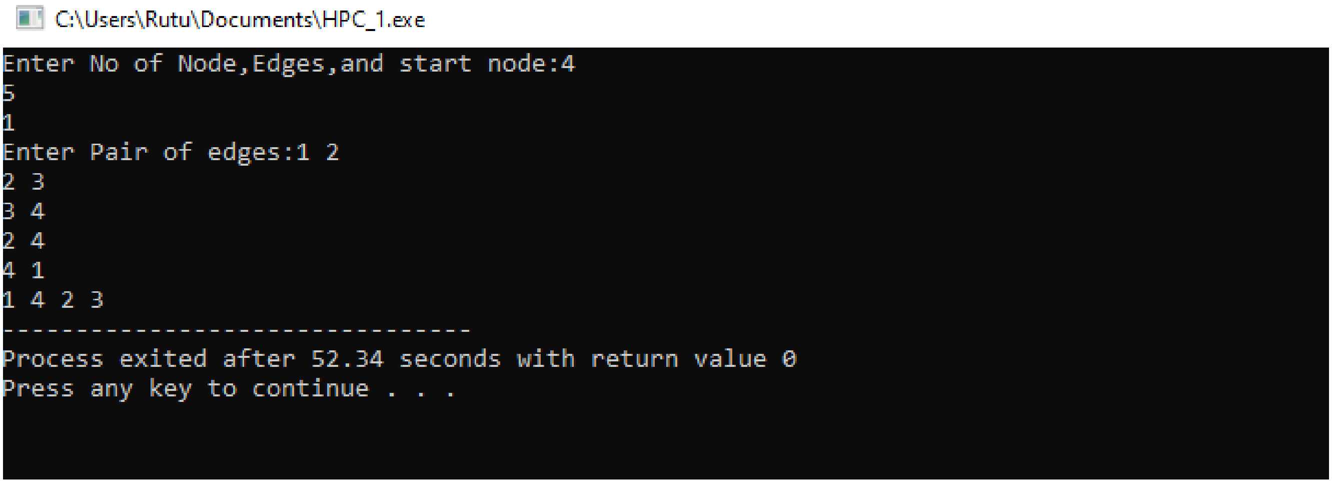
Write a program to implement Parallel Bubble Sort and Merge sort using OpenMP. Use existing algorithms and measure the performance of sequential and parallel algorithms.

Bubble Sort -

```
#include<iostream>
#include<stdlib.h>
#include<omp.h>
using namespace std;
void bubble(int *, int);
void swap(int &, int &);


void bubble(int *a, int n)
{
    int swapped;
    for(  int i = 0;  i < n;  i++ )
     {
        int first = i % 2;
        swapped=0;
        #pragma omp parallel for shared(a,first)
        for(  int j = first;  j < n-1;  j += 2  )
          {
            if(  a[ j ]  >  a[ j+1 ]  )
             {
                    swap(  a[ j ],  a[ j+1 ]  );
                    swapped=1;
             }
              }
             if(swapped==0)
             break;
     }
}


void swap(int &a, int &b)
{

    int test;
    test=a;
    a=b;
    b=test;

}

int main()
{

    int *a,n;
    cout<<"\n enter total no of elements=>";
    cin>>n;
    a=new int[n];
    cout<<"\n enter elements=>";
    for(int i=0;i<n;i++)
    {
        cin>>a[i];
    }

    double start_time = omp_get_wtime(); // start timer for sequential algorithm
    bubble(a,n);
    double end_time = omp_get_wtime(); // end timer for sequential algorithm

    cout<<"\n sorted array is=>";
    for(int i=0;i<n;i++)
    {
        cout<<a[i]<<endl;
    }

    cout << "Time taken by sequential algorithm: " << end_time - start_time << " seconds" << endl;

    start_time = omp_get_wtime(); // start timer for parallel algorithm
    bubble(a,n);
    end_time = omp_get_wtime(); // end timer for parallel algorithm

    cout<<"\n sorted array is=>";
    for(int i=0;i<n;i++)
    {
        cout<<a[i]<<endl;
    }

    cout << "Time taken by parallel algorithm: " << end_time - start_time << " seconds" << endl;
    return 0;
}
```

Output –



C:\Users\Rutu\Documents\HPC_1.exe

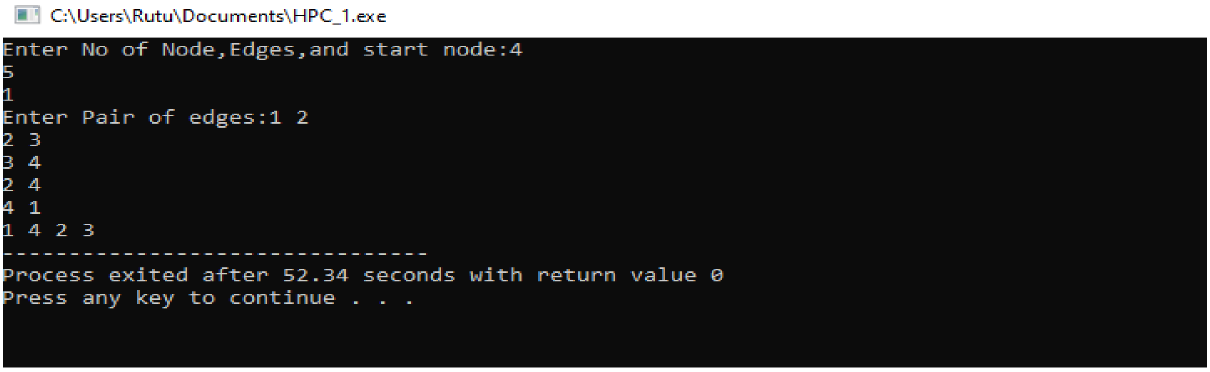
```
Enter No of Node,Edges,and start node:4
5
1
Enter Pair of edges:1 2
2 3
3 4
2 4
4 1
1 4 2 3
--------------------------------
Process exited after 52.34 seconds with return value 0
Press any key to continue . . .
```

Merge sort –

```
#include<iostream>
#include<stdlib.h>
#include<omp.h>
using namespace std;

void mergesort(int a[],int i,int j);
void merge(int a[],int i1,int j1,int i2,int j2);

void mergesort(int a[],int i,int j)
{
    int mid;
    if(i<j)
    {
        mid=(i+j)/2;

        #pragma omp parallel sections
        {

            #pragma omp section
            {
                mergesort(a,i,mid);
            }

            #pragma omp section
            {
                mergesort(a,mid+1,j);
            }
        }

        merge(a,i,mid,mid+1,j);
    }

}

void merge(int a[],int i1,int j1,int i2,int j2)
{
    int temp[1000];
    int i,j,k;
    i=i1;
    j=i2;
```

```
k=0;

while(i<=j1 && j<=j2)
{
    if(a[i]<a[j])
    {
        temp[k++]=a[i++];
    }
    else
    {
        temp[k++]=a[j++];
      }
}

while(i<=j1)
{
    temp[k++]=a[i++];
}

while(j<=j2)
{
    temp[k++]=a[j++];
}

for(i=i1,j=0;i<=j2;i++,j++)
{
    a[i]=temp[j];
    }
}



int main()
{
    int *a,n,i;
    double start_time, end_time, seq_time, par_time;

    cout<<"\n enter total no of elements=>";
    cin>>n;
    a= new int[n];

    cout<<"\n enter elements=>";
    for(i=0;i<n;i++)
    {
        cin>>a[i];
    }

    // Sequential algorithm
    start_time = omp_get_wtime();
    mergesort(a, 0, n-1);
    end_time = omp_get_wtime();
    seq_time = end_time - start_time;
    cout << "\nSequential Time: " << seq_time << endl;

    // Parallel algorithm
    start_time = omp_get_wtime();
    #pragma omp parallel
    {
        #pragma omp single
        {
            mergesort(a, 0, n-1);
        }
    }
    end_time = omp_get_wtime();
    par_time = end_time - start_time;
    cout << "\nParallel Time: " << par_time << endl;

    cout<<"\n sorted array is=>";
    for(i=0;i<n;i++)
    {
        cout<<"\n"<<a[i];
    }

    return 0;
}
```

Output –



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