- $\frac{d}{dx} \ln f(x) = \frac{f'(x)}{f(x) \cdot \ln e} = \frac{f'(x)}{f(x)}$

⟨· 합성함수!
얘를 X로 치환!
"$X = 1+e^{-x}$"⟩

- $sigmoid(x) = \frac{1}{1+e^{-x}} = (1+e^{-x})^{-1}$

⟨· 합성함수!
$-x$를 X로 치환!
"e^{X}"⟩

- $\frac{d}{dx} sigmoid(x) = -1 \cdot (1+e^{-x})^{-2} \cdot \frac{d}{dx} 1+e^{-x}$

$$= -1 \cdot (1+e^{-x})^{-2} \cdot e^{-x} \cdot (-1)$$

$$= (1+e^{-x})^{-2} \cdot e^{-x}$$

$$= \left(\frac{1}{1+e^{-x}}\right)^{2} \cdot e^{-x}$$

$$= \frac{1+e^{-x} - 1}{(1+e^{-x})^{2}}$$

$$= \cancel{\frac{1+e^{-x}}{(1+e^{-x})^{2}}} - \frac{1}{(1+e^{-x})^{2}} = 1 - \frac{1}{(1+e^{-x})^{2}}$$

$$= \frac{1}{1+e^{-x}} - \frac{1}{(1+e^{-x})^{2}} = \frac{1}{1+e^{-x}} - \left(\frac{1}{1+e^{-x}}\right)^{2}$$

$$= \mathrm{sigmoid}(x) - \mathrm{sigmoid}^2(x)$$

$$\boxed{= \mathrm{sigmoid}(x)\left(1 - \mathrm{sigmoid}(x)\right)}$$

- $$\frac{\partial}{\partial w}\mathrm{sigmoid}(wx_i+b) = -1\cdot\left(1+e^{-(wx_i+b)}\right)^{-2} \cdot \frac{d}{dx}\, 1+e^{\underline{-(wx_i+b)}}$$

'$-(wx_i+b)$'를 'X'로 치환하여 합성함수의 미분법 실시!

$$= -\left(1+e^{-(wx_i+b)}\right)^{-2} \cdot e^{-wx_i-b} \cdot -x_i$$

$$= \left(1+e^{-(wx_i+b)}\right)^{-2} \cdot e^{-wx_i-b} \cdot x_i$$

$$= \left(\frac{1}{1+e^{-wx_i-b}}\right)^2 \cdot e^{-wx_i-b} \cdot x_i$$

$$= \frac{1+e^{-wx_i-b}-1}{\left(1+e^{-wx_i-b}\right)^2} \cdot x_i$$

$$= \left(\cancel{\frac{1+e^{-wx_i+b}}{\left(1+e^{-wx_i-b}\right)^2}} - \frac{1}{1+e^{-wx_i-b}}\right) \cdot x_i$$

$$= \left(\frac{1}{1+e^{-wx_i-b}} - \frac{1}{\left(1+e^{-wx_i-b}\right)^2}\right) \cdot x_i$$

$$= \left(\mathrm{sigmoid}(w \cdot x_i + b) - \mathrm{sigmoid}^2(w \cdot x_i + b)\right) \cdot x_i$$

$$\boxed{= \underline{\mathrm{sigmoid}(w \cdot x_i + b) \cdot \left(1 - \mathrm{sigmoid}(w \cdot x_i + b)\right) \cdot x_i}}$$

`시그모이드 함수에 대한 미분 결과' X `인자에 대한 미분 결과'

- $$\mathrm{cost}(w,b) = -\sum_{i=1}^{n}\left[y_i \cdot \log\left(s(w x_i + b)\right) + (1-y_i) \cdot \log\left(1 - s(w x_i + b)\right)\right]$$

- $$\frac{\partial}{\partial b}\mathrm{cost}(w,b) = -\sum_{i=1}^{n}\left[y_i \cdot \frac{s'(w x_i + b)}{s(w x_i + b)} + (1-y_i) \cdot \frac{-s'(w \cdot x_i + b)}{1 - s(w x_i + b)}\right]$$

$$= -\sum_{i=1}^{n}\left[y_i \cdot \frac{\cancel{s(w x_i + b)}\left(1 - s(w x_i + b)\right)}{\cancel{s(w x_i + b)}} + (1-y_i) \times -1 \times \frac{s(w x_i + b)\cancel{\left(1 - s(w x_i + b)\right)}}{\cancel{1 - s(w x_i + b)}}\right]$$

$$= -\sum_{i=1}^{n}\left[y_i\left(1 - s(w x_i + b)\right) + (-1+y_i) \cdot s(w \cdot x_i + b)\right]$$

$$= -\sum_{i=1}^{n} y_i - \cancel{y_i \cdot s(w x_i + b)} - s(w \cdot x_i + b) + \cancel{y_i \cdot s(w x_i + b)}$$

$$\boxed{= -\sum_{i=1}^{n} y_i - s(w \cdot x_i + b)}$$ ← 답

$$\bullet\ \frac{\partial}{\partial w} \cdot Cost(w,b) = -\sum_{i=1}^{n}\left[y_i \cdot \frac{s'(wx_i+b)}{s(wx_i+b)} + (1-y_i) \cdot \frac{-s'(wx_i+b)}{1-s(w\cdot x_i+b)} \right]$$

$$= -\sum_{i=1}^{n}\left[y_i \cdot \frac{\cancel{s(w\cdot x_i+b)}(1-s(w\cdot x_i+b))\cdot x_i}{\cancel{s(wx_i+b)}} + (-1+y_i) \cdot \frac{s(wx_i+b)\cancel{(1-s(wx_i+b))}}{\cancel{1-s(wx_i+b)}} \cdot x_i \right]$$

$$= -\sum_{i=1}^{n}\left[y_i(1-s(w\cdot x_i+b))\cdot x_i + (-s(w\cdot x_i+b) + y_i \cdot s(wx_i+b))\cdot x_i \right]$$

$$= -\sum_{i=1}^{n}\left[x_i\left(y_i - \cancel{y_i \cdot s(w\cdot x_i+b)} - s(w\cdot x_i+b) + \cancel{y_i \cdot s(w\cdot x_i+b)}\right) \right]$$

$$\boxed{= -\sum_{i=1}^{n} x_i\left(y_i - s(w\cdot x_i+b)\right)}$$

답