$$C = (A_2 - Y)^2$$

$$A_2 = \text{sigmoid}(Z_2)$$

$$Z_2 = W_2 A_1 + B_2$$

$$A_1 = \text{Relu}(Z_1)$$

$$Z_1 = W_1 X + B_1$$

chain rule

$$\frac{dz}{dx} = \frac{dz}{dy} \times \frac{dy}{dx}$$

$$\frac{dC}{dW_2} = \frac{dZ_2}{dW_2} \times \frac{dA_2}{dZ_2} \times \frac{dC}{dA_2}$$

$$\boxed{\frac{dC}{dW_2}} = (A_1)\left(\sigma(x)(1 - \sigma(x))\right)(2A_2 - 2y)$$

sigmoid prime

delta

cost derivative

sigmoid

$$\boxed{\frac{dC}{dB_2}} = \frac{dZ_2}{dB_2} * \frac{dA_2}{dZ_2} * \frac{dC}{dA_2} = (1) * \left(\sigma(Z_2)(1 - \sigma(Z_2))(2A_2 - 2y)\right)$$

delta

$$\boxed{\frac{dC}{dW_1}} = \frac{dZ_1}{dW_1} * \frac{dA_1}{dZ_1} * \frac{dZ_2}{dA_1} * \frac{dA_2}{dZ_2} * \frac{dC}{dA_2} =$$

$$= (X)(Z_1 > 0) \cdot W_2 \cdot \sigma(Z_2)(1 - \sigma(Z_2)) \cdot (2A_2 - 2y)$$

$$\frac{dC}{dB_1} = \frac{dZ_1}{dB_1} * \frac{dA_1}{dZ_1} * \frac{dZ_2}{dA_1} * \frac{dA_2}{dZ_2} * \frac{dC}{dA_2} =$$

$$= (1)(Z_1 > 0) \cdot W_2 \cdot \sigma(Z_2)(1 - \sigma(Z_2)) \cdot (2A_2 - 2y)$$

sy

sigmoid prime

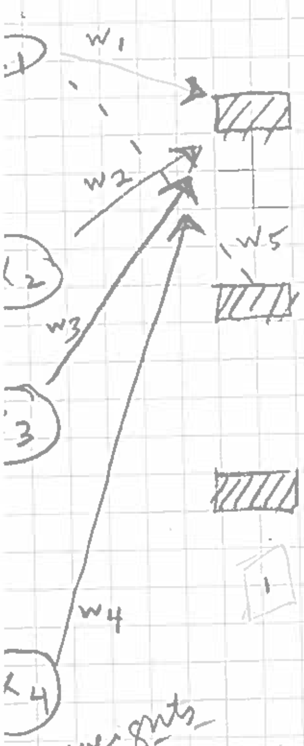
cost derivative

delta

previous layer.

Equation depects simple two layer neural network, A1 is the output of the first layer and input to the second layer. W and B are the weights (determining inputs importance) and bias (which shifts the activation function output). For a single neuron, this is the sum of each input multiplied by its weight plus bias and for entire layer of neurons this is done via matrix multiplication Z = WX + B

Z is the Weighted Sum, or output for a single Neuron, before Activation function
A is the result of the activation function which introduces non-linearity, allowing the network to learn complicated patterns
C is the Loss function which measures how far the network's prediction is from the target
dC/db and dC/dw are the gradient descent updates used to adjust weights and biases



$x_1 w_1 + x_2 w_2 + x_3 w_3 + x_4 w_4$

$x_1 w_5 + x_2 w_6 + x_3 w_7 + x_4 w_8$

$x_1 w_9 + x_2 w_{10} + x_3 w_{11} + x_4 w_{12}$

$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}$ [4×1]

$[x_1, x_2, x_3, x_4]$ [1×4] transpose

weights

$$\begin{bmatrix} w_1 & w_2 & w_3 & w_4 \\ w_5 & w_6 & w_7 & w_8 \\ w_9 & w_{10} & w_{11} & w_{12} \end{bmatrix} \qquad \begin{bmatrix} \_\_\_ \\ \_\_\_ \\ \_\_\_ \end{bmatrix}$$

[3×4] [3×1]

(hidden size, input size)

Jc 3.25

2:10 pm 3.25
3:18 pm
4:11 pm 325
4:13 pm 325
4:49 pm

wk
1:48 315
2:48 pm
3:18 pm 315
S
4:19 pm

$$\begin{bmatrix} 0 \\ 1 \\ 2 \\ 3 \end{bmatrix} \quad [4,1)$$

$[10, 20, 30, 40]$ (1,4) ← b.unti-shape (4,1)

$10*0 + 20*1 + 30*2 + 40*3$

$0 + 20 + 60 + 120$

$80 + 120$

200

$$\begin{array}{c|cccc} & 0 & 1 & 2 & 3 \\ \hline 10 & 0 & 10 & 20 & 30 \\ 20 & 0 & 20 & 40 & 60 \\ 30 & 0 & 30 & 60 & 90 \\ 40 & 0 & 40 & 80 & 120 \end{array}$$

(1x4)

(4x1)

$Z_1 = W_{hidden} X + B_{hidden}$

$$W_{hidden} = \begin{bmatrix} 0.05629 & 0.596 & 0.238 \\ 0.303 & 0.421 & 0.855 \\ 0.655 & 0.457 & 0.618 \end{bmatrix}$$

3x3