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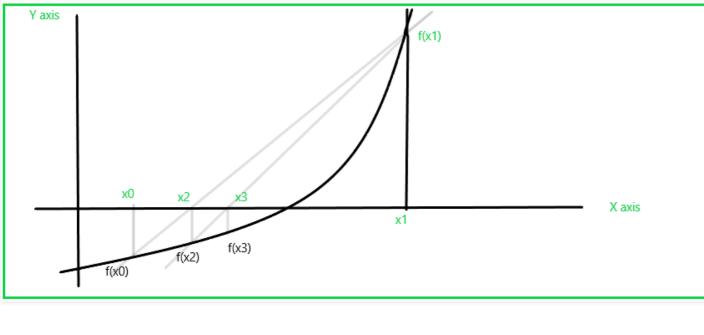
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Secant Method of Numerical analysis

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Secant method is also a recursive method for finding the root for the polynomials by successive approximation. It's similar to the **Regular-falsi** method but here we don't need to check $f(x_1)f(x_2)$ <0 again and again after every approximation. In this method, the neighbourhoods roots are approximated by secant line or chord to the function f(x). It's also advantageous of this method that we don't need to differentiate the given function **f(x)**, as we do in **Newton-raphson** method.



Now, we'll derive the formula for secant method. The equation of Secant line passing through two

Figure - Secant Method

points is: $Y - Y_1 = m(X - X_1)$

Here, m=slope So, apply for $(x_1, f(x_1))$ and $(x_0, f(x_0))$

 $Y - f(x_1) = [f(x_0)-f(x_1)/(x_0-x_1)] (x-x_1)$

As we're finding root of function f(x) so, Y=f(x)=0 in Equation (1) and the point where the secant

line cut the x-axis is,

Equation (1)

 $x = x_1 - [(x_0 - x_1)/(f(x_0) - f(x_1)]f(x_1)$.

We use the above result for successive approximation for the root of function f(x). Let's say the first approximation is $x=x_2$:

 $x_2 = x_1 - [(x_0 - x_1)/(f(x_0)-f(x_1))]f(x_1)$

Similarly, the second approximation would be $\mathbf{x} = \mathbf{x_3}$:

 $x_3 = x_2 - [(x_1-x_2)/(f(x_1)-f(x_2))]f(x_2)$

And so on, till kth iteration,,

 $x_{k+1} = x_k - [(x_{k-1} - x_k) / (f(x_{k-1}) - f(x_k))]f(x_k)$

three decimal places or four etc. Example-1: Compute the root of the equation $x^2e^{-x/2} = 1$ in the interval [0, 2] using the secant method. The root

<u>Note:</u> To start the solution of the function f(x) two initial guesses are required such that $f(x_0) < 0$

and $f(x_1)>0$. Usually it hasn't been asked to find, that root of the polynomial f(x) at which f(x)=0.

Mostly You would only be asked by the problem to find the root of the f(x) till two decimal places or

should be correct to three decimal places. Solution -

$x_0 = 1.42$, $x_1 = 1.43$, $f(x_0) = -0.0086$, $f(x_1) = 0.00034$.

Apply, secant method, The first approximation is,

 $x_2 = x_1 - [(x_0 - x_1) / (f(x_0) - f(x_1))]f(x_1)$

= 1.43 - [(1.42 - 1.43) / (0.00034 - (-0.0086))](0.00034)

= 1.4296 $f(x_2) = -0.000011 (-ve)$

The second approximation is,

 $x_3 = x_2 - [(x_1 - x_2) / (f(x_1) - f(x_2))]f(x_2)$

= 1.4296 - [(1.42 - 1.4296) / (0.00034 - (-0.000011) (-0.000011)

= 1.4292

Since, x_2 and x_3 matching up to three decimal places, the required root is 1.429.

A real root of the equation $f(x) = x^3 - 5x + 1 = 0$ lies in the interval (0, 1). Perform four iterations of the secant method.

Example-2:

Solution -

We have, $x_0 = 0$, $x_1 = 1$, $f(x_0) = 1$, $f(x_1) = -3$ $x_2 = x_1 - [(x_0 - x_1) / (f(x_0) - f(x_1))]f(x_1)$

= 1 - [(0-1)/((1-(-3))](-3)= 0.25.

 $f(x_2) = -0.234375$ The second approximation is,

 $x_3 = x_2 - [(x_1 - x_2) / (f(x_1) - f(x_2))]f(x_2)$ =(-0.234375) - [(1-0.25)/(-3-(-0.234375))](-0.234375)

= 0.186441 $f(x_{34} = x_3 - [(x_2 - x_3) / (f(x_2) - f(x_3))]f(x_3)$

= 0.186441 - [(0.25 - 0.186441) / (-0.234375) - (0.074276)](-0.234375)

= 0.201736. $f(x_4) = -0.000470$

The fourth approximation is, $x_5 = x_4 - [(x_3 - x_4) / (f(x_3) - f(x_4))]f(x_4)$ = 0.201736 - [(0.186441 - 0.201736) / (0.074276 - (-0.000470)] (-0.000470)

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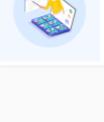
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