Secant Method Dataflow Computing

MAXELER Technologies
MAXIMUM PERFORMANCE COMPUTING

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Outline

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- Example
- Applications
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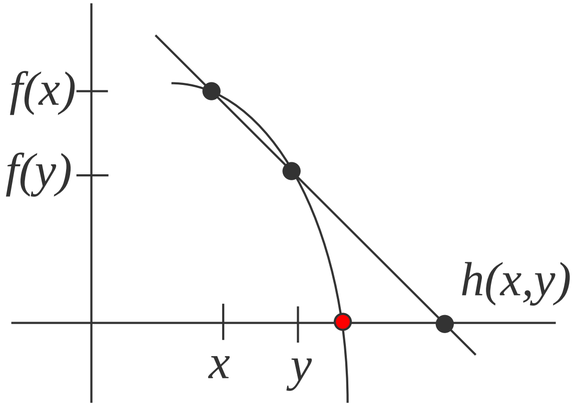
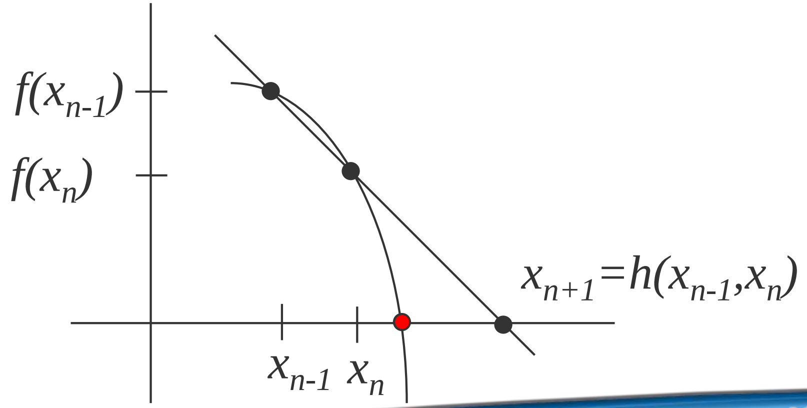
Secant Method

The secant method is a recursive method used to find the solution to an equation like Newton's Method. The idea for it is to follow the secant line to its x-intercept and use that as an approximation for the root. This is like Newton's Method (which follows the tangent line) but it requires two initial guesses for the root.

The big advantage of the secant method over Newton's Method is that it does not require the given function $f(x)$ to be a differential function or for the algorithm to have to compute a derivative. This can be a big deal in other languages since many derivatives can only be estimated.

The recursive function $h(x,y)$ depends on two parameters x and y the x-coordinates of two points on the function.





To get x_{n+1} from x_n and x_{n-1} we write out the equation of the secant line and using the points x_n and x_{n-1}. We then plug in the point $(x_{n+1},0)$ and solve for x_{n+1}.

$$y - f(x_n) = \frac{f(x_n) - f(x_{n-1})}{x_n - x_{n-1}}(x - x_n)$$

equation of secant

$$0 - f(x_n) = \frac{f(x_n) - f(x_{n-1})}{x_n - x_{n-1}}(x_{n+1} - x_n)$$

substitute $(x_{n+1},0)$

$$\frac{-f(x_n)(x_n - x_{n-1})}{f(x_n) - f(x_{n-1})} = x_{n+1} - x_n$$

solve for x_{n+1}

$$x_{n+1} = x_n - \frac{f(x_n)(x_n - x_{n-1})}{f(x_n) - f(x_{n-1})}$$

$x_{n+1}=h(x_{n-1},x_n)$

The equation above gives the recursively defined sequence for x_n. This is what is used for the Secant Method. The halting condition is usually given by the Standard Cauchy Error.

Example

$$f(x) = x^2 - 2$$

$$h(x,y) = x - \frac{f(x)(y-x)}{f(y) - f(x)}$$

$$h(x,y) = x - \frac{(x^2-2)(y-x)}{((y^2-2)-(x^2-2))}$$

n	x_n	$h(x_{n-1},x_n)$
0	0	
1	1	2
2	2	1.33333
3	1.33333	1.4

$$f(x) = x^3 - 2x - 3$$

$$h(x,y) = x - \frac{f(x)(y-x)}{f(y) - f(x)}$$

$$h(x,y) = x - \frac{(x^3-2x-3)(y-x)}{((y^3-2y-3)-(x^3-2x-3))}$$

n	x_n	$h(x_{n-1},x_n)$
0	0	
1	1	-3
2	-3	1.8
3	1.8	1.95868

Application

- Predict a stress-strain curve of a multi-microstructure steel Detection by subtracting two images
- Capturing peak response from complex buildings