**Heaven’s Light is Our Guide**

# Rajshahi University of Engineering and Technology

## Department of Computer Science and Engineering

**Course No:** CSE.2202
**Course Title:** Sessional based on CSE.2201 (Computer Algorithms)

**Lab Report No:** 05
**Lab Report On:** Sorting in linear time: Counting Sort.

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❖ **Problem Statement:** The problem is observe sorting in linear time with counting sort. That requires

i. To generate **N** random integers within range 0 to 10000 in a file named **input.txt**.

ii. To implement bubble sort to sort the numbers (from input.txt) and count the time.

iii. To implement counting sort to sort the numbers (from input.txt) and count the time.

iv. To increase the value of N and to plot the performance curve for sufficiently large N to see distinguishable performance.

❖ **Details description and Algorithm:** The sorting algorithms that can sort **N** numbers in **O(n)** time with special assumptions about input are called sorting algorithms of linear time. Counting sort is one of these. It works by-

i. Counting frequency of elements.

ii. Computing the position in the sorted array.

iii. Placing elements into the sorted array.

Let us consider the following algorithm for **Counting Sort**:

```
Counting_Sort ( Data[N] ) [ Counting_Sort is a function that sorts array Data of
"N" elements ]
    1. Repeat  i = 1 to N by 1.
    2. Set Element:=Data[i].    [Element takes one element from Data[] ].
    3. Set Frequency[Element]:= Frequency[Element] + 1. [ Counts frequency
       of elements, initialized all 0 ]
       [ End of repeat step 1 ]
    4. Repeat  i = 1 to N by 1.
    5. Set Position[i]:=Frequency[i] + Frequency[i-1].    [Computes position of
       elements ].
       [ End of repeat step 4 ]
    6. Repeat  i = 1 to N by 1.
    7. Set Element:=Data[i].
```

```
8.  Set Sorted_Array[Position[Element]]:= Element].  [ Places elements ]
    [ End of repeat step 6 ]
9.  Exit.
```

## ❖ Implemented Code:

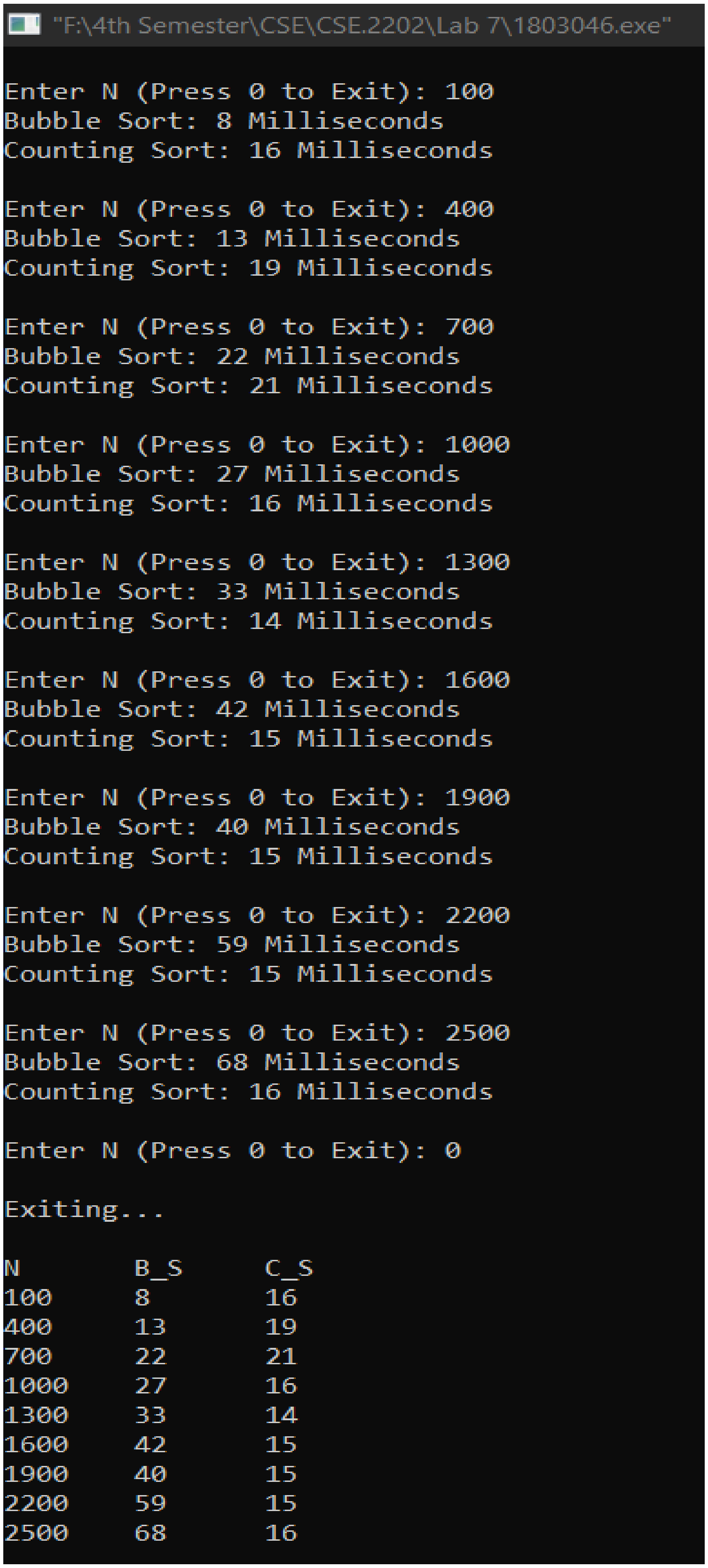
```
#include<bits/stdc++.h>
using namespace std;
using namespace std::chrono;

typedef long long ll;
#define M 10001

void menu(){
   cout<<"\nEnter N (Press 0 to Exit): ";
}


int main(){
   ll n,i,j;
   vector<ll>cn,cb,cc;

   while(1){
      ll a;
      menu();
      cin>>a;

      if(a<0) {
         cout<<"Invalid Input"<<endl;
         continue;
      }

      if(a==0){
         cout<<"\nExiting..."<<endl;
         break;
      }

      ll mx,mn,x;
```

```
vector<ll>bsort_array,pos_csort,csort_array;
map<ll,ll>mp;

//Creating File

ofstream f1;
ifstream f2;
f1.open("input.txt");

n=a;
cn.push_back(n);

srand(time(0));
x=rand()%M;
mx=x;
mn=x;
f1<<x;
csort_array.push_back(-1);

for(i=1;i<n;i++){
   x=rand()%M;
   f1<<" ";
   f1<<x;
   mx=max(mx,x);
   mn=min(mn,x);
   csort_array.push_back(-1);
}
f1.close();



//Counting time for bubble sort

auto start = high_resolution_clock::now();

f2.open("input.txt");

while(!f2.eof()){
   f2>>x;
   bsort_array.push_back(x);
}
f2.close();
```

```
// Bubble sort

for(i=0;i<n-1;i++){
   for(j=i+1;j<n;j++){
      if(bsort_array[i]>bsort_array[j]){
         swap(bsort_array[i],bsort_array[j]);
      }
   }
}

auto stop = high_resolution_clock::now();

auto duration = duration_cast<milliseconds>(stop - start);
cout<<"Bubble Sort: "<<duration.count()<<" Milliseconds"<<endl;
cb.push_back(duration.count());



//Counting time for counting sort

start = high_resolution_clock::now();

f2.open("input.txt");

//Counting sort

while(!f2.eof()){
   f2>>x;
   mp[x]+=1;
}
f2.close();

for(i=mn;i<=mx;i++){
   if(i==mn){
      pos_csort.push_back(mp[i]);
      continue;
   }
   pos_csort.push_back(mp[i]+pos_csort[i-mn-1]);
}

f2.open("input.txt");
while(!f2.eof()){
```

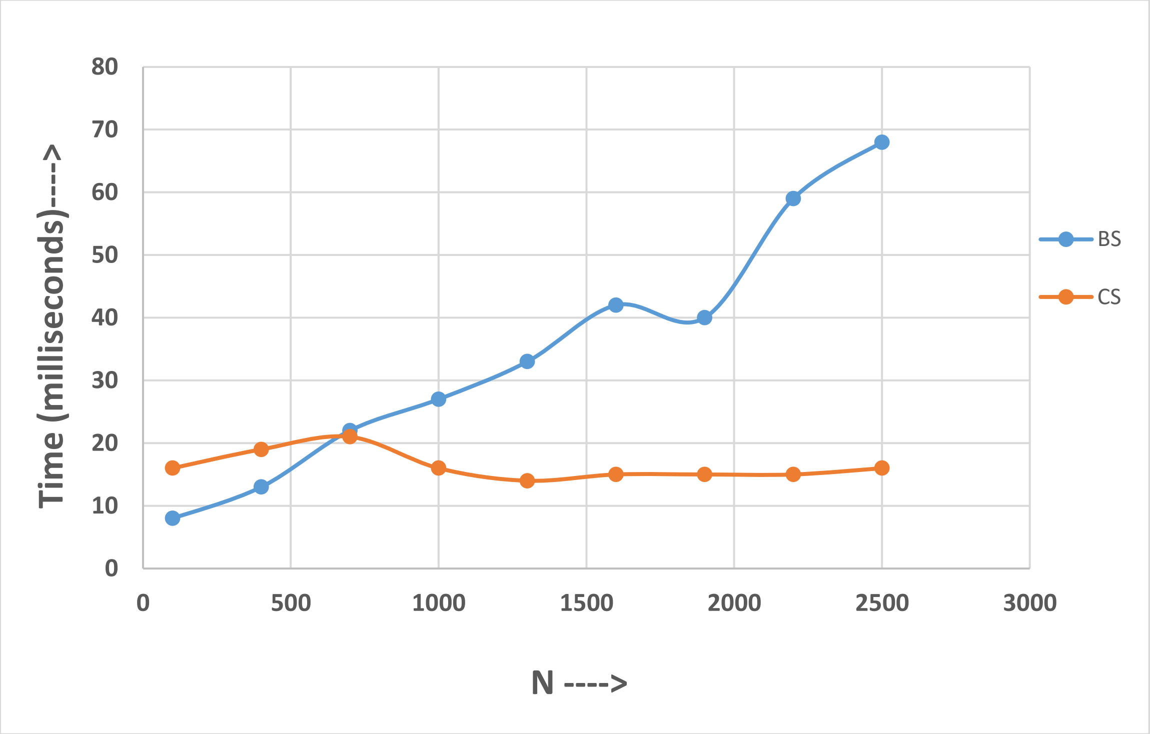
```
            f2>>x;
            csort_array[pos_csort[x-mn]-1]=x;
            pos_csort[x-mn]-=1;
        }

        stop = high_resolution_clock::now();

        duration = duration_cast<milliseconds>(stop - start);
        cout<<"Counting Sort: "<<duration.count()<<" Milliseconds"<<endl;
        cc.push_back(duration.count());

        f2.close();
    }

    for(i=0;i<cn.size()-1;i++){
        for(j=i+1;j<cn.size();j++){
            if(cn[i]>cn[j]){
                swap(cn[i],cn[j]);
                swap(cb[i],cb[j]);
                swap(cc[i],cc[j]);
            }
        }
    }

    cout<<"\nN\tB_S\tC_S"<<endl;
    for(i=0;i<cn.size();i++){
        cout<<cn[i]<<"\t"<<cb[i]<<"\t"<<cc[i]<<endl;
    }


    return 0;
}
```

## ❖ Output:



```
Enter N (Press 0 to Exit): 100
Bubble Sort: 8 Milliseconds
Counting Sort: 16 Milliseconds

Enter N (Press 0 to Exit): 400
Bubble Sort: 13 Milliseconds
Counting Sort: 19 Milliseconds

Enter N (Press 0 to Exit): 700
Bubble Sort: 22 Milliseconds
Counting Sort: 21 Milliseconds

Enter N (Press 0 to Exit): 1000
Bubble Sort: 27 Milliseconds
Counting Sort: 16 Milliseconds

Enter N (Press 0 to Exit): 1300
Bubble Sort: 33 Milliseconds
Counting Sort: 14 Milliseconds

Enter N (Press 0 to Exit): 1600
Bubble Sort: 42 Milliseconds
Counting Sort: 15 Milliseconds

Enter N (Press 0 to Exit): 1900
Bubble Sort: 40 Milliseconds
Counting Sort: 15 Milliseconds

Enter N (Press 0 to Exit): 2200
Bubble Sort: 59 Milliseconds
Counting Sort: 15 Milliseconds

Enter N (Press 0 to Exit): 2500
Bubble Sort: 68 Milliseconds
Counting Sort: 16 Milliseconds

Enter N (Press 0 to Exit): 0

Exiting...

N       B_S     C_S
100     8       16
400     13      19
700     22      21
1000    27      16
1300    33      14
1600    42      15
1900    40      15
2200    59      15
2500    68      16
```

## ❖ Performance Curve of Bubble Sort & Counting Sort:



❖ **Discussion & Conclusion:** From the output and graph we saw that for little value of **N** the sorting time of bubble sort was lower than counting sort. But as the value of **N** increases, the sorting time for bubble sort increases more than counting sort. For the higher value of **N** the Counting sort runs faster than the Bubble sort.

**# END #**