Machine Learning Principles

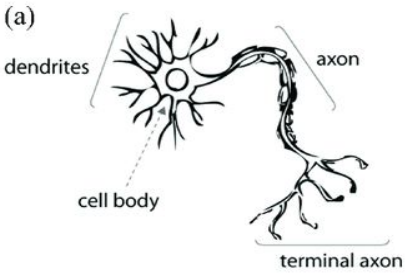
Multi Layer Perceptrons

Instructor: Tugce Gurbuz

Nov 4th, 2022

Perceptron (1958)

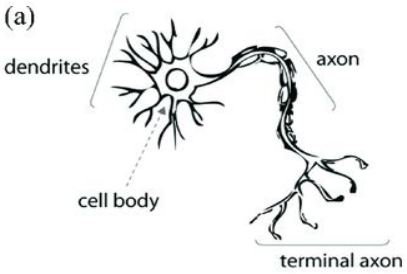
Source



1: fire
0: not fire

Perceptron (1958)

Source



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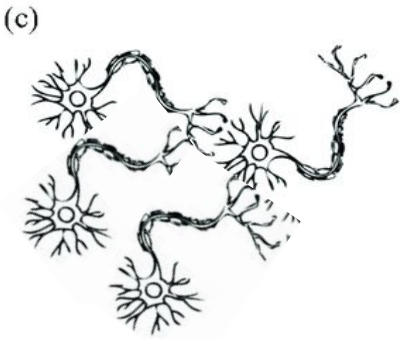
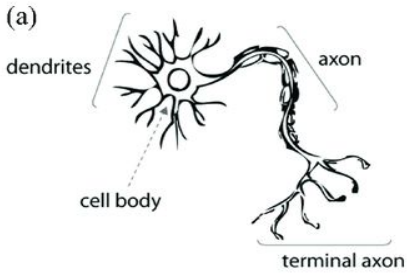


Excitatory and inhibitory connections

Perceptron (1958)

Source



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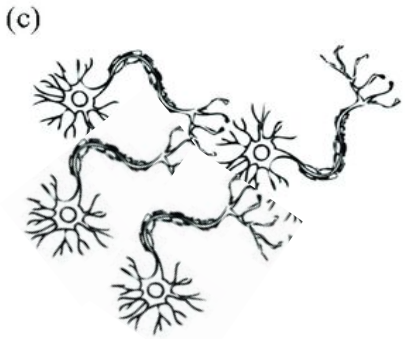
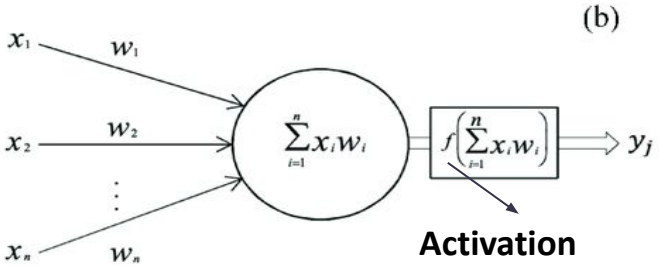
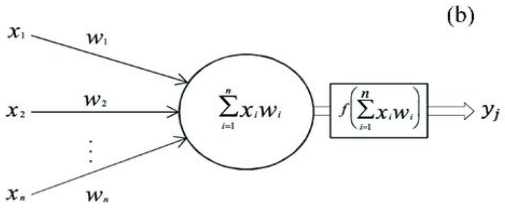


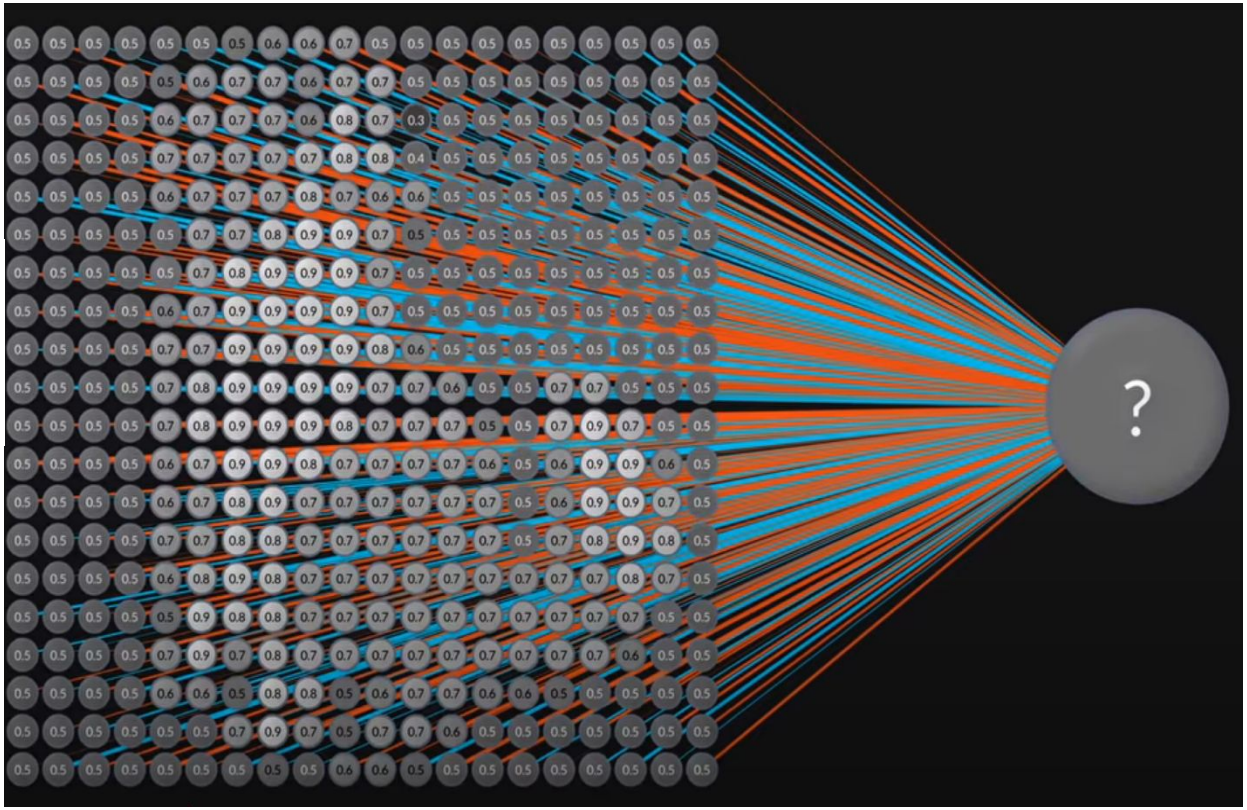
Excitatory and inhibitory connections



Activation function

How does perceptron distinguish between 2 images?





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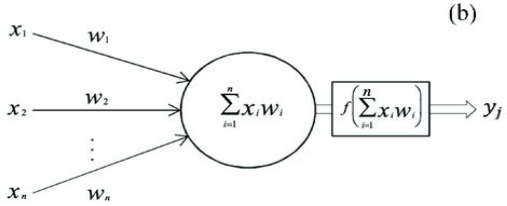

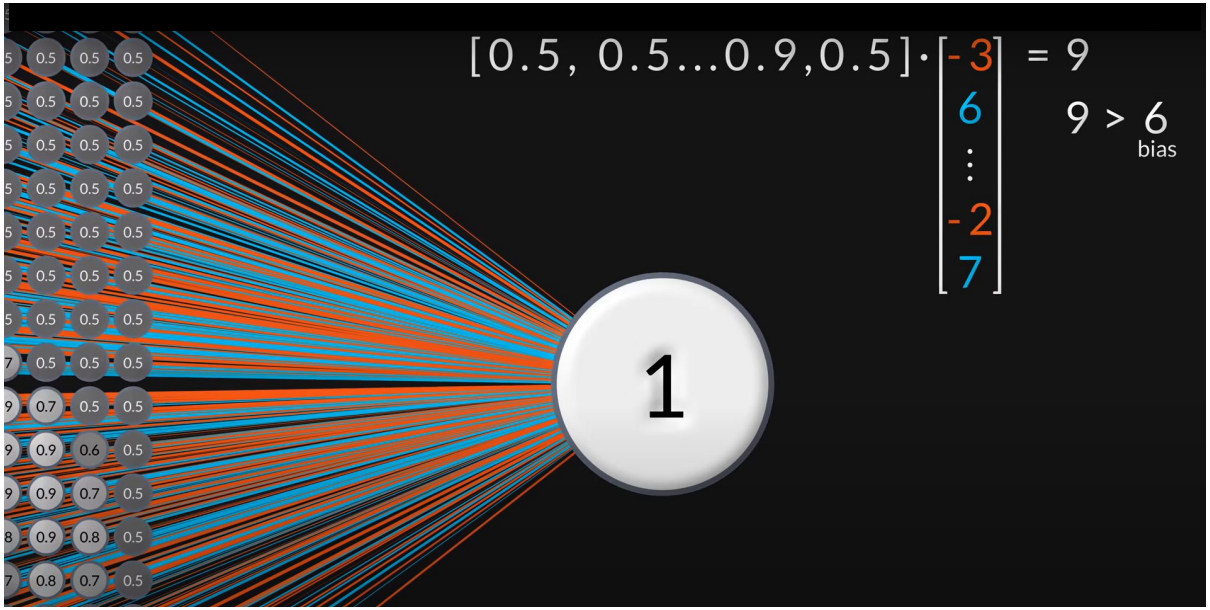

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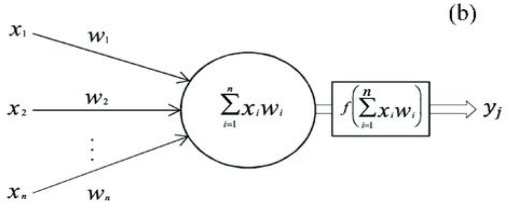

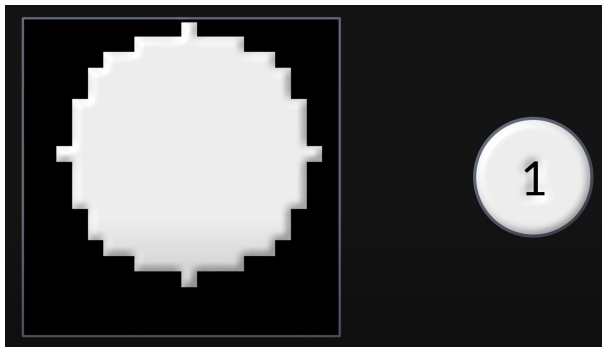

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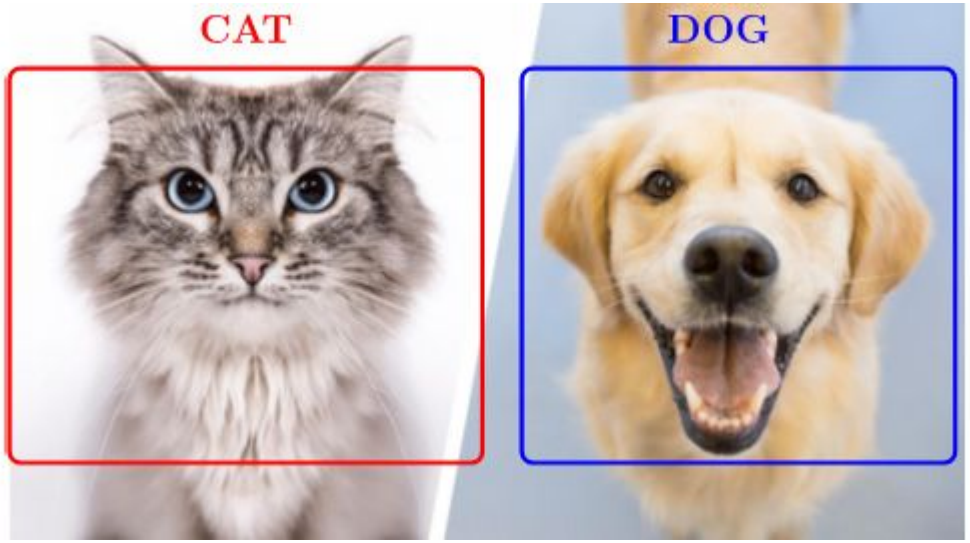
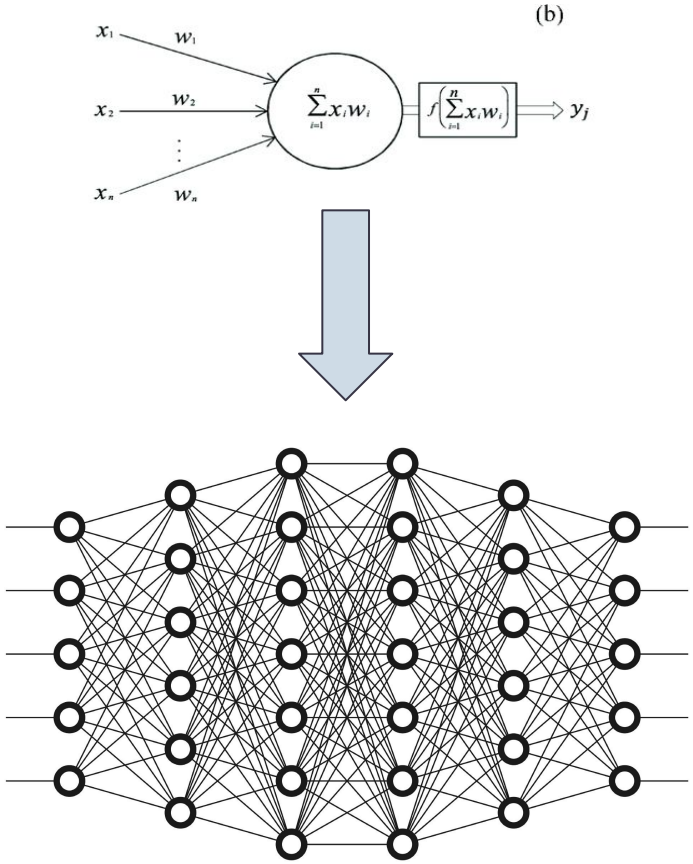


Multi Layer Perceptron



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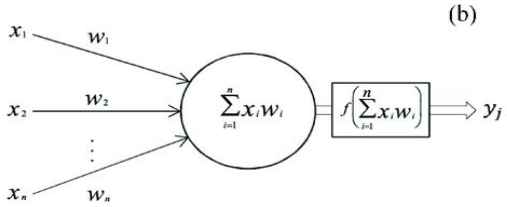
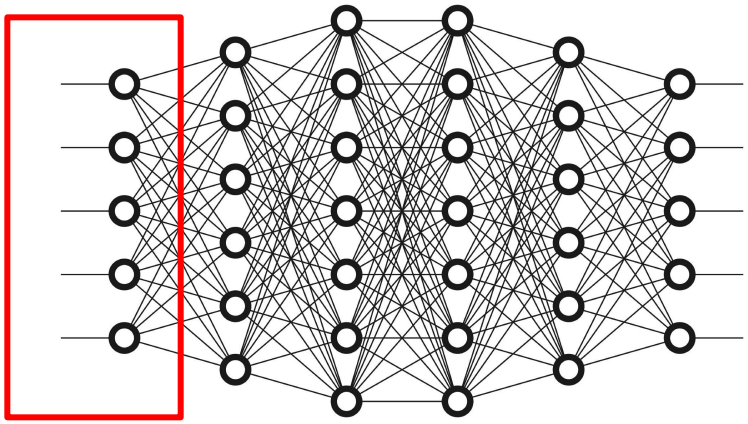
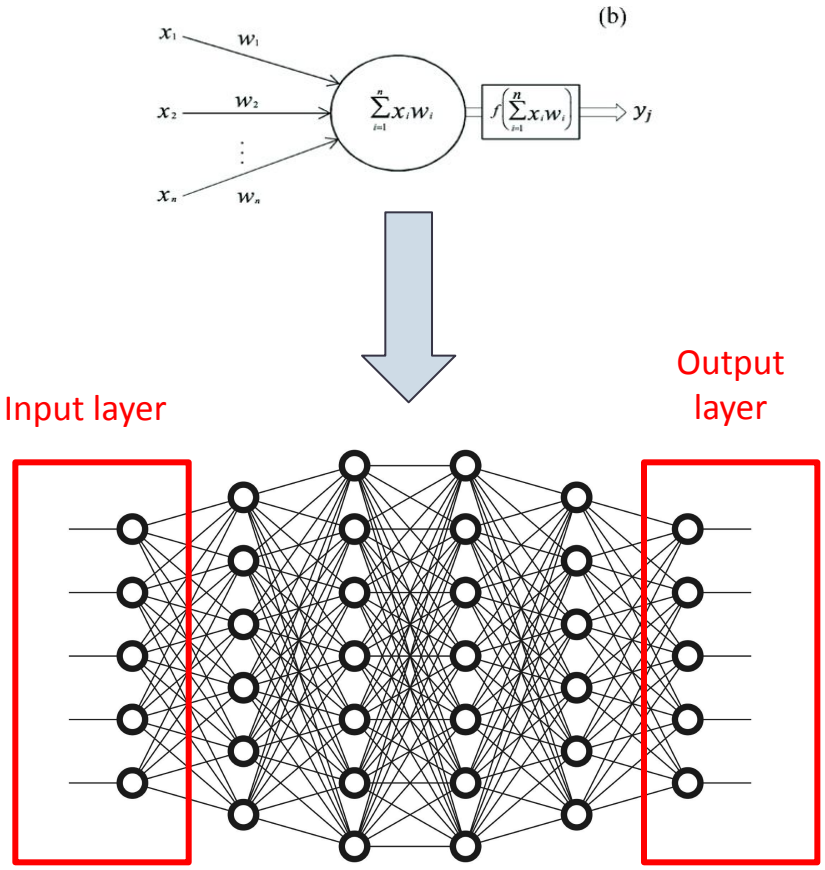


Input layer



Multi Layer Perceptron



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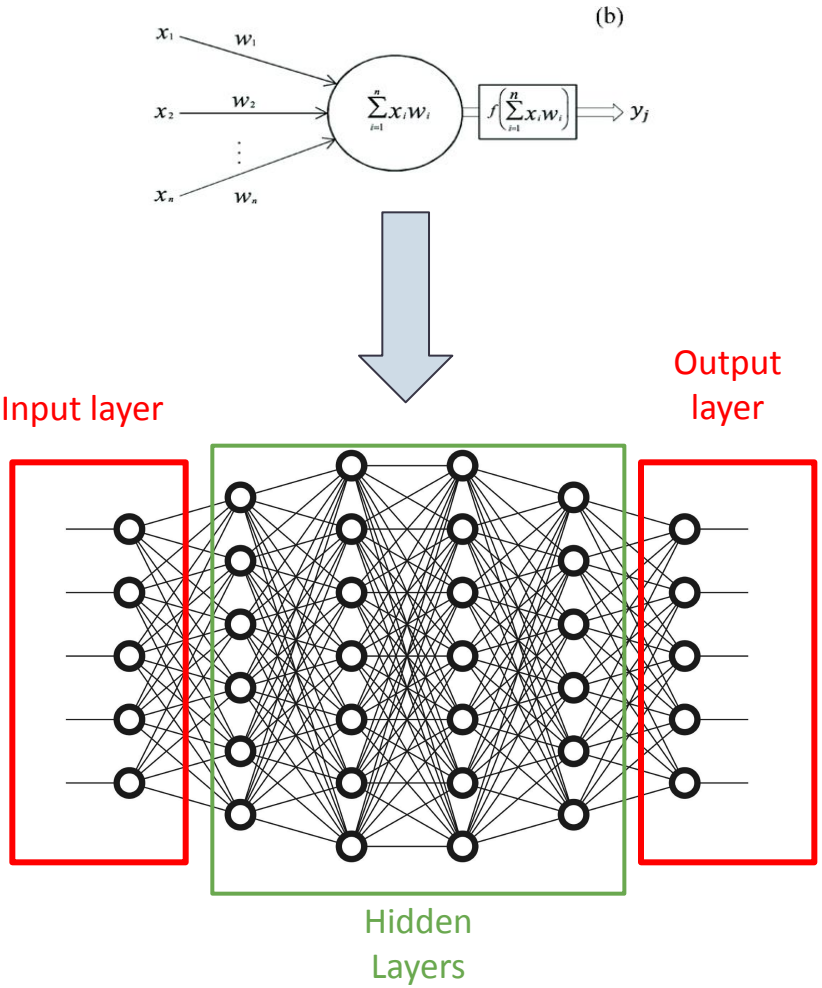
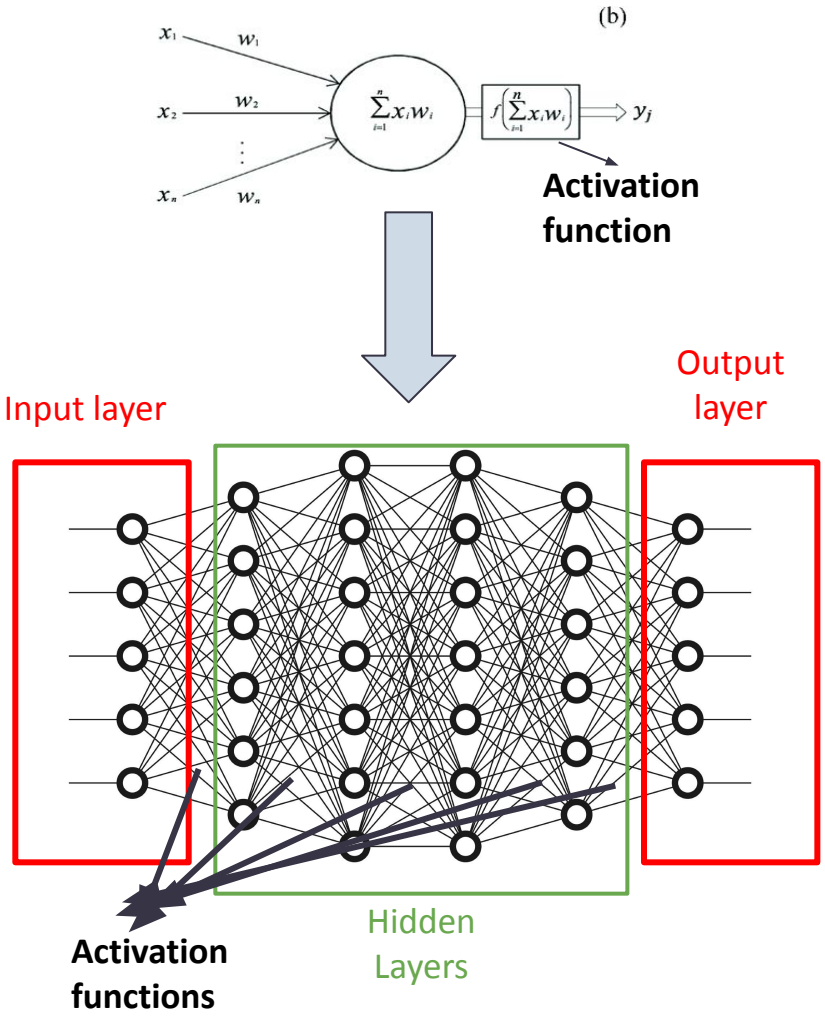


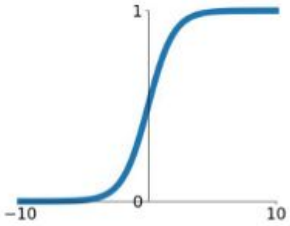
Multi Layer Perceptron



Activation Functions

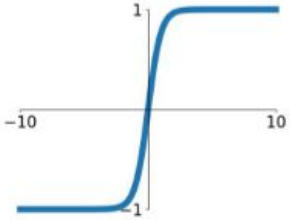
Sigmoid

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



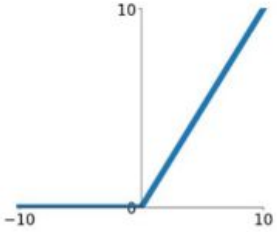
tanh

$$\tanh(x)$$



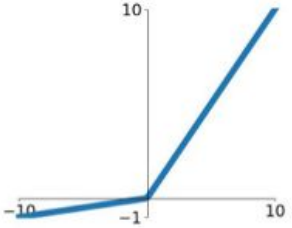
ReLU

$$\max(0, x)$$



Leaky ReLU

$$\max(0.1x, x)$$

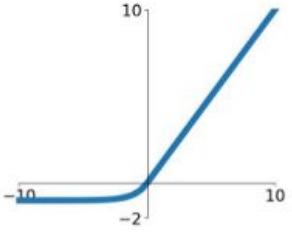


Maxout

$$\max(w_1^T x + b_1, w_2^T x + b_2)$$

ELU

$$\begin{cases} x & x \geq 0 \\ \alpha(e^x - 1) & x < 0 \end{cases}$$



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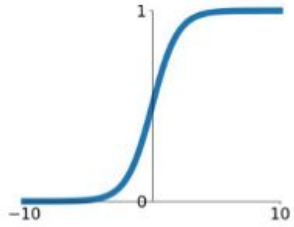

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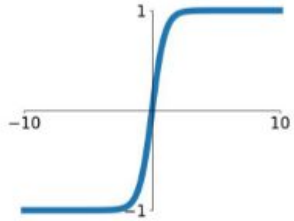

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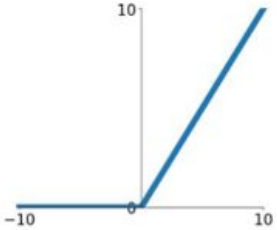

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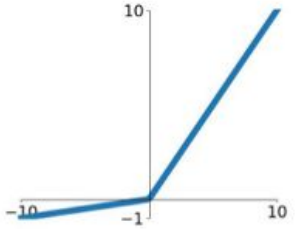

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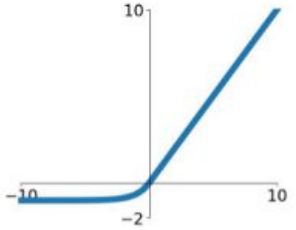
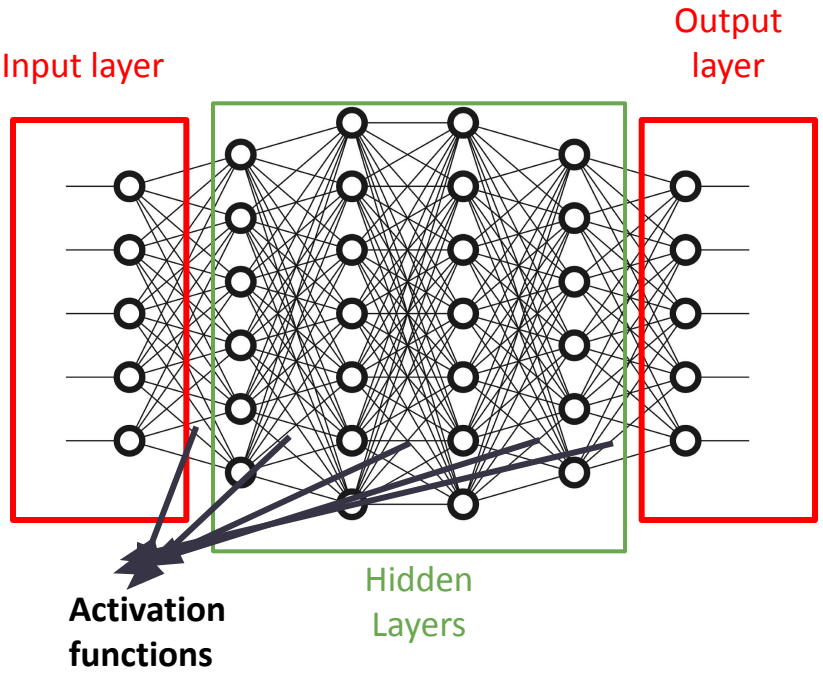


Let's implement our first ML model!



Let's go to our first tutorial and implement our first ML model!!

How do we teach MLP to classify?

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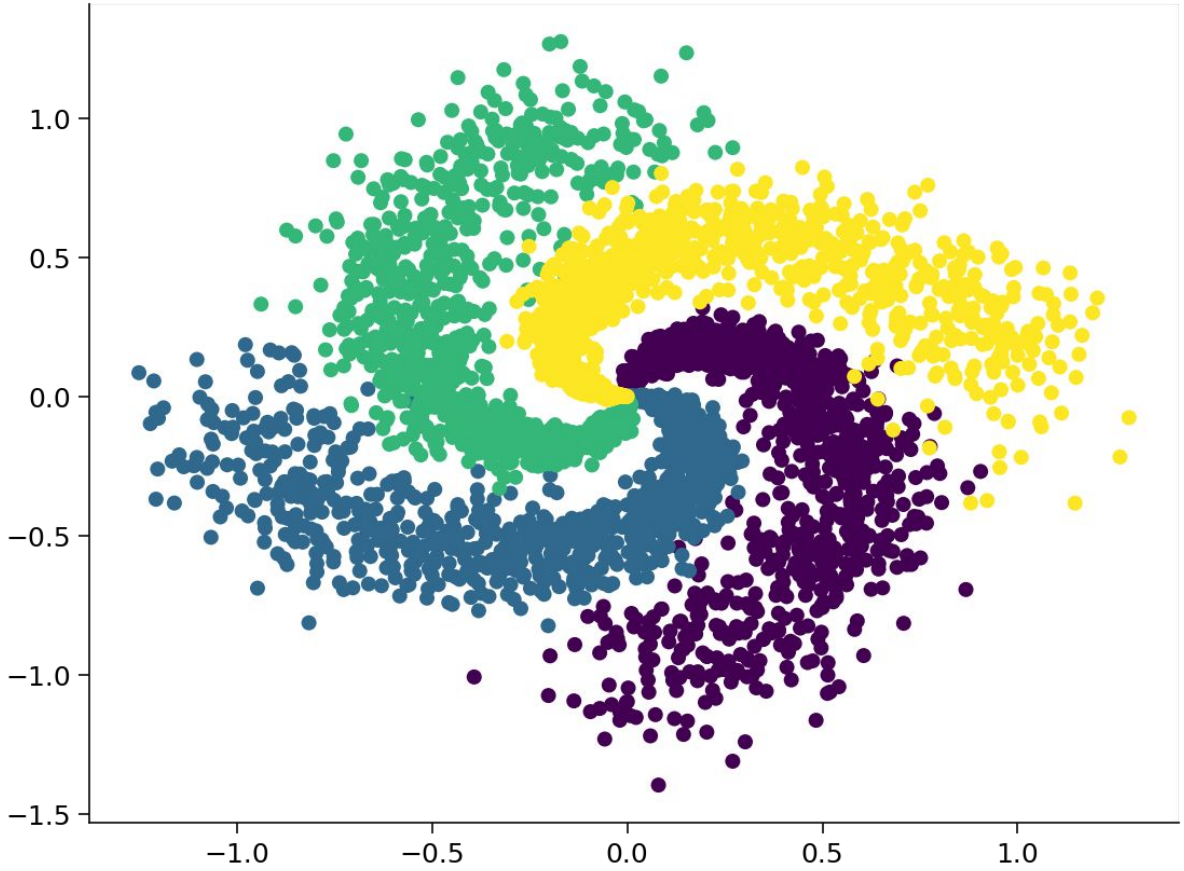
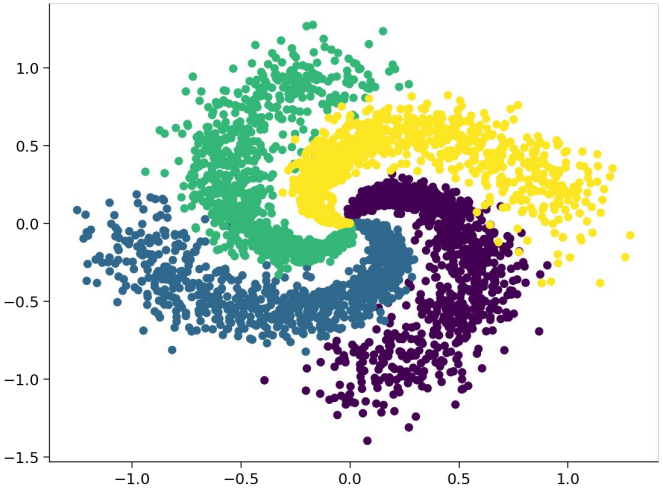
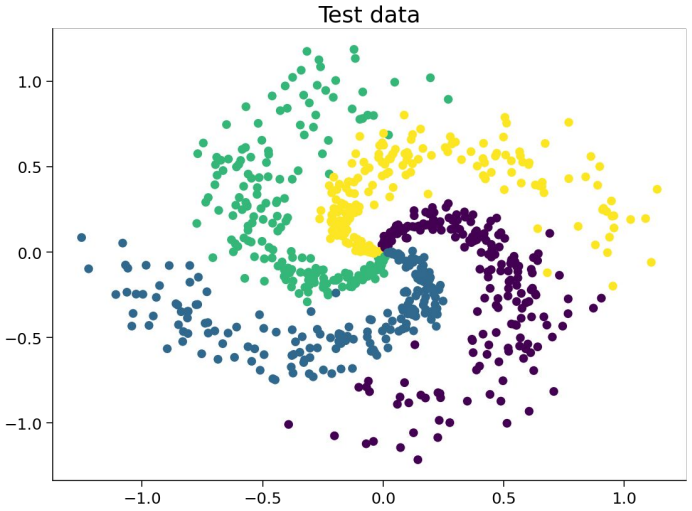
Dataset



How do we teach MLP to classify?

Dataset





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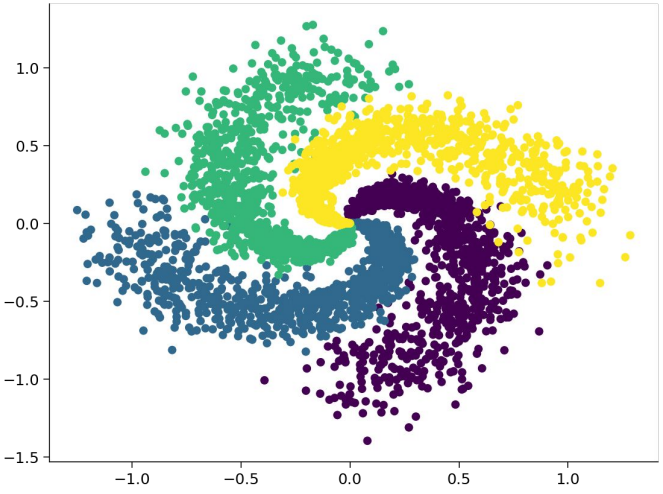
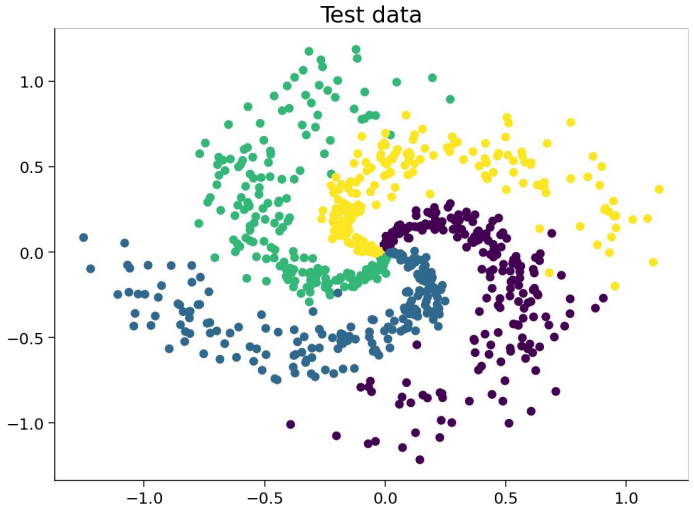
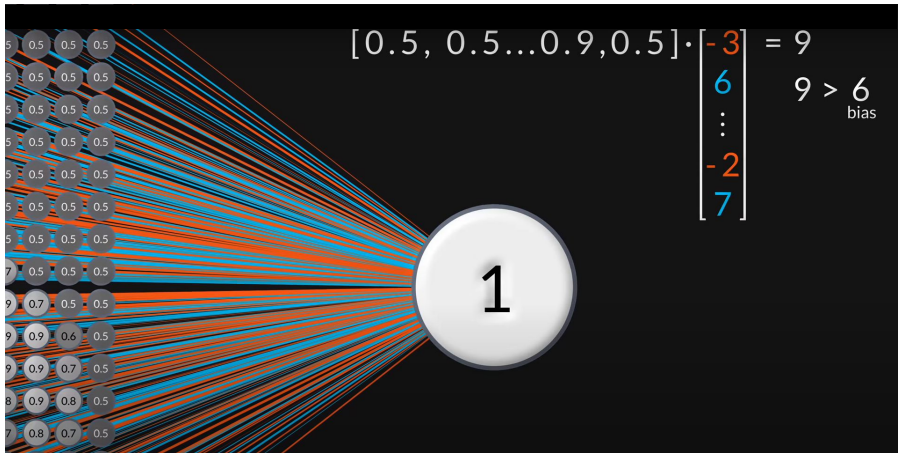
Dataset

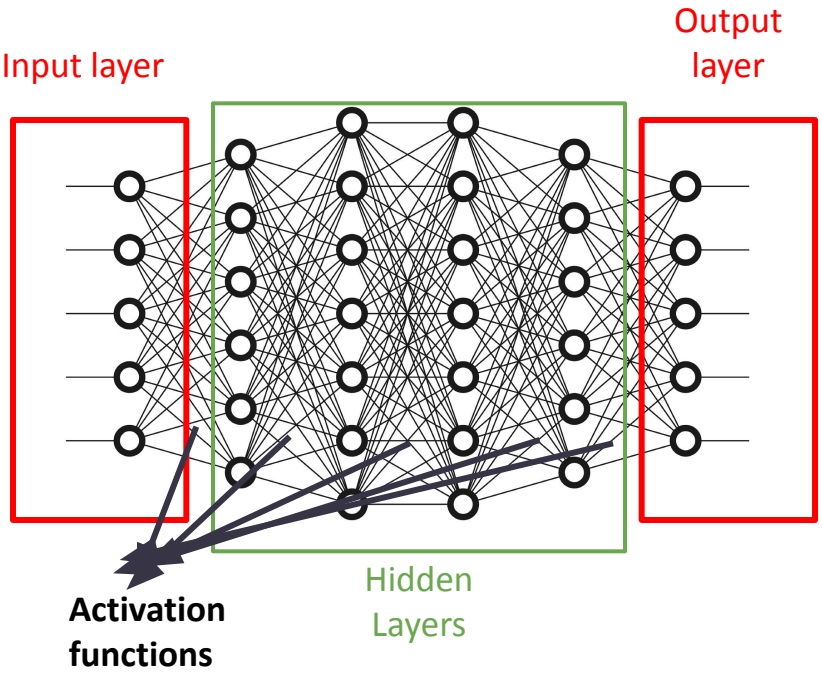




Let's prepare data for our model!

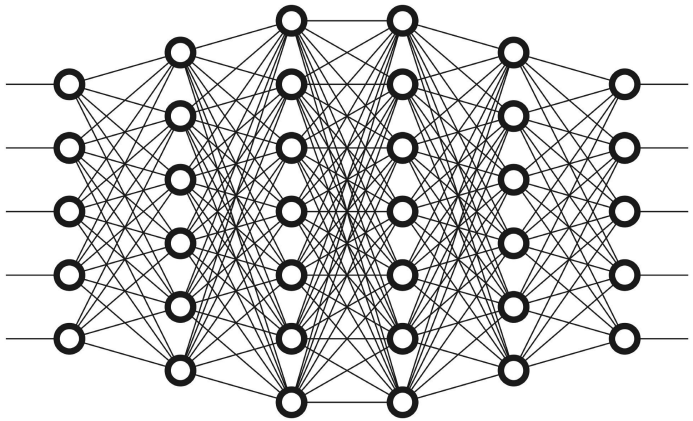
How do we teach MLP to classify?





How do we teach MLP to classify?

Learning good weights



Learning Recipe:

1-Initialize weights

2-Run a forward pass and make a prediction

3-Calculate loss to evaluate how good/bad your prediction was

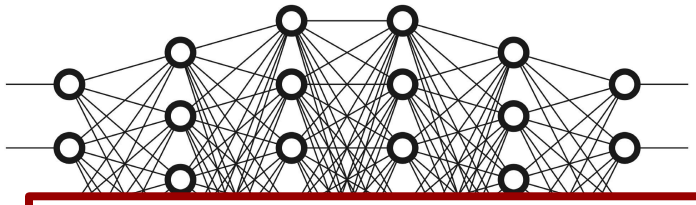
4-Adjust your weights in a way so that loss will be minimized

Popular weight initialization methods: Xavier/Glorot Initialization , Normalized Xavier/Glorot Initialization, He Weight Initialization, Random Weight Initialization

Appendix: Andrew Ng's Lecture on Weight Initialization

How do we teach MLP to classify?

Learning good weights

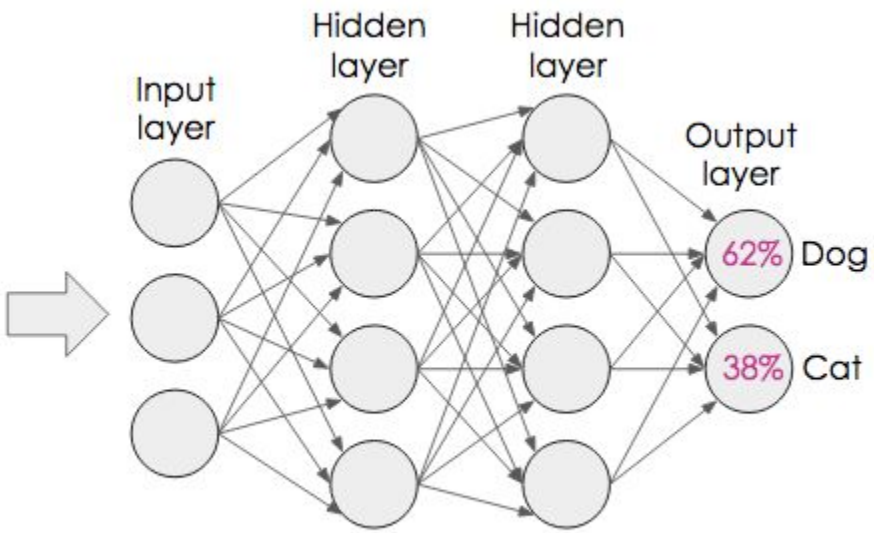


Learning Recipe:

1-Initialize weights

2-Run a forward pass and make a prediction

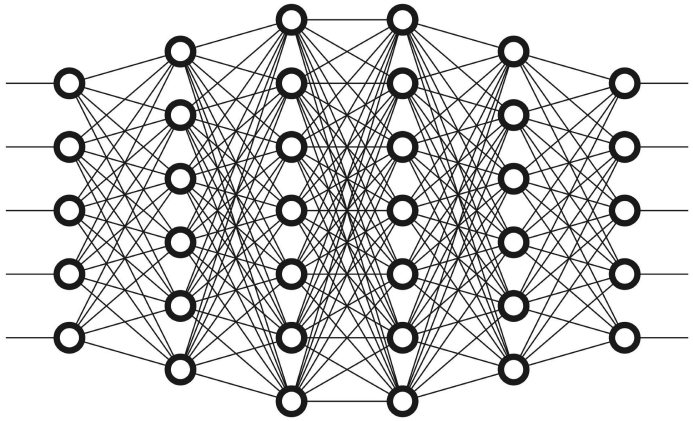
3-Calculate loss to evaluate how



It should be 100% Cat :(

How do we teach MLP to classify?

Learning good weights



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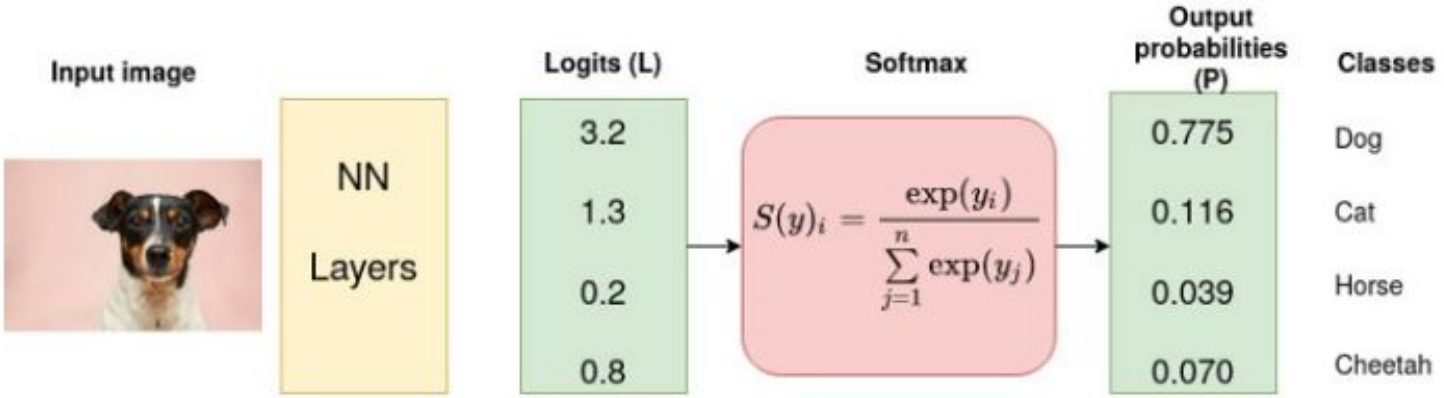
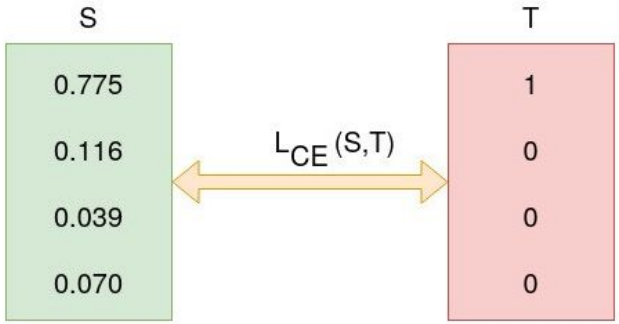
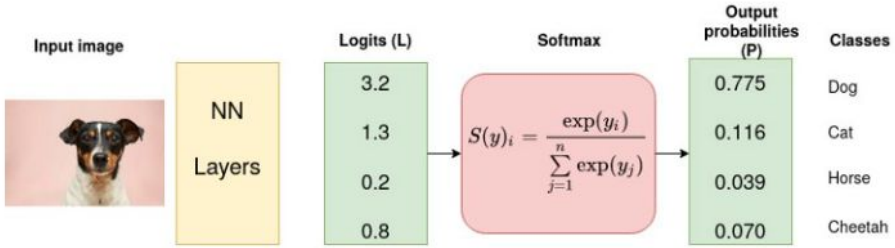
Classifying categorical variables -> Cross-entropy Loss Function



Input image source: Photo by Victor Grabarczyk on Unsplash . Diagram by author.



Cross Entropy (L) (Source: Author).



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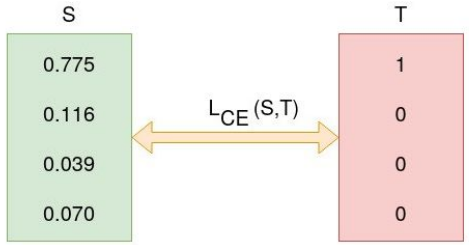

Cross Entropy (L) (Source: Author).

$$L_{\text{CE}} = -\sum_{i=1}^{n} t_i \log(p_i), \text{ for n classes,}$$

where t_i is the truth label and p_i is the Softmax probability for the i^{th} class.

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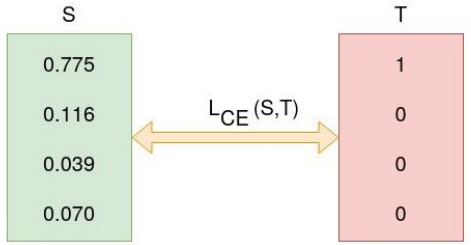
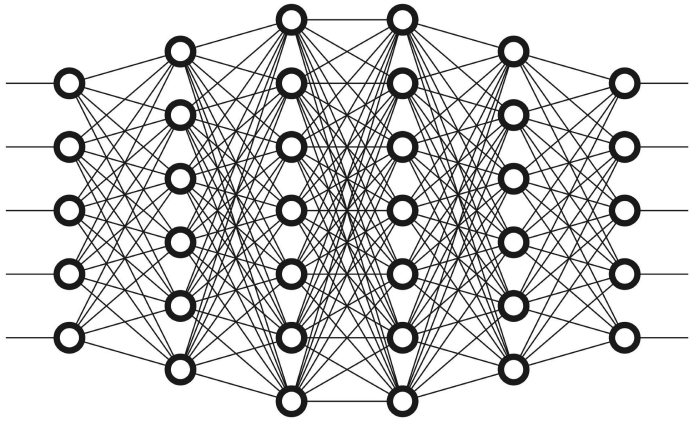


Cross Entropy (L) (Source: Author).

$$\begin{aligned} L_{CE} &= -\sum_{i=1} T_i \log(S_i) \\ &= -\left[1 \log_2(0.775) + 0 \log_2(0.126) + 0 \log_2(0.039) + 0 \log_2(0.070)\right] \\ &= -\log_2(0.775) \\ &= 0.3677 \end{aligned}$$

How do we teach MLP to classify?

Learning good weights



Learning Recipe:

1-Initialize weights

2-Run a forward pass and make a prediction

3-Calculate loss to evaluate how good/bad your prediction was

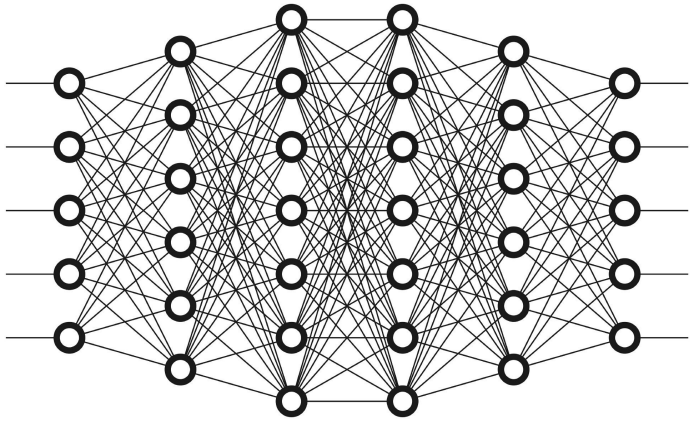
4-Adjust your weights in a way so that loss will be minimized

Optimization! -> More details in the next lecture

We will use Adam Optimizer for this tutorial

How do we teach MLP to classify?

Learning good weights



Learning Recipe:

1-Initialize weights

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Let's train our MLP model!!