Neural Network Activation Functions

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

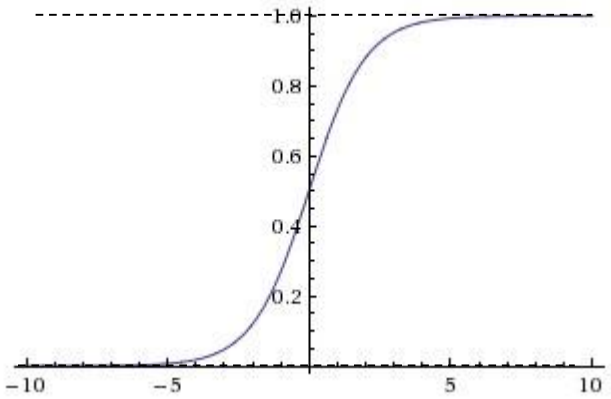
Sigmoid

Complies with the interpretation of a firing neuron, between zero and one

Saturates and vanishes gradients

Outputs are not zero-centered

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

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

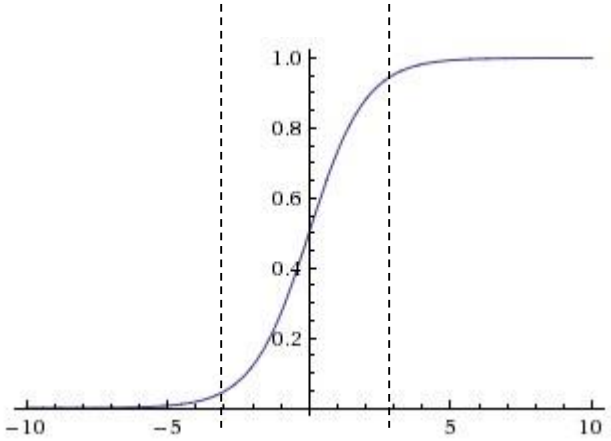
Sigmoid

Complies with the interpretation of a firing neuron, between zero and one

Saturates and vanishes gradients

Outputs are not zero-centered

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

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

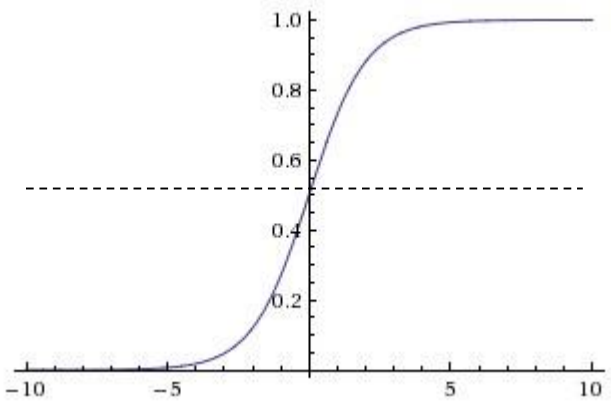
Sigmoid

Complies with the interpretation of a firing neuron, between zero and one

Saturates and vanishes gradients

Outputs are not zero-centered

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

Sigmoid

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

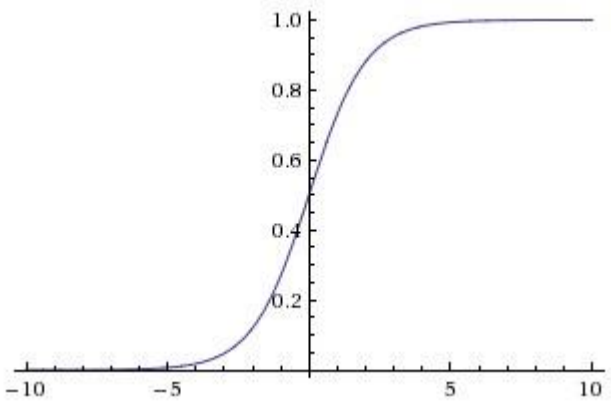
$$f'(z) = (1 - f(z))f(z)$$

Complies with the interpretation of a firing neuron, between zero and one

Saturates and vanishes gradients

Outputs are not zero-centered

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

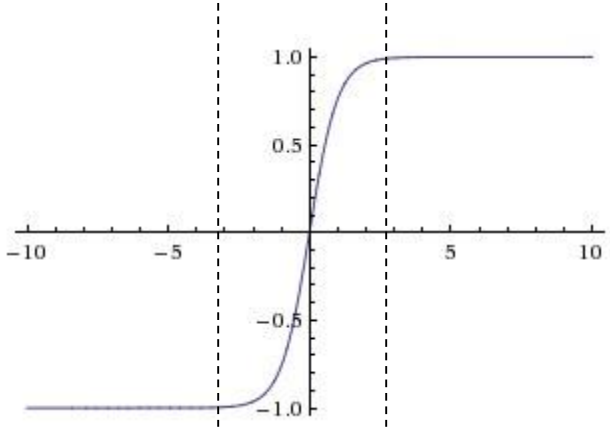
$$f(z) = 1 - \frac{2}{e^{2z} + 1}$$

Tanh

Saturates and vanishes gradients

Outputs are zero-centered in a range between minus one and one

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

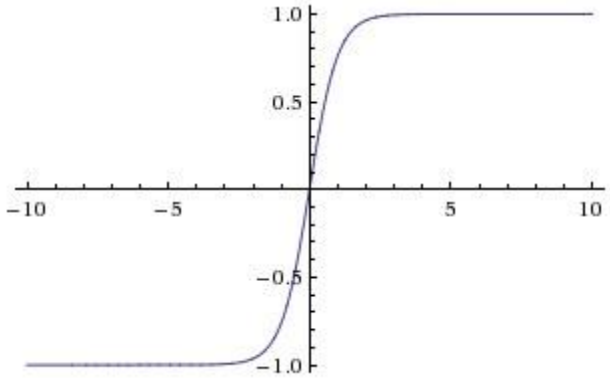
$$f(z) = 1 - \frac{2}{e^{2z} + 1}$$

Tanh

Saturates and vanishes gradients

Outputs are zero-centered in a range between minus one and one

Complying derivative characteristics



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

Tanh

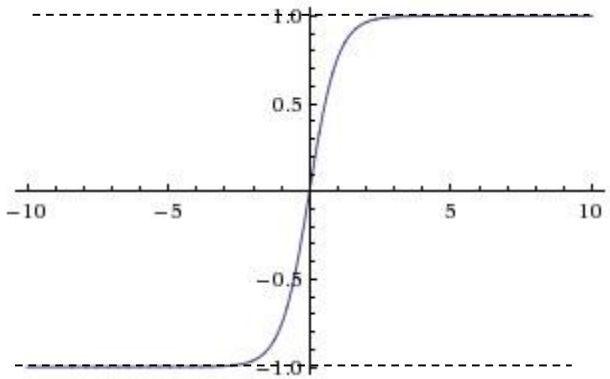
Saturates and vanishes gradients

Outputs are zero-centered in a range between minus one and one

Complying derivative characteristics

$$f(z) = 1 - \frac{2}{e^{2z} + 1}$$

$$f'(z) = 1 - f(z)^2$$



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

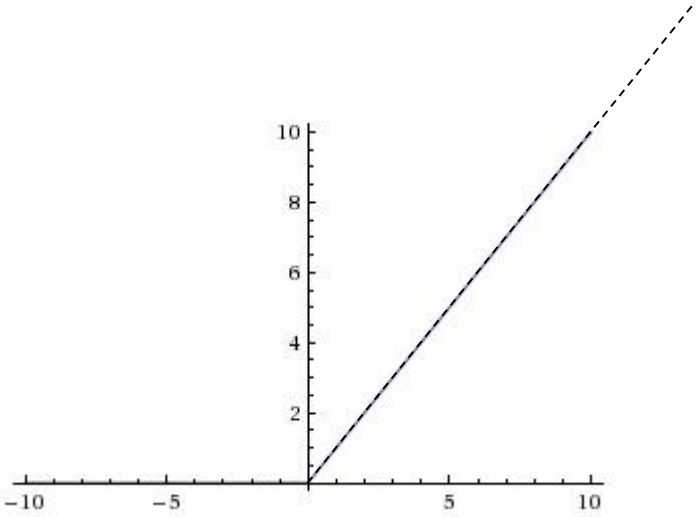
$$f(z) = \max\{0, z\}$$

ReLU (Rectified Linear Unit)

Does not saturate in the positive domain and thus the gradients do not vanish in the positive direction and learning is accelerated

Cheap operation of thresholding at zero

ReLUs can be fragile and "die" during training when the weights are updated too far into the negative domain. Fixed by leaky ReLU



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

ReLU (Rectified Linear Unit)

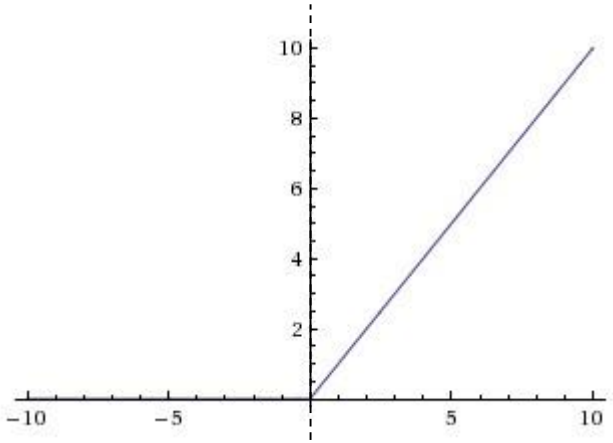
Does not saturate and thus the gradients do not vanish and learning is accelerated

Cheap operation of thresholding at zero

ReLUs can be fragile and "die" during training when the weights are updated too far into the negative domain. Fixed by leaky ReLU

$$f(z) = \max\{0, z\}$$

$$f'(z) = \begin{cases} 0, & \text{if } z < 0. \\ 1, & \text{if } z > 0. \end{cases}$$



http://cs231n.github.io/neural-networks-1/

Neural Network Activation Functions

ReLU (Rectified Linear Unit)

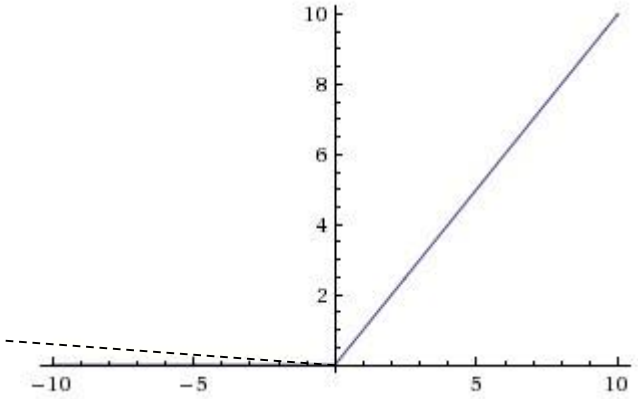
Does not saturate and thus the gradients do not vanish and learning is accelerated

Cheap operation of thresholding at zero

ReLUs can be fragile and "die" during training when the weights are updated too far into the negative domain. Fixed by leaky ReLUs and an adjusted learning rate.

$$f(z) = \max\{0, z\}$$

$$f'(z) = \begin{cases} 0, & \text{if } z < 0. \\ 1, & \text{if } z > 0. \end{cases}$$



http://cs231n.github.io/neural-networks-1/