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% Topic : Secant Method - Roots of Equations
% Simulation : Pitfall - Root Jumps Several Roots Away
% Language : Matlab r12
% Authors : Nathan Collier, Autar Kaw
% Date : 6 September 2002
% Abstract : This simulation shows the pitfall of root jumping in the secant method
% for finding roots of an equation  $f(x)=0$ 
%
% INPUTS: Enter the following
% Function in  $f(x)=0$ 
f = inline('sin(x)');
% Initial guess 1
xguess1 = 8.5;
% Initial guess 2
xguess2 = 7;
% Lower bound of range of 'x' to be seen
lrange = -10.0;
% Upper bound of range of 'x' to be seen
urange = 10;
%
% SOLUTION

% The following finds the upper and lower 'y' limits for the plot based on the given
% 'x' range in the input section.
maxi = f(lrange);
mini = f(lrange);
for i=lrange:(urange-lrange)/10:urange
    if f(i) > maxi
        maxi = f(i);
    end
    if f(i) < mini
        mini = f(i);
    end
end
tot=maxi-mini;
mini=mini-0.1*tot;
maxi=maxi+0.1*tot;

% This calculates window size to be used in figures
set(0,'Units','pixels')
scnsize = get(0,'ScreenSize');
wid = round(scnsize(3));
hei = round(0.95*scnsize(4));
wind = [1, 1, wid, hei];

% This graphs the function and two lines representing the two guesses

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figure('Position',wind)
clf
fplot(f,[lrange,urange])
hold on
plot([xguess1,xguess1],[maxi,mini],'g','linewidth',2)
plot([xguess2,xguess2],[maxi,mini],'g','linewidth',2)
plot([lrange,urange],[0,0],'k','linewidth',1)
title('Entered function on given interval with initial guesses')

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hold off

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% -----
% Iteration 1
figure('Position',wind)
x1 = xguess2-(f(xguess2)*(xguess1-xguess2))/(f(xguess1)-f(xguess2));
ea=abs((x1-xguess2)/x1)*100;
m=(f(xguess2)-f(xguess1))/(xguess2-xguess1);
b=f(xguess2)-m*xguess2;
lefty=(maxi-b)/m;
righty=(mini-b)/m;
% This graphs the function and two lines representing the two guesses
clf
subplot(2,1,2),fplot(f,[lrange,urange])
hold on
plot([x1,x1],[maxi,mini],'b','linewidth',2)
plot([xguess1,xguess1],[maxi,mini],'g','linewidth',2)
plot([xguess2,xguess2],[maxi,mini],'g','linewidth',2)
plot([lrange,urange],[0,0],'k','linewidth',1)
plot([lefty,righty],[maxi,mini],'r','linewidth',2)
title('Entered function on given interval with upper and lower guesses')

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% This portion adds the text and math to the top part of the figure window
subplot(2,1,1), text(0,1,['Iteration 1'])
text(0.1,.8,['x1 = xguess2-(f(xguess2)*(xguess1-xguess2))/(f(xguess1)-f(xguess2)) =
',num2str(x1)])
text(0,.4,['Absolute relative approximate error'])
text(0.1,.2,['ea = abs((x1 - xguess2) / x1)*100 = ',num2str(ea),'%'])
axis off
hold off

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% -----
% Iteration 2
figure('Position',wind)
x0=xguess2;
x2 = x1-(f(x1)*(x0-x1))/(f(x0)-f(x1));

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ea=abs((x2-x1)/x2)*100;
m=(f(x1)-f(x0))/(x1-x0);
b=f(x1)-m*x1;
lefty=(maxi-b)/m;
righty=(mini-b)/m;
% This graphs the function and two lines representing the two guesses
clf
subplot(2,1,2),fplot(f,[lrange,urange])
hold on
plot([x2,x2],[maxi,mini],'b','linewidth',2)
plot([x0,x0],[maxi,mini],'g','linewidth',2)
plot([x1,x1],[maxi,mini],'g','linewidth',2)
plot([lrange,urange],[0,0],'k','linewidth',1)
plot([lefty,righty],[maxi,mini],'r','linewidth',2)
title('Entered function on given interval with upper and lower guesses')

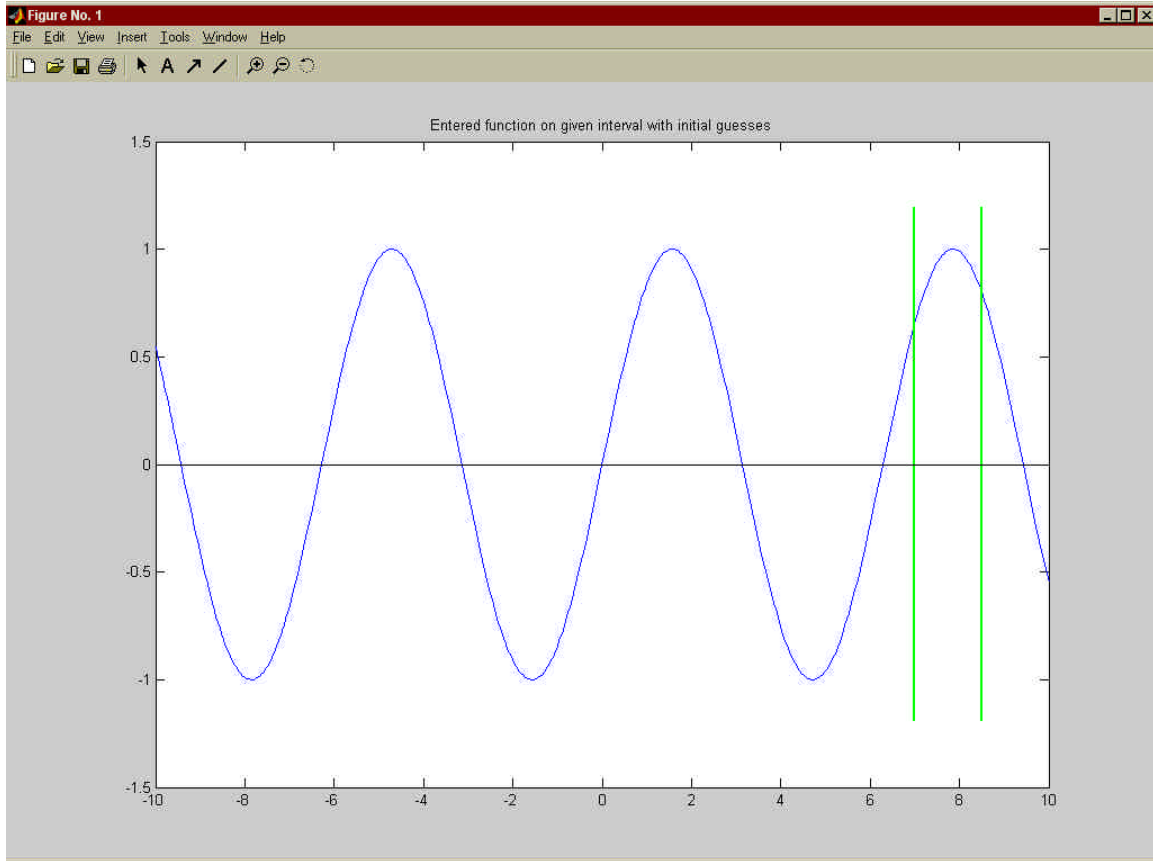
% This portion adds the text and math to the top part of the figure window
subplot(2,1,1), text(0,1,['Iteration 2'])
text(0.1,.8,['x2 = x1-(f(x1)*(x0-x1))/(f(x0)-f(x1)) = ',num2str(x2)])
text(0,.4,['Absolute relative approximate error'])
text(0.1,.2,['ea = abs((x2 - x1) / x2)*100 = ',num2str(ea),'%'])
axis off
hold off

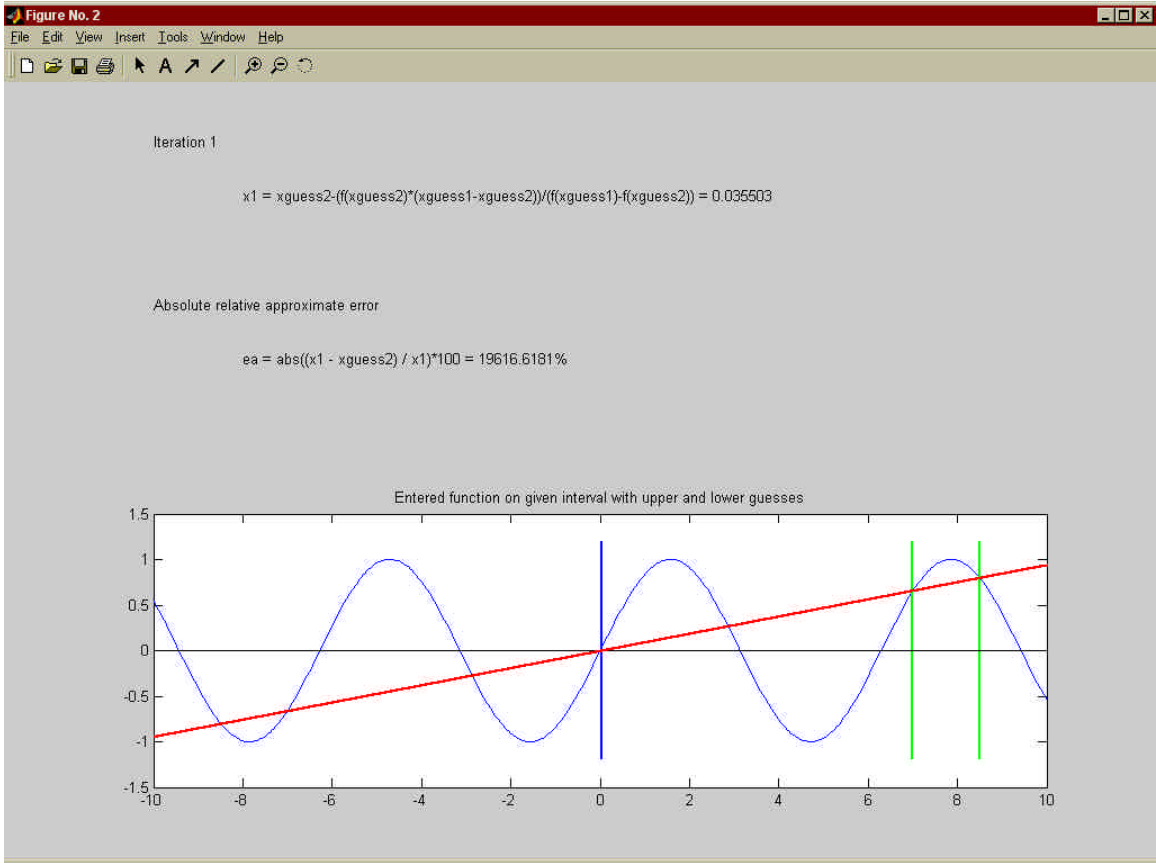
% -----
% Iteration 3
figure('Position',wind)

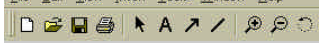
x3 = x2-(f(x2)*(x1-x2))/(f(x1)-f(x2));
ea=abs((x3-x2)/x3)*100;
m=(f(x2)-f(x1))/(x2-x1);
b=f(x2)-m*x2;
lefty=(maxi-b)/m;
righty=(mini-b)/m;
% This graphs the function and two lines representing the two guesses
clf
subplot(2,1,2),fplot(f,[lrange,urange])
hold on
plot([x3,x3],[maxi,mini],'b','linewidth',2)
plot([x1,x1],[maxi,mini],'g','linewidth',2)
plot([x2,x2],[maxi,mini],'g','linewidth',2)
plot([xguess2,xguess2],[maxi,mini],'k','linewidth',2)
plot([lrange,urange],[0,0],'k','linewidth',1)
plot([lefty,righty],[maxi,mini],'r','linewidth',2)
title('Entered function on given interval with upper and lower guesses')

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% This portion adds the text and math to the top part of the figure window
subplot(2,1,1), text(0,1,['Iteration 2'])
text(0.1,.8,['x3 = x2-(f(x2)*(x1-x2))/(f(x1)-f(x2)) = ',num2str(x3)])
text(0,.4,['Absolute relative approximate error'])
text(0.1,.2,['ea = abs((x3 - x2) / x3)*100 = ',num2str(ea),'%'])
axis off
hold off
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Iteration 2

$$x_2 = x_1 - \frac{f(x_1)(x_0 - x_1)}{f(x_0) - f(x_1)} = -0.36226$$

Absolute relative approximate error

$$ea = \frac{\text{abs}(x_2 - x_1)}{x_2} * 100 = 109.8003\%$$

