AMERICAN INTERNATIONAL UNIVERSITY BANGLADESH

Assignment Title: Activation Functions

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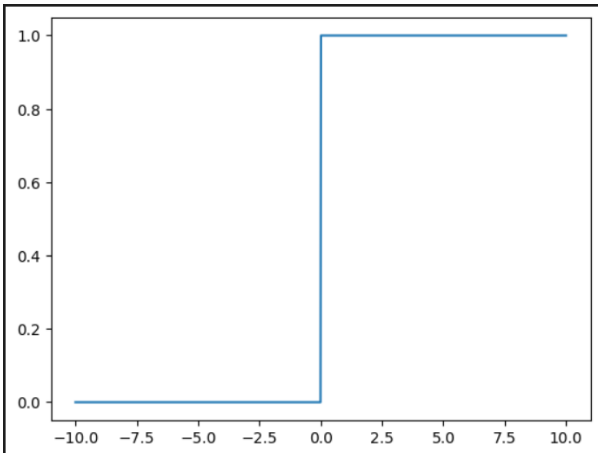
Answer:

An activation function is a mathematical function that controls the output of a neural network. Activation functions help in determining whether a neuron is to be fired or not.

Some popular activation function is-

Step Function:

The step function is a type of activation function commonly used in artificial neural networks. It is a simple function that maps any input to either 0 or 1 based on a threshold value. If the input is greater than or equal to the threshold value, the output is 1; otherwise, the output is 0. The step function is typically used in binary classification problems, where the output is either 0 or 1. However, it has some limitations, such as being non-differentiable and discontinuous, which can make it difficult to use in optimization algorithms for training neural networks.There are also variations of the step function, such as the sigmoidal step function, which introduces a smooth transition between 0 and 1 using a sigmoid function. The sigmoidal step function is a differentiable function that can be used in optimization algorithms for training neural networks.

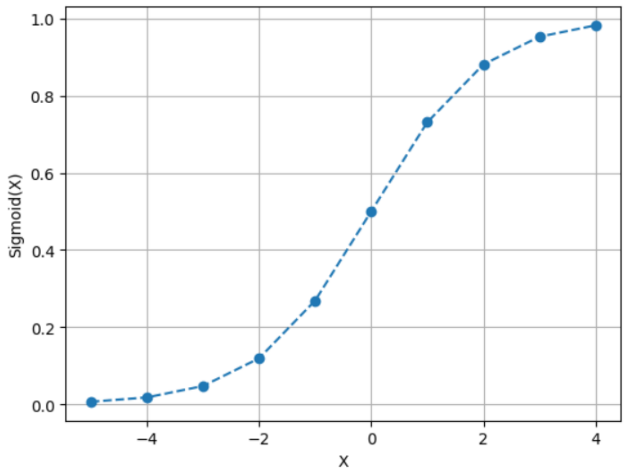


Sigmoid Function:

The sigmoid function is a commonly used activation function in artificial neural networks. It is a mathematical function that maps any input value to a value between 0 and 1, making it useful for binary classification problems where the output is either 0 or 1.The sigmoid function is defined as:

$f(x) = 1 / (1 + \exp(-x))$

where x is the input value and exp is the exponential function. The output of the sigmoid function is always between 0 and 1, and it has a characteristic S-shaped curve.

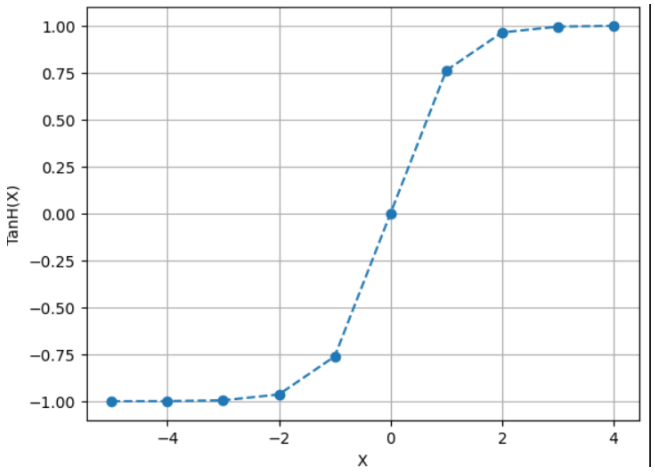


Tanh Function:

The tanh function, short for hyperbolic tangent function, is a commonly used activation function in artificial neural networks. It is a mathematical function that maps any input value to a value between -1 and 1.The tanh function is defined as:

f(x) = (exp(x) - exp(-x)) / (exp(x) + exp(-x))

where x is the input value and exp is the exponential function. The output of the tanh function is always between -1 and 1, and it has a characteristic S-shaped curve like the sigmoid function.It is a differentiable function, which means that it can be used in optimization algorithms for training neural networks. It has some advantages over the sigmoid function, such as being symmetric around the origin, which can help to reduce bias in the output of the neural network. The tanh function also helps to mitigate the vanishing gradient problem that can occur with the sigmoid function.



Relu Function:

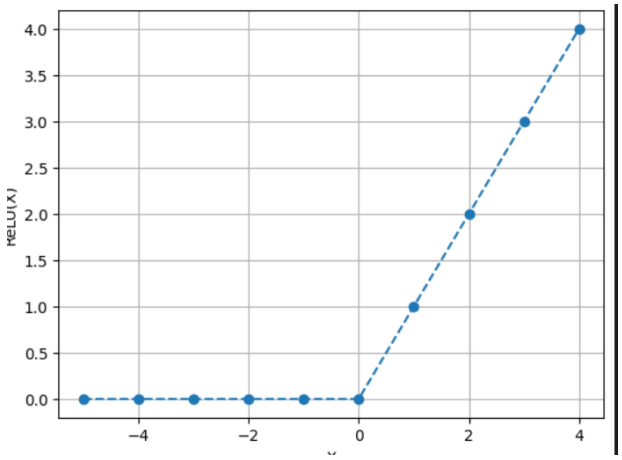
The Rectified Linear Unit (ReLU) function is a commonly used activation function in artificial neural networks. It is a simple function that returns 0 for negative inputs and the input value for positive inputs.

The ReLU function is defined as:

f(x) = max(0, x)

where x is the input value. The output of the ReLU function is 0 for any negative input value, and it is equal to the input value for any positive input value. The ReLU function is a piecewise linear function with a slope of 1 for positive inputs and a slope of 0 for negative inputs.

One of the advantages of the ReLU function is that it is computationally efficient, which makes it well-suited for deep neural networks with many layers. The ReLU function also helps to address the vanishing gradient problem that can occur with other activation functions like the sigmoid and tanh functions.



ELU Function:

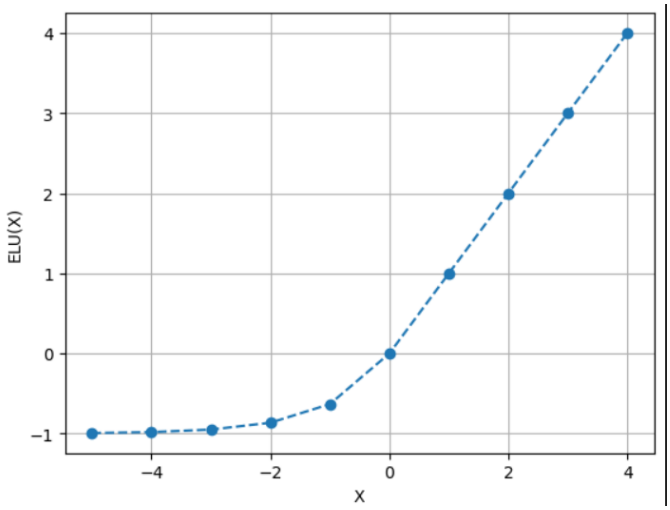
The Exponential Linear Unit (ELU) function is a type of activation function commonly used in artificial neural networks. It is similar to the ReLU function but has some advantages, especially when it comes to avoiding the "dying ReLU" problem.

The ELU function is defined as:

f(x) = { x if x >= 0, alpha * (exp(x) - 1) if x < 0 }

where x is the input value, alpha is a constant that determines the value of the function for negative inputs, and exp is the exponential function. The output of the ELU function is equal to the input value for positive inputs and a smooth curve for negative inputs.

ELU function is that it can produce more accurate predictions than the ReLU function, especially when dealing with noisy data. The ELU function also has a smooth derivative, which can make it easier to optimize in neural networks.



SELU Function:

The Scaled Exponential Linear Unit (SELU) function is an activation function for neural networks that has gained popularity in recent years, particularly for deep learning models. It is a self-

normalizing activation function, which means that it can help to stabilize the activation distributions of deep neural networks during training, leading to better performance and faster convergence.

The SELU function is defined as:

f(x) = lambda * { x if x > 0, alpha * (exp(x) - 1) if x <= 0 }

where x is the input value, lambda and alpha are constants, and exp is the exponential function. The constants lambda and alpha are chosen to ensure that the activation distribution remains stable and that the output of the SELU function has a mean of 0 and a standard deviation of 1.