Euler's Method of Solving ODEs - Applications

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Example

Given

$$\frac{dy}{dx} + 0.4y = 3e^{-x},\ y(0) = 5$$

Use Euler's method to find $y(3)$ using a step size of $h = 1.5$.

$$\frac{dy}{dx} + 0.4y = 3e^{-x}, \quad y(0) = 5$$

$$\frac{dy}{dx} = 3e^{-x} - 0.4y = f(x,y), \quad y(0) = 5$$

$$y_{i+1} = y_i + f(x_i, y_i)\,h$$

$i = 0$

$$y_1 = y_0 + f(x_0, y_0)\,h$$

$x_0 = 0, \; y_0 = 5, \; h = 1.5$

$$y_1 = 5 + f(0,5) * 1.5$$

$$= 5 + (3e^{-0} - 0.4 * 5) * 1.5$$

$$= 5 + (1)(1.5) = 6.5 \simeq y(1.5)$$

$$x_1 = x_0 + h = 0 + 1.5 = 1.5$$

$i=1$

$$y_2 = y_1 + f(x_1, y_1)\,h$$

$x_1 = 1.5,\ y_1 = 6.5,\ h = 1.5$

$x_2 = x_1 + h = 1.5 + 1.5 = 3$

$$y_2 = 6.5 + \underline{f(1.5, 6.5)} * 1.5$$

$$= 6.5 + \left(3e^{-1.5} - 0.4(6.5)\right) * 1.5$$

$$= 6.5 + (-1.93061) * 1.5$$

$$= 3.604 \simeq y(x_2) = y(3)$$

$y(3) \simeq 3.604$

$y(3) = 2.763$ (exact value)

$|\epsilon_t| = 30.44\%$

END

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