Homework 1

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Part 1

1.

Assume $f(x)$ is a linear function, i.e. $f(x) = kx + b$. Then

$$g_k(X) \equiv y_k = f\left(\sum_j w_{kj} f\left(\sum_i w_{ji}x_i + w_{jo}\right) + w_{ko}\right)$$

$$\begin{aligned} g_k(X) \equiv y_k &= f\left(\sum_j w_{kj} f\left(\sum_i w_{ji}x_i + w_{jo}\right) + w_{ko}\right) \\ &= k\left(\sum_j w_{kj} f\left(\sum_i w_{ji}x_i + w_{jo}\right) + w_{ko}\right) + b \\ &= k\left(\sum_j w_{kj}\left(k\left(\sum_i w_{ji}x_i + w_{jo}\right) + b\right) + w_{ko}\right) + b \\ &= k^2 \sum_i \sum_j w_{kj}w_{ji}x_i + k\left(\sum_j w_{kj}(kw_{jo} + b) + w_{k0}\right) + b \end{aligned}$$

Which is still a linear function of X.

2.

(1)

$$\text{Let } z = W^T X$$

$$\begin{aligned} \frac{\partial E}{\partial W} &= \frac{\partial E}{\partial y}\frac{\partial y}{\partial z}\frac{\partial z}{\partial W} \\ &= (y-g)y(1-y)X \end{aligned}$$

$$W' = W - \lambda\frac{\partial E}{\partial W} = W - \lambda(y-g)y(1-y)X$$

(2)

$$y = f(W^T X) = 0.953$$

$$\frac{\partial E}{\partial W} = -0.002[1, 2, 0.5]^T$$

$$W' = W - \lambda\frac{\partial E}{\partial W} = 0.5002, 1.0004, 1.0001$$