Activation Function

An activation function is a function that is applied to an artificial neural network in order to assist the network learning complex patterns in data. When compared to a neuron-based model that is in our brains, the activation function is responsible for determining what is to be fired to the next neuron at the end of the process.

When our brain is overloaded with a large amount of data at once, it works hard to evaluate and categorize it into "useful" and "not-so-useful" information. In the case of Neural Networks, an equivalent mechanism for identifying incoming information as "useful" or "less-useful" is essential. Because not all information is equally useful, this is crucial in how a network learns. Without an activation function, a neural network is only a linear regression model.

The types of Activision functions:

- Step Function
- Sigmoid or Logistic Activation Function
- Tanh
- Rectified Linear Units (ReLU)
- Softmax

Step Function: Step function is a threshold-based activation function which means after a certain threshold neuron is activated and below the said threshold neuron is deactivated.The step function can be used as an activation function while creating a binary classifier. This function will not be useful when there are multiple classes in the target variable. That is one of the limitations of step function.

$$f(x) = 1, x>=0$$

$$= 0, x<0$$

Sigmoid or Logistic Activation Function: It is one of the most widely used non-linear activation function. Sigmoid transforms the values between the range 0 and 1

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

Tanh: The tanh function is very similar to the sigmoid function. The only difference is that it is symmetric around the origin. The range of values in this case is from -1 to 1. Thus the inputs to the next layers will not always be of the same sign.

tanh(x)=2sigmoid(2x)-1

Rectified Linear Units (ReLU): The ReLU function is another non-linear activation function that has gained popularity in the deep learning domain. ReLU stands for Rectified Linear Unit. The main advantage of using the ReLU function over other activation functions is that it does not activate all the neurons at the same time.

f(x)=max(0,x)

Softmax: Softmax function is often described as a combination of multiple sigmoids. We know that sigmoid returns values between 0 and 1, which can be treated as probabilities of a data point belonging to a particular class. Thus sigmoid is widely used for binary classification problems.

The softmax function can be used for multiclass classification problems. This function returns the probability for a datapoint belonging to each individual class. Here is the mathematical expression of the same-

$$\sigma(\mathbf{z})_j = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}} \quad \text{for } j = 1, \ldots, K.$$

Activation Function allow back-propagation because they have a derivative function which is related to the inputs. They allow “stacking” of multiple layers of neurons to create a deep neural network. Multiple hidden layers of neurons are needed to learn complex data sets with high levels of accuracy.

We are try to discuss about activation function theoretically. Activation function is very necessary things because We know, neural network has neurons that work in correspondence of weight, bias and their respective activation function.

Contribution:

Name	ID	Contribution
1.Obidullah Sheck	18-36152-1	25%
2.Anoy, Sharain Islam	17-34184-1	25%
3.SK Sajib	18-36172-1	25%
4.Reefat Ahmed Ar Rafi	19-41750-3	25%

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