Heaven's Light is Our Guide

Rajshahi University of Engineering and Technology
Department of Computer Science and Engineering

Course No: CSE.2104

Course Title: Sessional based on CSE.2104 (Numerical Methods)

Lab Report On: Newton's Forward & Backward Interpolation Formula

Submitted To

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CHAPTER 1

Title: Implementation of Newton's Forward & Backward Interpolation Formula.

1.1 Objective

- Gathering knowledge about Newton's Forward and Backward interpolation formula.
- Implementing the Formula's in C++

1.2 Methodology

- Initialize the value of n
- Load n tabulated pointes
- Calculate missing values of y(x) by Newton's Interpolation
  - Generate difference table
  - Find the value of p
  - Build a Factorial function
  - Find y(x) by the interpolating formula

1.3 Implementation

I have implemented Newton's Forward & Backward Interpolation formula according the above Pseudocode. I have taken the tabulated values from a text file. The tools I used here are :

- C++
- Text File
- Editor: CodeBlocks

1.3.1 Code

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

int n;
double x[101];
double y[101][101];
string buffer;
vector<string>tmp;

void input(){
   ifstream f1;
   f1.open("Newton's.txt");

   while(! f1.eof()){
      f1>>buffer;
      tmp.push_back(buffer);
      buffer.clear();
   }

   for(int i=0,j=0;i<tmp.size();i+=2,j++){
      x[j]=stod(tmp.at(i));
      y[j][0]=stod(tmp.at(i+1));
      n=j+1;
   }
}

void NFD(){
   for(int i=1;i<n;i++){
      for(int j=0;j<n-i;j++){
         y[j][i]=y[j+1][i-1]-y[j][i-1];
      }
   }
}

void NBD(){
   for(int i=1;i<n;i++){
      for(int j=n-1;j>=i;j--){
         y[j][i]=y[j][i-1]-y[j-1][i-1];
      }
   }

}
```

```
void FDT(){
   cout<<"\n\tForward Table"<<endl;
   for(int i=0;i<n;i++){
      cout<<"\t"<<x[i]<<"\t";
      for(int j=0;j<n-i;j++){
         cout<<y[i][j]<<"\t";
      }
      cout<<endl;
   }
   cout<<endl;
}

void BDT(){
   cout<<"\n\tBackward Table"<<endl;
   for(int i=0;i<n;i++){
      cout<<"\t"<<x[i]<<"\t";
      for(int j=0;j<=i;j++){
         cout<<y[i][j]<<"\t";
      }
      cout<<endl;
   }
   cout<<endl;
}

int fact(int n){
   if(n==1)
      return 1;
   else
      return n*fact(n-1);
}

double Fp_val(int n,double p){
   double p_o = p;

   for(int i=1;i<n;i++){
      p_o*=(p-i);
   }

   return p_o;
}

double Bp_val(int n,double p){
   double p_o = p;

   for(int i=1;i<n;i++){
      p_o*=(p+i);
```

```
    }

    return p_o;
}

double FINT(double val){

    double result = y[0][0];
    double h=x[1]-x[0];
    double p= (val-x[0])/h;

    for(int i=1;i<n;i++){
        result+=(Fp_val(i,p)*y[0][i])/fact(i);
    }

    return result;
}

double BINT(double val){

    double result = y[n-1][0];
    double h=x[1]-x[0];
    double p= (val-x[n-1])/h;

    for(int i=1;i<n;i++){
        result+=(Bp_val(i,p)*y[n-1][i])/fact(i);
    }

    return result;
}

void menu(){

    cout<<"\n\tChoose Option \n"<<endl;
    cout<<"\t1. Forward\n\t2. Backward\n"<<endl;
}

int main(){
    /// Step 1: Input

    input();

    double vx;

    while(true){
        cout<<"\n\tEnter the value of x : ";
```

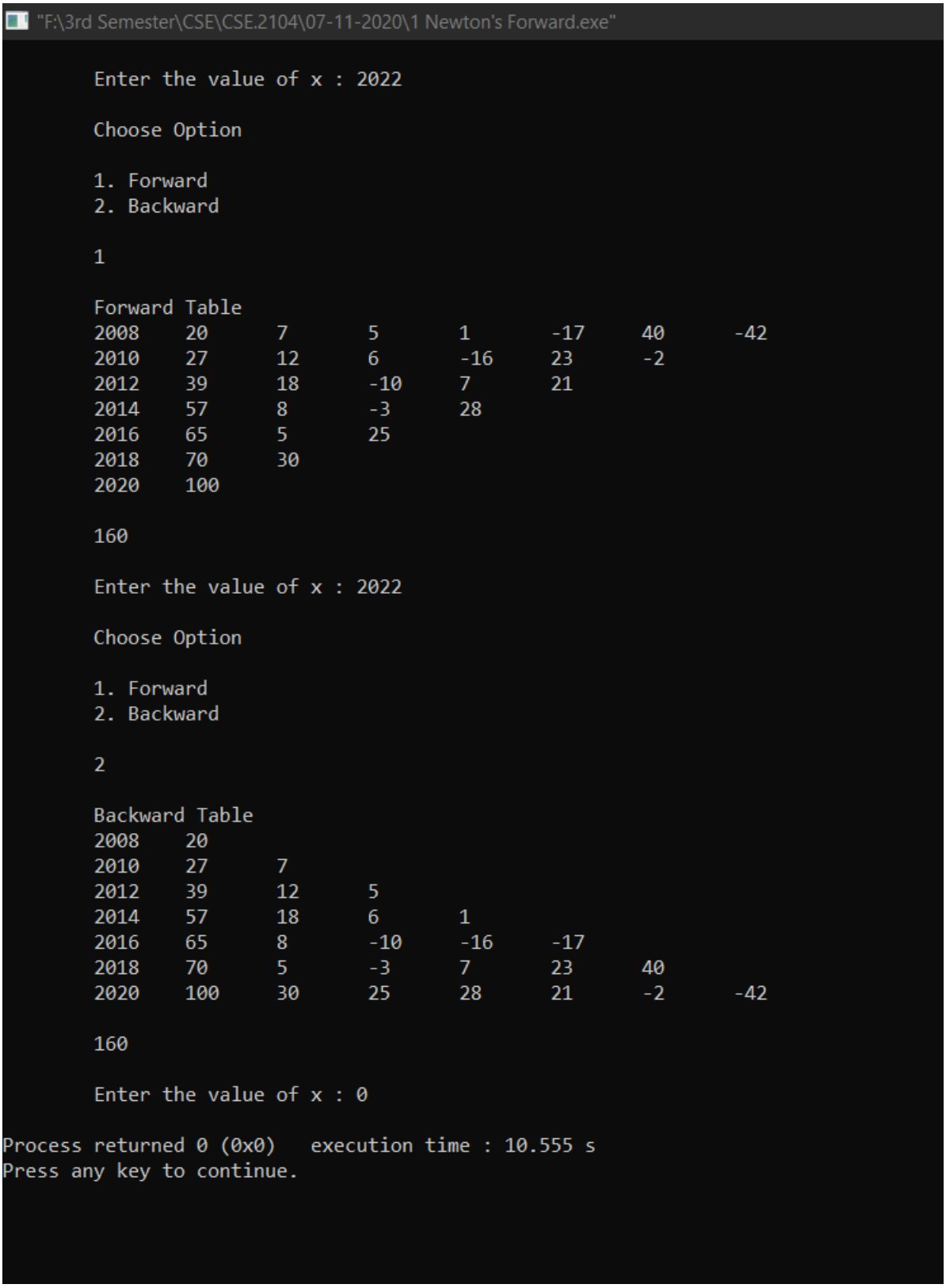
```
      cin>>vx;
      if(!vx){
         break;
      }
      menu();
      int a;
      cout<<"\t";
      cin>>a;
      switch(a){
         case 1: NFD();  /// Newton's Forward Diff.
               FDT();  /// Forward Diff. Table
               cout<<"\t"<<FINT(vx)<<endl;   /// Forward Interpolation
               break;

         case 2: NBD();  /// Newton's Backward Diff.
               BDT();  /// Backward Diff. Table
               cout<<"\t"<<BINT(vx)<<endl;   /// Backward Interpolation
               break;

         default:
            cout<<"Invalid Input\n"<<endl;
            break;
      }
   }


   return 0;
}
```

1.4 Output

I had used the following dataset in the implementation:

Year	2008	2010	2012	2014	2016	2018	2020
Sell	20	27	39	57	65	70	100

And my output was like below:


"F:\3rd Semester\CSE\CSE.2104\07-11-2020\1 Newton's Forward.exe"
Enter the value of x : 2022
Choose Option
1. Forward
2. Backward
1
Forward Table
2008 20 7 5 1 -17 40 -42
2010 27 12 6 -16 23 -2
2012 39 18 -10 7 21
2014 57 8 -3 28
2016 65 5 25
2018 70 30
2020 100
160
Enter the value of x : 2022
Choose Option
1. Forward
2. Backward
2
Backward Table
2008 20
2010 27 7
2012 39 12 5
2014 57 18 6 1
2016 65 8 -10 -16 -17
2018 70 5 -3 7 23 40
2020 100 30 25 28 21 -2 -42
160
Enter the value of x : 0
Process returned 0 (0x0) execution time : 10.555 s
Press any key to continue.

End