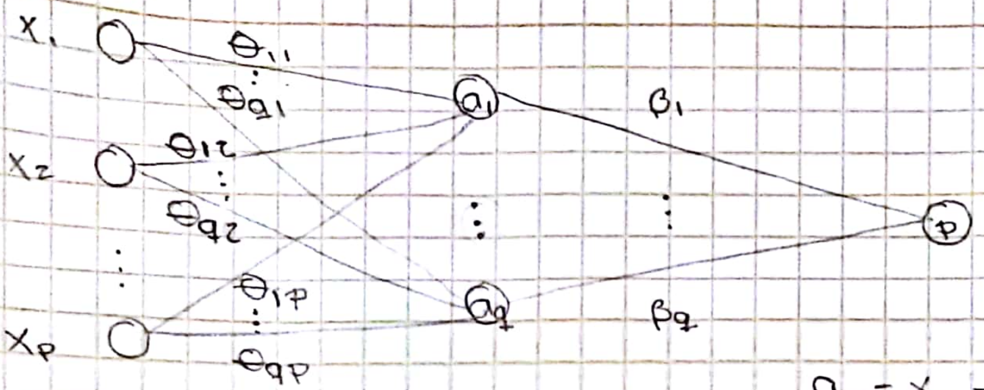
$$\frac{d\tanh(u)}{dx} = [1-\tanh^2(u)]\frac{du}{dx}$$



$a_0 = x_0 = 1$

$j=1,\dots,q$ ← tanh

$a_j = h\left(\sum_{i=0}^{p} \theta_{ji}\, x_i\right) = h(z_j)$ $\quad z_j = \sum_{i=0}^{p} \theta_{ji}\, x_i$ Una observación

$$p = h\left(\sum_{j=0}^{q} \beta_j\, a_j\right) = h\left(\sum_{j=0}^{q} \beta_j \left[h\left(\sum_{i=0}^{p} \theta_{ji}\, x_i\right)\right]\right)$$

Función de pérdida cuadrática:

$$L = \frac{1}{N}\sum_{k=1}^{N} (y_k - p_k)^2 \qquad p = h(w),\ w = \sum_{j=0}^{q} \beta_j a_j$$

Buscamos $\frac{\partial L}{\theta_{ij}}$ y $\frac{\partial L}{\partial \beta_i}$. Sea $l_k = (y_k - p_k)^2$.

$$\frac{\partial l_k}{\partial \beta_i} = \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial \beta_i} = \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial w}\cdot\frac{\partial w}{\partial \beta_i} = -2(y_k-p_k)(1-w^2)a_i$$

$$\frac{\partial l_k}{\partial \theta_{ij}} = \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial \theta_{ij}} = \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial w}\cdot\frac{\partial w}{\partial \theta_{ij}} = \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial w}\cdot\frac{\partial w}{\partial a_j}\cdot\frac{\partial a_j}{\partial \theta_{ij}}$$

$$= \frac{\partial l_k}{\partial p_k}\cdot\frac{\partial p_k}{\partial w}\cdot\frac{\partial w}{\partial a_j}\cdot\frac{\partial a_j}{z_j}\cdot\frac{\partial z_j}{\theta_{ij}} = -2(y_k-p_k)(1-w^2)a_i(1-z_j)x_i$$

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dos k de variables

x_{kj}

x_1	x_2	...	x_p	y
x_{11}	x_{21}			
x_{21}	x_{22}			
⋮				
x_{N1}	x_{N2}			

$m \in \{1, \ldots, q\}, \; n \in \{1, \ldots, p\}$

$$\frac{\partial l_k}{\partial \theta_{mn}} = \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial \theta_{mn}} = \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial W_k} \cdot \frac{\partial W_k}{\partial \theta_{mn}}$$

$$= \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial W_k} \cdot \frac{\partial W_k}{\partial a_{mk}} \cdot \frac{\partial a_{mk}}{\partial \theta_{mn}}$$

$$= \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial W_k} \cdot \frac{\partial W_k}{a_{mk}} \cdot \frac{\partial a_{mk}}{\partial Z_{mk}} \cdot \frac{\partial Z_{mk}}{\partial \theta_{mn}}$$

$$= -2(y_k - p_k)(1 - W_k^2)\beta_m(1 - Z_{mk}^2)X_{nk}$$

$$\therefore \frac{\partial L}{\partial \theta_{mn}} = \frac{1}{N}\sum_{k=1}^{N}\left[-2(y_k - p_k)(1 - W_k^2)\beta_m(1 - Z_{mk}^2)X_{nk}\right]$$

$$\frac{\partial l_k}{\partial \beta_m} = \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial \beta_m} = \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial W_k} \cdot \frac{\partial W_k}{\partial \beta_m} = \frac{\partial l_k}{\partial p_k} \cdot \frac{\partial p_k}{\partial W_k} \cdot \frac{\partial W_k}{\partial \beta_m}$$

$$= -2(y_k - p_k)(1 - W_k^2)a_{mk}$$

$$\Rightarrow \frac{\partial L}{\partial \beta_m} = \frac{1}{N}\sum_{k=1}^{N}\left[-2(y_k - p_k)(1 - W_k^2)a_{mk}\right]$$

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