LAB 7: Interpolation /Extrapolation using Newton's forward and backward difference formula

7.1 Objectives:

Use python

1. to interpolate using Newton's Forward interpolation method.
2. to interpolate using Newton's backward interpolation method.
3. to extrapolate using Newton's backward interpolation method.

1. Use Newtons forward interpolation to obtain the interpolating polynomial and hence calculate y(2) for the following:

x:	1	3	5	7	9
y:	6	10	62	210	502

```
from sympy import *
import numpy as np
n = int(input('Enter number of data points: '))
210
x = np.zeros((n))
y = np.zeros((n,n))


# Reading data points
print('Enter data for x and y: ')
for i in range(n):
    x[i] = float(input( 'x['+str(i)+']='))
    y[i][0] = float(input( 'y['+str(i)+']='))

# Generating forward difference table
for i in range(1,n):
    for j in range(0,n-i):
        y[j][i] = y[j+1][i-1] - y[j][i-1]

print('\nFORWARD DIFFERENCE TABLE\n');

for i in range(0,n):
    print('%0.2f' %(x[i]), end='')
    for j in range(0, n-i):
        print('\t\t%0.2f' %(y[i][j]), end='')
    print()
# obtaining the polynomial
t=symbols('t')
f=[] # f is a list type data


p=(t-x[0])/(x[1]-x[0])
f.append(p)
for i in range(1,n-1):
    f.append(f[i-1]*(p-i)/(i+1))
    poly=y[0][0]
for i in range(n-1):
    poly=poly+y[0][i+1]*f[i]
```

```
simp_poly=simplify(poly)
print('\nTHE INTERPOLATING POLYNOMIAL IS\n');
pprint(simp_poly)
# if you want to interpolate at some point the next session will help
inter=input('Do you want to interpolate at a point(y/n)? ') # y
if inter=='y':
    a=float(input('enter the point ')) #2
    interpol=lambdify(t,simp_poly)
    result=interpol(a)
    print('\nThe  value of the function at' ,a,'is\n',result);
```

```
Enter number of data points: 5
Enter data for x and y:
x[0]=1
y[0]=6
x[1]=3
y[1]=10
x[2]=5
y[2]=62
x[3]=7
y[3]=210
x[4]=9
y[4]=502

FORWARD DIFFERENCE TABLE

1.00        6.00        4.00        48.00       48.00       0.00
3.00        10.00       52.00       96.00       48.00
5.00        62.00       148.00      144.00
7.00        210.00      292.00
9.00        502.00

THE INTERPOLATING POLYNOMIAL IS

     3        2
1.0⋅t  - 3.0⋅t  + 1.0⋅t + 7.0
Do you want to interpolate at a point(y/n)? y
enter the point 2

The  value of the function at 2.0 is
```

2. Use Newtons backward interpolation to obtain the interpolating polynomial and hence calculate y(8) for the following data:

x:	1	3	5	7	9
y:	6	10	62	210	502

```
from sympy import *
import numpy as np
import sys
print("This will use Newton's backword intepolation formula ")
# Reading number of unknowns
n = int(input('Enter number of data points: '))

# Making numpy array of n & n x n size and initializing
# to zero for storing x and y value along with differences of y
x = np.zeros((n))
y = np.zeros((n,n))


# Reading data points
```

```
print('Enter data for x and y: ')
for i in range(n):
    x[i] = float(input( 'x['+str(i)+']='))
    y[i][0] = float(input( 'y['+str(i)+']='))

# Generating backward difference table
for i in range(1,n):
    for j in range(n-1,i-2,-1):
        y[j][i] = y[j][i-1] - y[j-1][i-1]


print('\nBACKWARD DIFFERENCE TABLE\n');

for i in range(0,n):
    print('%0.2f' %(x[i]), end='')
    for j in range(0, i+1):
        print('\t%0.2f' %(y[i][j]), end='')
    print()


# obtaining the polynomial
t=symbols('t')
f=[]


p=(t-x[n-1])/(x[1]-x[0])
f.append(p)
for i in range(1,n-1):
        f.append(f[i-1]*(p+i)/(i+1))

poly=y[n-1][0]
print(poly)
for i in range(n-1):
        poly=poly+y[n-1][i+1]*f[i]
        simp_poly=simplify(poly)
print('\nTHE INTERPOLATING POLYNOMIAL IS\n');
pprint(simp_poly)
# if you want to interpolate at some point the next session will help
inter=input('Do you want to interpolate at a point(y/n)? ')
if inter=='y':
        a=float(input('enter the point '))
        interpol=lambdify(t,simp_poly)
        result=interpol(a)
        print('\nThe  value of the function at' ,a,'is\n',result);
```

```
This will use Newton's backword intepolation formula
Enter number of data points: 5
Enter data for x and y:
x[0]=1
y[0]=6
x[1]=3
y[1]=10
x[2]=5
y[2]=62
x[3]=7
y[3]=210
x[4]=9
y[4]=502

BACKWARD DIFFERENCE TABLE

1.00    6.00
3.00    10.00   4.00
5.00    62.00   52.00   48.00
7.00    210.00  148.00  96.00   48.00
9.00    502.00  292.00  144.00  48.00   0.00
502.0

THE INTERPOLATING POLYNOMIAL IS

     3         2
1.0·t  - 3.0·t  + 1.0·t + 7.0
Do you want to interpolate at a point(y/n)? y
enter the point 8

The  value of the function at 8.0 is
335.0
```

7.2 Exercise:

1. Obtain the interpolating polynomial for the following data

x:	0	1	2	3
y:	1	2	1	10

Ans: $2x^3 - 7x^2 + 6x + 1$

2. Find the number of men getting wage Rs. 100 from the following table:

wage:	50	150	250	350
No. of men:	9	30	35	42

Ans: 23 men

3. Using Newton's backward interpolation method obtain y(160) for the following data

x :	100	150	200	250	300
y :	10	13	15	17	18

Ans: 13.42

4. Using Newtons forward interpolation polynomial and calculate y(1) and y(10).

x :	3	4	5	6	7	8	9
y :	4.8	8.4	14.5	23.6	36.2	52.8	73.9

Ans: 3.1 and 100