

# Instance-Based vs Model-Based Machine Learning

Machine Learning algorithms can be broadly classified into **Instance-Based Learning** and **Model-Based Learning** based on how they learn and make predictions.

## 1 Instance-Based Machine Learning

### Definition

Instance-Based Learning (also called **lazy learning**) stores the **training data** and makes predictions **only when a new instance is given**.

- No explicit training phase
- Learning happens at **prediction time**

### How it Works

- Store all training examples
- When a new input comes:
  - Compare it with stored instances
  - Find the most similar ones
  - Predict based on similarity

### Common Algorithms

- **K-Nearest Neighbors (KNN)**
- Locally Weighted Regression
- Case-Based Reasoning

### Advantages

- Simple and easy to understand 😊

- No training time required
- Adapts well to complex data patterns

## Disadvantages

- High memory usage (stores all data )
- Slow during prediction
- Sensitive to noisy and irrelevant features



## Example

In **KNN**, to classify a new student as *pass/fail*, the algorithm:

- Finds the nearest students based on marks
- Assigns the class based on majority voting

## 2 Model-Based Machine Learning



### Definition

Model-Based Learning builds a **generalized model** from training data and uses this model to make predictions.

- ➔ Explicit **training phase**
- ➔ Fast predictions after training

### How it Works

- Learn patterns from training data
- Create a mathematical or logical model
- Use the model for future predictions

### Common Algorithms

- Linear Regression
- Logistic Regression

- Decision Trees
- Naive Bayes
- Neural Networks

## Advantages

- Fast prediction 
- Requires less memory
- Works well with large datasets

## Disadvantages

- Training can be time-consuming
- May not adapt well to new patterns
- Risk of underfitting or overfitting



## Example

In **Linear Regression**, the model learns a line:

$$[ \quad y = mx + c \quad ]$$

and uses it to predict values for new inputs.

## Key Differences (Exam Table)

| Feature          | Instance-Based Learning | Model-Based Learning      |
|------------------|-------------------------|---------------------------|
| Learning Type    | Lazy Learning           | Eager Learning            |
| Training Phase   | No                      | Yes                       |
| Prediction Speed | Slow                    | Fast                      |
| Memory Usage     | High                    | Low                       |
| Generalization   | No explicit model       | Uses a trained model      |
| Examples         | KNN                     | Regression, Decision Tree |