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Assignment – 5

Polynomial interpolation 2: Given the data table:

x	1	1.1	1.2	1.3	1.4
f(x)	0.5403	0. 48360	0. 30236	0. 22150	0.18497

Calculate the value of

a) f(1.03)

b) f(1.38)

by applying Newton's forward difference approach and considering the full 4th order polynomial. Verify if the values are matching with the one obtained from Lagrange's method discussed in the previous class.

ANSWER:

```
function res = Newton(x,order)
%A = [1,8;2.1,20.6;5,13.7];
%X=A(:,1);
%Y=A(:,2);
X=1:0.1:1.4;
Y=[0.54030 0.48360 0.30236 0.22150 0.18497];
n=length(X);
diff=zeros(n,n);
diff(:,1)=Y;
for i=2:n
    for j=1:n-(i-1)
        diff(j,i)=(diff(j+1,i-1)-diff(j,i-1))/(X(j+i-1)-
X(j));
    end
end
disp(diff);
res=diff(1,1);
for i=1:order
    f=1;
    for j=1:i
        f=f*(x-X(j));
    end
    res=res+f*diff(1,i+1);
    %fprintf('%d %d %d\n',res,f,diff(i+1,1));
end
end
```

Answer

Using Newton Forward Interpolation

f(1.03) = 0.5610

f(1.38) = 0.2009

Using Lagrange's Interpolation

f(1.03) = 0.5610

f(1.38) = 0.3800

```
function res = Lagrange(x)

X=1:0.1:1.4;
Y=[0.54030 0.48360 0.30236 0.22150 0.18497];

n=length(X);

res=0;
for i=1:n
    f=1;
    for j=1:n
        if j==i
           continue;
        end
        f=f*(x-X(j))/(X(i)-X(j));
    end
    res=res+Y(i)*f;
end
```

Polynomial interpolation 3: Given the data table:

x	1	2	3	4	5	6	7	8	9	10
f(x)	1	0.4444	0.2632	0.1818	0.1373	0.1096	0.0929	0.0775	0.0675	0.0597

a) Use Newton-Gregory forward difference formula to interpolate a polynomial through these points.
b) Check if a 9_{th} order polynomial is any better than a 5_{th} order polynomial by

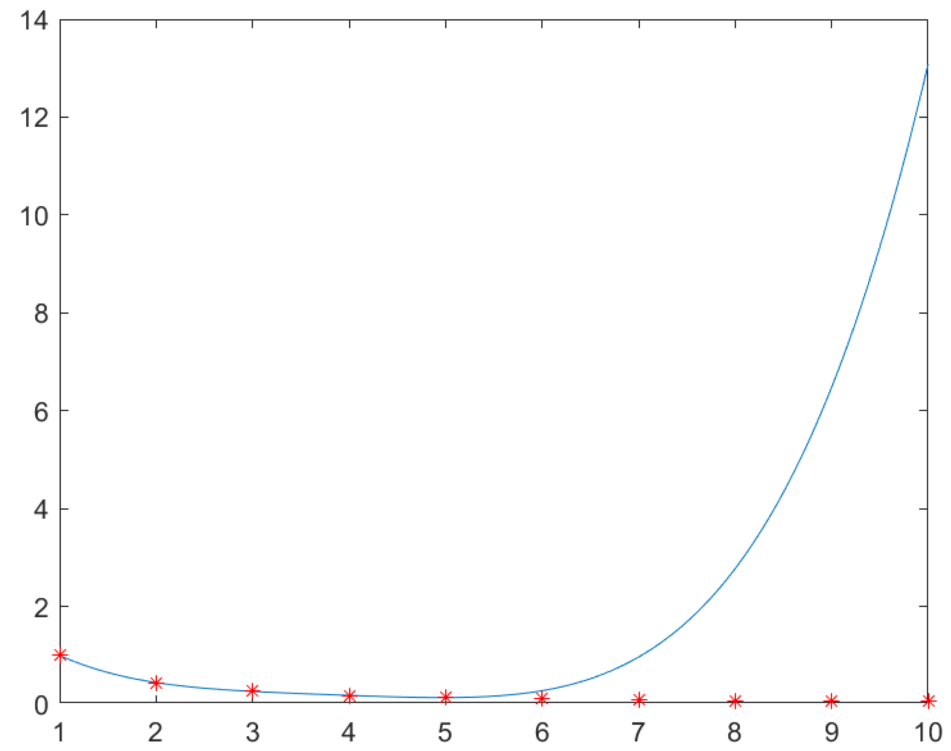
plotting the polynomial alongside data points.
c) Based on this plot write a discussion that if you need to estimate i) f(2.22) ii) f(5.7) and iii) f(8.11), will you be using the 5th order polynomial?

ANSWER:

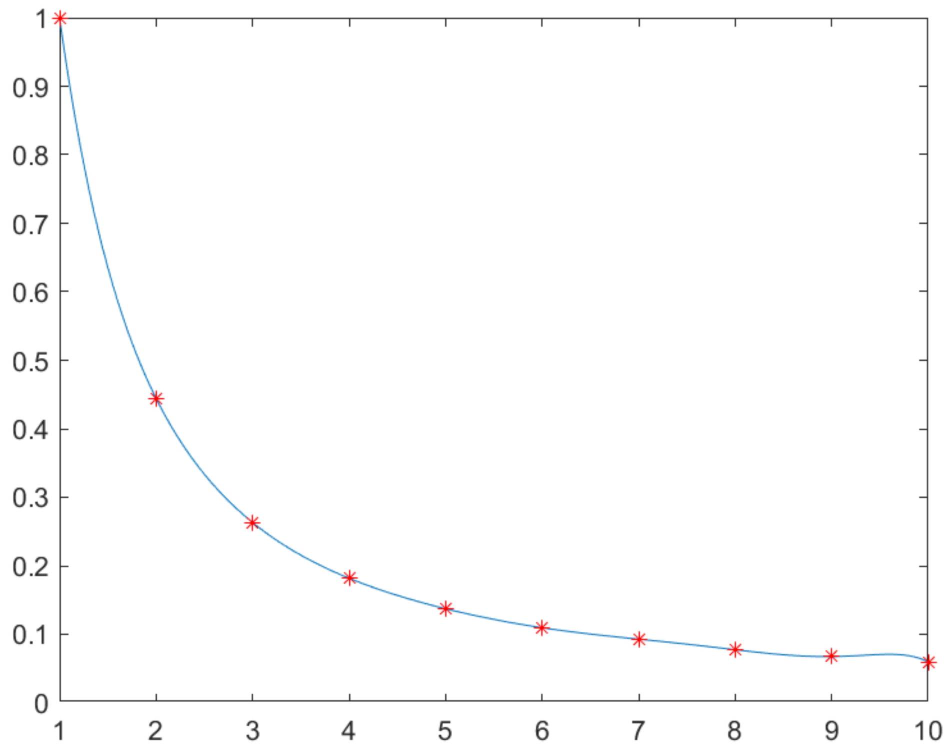
```
function res = Newton2(x,order)
%A = [1,8;2.1,20.6;5,13.7];
A=[1 1;2 .4444;3 .2632;4 .1818;5 .1373;6 .1096;7
.0929;8 .0775;9 .0675;10 .0597];
X=A(:,1);
Y=A(:,2);

n=length(X);
diff=zeros(n,n);
diff(:,1)=Y;
for i=2:n
    for j=1:n-(i-1)
        diff(j,i)=(diff(j+1,i-1)-diff(j,i-1))/(X(j+i-
1)-X(j));
    end
end
disp(diff);
res=diff(1,1);

for i=1:order
    f=1;
    for j=1:i
        f=f*(x-X(j));
    end
    res=res+f*diff(1,i+1);
    %fprintf('%d %d %d\n',res,f,diff(i+1,1));
end
end
```

```
X=[1 1;2 .4444;3 .2632;4 .1818;5 .1373;6 .1096;7
.0929;8 .0775;9 .0675;10 .0597];
x=1:.05:10;
y=zeros(1,length(x));

%part 1 with order 9
n=10;
for i=1:length(x)
y(i)=newtonfor(X,x(i),n);
end
plot(x,y,'-');
hold on
plot(X(:,1),X(:,2),'r*')

%%part 2 with order 5
n=5;
for i=1:length(x)
y(i)=newtonfor(X,x(i),n);
end
figure;
plot(x,y,'-');
hold on
plot(X(:,1),X(:,2),'r*')

f1=newtonfor(X,2.22,10);
f2=newtonfor(X,5.7,10);
f3=newtonfor(X,8.11,10);
```

Newton 5:



Newton 9:



Results: It is evident that Newton's 9 order polynomial fits better than the 5 th order one. We can use the 5 th order one to estimate f(2.22) but for higher values it is essential that we use the 9 th order polynomial.

Since this is a forward difference method if we do not take all the orders, we will not get a good estimate for values towards the end of the data and thus we obtain such plots

Newton's 5 order

f(2.2)=0.3900

f(5.7)=0.1993

f(8.11)=3.0703

Newton's 9 order

f(2.2)=0.3930

f(5.7)=0.1166

f(8.11)=0.0752