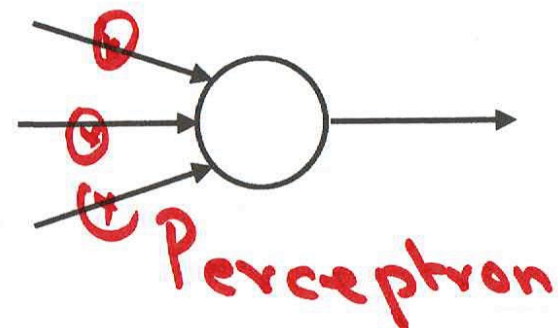
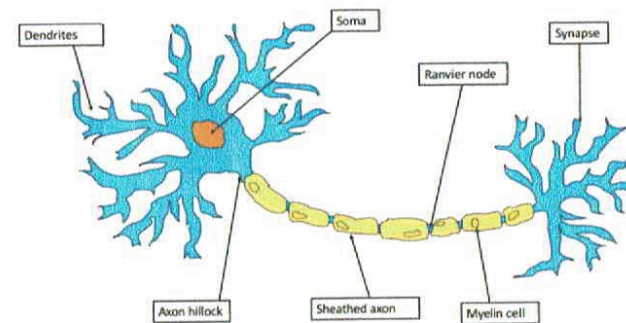
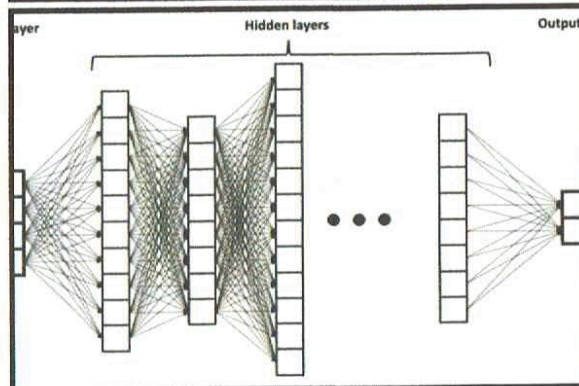
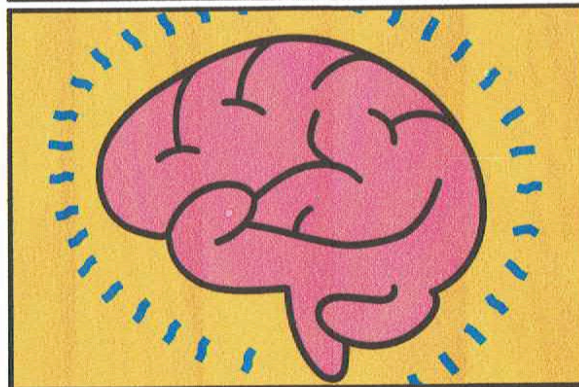


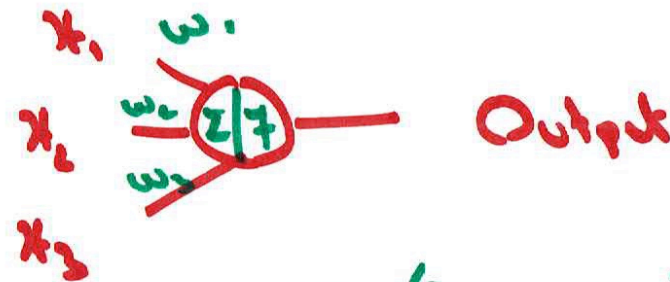
# Building towards a complex task!



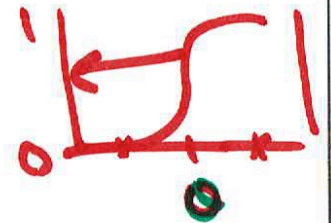
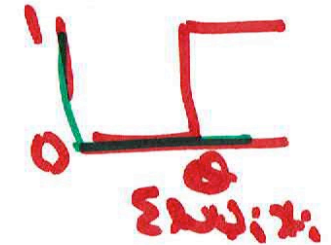
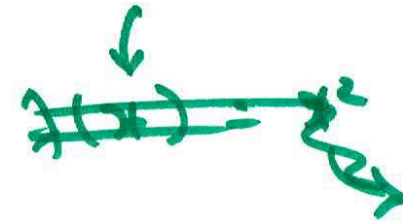
# Perceptron!

- What does it do?

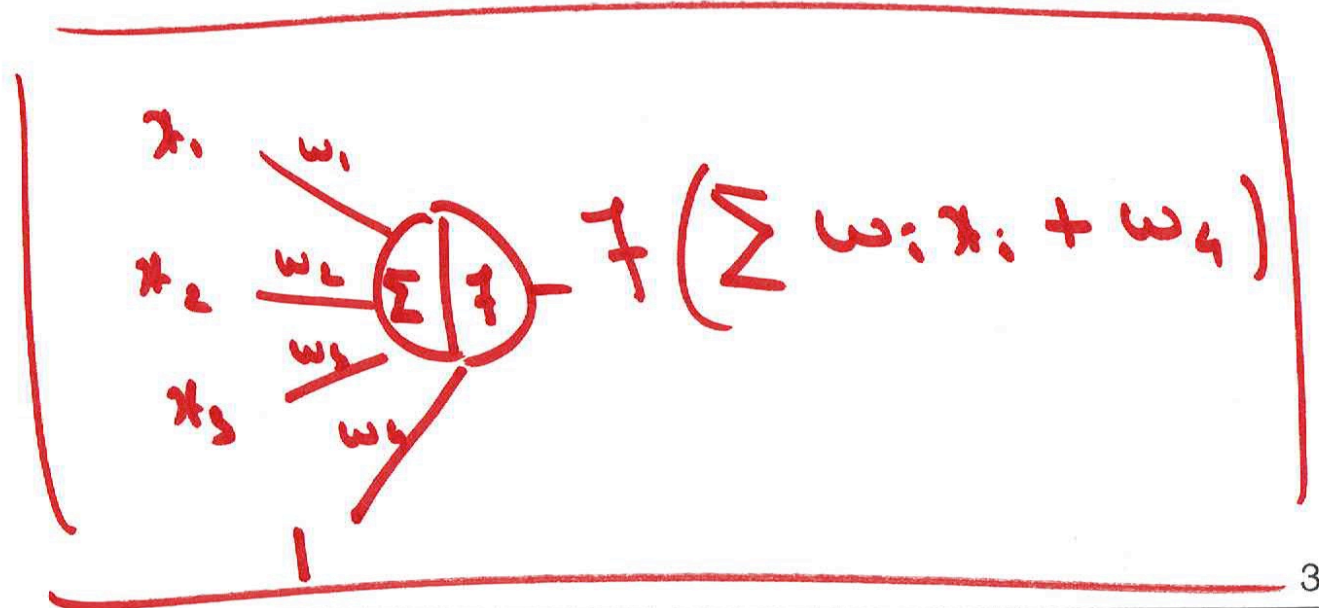
1958



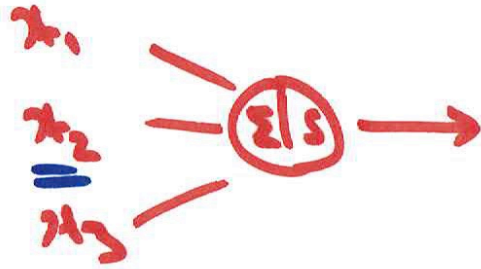
$$\lceil (\sum w_i x_i) = \text{Output}$$



- Bias



# Perception

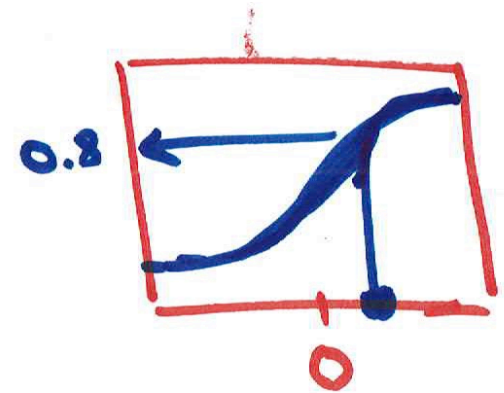
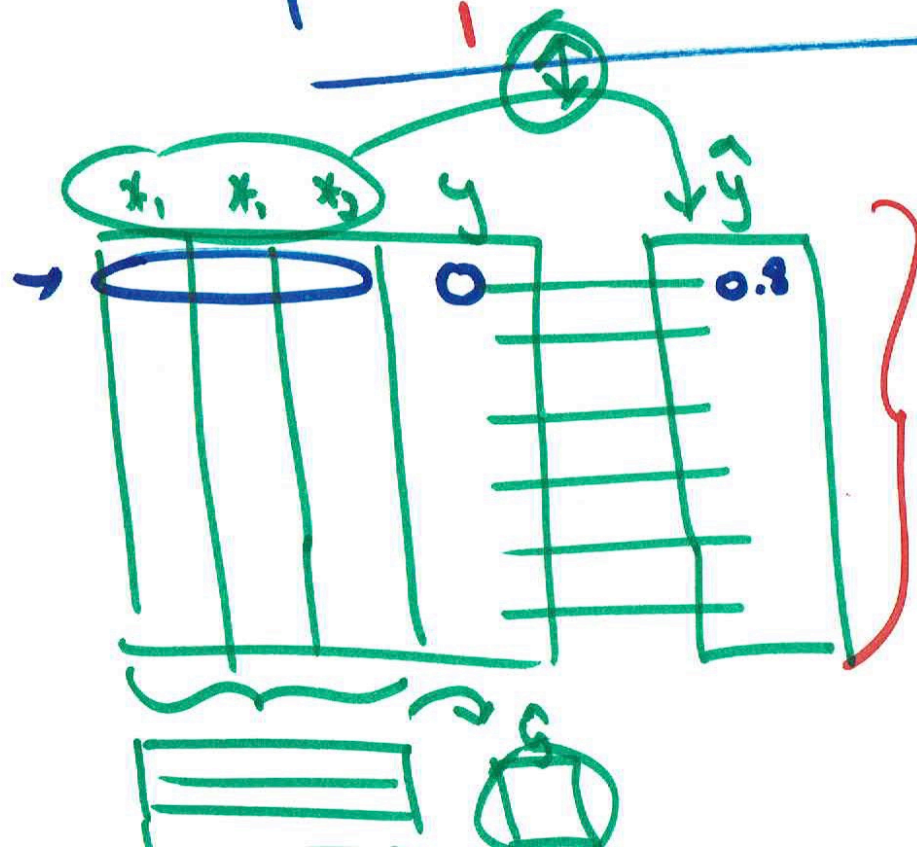
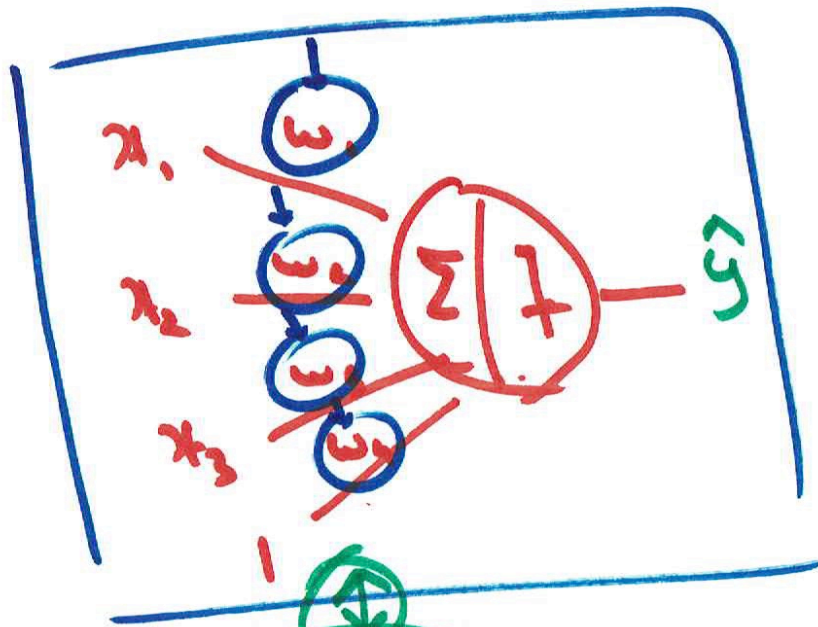


$$\text{if } \sum x_i \geq 0 \Rightarrow 1$$

$$\text{if } \sum x_i < 0 \Rightarrow 0$$

$$0 = 1 \Rightarrow \underline{\underline{\text{"OR"}}}$$

$$0 = 3 \Rightarrow \underline{\underline{\text{"AND"}}}$$



$$f(\sum w_i x_i + w_n)$$



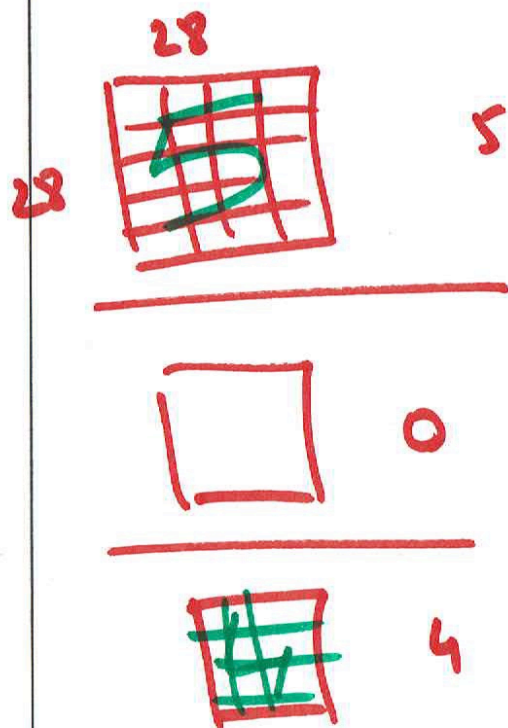
MNIST

# An Example

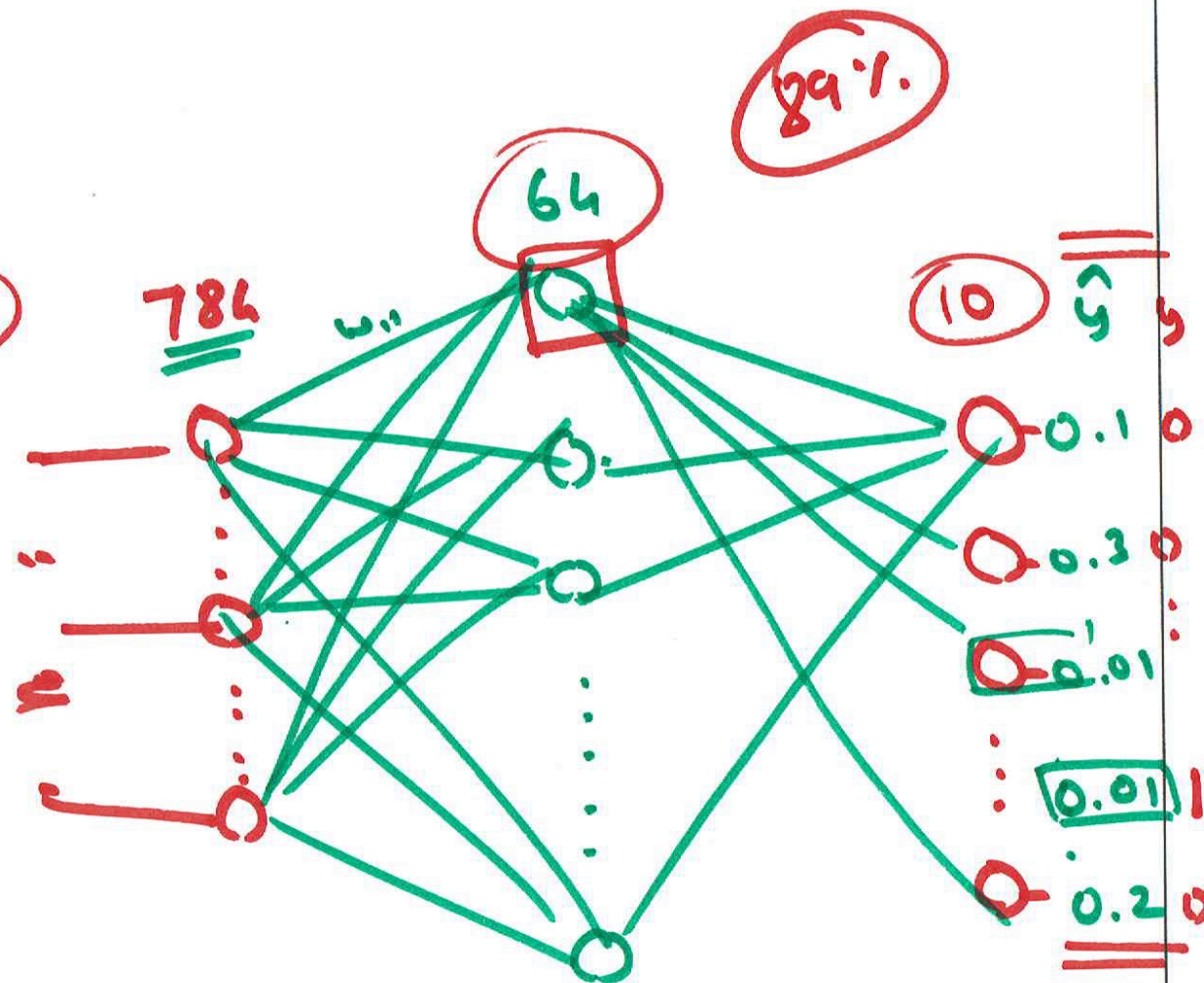
5 0 4 1 9 2 1 3 1 4  
5 0 4 1 9 2 1 3 1 4

60000 train

10000



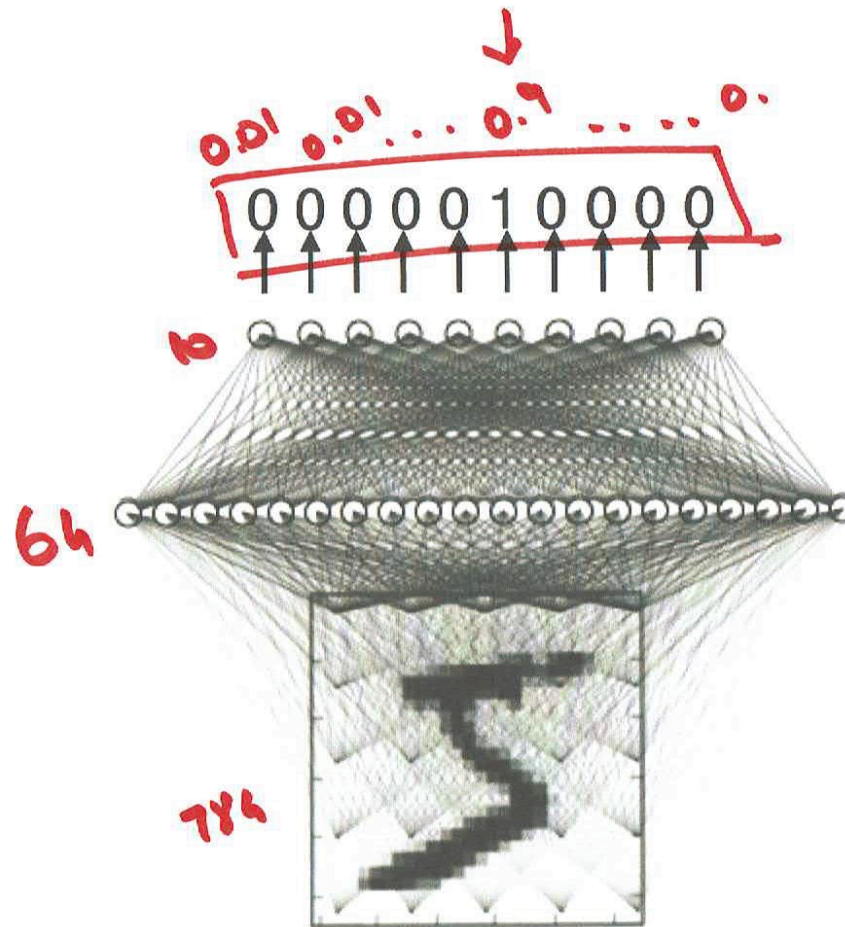
9

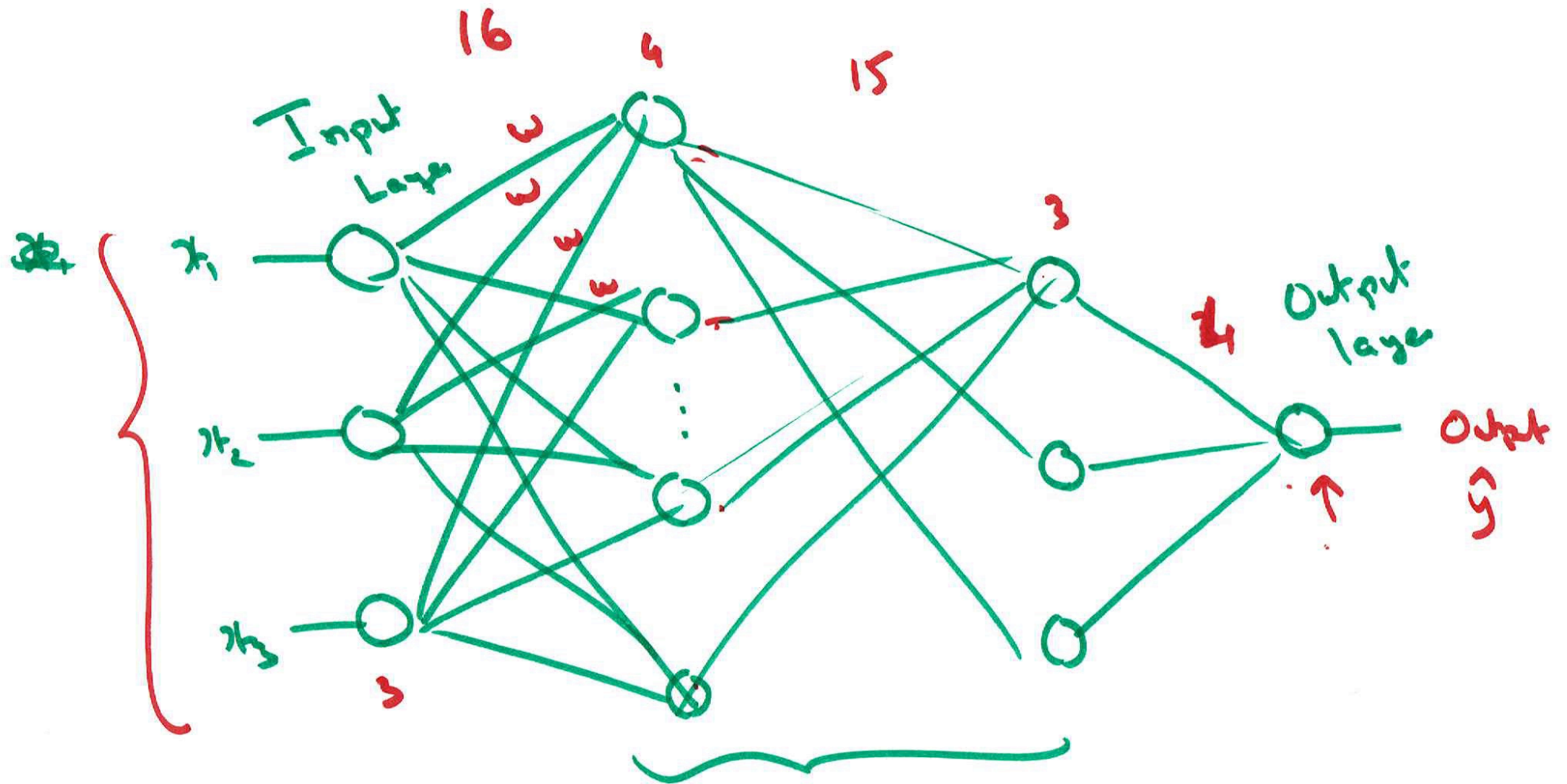


$$(784 \times 64 + 64) + (64 \times 10 + 10)$$

$$= \underline{\underline{50890}}$$

# An Example

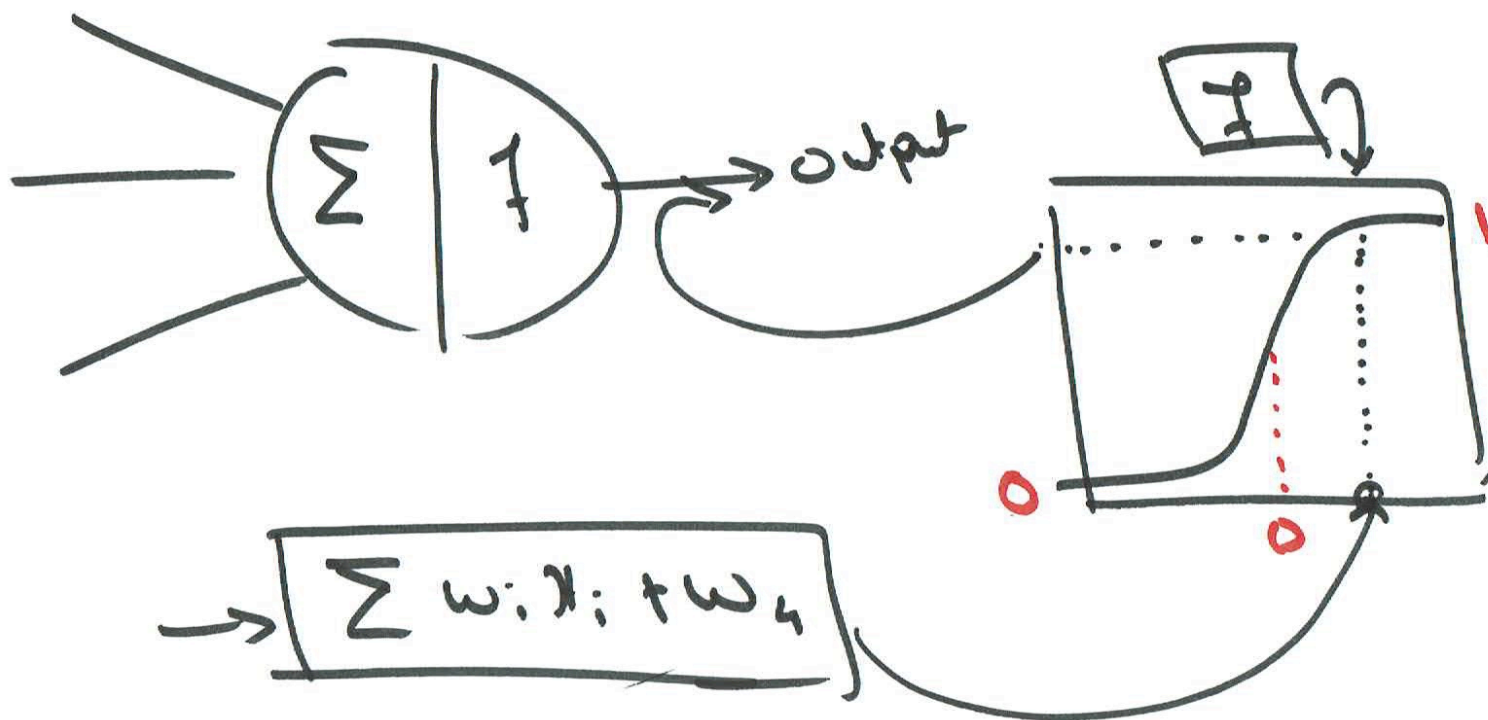




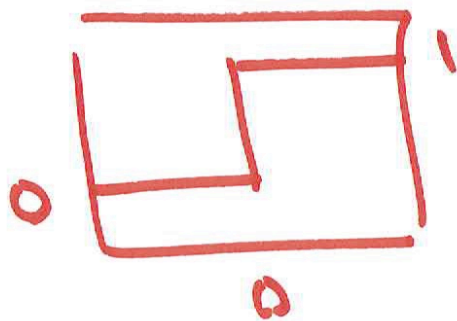
$$\frac{1}{n} \sum w_i x_i + w_n$$

Hidden Layer

Sigmoid



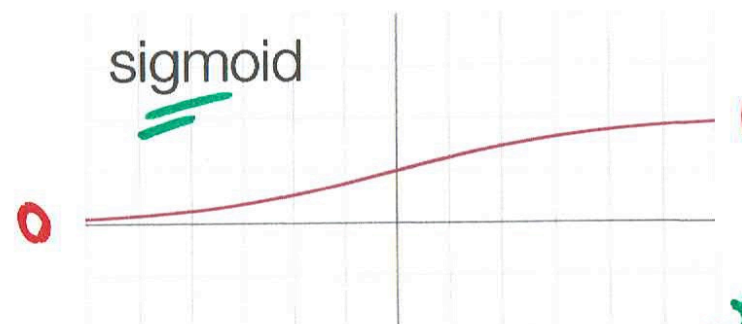
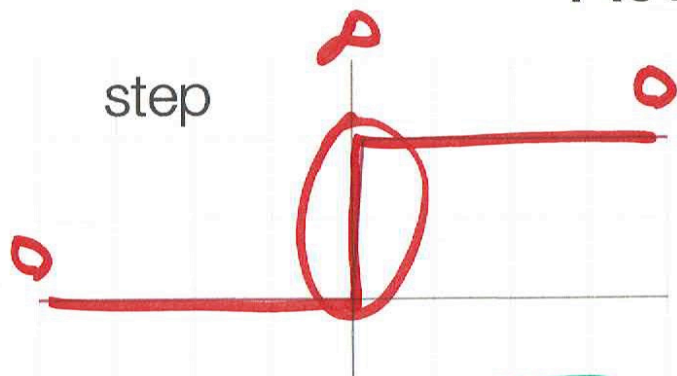
Step



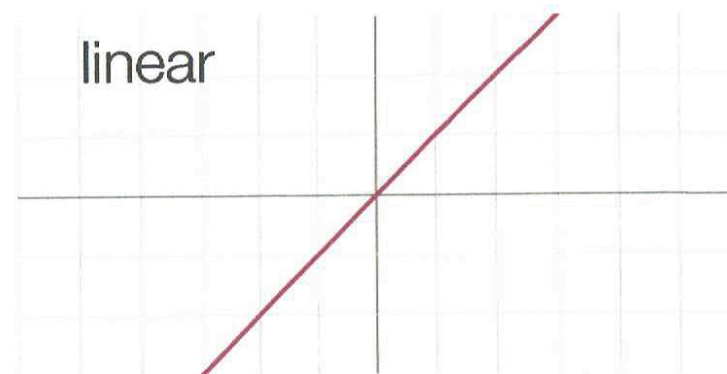
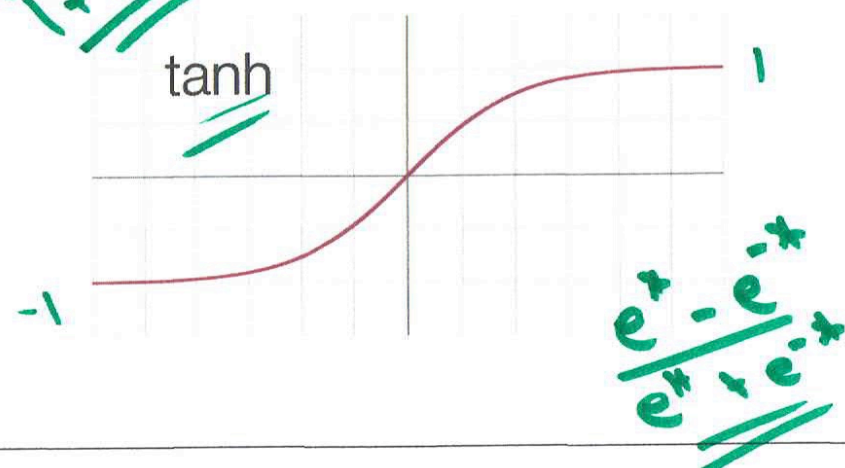
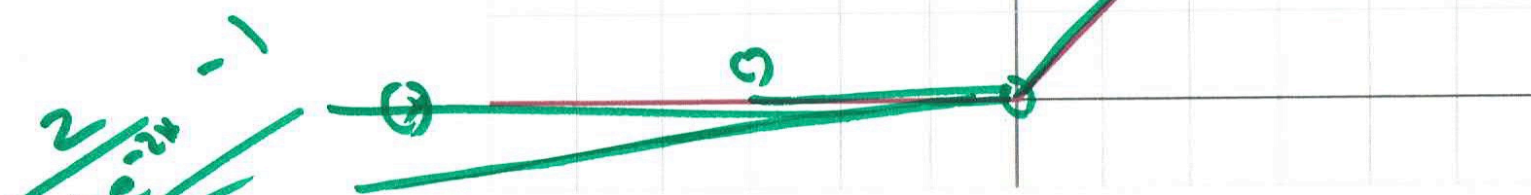
$$\text{Output} = f(\Sigma w_i x_i + w_n)$$



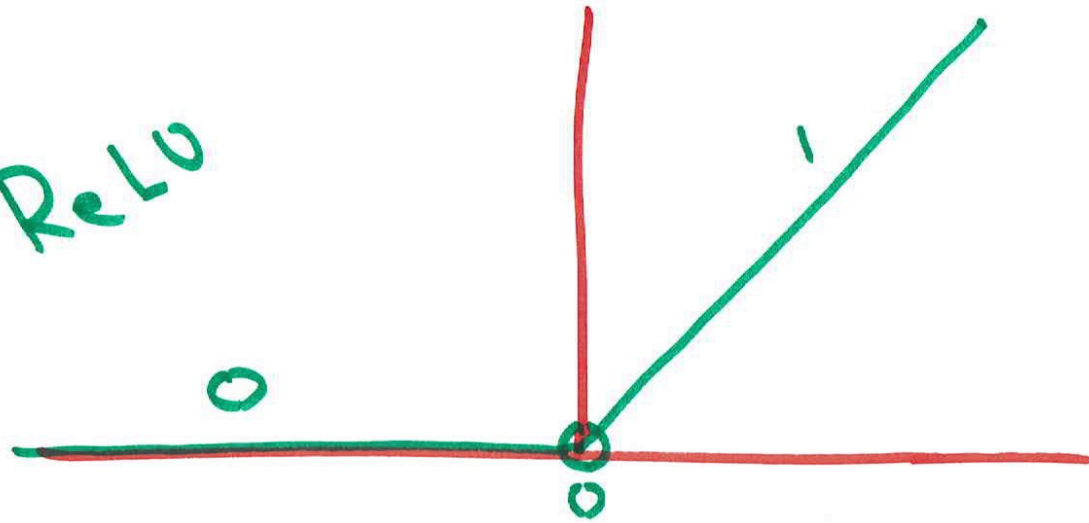
# Activation Functions



$$\frac{1}{1+e^{-x}} = \frac{e^x}{e^x+1}$$

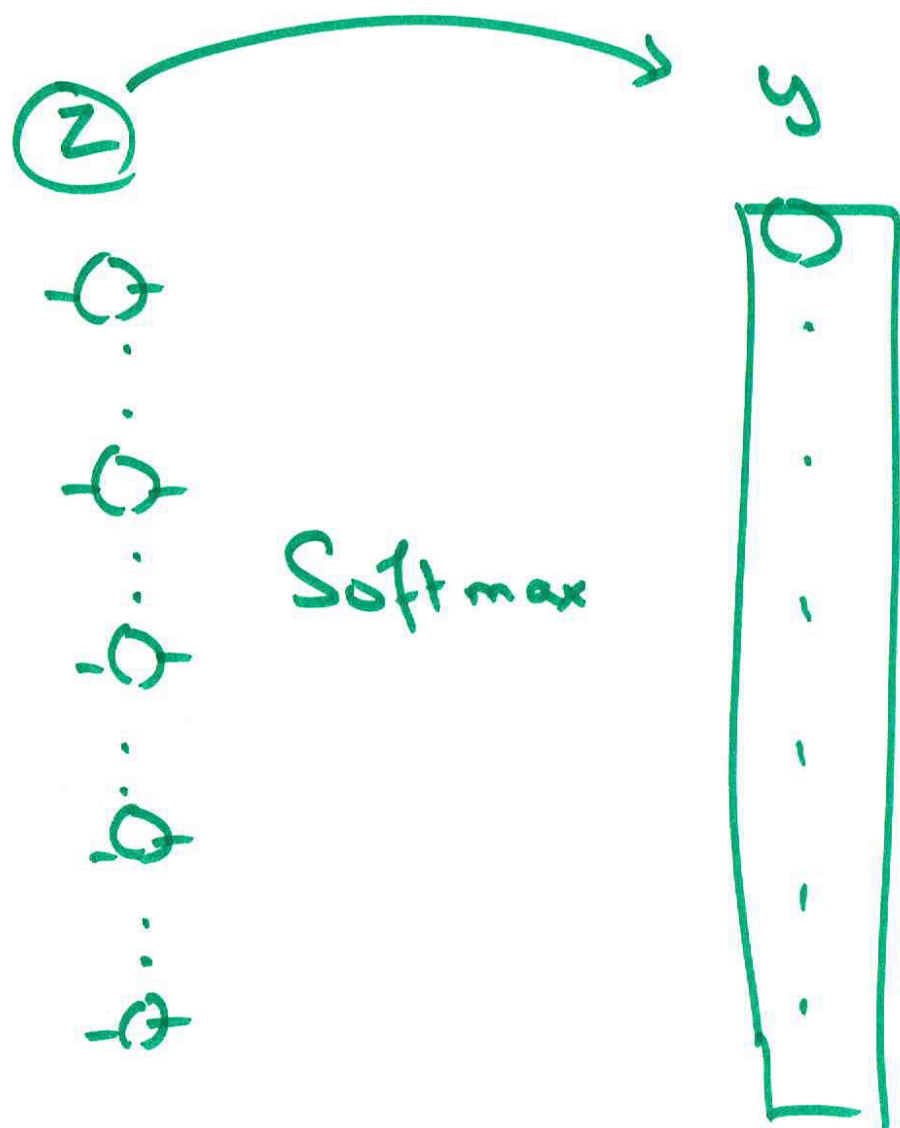


ReLU



$$f(x) = \begin{cases} x & \text{if } x \geq 0 \\ 0 & \text{if } x < 0 \end{cases}$$

$$f(x) = \max(0, x)$$



z

y

$$y_i = \frac{e^{z_i}}{\sum e^{z_i}}$$