Homework 8 Sarah Verderame

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MECH 105
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Problem 1

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%Use zero through third- order Taylor Series Expansion to predict f(3)
 for f(x)=25x^3+-6x^2+7x-88 using a base point of x=1. Compute the
 true percent relative error for each approximation.

%Define the function f(x) and that x is a symbolic function.
%Find the true answer of f(3):
syms f(x)
f(x)=25*x.^3-6*x.^2+(7*x)-88;
real_a=f(3)
h=1;                                        %Initialize step size

%Zeroeth Order Approximation:
f_0=f(1);
f3=f_0                                      %"f3" is our approximation for
 f(3)

%True Percent Relative Error Value for f_0:
Ct=((real_a-f3)/real_a)*100;
Ct=double(Ct)                               %convert the answer to a
 decimal; this answer is a percentage

%First Order Approximation:
f_1=diff(f);                                %derivative function
f_1=f_1(1);                                 %derivative with respect to
 base point x=1
f3=f_0+f_1*(h^1/factorial(1))               %approximation

%True Relative Percent Error Value for f_1:
Ct=((real_a-f3)/real_a)*100;
Ct=double(Ct)

%Second Order Approximation:
f_2=diff(f,2);
f_2=f_2(1);
f3=f3+f_2*(h^2/factorial(2))

%True Relative Percent Error Value for f_2:
Ct=((real_a-f3)/real_a)*100;
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Ct=double(Ct)

%Third Order Approximation:
f_3=diff(f,3);
f_3=f_3(1);
f3=f3+f_3*(h^3/factorial(3))

%True Relative Percent Error Value for f_3:
Ct=((real_a-f3)/real_a)*100;
Ct=double(Ct)

% Notice the last true relative percent error value is still a vary
 large
% percent error.


real_a =

554


f3 =

-62


Ct =

  111.1913


f3 =

8


Ct =

   98.5560


f3 =

77


Ct =

   86.1011


f3 =

102
```

```
Ct =

   81.5884
```

Problem 2

```
Use forward and backward difference approximations of O(h) and a
centered difference approximation of O(h^2) to estimate the first
derivative of the function described in Problem 1. Evaluate the
derivative at x=2 using a step size of h=0.25. Compare your results
with the true value of the derivative. Interpret your results on the
basis of the remainder term of the Taylor Series expansion.

%Define the real function first and find the value of the derivative
 at
%x=2.
syms f(x)
f(x)=25*x.^3-6*x.^2+(7*x)-88;
h=0.25;
real_D=diff(f);
real_D=real_D(2)


%Forward Difference Approximation at x=2
% Given by: f'(xi)=((yi+1)-yi)/((xi+1)-xi), 1 in this case is h=0.25.

F_A2=(f(2+h)-f(2))/(h);
F_A2=double(F_A2);
Et=abs(real_D-F_A2);            %Et is the true error of this approx.
Et=double(Et);
a1='The forward difference approximation at x=2 is ';
a2=[a1, num2str(F_A2)];
a3=[a2,', the true error is '];
a4=[a3, num2str(Et)];
F=[a4, ', and the remainder term is 36'];
disp(F)

%Backward Difference Approximation at x=2
% Given by: f'(xi)=(yi-(yi-1))/(xi-(xi-1)), 1 in this case is h=0.25.
B_A2=(f(2)-f(2-h))/(h);
B_A2=double(B_A2);
Et=abs(real_D-B_A2);            %Et is the true error of this approx.
Et=double(Et);
a1='The backward difference approximation at x=2 is ';
a2=[a1, num2str(B_A2)];
a3=[a2,', the true error is '];
a4=[a3, num2str(Et)];
B=[a4, ', and the remainder term is 33'];
disp(B)
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```
%Centered Difference at x=2
% Given by: f'(xi)=((yi+1)-(yi-1))/(2(h)),h=0.25.
C_A2=((f(2+h))-(f(2-h)))/(2*h);
C_A2=double(C_A2);
Et=abs(real_D-C_A2);            %Et is the true error of this approx.
Et=double(Et);
a1='The centered difference approximation at x=2 is ';
a2=[a1, num2str(C_A2)];
a3=[a2,', the true error is '];
a4=[a3, num2str(Et)];
C=[a4, ', and the remainder term is 1'];
disp(C)
```

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real_D =

283

The forward difference approximation at x=2 is 320.5625, the true
 error is 37.5625, and the remainder term is 36
The backward difference approximation at x=2 is 248.5625, the true
 error is 34.4375, and the remainder term is 33
The centered difference approximation at x=2 is 284.5625, the true
 error is 1.5625, and the remainder term is 1
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