CSE427 ASSIGNMENT 2

NAME: ANIKA ISLAM
ID: 21101298
SECTION: 01

$$\overline{y}_i = w_1 x_{i,1} + w_2 x_{i,2} + \dots \dots + w_n x_{i,n} + b$$

$$\overline{y}_i = w x_i + b$$

$$w \to \{w_1, w_2 \dots \dots, w_n\}$$

$$x_{i,j} \to \{x_{i,1}, x_{i,2} \dots \dots x_{i,n}\}$$

(1) $$E = \frac{1}{m}\sum_{i=1}^{m}(y_i - \overline{y}_i)^2$$

$$E = \frac{1}{m}\sum_{i=1}^{m}(y_i - w x_{i,j} - b)^2$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m}(2)(y_i - w x_{i,j} - b)(-x_{i,j}) = -\frac{2x_{i,j}}{m}\sum_{i=1}^{m}(y_i - w x_{i,j} - b)$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m}(2)(y_i - w x_{i,j} - b)(-1) = -\frac{2}{m}\sum_{i=1}^{m}(y_i - w x_{i,j} - b)$$

(2) $$E = \sum_{i=1}^{m}(y_i - \overline{y}_i)^2$$

$$E = \sum_{i=1}^{m}(y_i - w x_{i,j} - b)^2$$

$$\frac{\partial E}{\partial w_i} = \sum_{i=1}^{m}(2)(y_i - w x_{i,j} - b)(-x_{i,j}) = -2x_{i,j}\sum_{i=1}^{m}(y_i - w x_{i,j} - b)$$

$$\frac{\partial E}{\partial b} = \sum_{i=1}^{m}(2)(y_i - w x_{i,j} - b)(-1) = -2\sum_{i=1}^{m}(y_i - w x_{i,j} - b)$$

(3) $E = \frac{1}{m}\sum_{i=1}^{m}(\log y_i - \log \bar{y}_i)^2$

$$E = \frac{1}{m}\sum_{i=1}^{m}(\log y_i - \log(wx_{i,j} - b))^2$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m}(2)(\log y_i - \log(wx_{i,j} - b))\left(\frac{-1}{wx_{i,j}-b}\right)(x_{i,j})$$

$$= \frac{-2x_{i,j}}{m(wx_{i,j}-b)}\sum_{i=1}^{m}(\log y_i - \log(wx_{i,j} - b))$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m}(2)(\log y_i - \log(wx_{i,j} - b))\left(\frac{-1}{wx_{i,j}-b}\right)(1)$$

$$= \frac{-2}{(wx_{i,j}-b)}\sum_{i=1}^{m}(2)(\log y_i - \log(wx_{i,j} - b))$$

(4) $E = \frac{1}{m}\sum_{i=1}^{m}|y_i - \bar{y}_i|$

$$E = \frac{1}{m}\sum_{i=1}^{m}|y_i - wx_{i,j} - b|$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m}\frac{y_i - wx_{i,j} - b}{|y_i - wx_{i,j} - b|}(-x_{i,j}) = -\frac{x_{i,j}}{m}\sum_{i=1}^{m}\frac{y_i - wx_{i,j} - b}{|y_i - wx_{i,j} - b|}$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m}\frac{y_i - wx_{i,j} - b}{|y_i - wx_{i,j} - b|}(-1) = \frac{-1}{m}\sum_{i=1}^{m}\frac{y_i - wx_{i,j} - b}{|y_i - wx_{i,j} - b|}$$

$$(B)\; E = \frac{1}{m}\sum_{i=1}^{m} \begin{cases} \frac{1}{2}(y_i - \bar{y}_i)^2, & \text{if } |y_i - \bar{y}_i| \leq \delta \\ \delta\left(|y_i - \bar{y}_i| - \frac{1}{2}\delta\right), & \text{if } |y_i - \bar{y}_i| > \delta \end{cases}$$

if $|y_i - \bar{y}_i| \leq \delta$,

$$E = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{2}(y_i - \bar{y}_i)^2$$

$$E = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{2}(y_i - w x_{i,j} - b)^2$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{2}(2)(y_i - w x_{i,j} - b)(-x_{i,j}) = -\frac{x_{i,j}}{m}\sum_{i=1}^{m}(y_i - w x_{i,j} - b$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{2}(2)(y_i - w x_{i,j} - b)(-1) = \frac{-1}{m}\sum_{i=1}^{m}(y_i - w x_{i,j} - b)$$

if $|y_i - \bar{y}_i| > \delta$,

$$E = \frac{1}{m}\sum_{i=1}^{m} \delta\,|y_i - \bar{y}_i| - \frac{1}{2}\delta$$

$$E = \frac{1}{m}\sum_{i=1}^{m} \delta\,|y_i - w x_{i,j} - b| - \frac{1}{2}\delta$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m} \delta \frac{(y_i - w x_{i,j} - b)}{|y_i - w x_{i,j} - b|}(-x_{i,j}) = \frac{-\delta x_{i,j}}{m}\sum_{i=1}^{m} \frac{y_i - w x_{i,j} - b}{|y_i - w x_{i,j} - b|}$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m} \delta \frac{(y_i - w x_{i,j} - b)}{|y_i - w x_{i,j} - b|}(-1) = \frac{-\delta}{m}\sum_{i=1}^{m} \frac{y_i - w x_{i,j} - b}{|y_i - w x_{i,j} - b|}$$

(b) $E = \frac{1}{m}\sum_{i=1}^{m} \log(\cosh(y_i - \bar{y}_i))$

$$E = \frac{1}{m}\sum_{i=1}^{m} \log(\cosh(y_i - w x_{ij} - b))$$

$$\frac{\partial E}{\partial w_i} = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{\cosh(y_i - w x_{ij} - b)} \sinh(y_i - w x_{ij} - b)(-x_{ij})$$

$$= \frac{-x_{ij}}{m}\sum_{i=1}^{m} \tanh(y_i - w x_{ij} - b)$$

$$\frac{\partial E}{\partial b} = \frac{1}{m}\sum_{i=1}^{m} \frac{1}{\cosh(y_i - w x_{ij} - b)} \sinh(y_i - w x_{ij} - b)(-1)$$

$$= \frac{-1}{m}\sum_{i=1}^{m} \tanh(y_i - w x_{ij} - b)$$