Assignment 5

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%Date: 3/13/2021
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Part a

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%Estimate the derivative of the function at the point x = 1 using 3-
point midpoint formula for the
%following values of h: h = 10#n for n going from 16 by integers to 1
 (e.g., h = 10#1
%Plot the step size h versus the relative error in a loglog plot.
%On the same figure, plot the estimated truncation error for those
 same h values in red.
%(Hint: Try plotting the 3rd derivative to figure out for which #
 value the the third derivative will be maximum at! )

%the code for part a

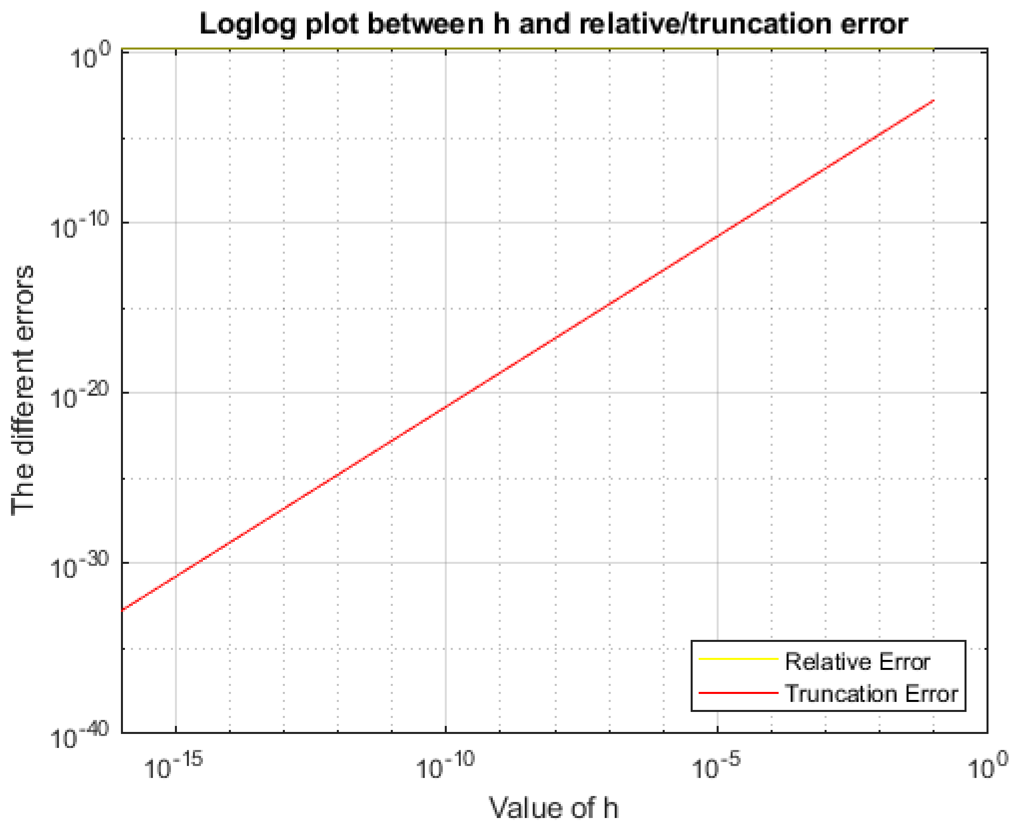
f = @(x) sin(x);
dddf = @(x) -cos(x); % the third derivative of sin(x) is -cos(x)
x = 1; % the pt we are estimating the derivative of the function
h =
 [10^-1,10^-2,10^-3,10^-4,10^-5,10^-6,10^-7,10^-8,10^-9,10^-10,10^-11,10^-12,10^-1
 the multiple values of h
CD3 = zeros(1,16);
CD3_truncation_error = zeros(1,16);
CD3_relative_error = zeros(1,16);

for i = 1:16
    CD3(i) = (1/(2*h(i)) * (f(x + h(i)) - f(x - h(i))));

    %maxdddf = max(dddf(h(i))); % finds ths max value of all the
 elements
    %indexOfFirstMax = find(dddf(h) == maxdddf,1,'first'); % gets the
 first element that is the max value
    %E = h(indexOfFirstMax); % gets the x value at the index

    CD3_truncation_error(i) = -(h(i)^2 / 6) * dddf(E);
    CD3_relative_error(i) = abs((dddf(x) - CD3(i)) / dddf(x));
end

loglog(h,CD3_relative_error,'y'); % this is plotting the step size h
 verus relative error in a loglog plot
hold on
loglog(h,CD3_truncation_error,'r'); % this is just plotting the
 estimated truncation error for same h in red.
legend('Relative Error','Truncation Error','Location','southeast');
xlabel('Value of h');
ylabel('The different errors');
title('Loglog plot between h and relative/truncation error');
hold off
grid on
```



Part b We can see that as h grows smaller, then the error increases. This can be seen in the yellow line of relative error at the top of the graph. The red line of the graph shows the truncation error. As you can see, we can see that as h decreases, the truncation error also decreases as well. we see that the actual error does follow the truncation error estimate as it is one of the reasons why the error increases as h decreases. grows smaller.

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