3.c
1_4.c
Lab1 > 1_4.c > main()
1 //Q4. Write an OpenMP program to demonstrate the t
2
3 # include <stdlib.h>
4 # include <stdio.h>
5 # include <omp.h>
6
7 //19BCE2105, Sharadindu Adhikari
8
PROBLEMS OUTPUT TERMINAL DEBUG CONSOLE
bash - Lab1
shara-d@Rohans-Workstation:~/PDC$ cd Lab1
shara-d@Rohans-Workstation:~/PDC/Lab1$ gcc -o 1_4 -fopenmp 1_4.c
shara-d@Rohans-Workstation:~/PDC/Lab1$ ./1_4
Time effectiveness of Static Schedule
Thread 2 is running number 6
Thread 2 is running number 7
Thread 2 is running number 8
Thread 5 is running number 15
Thread 5 is running number 16
Thread 5 is running number 17
Thread 4 is running number 12
Thread 4 is running number 13
Thread 4 is running number 14
Thread 1 is running number 3
Thread 1 is running number 4
Thread 1 is running number 5
Thread 0 is running number 0
Thread 0 is running number 1
Thread 0 is running number 2
Thread 3 is running number 9
Thread 3 is running number 10
Thread 3 is running number 11
Thread 6 is running number 18
Thread 6 is running number 19
Time effectiveness of Dynamic Schedule
Thread 2 is running number 0
Thread 2 is running number 1
Thread 2 is running number 2
Thread 2 is running number 3
Thread 2 is running number 4
Thread 2 is running number 5
Thread 2 is running number 6
Thread 2 is running number 7
Thread 2 is running number 8
Thread 2 is running number 9
Thread 2 is running number 10
Thread 2 is running number 11
Thread 2 is running number 12
Thread 2 is running number 13
Thread 2 is running number 14
Thread 2 is running number 15
Thread 2 is running number 16
Thread 2 is running number 17
Thread 2 is running number 18
Thread 2 is running number 19
Time effectiveness of Guided Schedule
Thread 0 is running number 0
Thread 0 is running number 1
Thread 0 is running number 2
Thread 0 is running number 3
Thread 0 is running number 4
Thread 0 is running number 15
Thread 0 is running number 16
Thread 0 is running number 17
Thread 0 is running number 18
Thread 0 is running number 19
Thread 2 is running number 9
Thread 2 is running number 10
Thread 2 is running number 11
Thread 1 is running number 5
Thread 1 is running number 6
Thread 1 is running number 7
Thread 1 is running number 8
Thread 3 is running number 12
Thread 3 is running number 13
Thread 3 is running number 14
shara-d@Rohans-Workstation:~/PDC/Lab1$
OUTLINE
WSL: Ubuntu
Ln 31, Col 2 Spaces: 4 UTF-8 LF C Linux
100%
ENG 04:56 PM