

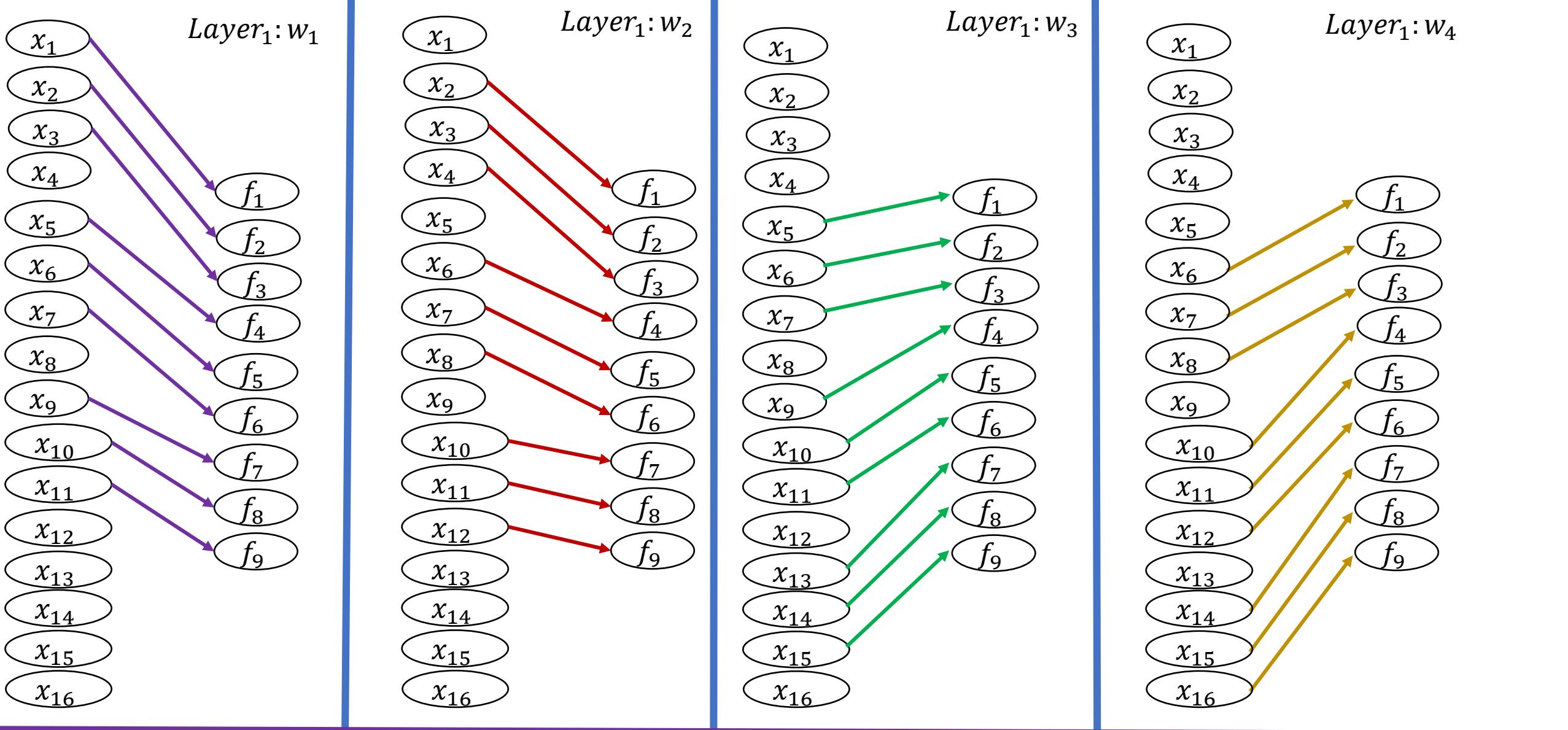
Shared Weights

Layer₁: w_1, w_2, w_3, w_4

Layer₂: w_5, w_6, w_7, w_8

Weights

Layer₃: $w_9, w_{10}, w_{11}, w_{12}, w_{13}, w_{14}, w_{15}, w_{16}$



$$f_1 = w_1 * x_1 + w_2 * x_2 + w_3 * x_5 + w_4 * x_6$$

$$f_2 = w_1 * x_2 + w_2 * x_3 + w_3 * x_6 + w_4 * x_7$$

$$f_3 = w_1 * x_3 + w_2 * x_4 + w_3 * x_7 + w_4 * x_8$$

$$f_4 = w_1 * x_5 + w_2 * x_6 + w_3 * x_9 + w_4 * x_{10}$$

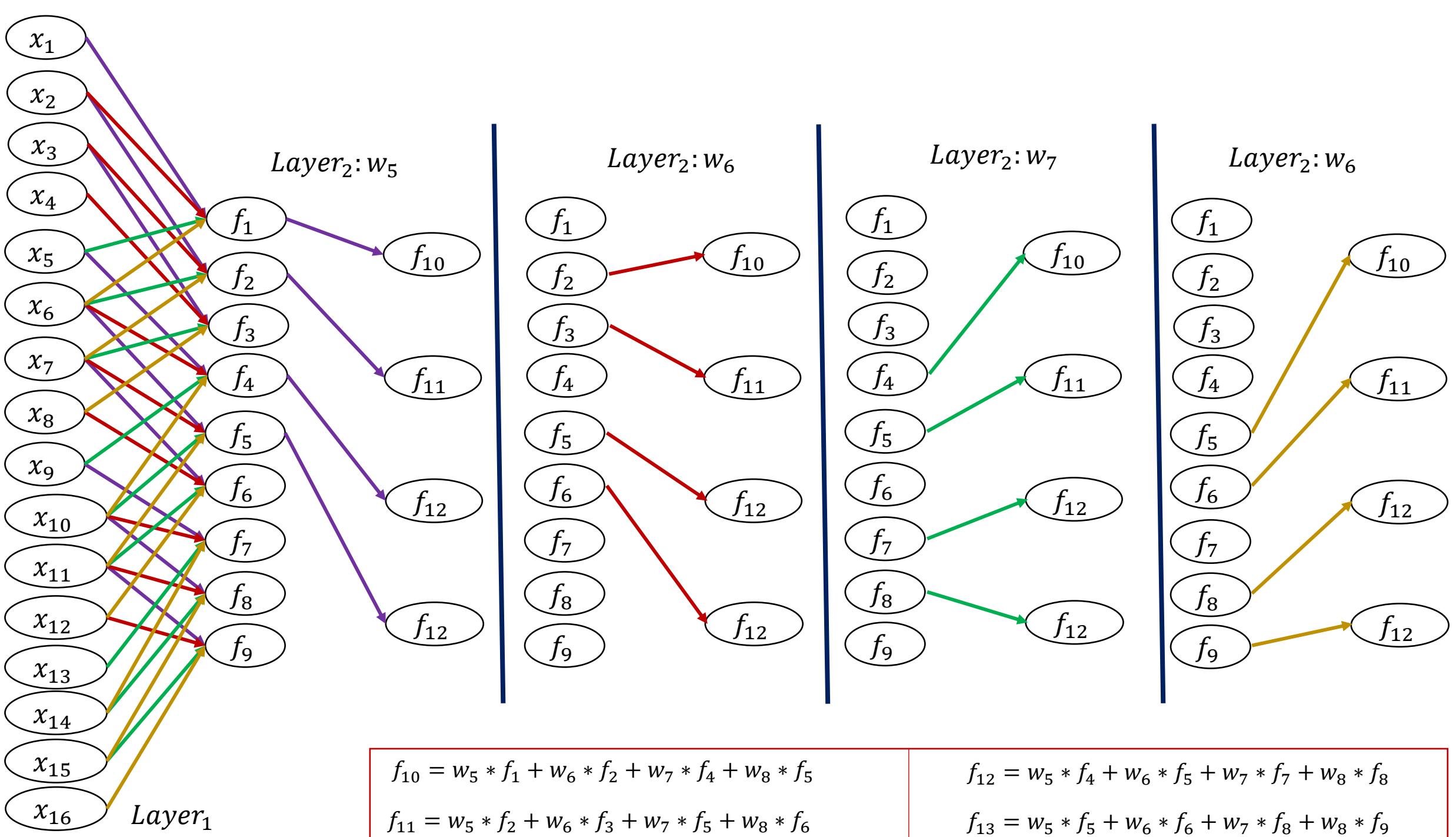
$$f_5 = w_1 * x_6 + w_2 * x_7 + w_3 * x_{10} + w_4 * x_{11}$$

$$f_6 = w_1 * x_7 + w_2 * x_8 + w_3 * x_{11} + w_4 * x_{12}$$

$$f_7 = w_1 * x_9 + w_2 * x_{10} + w_3 * x_{13} + w_4 * x_{14}$$

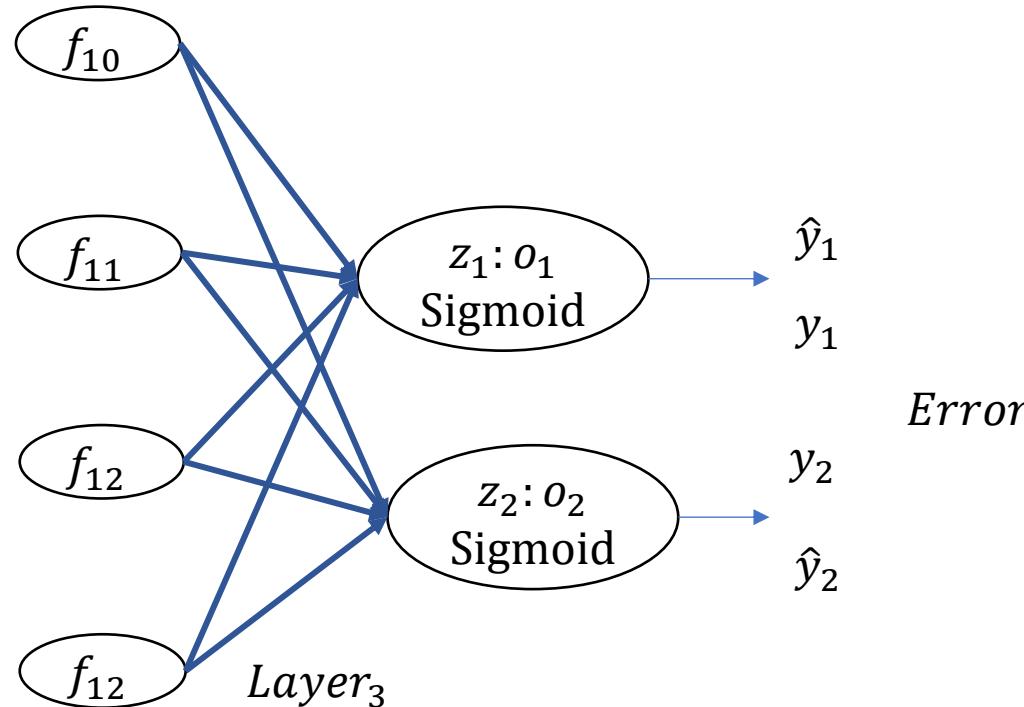
$$f_8 = w_1 * x_{10} + w_2 * x_{11} + w_3 * x_{14} + w_4 * x_{15}$$

$$f_9 = w_1 * x_{11} + w_2 * x_{12} + w_3 * x_{15} + w_4 * x_{16}$$



Weights

*Layer*₃: $w_9, w_{10}, w_{11}, w_{12}, w_{13}, w_{14}, w_{15}, w_{16}$



$$z_1 = w_9 * f_{10} + w_{10} * f_{11} + w_{11} * f_{12} + w_{12} * f_{13}$$

$$z_2 = w_{13} * f_{10} + w_{14} * f_{11} + w_{15} * f_{12} + w_{16} * f_{13}$$

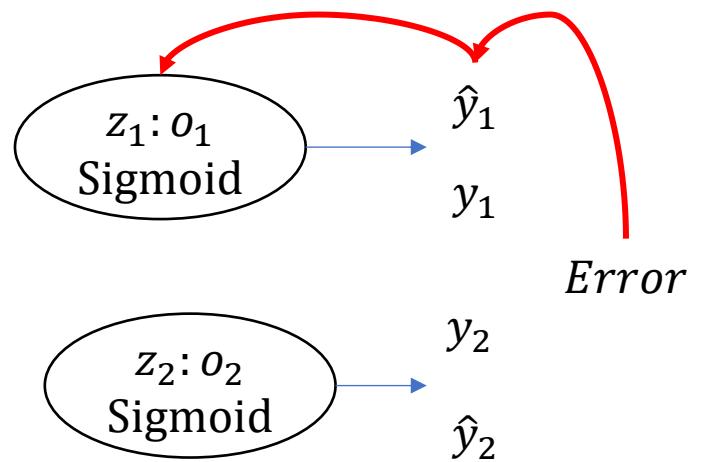
$$o_1 = \frac{1}{(1 + e^{-z_1})} = \hat{y}_1 =$$

$$o_2 = \frac{1}{(1 + e^{-z_2})} = \hat{y}_2 =$$

$$\text{Error}_1 = -y_1 \log(\hat{y}_1) - (1 - y_1) \log(1 - \hat{y}_1)$$

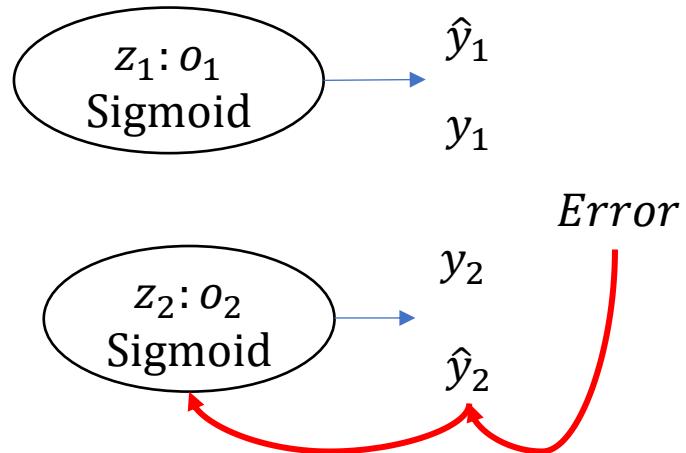
$$\text{Error}_2 = -y_2 \log(\hat{y}_2) - (1 - y_2) \log(1 - \hat{y}_2)$$

$$\text{Error} = \text{Error}_1 + \text{Error}_2$$



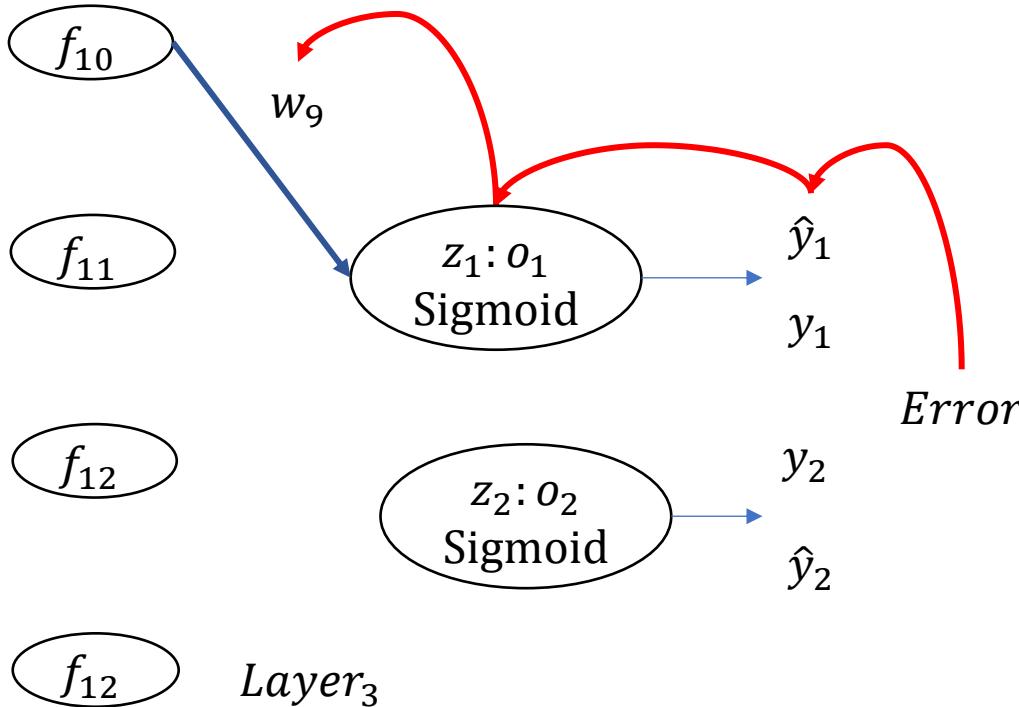
$$\frac{\partial \text{Error}}{\partial o_1} = \frac{\partial \text{Error}_{o1}}{\partial o_1} + \frac{\partial \text{Error}_{o2}}{\partial o_1}$$

$$\frac{\partial \text{Error}_{o1}}{\partial o_1} = -\left(\frac{y_1}{\hat{y}_1}\right) - \frac{(1 - y_1)}{(1 - \hat{y}_1)}$$



$$\frac{\partial \text{Error}}{\partial o_2} = \frac{\partial \text{Error}_{o1}}{\partial o_2} + \frac{\partial \text{Error}_{o2}}{\partial o_2}$$

$$\frac{\partial \text{Error}_{o1}}{\partial o_2} = -\left(\frac{y_2}{\hat{y}_2}\right) - \frac{(1 - y_2)}{(1 - \hat{y}_2)}$$



$$\frac{\partial o_1}{\partial z_1} = \frac{\partial(\frac{1}{1 + e^{-z_1}})}{\partial z_1} = o_1(1 - o_1)$$

$$\frac{\partial z_1}{\partial w_9} = \frac{\partial(w_9 * f_{10} + w_{10} * f_{11} + w_{11} * f_{12} + w_{12} * f_{13})}{\partial w_9}$$

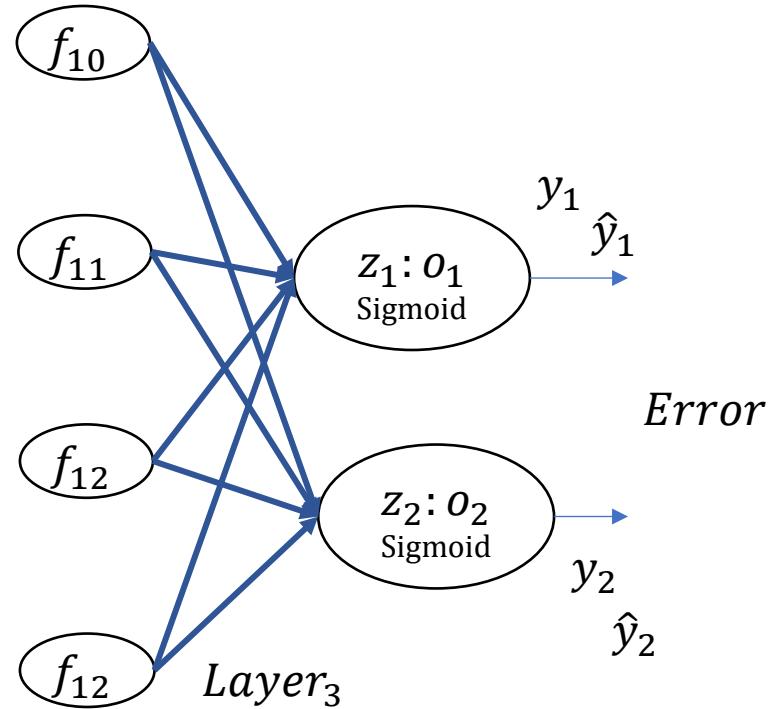
$$\frac{\partial Error_{o1}}{\partial w_9} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_9}$$

$$\frac{\partial Error}{\partial w_9} = \frac{\partial Error_{o1}}{\partial w_9} + \frac{\partial Error_{o2}}{\partial w_9}$$

$$\frac{\partial Error_{o1}}{\partial w_9} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_9}$$

Weights

Layer₃: $w_9, w_{10}, w_{11}, w_{12}, w_{13}, w_{14}, w_{15}, w_{16}$



$$\frac{\partial Error_{o1}}{\partial w_9} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_9}$$

$$\frac{\partial Error_{o1}}{\partial w_{10}} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_{10}}$$

$$\frac{\partial Error_{o1}}{\partial w_{11}} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_{11}}$$

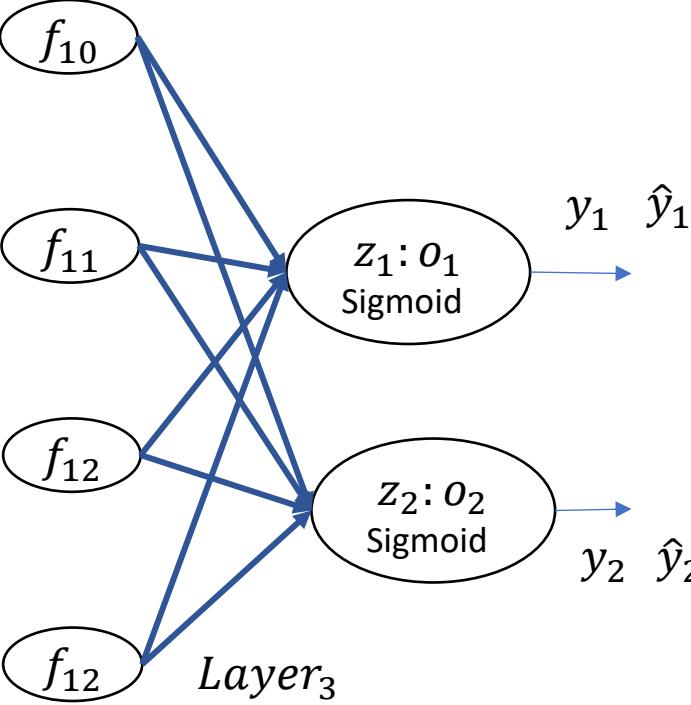
$$\frac{\partial Error_{o1}}{\partial w_{12}} = \frac{\partial Error_{o1}}{\partial o_1} \times \frac{\partial o_1}{\partial z_1} \times \frac{\partial z_1}{\partial w_{12}}$$

$$\frac{\partial Error_{o2}}{\partial w_{13}} = \frac{\partial Error_{o2}}{\partial o_2} \times \frac{\partial o_2}{\partial z_2} \times \frac{\partial z_2}{\partial w_{13}}$$

$$\frac{\partial Error_{o2}}{\partial w_{14}} = \frac{\partial Error_{o2}}{\partial o_2} \times \frac{\partial o_2}{\partial z_2} \times \frac{\partial z_2}{\partial w_{14}}$$

$$\frac{\partial Error_{o2}}{\partial w_{15}} = \frac{\partial Error_{o2}}{\partial o_2} \times \frac{\partial o_2}{\partial z_2} \times \frac{\partial z_2}{\partial w_{15}}$$

$$\frac{\partial Error_{o2}}{\partial w_{16}} = \frac{\partial Error_{o2}}{\partial o_2} \times \frac{\partial o_2}{\partial z_2} \times \frac{\partial z_2}{\partial w_{16}}$$



$$\frac{\partial \text{Error}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial f_{10}} + \frac{\partial \text{Error}_{o2}}{\partial f_{10}}$$

$$\frac{\partial \text{Error}_{o1}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{10}}$$

$$\frac{\partial \text{Error}_{o2}}{\partial f_{10}} = \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{10}}$$

$$\frac{\partial z_1}{\partial f_{10}} = \frac{\partial (w_9 * f_{10} + w_{10} * f_{11} + w_{11} * f_{12} + w_{12} * f_{13})}{\partial f_{10}} = w_9$$

$$\frac{\partial z_2}{\partial f_{10}} = \frac{\partial (w_{13} * f_{10} + w_{14} * f_{11} + w_{15} * f_{12} + w_{16} * f_{13})}{\partial f_{10}} = w_{13}$$

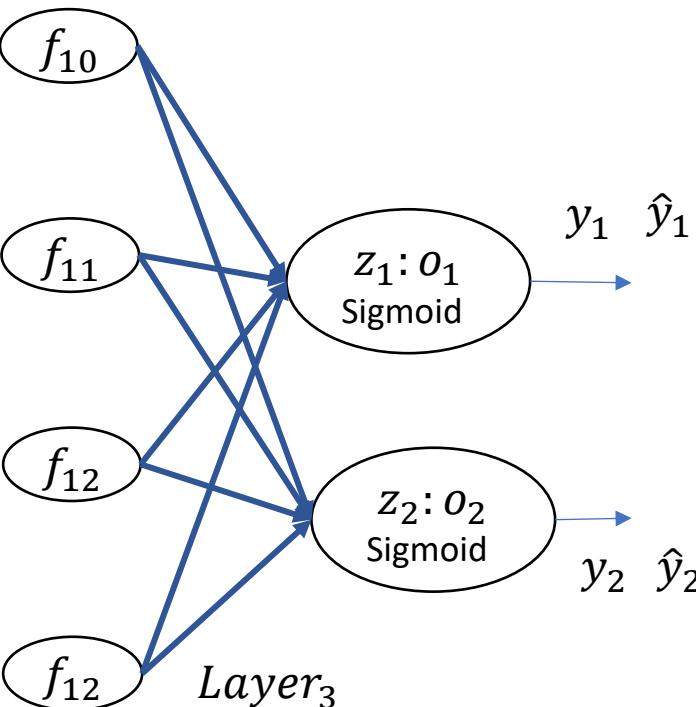
$$\frac{\partial \text{Error}_{o1}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{10}}$$

$$\frac{\partial \text{Error}_{o2}}{\partial f_{10}} = \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{10}}$$

$$\frac{\partial \text{Error}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial f_{10}} + \frac{\partial \text{Error}_{o2}}{\partial f_{10}}$$

$$\frac{\partial \text{Error}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial f_{10}} + \frac{\partial \text{Error}_{o2}}{\partial f_{10}}$$

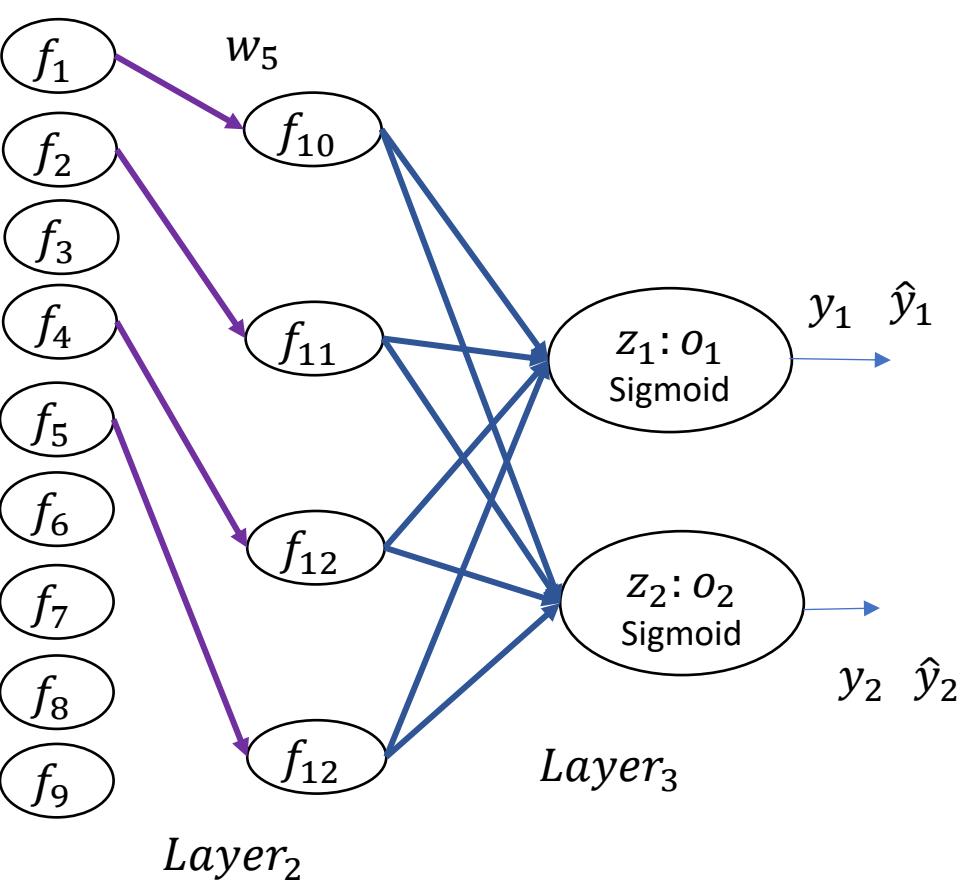
$$\frac{\partial \text{Error}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial f_{10}} + \frac{\partial \text{Error}_{o2}}{\partial f_{10}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{10}} + \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{10}} = 0$$



$$\frac{\partial \text{Error}}{\partial f_{11}} = \frac{\partial \text{Error}_{o1}}{\partial f_{11}} + \frac{\partial \text{Error}_{o2}}{\partial f_{11}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{11}} + \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{11}} = 0$$

$$\frac{\partial \text{Error}}{\partial f_{12}} = \frac{\partial \text{Error}_{o1}}{\partial f_{12}} + \frac{\partial \text{Error}_{o2}}{\partial f_{12}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{12}} + \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{12}} = 0$$

$$\frac{\partial \text{Error}}{\partial f_{13}} = \frac{\partial \text{Error}_{o1}}{\partial f_{13}} + \frac{\partial \text{Error}_{o2}}{\partial f_{13}} = \frac{\partial \text{Error}_{o1}}{\partial o_1} X \frac{\partial o_1}{\partial z_1} X \frac{\partial z_1}{\partial f_{13}} + \frac{\partial \text{Error}_{o2}}{\partial o_2} X \frac{\partial o_2}{\partial z_2} X \frac{\partial z_2}{\partial f_{13}} = 0$$



$$\frac{\partial \text{Error}}{\partial w_5} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_5}$$

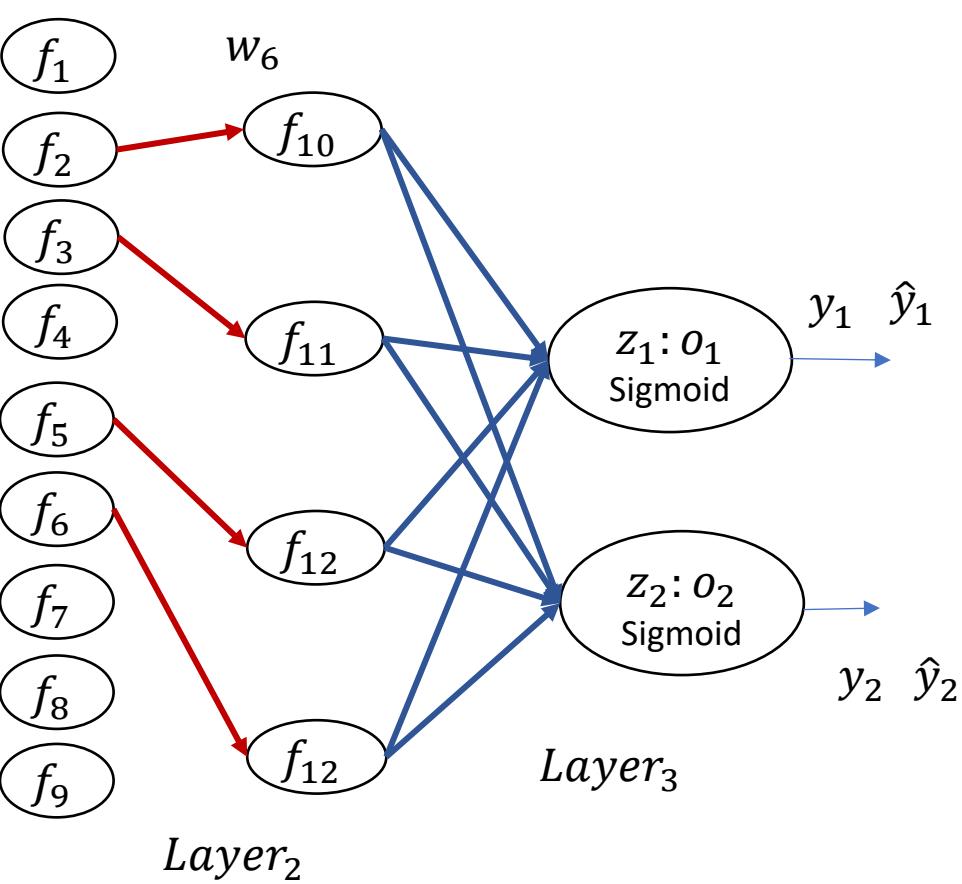
$$\frac{\partial f_{10}}{\partial w_5} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial w_5} = f_1 = 0$$

$$\frac{\partial f_{11}}{\partial w_5} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial w_5} = f_2 = 0$$

$$\frac{\partial f_{12}}{\partial w_5} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial w_5} = f_4 = 0$$

$$\frac{\partial f_{13}}{\partial w_5} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial w_5} = f_5 = 0$$

$$\frac{\partial \text{Error}}{\partial w_5} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_5} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_5}$$



$$\frac{\partial \text{Error}}{\partial w_6} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_6}$$

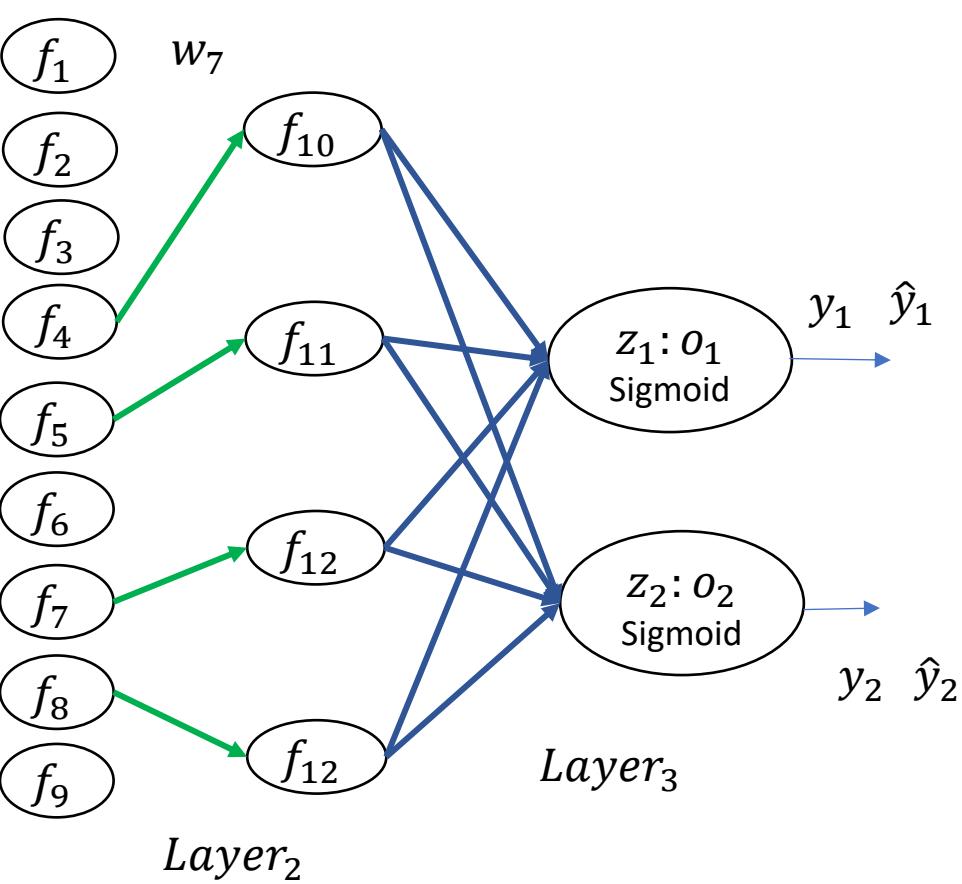
$$\frac{\partial f_{10}}{\partial w_6} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial w_6} = f_2 = 0$$

$$\frac{\partial f_{11}}{\partial w_6} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial w_6} = f_3 = 0$$

$$\frac{\partial f_{12}}{\partial w_6} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial w_6} = f_5 = 0$$

$$\frac{\partial f_{13}}{\partial w_6} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial w_6} = f_6 = 0$$

$$\frac{\partial \text{Error}}{\partial w_6} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_6} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_6}$$



$$\frac{\partial \text{Error}}{\partial w_7} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_7}$$

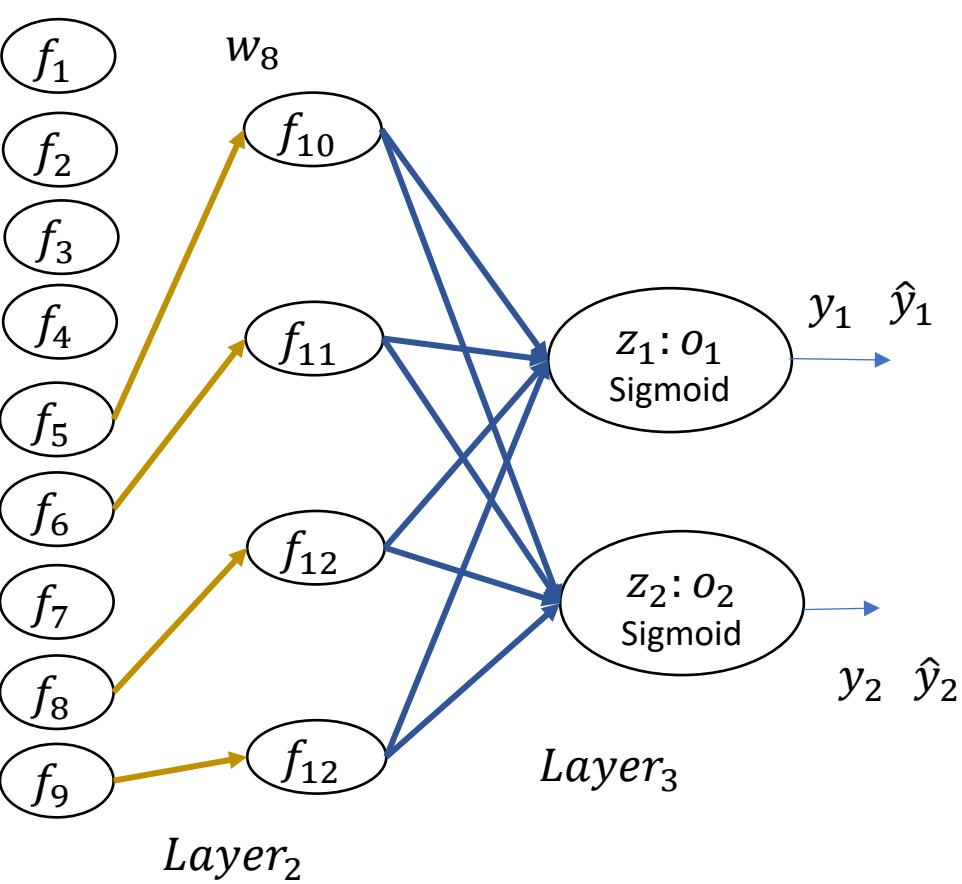
$$\frac{\partial f_{10}}{\partial w_7} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial w_7} = f_4 = 0$$

$$\frac{\partial f_{11}}{\partial w_7} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial w_7} = f_5 = 0$$

$$\frac{\partial f_{12}}{\partial w_7} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial w_7} = f_6 = 0$$

$$\frac{\partial f_{13}}{\partial w_7} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial w_7} = f_8 = 0$$

$$\frac{\partial \text{Error}}{\partial w_7} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_7} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_7}$$



$$\frac{\partial \text{Error}}{\partial w_8} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_8}$$

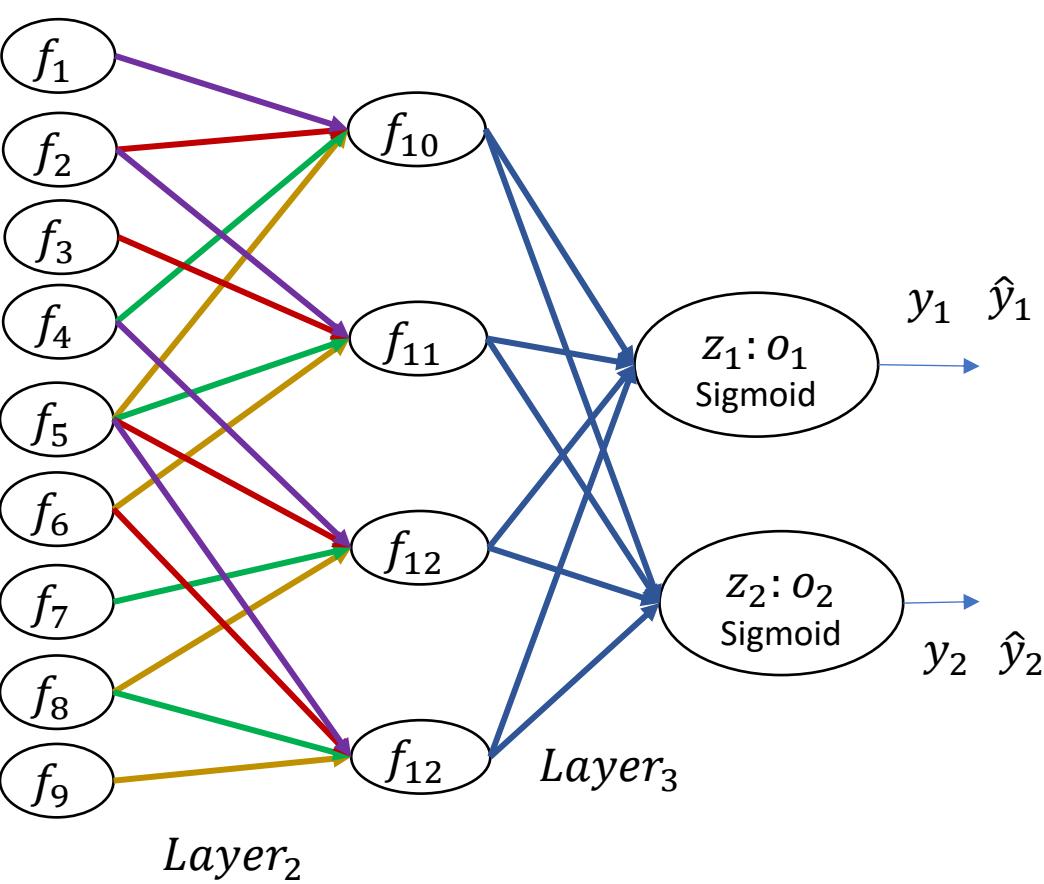
$$\frac{\partial f_{10}}{\partial w_8} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial w_8} = f_5 = 0$$

$$\frac{\partial f_{11}}{\partial w_8} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial w_8} = f_6 = 0$$

$$\frac{\partial f_{12}}{\partial w_8} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial w_8} = f_8 = 0$$

$$\frac{\partial f_{13}}{\partial w_8} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial w_8} = f_9 = 0$$

$$\frac{\partial \text{Error}}{\partial w_8} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial w_8} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial w_8}$$



$$\frac{\partial \text{Error}}{\partial f_1} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_1}$$

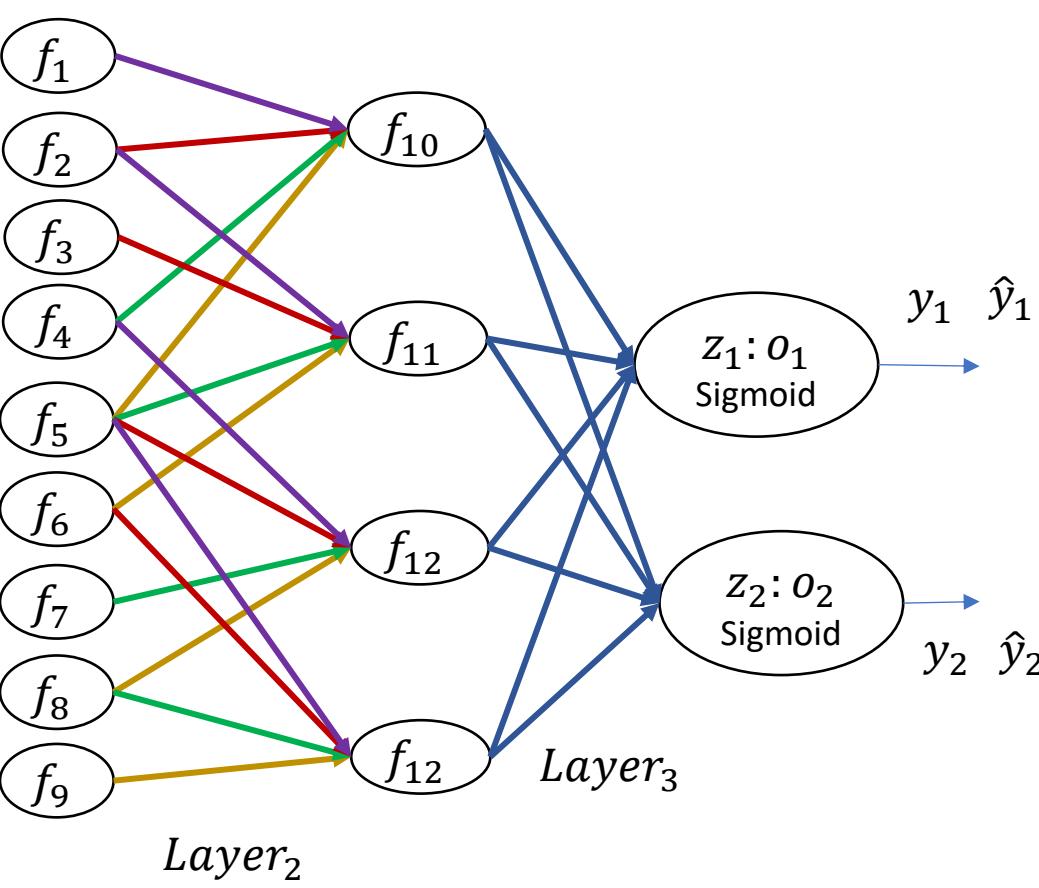
$$\frac{\partial f_{10}}{\partial f_1} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial f_1} = w_5 = 0$$

$$\frac{\partial f_{11}}{\partial f_1} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial f_1} = 0 = 0$$

$$\frac{\partial f_{12}}{\partial f_1} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial f_1} = 0 = 0$$

$$\frac{\partial f_{13}}{\partial f_1} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial f_1} = 0 = 0$$

$$\frac{\partial \text{Error}}{\partial f_1} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_1}$$



$$\frac{\partial \text{Error}}{\partial f_2} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_2}$$

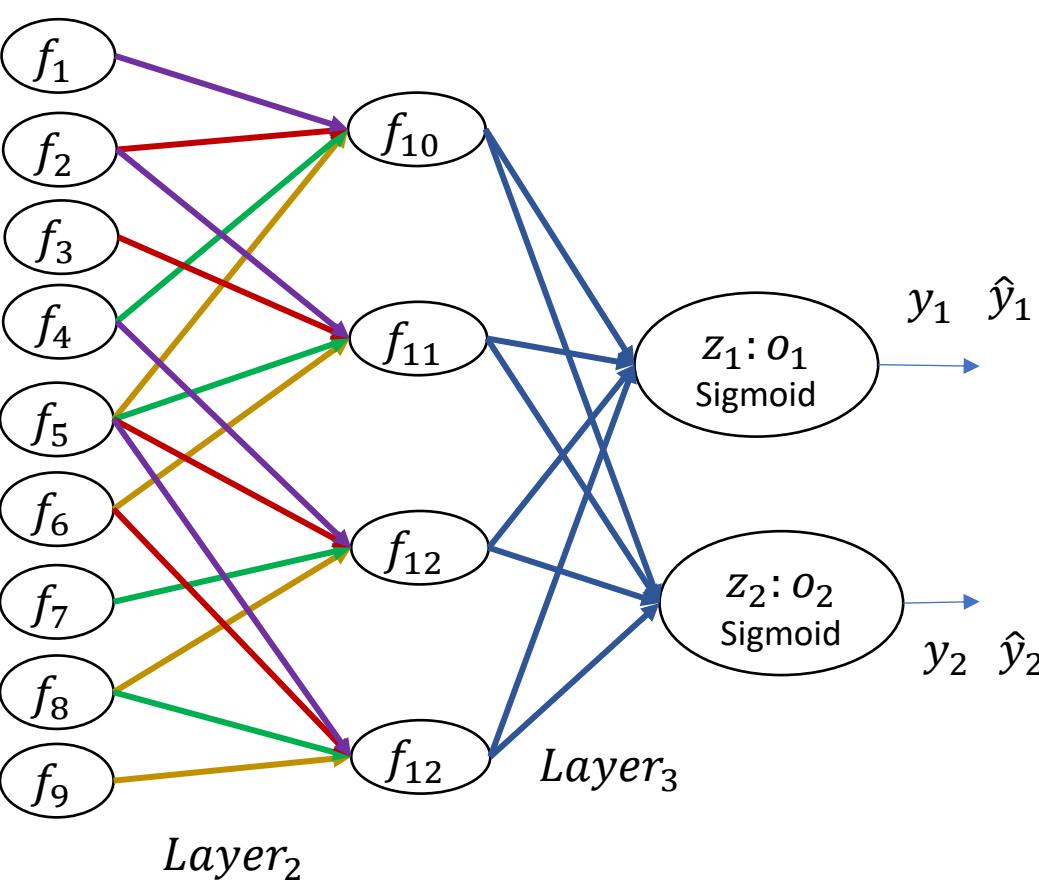
$$\frac{\partial f_{10}}{\partial f_2} = \frac{\partial(w_5 * f_1 + w_6 * f_2 + w_7 * f_4 + w_8 * f_5)}{\partial f_2} = w_6 = 0$$

$$\frac{\partial f_{11}}{\partial f_2} = \frac{\partial(w_5 * f_2 + w_6 * f_3 + w_7 * f_5 + w_8 * f_6)}{\partial f_2} = w_5 = 0$$

$$\frac{\partial f_{12}}{\partial f_2} = \frac{\partial(w_5 * f_4 + w_6 * f_5 + w_7 * f_7 + w_8 * f_8)}{\partial f_2} = 0 = 0$$

$$\frac{\partial f_{13}}{\partial f_2} = \frac{\partial(w_5 * f_5 + w_6 * f_6 + w_7 * f_8 + w_8 * f_9)}{\partial f_2} = 0 = 0$$

$$\frac{\partial \text{Error}}{\partial f_2} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_2}$$



$$\frac{\partial \text{Error}}{\partial f_1} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_1} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_1}$$

$$\frac{\partial \text{Error}}{\partial f_2} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_2} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_2}$$

$$\frac{\partial \text{Error}}{\partial f_3} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_3} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_3} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_3} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_3}$$

$$\frac{\partial \text{Error}}{\partial f_4} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_4} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_4} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_4} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_4}$$

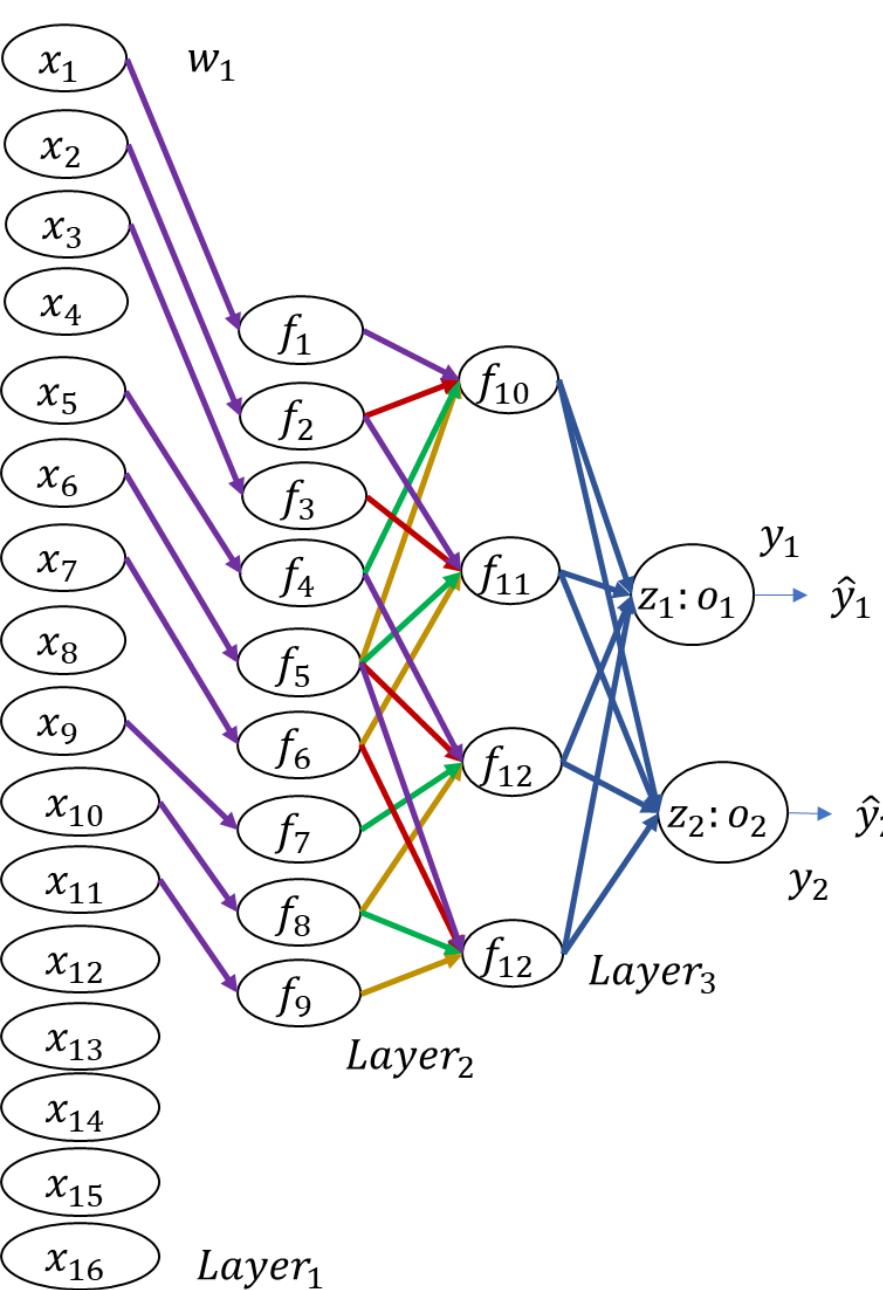
$$\frac{\partial \text{Error}}{\partial f_5} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_5} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_5} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_5} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_5}$$

$$\frac{\partial \text{Error}}{\partial f_6} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_6} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_6} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_6} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_6}$$

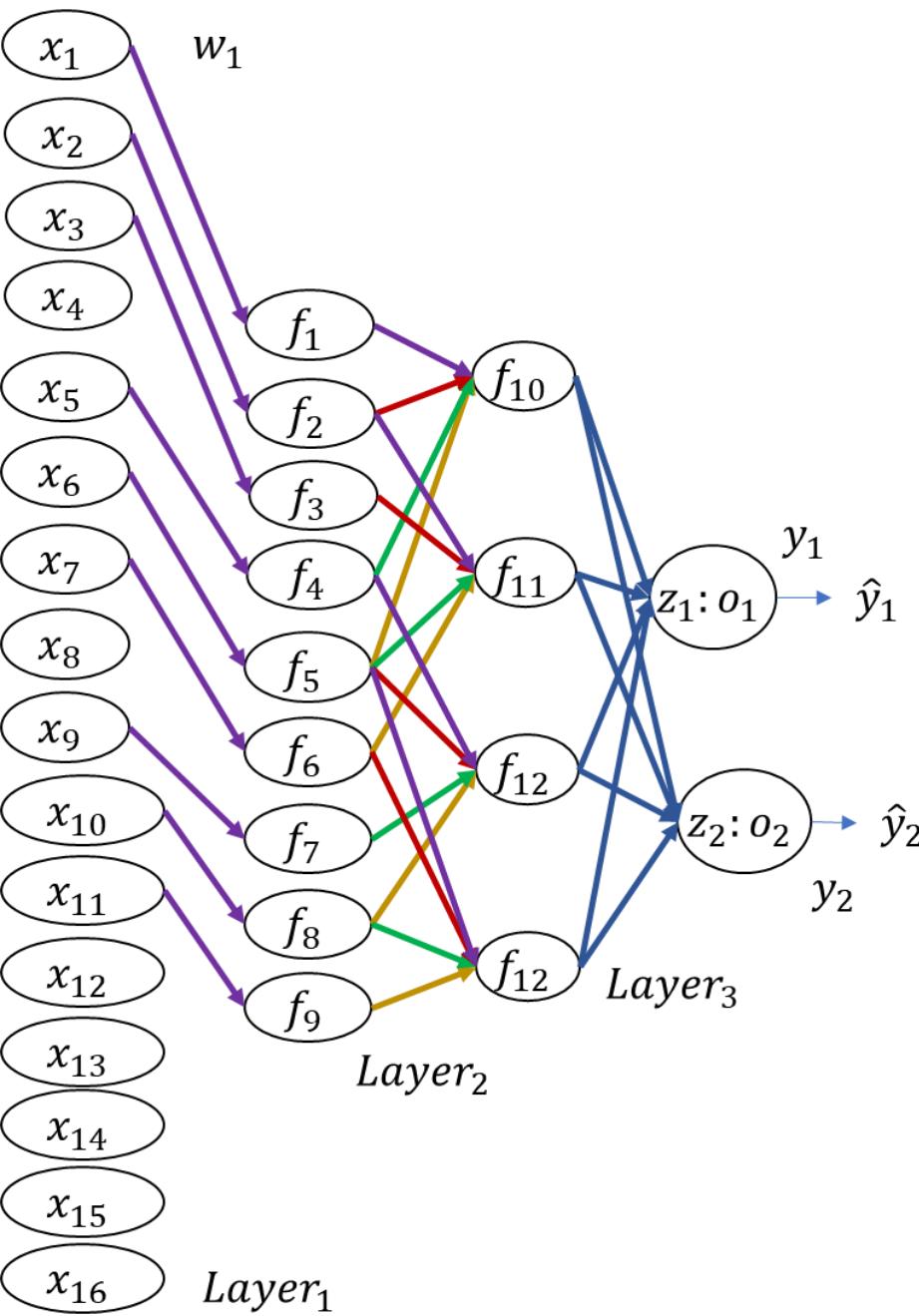
$$\frac{\partial \text{Error}}{\partial f_7} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_7} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_7} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_7} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_7}$$

$$\frac{\partial \text{Error}}{\partial f_8} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_8} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_8} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_8} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_8}$$

$$\frac{\partial \text{Error}}{\partial f_9} = \frac{\partial \text{Error}}{\partial f_{10}} X \frac{\partial f_{10}}{\partial f_9} + \frac{\partial \text{Error}}{\partial f_{11}} X \frac{\partial f_{11}}{\partial f_9} + \frac{\partial \text{Error}}{\partial f_{12}} X \frac{\partial f_{12}}{\partial f_9} + \frac{\partial \text{Error}}{\partial f_{13}} X \frac{\partial f_{13}}{\partial f_9}$$



$$\frac{\partial \text{Error}}{\partial w_1} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_1} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_1} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_1}$$



$$\frac{\partial f_1}{\partial w_1} = \frac{\partial(w_1 * x_1 + w_2 * x_2 + w_3 * x_5 + w_4 * x_6)}{\partial w_1} = x_1 = 0$$

$$\frac{\partial f_2}{\partial w_1} = \frac{\partial(w_1 * x_2 + w_2 * x_3 + w_3 * x_6 + w_4 * x_7)}{\partial w_1} = x_2 = 0$$

$$\frac{\partial f_3}{\partial w_1} = \frac{\partial(w_1 * x_3 + w_2 * x_4 + w_3 * x_7 + w_4 * x_8)}{\partial w_1} = x_3 = 0$$

$$\frac{\partial f_4}{\partial w_1} = \frac{\partial(w_1 * x_5 + w_2 * x_6 + w_3 * x_9 + w_4 * x_{10})}{\partial w_1} = x_5 = 0$$

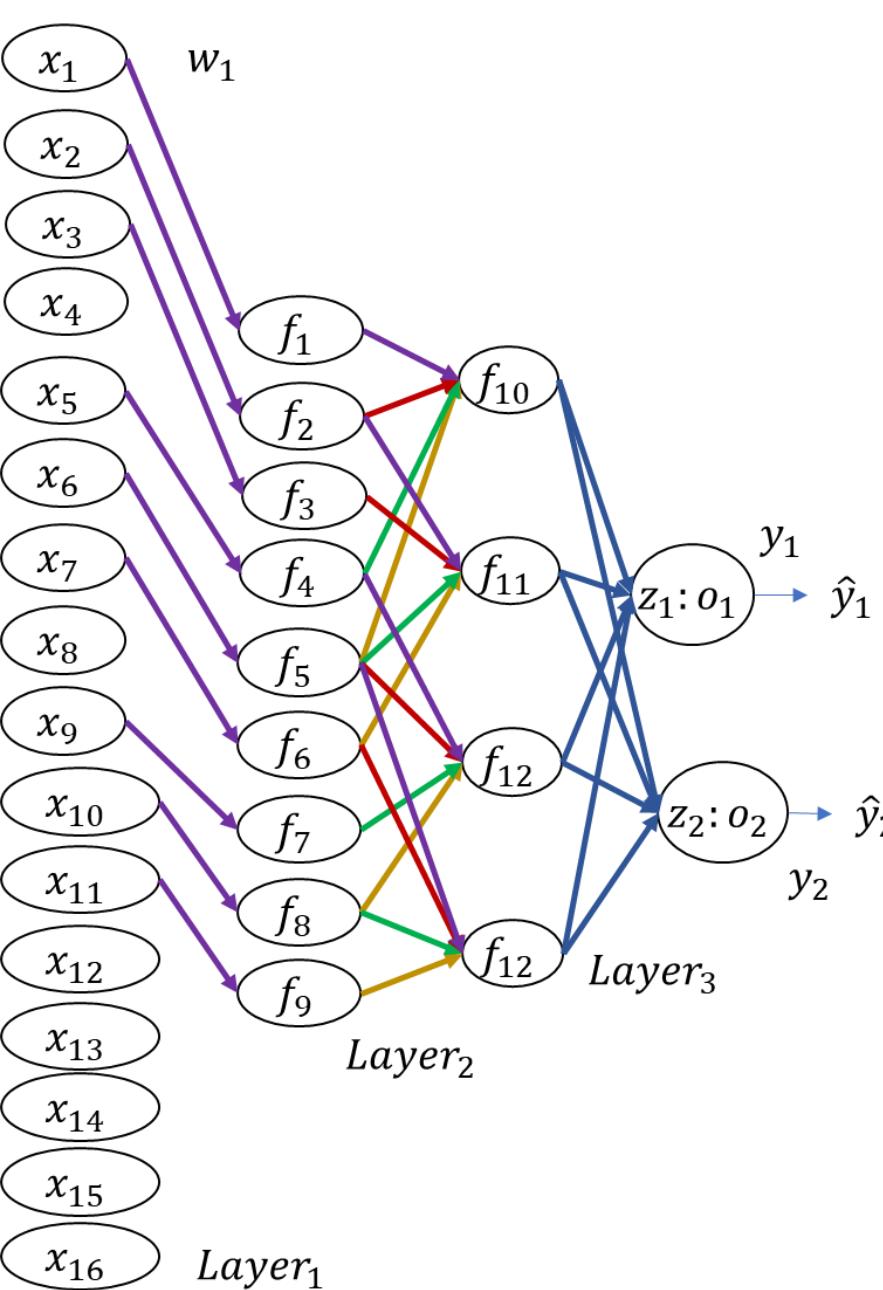
$$\frac{\partial f_5}{\partial w_1} = \frac{\partial(w_1 * x_6 + w_2 * x_7 + w_3 * x_{10} + w_4 * x_{11})}{\partial w_1} = x_6 = 0$$

$$\frac{\partial f_6}{\partial w_1} = \frac{\partial(w_1 * x_7 + w_2 * x_8 + w_3 * x_{11} + w_4 * x_{12})}{\partial w_1} = x_7 = 0$$

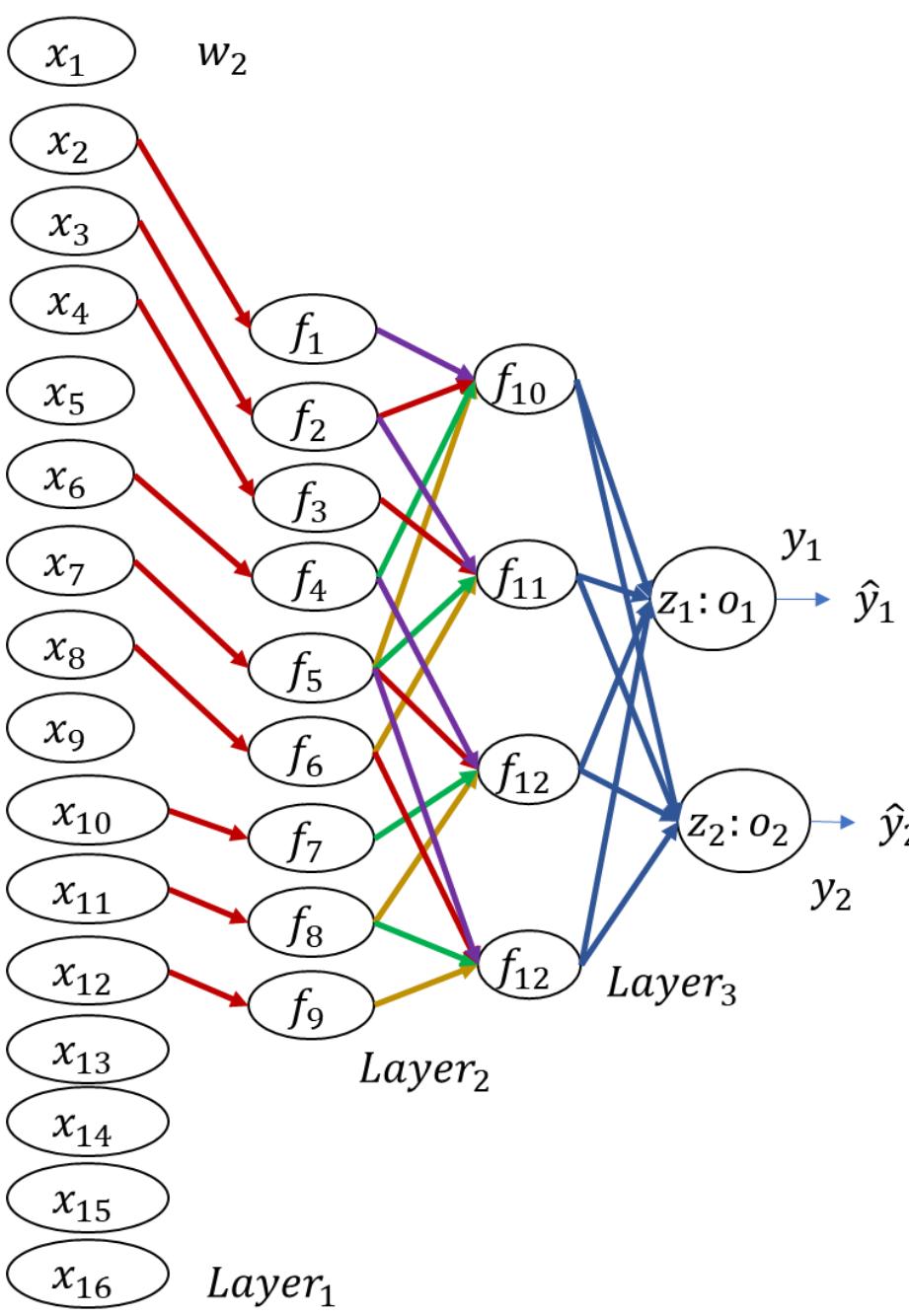
$$\frac{\partial f_7}{\partial w_1} = \frac{\partial(w_1 * x_9 + w_2 * x_{10} + w_3 * x_{13} + w_4 * x_{14})}{\partial w_1} = x_9 = 0$$

$$\frac{\partial f_8}{\partial w_1} = \frac{\partial(w_1 * x_{10} + w_2 * x_{11} + w_3 * x_{14} + w_4 * x_{15})}{\partial w_1} = x_{10} = 0$$

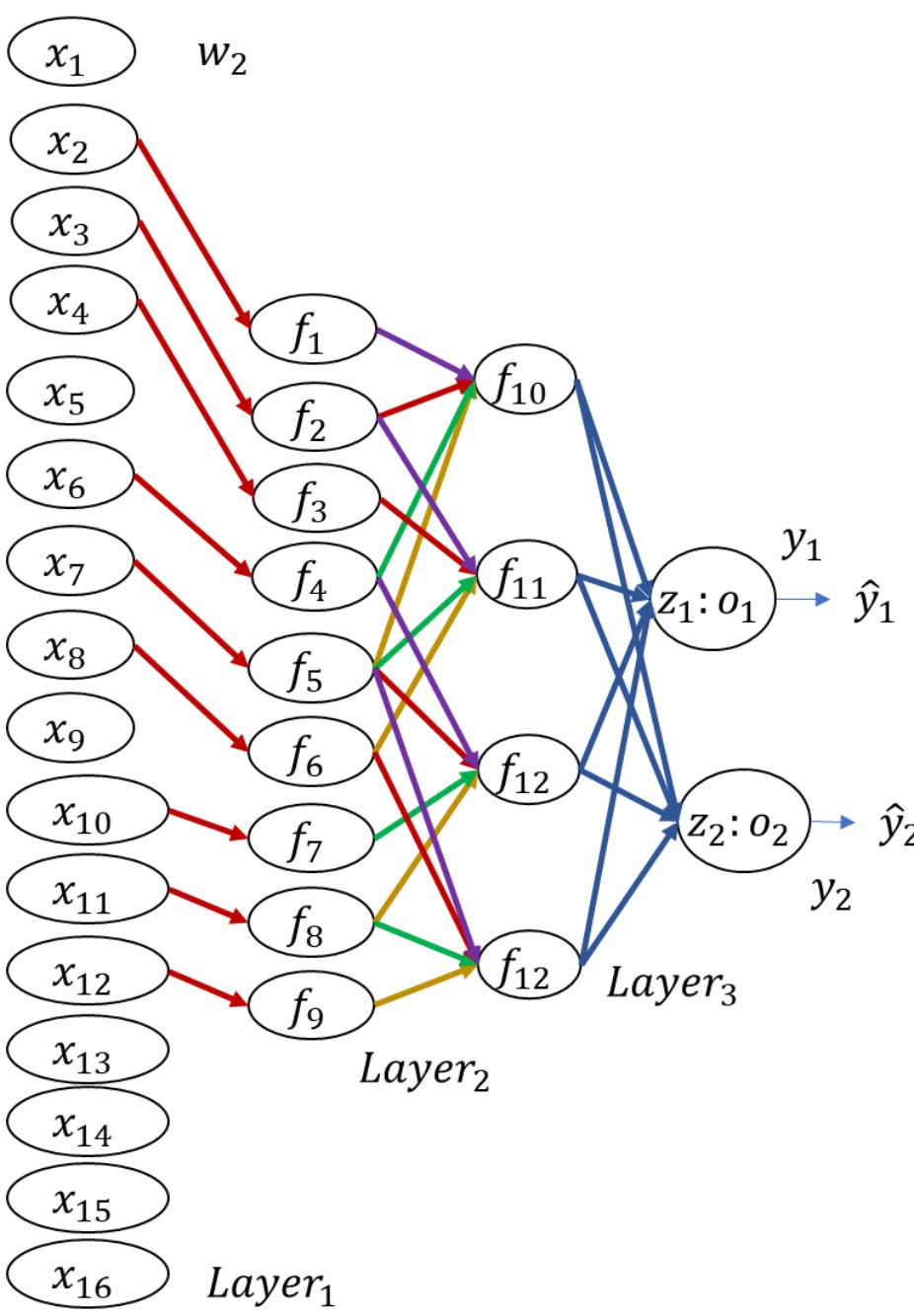
$$\frac{\partial f_9}{\partial w_1} = \frac{\partial(w_1 * x_{11} + w_2 * x_{12} + w_3 * x_{15} + w_4 * x_{16})}{\partial w_1} = x_{11} = 0$$



$$\frac{\partial \text{Error}}{\partial w_1} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_1} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_1} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_1} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_1}$$



$$\frac{\partial \text{Error}}{\partial w_2} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_2} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_2} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_2}$$



$$\frac{\partial f_1}{\partial w_2} = \frac{\partial(w_1 * x_1 + w_2 * x_2 + w_3 * x_5 + w_4 * x_6)}{\partial w_2} = x_2 = 0$$

$$\frac{\partial f_2}{\partial w_2} = \frac{\partial(w_1 * x_2 + w_2 * x_3 + w_3 * x_6 + w_4 * x_7)}{\partial w_2} = x_3 = 0$$

$$\frac{\partial f_3}{\partial w_2} = \frac{\partial(w_1 * x_3 + w_2 * x_4 + w_3 * x_7 + w_4 * x_8)}{\partial w_2} = x_4 = 0$$

$$\frac{\partial f_4}{\partial w_2} = \frac{\partial(w_1 * x_5 + w_2 * x_6 + w_3 * x_9 + w_4 * x_{10})}{\partial w_2} = x_6 = 0$$

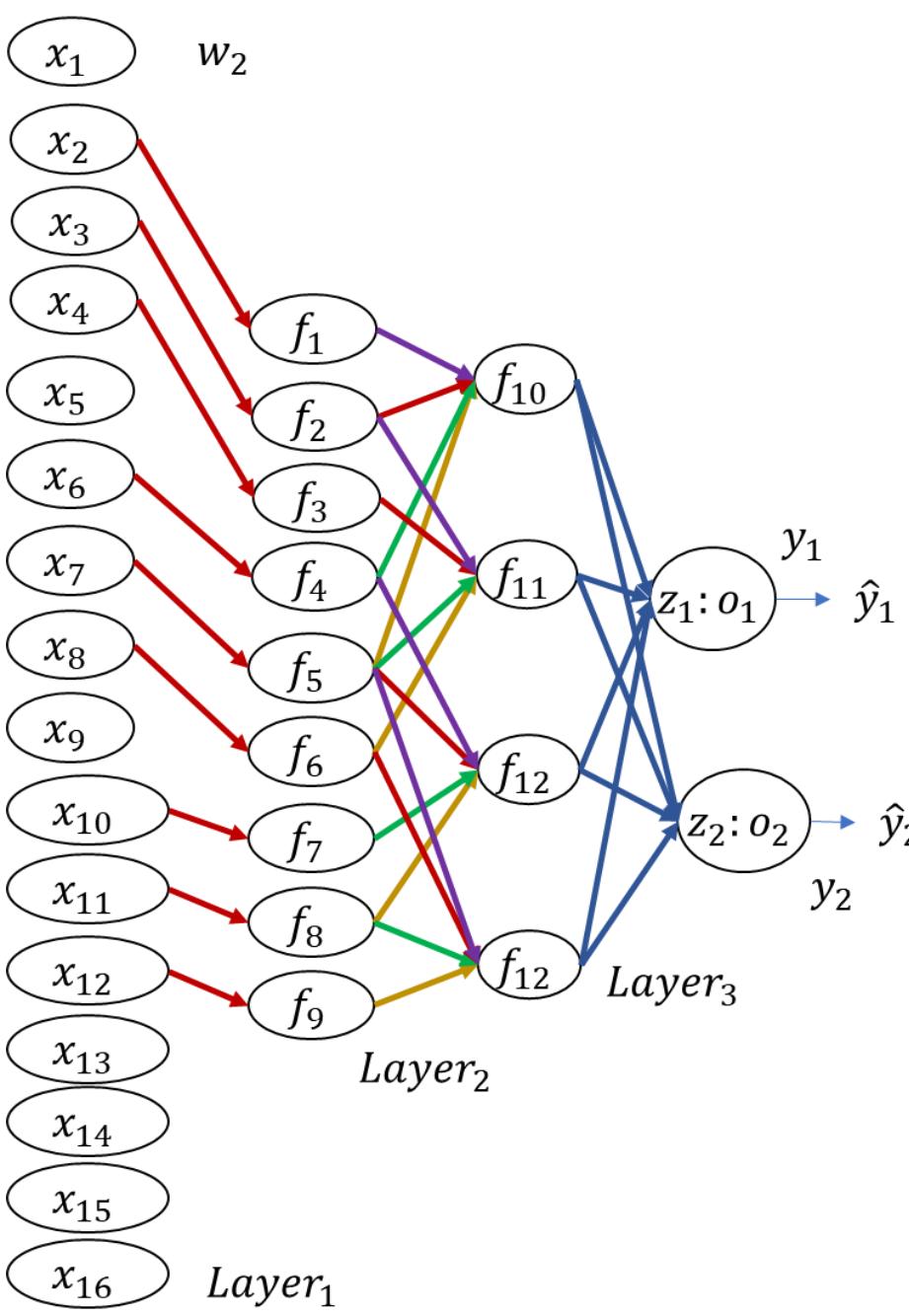
$$\frac{\partial f_5}{\partial w_2} = \frac{\partial(w_1 * x_6 + w_2 * x_7 + w_3 * x_{10} + w_4 * x_{11})}{\partial w_2} = x_7 = 0$$

$$\frac{\partial f_6}{\partial w_2} = \frac{\partial(w_1 * x_7 + w_2 * x_8 + w_3 * x_{11} + w_4 * x_{12})}{\partial w_2} = x_8 = 0$$

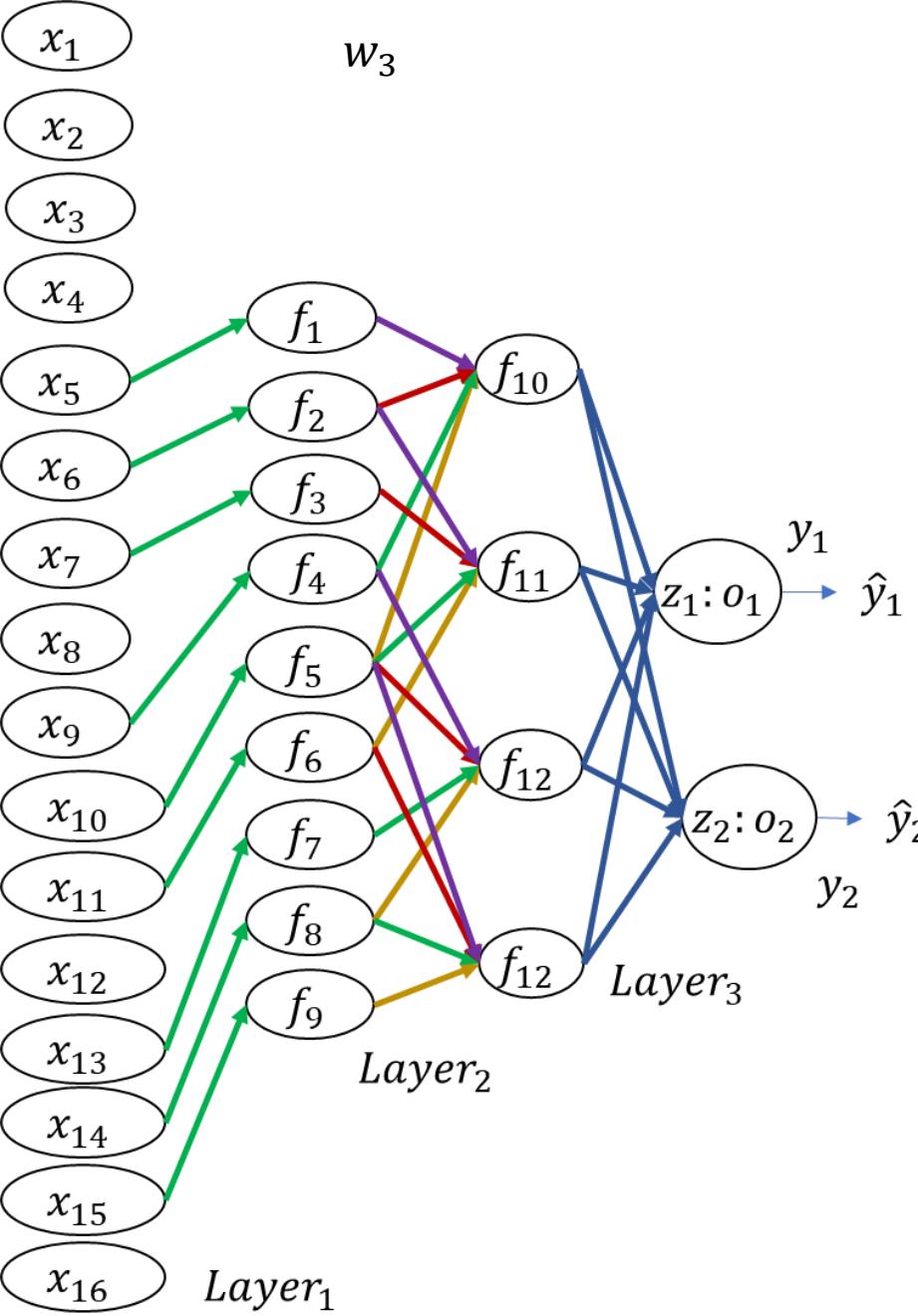
$$\frac{\partial f_7}{\partial w_2} = \frac{\partial(w_1 * x_9 + w_2 * x_{10} + w_3 * x_{13} + w_4 * x_{14})}{\partial w_2} = x_{10} = 0$$

$$\frac{\partial f_8}{\partial w_2} = \frac{\partial(w_1 * x_{10} + w_2 * x_{11} + w_3 * x_{14} + w_4 * x_{15})}{\partial w_2} = x_{11} = 0$$

$$\frac{\partial f_9}{\partial w_2} = \frac{\partial(w_1 * x_{11} + w_2 * x_{12} + w_3 * x_{15} + w_4 * x_{16})}{\partial w_2} = x_{12} = 0$$



$$\frac{\partial \text{Error}}{\partial w_2} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_2} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_2} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_2} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_2}$$



$$\frac{\partial f_1}{\partial w_3} = \frac{\partial(w_1 * x_1 + w_2 * x_2 + w_3 * x_5 + w_4 * x_6)}{\partial w_3} = x_2 = 0$$

$$\frac{\partial f_2}{\partial w_3} = \frac{\partial(w_1 * x_2 + w_2 * x_3 + w_3 * x_6 + w_4 * x_7)}{\partial w_3} = x_3 = 0$$

$$\frac{\partial f_3}{\partial w_3} = \frac{\partial(w_1 * x_3 + w_2 * x_4 + w_3 * x_7 + w_4 * x_8)}{\partial w_3} = x_4 = 0$$

$$\frac{\partial f_4}{\partial w_3} = \frac{\partial(w_1 * x_5 + w_2 * x_6 + w_3 * x_9 + w_4 * x_{10})}{\partial w_3} = x_6 = 0$$

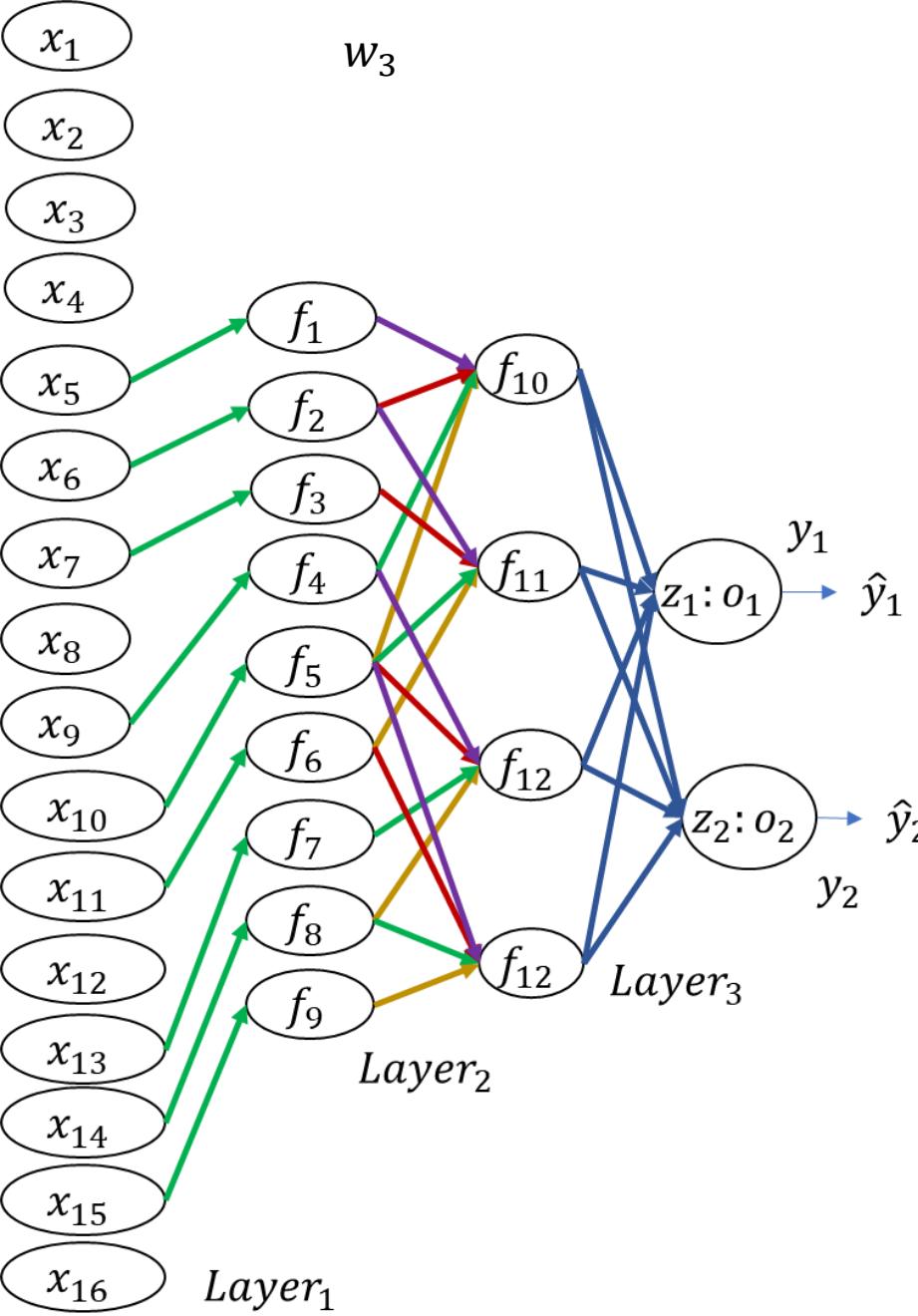
$$\frac{\partial f_5}{\partial w_3} = \frac{\partial(w_1 * x_6 + w_2 * x_7 + w_3 * x_{10} + w_4 * x_{11})}{\partial w_3} = x_7 = 0$$

$$\frac{\partial f_6}{\partial w_3} = \frac{\partial(w_1 * x_7 + w_2 * x_8 + w_3 * x_{11} + w_4 * x_{12})}{\partial w_3} = x_8 = 0$$

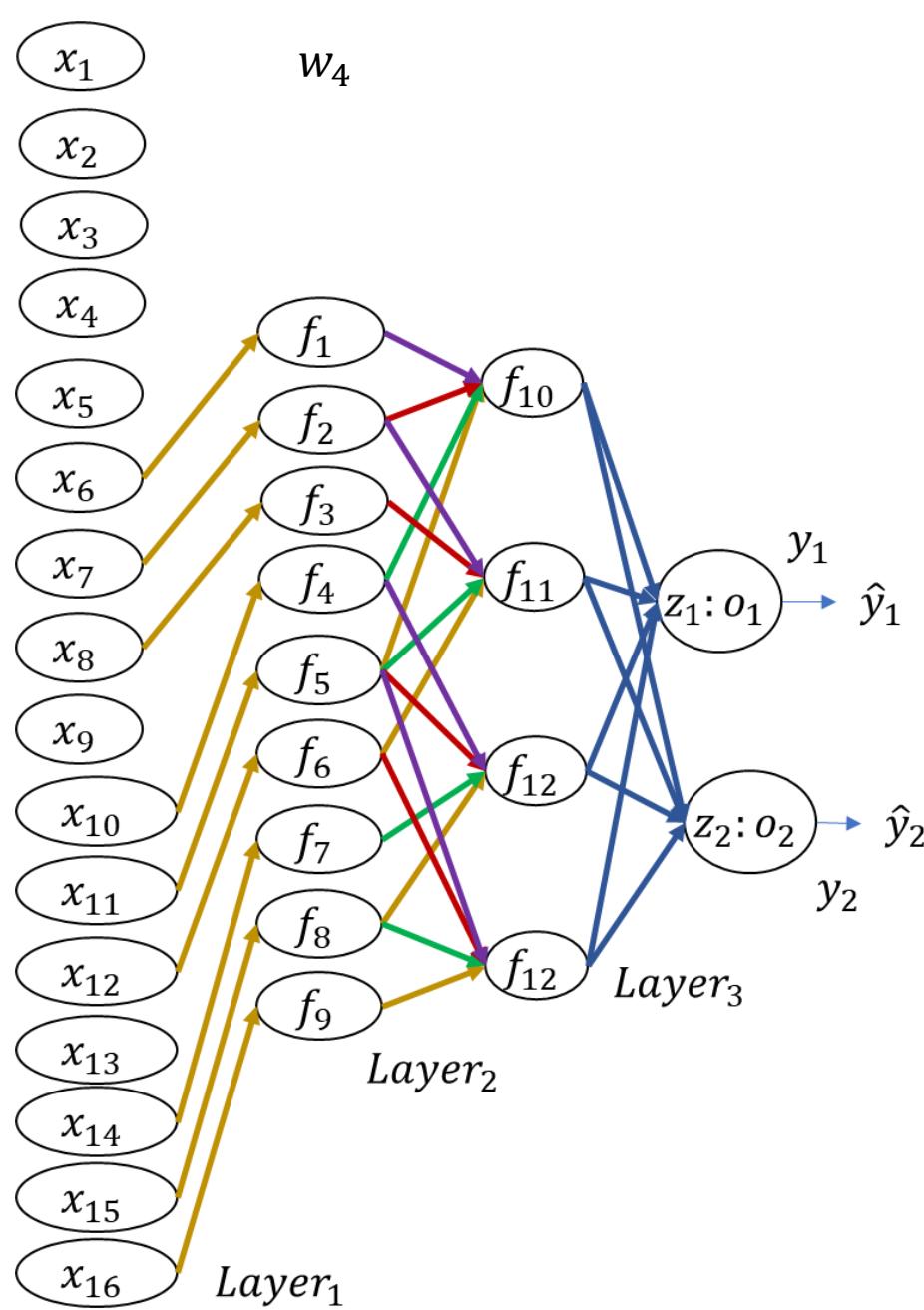
$$\frac{\partial f_7}{\partial w_3} = \frac{\partial(w_1 * x_9 + w_2 * x_{10} + w_3 * x_{13} + w_4 * x_{14})}{\partial w_3} = x_{10} = 0$$

$$\frac{\partial f_8}{\partial w_3} = \frac{\partial(w_1 * x_{10} + w_2 * x_{11} + w_3 * x_{14} + w_4 * x_{15})}{\partial w_3} = x_{11} = 0$$

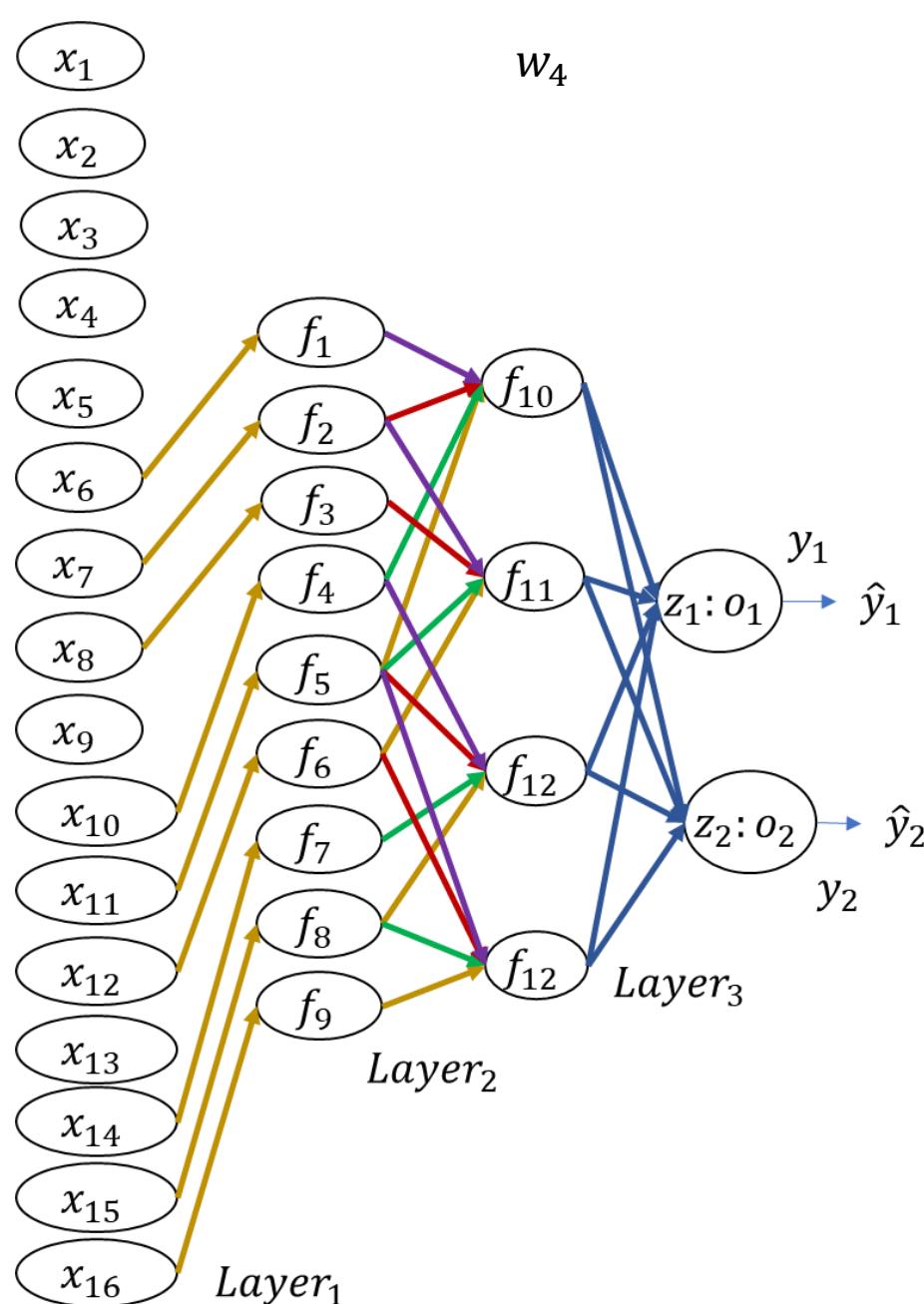
$$\frac{\partial f_9}{\partial w_3} = \frac{\partial(w_1 * x_{11} + w_2 * x_{12} + w_3 * x_{15} + w_4 * x_{16})}{\partial w_3} = x_{12} = 0$$



$$\frac{\partial \text{Error}}{\partial w_3} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_3} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_3} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_3} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_3}$$



$$\frac{\partial \text{Error}}{\partial w_4} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_4} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_4} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_4}$$



$$\frac{\partial f_1}{\partial w_4} = \frac{\partial(w_1 * x_1 + w_2 * x_2 + w_3 * x_5 + w_4 * x_6)}{\partial w_4} = x_2 = 0$$

$$\frac{\partial f_2}{\partial w_4} = \frac{\partial(w_1 * x_2 + w_2 * x_3 + w_3 * x_6 + w_4 * x_7)}{\partial w_4} = x_3 = 0$$

$$\frac{\partial f_3}{\partial w_4} = \frac{\partial(w_1 * x_3 + w_2 * x_4 + w_3 * x_7 + w_4 * x_8)}{\partial w_4} = x_4 = 0$$

$$\frac{\partial f_4}{\partial w_4} = \frac{\partial(w_1 * x_5 + w_2 * x_6 + w_3 * x_9 + w_4 * x_{10})}{\partial w_4} = x_6 = 0$$

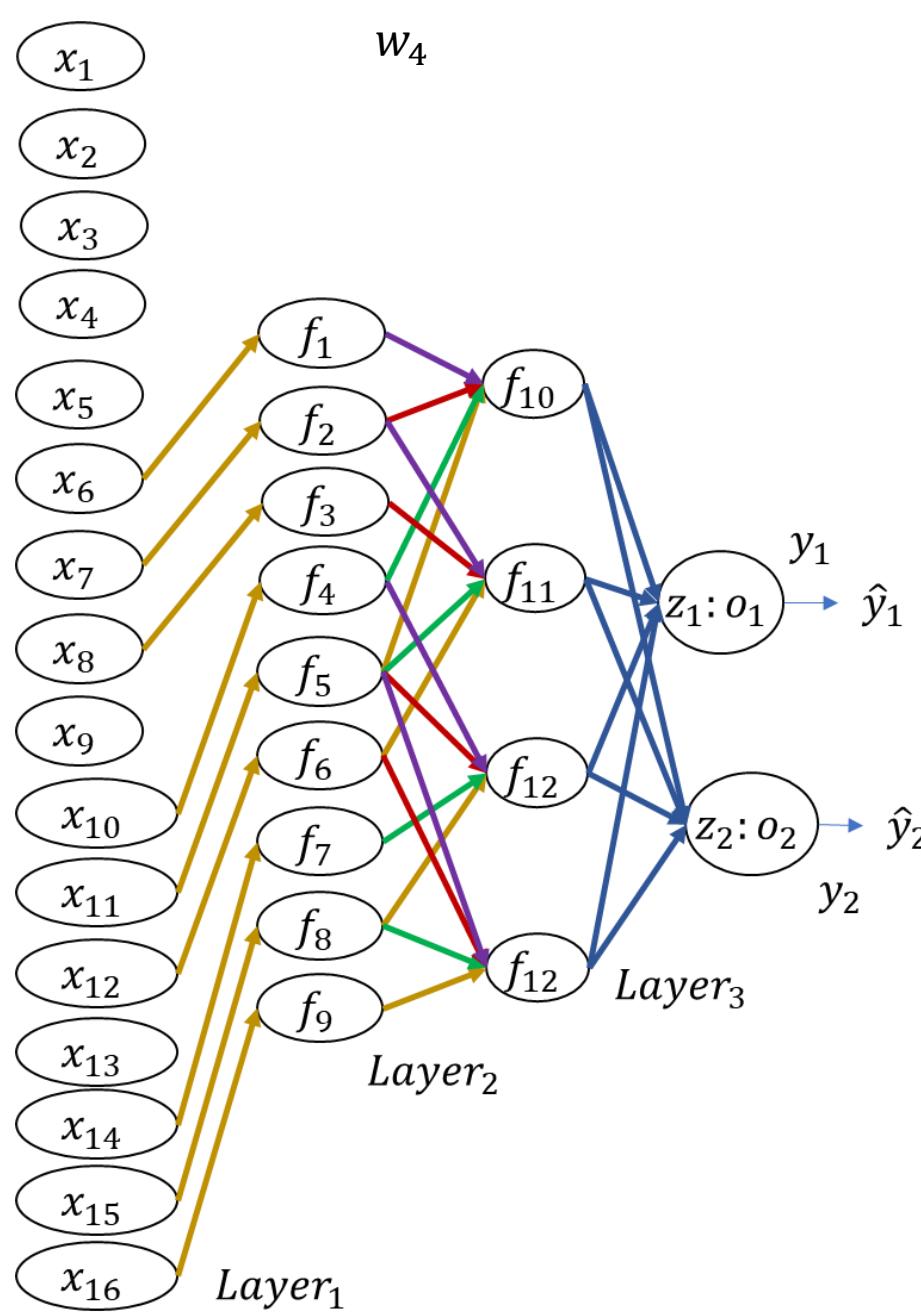
$$\frac{\partial f_5}{\partial w_4} = \frac{\partial(w_1 * x_6 + w_2 * x_7 + w_3 * x_{10} + w_4 * x_{11})}{\partial w_4} = x_7 = 0$$

$$\frac{\partial f_6}{\partial w_4} = \frac{\partial(w_1 * x_7 + w_2 * x_8 + w_3 * x_{11} + w_4 * x_{12})}{\partial w_4} = x_8 = 0$$

$$\frac{\partial f_7}{\partial w_4} = \frac{\partial(w_1 * x_9 + w_2 * x_{10} + w_3 * x_{13} + w_4 * x_{14})}{\partial w_4} = x_{10} = 0$$

$$\frac{\partial f_8}{\partial w_1} = \frac{\partial(w_1 * x_{10} + w_2 * x_{11} + w_3 * x_{14} + w_4 * x_{15})}{\partial w_1} = x_{11} = 0$$

$$\frac{\partial f_9}{\partial w_4} = \frac{\partial(w_1 * x_{11} + w_2 * x_{12} + w_3 * x_{15} + w_4 * x_{16})}{\partial w_4} = x_{12} = 0$$



$$\frac{\partial \text{Error}}{\partial w_4} = \frac{\partial \text{Error}}{\partial f_1} X \frac{\partial f_1}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_2} X \frac{\partial f_2}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_3} X \frac{\partial f_3}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_4} X \frac{\partial f_4}{\partial w_4} X \\ \frac{\partial \text{Error}}{\partial f_5} X \frac{\partial f_5}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_6} X \frac{\partial f_6}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_7} X \frac{\partial f_7}{\partial w_4} + \frac{\partial \text{Error}}{\partial f_8} X \frac{\partial f_8}{\partial w_4} X \frac{\partial \text{Error}}{\partial f_9} X \frac{\partial f_9}{\partial w_4}$$