**What is Logistic Regression?**

**📌 Definition**

**Logistic Regression** is a **supervised learning algorithm** used to **predict the probability** that a given input belongs to a **particular class**.

It's most commonly used for **binary classification problems**, where the target variable has two classes — like:

* Spam (1) or Not Spam (0)
* Disease (1) or No Disease (0)
* Click Ad (1) or Don’t Click (0)

**🎯 The Goal of Logistic Regression**

The main goal is to **model the probability** that a data point belongs to **Class 1** (positive class).  
Mathematically, we want to estimate:

P(y=1∣x)=?

Once we know that probability, we can apply a **threshold** (usually 0.5) to **decide** the class.

**🧮 Why It’s Called "Regression"?**

That’s a common confusion. Here’s the logic:

* It starts with a **linear regression-like equation**:

Z = θ0+ θ1X1+ θ2X2+⋯+θnXn ​

* But instead of directly predicting z, we **pass it through a sigmoid function** to turn it into a probability.

So, although it uses a regression-style formula under the hood, the output is **used for classification**.

**🧠 What Does the Model Learn?**

It learns the **weights (θ)** for each feature such that the **sigmoid output** gets close to:

* 1 for positive class examples
* 0 for negative class examples

Over time, the model becomes good at **drawing a boundary** between the two classes.

This boundary is called a **decision boundary**.

**📉 Real-Life Example**

**Let's say you want to predict if a person will buy a product or not.**

You have features like:

* Age
* Salary
* Time spent on the website

Your logistic regression model will:

1. Multiply each feature by a weight
2. Add them up (linear combination)
3. Apply the **sigmoid function** to get a probability (e.g., 0.87)
4. If the probability ≥ 0.5, it predicts the person **will buy** (class = 1)
5. Otherwise, it predicts **won’t buy** (class = 0)

**📦 Logistic Regression vs Linear Regression Summary**

|  |  |  |
| --- | --- | --- |
| **Aspect** | **Linear Regression** | **Logistic Regression** |
| Output | Continuous value | Probability (0 to 1) |
| Used for | Regression tasks | Classification tasks |
| Function | Straight line | Sigmoid curve |
| Interpretation | Predict a quantity | Predict a probability |

**🔍 Core Insight**

**Logistic Regression transforms a linear equation into a probability using the sigmoid function.**

This probability then helps us **classify** an instance into one of two categories.