

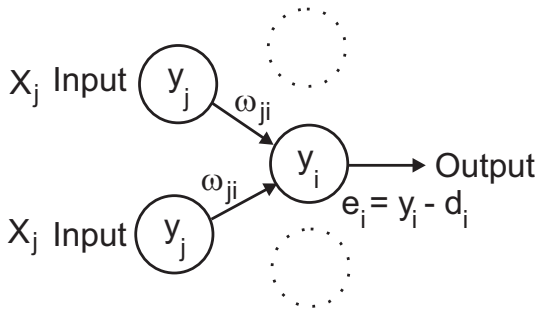




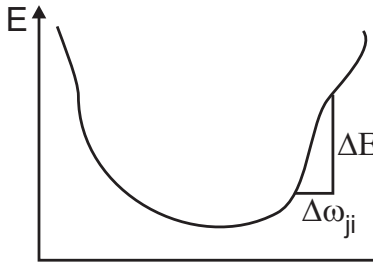




A



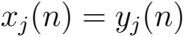
B





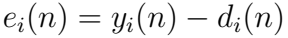








$$y_i(n) = \sum_j y_j(n) w_{ji}$$





2020

E

$=$

$\frac{1}{2}e^2$





$$-\mu \frac{\partial E}{\partial \omega_j}$$







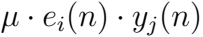


$$-\mu \frac{1}{2} \frac{\partial (d_i(n) - y_i(n))^2}{\partial w_{ji}}$$

$$-\mu \frac{1}{2} \frac{\partial \left(d_i(n) - \sum_j y_j(n) w_{ji} \right)^2}{\partial w_{ji}}$$

$$\underbrace{\mu \left(d_i(n) - \sum_j y_j(n) w_{ji} \right)}_{-e_i(n)} \cdot y_j(n)$$

$$\begin{array}{cc}
 \frac{\partial E}{\partial y_i} & \frac{\partial y_i}{\partial \omega_{ji}} \\
 \underbrace{\hspace{1.5cm}}_{-e_i(n)} & \underbrace{\hspace{1.5cm}}_{y_j(n)}
 \end{array}$$

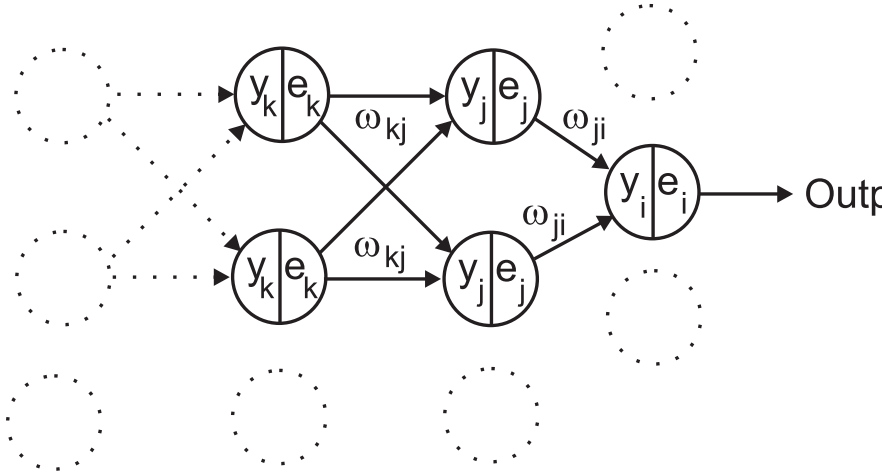






A pixelated, black and white representation of the number 2020. The digits are formed by thick, irregular strokes of black pixels on a white background, giving it a hand-drawn or digital art appearance. The number is centered horizontally and occupies most of the vertical space.

Input

















$$\frac{\partial E}{\partial \omega_{kj}} = \underbrace{\frac{\partial E}{\partial y_j}}_{\text{trick!}} \frac{\partial y_j}{\partial \omega_{kj}}$$

25



25

$$\frac{\partial E}{\partial y_j} = \sum_i \underbrace{\frac{\partial E}{\partial y_i}}_{-e_i} \cdot \underbrace{\frac{\partial y_i}{\partial y_j}}_{w_{ji}}$$

$$\frac{\partial E}{\partial \omega_{kj}} = - \left(\sum_i e_i \omega_{ji} \right) \frac{\partial y_j}{\partial \omega_{kj}}$$

$$y_j = \sum_k y_k(r) w_{kj}$$

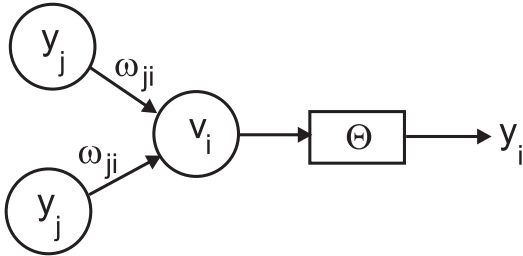
∂E

$\partial \omega_{kj}$

$$- \left(\sum_i e_i w_{ji} \right) \underbrace{\frac{\partial \left(\sum_k y_k(n) w_{kj} \right)}{\partial w_{kj}}}_{y_k}$$

$$-\left(\sum_i e_i w_{ji}\right) y_k$$

$$\Delta \omega_{kj} = \mu \cdot y_k \cdot \underbrace{\sum_i e_i \omega_{ji}}_{e_j}$$

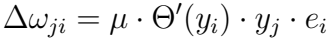




$$y_i(n) = \Theta \left(\underbrace{\sum_j y_j(n) w_{ji}}_{v_i} \right)$$

$$\frac{\partial E}{\partial \omega_{ji}} = \frac{\partial E}{\partial y_i} \underbrace{\frac{\partial y_i}{\partial v_i}}_{\Theta'} \frac{\partial v_i}{\partial \omega_{ji}}$$





$$\Delta w_{kj} = \mu \cdot \Theta'(y_j) \cdot y_k \cdot \underbrace{\sum_i e_i w_{ji}}_{e_j}$$

$$\Theta(v) = \begin{cases} 0, & \text{if } v < 0 \\ v, & \text{otherwise} \end{cases}$$

Equal to standard

$\mathcal{E}(v)$

$=$

$\frac{1}{1 + e^{-v}}$