**Linear Regression Vs Logistic Regression**

Linear regression and logistic regression are both supervised learning algorithms, but they are used for different types of problems and have different methodologies. Here’s a comparison between the two:

**Linear Regression**

**Purpose**:

* Used for predicting a continuous target variable.

**Methodology**:

* Establishes a linear relationship between the dependent variable (target) and one or more independent variables (features).
* The model takes the form



where y is the predicted value, 𝑥𝑖​ are the input features, and 𝛽𝑖​ are the coefficients.

**Output**:

* Produces a continuous numeric output.

**Loss Function**:

* Minimizes the Mean Squared Error (MSE), which is the average of the squares of the errors (differences between the predicted and actual values).

**Applications**:

* Predicting house prices, stock prices, sales forecasting, etc.

**Logistic Regression**

**Purpose**:

* Used for binary classification problems (though extensions like multinomial logistic regression exist for multi-class problems).

**Methodology**:

* Models the probability that a given input belongs to a particular class. It uses the logistic (sigmoid) function to map the output of a linear equation into a probability (between 0 and 1).
* The model takes the



​, where p is the probability of the target class.

**Output**:

* Produces a probability score between 0 and 1, which can be thresholded to produce a binary outcome (0 or 1).

**Loss Function**:

* Minimizes the Log Loss (Cross-Entropy Loss), which measures the performance of a classification model whose output is a probability value between 0 and 1.

**Applications**:

* Spam detection, disease diagnosis (e.g., predicting if a patient has a particular disease), churn prediction, etc.

**Key Differences**

1. **Nature of the Target Variable**:
   * Linear Regression: Continuous.
   * Logistic Regression: Categorical (binary).
2. **Model Equation**:
   * Linear Regression: Predicts values directly using a linear combination of inputs.
   * Logistic Regression: Predicts the probability of class membership using the logistic function applied to a linear combination of inputs.
3. **Output**:
   * Linear Regression: Real-valued numbers.
   * Logistic Regression: Probability values (0 to 1), which can be converted to binary outcomes.
4. **Assumptions**:
   * Linear Regression: Assumes a linear relationship between the input features and the target variable.
   * Logistic Regression: Does not assume a linear relationship; instead, it assumes a linear relationship between the input features and the log-odds of the target variable.
5. **Use Cases**:
   * Linear Regression: Suitable for regression problems where the goal is to predict a numeric value.
   * Logistic Regression: Suitable for classification problems where the goal is to predict a class label.

By understanding these differences, one can better choose the appropriate model based on the nature of the problem at hand.