DAA – PRACTICALS

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BSC HONS COMPUTER SCIENCE

Practicals List

1) Write a program to sort the elements of an array using Insertion Sort (The program should report the number of comparisons).

```cpp
#include <iostream>
using namespace std;

void insertionSort(int arr[], int n, int& comparisons) {
    int i, key, j;
    for (i = 1; i < n; i++) {
        key = arr[i];
        j = i - 1;
        comparisons = 0; // reset comparisons for each iteration
        while (j >= 0 && arr[j] > key) {
            arr[j + 1] = arr[j];
            j = j - 1;
            comparisons++; // increment comparisons
        }
        arr[j + 1] = key;
    }
}

int main() {
    int arr[] = {10, 20, 7, 15, 5};
    int n = sizeof(arr) / sizeof(arr[0]);
    int comparisons = 0;

    insertionSort(arr, n, comparisons);
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";

    cout << "\nComparisons made: " << comparisons << endl;
```

```
    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q1.cpp -o Q1 } ; if ($?) { .\Q1 }
5 7 10 15 20
Comparisons made: 4
PS D:\algo-prac>
```

2) Write a program to sort the elements of an array using Merge Sort (The program should report the number of comparisons).

```
#include <iostream>
using namespace std;

void merge(int arr[], int l, int m, int r, int& comparisons) {
    int i, j, k;
    int n1 = m - l + 1;
    int n2 = r - m;

    int L[n1], R[n2];

    for (i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    i = 0;
    j = 0;
    k = l;

    while (i < n1 && j < n2) {
        comparisons++; // increment comparisons
        if (L[i] <= R[j]) {
            arr[k] = L[i];
```

```
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}

void mergeSort(int arr[], int l, int r, int& comparisons) {
    if (l >= r) {
        return;
    }

    int m = l + (r - l) / 2;

    mergeSort(arr, l, m, comparisons);
    mergeSort(arr, m + 1, r, comparisons);

    merge(arr, l, m, r, comparisons);
}

int main() {
    int arr[] = {11, 30, 70, 15, 25};
```

```
    int n = sizeof(arr) / sizeof(arr[0]);
    int comparisons = 0;

    mergeSort(arr, 0, n - 1, comparisons);
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";

    cout << "\nComparisons made: " << comparisons << endl;

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q2.cpp -o Q2 } ; if ($?) { .\Q2 }
11 15 25 30 70
Comparisons made: 7
PS D:\algo-prac>
```

3) Write a program to sort the elements of an array using Heap Sort (The program should report the number of comparisons).

```
#include <iostream>
using namespace std;

void heapify(int arr[], int n, int i, int& comparisons) {
    int largest = i;
    int l = 2 * i + 1;
    int r = 2 * i + 2;

    if (l < n && arr[l] > arr[largest]) {
        largest = l;
        comparisons++; // increment comparisons
    }

    if (r < n && arr[r] > arr[largest]) {
        largest = r;
```

```
        comparisons++; // increment comparisons
    }

    if (largest!= i) {
        swap(arr[i], arr[largest]);
        heapify(arr, n, largest, comparisons);
    }
}

void heapSort(int arr[], int n, int& comparisons) {
    for (int i = n / 2 - 1; i >= 0; i--) {
        heapify(arr, n, i, comparisons);
    }

    for (int i = n - 1; i >= 0; i--) {
        swap(arr[0], arr[i]);
        heapify(arr, i, 0, comparisons);
    }
}

int main() {
    int arr[] = {33, 6, 1, 90, 4, 7};
    int n = sizeof(arr) / sizeof(arr[0]);
    int comparisons = 0;

    heapSort(arr, n, comparisons);
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";

    cout << "\nComparisons made: " << comparisons << endl;

    return 0;
}
```

Output:

```
Comparisons made: 7
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q3.cpp -o Q3 } ; if ($?) { .\Q3 }
1 4 6 7 33 90
Comparisons made: 8
PS D:\algo-prac>
```

4) Write a program to sort the elements of an array using Quick Sort (The program should report the number of comparisons).

```cpp
#include <iostream>
using namespace std;

int partition(int arr[], int low, int high, int& comparisons) {
    int pivot = arr[high];
    int i = (low - 1);

    for (int j = low; j <= high - 1; j++) {
        comparisons++; // increment comparisons
        if (arr[j] < pivot) {
            i++;
            swap(arr[i], arr[j]);
        }
    }
    swap(arr[i + 1], arr[high]);
    return (i + 1);
}

void quickSort(int arr[], int low, int high, int& comparisons) {
    if (low < high) {
        int pi = partition(arr, low, high, comparisons);

        quickSort(arr, low, pi - 1, comparisons);
        quickSort(arr, pi + 1, high, comparisons);
    }
}

int main() {
```

```
    int arr[] = {55, 34, 12, 32, 89, 10};
    int n = sizeof(arr) / sizeof(arr[0]);
    int comparisons = 0;

    quickSort(arr, 0, n - 1, comparisons);
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";

    cout << "\nComparisons made: " << comparisons << endl;

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q4.cpp -o Q4 } ; if ($?) { .\Q4 }
10 12 32 34 55 89
Comparisons made: 11
PS D:\algo-prac>
```

5) Write a program to multiply two matrices using the Strassen's algorithm for matrix multiplication.

```
#include <iostream>
using namespace std;

const int N = 2;     // Matrix size
// N must be a power of 2 (N = 2^k)
// If N is not a power of 2, we add additional rows and columns as
needed
// This program automatically does not add extra rows and columns

template<typename T>
void Strassen(int n, T A[][N], T B[][N], T C[][N]);

template<typename T>
void input(int n, T p[][N]);
```

```
template<typename T>
void output(int n, T C[][N]);

int main() {

    int A[N][N],B[N][N],C[N][N];

    cout<<"Enter A\n";
    input(N,A);
    cout<<"\nEnter B\n";
    input(N,B);
    cout<<"\nMatrix A is:\n";
    output(N, A);
    cout<<"\nMatrix B is:\n";
    output(N, B);

    //C=A*B
    Strassen(N, A, B, C);

    output(N, C);

    return 0;
}

// Input
template<typename T>
void input(int n, T p[][N]) {
     for(int i=0; i<n; i++) {
        cout<<"Please Input Line "<<i+1<<endl;
        for(int j=0; j<n; j++) {
           cin>>p[i][j];
        }
     }
}

// Output
```

```
template<typename T>
void output(int n, T C[][N]) {
    cout<<"\n";
     for(int i=0; i<n; i++) {
        for(int j=0; j<n; j++) {
           cout<<C[i][j]<<"\t";
        }
        cout<<"\n";
     }
}

// Multiplication
template<typename T>
void Matrix_Multiply(T A[][N], T B[][N], T C[][N]) {  //
Calculating A*B -> C
     //output(2,A);
     //output(2,B);
     for(int i=0; i<2; i++) {
        for(int j=0; j<2; j++) {
           C[i][j] = 0;
           for(int t=0; t<2; t++) {
              C[i][j] = C[i][j] + A[i][t]*B[t][j];
           }
        }
     }
}

// Addition
template <typename T>
void Matrix_Add(int n, T X[][N], T Y[][N], T Z[][N]) {
     //output(n,X);
     //output(n,Y);
     for(int i=0; i<n; i++) {
        for(int j=0; j<n; j++) {
           Z[i][j] = X[i][j] + Y[i][j];
        }
```

```
    }
}

// Under construction
template <typename T>
void Matrix_Sub(int n, T X[][N], T Y[][N], T Z[][N]) {
    for(int i=0; i<n; i++) {
       for(int j=0; j<n; j++) {
          Z[i][j] = X[i][j] - Y[i][j];
       }
    }
}

//              STRASSEN
template <typename T>
void Strassen(int n, T A[][N], T B[][N], T C[][N]) {
    T A11[N][N], A12[N][N], A21[N][N], A22[N][N];
    T B11[N][N], B12[N][N], B21[N][N], B22[N][N];
    T C11[N][N], C12[N][N], C21[N][N], C22[N][N];
    T M1[N][N], M2[N][N], M3[N][N], M4[N][N], M5[N][N], M6[N][N],
M7[N][N];
    T AA[N][N], BB[N][N];

    if(n == 2) {  //2-order
       Matrix_Multiply(A, B, C);
    } else {

       for(int i=0; i<n/2; i++) {
          for(int j=0; j<n/2; j++) {
             A11[i][j] = A[i][j];
             A12[i][j] = A[i][j+n/2];
             A21[i][j] = A[i+n/2][j];
             A22[i][j] = A[i+n/2][j+n/2];

             B11[i][j] = B[i][j];
             B12[i][j] = B[i][j+n/2];
```

```
            B21[i][j] = B[i+n/2][j];
            B22[i][j] = B[i+n/2][j+n/2];
        }
    }

    cout<<"\n Dividing A and B :\n";
    cout<<"\n\tA11:\n";
    output(n/2, A11);

    cout<<"\n\tA12:\n";
    output(n/2, A12);

    cout<<"\n\tA21:\n";
    output(n/2, A21);

    cout<<"\n\tA22:\n";
    output(n/2, A22);

    cout<<"\n\tB11:\n";
    output(n/2, B11);

    cout<<"\n\tB12:\n";
    output(n/2, B12);

    cout<<"\n\tB21:\n";
    output(n/2, B21);

    cout<<"\n\tB22:\n";
    output(n/2, B22);

    cout<<"\n\n\n----------------------------------------";
    cout<<"\n----------------------------------------";
    cout<<"\n----------------------------------------";


    // Calculation of M1 = (A0 + A3) * (B0 + B3)
```

```
        cout<<"\n-----------------------------------";
        cout<<"\nM1 =\n________";
        output(n/2, A11);
        cout<<"++++++++";
        output(n/2, A22);
        cout<<"________\n********\n________";
        output(n/2, B11);
        cout<<"++++++++";
        output(n/2, B22);
        cout<<"________\n-----------------------------------";

        Matrix_Add(n/2, A11, A22, AA);
        Matrix_Add(n/2, B11, B22, BB);
        Strassen(n/2, AA, BB, M1);


        // Calculation of M2 = (A2 + A3) * B0
        cout<<"-----------------------------------";
        cout<<"\nM2 =\n________";
        output(n/2, A21);
        cout<<"++++++++";
        output(n/2, A22);
        cout<<"________\n********\n________";
        output(n/2, B11);
        cout<<"________\n-----------------------------------";

        Matrix_Add(n/2, A21, A22, AA);
        Strassen(n/2, AA, B11, M2);


        // Calculation M3 = A0 * (B1 - B3)
        cout<<"-----------------------------------";
        cout<<"\nM3 =\n________";
        output(n/2, A11);
        cout<<"________\n********\n________";
        output(n/2, B12);
```

```
        cout<<"--------";
        output(n/2, B22);
        cout<<"_________\n-----------------------------------";

        Matrix_Sub(n/2, B12, B22, BB);
        Strassen(n/2, A11, BB, M3);


        // Calculation M4 = A3 * (B2 - B0)
        cout<<"-----------------------------------";
        cout<<"\nM4 =\n_________";
        output(n/2, A22);
        cout<<"_________\n********\n_________";
        output(n/2, B21);
        cout<<"--------";
        output(n/2, B11);
        cout<<"_________\n-----------------------------------";

        Matrix_Sub(n/2, B21, B11, BB);
        Strassen(n/2, A22, BB, M4);


        // Calculation M5 = (A0 + A1) * B3
        cout<<"-----------------------------------";
        cout<<"\nM5 =\n_________";
        output(n/2, A11);
        cout<<"++++++++";
        output(n/2, A12);
        cout<<"_________\n********\n_________";
        output(n/2, B22);
        cout<<"_________\n-----------------------------------";

        Matrix_Add(n/2, A11, A12, AA);
        Strassen(n/2, AA, B22, M5);
```

```
        // Calculation M6 = (A2 - A0) * (B0 + B1)
        cout<<"-----------------------------------";
        cout<<"\nM6 =\n________";
        output(n/2, A21);
        cout<<"--------";
        output(n/2, A11);
        cout<<"________\n********\n________";
        output(n/2, B11);
        cout<<"++++++++";
        output(n/2, B12);
        cout<<"________\n-----------------------------------";

        Matrix_Sub(n/2, A21, A11, AA);
        Matrix_Add(n/2, B11, B12, BB);
        Strassen(n/2, AA, BB, M6);


        // Calculation M7 = (A1 - A3) * (B2 + B3)
        cout<<"-----------------------------------";
        cout<<"\nM7 =\n________";
        output(n/2, A12);
        cout<<"--------";
        output(n/2, A22);
        cout<<"________\n********\n________";
        output(n/2, B21);
        cout<<"++++++++";
        output(n/2, B22);
        cout<<"________\n-----------------------------------";

        Matrix_Sub(n/2, A12, A22, AA);
        Matrix_Add(n/2, B21, B22, BB);
        Strassen(n/2, AA, BB, M7);

        cout<<"\n\n\n---------------------------------------";
        cout<<"\n---------------------------------------";
        cout<<"\n---------------------------------------";
```

```
    cout<<"\n_________\nM1=";
    output(n/2, M1);
    cout<<"_________\nM2=";
    output(n/2, M2);
    cout<<"_________\nM3=";
    output(n/2, M3);
    cout<<"_________\nM4=";
    output(n/2, M4);
    cout<<"_________\nM5=";
    output(n/2, M5);
    cout<<"_________\nM6=";
    output(n/2, M6);
    cout<<"_________\nM7=";
    output(n/2, M7);

    cout<<"\n\n\n---------------------------------------";
    cout<<"\n---------------------------------------";
    cout<<"\n---------------------------------------";


    // Calculation C0 = M1 + M4 - M5 + M7
    cout<<"\n-----------------------------------";
    cout<<"\nC11 =\n_________";
    output(n/2, M1);
    cout<<"+++++++";
    output(n/2, M4);
    cout<<"-------";
    output(n/2, M5);
    cout<<"++++++++";
    output(n/2, M7);
    cout<<"_________\n-----------------------------------";
    Matrix_Add(n/2, M1, M4, AA);
    Matrix_Sub(n/2, M7, M5, BB);
    Matrix_Add(n/2, AA, BB, C11);
```

```
        // Calculation C1 = M3 + M5
        cout<<"-----------------------------------";
        cout<<"\nC12 =\n________";
        output(n/2, M3);
        cout<<"+++++++";
        output(n/2, M5);
        cout<<"________\n-----------------------------------";
        Matrix_Add(n/2, M3, M5, C12);

        // Calculation C2 = M2 + M4
        cout<<"-----------------------------------";
        cout<<"\nC21 =\n________";
        output(n/2, M2);
        cout<<"+++++++";
        output(n/2, M4);
        cout<<"________\n-----------------------------------";
        Matrix_Add(n/2, M2, M4, C21);

        // Calculation C3 = M1 - M2 + M3 + M6
        cout<<"-----------------------------------";
        cout<<"\nC22 =\n________";
        output(n/2, M1);
        cout<<"-------";
        output(n/2, M2);
        cout<<"+++++++";
        output(n/2, M3);
        cout<<"++++++++";
        output(n/2, M6);
        cout<<"________\n-----------------------------------";
        Matrix_Sub(n/2, M1, M2, AA);
        Matrix_Add(n/2, M3, M6, BB);
        Matrix_Add(n/2, AA, BB, C22);

        cout<<"\n\n\n---------------------------------------";
        cout<<"\n---------------------------------------";
        cout<<"\n---------------------------------------";
```

```
        cout<<"\n_________\nC11=";
        output(n/2, C11);
        cout<<"_________\nC12=";
        output(n/2, C12);
        cout<<"_________\nC21=";
        output(n/2, C21);
        cout<<"_________\nC22=";
        output(n/2, C22);
        cout<<"_________";


        cout<<"\n\n\n----------------------------------------";
        cout<<"----------------------------------------";
        cout<<"\nFinal Answer:\n\n";

        for(int i=0; i<n/2; i++) {
           for(int j=0; j<n/2; j++) {
              C[i][j] = C11[i][j];
              C[i][j+n/2] = C12[i][j];
              C[i+n/2][j] = C21[i][j];
              C[i+n/2][j+n/2] = C22[i][j];
           }
        }
     }
}
```

Input:

```
Enter A
Please Input Line 1
1
2
3
4
Please Input Line 2
2
3
4
5
Please Input Line 3
3
4
1
2
Please Input Line 4
1
1
1
1

Enter B
Please Input Line 1
10
2
3
4
Please Input Line 2
20
3
4
1
Please Input Line 3
1
1
1
1
Please Input Line 4
4
3
2
1
```

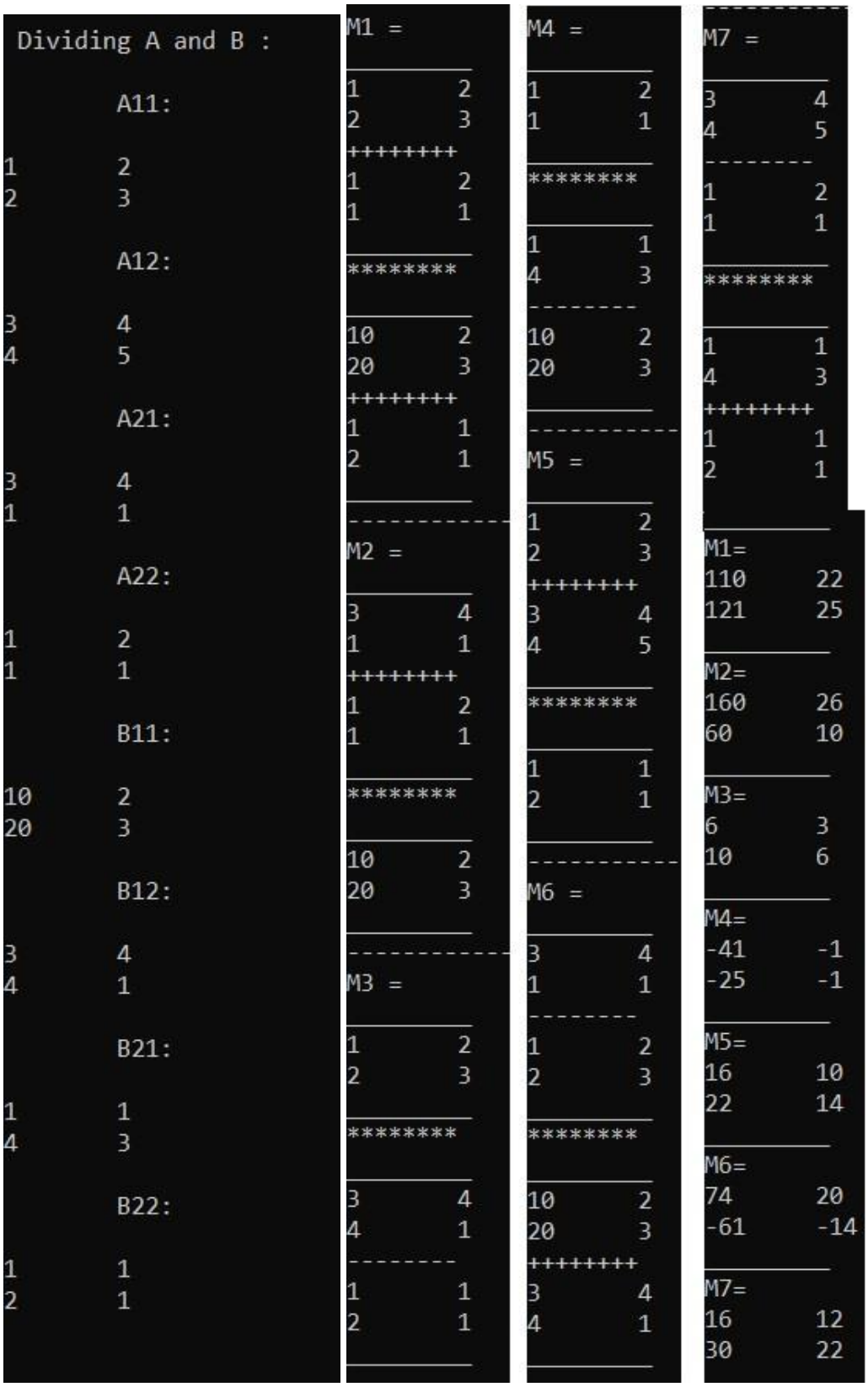
```
Matrix A is:

1       2       3       4
2       3       4       5
3       4       1       2
1       1       1       1

Matrix B is:

10      2       3       4
20      3       4       1
1       1       1       1
4       3       2       1
```

Output:


Dividing A and B :
A11:
1 2
2 3
A12:
3 4
4 5
A21:
3 4
1 1
A22:
1 2
1 1
B11:
10 2
20 3
B12:
3 4
4 1
B21:
1 1
4 3
B22:
1 1
2 1
M1 =
1 2
2 3
++++++++
1 2
1 1
****
10 2
20 3
++++++++
1 1
2 1
M2 =
3 4
1 1
++++++++
1 2
1 1
****
10 2
20 3
M3 =
1 2
2 3
****
3 4
4 1
1 1
2 1
M4 =
1 2
1 1
****
1 1
4 3
10 2
20 3
M5 =
1 2
2 3
++++++++
3 4
4 5
****
1 1
2 1
M6 =
3 4
1 1
1 2
2 3
****
10 2
20 3
++++++++
3 4
4 1
M7 =
3 4
4 5
1 2
1 1
****
1 1
4 3
++++++++
1 1
2 1
M1=
110 22
121 25
M2=
160 26
60 10
M3=
6 3
10 6
M4=
-41 -1
-25 -1
M5=
16 10
22 14
M6=
74 20
-61 -14
M7=
16 12
30 22

```
C11 =
_________
110     22
121     25
+++++++
-41     -1
-25     -1
-------
16      10
22      14
++++++++
16      12
30      22
_________
------------
C12 =
_________
6       3
10      6
+++++++
16      10
22      14
_________
------------
C21 =
_________
160     26
60      10
+++++++
-41     -1
-25     -1
_________
------------
C22 =
_________
110     22
121     25
-------
160     26
60      10
+++++++
6       3
10      6
++++++++
74      20
-61     -14
_________
```

```
_________
C11=
69      23
104     32
_________
C12=
22      13
32      20
_________
C21=
119     25
35      9
_________
C22=
30      19
10      7
_________
```

```
Final Answer:


69      23      22      13
104     32      32      20
119     25      30      19
35      9       10      7
```

6) Write a program to sort the elements of an array using Count Sort.

```cpp
#include <iostream>
using namespace std;

void countSort(int arr[], int n) {
    int k = arr[0];
    for (int i = 0; i < n; i++)
        k = max(k, arr[i]);

    int count[k + 1] = {0};
    for (int i = 0; i < n; i++)
        count[arr[i]]++;

    for (int i = 1; i <= k; i++)
        count[i] += count[i - 1];

    int output[n];
    for (int i = n - 1; i >= 0; i--) {
        output[count[arr[i]] - 1] = arr[i];
        count[arr[i]]--;
    }

    for (int i = 0; i < n; i++)
        arr[i] = output[i];
}

int main() {
    int arr[] = {35, 40, 11, 20, 78, 43, 51};
    int n = sizeof(arr) / sizeof(arr[0]);

    countSort(arr, n);
    for (int i = 0; i < n; i++)
        cout << arr[i] << " ";

    return 0;
```

```
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q6.cpp -o Q6 } ; if ($?) { .\Q6 }
11 20 35 40 43 51 78
PS D:\algo-prac>
```

7) Display the data stored in a given graph using the Breadth-First Search algorithm.

```cpp
#include <iostream>
#include <queue>
#include <vector>
using namespace std;

class Graph {
public:
    vector<vector<int>> adj;
    Graph(int n) {
        adj.resize(n);
    }

    void addEdge(int u, int v) {
        adj[u].push_back(v);
        adj[v].push_back(u);
    }

    void BFS(int src) {
        vector<bool> visited(adj.size(), false);
        queue<int> q;
        q.push(src);
        visited[src] = true;

        while (!q.empty()) {
            int u = q.front();
            q.pop();
```

```
            cout << u << " ";

            for (auto v : adj[u]) {
                if (!visited[v]) {
                    q.push(v);
                    visited[v] = true;
                }
            }
        }
    }
};

int main() {
    Graph abc(13);
    abc.addEdge(0, 12);
    abc.addEdge(0, 2);
    abc.addEdge(1, 9);
    abc.addEdge(2, 6);
    abc.addEdge(2, 4);
    abc.addEdge(3, 10);
    abc.addEdge(4, 5);

    abc.BFS(0);

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q7.cpp -o Q7 } ; if ($?) { .\Q7 }
0 12 2 6 4 5
PS D:\algo-prac>
```

8) Display the data stored in a given graph using the Depth-First Search algorithm.

```
#include <iostream>
#include <vector>
#include <stack>
using namespace std;

class Graph {
public:
    vector<vector<int>> adj;
    Graph(int n) {
        adj.resize(n);
    }

    void addEdge(int u, int v) {
        adj[u].push_back(v);
        adj[v].push_back(u);
    }

    void DFS(int src, vector<bool>& visited) {
        stack<int> s;
        s.push(src);
        visited[src] = true;

        while (!s.empty()) {
            int u = s.top();
            s.pop();
            cout << u << " ";

            for (auto v : adj[u]) {
                if (!visited[v]) {
                    s.push(v);
                    visited[v] = true;
                }
            }
```

```
        }
    }
};

int main() {
    Graph abc(13);
    abc.addEdge(0, 12);
    abc.addEdge(0, 2);
    abc.addEdge(1, 9);
    abc.addEdge(2, 6);
    abc.addEdge(2, 4);
    abc.addEdge(3, 10);
    abc.addEdge(4, 5);

    vector<bool> visited(abc.adj.size(), false);
    abc.DFS(0, visited);

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q8.cpp -o Q8 } ; if ($?) { .\Q8 }
 0 2 4 5 6 12
PS D:\algo-prac>
```

9) Write a program to determine a minimum spanning tree of a graph using the Prim's algorithm.

```
#include <iostream>
#include <vector>
#include <queue>
using namespace std;

class Graph {
public:
    vector<vector<pair<int, int>>> adj;
```

```
    Graph(int n) {
        adj.resize(n);
    }

    void addEdge(int u, int v, int w) {
        adj[u].push_back(make_pair(v, w));
        adj[v].push_back(make_pair(u, w));
    }

    int prim() {
        int n = adj.size();
        vector<bool> visited(n, false);
        vector<int> key(n, 999999);  // Manual maximum value
        vector<int> parent(n, -1);
        priority_queue<pair<int, int>, vector<pair<int, int>>,
greater<pair<int, int>>> pq;

        key[0] = 0;
        pq.push(make_pair(0, 0));

        int mstCost = 0;
        while (!pq.empty()) {
            int u = pq.top().second;
            pq.pop();

            if (visited[u])
                continue;

            visited[u] = true;
            mstCost += key[u];

            for (auto v : adj[u]) {
                if (!visited[v.first] && v.second < key[v.first]) {
                    key[v.first] = v.second;
                    parent[v.first] = u;
                    pq.push(make_pair(v.second, v.first));
```

```
                }
            }
        }

        return mstCost;
    }
};

int main() {
    Graph abc(13);
    abc.addEdge(0, 1, 10);
    abc.addEdge(0, 2, 6);
    abc.addEdge(0, 3, 5);
    abc.addEdge(1, 3, 15);
    abc.addEdge(2, 3, 4);
    abc.addEdge(2, 4, 2);
    abc.addEdge(3, 4, 1);

    cout << "Minimum Spanning Tree Cost: " << abc.prim() << endl;

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q9.cpp -o Q9 } ; if ($?) { .\Q9 }
Minimum Spanning Tree Cost: 18
PS D:\algo-prac>
```

10) Write a program to solve the 0-1 knapsack problem

```
#include <iostream>
#include <vector>
using namespace std;

int knapSack(int W, vector<int> wt, vector<int> val, int n) {
```

```
    vector<vector<int>> K(n + 1, vector<int>(W + 1));

    for (int i = 0; i <= n; i++) {
        for (int w = 0; w <= W; w++) {
            if (i == 0 || w == 0)
                K[i][w] = 0;
            else if (wt[i - 1] <= w)
                K[i][w] = max(val[i - 1] + K[i - 1][w - wt[i - 1]],
K[i - 1][w]);
            else
                K[i][w] = K[i - 1][w];
        }
    }

    return K[n][W];
}

int main() {
    vector<int> wt = {1, 2, 3, 12, 22, 30};
    vector<int> val = {40, 30, 60, 80, 90, 99};
    int W = 20;
    int n = wt.size();

    cout << "Maximum value that can be obtained: " << knapSack(W,
wt, val, n) << endl;

    return 0;
}
```

Output:

```
PS D:\algo-prac> cd "d:\algo-prac\" ; if ($?) { g++ Q10.cpp -o Q10 } ; if ($?) { .\Q10 }
Maximum value that can be obtained: 210
PS D:\algo-prac>
```

THANK YOU!

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