# **DAA Assignment**

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Roll No: 42

Course: MCA 2<sup>nd</sup> SEM

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1.Run on randomly generated data and plot graph.

//Program 1 - It generate random arrays and after doing insertion sort in each array it compares all the comparisions to get the best, worst and average time complexities

```
#include <iostream>
#include <vector>
#include <cstdlib>
#include <algorithm> //for rnad and srand
#include <ctime>
#include <fstream>
using namespace std;
int insertionSort(int *arr, int size){
  int comparision = 0;
  int key;
  int j;
  for (int i = 1; i < size; i++)
    key = arr[i];
    j = i - 1;
    while (j \ge 0 \&\& key < arr[j])
      comparision++;
      arr[j + 1] = arr[j];
      j--;
    arr[j + 1] = key;
```

```
}
  return comparision;
}
int main()
{
  srand(time(0));
  int minBound = 1, maxBound = 100;
  int *arr;
  // file opening
  ofstream csvFile("search_comparisons.csv");
  csvFile << "DataSize,BestCase,WorstCase,AverageCase\n";</pre>
  for (int i = 10; i <= 100; i = i + 5)
    int bestCase = INT16_MAX;
    int worstCase = INT16_MIN;
    int averageCase = 0;
    for (int j = 0; j < 10; j++)
      arr = new int[i];
      for (int k = 0; k < i; k++)
        int randomNumber = minBound + rand() % (maxBound - minBound + 1);
        arr[k] = randomNumber;
      }
      int compare = insertionSort(arr, i);
      bestCase = bestCase > compare ? compare : bestCase;
      worstCase = worstCase > compare ? worstCase : compare;
      averageCase += compare;
      delete[] arr;
      // printArray(arr, i);
    }
```

```
// inserting data in the csv file
    csvFile << i << "," << bestCase << "," << worstCase << "," << averageCase / 10 << "\n";
}
return 0;
}</pre>
```

## //csv file after running the above program

 ${\tt DataSize, Best Case, Worst Case, Average Case}$ 

10,14,29,22

15,46,61,52

20,64,132,97

25,123,185,152

30,136,251,204

35,234,341,287

40,343,459,408

45,457,543,487

50,477,701,582

55,562,812,709

60,868,974,903

65,970,1149,1042

70,1019,1320,1160

75,1230,1608,1396

80,1376,1780,1590

85,1570,1900,1782

90,1775,2134,2002

95,2062,2519,2267

100,2221,2804,2407

### Python Code to plot the graph:-

```
import pandas as pd
```

import matplotlib.pyplot as plt

df = pd.read\_csv("search\_comparisons.csv")

size = df["DataSize"]

bestCase = df["BestCase"]

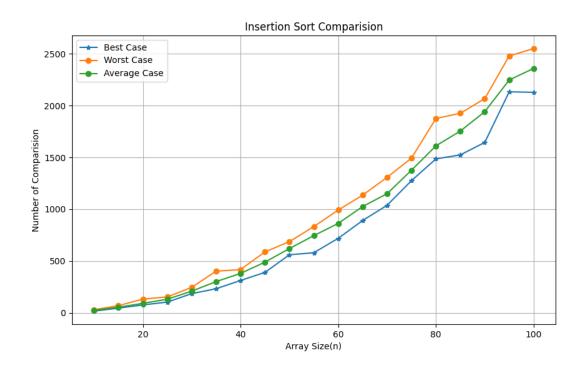
worstCase = df["WorstCase"]

averageCase = df["AverageCase"]

#//plotting the graph

```
plt.figure(figsize=(10,6))
plt.plot(size,bestCase,label="Best Case",marker="*")
plt.plot(size, worstCase, label="Worst Case", marker='o')
plt.plot(size, averageCase, label="Average Case", marker='o')
plt.title("Insertion Sort Comparision")
plt.xlabel("Array Size(n)")
plt.ylabel("Number of Comparision")
plt.legend()
plt.grid(True)
plt.savefig("diagram.png")
plt.show()
```

#### **OUTPUT GRAPH:**



//Program 2: Insertion sort applying on all the permutation of a randomly generated array and finding it's best, worst and average time complexity

#include <iostream>

#include <vector>

```
#include <cstdlib>
#include <algorithm> //for rnad and srand
#include <ctime>
#include <fstream>
using namespace std;
// Insertion sort function
int insertionSort(vector<int> arr, int size){
  int comparision = 0;
 int key;
  int j;
  for (int i = 1; i < size; i++)
    key = arr[i];
    j = i - 1;
    while (j \geq 0 && key < arr[j])
      comparision++;
      arr[j + 1] = arr[j];
      j--;
    }
    arr[j + 1] = key;
  }
  return comparision;
// to print vector
void print(vector<int> vec){
  cout<<endl;
  cout<<"Array is: ";
  for(int i=0;i<vec.size();i++){</pre>
    cout<<vec[i]<<" ";
  }
  cout<<endl;
// function to swap two numbers in a vector
void swap(vector<int>& vec,int start,int end){
```

```
int temp = vec[start];
  vec[start] = vec[end];
 vec[end] = temp;
}
//Function to find permutation of the given vector \ensuremath{\mathsf{vec}}
void\ permute(vector{<}int{>}\ vec, vector{<}vector{<}int{>}{>}\&\ ans, int\ index)\{
  if(index>= vec.size()){
    ans.push_back(vec);
    return;
  }
  for(int i=index;i<vec.size();i++){
    swap(vec,index,i);
    permute(vec,ans,index+1);
    swap(vec,index,i);
  }
}
int fact(int n){
  if(n<=1)return 1;
  return n*fact(n-1);
}
// Main function
int main(){
 srand(time(0));
  int size=5;
  vector<int> vec;
  for(int i=0;i < size;i++)\{
    int random_number = rand()%100;
    vec.push_back(random_number);
  }
  print(vec);
  vector<vector<int>> pVector;
  int index=0;
  permute(vec,pVector,index);
```

```
int bestCase = INT16_MAX;
  int worstCase = INT16_MIN;
  int averageCase = 0;
  for(int i=0;i<fact(size);i++){</pre>
    //sorting the data and taking the number of comparision as output
    int compare = insertionSort(pVector[i],size);
    bestCase = bestCase > compare ? compare : bestCase;
    worstCase = worstCase > compare ? worstCase : compare;
    averageCase += compare;
  }
  // output (time complexity)
  cout<<"Best Case : "<<bestCase<<endl;</pre>
  cout<<"Worst Case : "<<worstCase<<endl;</pre>
  cout<<"Average Case : "<<averageCase/fact(size)<<endl;</pre>
  return 0;
}
```

#### Output:

Array is : 49 81 78 41 89

Best Case : 0 Worst Case : 10 Average Case : 5

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2. Run on weather data of size at least 100 and argue that IS is stable.

#include <iostream>

#include <vector>

#include <string>

```
#include <iomanip>
#include <cstdlib> // For rand() and srand()
#include <ctime> // For time()
using namespace std;
// Structure to represent weather data
struct WeatherData {
  string city;
  string timeStamp;
  double temperature;
  double humidity;
  double rainfall;
};
// Function to perform Insertion Sort
void insertionSort(vector<WeatherData>& data) {
  for (size_t i = 1; i < data.size(); ++i) {
    WeatherData key = data[i];
    int j = i - 1;
    // Move elements of data[0..i-1] that are greater than key.city to one position ahead of their current position
    while (j \geq 0 && data[j].city \geq key.city) {
      data[j + 1] = data[j];
      j = j - 1;
    data[j + 1] = key;
  }
// Function to generate random weather data
vector<WeatherData> generateWeatherData(int numSamples) {
  vector<string> cities = {"Delhi", "Bangalore", "Mumbai", "UP", "Goa"};
  vector<string> times = {"5:00 AM", "6:00 AM", "7:00 AM", "8:00 AM", "9:00 AM",
               "10:00 AM", "11:00 AM", "12:00 PM", "1:00 PM", "2:00 PM"};
  vector<WeatherData> data;
```

```
srand(time(0)); // Seed the random number generator
     for (int i = 0; i < numSamples; ++i) {
           WeatherData record;
          record.city = cities[rand() % cities.size()];
          record.timeStamp = times[rand() % times.size()];
           record.temperature = 20 + (rand() % 20); // Random temperature between 20 and 40
           record.humidity = 30 + (rand() % 70); // Random humidity between 30% and 100%
          record.rainfall = (rand() % 50);
                                                                                            // Random rainfall between 0 and 50 mm
           data.push_back(record);
    }
    return data;
}
// Function to print the weather data
void printWeatherData(const vector<WeatherData>& data) {
    cout << setw(5) << "S.No." << setw(15) << "City" << setw(15) << "Time Stamp" << setw(15) << "Temp. (C)" << setw(15) << "Humidity (%)" <<
setw(15) << "Rainfall (mm)" << endl;
    // if we write data.size() instead of 15 it will print all the data
    for (size_t i = 0; i < 15; ++i) {
          cout << setw(5) << i+1 << setw(15) << data[i].city << setw(15) << data[i].timeStamp << setw(15) << data[i].temperature << setw(15) << data[i].timeStamp << setw(15) << setw(
data[i].humidity << setw(15) << data[i].rainfall << endl;
    }
int main() {
    // Generate weather data with at least 100 samples
    vector<WeatherData> weatherData = generateWeatherData(100);
    // Input data sorted by time
    cout << "Input Data (Unsorted) first 15 data only:" << endl;
     printWeatherData(weatherData);
     insertionSort(weatherData);
    // Output data sorted by city
```

```
cout << "\nOutput Data (Sorted by City) first 15 data only:" << endl;
printWeatherData(weatherData);
return 0;</pre>
```

#### Output:

Input Data (Unsorted) first 15 data only:  S.No. City Time Stamp Temp. (C) Humidity (%) Rainfall (mm)  1 Bangalore 7:00 AM 25 64 34  2 Bangalore 2:00 PM 39 62 30  3 Delhi 11:00 AM 32 54 112  4 UP 11:00 AM 25 33 06  5 Mumbai 11:00 AM 21 46 110  6 Bangalore 11:00 AM 27 57 28  8 Goa 8:00 AM 27 57 28  8 Goa 8:00 AM 29 45 00  9 Goa 7:00 AM 33 77 47  10 UP 6:00 AM 22 69 32  11 Bangalore 10:00 AM 22 86 39  12 Bangalore 5:00 AM 28 47 13  13 Mumbai 5:00 PM 25 36 13  Output Data (Sorted by City) first 15 data only:  S.No. City Time Stamp Temp. (C) Humidity (%) Rainfall (mm)  Output Data (Sorted by City) first 15 data only:  S.No. City Time Stamp Temp. (C) Humidity (%) Rainfall (mm)  1 Bangalore 7:00 AM 25 36 39  3 Bangalore 11:00 AM 25 36 39  5 Bangalore 2:00 PM 39 62 30  3 Bangalore 11:00 AM 27 44 14  4 Bangalore 10:00 AM 27 44 14  4 Bangalore 10:00 AM 27 44 14  4 Bangalore 10:00 AM 28 47 13  6 Bangalore 11:00 AM 27 44 14  14 Bangalore 10:00 AM 28 47 13  Bangalore 11:00 AM 27 44 14  Bangalore 10:00 AM 28 47 13  Bangalore 11:00 AM 27 44 14  Bangalore 10:00 AM 28 47 13  Bangalore 10:00 AM 34 97 41  Bangalore 10:00 AM 36 37 5  Bangalore 10:00 AM 36 37 5  Bangalore 10:00 AM 38 49 99  12 Bangalore 10:00 AM 38 49 99  12 Bangalore 10:00 AM 38 49 99  13 Bangalore 10:00 AM 38 49 99  14 Bangalore 10:00 AM 38 49 99  15 Bangalore 10:00 AM 38 49 99  15 Bangalore 10:00 AM 38 49 99  16 Bangalore 10:00 AM 38 49 99  17 Bangalore 10:00 AM 38 49 99  18 Bangalore 10:00 AM 38 49 99  19 Bangalore 10:00 AM 38 49 99  10 Bangalore 10:00 AM 38 49 99  11 Bangalore 10:00 AM 38 49 99  12 Bangalore 10:00 AM 38 49 99  13 Bangalore 10:00 AM 38 49 99  14 Bangalore 10:00 AM 38 49 99  15 Bangalore 10:00 AM 38 49 99	Outpu	<u>.                                    </u>				
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13       Mumbai       5:00 AM       24       42       8         14       Mumbai       2:00 PM       25       46       40         15       Goa       7:00 AM       25       36       13         Output Data (Sorted by City) first 15 data only:         S.No.       City       Time Stamp       Temp. (C)       Humidity (%)       Rainfall (mm)         1       Bangalore       7:00 AM       25       64       34         2       Bangalore       2:00 PM       39       62       30         3       Bangalore       11:00 AM       27       44       14         4       Bangalore       10:00 AM       28       47       13         6       Bangalore       5:00 AM       28       47       13         6       Bangalore       5:00 AM       34       97       41         8       Bangalore       1:00 PM       30       58       31         9       Bangalore       1:00 AM       36       37       5         10       Bangalore       10:00 AM       33       48       23         11       Bangalore       10:00 AM       34       39 <th>11</th> <th>Bangalore</th> <th>10:00 AM</th> <th>22</th> <th>86</th> <th>39</th>	11	Bangalore	10:00 AM	22	86	39
14       Mumbai       2:00 PM       25       46       40         15       Goa       7:00 AM       25       36       13         Output Data (Sorted by City) first 15 data only:         S.No.       City       Time Stamp       Temp. (C)       Humidity (%)       Rainfall (mm)         1       Bangalore       7:00 AM       25       64       34         2       Bangalore       2:00 PM       39       62       30         3       Bangalore       11:00 AM       27       44       14         4       Bangalore       10:00 AM       22       86       39         5       Bangalore       5:00 AM       28       47       13         6       Bangalore       5:00 AM       34       97       41         8       Bangalore       1:00 PM       30       58       31         9       Bangalore       10:00 AM       36       37       5         10       Bangalore       2:00 PM       33       48       23         11       Bangalore       10:00 AM       28       39       9         12       Bangalore       7:00 AM       34       38       <	12	Bangalore	5:00 AM	28	47	13
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S.No.       City       Time Stamp       Temp. (C)       Humidity (%)       Rainfall (mm)         1       Bangalore       7:00 AM       25       64       34         2       Bangalore       2:00 PM       39       62       30         3       Bangalore       11:00 AM       27       44       14         4       Bangalore       10:00 AM       22       86       39         5       Bangalore       5:00 AM       28       47       13         6       Bangalore       5:00 AM       25       42       19         7       Bangalore       5:00 AM       34       97       41         8       Bangalore       1:00 PM       30       58       31         9       Bangalore       10:00 AM       36       37       5         10       Bangalore       2:00 PM       33       48       23         11       Bangalore       10:00 AM       28       39       9         12       Bangalore       7:00 AM       34       38       43         13       Bangalore       10:00 AM       26       97       27         14       Bangalore       10:						
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Conclusion: Insertion Sort maintains the relative order of elements with equal city values because it only shifts elements when it finds a smaller value. Since it doesn't change the order of equal elements, Insertion Sort is stable.