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Question 1)

Forward Pass

$$z_1, z_2, z_3 = \begin{bmatrix} 0.5726 & 0.5833 \end{bmatrix} \begin{bmatrix} -3.6 & 1.5 & 0.99 \\ -1.23 & -3.6 & 1.4 \end{bmatrix}$$

$$= \begin{bmatrix} -2.7788 & -1.2409 & 1.3834 \end{bmatrix}$$

Sigmoid $A_1, A_2, A_3 = \begin{bmatrix} 0.0584 & 0.2242 & 0.7995 \end{bmatrix}$

$$z_4 = \begin{bmatrix} 0.0584 & 0.2242 & 0.7995 \end{bmatrix} \begin{bmatrix} 0.11 \\ 2.22 \\ 1.4 \end{bmatrix}$$

$$= \begin{bmatrix} 1.6234 \end{bmatrix}$$

Sigmoid $\hat{y} = 0.8352$

$\approx 83.52\%$ (Prediction)

$$Loss = \frac{1}{2}(0.75 - 0.8352)^2$$

$$= 0.00362$$

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Backpropagation Pass

$\delta = (\hat{y} - Y)(\hat{y})(1-\hat{y})$

$= (0.8352 - 0.75)(0.8352)(1-0.8352)$

$= 0.01172.$

$W_{21}^{*} = W_{21} - \eta\delta(A_1)$
$= 0.11 - 0.5(0.0117)(0.0584)$
$= 0.1096$

$W_{22}^{*} = 2.22 - 0.5(0.0117)(0.2242)$
$= 2.2186$

$W_{23}^{*} = 1.4 - 0.5(0.0117)(0.7995)$
$= 1.3953$

$W_{11}^{*} = W_{11} - \eta\delta(W_{21})(A_1)(1-A_1)(In_1)$
$= -3.6 - (0.5)(0.0117)(0.11)(0.0584)(1-0.0584)(0.5726)$
$= -3.6$

$W_{12}^{*} = 1.5 - (0.5)(0.0117)(\overset{In_1}{0.5726})(0.2242)(1-0.2242)(2.22)$
$= 1.4987$

$W_{13}^{*} = 0.99 - (0.5)(0.0117)(0.5726)(0.7995)(1-0.7995)(1.4)$
$= 0.9892$

$W_{14}^{*} = -1.23 - (0.5)(0.0117)(0.5833)(0.11)(0.0584)(1-0.0584)$
$= -1.23$

$W_{15}^{*} = -3.6 - (0.5)(0.0117)(0.5833)(2.22)(0.2242)(1-0.2242)$
$= -3.6013$

$W_{16}^{*} = 1.4 - (0.5)(0.0117)(0.5833)(1.4)(0.7995)(1-0.7995)$
$= 1.3992$

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Forward Pass (2nd Times)

$$Z_1, Z_2, Z_3 = \begin{bmatrix} 0.5726 & 0.5833 \end{bmatrix} \begin{bmatrix} -3.6 & 1.4987 & 0.9892 \\ -1.23 & -3.6013 & 1.3992 \end{bmatrix}$$

$$= \begin{bmatrix} -2.7788 & -1.2424 & 1.3826 \end{bmatrix}$$

Sigmoid $A_1, A_2, A_3 = \begin{bmatrix} 0.0584 & 0.224 & 0.7994 \end{bmatrix}$

$$Z_4 = \begin{bmatrix} 0.0584 & 0.224 & 0.7994 \end{bmatrix} \begin{bmatrix} 0.1096 \\ 2.2186 \\ 1.3953 \end{bmatrix}$$

$= 1.6187$

Sigmoid $\hat{y} = 0.8346$

$\approx 83.46\%$

$$\text{Loss} = \frac{1}{2}(0.75 - 0.8346)^2$$

$= 0.00357$ //

∴ From 0.00362 to 0.00357, it decrease "0.00005"

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Question 1 (using tanh)

we know that

$$z_1, z_2, z_3 = \begin{bmatrix} -2.7788 & -1.24098 & 1.383494 \end{bmatrix}$$

$$\therefore \tanh A_1, A_2, A_3 = \frac{1-e^{-2(z_i)}}{1+e^{-2(z_i)}}$$

$$= \begin{bmatrix} -0.9923 & -0.84573 & 0.88173 \end{bmatrix}$$

$$z_4 = \begin{bmatrix} -0.9923 & -0.84573 & 0.88173 \end{bmatrix} \begin{bmatrix} 0.11 \\ 2.22 \\ 1.4 \end{bmatrix}$$

$$= -0.752262$$

$$\hat{y} = \frac{1}{1+e^{-(z_4)}}$$

$$= 0.32032$$

$$\approx 32.03\%$$

$$Loss = \frac{1}{2}(0.75 - 0.3203)^2$$

$$= 0.0923$$

Backpropagation (tanH)

$$\delta = (\hat{y} - Y)(\hat{y})(1 - \hat{y})$$
$$= (0.3203)(1 - 0.3203)(0.3203 - 0.75)$$
$$= -0.09354$$

$$W_{21} = W_{21} - \eta \delta A_1$$
$$= 0.11 - (0.5)(-0.09354)(-0.9923)$$
$$= 0.06358$$

$$W_{22} = 2.23 - (0.5)(-0.09354)(-0.8457)$$
$$= 2.1804$$

$$W_{23} = 1.4 - (0.5)(-0.09354)(0.88173)$$
$$= 1.4412$$

$$W_{11} = W_{11} - \eta \delta W_{21}(1 - A_1^2) In_1$$
$$= -3.6 - (0.5)(-0.09354)(0.11)(1 - (-0.9923)^2)(0.5726)$$
$$= -3.5999$$

$$W_{12} = 1.5 - (0.5)(-0.09354)(2.23)(1 - (\overset{-0.8457}{\cancel{-0.09354}})^2)(0.5726)$$
$$= 1.5169$$

$$W_{13} = 0.99 - (0.5)(-0.09354)(1.4)(1 - (0.88173)^2)(0.5726)$$
$$= 0.9983$$

$$W_{14} = -1.23 - (0.5)(-0.09354)(0.11)(1 - (-0.9923)^2)(0.5833)$$
$$= -1.2299$$

$$W_{15} = -3.6 - (0.5)(-0.09354)(2.23)(1 - (-0.8457)^2)(0.5833)$$
$$= -3.5827$$

$$W_{16} = 1.4 - (0.5)(-0.09354)(1.4)(1 - (0.88173)^2)(0.5833)$$
$$= 1.4085$$

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2nd Forward Pass (tanH)

$$z_1, z_2, z_3 = \begin{bmatrix} 0.5726 & 0.5833 \end{bmatrix} \begin{bmatrix} -3.5999 & 1.5169 & 0.9983 \\ -1.2299 & -3.5827 & 1.4085 \end{bmatrix}$$

$$= \begin{bmatrix} -2.7787 & -1.2212 & 1.3932 \end{bmatrix}$$

$$\tanh\ A_1, A_2, A_3 = \begin{bmatrix} -0.9923 & -0.84 & -0.8838 \end{bmatrix}$$

$$z_4 = \begin{bmatrix} -0.9923 & -0.84 & 0.8838 \end{bmatrix} \begin{bmatrix} 0.0635 \\ 2.1804 \\ \cancel{2}. \\ 1.4412 \end{bmatrix}$$

$$= -0.6208$$

$$\hat{y} = 0.3495$$

$$\approx 34.95\%$$

$$Loss = \frac{1}{2}(0.75 - 0.3495)^2$$

$$= 0.08016$$

Forward Pass (Relu)

$\therefore z_1, z_2, z_3 = [-2.7788 \quad -1.24098 \quad 1.3834]$

$A_1 = 0$, $A_2 = 0$, $A_3 = 1.3834$

↳ since negative ; so equal 0.

value

* when value ≤ 0, change number $= 0$;

when value > 0, remain the value as the same.

$z_4 = (0 \times 0.11) + (0 \times 2.22) + (1.3834 \times 1.4)$

$= 1.9368$

Sigmoid $\hat{y} = 0.87401$

$\approx 87.401\%$

Loss $= \frac{1}{2}(0.75 - 0.87401)^2$

$= 0.00768$

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Backpropagation (Relu)

$loss = \frac{1}{2}(Y - \hat{y})^2 = \frac{1}{2}(0.75 - 0.874)^2$
$= 0.00768$

$\delta = (\hat{y} - Y)(\hat{y})(1 - \hat{y}) = (0.874 - 0.75)(0.874)(1 - 0.874)$
$= 0.01365$

$\therefore W_{21} = W_{21} - \eta \delta (A_1)$
$= 0.11 - (0.5)(0.01365)(0)$
$= 0.11$

$W_{22} = 2.22 - (0.5)(0.01365)(0)$
$= 2.22$

$W_{23} = (1.4) - (0.5)(0.01365)(1.3834)$
$= 1.39317$

$f'(Relu(A_1)) \begin{cases} \text{if } 0 = 0; \\ \text{else } = 1 \end{cases}$ $\quad \therefore A_1 = 0,\ A_2 = 0,\ A_3 = 1$

$W_{11} = W_{11} - \eta \delta W_{21} A_1 x_1$
$= -3.6 - (0.5)(0.01365)(0.11)(0)(0.5726)$
$= -3.6$

$W_{12} = 1.5 - (0.5)(0.01365)(2.22)(0)(0.5726)$
$= 1.5$

$W_{13} = 0.99 - (0.5)(0.01365)(1.4)(1)(0.5726)$
$= 0.9896$

$W_{14} = -1.23 - (0.5)(0.01365)(0.11)(0)(0.5833)$
$= -1.23$

$W_{15} = -3.6 - (0.5)(0.01365)(2.22)(0)(0.5833)$
$= -3.6$

$W_{16} = 1.4 - (0.5)(0.01365)(1.4)(1)(0.5833)$
$= 1.3944$

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2nd Forward Pass (Relu)

$$z_1, z_2, z_3 = \begin{bmatrix} 0.5726 & 0.5833 \end{bmatrix} \begin{bmatrix} -3.6 & 1.5 & 0.9896 \\ -1.23 & -3.6 & 1.3944 \end{bmatrix}$$

$$= \begin{bmatrix} -2.7788 & -1.2409 & 1.3771 \end{bmatrix}$$

$$\downarrow \quad \downarrow \quad \downarrow$$

$$\text{Relu } A_1, A_2, A_3 = \begin{bmatrix} 0 & 0 & 1.3771 \end{bmatrix}$$

$$z_4 = (0 \times 0.11) + (0 \times 2.22) + (1.3771 \times 1.4)$$
$$= 1.9149$$

$$\hat{y} = 0.87157$$
$$\approx 87.16\%$$

$$\text{Loss} = \frac{1}{2}(0.75 - 0.87157)^2$$

$$= 0.00739$$