Title : solution of Non-linear Equation by using Secant Method

Theory :

A secant method is an algorithmic modification of False Position Method, such that it does not require to satisfy the intermediate value property.

i.e. $f(x_0) * f(x) < 0$

It uses same formula as of false position method given by,

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

But it uses two recent values of root to calculate better next approximated root, instead of checking for intermediate value property.

This process is repeated until we get the value of root correct upto desired accuracy. i.e. $|x_n - x_{n-1}| \leq \varepsilon$

Hence, this process is called secant method.

Algorithm for secant Method :

1) Define function $f(x)$ of Error (ε_0).

2) Input the initial value of root $[x_0, x_1]$

3) calculate root, $x_2 = \frac{x_0 y_1 - x_1 y_0}{y_1 - y_0}$

4) if (abs $(x_2 - x_1) > \varepsilon$)

then set

$x_0 = x_1$, $f(x_0) = f(x_1)$

$x_1 = x_2$, $f(x_1) = f(x_2)$

goto step 3

else print ("the root lies at $x = x_2$"),

end

5) stop

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% Title: To calculate root of given equation using Secant Method.
% Developed by: Arpan Adhikari
% Date: 2025 June 18

% Three critical statements:
close all;
clear variables;
clc;

% Function declaration section:
func = input('Enter the function f(x) = ', 's');
f = inline(func);

% Tolerance
E = 0.0005;
max_iter = 100;

% User input section:
x0 = input('Enter the first initial guess x0 = ');
x1 = input('Enter the second initial guess x1 = ');

f0 = f(x0);
f1 = f(x1);

% Display header
disp('-------------------------------------------------------------------');
disp(' Iter      x0          x1          x_new      f(x_new)     Error');
disp('-------------------------------------------------------------------');

% Iterative Secant Method Loop
for iter = 1:max_iter
    if f1 - f0 == 0
        disp('Error: Division by zero in Secant formula.');
        break;
    end

    x_new = x1 - f1 * (x1 - x0) / (f1 - f0);
    f_new = f(x_new);
    error = abs(x_new - x1);

    fprintf('%3d   %10.6f  %10.6f  %10.6f  %10.6f  %10.6f\n', iter, x0, x1,
x_new, f_new, error);

    if error < E
        break;
    end

    % Update values
    x0 = x1;
    f0 = f1;
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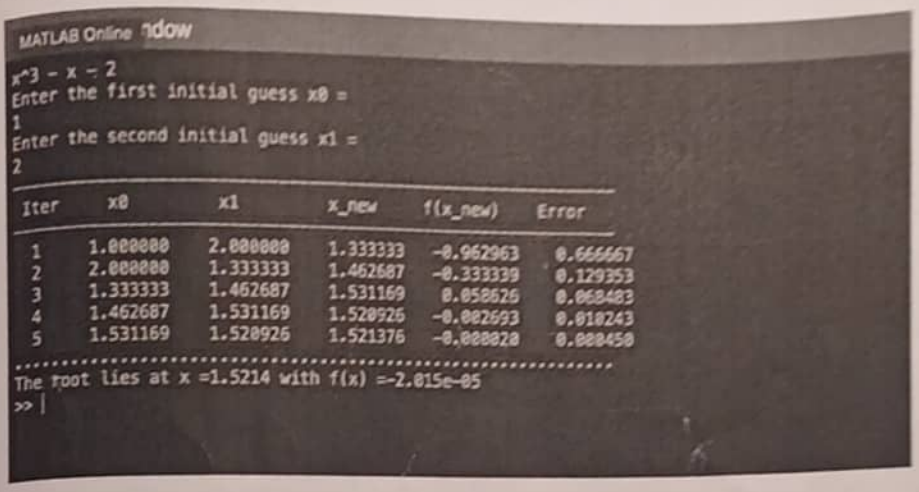
```
    x1 = x_new;
    f1 = f_new;
end

% Output final result
disp('.....');
result = strcat('The root lies at x = ', num2str(x_new), ' with f(x) = ',
num2str(f_new));
disp(result);
```

Output :



```
MATLAB Online Window
x^3 - x - 2
Enter the first initial guess x0 =
1
Enter the second initial guess x1 =
2

 Iter     x0          x1          x_new      f(x_new)     Error
 ----------------------------------------------------------------
    1    1.000000    2.000000    1.333333   -0.962963    0.666667
    2    2.000000    1.333333    1.462687   -0.333339    0.129353
    3    1.333333    1.462687    1.531169    0.058626    0.068483
    4    1.462687    1.531169    1.520926   -0.002693    0.010243
    5    1.531169    1.520926    1.521376   -0.000020    0.000450
.....
The root lies at x =1.5214 with f(x) =-2.015e-05
>>
```

Conclusion :

Hence, the root of any equation can be found using the Secant Method, which offers faster convergence by using two initial guesses and updating based on the secant line. It is an efficient open-end method for solving nonlinear equations.