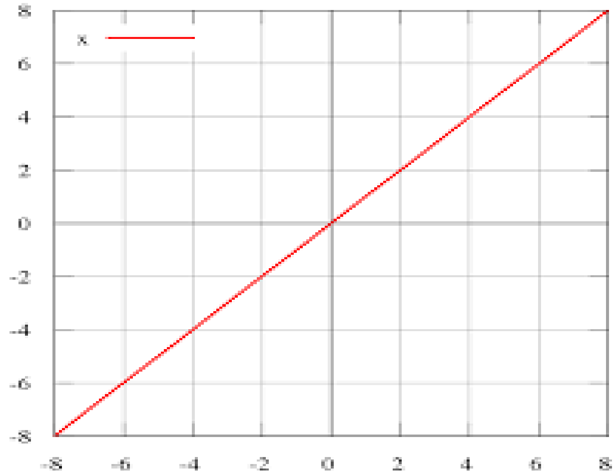
ACTIVATION FUNCTIONS

Neural Network

It can be defined as f(x) = x for all values of x. This is a linear function where the output is the same as the input.

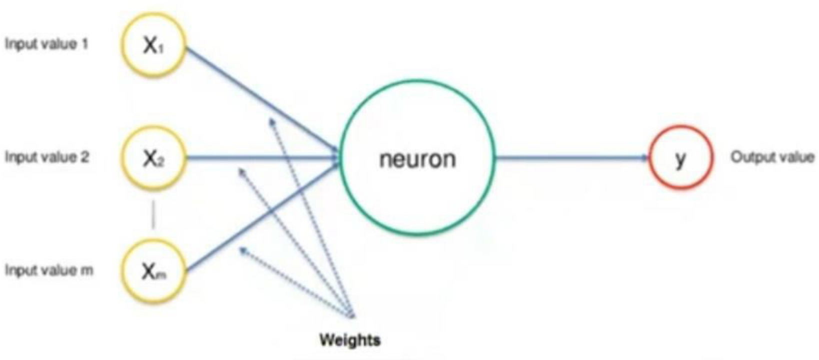


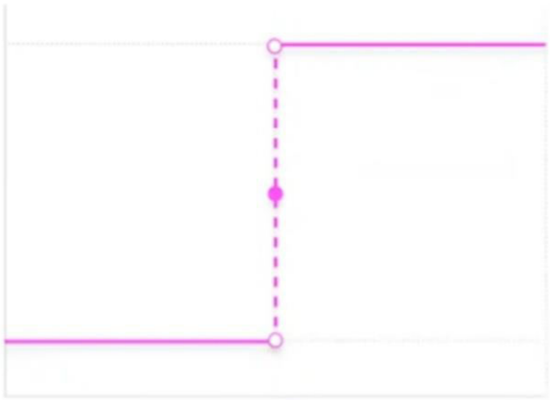
This function is used in single layer networks to convert the net input to output. The output is binary i.e. 0 or 1. The theta represents the threshold value.

Non Linear Activation Functions

1. Binary Step Function

$$f(x) = \begin{cases} 1 & \text{if } x \geqslant \theta \\ 0 & \text{if } x < \theta \end{cases}$$



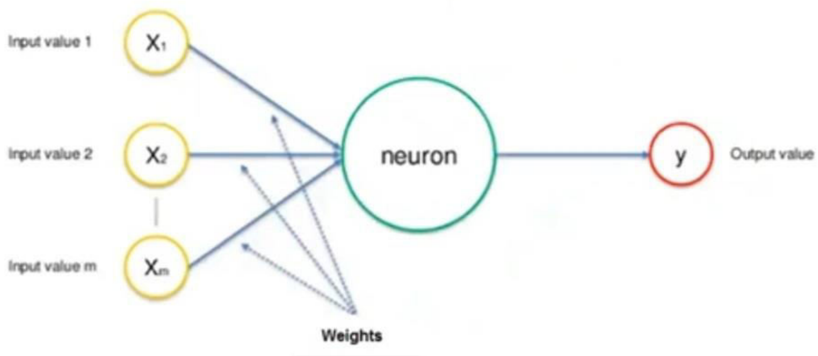


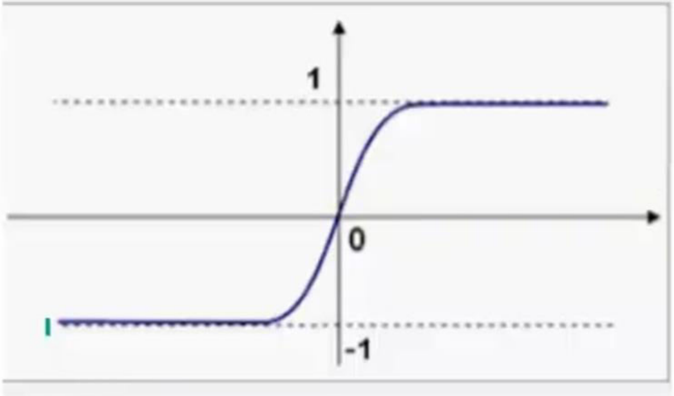
The bipolar step function has bipolar outputs (+1 or -1) for the net input. Theta represents the threshold value.

Non Linear Activation Functions

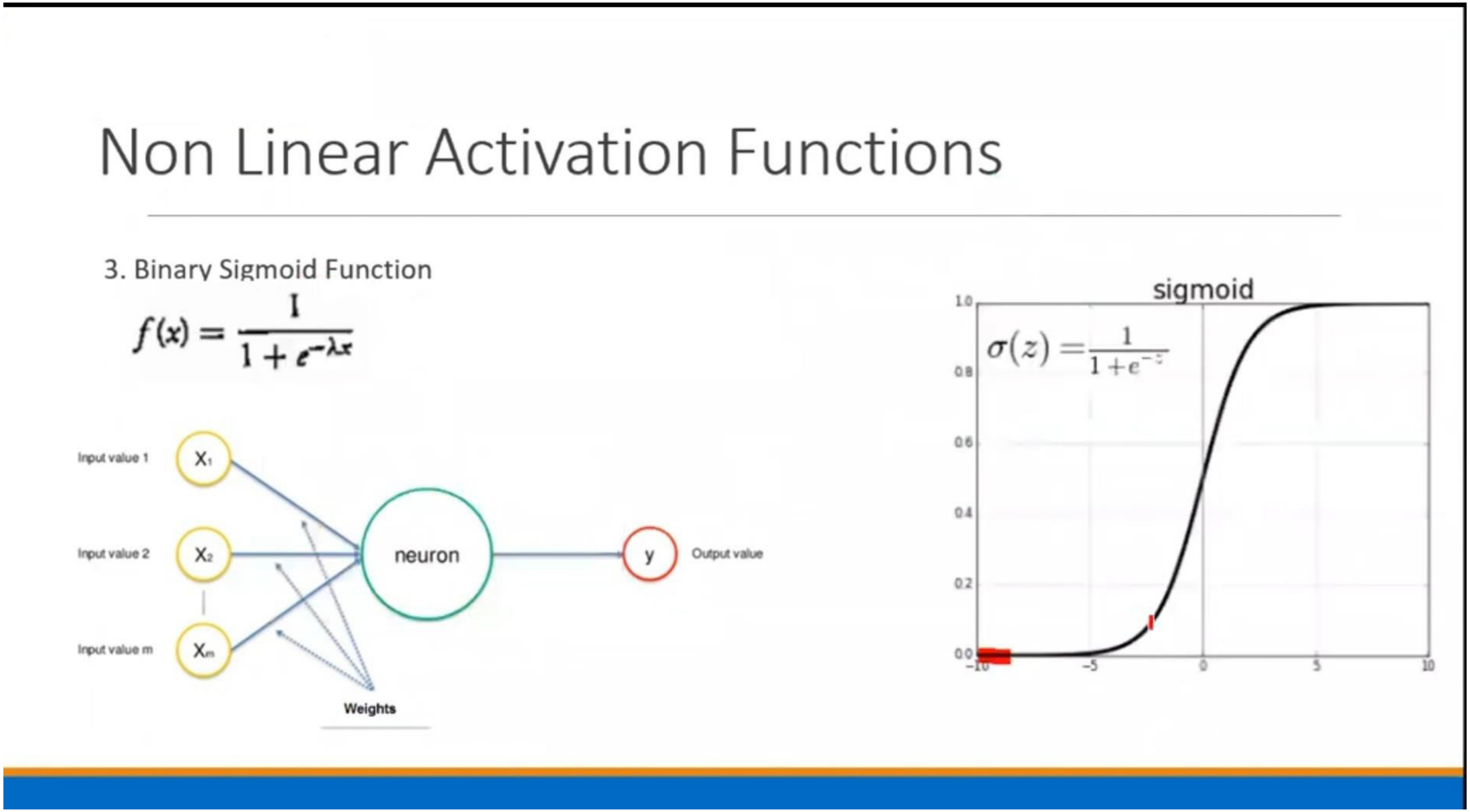
2. Bipolar Step Function

$$f(x) = \begin{cases} 1 & \text{if } x \geqslant \theta \\ -1 & \text{if } x < \theta \end{cases}$$

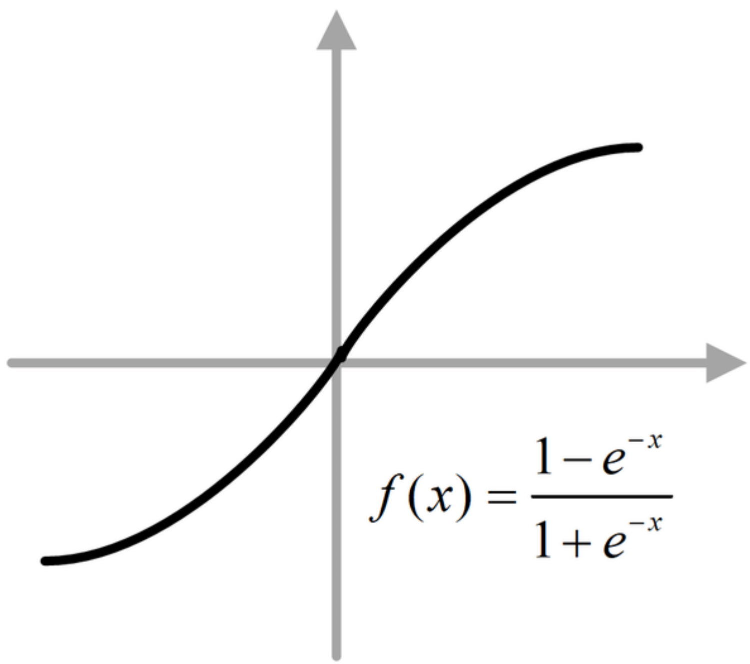




Binary Sigmoid function: It is also called as the unipolar sigmoid function or logistic sigmoid function. The range of sigmoidal functional is 0 to 1.



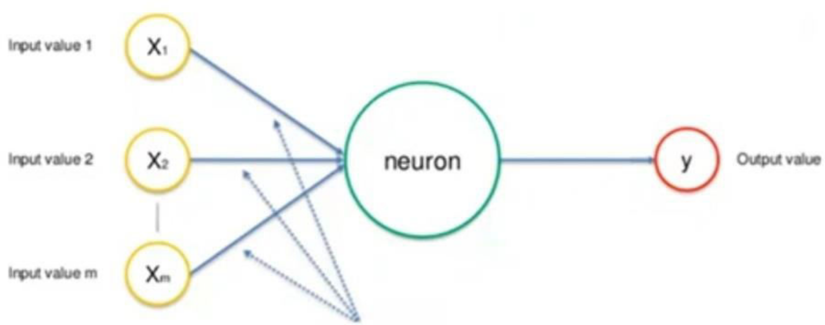
4. Bipolar Sigmoid: The bipolar sigmoidal function ranges from -1 to +1. It is similar to the hyperbolic tangent function.

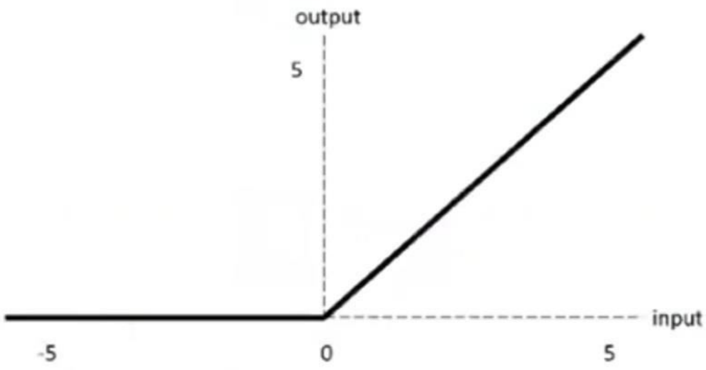
- 

Non Linear Activation Functions

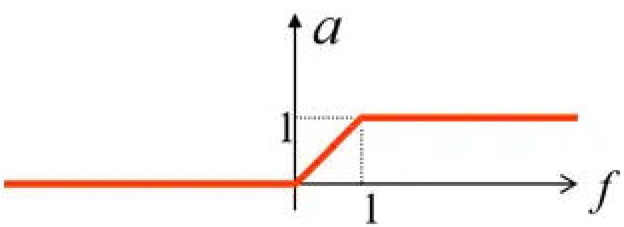
5. RELU (Rectified Linear Unit)

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





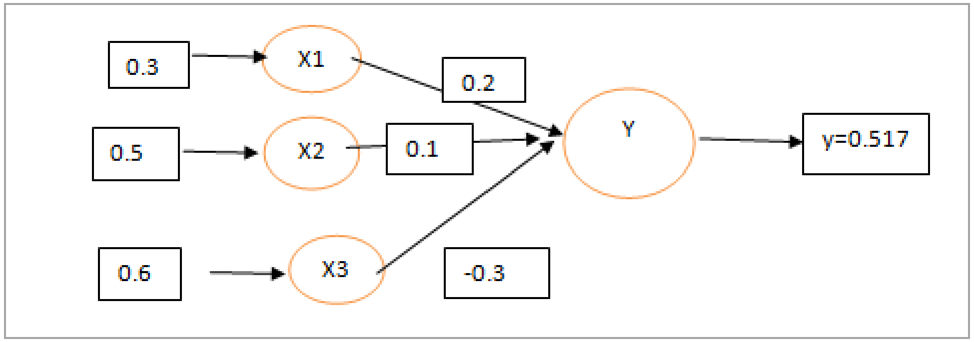
- It looks very similar to the sigmoid activation function, it maps the inputs to output over a range (0,1), instead of a smooth curve the ramp will have a sharp curve. It is a truncated version of the linear function.



$$\mathrm{f}(\mathrm{x}) = \begin{cases} 1 & x \geq 0 \\ x & 0 \leq x \leq 1 \\ 0 & otherwise \end{cases}$$

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

- The input has 3 neurons X1, X2 and X3, and single output Y.
- The weights associated with the inputs are: {0.2, 0.1, -0.3}
- Inputs= {0.3, 0.5, 0.6}
- Net input ={x1*w1+x2*w2+ x3*w3}
- Net input = (0.3*0.2) + (0.5*0.1) + (0.6*-0.3)
- Net input= -0.07
-



Biological Neuron vs. Artificial Neuron

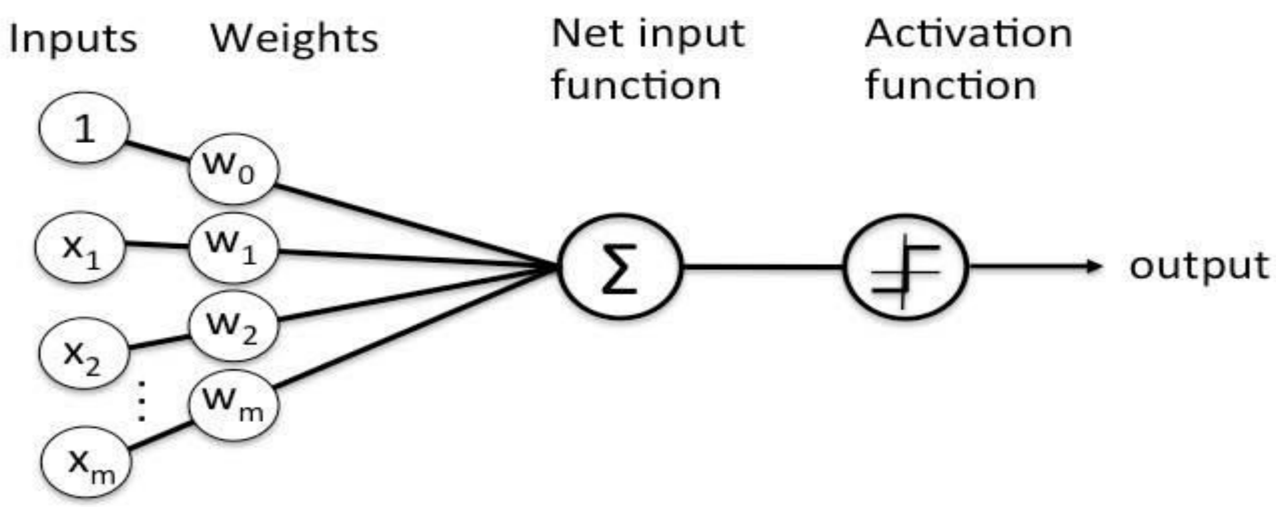
The biological neuron is analogous to artificial neurons in the following terms:

Biological Neuron	Artificial Neuron
Cell Nucleus (Soma)	Node
Dendrites	Input
Synapse	Weights or interconnections
Axon	Output

Artificial Neuron

- Artificial Neuron at a Glance
- The artificial neuron has the following characteristics:
- A neuron is a mathematical function modeled on the working of biological neurons
- It is an elementary unit in an artificial neural network
- One or more inputs are separately weighted
- Inputs are summed and passed through a nonlinear function to produce output
- Every neuron holds an internal state called activation signal
- Each connection link carries information about the input signal
- Every neuron is connected to another neuron via connection link

Perceptron

- Perceptron was introduced by Frank Rosenblatt in 1957. A Perceptron is an algorithm for supervised learning of binary classifiers. This algorithm enables neurons to learn and processes elements in the training set one at a time.
- 

Perceptron Learning Rule

- states that the algorithm would automatically learn the optimal weight coefficients. The input features are then multiplied with these weights to determine if a neuron fires or not.
-

Perceptron function

- Perceptron is a function that maps its input “x,” which is multiplied with the learned weight coefficient; an output value ”f(x)”is generated.

$$f(x) = \begin{cases} 1 & \text{if } w \cdot x + b > 0 \\ 0 & \text{otherwise} \end{cases}$$

- In the equation given above:
- “w” = vector of real-valued weights
- “b” = bias (an element that adjusts the boundary away from origin without any dependence on the input value)
- “x” = vector of input x values

$$\sum_{i=1}^{m} w_i x_i$$

- “m” = number of inputs to the Perceptron
- The output can be represented as “1” or “0.” It can also be represented as “1” or “-1” depending on which activation function is used.

Steps to perform a perceptron learning algorithm

- Feed the features of the model that is required to be trained as input in the first layer.
- All weights and inputs will be multiplied – the multiplied result of each weight and input will be added up
- The Bias value will be added to shift the output function
- This value will be presented to the activation function (the type of activation function will depend on the need)
- The value received after the last step is the output value.
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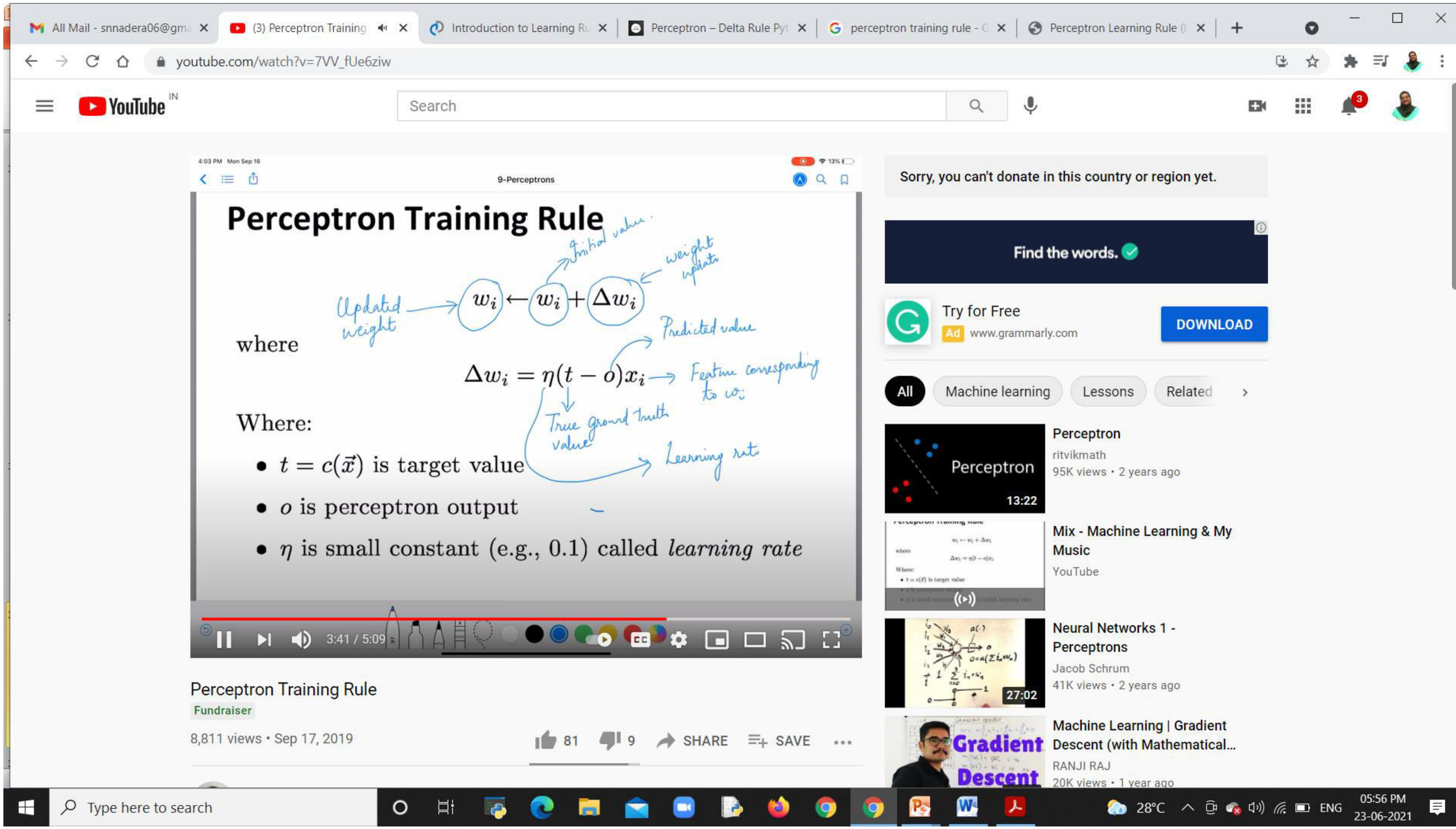
youtube.com/watch?v=7VV_fUe6ziw
9-Perceptrons
Perceptron Training Rule
Initial value
weight update
Updated weight
$w_i \leftarrow w_i + \Delta w_i$
where
Predicted value
$\Delta w_i = \eta(t - o)x_i$
Feature corresponding to w_i
True ground truth value
Where:
• $t = c(\vec{x})$ is target value
Learning rate
• o is perceptron output
• η is small constant (e.g., 0.1) called *learning rate*
3:41 / 5:09
Perceptron Training Rule
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- Learning rate How fast the perceptron algorithm converges to the line that separates the two classes