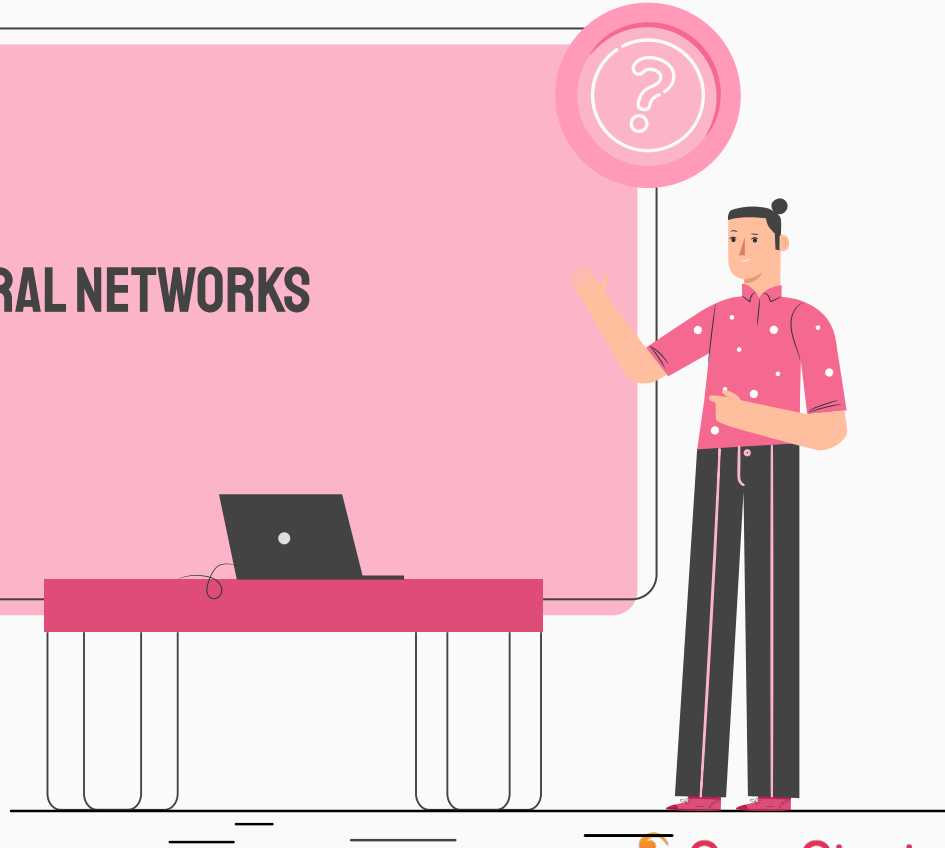
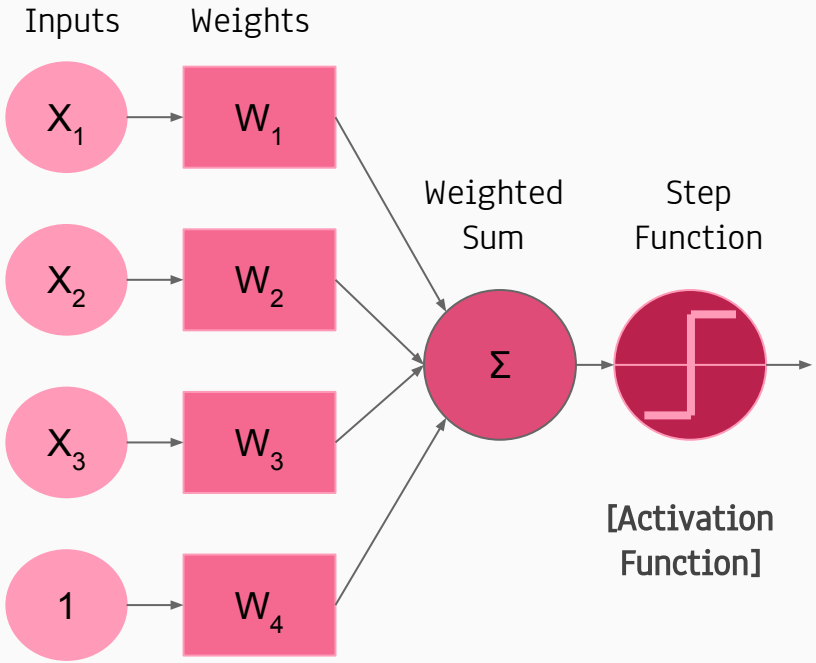
ARTIFICIAL NEURAL NETWORKS



ARTIFICIAL NEURAL NETWORK



An artificial neural network consists of a pool of simple processing units, which communicate by sending signals to each other over a large number of weighted connections.

Processing of ANNs have three building blocks -

- Network topology: nodes and connecting lines
- Adjustments of weights (this is what is being "learned")
- Activation functions

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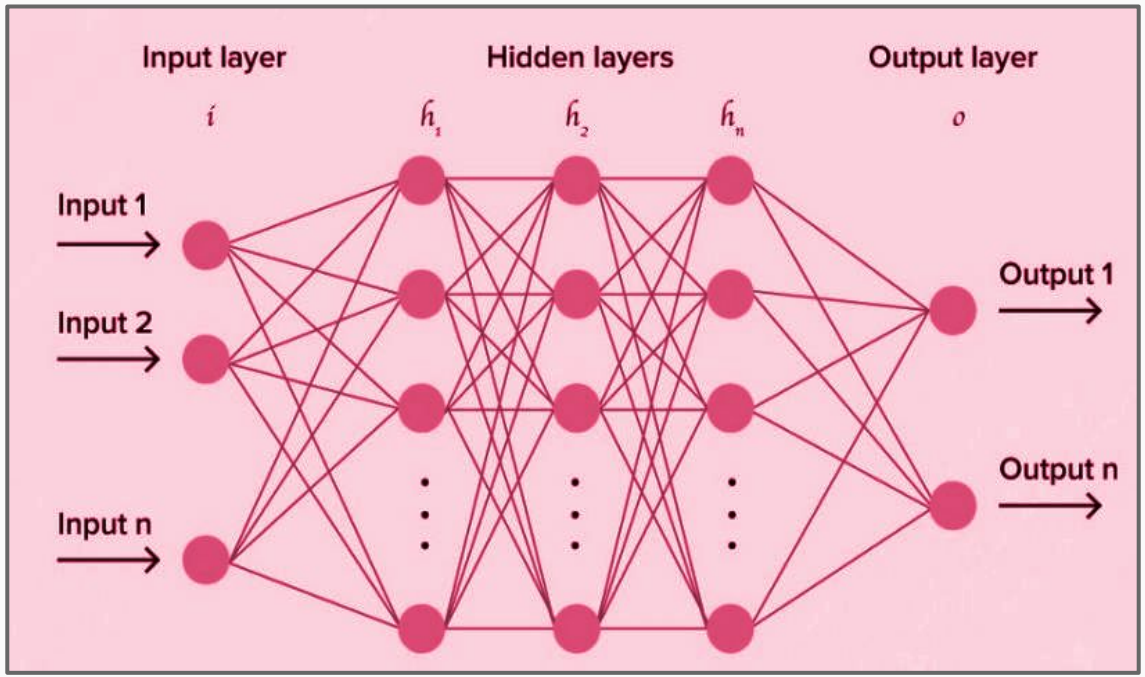
ANN ARCHITECTURE

- Nodes are the building block of ANNs.
- ANNs are organized in layers made up of several interconnected nodes.
- Signals are passed between neurons over connection links.
- Each connection link has an associated weight; which, in a typical neural net, multiplies the transmitted signal.
- Each neuron applies a nonlinear function (i.e., activation function) to its net input to determine its output signal.



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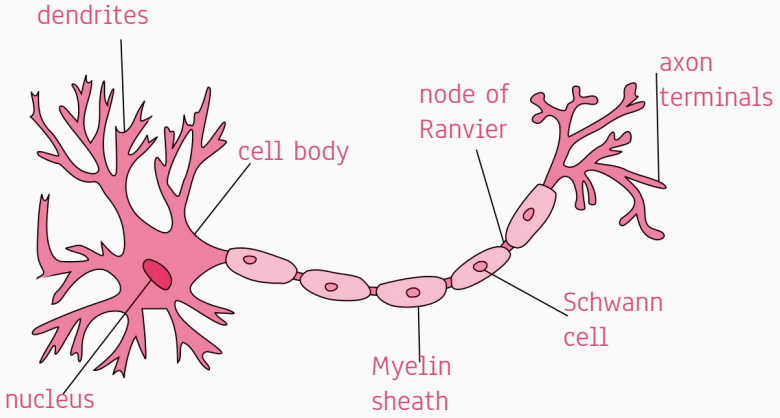
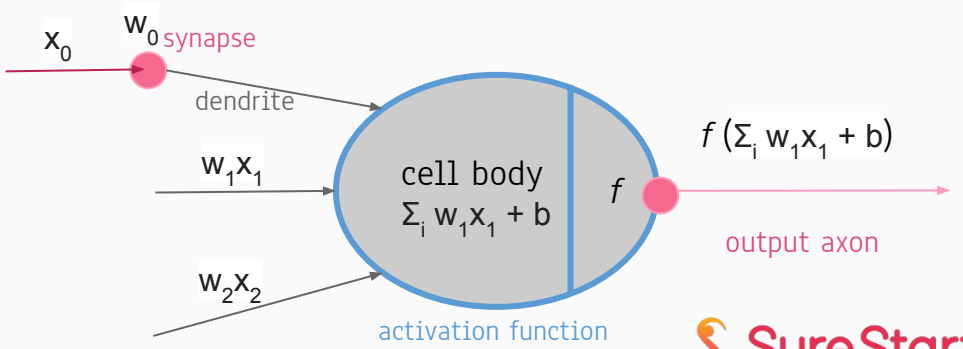
ANN FUNCTIONALITY

Artificial NN are inspired by the human brain

- **Neuron** is the basic computational unit.
- The **input information** x_0 travel along the axons and get multiply with the **weight** w_0 (synaptic strength).
- The dendrites carry the **multiplied signal** w_0x_0 to the cell body where they all get **summed**.
- If the final sum is above a **certain threshold**, the neuron can **pass** information fed through an activation function *f*.





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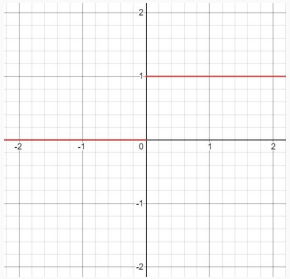
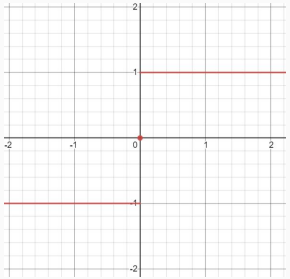
ACTIVATION FUNCTION

It determines the threshold at which the neuron is activated and strength of the output signal.

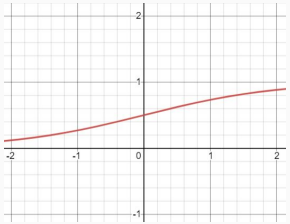
Some common activation functions:



Step function gets triggered above a certain value of the neuron output; else it outputs zero.



Sign function outputs +1 or -1 depending on whether neuron output is greater than zero or not.



Sigmoid is the S-curve and outputs a value between 0 and 1.

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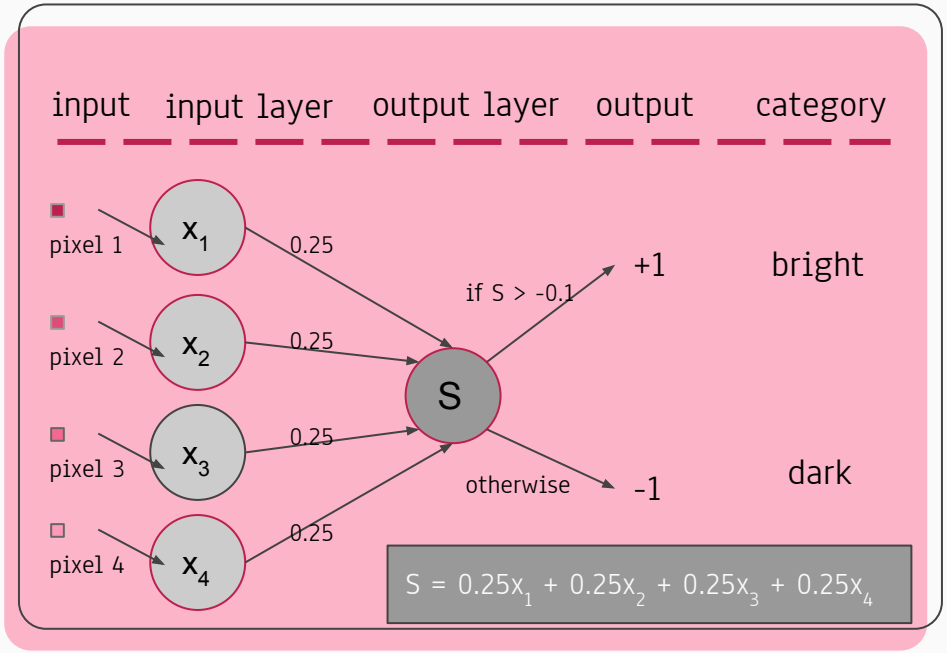
WEIGHTS AND BIASES



Weights show the strength of a particular node. They are initialized with small random values.

Biases allow you to shift the activation function curve up or down.

The bias is similar to the constant *b* of a linear function *y = ax + b*. *b* allows the line to move up and down rather than just going through the origin. Bias provides a similar flexibility to the activation function so that the prediction can fit the data more flexibly.

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DIFFERENT DIMENSIONS OF ANNS

Based on the number of hidden layers:

SINGLE LAYER

Having one secret layer.
E.g., Single Perceptron

MULTI-LAYER

Having multiple secret layers.
E.g., Multilayer Perceptron

Based on the connection patterns:

FEED-FORWARD

The network doesn't have any memory, which means the ANN graph network does not have a loop.

RECURRENT

This network does have memory, thus it remembers the results of the previous iteration to make better decisions in the current iteration. One or more loops occur in the recurrent ANN graph network.

SINGLE PERCEPTRON

Single perceptron is the first modern single-layer neural network.
A linear binary classifier for supervised learning.

Perceptron was introduced by Frank Rosenblatt [American psychologist, 1928-1971] in 1957.

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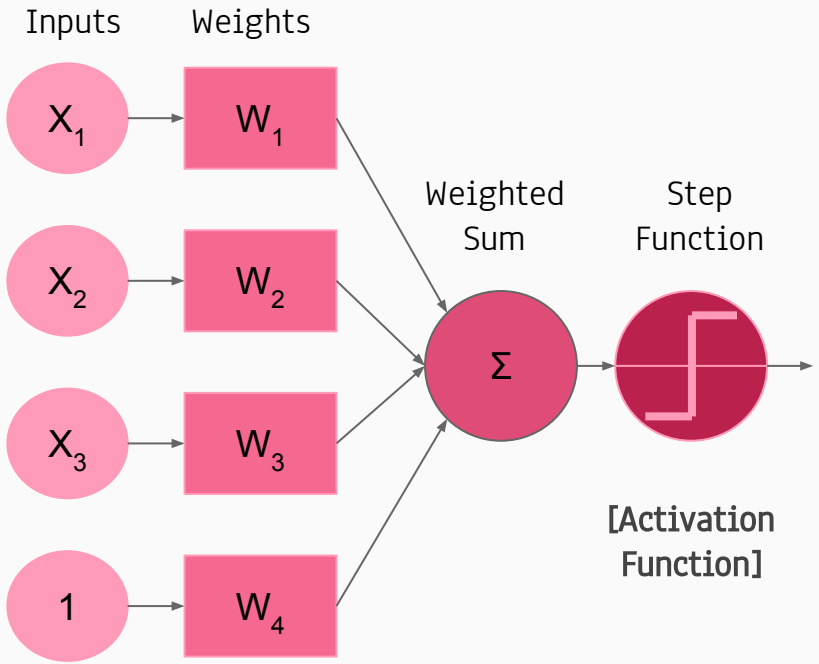
PERCEPTRON FUNCTIONALITY

Steps:

1. All the **inputs** *x* are to be multiplied with their **weights** *w*.
2. **Add** all the multiplied values and call them **weighted sum**.
3. **Apply** that weighted sum to the correct **activation function**.



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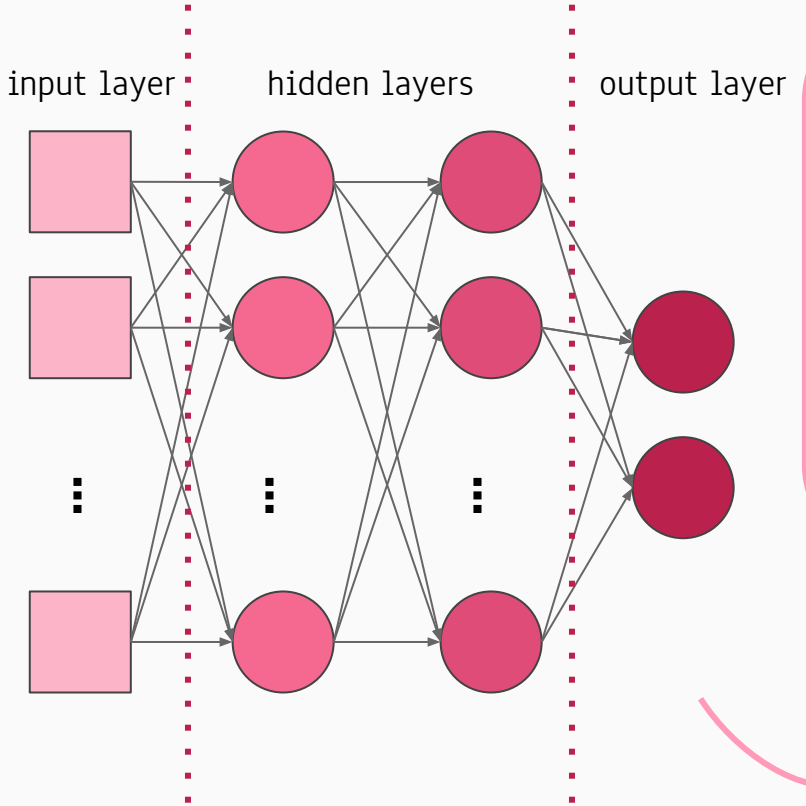
MULTILAYER PERCEPTRON



A multilayer perceptron is a type of **feed-forward** artificial neural network.

A multi layer perceptron has one or more **hidden layers**.

A multi layer perceptron can learn both linear and **nonlinear** functions.

This network utilizes **backpropagation** for training the network

An MLP has three kind of layers:
Input Layer, Hidden Layers, Output Layer

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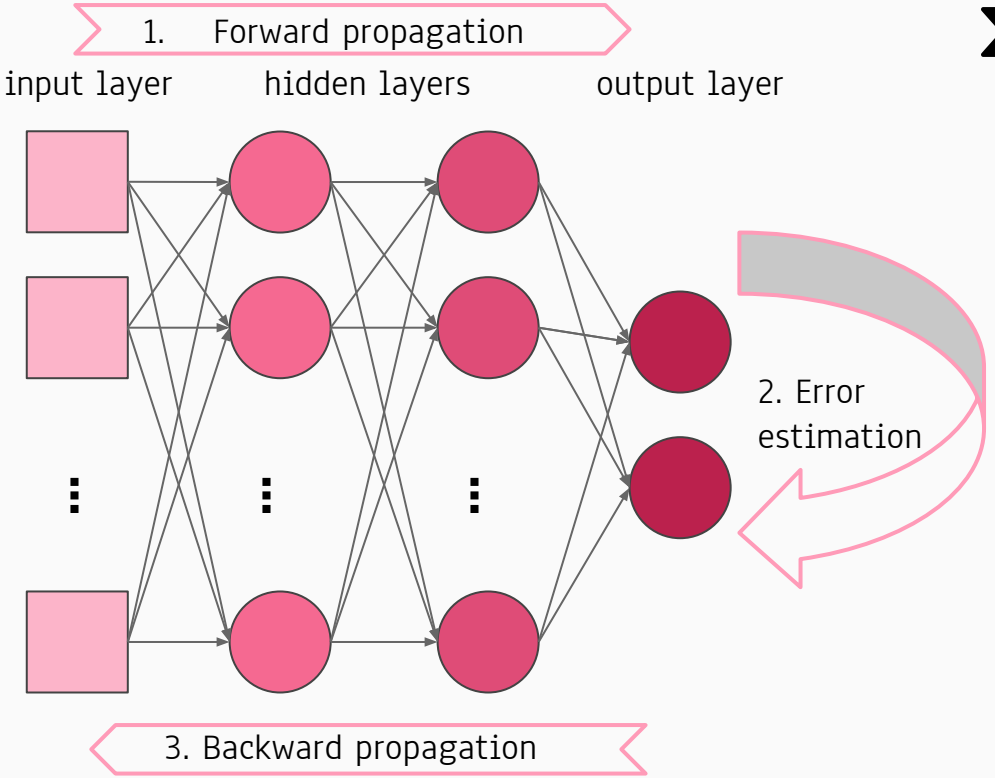
BACKPROPAGATION



In supervised learning technique, naturally the model output sometimes differs from the expected output. The difference between the two values is called the **error**.

Backpropagation is "*learning from mistakes*".

This technique is used to optimize the weights of an MLP using the outputs as inputs.

Backpropagation refers to the process of - sending this error back through the network, **readjusting the weights** automatically so that eventually, the error between the actual and expected output is minimized.

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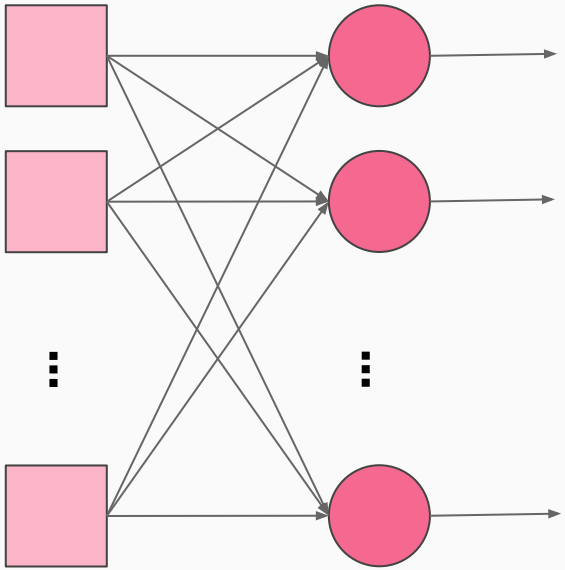
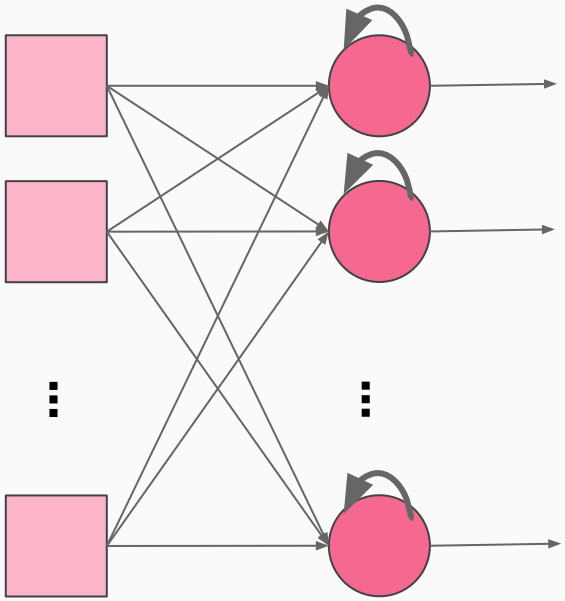
FEEDFORWARD NETWORKS



Feed Forward neural network is a multilayer neural network where -

- Data enters at the inputs and passes through the network, layer by layer, until it arrives at the outputs. There is no **feedback between layers**.
- Each perceptron in one layer is connected to every perceptron on the next layer. Hence information is constantly "fed forward" from one layer to the next.
- There is **no connection among perceptrons** in the same layer.

RECURRENT NEURAL NETWORKS (RNN)



In a RNN the information cycles through a **loop**. When it makes a decision, it considers the current input plus what it has *learned from the inputs it received previously*.

- A class of neural networks that are helpful in modeling sequence data.
- It remembers its input, due to an internal memory.
- Works best for sequential data like time series, speech, text, financial data, audio, video, weather and much more.

- **An RNN has two inputs: the present and the recent past.**

- **RNN networks add the immediate past to the present.**

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