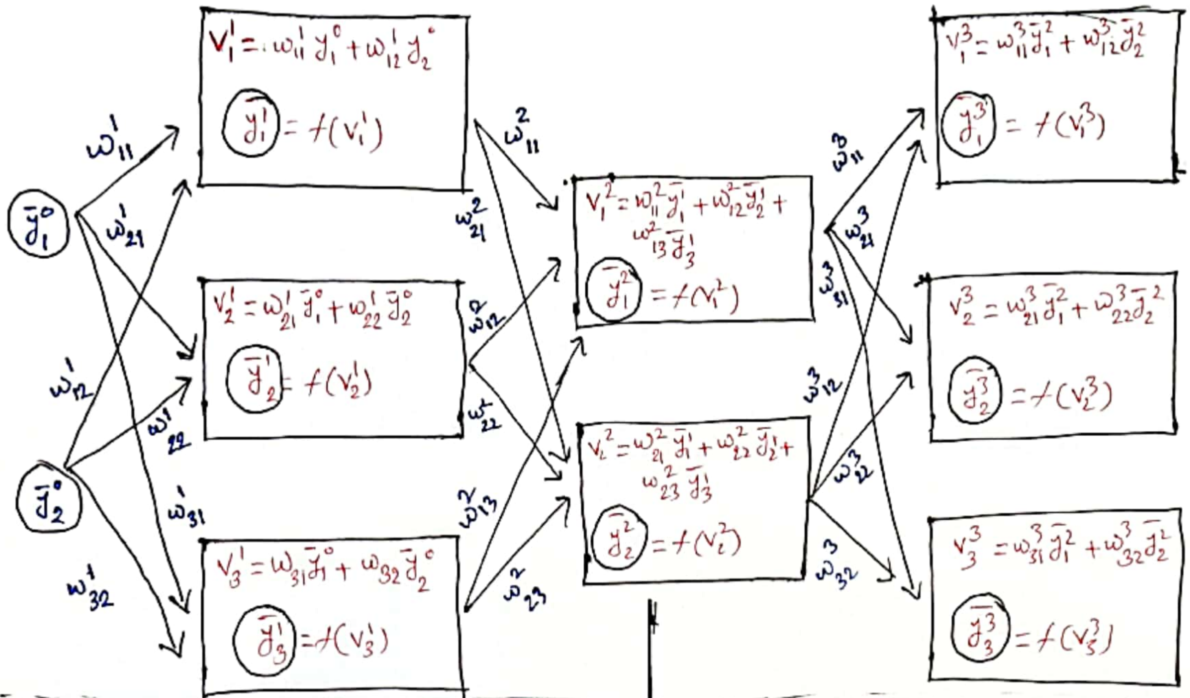

$$\varepsilon(i) = \frac{1}{2}\left[(\bar{y}_1^3 - y_1)^2 + (\bar{y}_2^3 - y_2)^2 + (\bar{y}_3^3 - y_3)^2\right]$$

$$\frac{\partial \varepsilon(i)}{\partial w_1^3} = \begin{pmatrix} \frac{\partial \varepsilon(i)}{\partial w_{11}^3} \\ \frac{\partial \varepsilon(i)}{\partial w_{12}^3} \end{pmatrix} = \begin{pmatrix} \frac{\partial \varepsilon(i)}{\partial v_1^3}\frac{\partial v_1^3}{\partial w_{11}^3} \\ \frac{\partial \varepsilon(i)}{\partial v_1^3}\frac{\partial v_1^3}{\partial w_{12}^3} \end{pmatrix}$$

$$= \begin{pmatrix} \frac{\partial \varepsilon(i)}{\partial v_1^3}\bar{y}_1^2 \\ \frac{\partial \varepsilon(i)}{\partial v_1^3}\bar{y}_2^2 \end{pmatrix} = \frac{\partial \varepsilon(i)}{\partial v_1^3}\begin{pmatrix} \bar{y}_1^2 \\ \bar{y}_2^2 \end{pmatrix}$$

$$\boxed{\frac{\partial \varepsilon(i)}{\partial v_j^r} = \delta_j^r}$$

If $r = L : (r=3)$

$$\frac{\partial \varepsilon(i)}{\partial v_1^3} = (\bar{y}_1^3 - y_1)\,\bar{y}_1^{3\prime} = e_1(i)\, f'(v_1^3)$$

$$dw^3_{new} = dw^3_{old} - \mu \Delta w^3$$

$$= \begin{pmatrix} w_{11}^3 & w_{12}^3 \\ w_{21}^3 & w_{22}^3 \\ w_{31}^3 & w_{32}^3 \end{pmatrix} - \mu \begin{pmatrix} \frac{\partial \varepsilon(i)}{\partial w_1^3} \\ \frac{\partial \varepsilon(i)}{\partial w_2^3} \\ \frac{\partial \varepsilon(i)}{\partial w_3^3} \end{pmatrix}$$

$$= \begin{pmatrix} \leftarrow w_1^3 \rightarrow \\ \leftarrow w_2^3 \rightarrow \\ \leftarrow w_3^3 \rightarrow \end{pmatrix} - \mu \begin{pmatrix} \delta_1^3 \bar{y}_1^2 & \delta_1^3 \bar{y}_2^2 \\ \delta_2^3 \bar{y}_1^2 & \delta_2^3 y_2^2 \\ \delta_3^3 \bar{y}_1^2 & \delta_3^3 \bar{y}_1^2 \end{pmatrix}$$

$$\delta^3 = \begin{pmatrix} \delta_1^3 \\ \delta_2^3 \\ \delta_3^3 \end{pmatrix} \qquad \bar{y}^2 = \begin{pmatrix} \bar{y}_1^2 \\ \bar{y}_2^2 \end{pmatrix}$$

$$\boxed{\therefore \Delta w^3 = \delta^3 \, \bar{y}^{2T}}$$

If $r < L : (r=2)$

$$\frac{\partial \varepsilon(i)}{\partial v_1^2} = \frac{\partial \varepsilon(i)}{\partial v_1^3}\frac{\partial v_1^3}{\partial v_1^2} + \frac{\partial \varepsilon(i)}{\partial v_2^3}\frac{\partial v_2^3}{\partial v_1^2} + \frac{\partial \varepsilon(i)}{\partial v_3^3}\frac{\partial v_3^3}{\partial v_1^2}$$

$$= \delta_1^3 \frac{\partial v_1^3}{\partial v_1^2} + \delta_2^3 \frac{\partial v_2^3}{\partial v_1^2} + \delta_3^3 \frac{\partial v_3^3}{\partial v_1^2}$$

$$= (\delta_1^3 \;\; \delta_2^3 \;\; \delta_3^3)\begin{pmatrix} \frac{\partial v_1^3}{\partial v_1^2} \\ \frac{\partial v_2^3}{\partial v_1^2} \\ \frac{\partial v_3^3}{\partial v_1^2} \end{pmatrix}$$

$$\frac{\partial v_1^3}{\partial v_1^2} = \frac{\partial\left[w_{11}^3 f(v_1^2) + w_{12}^3 f(v_2^2)\right]}{\partial v_1^2} = w_{11}^3 f'(v_1^2)$$

$$\therefore \delta_1^2 = \frac{\partial \varepsilon(i)}{\partial v_1^2} = \delta^{3T} \begin{pmatrix} w_{11}^3 f'(v_1^2) \\ w_{21}^3 f'(v_1^2) \\ w_{31}^3 f'(v_1^2) \end{pmatrix}$$

$$\therefore \delta_2^2 = \delta^{3T} \begin{pmatrix} w_{12}^3 f'(v_2^2) \\ w_{22}^3 f'(v_2^2) \\ w_{32}^3 f'(v_2^2) \end{pmatrix}$$

$$\therefore \delta^2 = \delta^{3T} w^3 f'(v^2)$$

$$= (\delta_1^3 \;\; \delta_2^3 \;\; \delta_3^3)\begin{pmatrix} w_{11}^3 & w_{12}^3 \\ w_{21}^3 & w_{22}^3 \\ w_{31}^3 & w_{32}^3 \end{pmatrix}\begin{pmatrix} f'(v_1^2) \\ f'(v_2^2) \end{pmatrix}$$

$$dW^2_{new} = dW^2_{old} - \mu\, \delta W^2$$

$$= \begin{pmatrix} w^2_{11} & w^2_{12} & w^2_{13} \\ w^2_{21} & w^2_{22} & w^2_{23} \end{pmatrix} - \mu\, \delta^2\, \bar{y}^{1T}$$

$$= \begin{pmatrix} \leftarrow w^2_1 \rightarrow \\ \leftarrow w^2_2 \rightarrow \end{pmatrix} - \mu\, \delta^2 \begin{pmatrix} \bar{y}^1_1 \\ \bar{y}^1_2 \\ \bar{y}^1_3 \end{pmatrix}^T$$

$$= \begin{pmatrix} \leftarrow w^2_1 \rightarrow \\ \leftarrow w^2_2 \rightarrow \end{pmatrix} - \mu \begin{pmatrix} \delta^2_1 \\ \delta^2_2 \end{pmatrix} \begin{pmatrix} \bar{y}^1_1 & \bar{y}^1_2 & \bar{y}^1_3 \end{pmatrix}$$

$$= \begin{pmatrix} w^2_{11} & w^2_{12} & w^2_{13} \\ w^2_{21} & w^2_{22} & w^2_{23} \end{pmatrix} - \mu \begin{pmatrix} \delta^2_1 \bar{y}^1_1 & \delta^2_1 \bar{y}^1_2 & \delta^2_1 \bar{y}^1_3 \\ \delta^2_2 \bar{y}^1_1 & \delta^2_2 \bar{y}^1_2 & \delta^2_2 \bar{y}^1_3 \end{pmatrix}$$