

CSE 4001

PARALLEL AND DISTRIBUTED COMPUTING



Lab Assessment – 2

L27+L28 | PLBG04

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by

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19BCE2105

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

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

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

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int a[1000] = {8,4,6,7,1,2,5,3};
int b[1000];

void Merge(int low, int mid, int high)
{
    int i, j, k;

    i=low; j=mid+1; k=low;
    while ( i <= mid && j <= high )
    {
        if( a[i] <= a[j] )
            b[k++] = a[i++] ;
        else
            b[k++] = a[j++] ;
    }
    while (i <= mid) b[k++] = a[i++] ;
    while (j <= high) b[k++] = a[j++] ;
    for(k=low; k <= high; k++) a[k] = b[k];
}

void MergeSort(int low, int high)
{
    int mid;
    if(low < high)
    {
        mid = (low+high)/2 ;
        #pragma omp parallel sections
        {
            #pragma omp section

            {
                MergeSort(low, mid);
```

```
    }
    #pragma omp section
    {
        MergeSort(mid+1, high);
    }
}
Merge(low, mid, high);
}
}

void main()
{
    int n, k;
    clock_t st, et;
    double ts;
    printf("Enter input size: ");
    scanf("%d", &n);
    srand(time(0));
    for(k=0; k < n; k++)
    {
        a[k]=rand()%n;
    }
    st=clock(); MergeSort(0, n-1); et=clock();
    ts=(double)(et-st)/CLOCKS_PER_SEC;

    printf("Sorted Numbers are : \n ");
    for(k=0; k < n; k++) printf("%d ", a[k]);
    printf("\nThe time taken is %e\n", ts);
}
```

Input:

Enter input size: 5

Output:

```
shara-d@Rohans-Workstation:~/PDC$ cd Lab2
shara-d@Rohans-Workstation:~/PDC/Lab2$ gcc -o 2_1 -fopenmp 2_1.c
shara-d@Rohans-Workstation:~/PDC/Lab2$ ./2_1
Enter input size: 5
Sorted Numbers are :
0 1 1 3 4
The time taken is 3.125000e-02
```

Screenshot:

```

1 //Q1. Develop an OpenMP program to parallelize the matrix vector multiplication.
2
3 #include <stdio.h>
4 #include <time.h>
5 #include <omp.h>
6
7 //19BCE2105, Sharadindu Adhikari
8
9
10 int a[1000] = {8,4,6,7,1,2,5,3};
11 int b[1000];
12
13 void Merge(int low, int mid, int high)
14 {
15     int i, j, k;
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```

```

shara-d@Rohans-Workstation:~/PDC$ cd Lab2
shara-d@Rohans-Workstation:~/PDC/Lab2$ gcc -o 2_1 -fopenmp 2_1.c
2_1.c: In function 'main':
2_1.c:56:6: warning: implicit declaration of function 'srand' [-Wimplicit-function-declaration]
56 |     srand(time(0));
    |     ^~~~~
2_1.c:59:15: warning: implicit declaration of function 'rand' [-Wimplicit-function-declaration]
59 |     a[k]=rand()%n;
    |             ^~~~
shara-d@Rohans-Workstation:~/PDC/Lab2$ ./2_1
Enter input size: 5
Sorted numbers are :
0 1 1 3 4
The time taken is 3.125000e-02
shara-d@Rohans-Workstation:~/PDC/Lab2$

```

Q2. Parallelize the operations of linear and binary search using OpenMP constructs. Compute the time taken by the above approaches.

Code:

//Q2. Parallelize the operations of linear and binary search using OpenMP constructs. Compute the time taken by the above approaches.

```

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

```

//19BCE2105, Sharadindu Adhikari

```

int linear(int*,int);
void binary(int*,int);
double st,et;

```

```

int linear(int* a,int p)
{

```

```
int f=-1;
st=omp_get_wtime();
#pragma omp parallel for
for(int h=0;h<5;h++)
{
    if(a[h]==p)
    {
        f++;
    }
}
et=omp_get_wtime()-st;
return f;
}

void binary(int* a,int key)
{
    double end_time,start_time;
    int sep[5],i,j,n=2,left,right,size=5,interval,index,break_value=0,tid;
    left=0;
    right=size-1;

    if(key>=a[left] && key<=a[right])
    {
        while(left!=right)
        {

            start_time = omp_get_wtime();
            printf("left=%d, right=%d, size=%d\n",left,right,size);
            if(size<=n)
            {

                #pragma omp parallel for num_threads(size)
                for(i=0;i<size;i++)
                {
                    sep[i]=left+i;
                    tid=omp_get_thread_num();
                    printf("Thread %d allocated sep[%d]=%d\n",tid,i,sep[i]);
                }
            }

            else
            {
                sep[0]=left;
                interval=ceil((float)size/(float)n);
```

```
#pragma omp parallel for num_threads(n-1)
for(i=1;i<=n-1;i++)
{
    sep[i]=left+interval*i-1;
    tid=omp_get_thread_num();
    printf("Thread %d allocated sep[%d]=%d\n",tid,i,sep[i]);
}

sep[n]=right;
}

end_time = omp_get_wtime()-start_time;
```

```
for(i=0;i<=n;i++)
{
    if(key==a[sep[i]])
    {
        index=sep[i];
        printf("Element found at position %d\n",index+1);
        break_value=1;
        break;
    }
    if(key<a[sep[i]])
    {
        right=sep[i];
        if(i!=0)
            left=1+sep[i-1];
        size=right-left+1;
        break;
    }
}
```

```
if(break_value==1)
    break;
```

```
}
```

```
if(left==right || !(key>=a[left] && key<=a[right]))
    printf("Element does not present in the list\n");
```

```
printf("Time taken for Binary Search is :%fs\n",end_time);
```

```
}

int main()
{

    int a[5]={11,22,69,99,100};
    int p;
    printf("Enter the key to be searched\n");
    scanf("%d",&p);
    if(linear(a,p)==0)
    printf("Found\n");
    else
    printf("Not Found\n");
    printf("Time taken for Linear Search is: %fs\n",et);
    binary(a,p);

}
```

Input:

Enter the key to be searched: 22

Output:

shara-d@Rohans-Workstation:~/PDC/Lab2\$ gcc -o 2_2 -fopenmp 2_2.c -lm

shara-d@Rohans-Workstation:~/PDC/Lab2\$./2_2

Enter the key to be searched

22

Found

Time taken for Linear Search is: 0.001318s

left=0, right=4, size=5

Thread 0 allocated sep[1]=2

left=1, right=2, size=2

Thread 1 allocated sep[1]=2

Thread 0 allocated sep[0]=1

Element found at position 2

Time taken for Binary Search is :0.000366s

Screenshot:

```

1 //Q2. Parallelize the operations of Linear and binary search using OpenMP constructs. Compute the time taken by the above
2
3 #include <stdio.h>
4 #include <time.h>
5 #include <omp.h>
6 #include <math.h>
7
8 //19BCE2105, Sharadindu Adhikari
9
10 int linear(int*,int);
11 void binary(int*,int);
12 double st,et;
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```
int i,j,k;
int arr1[N][P]={
    {1, 1, 1, 1},
    {2, 2, 2, 2},
    {3, 3, 3, 3},
    {4, 4, 4, 4}
}, arr2[M][L]={
    {1, 1, 1, 1},
    {2, 2, 2, 2},
    {3, 3, 3, 3},
    {4, 4, 4, 4}
}, arr3[N][L];

/*Create a parallel region explicitly scoping all variables */
#pragma omp critical
{

    for( i=0; i<4; i++)
    {

        for( j=0; j<4;j++)
        {
            arr3[i][j] = 0;
            for( k=0; k<4;k++)
            {
                arr3[i][j] +=arr1[i][k] * arr2[k][j];
            }
            printf("%d\t", arr3[i][j]);
        }
        printf("\n");
    }
}
return 0;
}
```

Output:

shara-d@Rohans-Workstation:~/PDC/Lab2\$ gcc -o 2_3 -fopenmp 2_3.c

shara-d@Rohans-Workstation:~/PDC/Lab2\$./2_3

10	10	10	10
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40	40	40	40

Screenshot:

```

1 //Q3. Develop an OpenMP program to perform Matrix multiplications using the appropriate synchronization constructs.
2
3 #include <omp.h>
4 #include <stdio.h>
5 #include <stdlib.h>
6
7 //19BCE2105, Sharadindu Adhikari
8
9 #define N 4
10 #define P 4
11 #define M 4
12 #define L 4
13
14 int main(int argc, char *argv[])
15 {
16
17

```

```

shara-d@Rohans-Workstation:~/PDC$ cd Lab2
shara-d@Rohans-Workstation:~/PDC/Lab2$ gcc -o 2_3 -fopenmp 2_3.c
shara-d@Rohans-Workstation:~/PDC/Lab2$ ./2_3
10 10 10 10
20 20 20 20
30 30 30 30
40 40 40 40
shara-d@Rohans-Workstation:~/PDC/Lab2$

```

Q4. Generate a Fibonacci sequence using lock synchronization tool.

Code and Input:

//Q4. Generate a Fibonacci sequence using Lock synchronization tool.

```

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

```

/*19BCE2105, Sharadindu Adhikari

In this question here, I'm going to find the 10th number of the Fibonacci Sequence*/

```

int value[10];
int done[10];
int dolock[10];

```

```

int main() {
    int num=10;

```

```
for (int i=0; i<=10; i++)
    done[i] = 0;
done[0] = 0;
done[1] = 1;
value[0] = 0;
value[1] = 1;
printf("The %dth number of the Fibonacci Sequence is:%d\n",num,fib(num));
}

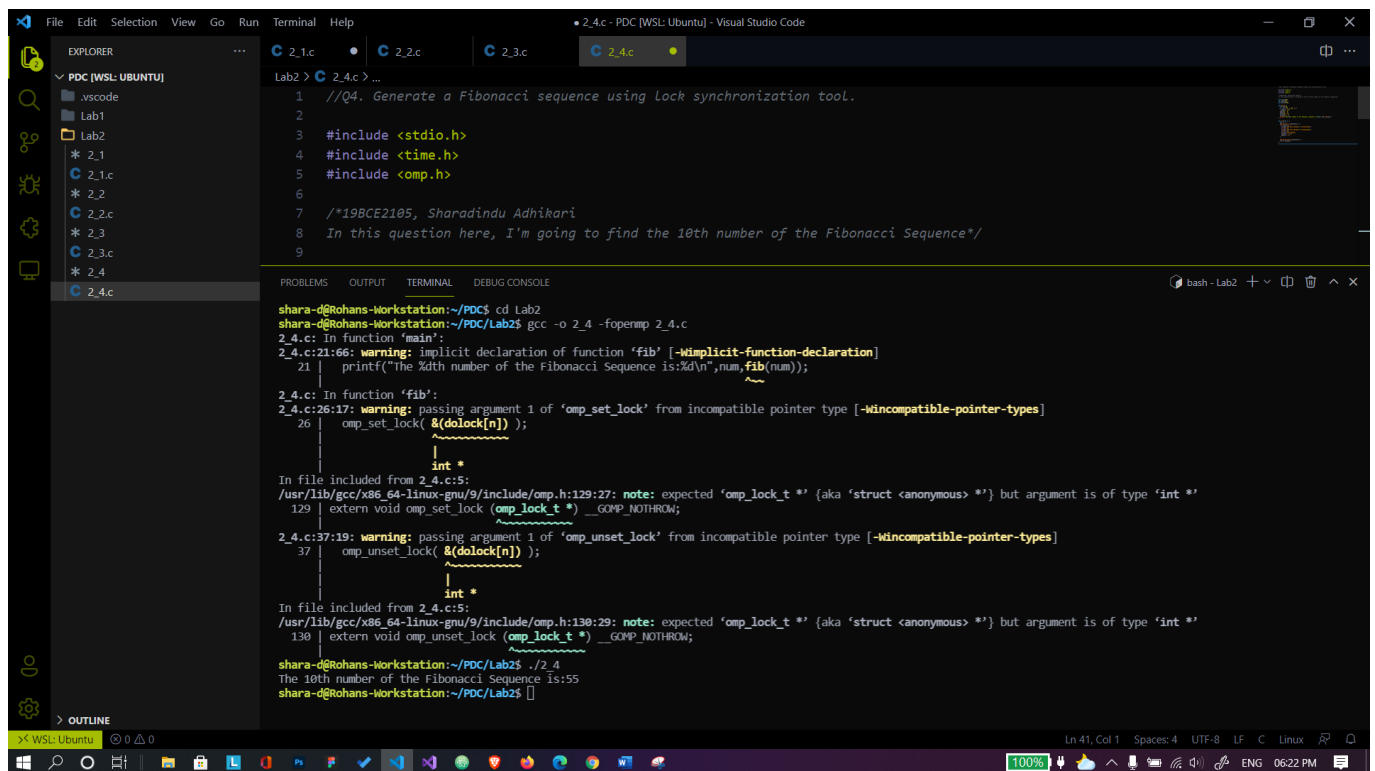
int fib(int n) {
    int i, j;
    omp_set_lock( &(amp;do_lock[n]) );
    if (!done[n]) {
        #pragma omp task shared(i) firstprivate(n)
        i=fib(n-1);
        #pragma omp task shared(j) firstprivate(n)
        j=fib(n-2);
        #pragma omp taskwait
        value[n] = i+j;
        done[n] = 1;
    }

    omp_unset_lock( &(amp;do_lock[n]) );
    return value[n];
}
```

Output:

```
shara-d@Rohans-Workstation:~/PDC/Lab2$ gcc -o 2_4 -fopenmp 2_4.c
shara-d@Rohans-Workstation:~/PDC/Lab2$ ./2_4
The 10th number of the Fibonacci Sequence is: 55
```

Screenshot:



```
1 //Q4. Generate a Fibonacci sequence using Lock synchronization tool.
2
3 #include <stdio.h>
4 #include <time.h>
5 #include <omp.h>
6
7 /*19BCE2105, Sharadindu Adhikari
8  In this question here, I'm going to find the 10th number of the Fibonacci Sequence*/
9
10
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21 printf("The %dth number of the Fibonacci Sequence is:%d\n",num,fib(num));
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26 omp_set_lock( &(doloack[n]) );
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37 omp_unset_lock( &(doloack[n]) );
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```

shara-d@Rohans-Workstation:~/PDC\$ cd Lab2
shara-d@Rohans-Workstation:~/PDC/Lab2\$ gcc -o 2_4 -fopenmp 2_4.c
2_4.c: In function 'main':
2_4.c:21:66: warning: implicit declaration of function 'fib' [-Wimplicit-function-declaration]
21 | printf("The %dth number of the Fibonacci Sequence is:%d\n",num,fib(num));
 | ~~~~~
2_4.c: In function 'fib':
2_4.c:26:17: warning: passing argument 1 of 'omp_set_lock' from incompatible pointer type [-Wincompatible-pointer-types]
26 | omp_set_lock(&(doloack[n]));
 | ~~~~~
 | int *
In file included from 2_4.c:5:
/usr/lib/gcc/x86_64-linux-gnu/9/include/omp.h:129:27: note: expected 'omp_lock_t *' {aka 'struct <anonymous> *'} but argument is of type 'int *'
129 | extern void omp_set_lock (omp_lock_t *) __GOMP_NOTHROW;
2_4.c:37:19: warning: passing argument 1 of 'omp_unset_lock' from incompatible pointer type [-Wincompatible-pointer-types]
37 | omp_unset_lock(&(doloack[n]));
 | ~~~~~
 | int *
In file included from 2_4.c:5:
/usr/lib/gcc/x86_64-linux-gnu/9/include/omp.h:130:29: note: expected 'omp_lock_t *' {aka 'struct <anonymous> *'} but argument is of type 'int *'
130 | extern void omp_unset_lock (omp_lock_t *) __GOMP_NOTHROW;
shara-d@Rohans-Workstation:~/PDC/Lab2\$./2_4
The 10th number of the Fibonacci Sequence is:55
shara-d@Rohans-Workstation:~/PDC/Lab2\$