Assignment - 07 Submission

MA-202 Numerical Techniques (2022)

B. Tech. II year CSE

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Exercise 1

A) Consider the function $g(x) = \dfrac{1}{x^2 + 0.25}$ where is a real number. Generate a data random data set $\{x0, x1, x2, , \ldots . xn\}$ having n+1 data points in the interval . At each of these points evaluate the function , and construct the data . Now write a program to find the interpolating polynomial using both the Lagrange method and the Newton divided difference method. Use the above generated data to find the interpolating polynomial using both these methods. Plots the results obtained, along with the original function and the original data. Do this exercise for n = 3,5,8,10,20

B) Do the same exercise but now take the data points $\{x0, x1, \ldots . xn\}$ to be equispaced in the interval. Comment on the results obtained in both the cases and with both the methods.

```
x = [1,2,3,4,5];
disp(x)
```

```
     1     2     3     4     5
```

```
for i=1:length(x)
    A(i) = 1/(x(i)^2 + 0.25)
end
```

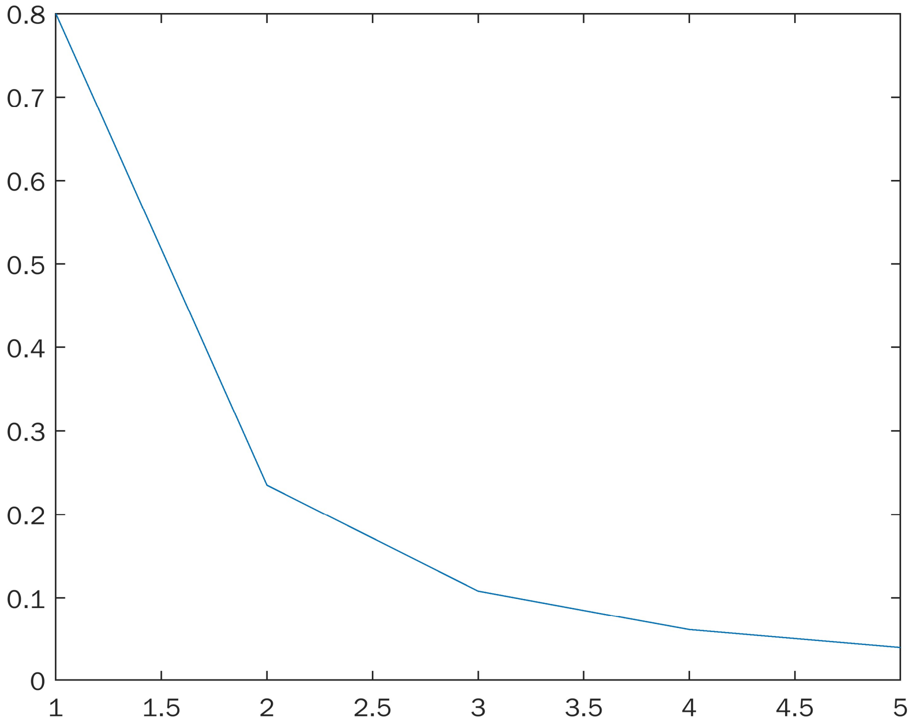
```
A = 1×5
10^11 ×
    0.0000    0.0000    0.0000    0.0004    3.6002
A = 1×5
10^11 ×
    0.0000    0.0000    0.0000    0.0004    3.6002
A = 1×5
10^11 ×
    0.0000    0.0000    0.0000    0.0004    3.6002
A = 1×5
```

```
10^11 ×
    0.0000    0.0000    0.0000    0.0000    3.6002
A = 1×5
    0.8000    0.2353    0.1081    0.0615    0.0396
```

```
disp(A)
```

```
    0.8000    0.2353    0.1081    0.0615    0.0396
```

```
% here we are plotting a point (xi , yi).
plot(x, A);
```




```
%Interpolating method (Lagrange's)
sum = 0;
syms a
for i = 1:length(x)
    u = 1;
    l = 1;
    for j = 1:length(x)
        if j ~= i
            u = u * (a - x(j));
            l = l * (x(i) - x(j));
        end
    end
    sum= sum + u / l * A(i);
end
fprintf("Interpolating Polynomial Using Lagrange's.......\n")
```

```
Interpolating Polynomial Using Lagrange's ......
```

```
disp(sum);
```

$$\frac{(a-1)\ (a-2)\ (a-3)\ (a-4)}{606} - \frac{2\ (a-1)\ (a-2)\ (a-3)\ (a-5)}{195} + \frac{(a-1)\ (a-2)\ (a-4)\ (a-5)}{37} - \frac{2\ (}{}$$

```
%Newton's Divided Difference Implementation and finding polynomial.
ddTable = divDiff(x, A);
disp('the divided difference table is : ')
```

```
the divided difference table is :
```

```
disp(ddTable)
```

```
    0.8000   -0.5647    0.2188   -0.0595    0.0125
    0.2353   -0.1272    0.0403   -0.0093         0
    0.1081   -0.0466    0.0123         0         0
    0.0615   -0.0219         0         0         0
    0.0396         0         0         0         0
```

```
syms X
 sum = 0;
 for i = 1:size(x,2)
      sum = sum + prod(X - x(:,1:i))*divDiff(1,i+1);
 end
 Y = A(1) + sum;
 disp('Newton"s divided difference polynomial');
```

```
Newton"s divided difference polynomial
```

```
disp(Y)
```

$$2\,X + 3\,(X-1)\,(X-2) + 4\,(X-1)\,(X-2)\,(X-3) + 5\,(X-1)\,(X-2)\,(X-3)\,(X-4) + 6\,(X-1)\,($$

Exercise 2

Do the same exercise as above, now for the function $g(x) = xe^{-x^2}$. Comment on the results obtained in this case.

```
 for i=1:length(x)
    A(i) = x(i)*(exp((-x(i))^2))
end
```

```
A = 1×5
    2.7183    0.2353    0.1081    0.0615    0.0396
A = 1×5
    2.7183  109.1963    0.1081    0.0615    0.0396
A = 1×5
10^4 ×
    0.0003    0.0109    2.4309    0.0000    0.0000
A = 1×5
10^7 ×
```

```
    0.0000    0.0000    0.0024    3.5544    0.0000
A = 1×5
10^11 ×
    0.0000    0.0000    0.0000    0.0004    3.6002
```

```
disp(A)
```

```
   1.0e+11 *

    0.0000    0.0000    0.0000    0.0004    3.6002
```

```
sum = 0;
syms a
for i = 1:length(x)
    u = 1;
    l = 1;
    for j = 1:length(x)
        if j ~= i
            u = u * (a - x(j));
            l = l * (x(i) - x(j));
        end
    end
    sum= sum + u / l * A(i);
end
fprintf("Interpolating Polynomial Using Lagrange's.......\n")
```

```
Interpolating Polynomial Using Lagrange's ......
```

```
disp(sum)
```

$$\frac{5898641353718651\,(a-1)\,(a-2)\,(a-3)\,(a-4)}{393216} - \frac{149084195602433\,(a-1)\,(a-2)\,(a-3)\,(a-5)}{25165824} +$$

```
 %Newton's Divided Difference Implementation and finding polynomial.
ddTable = divDiff(x, A);
disp('the divided difference table is : ')
```

```
the divided difference table is :
```

```
disp(ddTable)
```

```
   1.0e+11 *

    0.0000    0.0000    0.0000    0.0001    0.1500
    0.0000    0.0000    0.0002    0.5999         0
    0.0000    0.0004    1.7998         0         0
    0.0004    3.5999         0         0         0
    3.6002         0         0         0         0
```

```
syms X
 sum = 0;
 for i = 1:size(x,2)
      sum = sum + prod(X - x(:,1:i))*divDiff(1,i+1);
 end
 Y = A(1) + sum;
```

```
disp('Newton"s divided difference polynomial');
```

```
Newton"s divided difference polynomial
```

```
disp(Y)
```

$$2\,X + 3\,(X-1)\,(X-2) + 4\,(X-1)\,(X-2)\,(X-3) + 5\,(X-1)\,(X-2)\,(X-3)\,(X-4) + 6\,(X-1)\,($$

```
function ddTable = divDiff(x, y)
    n = length(x) - 1;
    ddTable = zeros(n + 1, n + 1);
    ddTable(1 : n + 1, 1) = y';
    for i = 2 : n + 1
        for j = 1 : n - i + 2
            ddTable(j, i) = (ddTable(j+1, i-1) - ddTable(j, i-1))/(x(i+j - 1) - x(j));
        end
    end
end
```