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Course Code	CSE-4746
Course Title	Numerical Method Lab

1. The following values of $f(x)$ are given:

x : 1 2 3 4 5

$y = f(x)$: 1 8 27 64 125

Write a program to find the difference table for the above values.

2. The following values of $f(x)$ are given:

x : 1 2 3 4 5

$y = f(x)$: 1 8 27 64 125

Write a program to find the value of y when $x = 1.7$ by using Newton's forward interpolation formula.

3. The following values of $f(x)$ are given:

x : 1 2 3 4 5

$y = f(x)$: 1 8 27 64 125

Write a program to find the value of y when $x = 4.7$ by using Newton's backward interpolation formula.

4. The following values of $f(x)$ are given:

x : 1 2 3 4 5

$y = f(x)$: 1 8 27 64 125

Write a program to find the value of x for which $f(x) = 85$ by using Lagrange's inverse interpolation formula.

5. The following values of $f(x)$ are given:

x : 1 3 4 6 10

$y = f(x)$: 0 18 58 190 920

Write a program to:

- Prepare the divided difference table.
 - Find the value of y when $x = 2.7$ by using Newton's divided difference formula.
-

Solution 1:

```
#include<bits/stdc++.h>

using namespace std;

void Print(vector <int> x)
{
    for(auto a : x)
        cout<<a<<' ';
    cout<<'\n';
}

int main()
{
    int n,t;
    cout<<"Enter the number of entries: ";
    cin>>n;
    vector<int>x,y,ans[n + 2];
    for(int i = 0 ; i < n;i++)
    {
        cout<<"x: ";
        Print(x);
        cout<<"Enter x["<<i + 1<<"] : ";
        cin>>t;
        x.push_back(t);
        system("CLS");
    }

    for(int i = 0 ; i < n;i++)
    {
        cout<<"y: ";
        Print(y);
        cout<<"Enter x["<<i + 1<<"] : ";
        cin>>t;
        y.push_back(t);
    }
}
```

```

    system("CLS");
}
ans[0] = y;
for( int i = 1; i < n ;i++ )
{
    for( int j = 1 ; j < ans[i - 1].size() ; j++)
        ans[i].push_back(ans[i - 1][j] - ans[i - 1][j - 1]);
}
cout<<"x : ";
Print(x);
cout<<"y : ";
Print(y);
for( int i = 1 ; i < n ;i++)
{
    cout<<"D^"<<i<<": ";
    Print(ans[i]);
}
}

```

Solution 2:

```
#include<bits/stdc++.h>

using namespace std;

int fact( int x)
{
    int ans = 1;
    for(int i = 2; i <= x;i++)
        ans *= i;
    return ans;
}

void Print(vector <int> x)
{
    for(auto a : x)
        cout<<a<<' ';
    cout<<'\n';
}

int main()
{
    int n,t;
    cout<<"Enter the number of entries: ";
    cin>>n;
    vector<int>x,y,D[n + 2];
    for(int i = 0 ; i < n;i++)
    {
        cout<<"x: ";
        Print(x);
        cout<<"Enter x["<<i + 1<<"] : ";
        cin>>t;
        x.push_back(t);
        system("CLS");
    }
}
```

```

for(int i = 0 ; i < n;i++)
{
    cout<<"y: ";
    Print(y);
    cout<<"Enter x["<<i + 1<<"] : ";
    cin>>t;
    y.push_back(t);
    system("CLS");
}
D[0] = y;
for( int i = 1; i < n ;i++ )
{
    for( int j = 1 ; j < D[i - 1].size() ; j++)
        D[i].push_back(D[i - 1][j] - D[i - 1][j - 1]);
}
cout<<"x : ";
Print(x);
cout<<"y : ";
Print(y);
///Finished calculation of forward difference table
double X;
cout<<"Enter 'x' to find f(x):";
cin>>X;
int h = x[1] - x[0];
double u = (1.00 * (X - x[0]))/h;
double ans = y[0] * 1.00;

for( int i = 1 ; i <= n - 1 ;i++)
{
    double temp_u = u;
    for( int j = 1; j < i;j++)
        temp_u *= (u - (double)j);
}

```

```

        temp_u *= 1.00 * D[i][0];
        temp_u/= 1.00 * fact(i);
        ans += 1.00 * temp_u;
    }
    cout<<"f("<<X<<") = "<<ans<<'\n';
}

```

Solution 3:

```

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

int fact( int x)
{
    int ans = 1;
    for(int i = 2; i <= x;i++)
        ans *= i;
    return ans;
}

void Print(vector <int> x)
{
    for(auto a : x)
        cout<<a<<' ';
    cout<<'\n';
}

int main()
{
    int n,t;
    cout<<"Enter the number of entries: ";
    cin>>n;
    vector<int>x,y,D[n + 2];
    for(int i = 0 ; i < n;i++)

```

```

{
    cout<<"x: ";
    Print(x);
    cout<<"Enter x["<<i + 1<<"] : ";
    cin>>t;
    x.push_back(t);
    system("CLS");
}

for(int i = 0 ; i < n;i++)
{
    cout<<"y: ";
    Print(y);
    cout<<"Enter x["<<i + 1<<"] : ";
    cin>>t;
    y.push_back(t);
    system("CLS");
}
D[0] = y;
for( int i = 1; i < n ;i++ )
{
    for( int j = 1 ; j < D[i - 1].size() ; j++)
        D[i].push_back(D[i - 1][j] - D[i - 1][j - 1]);
}
cout<<"x : ";
Print(x);
cout<<"y : ";
Print(y);
///Finished calculation of backward difference table
double X;
cout<<"Enter 'x' to find f(x):";
cin>>X;
int h = x[1] - x[0];

```

```

double u = (1.00 * (X - x[n - 1]))/h;
double ans = y[ n-1] * 1.00;
for( int i = 1 ; i <= n - 1 ;i++)
{
    double temp_u = u;
    for( int j = 1; j < i;j++)
        temp_u *= (u + (double)j);
    temp_u *= 1.00 *D[i][n - i - 1];
    temp_u/= 1.00 * fact(i);
    ans += 1.00 * temp_u;
}
cout<<"f("X<<" ) = "<<ans<<'\\n';
}

```


Solution 4:

```
#include <bits/stdc++.h>

using namespace std;

int main()
{
    cout<<"Enter number of tabular points: ";
    int n;
    cin>>n;
    double x[n],y[n];
    for(int i =0 ; i < n; i++)
    {
        cout<<"Enter x"<<i<<":";
        cin>>x[i];
    }

    for(int i =0 ; i <n; i++)
    {
        cout<<"Enter y"<<i<<":";
        cin>>y[i];
    }
    cout<<"Enter f(x) to find corresponding x:";
    double Y;
    cin>>Y;
    double ans  = 0;
    for( int i = 0; i<n; i++)
    {
        double temp = 1.00,temp2 = 1.00;
        for( int j = 0 ; j < n; j++)
        {
            if(j == i)
                continue;
            temp *= (Y - y[j]);
        }
    }
}
```

```

        temp2 *= (y[i] - y[j]);
    }
    ans += ((temp * 1.00) / temp2) * x[i];
}
cout<<"x for given f(x) is "<<ans<<'\\n';
}

```

Solution 5:

```

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

int main()
{
    cout<<"Enter number of tabular points: ";
    int n;
    cin>>n;
    vector<double>x(n);
    vector<pair<double,pair<int,int>>>D[n],Y(n);
    for(int i =0 ; i < n; i++)
    {
        cout<<"Enter x"<<i<<":";
        cin>>x[i];
    }

    for(int i =0 ; i <n; i++)
    {
        cout<<"Enter y"<<i<<":";
        cin>>Y[i].first;
        Y[i].second = {i,i};
    }
    D[0] = Y;
}

```

```

for( int i = 1 ; i < n ; i++)
{
    for(int j = 1 ; j < D[i-1].size(); j++)
    {
        int st = D[i -1][j-1].second.first;
        int stp = D[i -1][j].second.second;
        double diff = (D[i - 1][j].first - D[i - 1][j - 1].first)/(x[stp] - x[st]);
        D[i].push_back({diff,{st,stp}});
    }
}
///End of formation of table
cout<<"Enter x to find f(x): ";
double X;
cin>>X;
double ans = 0;
ans = D[0][0].first;
for( int i = 1; i < n; i++)
{
    double temp = 1.00;
    for( int j = 0; j < i; j++)
        temp *= X - x[j];
    temp *= D[i][0].first;
    ans += temp;
}
cout<<"f("<<X<<") is : "<<ans<<'\n';
}

```