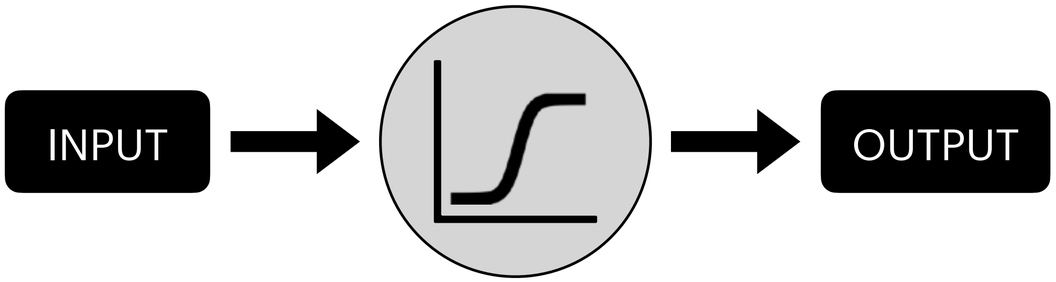
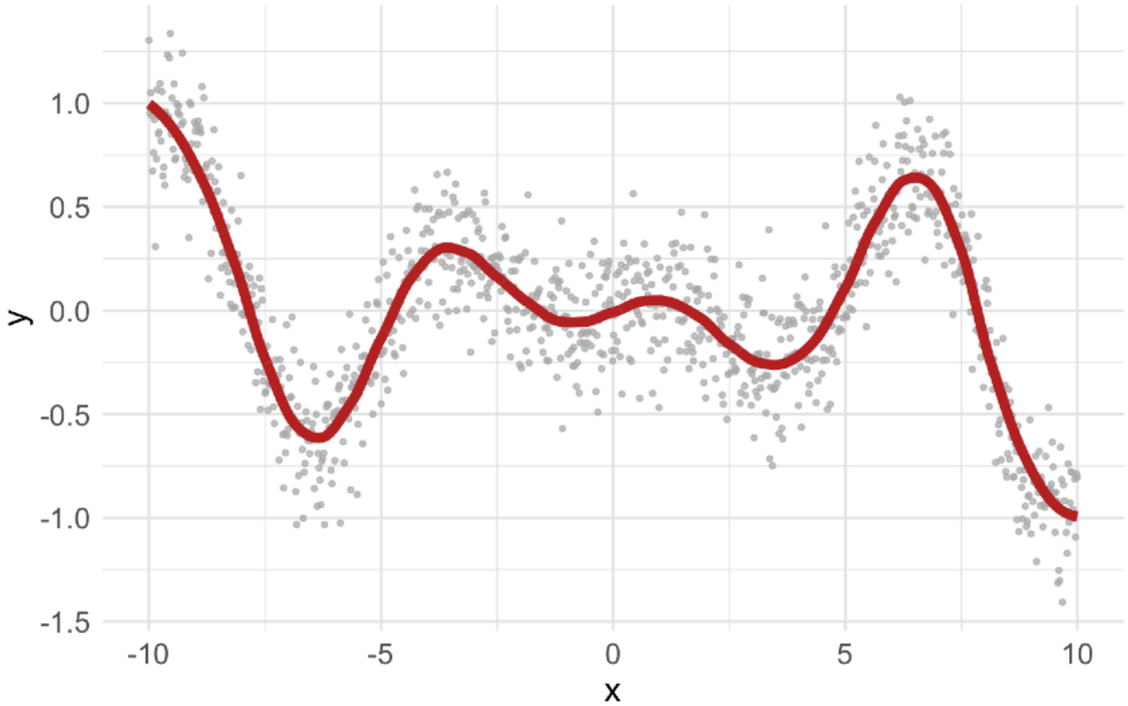
Activation Function

the purpose of an activation function is to add non-linearity to the neural network.

they determine whether a neuron should be activated based on its input





Without activation functions, the hidden layers would only apply linear transformations (weighted sums), and the entire network is collapsed into a single-layer model because the composition of two linear functions is a linear function itself

Activation Function

Activation Function	Equation	Range	Use Case
Sigmoid	$f(x) = \frac{1}{1 + e^{-x}}$	(0, 1)	Binary classification, hidden layers in small networks.
Tanh	$f(x) = \tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$	(-1, 1)	Hidden layers, encourages zero-centered outputs.
ReLU	$f(x) = \max(0,x)$	[0, ∞)	Default for most hidden layers, efficient computation.
Leaky ReLU	$f(x) = \max(0.01x, x)$	(-∞, ∞)	Avoids dying ReLU problem, suitable for hidden layers.
Softmax	$f(x_i) = \frac{e^{x_i}}{\sum_j e^{x_j}}$	(0, 1)	Output layers in multi-class classification problems.
Swish	$f(x) = x \cdot \text{sigmoid}(x)$	(-∞, ∞)	Recent innovation, smooth activation for better gradients.
GELU	$f(x) = 0.5x(1 + \tanh(\sqrt{2/\pi}(x + 0.044715x^3)))$	(-∞, ∞)	High-performing activation in transformers.