Numerical Differentiation Formulae

Forward Differentiation Formulae:

Derivative	Formula	Error
1st	$f'(x_i) = \frac{f(x_{i+1}) - f(x_i)}{h}$	$O(h)$
2nd	$f''(x_i) = \frac{f(x_{i+2}) - 2f(x_{i+1}) + f(x_i)}{h^2}$	$O(h)$
3rd	$f'''(x_i) = \frac{f(x_{i+3}) - 3f(x_{i+2}) + 3f(x_{i+1}) - f(x_i)}{h^3}$	$O(h)$

Backward Differentiation Formulae:

Derivative	Formula	Error
1st	$f'(x_i) = \frac{f(x_i) - f(x_{i-1})}{h}$	$O(h)$
2nd	$f''(x_i) = \frac{f(x_i) - 2f(x_{i-1}) + f(x_{i-2})}{h^2}$	$O(h)$
3rd	$f'''(x_i) = \frac{f(x_i) - 3f(x_{i-1}) + 3f(x_{i-2}) - f(x_{i-3})}{h^3}$	$O(h)$

Centered (Central) Differentiation Formulae:

Derivative	Formula	Error
1st	$f'(x_i) = \frac{f(x_{i+1}) - f(x_{i-1})}{2h}$	$O(h^2)$
2nd	$f''(x_i) = \frac{f(x_{i+1}) - 2f(x_i) + f(x_{i-1})}{h^2}$	$O(h^2)$
3rd	$f'''(x_i) = \frac{f(x_{i+2}) - 2f(x_{i+1}) + 2f(x_{i-1}) - f(x_{i-2})}{2h^3}$	$O(h^2)$

Note: $x_{i+1} = x_i + h$