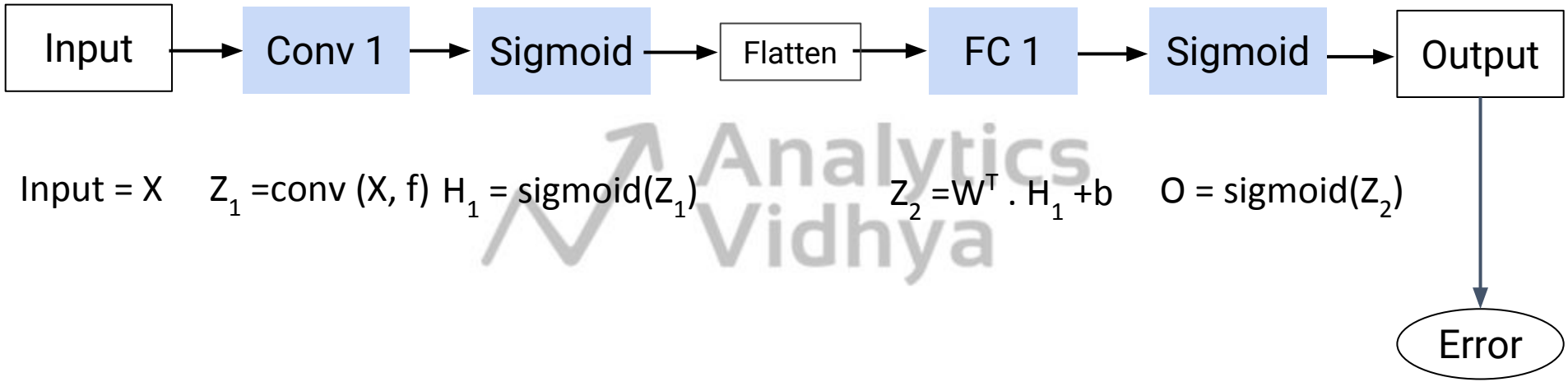
Backward Propagation in Convolutional Neural Network

Backward Propagation in CNN

Input = X Z_1 =conv (X, f) H_1 = sigmoid(Z_1) $Z_2 = W^T . H_1 + b$ O = sigmoid(Z_2)

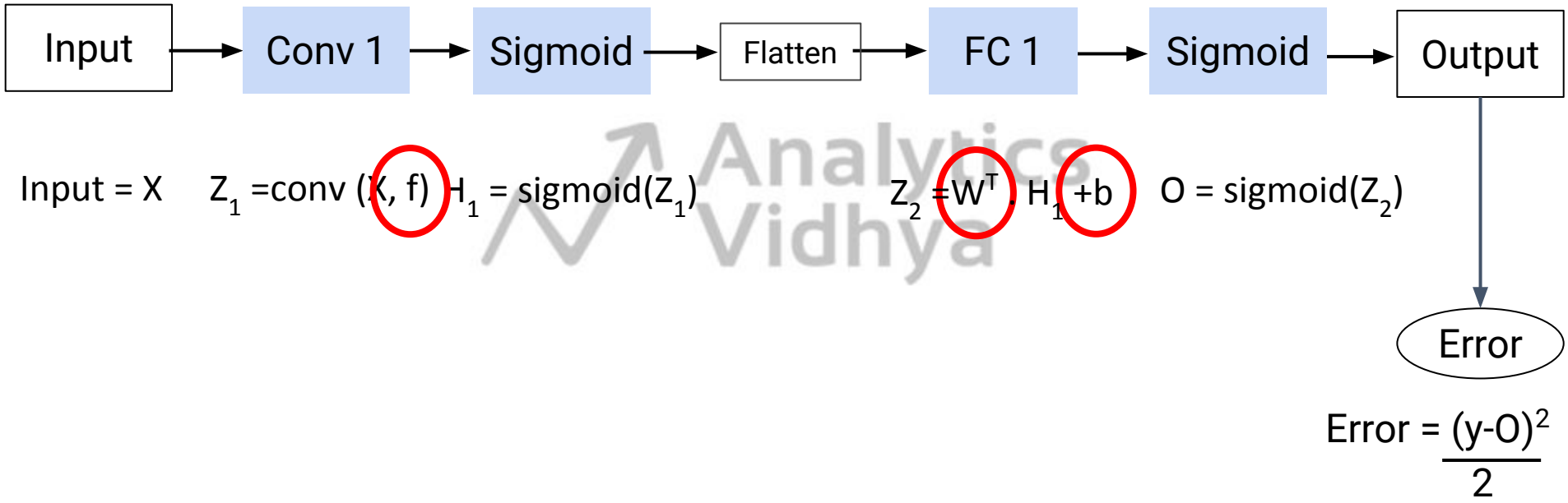
Backward Propagation in CNN



Input = X Z_1 =conv (X, f) H_1 = sigmoid(Z_1) $Z_2 = W^T . H_1 + b$ O = sigmoid(Z_2)

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

Backward Propagation in CNN



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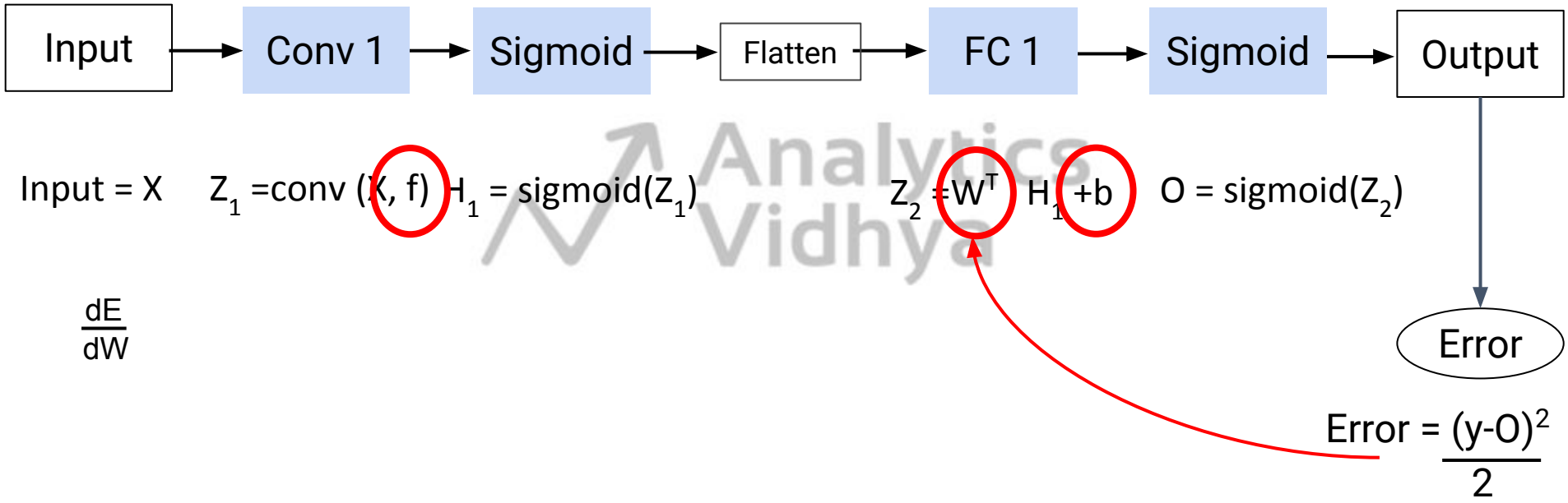

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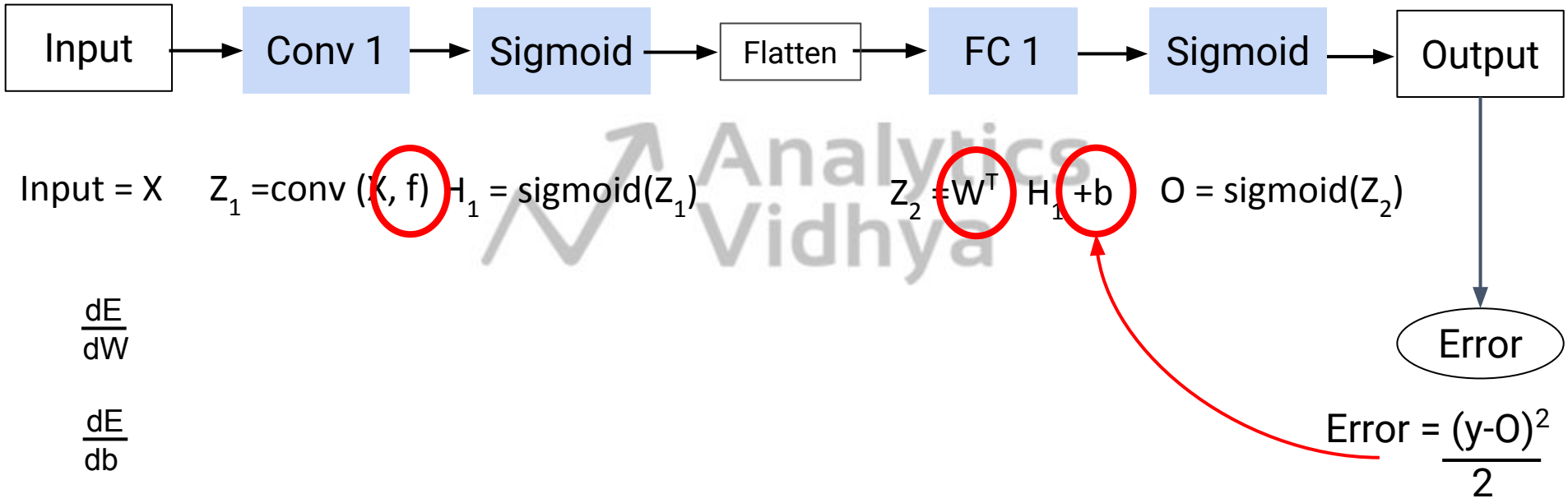

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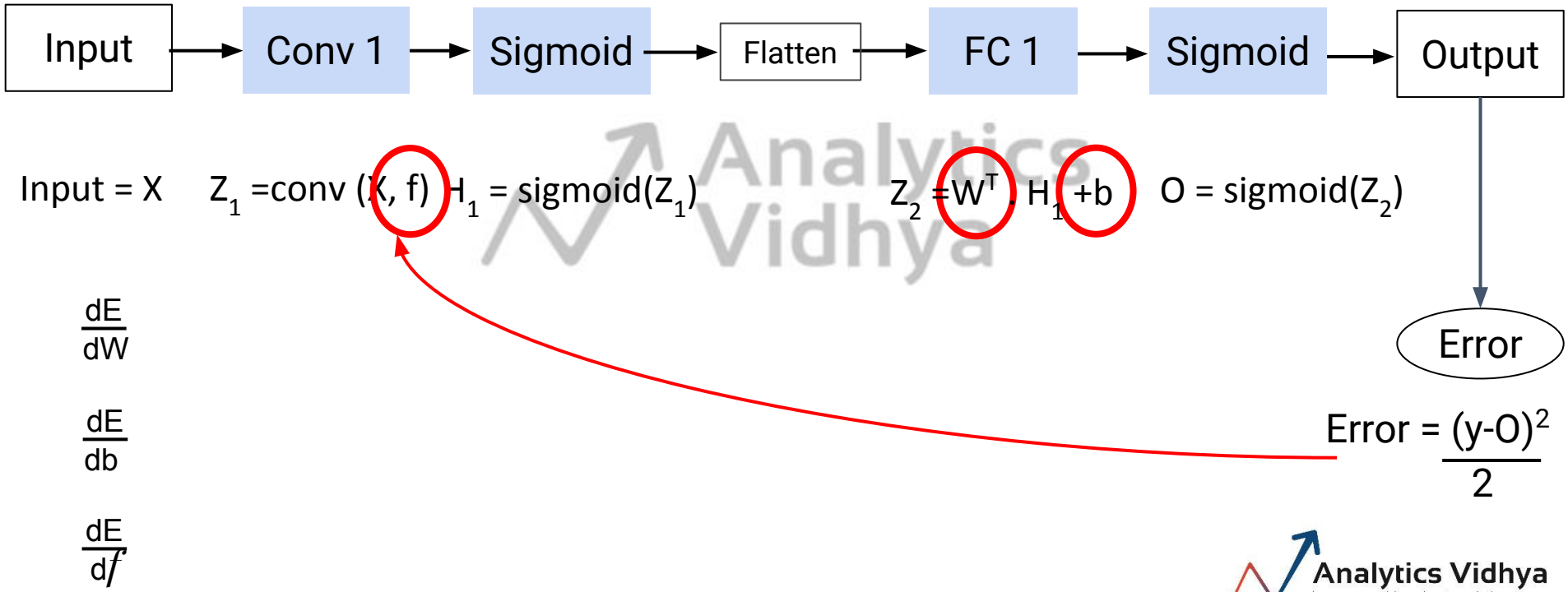


Backward Propagation in CNN

Input = X $\quad Z_1 = conv(X, f) \quad H_1 = sigmoid(Z_1) \quad Z_2 = W^T \cdot H_1 + b \quad O = sigmoid(Z_2)$

$\frac{dE}{dW}$ $\quad$ **w = w - α * dE / dw**

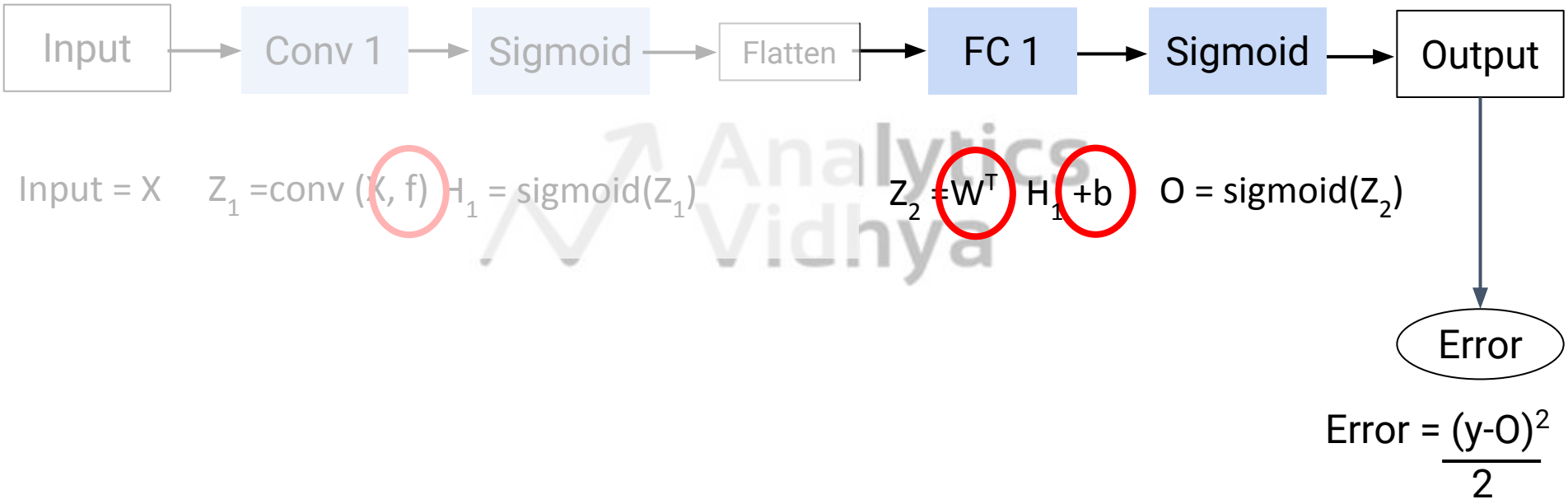
$\frac{dE}{db}$ $\quad$ **b = b - α * dE / db**

$\frac{dE}{df}$ $\quad$ ***f* = *f* - α * dE / d*f***

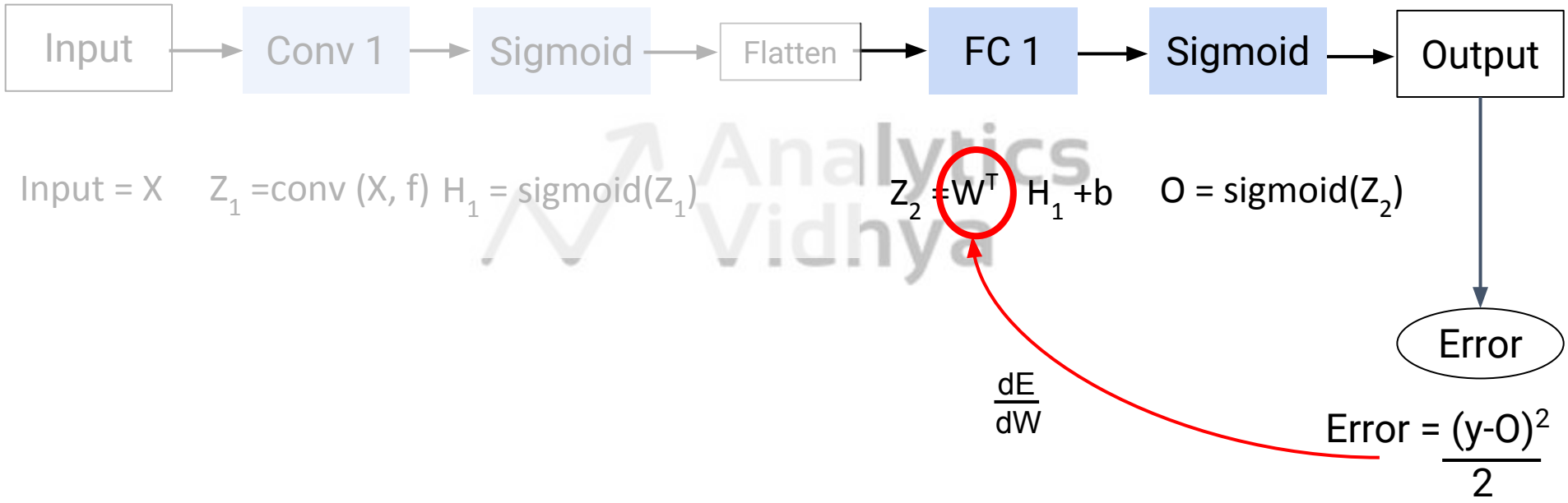
Error

$$Error = \frac{(y-O)^2}{2}$$

Backward Propagation in CNN: FC Layer



Backward Propagation in CNN: FC Layer



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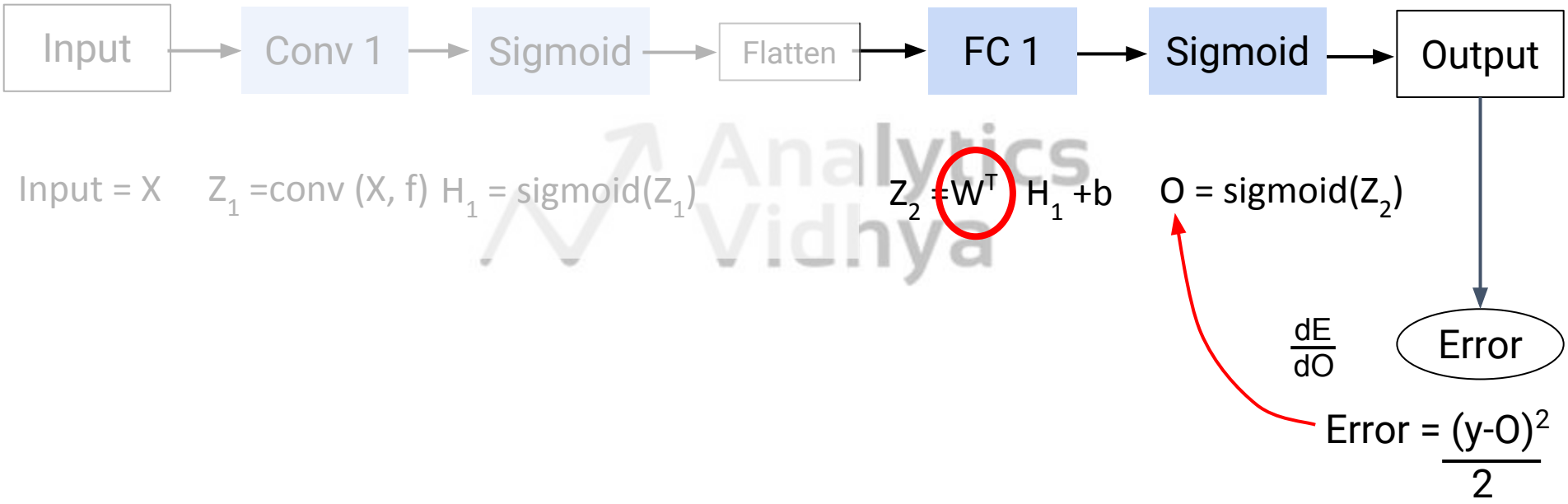

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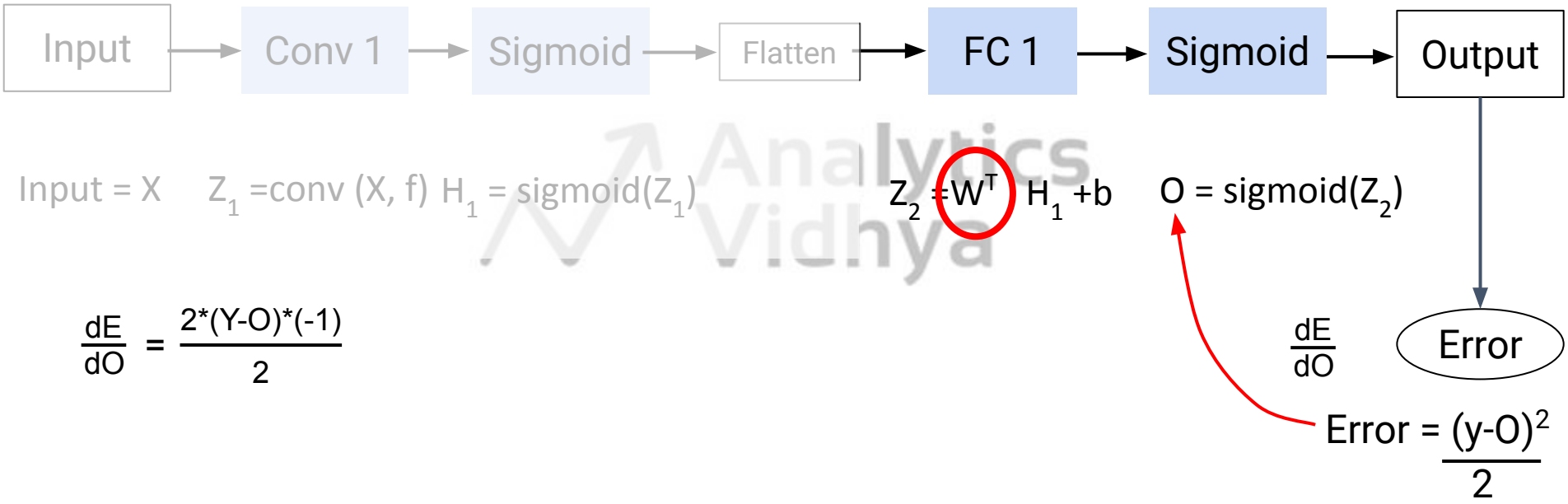

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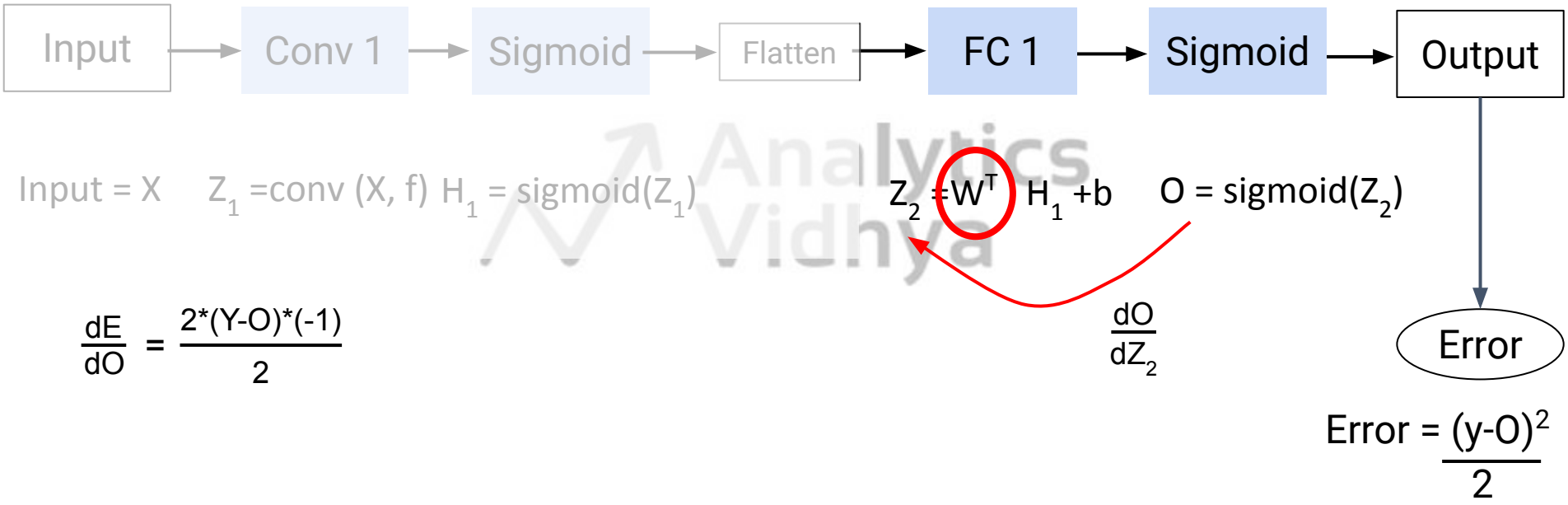

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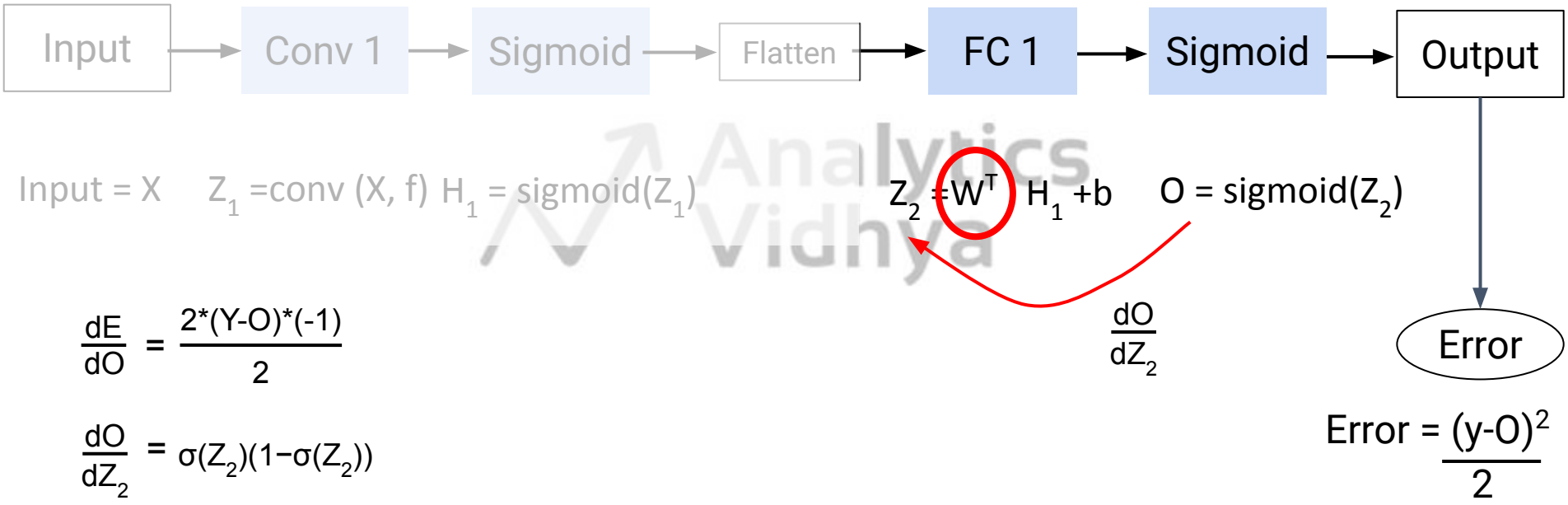

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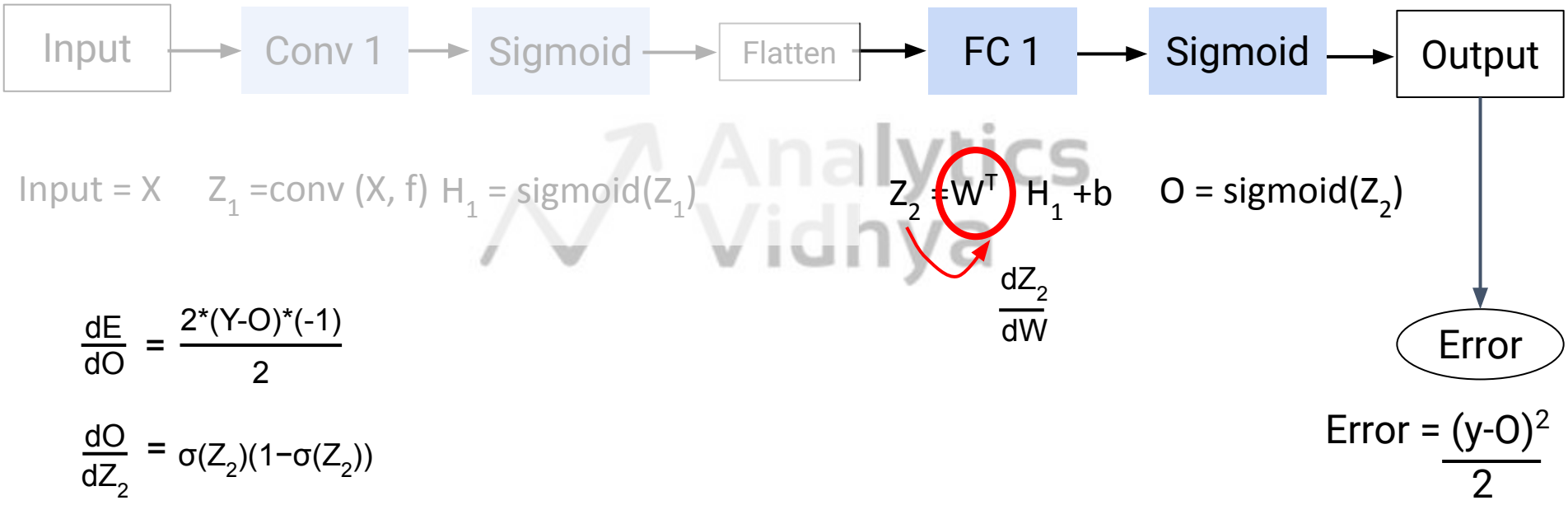

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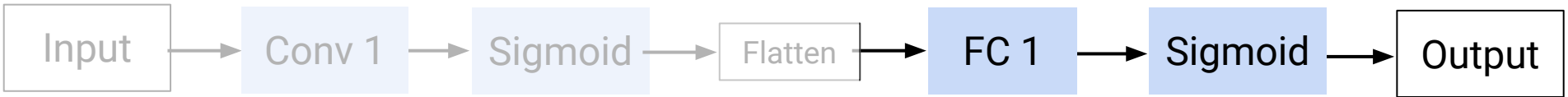


Input = X $\quad Z_1 = conv(X, f) \quad H_1 = sigmoid(Z_1)$ $\quad Z_2 = W^T H_1 + b \quad O = sigmoid(Z_2)$

$$\frac{dZ_2}{dW}$$

Error

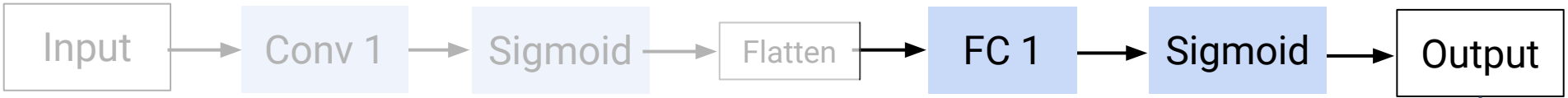
$$Error = \frac{(y-O)^2}{2}$$

$$\frac{dE}{dO} = \frac{2*(Y-O)*(-1)}{2}$$

$$\frac{dO}{dZ_2} = \sigma(Z_2)(1-\sigma(Z_2))$$

$$\frac{dZ_2}{dW} = H_1$$

Backward Propagation in CNN: FC Layer



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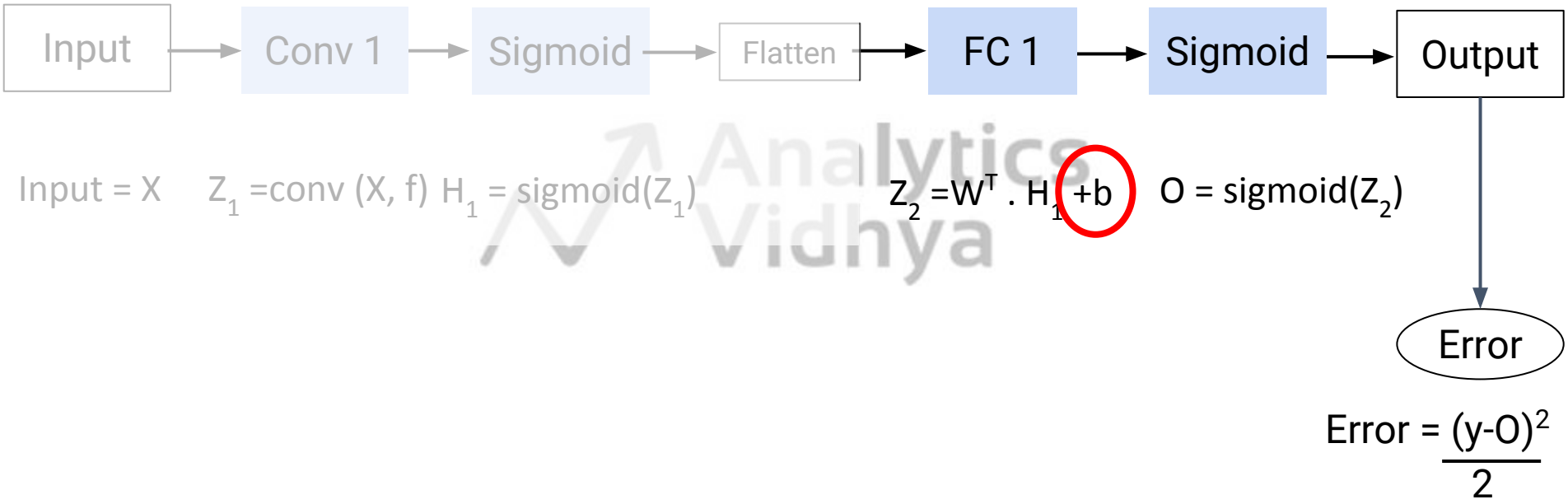
$$\frac{dZ_2}{dW} = H_1$$

$$\frac{dE}{dW} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dW} = (O-Y) * O(1-O) * H_1$$

Backward Propagation in CNN: FC Layer



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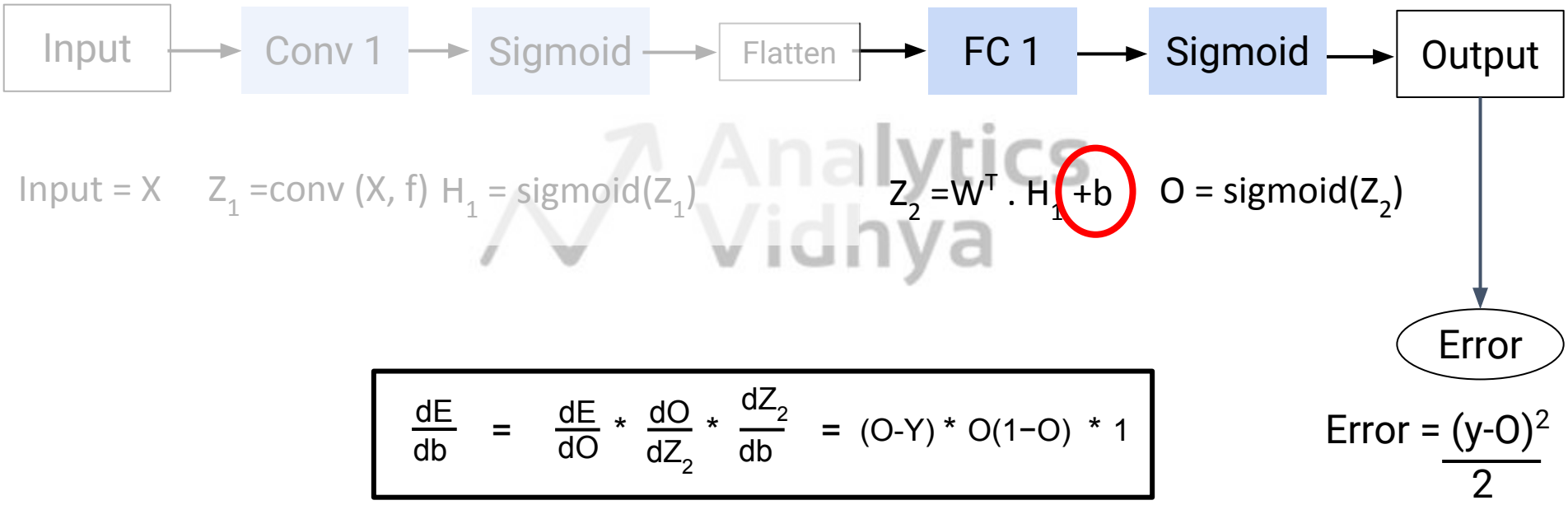

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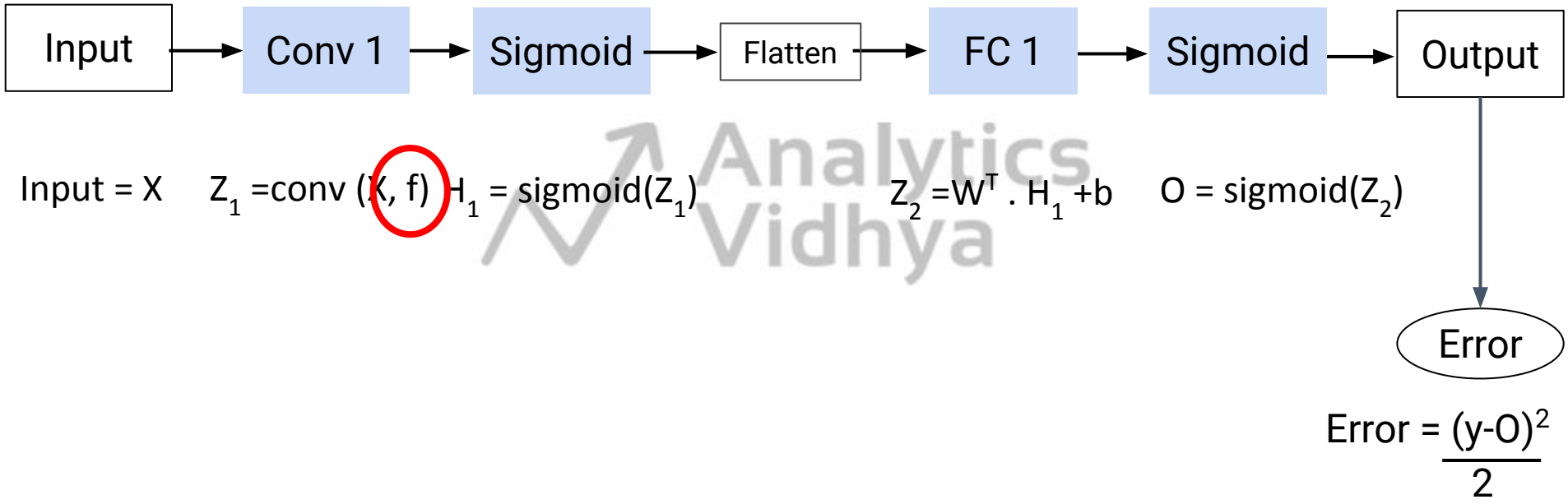

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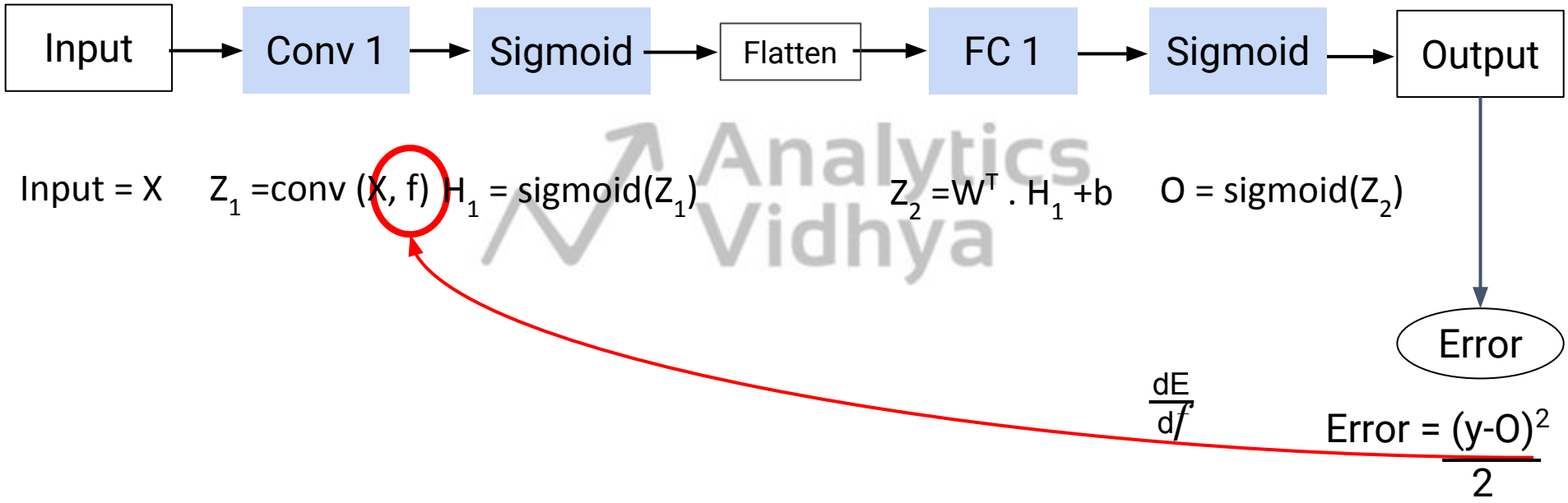

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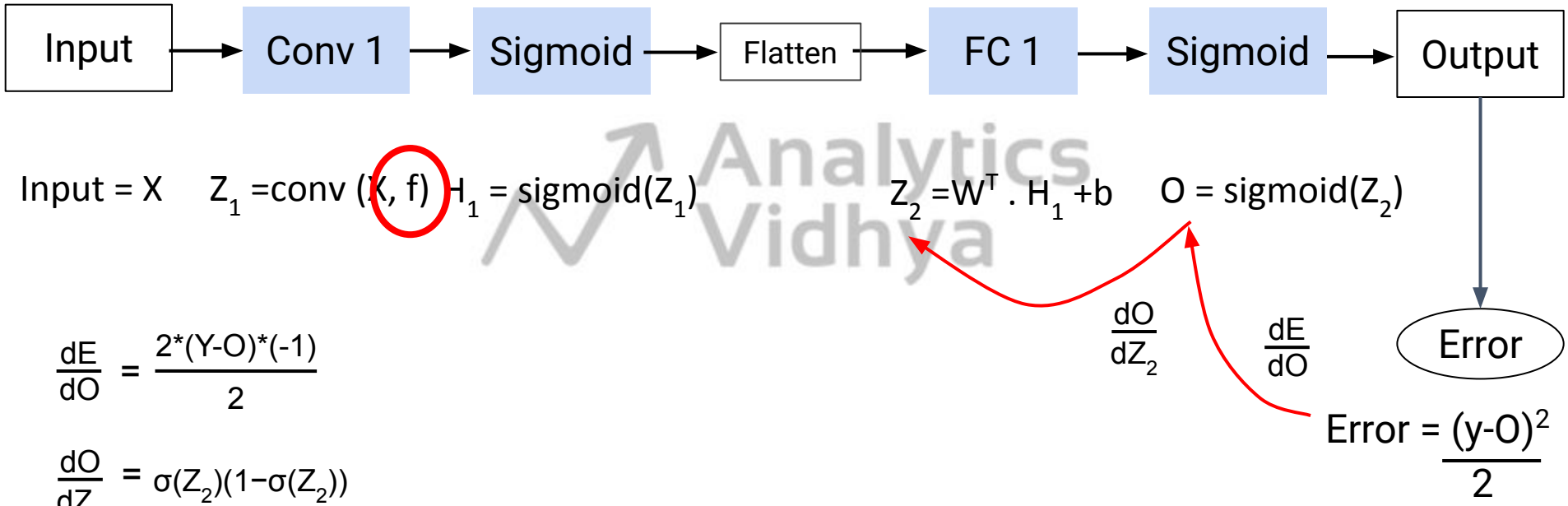

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Input = X $\quad Z_1 = \text{conv}(X, f) \quad H_1 = \text{sigmoid}(Z_1) \quad Z_2 = W^T \cdot H_1 + b \quad O = \text{sigmoid}(Z_2)$

$\frac{dZ_2}{dH_1}$

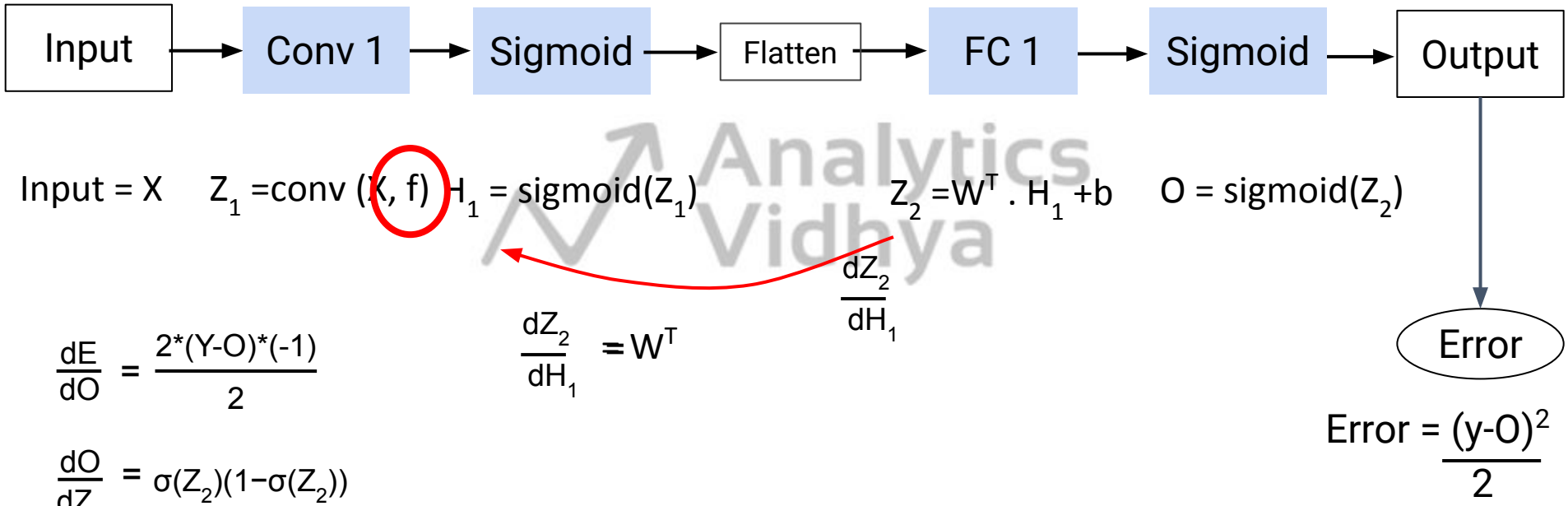
Error

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

$$\frac{dE}{dO} = \frac{2*(Y-O)*(-1)}{2}$$

$$\frac{dO}{dZ_2} = \sigma(Z_2)(1-\sigma(Z_2))$$

Backward Propagation in CNN: Conv Layer



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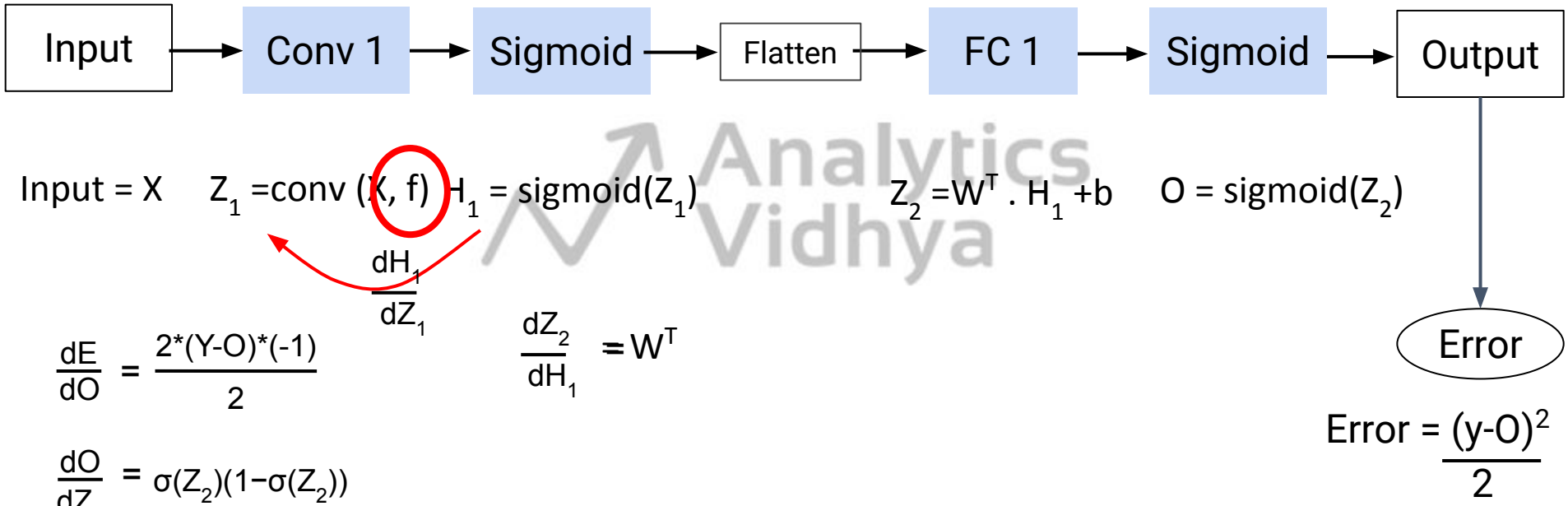

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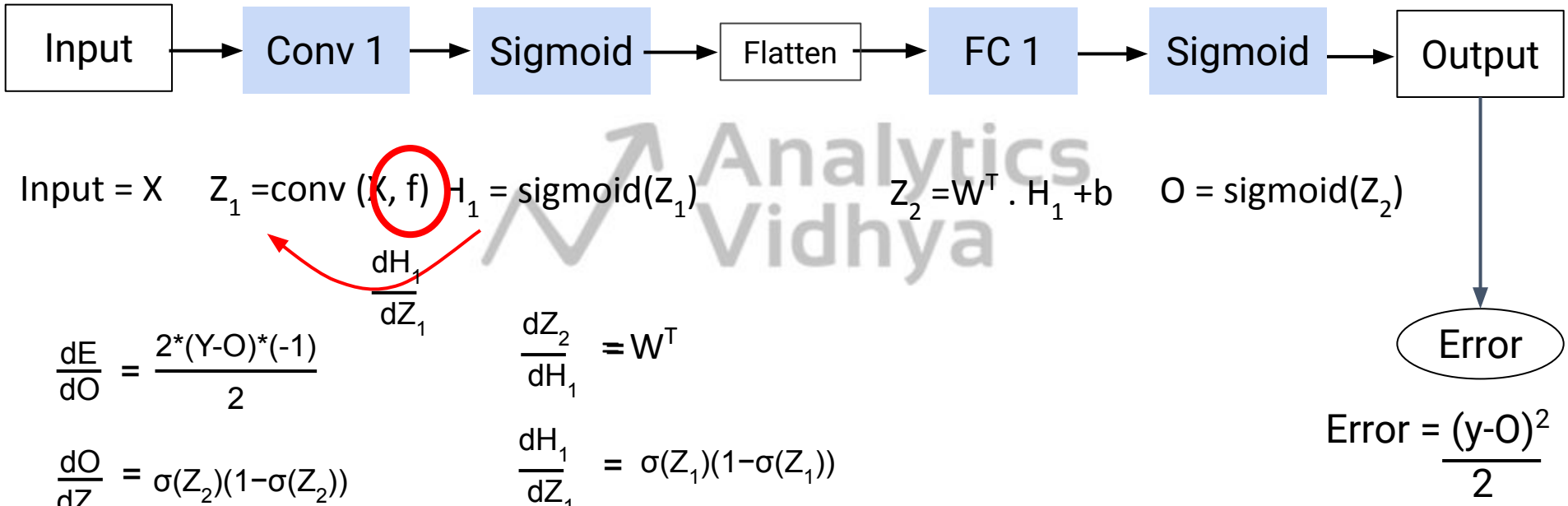

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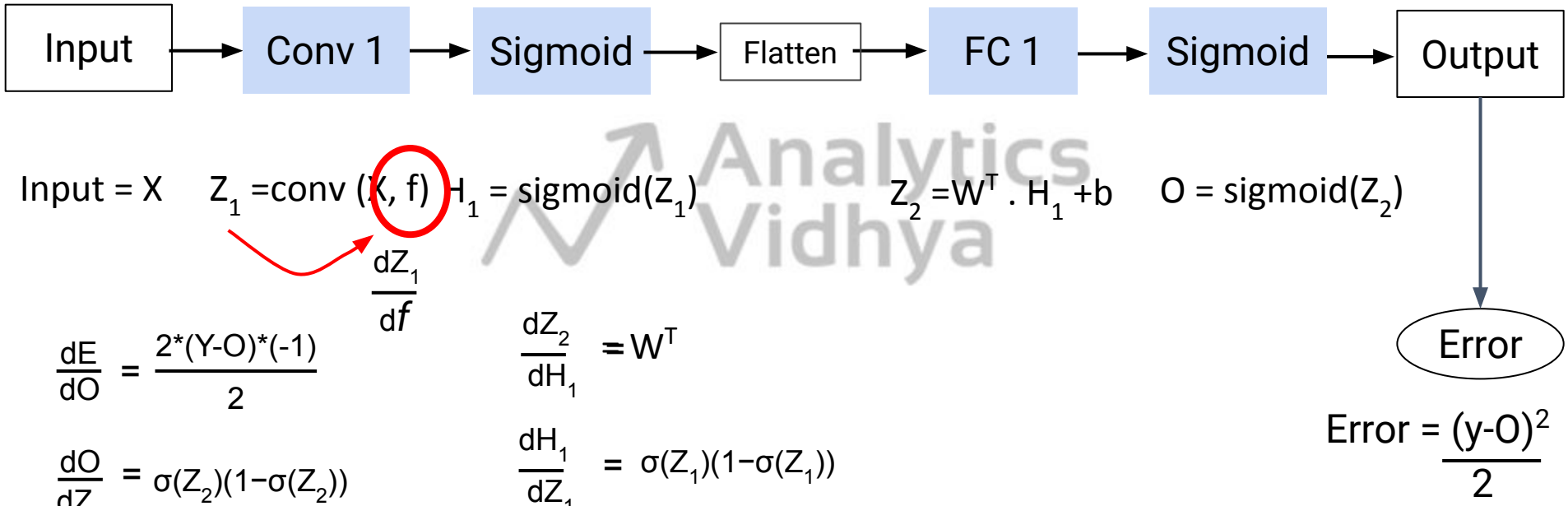

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$\frac{dZ_1}{df}$

$\frac{dE}{dO} = \frac{2*(Y-O)*(-1)}{2}$

$\frac{dO}{dZ_2} = \sigma(Z_2)(1-\sigma(Z_2))$

$\frac{dZ_2}{dH_1} = W^T$

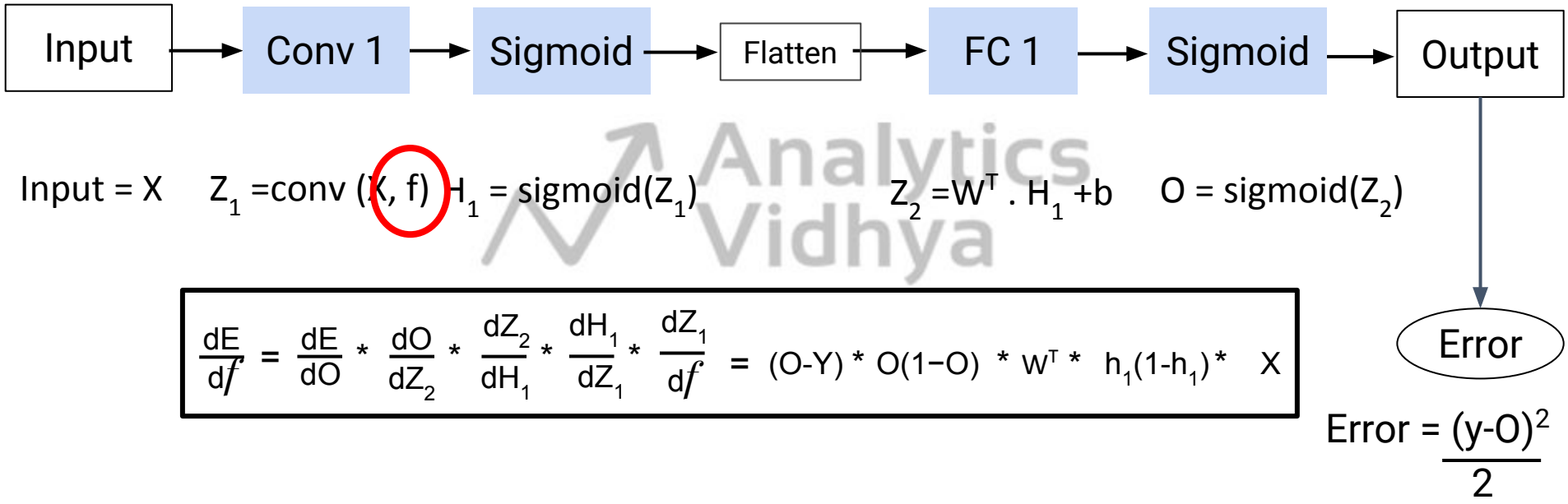
$\frac{dH_1}{dZ_1} = \sigma(Z_1)(1-\sigma(Z_1))$

$\frac{dZ_1}{df} = X$

Error

$Error = \frac{(y-O)^2}{2}$

Backward Propagation in CNN: Conv Layer



Backward Propagation in CNN: Conv Layer

Input = X $\quad Z_1 = \text{conv}(X, f) \quad H_1 = \text{sigmoid}(Z_1) \quad Z_2 = W^T \cdot H_1 + b \quad O = \text{sigmoid}(Z_2)$

$$\frac{dE}{df} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dH_1} * \frac{dH_1}{dZ_1} * \frac{dZ_1}{df} = (O-Y) * O(1-O) * W^T * h_1(1-h_1) * X$$

Error

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

$$\frac{dE}{df} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dH_1} * \frac{dH_1}{dZ_1} * \frac{dZ_1}{df} = \text{conv}\left((O-Y) * O(1-O) * W^T * h_1(1-h_1), X \right)$$

Update equation

$$\frac{dE}{dW} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dW} = (O-Y) * O(1-O) * H_1$$

$$\frac{dE}{db} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{db} = (O-Y) * O(1-O)$$

$$\frac{dE}{df} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dH_1} * \frac{dH_1}{dZ_1} * \frac{dZ_1}{df} = \text{conv}\left((O-Y)* O(1-O)* w^T * h_1(1-h_1), X\right)$$

Update equation

$$w = w - \alpha * dE / dw \qquad \frac{dE}{dW} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dW} = (O-Y) * O(1-O) * H_1$$

$$b = b - \alpha * dE / db \qquad \frac{dE}{db} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{db} = (O-Y) * O(1-O)$$

$$f = f - \alpha * dE / df \qquad \frac{dE}{df} = \frac{dE}{dO} * \frac{dO}{dZ_2} * \frac{dZ_2}{dH_1} * \frac{dH_1}{dZ_1} * \frac{dZ_1}{df} = \text{conv}\left((O-Y) * O(1-O) * w^T * h_1(1-h_1),\ X\right)$$

Thank You!