What is the Softmax Function?

The **softmax function** is a mathematical function used in **multi-class classification** to convert raw model outputs (logits) into **probabilities**. It ensures that the output values sum to **1**, making them interpretable as probability scores.

Softmax is commonly used in **classification problems** where the model must decide between **three or more classes** (e.g., recognizing digits in handwritten text, classifying different species of animals, etc.).

Mathematical Formula of Softmax:

For a given input vector z containing raw scores (logits) for each class:

$$\sigma(z_i) = \frac{e^{z_i}}{\sum_{j=1}^{n} e^{z_j}}$$

Where:

- z_i = Raw score (logit) for class i.

- e^{z_i} = Exponential function applied to logits (to ensure all values are positive).

- $\sum_{j=1}^{n} e^{z_j}$ = Normalization term ensuring probabilities sum to 1.

- n = Number of classes.

Example of Softmax Calculation:

Class	Logit (z)
A	2.0
B	1.0
C	0.1

1. Compute exponentials:

$$e^{2.0} = 7.389, \quad e^{1.0} = 2.718, \quad e^{0.1} = 1.105$$

2. Compute the sum:

$$7.389 + 2.718 + 1.105 = 11.212$$

3. Compute softmax probabilities:

$$P(A) = \frac{7.389}{11.212} = 0.659$$

$$P(B) = \frac{2.718}{11.212} = 0.242$$

$$P(C) = \frac{1.105}{11.212} = 0.099$$