Numerical Differentiation
Interpolation

Newton's forward difference ~~interpolation~~ formula

$$\frac{dy_p}{dx} = \frac{1}{h}\left[\Delta y_0 + (2p-1)\frac{\Delta^2 y_0}{2!} + (3p^2-6p+2)\frac{\Delta^3 y_0}{3!} + (4p^3-18p^2+22p-6)\frac{\Delta^4 y_0}{4!} + \ldots\ldots\right]$$

↳ 1st Derivative for forward point

$$\frac{d^2 y_p}{dx^2} = \frac{1}{h^2}\left[\Delta^2 y_0 + (6p-6)\frac{\Delta^3 y_0}{3!} + (12p^2-36p+22)\frac{\Delta^4 y_0}{4!} + \ldots\right]$$

↳ 2nd Derivative for forward point.

• Newton's backward difference formula

$$\frac{dy_p}{dx} = \frac{1}{h}\left[\nabla y_0 + (2p+1)\frac{\nabla^2 y_0}{2!} + (3p^2+6p+2)\frac{\nabla^3 y_0}{3!} + (4p^3+18p^2+22p+6)\frac{\nabla^4 y_0}{4!} + \ldots\ldots\right]$$

↳ 1st Derivative for backward point

$$\frac{d^2y_p}{dx^2} = \frac{1}{h^2}\left[\nabla^2 y_0 + (6p+6)\frac{\nabla^3 y_0}{3!} + (12p^2+36p+22)\frac{\nabla^4 y_0}{4!} + \cdots\cdots\right]$$

↳ 2nd Derivative for backward point

Stirling's Difference Formula

$$\frac{dy_p}{dx} = \frac{1}{h}\left[\mu\delta y_0 + p\delta^2 y_0 + (3p^2-1)\frac{\mu\delta^3 y_0}{3!} + (4p^3-2p)\frac{\delta^4 y_0}{4!} + \cdots\cdots\right]$$

↳ 1st Derivative for Stirling point

$$\frac{d^2y_p}{dx^2} = \frac{1}{h^2}\left[\delta^2 y_0 + p(\mu\delta^3 y_0) + (12p^2-2)\frac{\delta^4 y_0}{4!} + \cdots\cdots\right]$$

↳ 2nd Derivative for Stirling point