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Exercise 1 :

Minimize the mean square error of single regression by the steepest descent method

$$E(w) = \frac{1}{N}\sum_{i=1}^{N}(t_i - (wx_i + b))^2$$

1. Find the derivative of the mean squared error $E(w)$ with parameters w and b.
2. Find the update equation for Step 2 of the Steepest Descent Method. Let the initial parameters be (w_0, b_0), the t–th update parameters be (w_t, b_t), and the step size parameter be η.

$$E(w) = \frac{1}{N}\sum_{i=1}^{N}(t_i - (wx_i + b))^2$$

1. $\frac{\partial E}{\partial w} = \frac{1}{N}\sum_{i=1}^{N} 2(t_i - wx_i - b)\cdot(-x_i) = -\frac{2}{N}\sum_{i=1}^{N} x_i[t_i - (wx_i + b)]$

$\frac{\partial E}{\partial b} = \frac{-2}{N}\sum_{i=1}^{N}[t_i - (wx_i + b)]$

2. $w_{t+1} = w_t - \eta\frac{\partial E}{\partial w}$, $b_{t+1} = b_t - \eta\frac{\partial E}{\partial b}$

From problem 1, $\frac{\partial E}{\partial w}$ and $\frac{\partial E}{\partial b}$ are known

thus, the update equation can be calculated:

$w_{t+1} = w_t + \frac{2\eta}{N}\sum_{i=1}^{N}[t_i - (w_i x_i + b_i)]x_i$

$b_{t+1} = b_t + \frac{2\eta}{N}\sum_{i=1}^{N}(t_i - (w_i x_i + b_i))$