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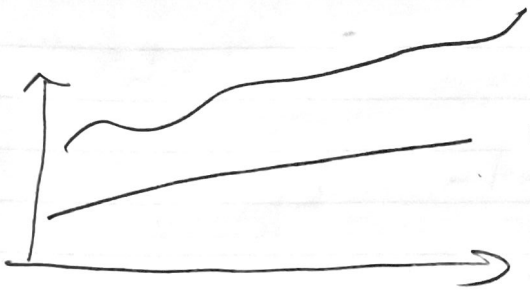



High bias = Underfitting

↑ Layers = ↑ Overfitting

6. a) A1 = [2, 10]

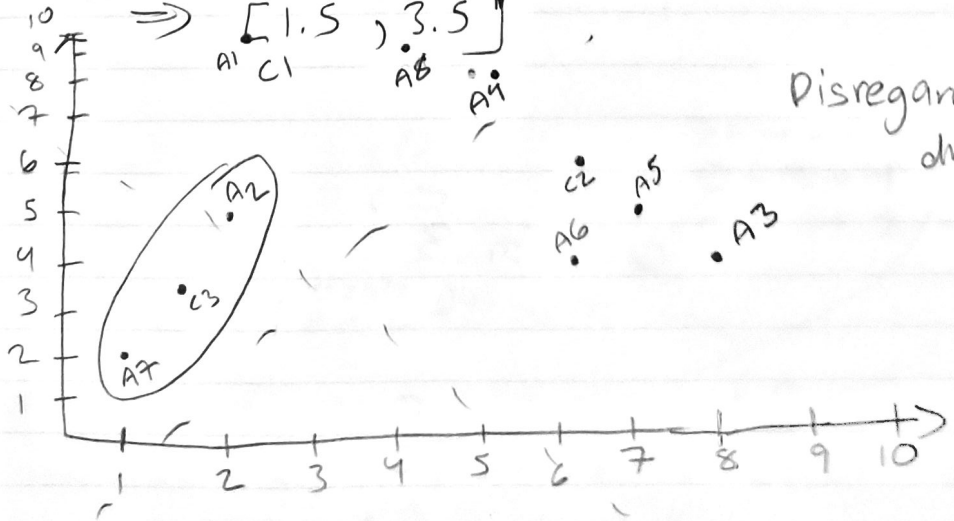
A8, A4, A6, A5, A3

⇒ [(4+5+6+7+8)/5, (9+8+4+5+4)/5]

⇒ [6, 6] Cluster 2

Cluster 3: [(1+2)/2, (2+5)/2]

⇒ [1.5, 3.5]




Disregard my drawing here

Note: I believe Cluster 1 will be A1, A8, A4
Cluster 2 " " A6, A5, A3
Cluster 3 " " A2, A7

Cluster 1: A1, A8, A4

A1 = [2, 10], A8 = [4, 9], A4 = [5, 8]

Cluster 1 center = [(2+4+5)/3, (10+9+8)/3]

= [(3.67, 9)]

Cluster 2: A6, A5, A3

A6 = [6, 4], A5 = [7, 5], A3 = [8, 4]

Cluster 2 center = [(6+7+8)/3, (4+5+4)/3]

= [7, 4.33]

Cluster 3: A2, A7

A2 = [2, 5], A7 = [1, 2]

Cluster 3 center = [(2+1)/2, (5+2)/2]

= [1.5, 3.5]

8.

Question 8 on next page

Red

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 2 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 2 | 0 |
| 0 | 2 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 2 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

Filter - Red

| | | |
|---|---|---|
| 2 | 0 | 0 |
| 0 | 1 | 0 |
| 2 | 1 | 0 |

Green

| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 1 | 2 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 2 | 2 | 0 |
| 0 | 2 | 0 | 0 | 2 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

Filter = Green

| | | |
|---|---|---|
| 1 | 1 | 0 |
| 0 | 2 | 2 |
| 0 | 0 | 2 |

a) Stride = 3, Bias = 1

1st Run: $0+0+0 + 0+1+0 + 0+0+0 = 1$

$0+0+0 + 0+4+0 + 0+0+0 = 4$

$4+1+1 = 6$

2nd Run: $0+0+0 + 0+0+0 + 0+0+0 = 0$

$2+2+0 + 0+4+0 + 0+0+0 = 8$

$8+1 = 9$

3rd Run: $0+0+0 + 0+2+0 + 0+0+0 = 2$

$0+0+0 + 0+0+4 + 0+0+2 = 6$

$6+2+1 = 9$

4th Run: $0+0+0 + 0+1+0 + 0+2+0 = 3$

$0+0+0 + 0+4+0 + 0+0+0 = 4$

$3+4+1 = 8$

next page

| | |
|---|---|
| 9 | 8 |
| 6 | 9 |

is the convolution

b.

| | |
|---|---|
| 9 | 8 |
| 6 | 9 |

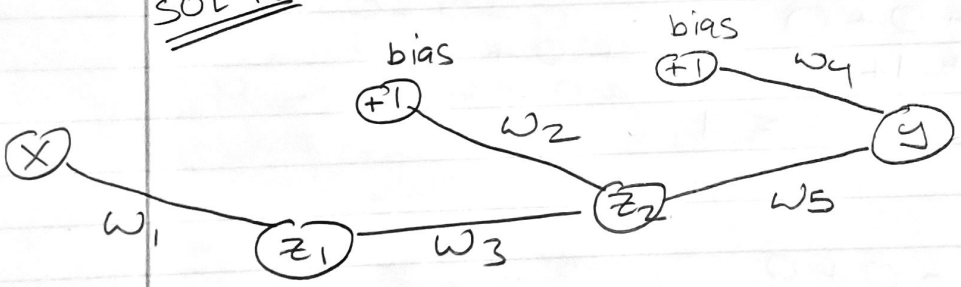
$\Rightarrow$ Relu

| | |
|---|---|
| 9 | 8 |
| 6 | 9 |

9. $x = 1$, $y = 4$, $f(z) = z$ for all neurons,
$\alpha = 0.1$, & $w_1 = w_2 = w_3 = w_4 = w_5 = 1$

a) Find initial error

SOLN




$z_1 = w_1 x_1 = x_1$

$z_2 = w_3 z_1 + w_2 \cdot 1 = z_1 + 1 = x_1 + 1$

$\hat{y} = z_2 w_5 + w_4 \cdot 1$

$= (1) \cdot (x_1 + 1) + 1 = x_1 + 2 = \hat{y}$

$\hat{y} = (1) + 2 = 3$

$\text{Error} = \frac{1}{2}(\hat{y} - y)^2$

$= \frac{1}{2}(3 - 4)^2 = \underline{1/2}$

① Update $w_5$ $\quad \hat{y} - y = 3 - 4 = -1$

$$w_{5\,new} = w_{5\,old} - \alpha \frac{\partial E}{\partial w_5}$$

$$\frac{\partial E}{\partial w_5} = \frac{\partial E}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial w_5}$$

$\frac{\partial E}{\partial \hat{y}}$: $\hat{y} - y$

$\frac{\partial \hat{y}}{\partial w_5}$: $y = z_2 w_5 + w_4 \cdot 1$, $\quad \frac{\partial y}{\partial w_5} = z_2$

$$\frac{\partial E}{\partial w_5} = (\hat{y} - y)(z_2)$$

$$= -(x_1 + 1) = -2$$

$$w_{5\,new} = w_{5\,old} - \alpha \frac{\partial E}{\partial w_5}$$

$$= 1 - (0.1)(-2) = \underline{\underline{1.2}}$$

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② Update $w_4$

$$\frac{\partial E}{\partial w_4} = \frac{\partial E}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial w_4} \rightarrow 1$$

$$= (-1) \cdot 1 = -1$$

$$w_{4\,new} = w_{4\,old} - \alpha \frac{\partial E}{\partial w_4}$$

$$= (1) - (0.1)(-1) = \underline{\underline{1.1}}$$

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③ Update $w_3$ $\quad \frac{\partial \hat{y}}{\partial z_2} \rightarrow w_5$, $\quad \frac{\partial z_2}{\partial w_3} \rightarrow z_1$

$$\frac{\partial E}{\partial w_3} = \frac{\partial E}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial z_2} \cdot \frac{\partial z_2}{\partial w_3}$$

$$= (-1)(1)(1) = -1$$

$$w_{3\,new} = w_{3\,old} - \alpha \cdot \frac{\partial E}{\partial w_3} = (1) - (0.1)(-1) = \underline{\underline{1.1}}$$

④ Update $w_2$

$$\frac{\partial E}{\partial w_2} = \frac{\partial E}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial z_2} \cdot \frac{\partial z_2}{\partial w_2}$$

($\frac{\partial \hat{y}}{\partial z_2} = w_5$, $\frac{\partial z_2}{\partial w_2} = 1$)

$$= (-1)(1)(1) = -1$$

$$w_{2new} = w_{2old} - \alpha \frac{\partial E}{\partial w_5}$$

$$= 1 - (0.1)(-1) = \underline{\underline{1.1}}$$

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⑤ Update $w_1$

$$\frac{\partial E}{\partial w_1} = \frac{\partial E}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial z_2} \cdot \frac{\partial z_2}{\partial z_1} \cdot \frac{\partial z_1}{\partial w_1}$$

($\frac{\partial \hat{y}}{\partial z_2} = w_5$, $\frac{\partial z_2}{\partial z_1} = w_3$, $\frac{\partial z_1}{\partial w_1} = x$)

$$= (-1)(1)(1)(1) = -1$$

$$w_{1new} = w_{1old} - \alpha \frac{\partial E}{\partial w_1}$$

$$= 1 - (0.1)(-1) = \underline{\underline{1.1}}$$

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⑥ Error after updating

$$z_1 = w_1 x_1 = (1.1)(1) = 1.1$$

$$z_2 = w_3 z_1 + w_2 \cdot 1 = (1.1)(1.1) + 1.1 = 2.31$$

$$\hat{y} = z_2 \cdot w_5 + w_4 \cdot 1$$

$$= (2.31)(1.2) + 1.1 = \underline{\underline{3.872}}$$

$$\text{Error} = \frac{1}{2}(\hat{y} - y)^2$$

$$= \frac{1}{2}(3.872 - 4)^2 = \underline{\underline{8.192 \cdot 10^{-3}}}$$

7. Matrix :

| | |
|---|---|
| -1 | -1 |
| 0 | 0 |
| 1 | 1 |

Matrix Transposed =

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -1 | 0 | 1 |

a.

3 samples = n

$$Cov = \frac{1}{n-1} \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}_{2\times 3} \cdot \begin{bmatrix} -1 & -1 \\ 0 & 0 \\ 1 & 1 \end{bmatrix}_{3\times 2}$$

$$= \frac{1}{2} \begin{bmatrix} (-1)(-1)+(1)(1) & (-1)(-1)+(1)(1) \\ (-1)(-1)+(1)(1) & (-1)(-1)+(1)(1) \end{bmatrix}$$

$$= \frac{1}{2} \begin{bmatrix} 2 & 2 \\ 2 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$