Applied Numerical Analysis (7th Edition)

Chapter 3, Problem 14E

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Problem

Use the divided-difference table from Exercise to interpolate for $f(0.4)$

a. Using the first three points.

b. Using the last three points.

c. Using the best set of three points. Which points should be used?

d. Using the best set of four points.

e. Using all of the points.

f. Explain why the results are not all the same.

Exercise

Construct the divided-difference table from these data:

x	−0.2	0.3	0.7	−0.3	0.1
$f(x)$	1.23	2.34	−1.05	6.51	−0.06

Step-by-step solution

Step 1 of 7

When using numerical approximation techniques, it is useful to have programs written to aid in numerical calculations to avoid calculations by hand. Using Matlab, create an

M-file named "ddtinterp.m" which will contain Matlab code that implements the algorithm to create a divided difference table interpolation corresponding to a set of node data points and interpolation point.

Inside this file, write the code to implement the method. One example of a correctly executable routine based on the algorithm description in the text is as follows:

```
function fp = ddtinterp(x,y,p)
%given an input vector x of x data values
%and an input vector f of f data values,
%the divided difference table d is generated
%and outputed. Additionally, an interpolation is
%performed using x=p.
n = length(x);
a(1) = y(1);
for k = 1 : n - 1
d(k, 1) = (y(k+1) - y(k))/(x(k+1) - x(k));
end
for j = 2 : n - 1
for k = 1 : n - j
d(k, j) = (d(k+1, j - 1) - d(k, j - 1))/(x(k+j) - x(k));
end
end
for j = 2 : n
a(j) = d(1, j-1);
end
Df(1) = 1;
c(1) = a(1);
for j = 2 : n
Df(j)=(p - x(j-1)) .* Df(j-1);
c(j) = a(j) .* Df(j);
end
d(n,:)=0;
d=[x' y' d];
d
fp=sum(c);
```

Comment

Step 2 of 7

a) To interpolate $f(0.4)$ using the first three points, use the following Matlab commands

INPUT:

```
>> x=[-0.2,0.3,0.7];
>> f=[1.23,2.34,-1.05];
>> ddtinterp(x,f,0.4)
```

OUTPUT:

```
d =
-0.2000 1.2300 2.2200 -11.8833
0.3000 2.3400 -8.4750 0
0.7000 -1.0500 0 0
ans =
1.8490
```

Comment

b) To interpolate $f(0.4)$ using the last three points, use the following Matlab commands

INPUT:

```
>> x=[0.7,-0.3,0.1];
>> f=[-1.05,6.51,-0.06];
>> ddtinterp(x,f,0.4)
```

OUTPUT:

```
d =
0.7000 -1.0500 -7.5600 14.7750
-0.3000 6.5100 -16.4250 0
0.1000 -0.0600 0 0
ans =
-1.8847
```

Comment

Step 4 of 7

c) To interpolate $f(0.4)$ using the best three points, use the following Matlab commands with the data values corresponding to $x=.1$, $x=.3$, and $x=.7$ since they are best centered around $x=0.4$.

INPUT:

```
>> x=[0.3,0.7,0.1];
>> f=[2.34,-1.05,-0.06];
>> ddtinterp(x,f,0.4)
```

OUTPUT:

```
d =
0.3000 2.3400 -8.4750 -34.1250
0.7000 -1.0500 -1.6500 0
0.1000 -0.0600 0 0
ans =
2.5162
```

Comment

Step 5 of 7

d) To interpolate $f(0.4)$ using the best four points, use the following Matlab commands with the data values corresponding to $x=.1$, $x=.3$, and $x=.7$ since they are best centered around $x=0.4$, and $x=-0.2$ since it is the next closest eligible point

INPUT:

```
>> x=[-0.2,0.3,0.7,0.1];
>> f=[1.23,2.34,-1.05,-0.06];
>> ddtinterp(x,f,0.4)
```

OUTPUT:

```
d =
-0.2000 1.2300 2.2200 -11.8833 -74.1389
0.3000 2.3400 -8.4750 -34.1250 0
0.7000 -1.0500 -1.6500 0 0
0.1000 -0.0600 0 0 0
ans =
3.1835
```

Comment

Step 6 of 7

e) To interpolate $f(0.4)$ using all the points, use the following Matlab commands

INPUT:

```
>> x=[-0.2,0.3,0.7,-0.3,0.1];
>> f=[1.23,2.34,-1.05,6.51,-0.06];
>> ddtinterp(x,f,0.4)
```

OUTPUT:

```
d =
-0.2000 1.2300 2.2200 -11.8833 -103.5833 73.6111
0.3000 2.3400 -8.4750 -1.5250 -81.5000 0
0.7000 -1.0500 -7.5600 14.7750 0 0
-0.3000 6.5100 -16.4250 0 0 0
0.1000 -0.0600 0 0 0 0
ans =
2.7860
```

Comment

Step 7 of 7

f) The results will not all be the same because each divided difference table represents a different interpolating polynomial function. So when interpolating at the point $x=0.4$ in the previous steps, a different polynomial function was used to evaluate $f(0.4)$.

Comment

Recommended solutions for you in Chapter 3

Exercises 1 and 2 to get the quadratics in the form ax2 + bx + c. How different are the values for a, b, and c?Exercise 1Write out the Lagrangian polynomial from this table:...

View this solution

of points: Point # 0123456789x10507590105150180190160130y101560 Draw the graph determined by the ten points.b. Why is the graph smoothly connected at points 3 and 6?c....

View this solution