NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL
DEPARTMENT OF INFORMATION TECHNOLOGY

IT 301 Parallel Computing LAB 4

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1. Execute following code and observe the working of task directive. Check the result by removing if() clause with task.

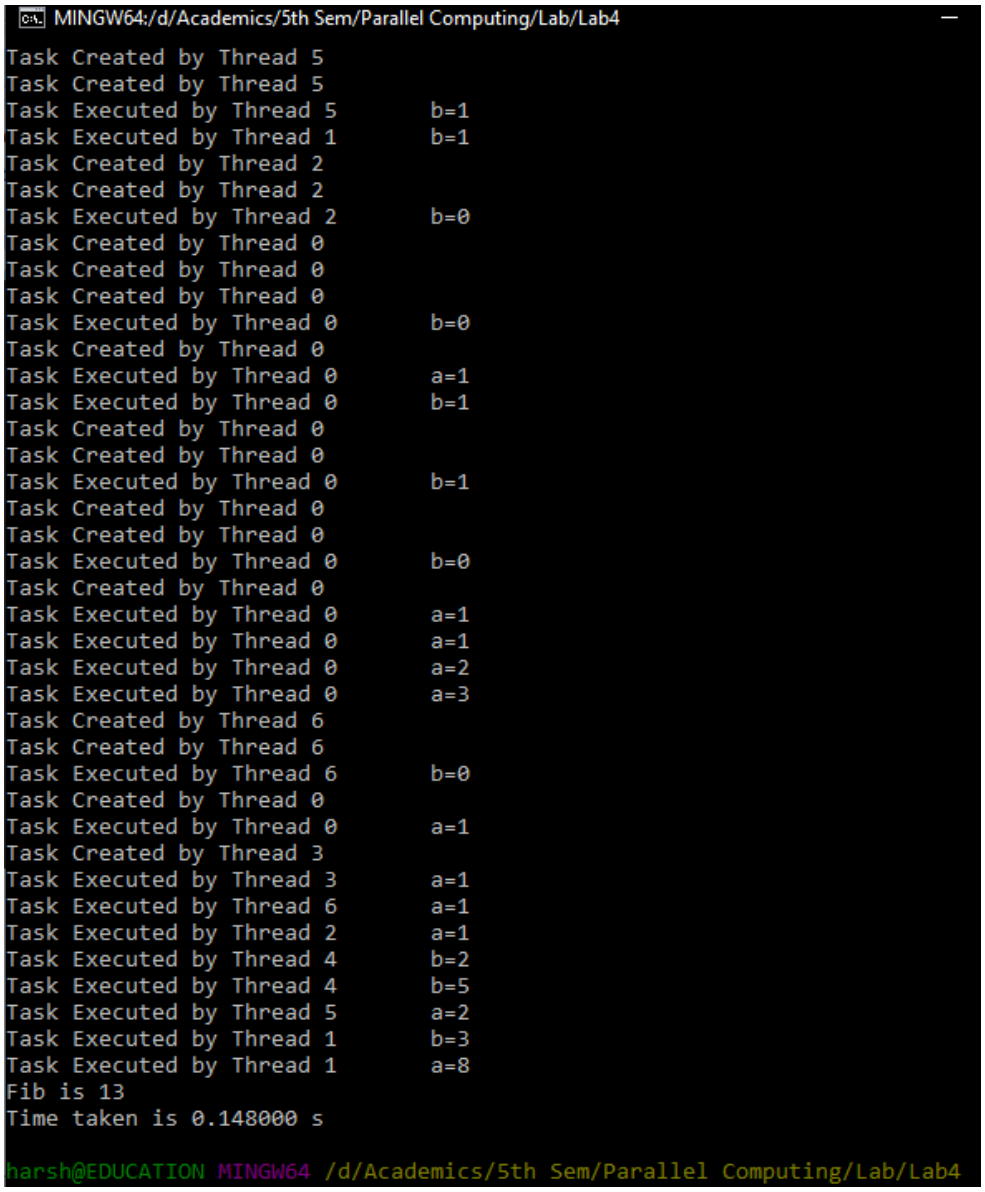
Code:

```
#include<stdio.h>
#include<omp.h>
int fibo(int n);

int main(void){
	int n,fib;
	double t1,t2;
	printf("Enter the value of n:\n");
	scanf("%d",&n);
	t1=omp_get_wtime();
	#pragma omp parallel shared(n)
	{
	#pragma omp single
	{
		fib=fibo(n);
	}
	}
	t2=omp_get_wtime();
	printf("Fib is %d\n",fib);
	printf("Time taken is %f s \n",t2-t1);
	return 0;
}

int fibo(int n){
	int a,b;
	if(n<2)
		return n;
	else{
		#pragma omp task shared(a)
		{
			printf("Task Created by Thread %d\n",omp_get_thread_num());
			a=fibo(n-1);
			printf("Task Executed by Thread %d \ta=%d\n",omp_get_thread_num(),a);
		}
		#pragma omp task shared(b)
```

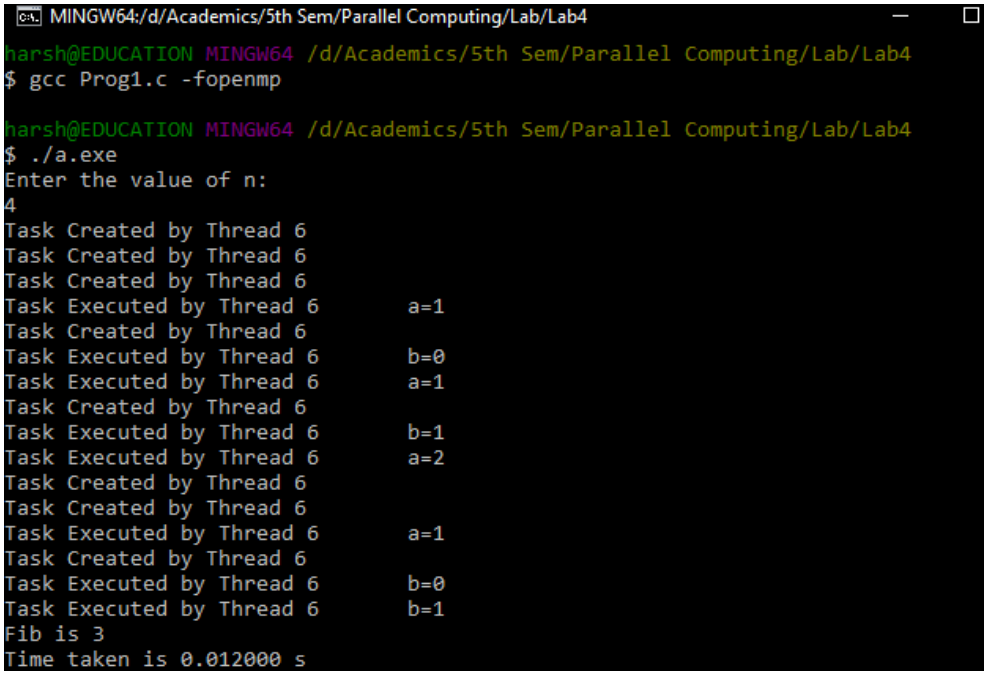
```
                {
                        printf("Task Created by Thread %d\n",omp_get_thread_num());
                        b=fibo(n-2);
                        printf("Task Executed by Thread %d \tb=%d\n",omp_get_thread_num(),b);
                }
                #pragma omp taskwait
                return a+b;
        }
}
```

Output:

For n = 7:

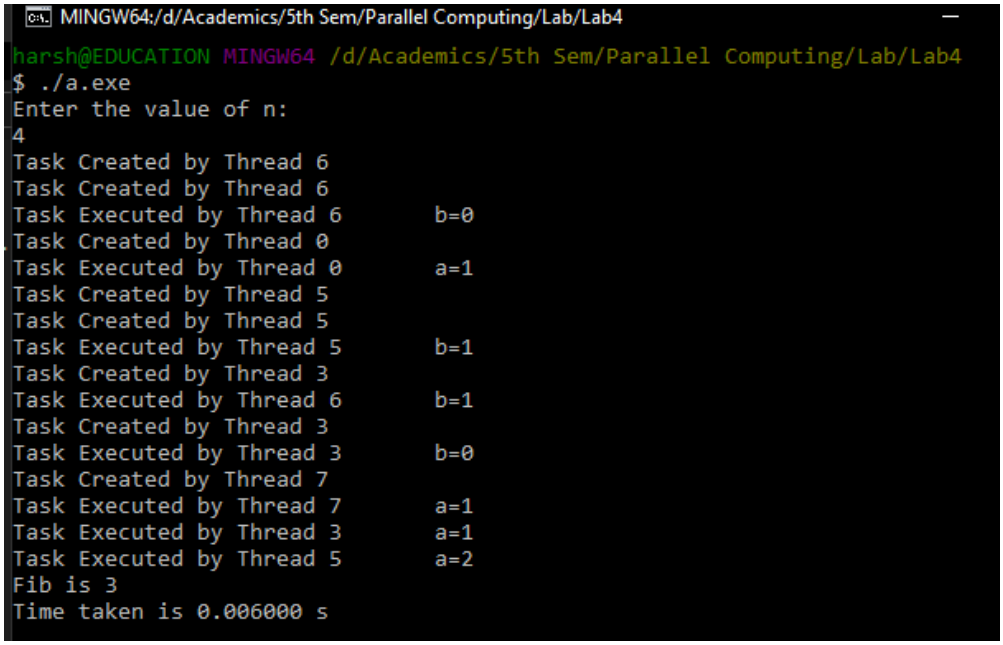


For n = 4:



After removing the if( ) clause:

For n = 4:



Analysis:
After removing the if( ) clause, we are able to achieve Task Scheduling for all the values of n, but in the presence of if( ) clause, it was not possible for values of n < 5.
Therefore in this case of n = 4, our execution time reduces.

2. Write a C/C++ OpenMP program to find ROWSUM and COLUMNSUM of a matrix a[n][n]. Compare the time of parallel execution with sequential execution.

Code:

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

int main(void){
	int n,i,j;
	double t1_s,t2_s,t1_p,t2_p;
	printf("Enter the value n : ");
	scanf("%u",&n);
	int m[n][n], rsum[n],csum[n];
	srand(time(0));
	printf("matrix:\n");
	for(i=0;i<n;i++){
		for(j=0;j<n;j++){
			int k=(rand())%10000;
			m[i][j]=k;
			printf("%d ",k);
		}
		printf("\n");
	}


	t1_s=omp_get_wtime();
	for(i=0;i<n;i++){
		int temp=0;
		for(j=0;j<n;j++)temp+=m[i][j];
		rsum[i]=temp;
	}
	for(i=0;i<n;i++){
		int temp=0;
		for(j=0;j<n;j++)
			temp+=m[j][i];
		csum[i]=temp;
	}

	t2_s=omp_get_wtime();
```

```
	int temp;


	t1_p=omp_get_wtime();
	#pragma omp parallel shared(n)
	{
	#pragma omp for schedule(static,10) private(i,j,temp)
	for(i=0;i<n;i++){
		temp=0;
		for(j=0;j<n;j++)
			temp+=m[i][j];
		rsum[i]=temp;
	}
	#pragma omp for schedule(static,10) private(i,j,temp)
	for(i=0;i<n;i++){
		temp=0;
		for(j=0;j<n;j++)
			temp+=m[j][i];
		csum[i]=temp;
		}
	}
	t2_p=omp_get_wtime();

	printf("Row Sum : \n");
	for(i=0;i<n;i++){
		printf("Row %d: %d \n", i,rsum[i]);
	}
	printf("\nColumn Sum : \n");
	for(i=0;i<n;i++){
		printf("Column %d : %d \n", i,csum[i]);
	}
	printf("\nTime taken for sequential execution is %f s \n",t2_s-t1_s);
	printf("\nTime taken for parallel execution is %f s \n",t2_p-t1_p);
	return 0;
}
```

Output:

```
harsh@EDUCATION MINGW64 /d/Academics/5th Sem/Parallel Computing/Lab/Lab4
$ gcc Prog2.c -fopenmp

harsh@EDUCATION MINGW64 /d/Academics/5th Sem/Parallel Computing/Lab/Lab4
$ ./a.exe
Enter the value n : 4
matrix:
6058 5378 2398 4847
8462 6649 1782 9492
5319 2491 4818 6675
3264 7211 5568 5201
Row Sum :
Row 0: 18681
Row 1: 26385
Row 2: 19303
Row 3: 21244

Column Sum :
Column 0 : 23103
Column 1 : 21729
Column 2 : 14566
Column 3 : 26215

Time taken for sequential execution is 0.000000 s

Time taken for parallel execution is 0.002000 s
```

Analysis:
The matrix is generated using random function. For parallel execution, schedule clause is used with parallel for directive which calculates the sum of each row and column.

3. Write a C/C++ OpenMP program to perform matrix multiplication. Compare the time of parallel execution with sequential execution.

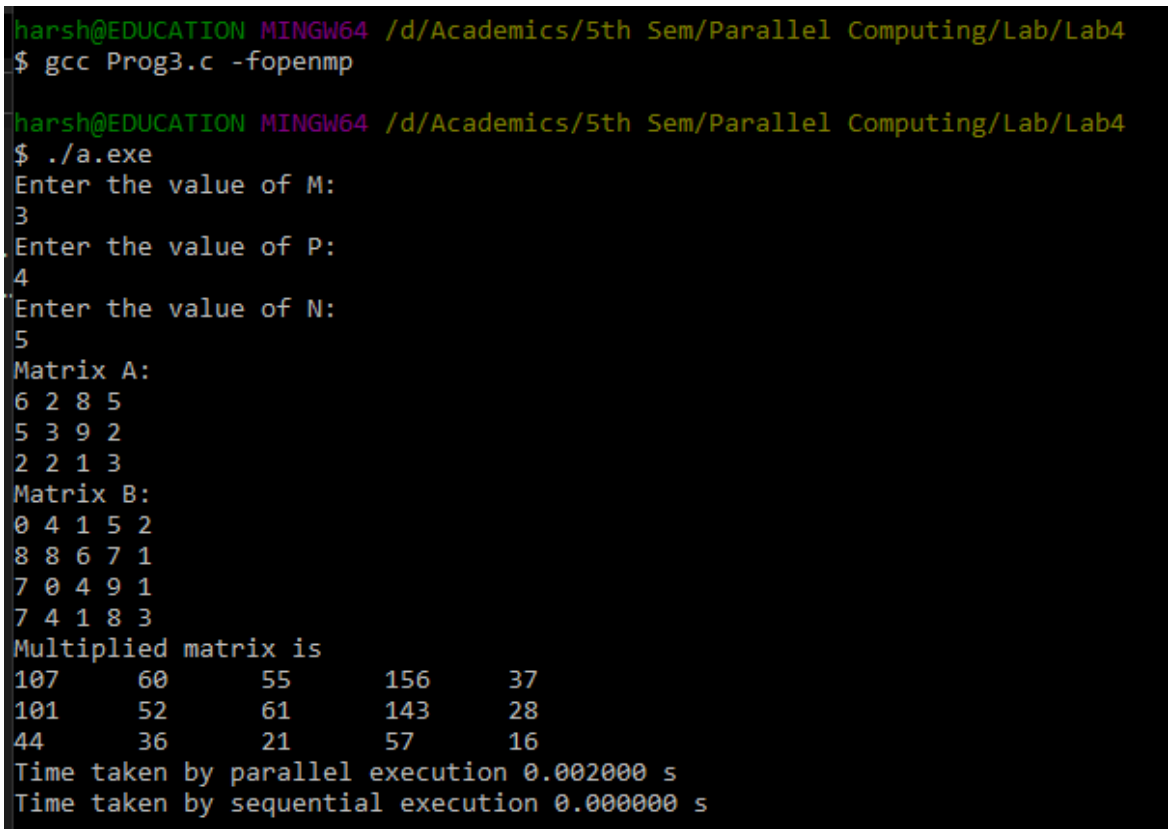
Code:

```
#include <stdio.h>
#include <omp.h>
#include <time.h>
#include<stdlib.h>
int main(){

        int tmp,i,j,k,M,N,P;printf("Enter the value of M:\n");
        scanf("%d",&M);
        printf("Enter the value of P:\n");
        scanf("%d",&P);
        printf("Enter the value of N:\n");
        scanf("%d",&N);
        int C[M][N],S[M][N],B[P][N],A[M][P];
        srand(time(0));
        printf("Matrix A:\n");
```

```
for(i=0;i<M;i++){
        for(j=0;j<P;j++){
                int k=(rand())%10;
                A[i][j]=k;
                printf("%d ",k);
        }
        printf("\n");
}
printf("Matrix B:\n");
for(i=0;i<P;i++){
        for(j=0;j<N;j++){
                int k=(rand())%10;
                B[i][j]=k;
                printf("%d ",k);
        }
        printf("\n");
}
double start_time = omp_get_wtime();
#pragma omp parallel for private(tmp, j, k)
for (i=0; i<M; i++){
        for (j=0; j<N; j++){
                tmp = 0.0;
                for( k=0; k<P; k++){
                        /*C(i,j) = sum(over k) A(i,k) * B(k,j)*/
                        tmp += A[i][k] * B[k][j];
                }
                C[i][j] = tmp;
        }
}
double run_time = omp_get_wtime() - start_time;
printf("Multiplied matrix is \n");
for (int i = 0; i < M; ++i){
        for (int j = 0; j < N; ++j){
                printf("%d\t", C[i][j]);
        }
        printf("\n");
}
printf("Time taken by parallel execution %f s \n",run_time);
clock_t t;
t = clock();
for (i=0; i<M; i++){
        for (j=0; j<N; j++){
                tmp = 0.0;
                for( k=0; k<P; k++){
                /*C(i,j) = sum(over k) A(i,k) * B(k,j)*/
                        tmp += A[i][k] * B[k][j];
                }
                S[i][j] = tmp;
```

```
                }
        }
        t= clock() - t;
        double time_taken = ((double)t)/CLOCKS_PER_SEC;
        printf("Time taken by sequential execution %f s \n",time_taken);
        return 0;
}
```

Output:



Analysis:

The matrices are generated using random function. For parallel execution, parallel for directive is used keeping the temporary variables (iterator variables on the rows as well as columns) private.