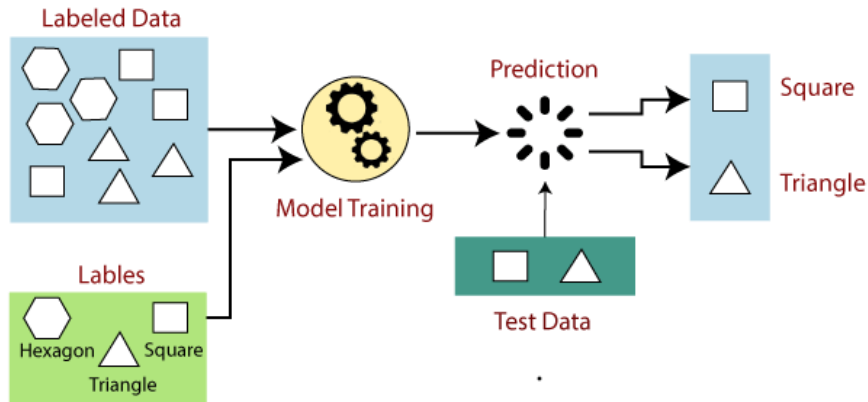


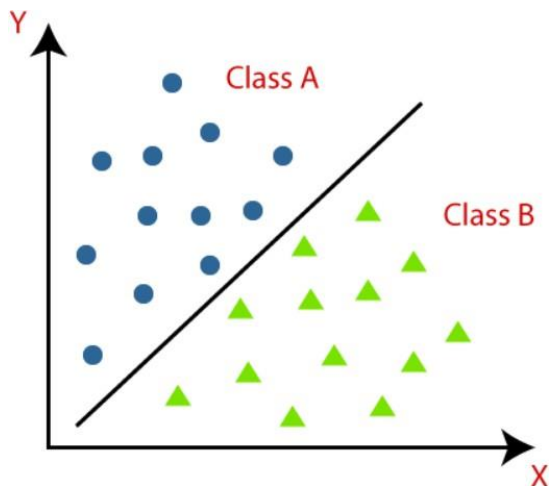
Classification in Machine Learning

Classification involves the process of grouping data or objects into predetermined categories or classes, relying on their inherent features or attributes.



In the context of machine learning, classification is a specific type of supervised learning approach. It entails training an algorithm using a labeled dataset to make predictions about the class or category of new, previously unseen data.

- For instance, a classification model could be trained on a dataset of images, which are marked as either dogs or cats. Subsequently, it can be employed to predict the class of new, unclassified images of dogs or cats by analyzing features like color, texture, and shape.



[Having Similarity in One Class and Dissimilarities in Other Class]

Types of Classification:

Binary Classification:

- Binary classification aims to categorize input data into one of two predefined classes or categories.
- For instance, in the context of binary classification, we might assess a person's health condition to determine whether they have a specific disease or not.

Example:

1. Spam Email Detection:

Binary Outcome: Spam or Not Spam

Given an email, classify it as either spam or not spam based on its content and characteristics.

2. Medical Diagnosis - Disease Detection:

Binary Outcome: Presence of a Disease or No Disease

Evaluate a patient's medical data to determine whether they have a specific disease (e.g., diabetes, cancer).

Multiclass Classification:

- Multiclass classification involves the objective of classifying input data into one of multiple classes or categories, more than two.
- As an example of multiclass classification, we can use data related to various species of flowers to identify which species a given observation belongs to.

Example:

1. Language Identification:

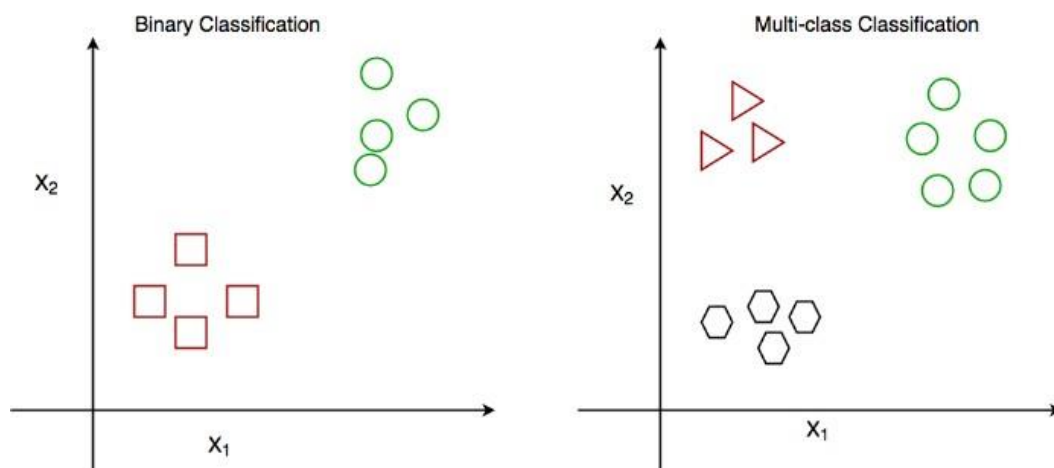
Multiple Classes: English, French, Spanish, etc.

Determine the language of a given text, classifying it into one of several language categories.

2. Iris Flower Species Classification:

Multiple Classes: Setosa, Versicolor, Virginica

Using features like sepal length and width, and petal length and width, classify iris flowers into one of three species.



Types of classification algorithms

1. Linear Classifiers:

Linear classifiers establish a straight-line decision boundary between classes. Some examples of linear classification models include:

- Logistic Regression
- Support Vector Machines with a linear kernel
- Single-layer Perceptron

2. Non-linear Classifiers:

Non-linear classifiers define a curved or non-linear decision boundary between classes. Some non-linear classification models include:

- K-Nearest Neighbors
- Kernel Support Vector Machines
- Naive Bayes
- Decision Tree Classification
- Ensemble Learning Classifiers:

3. Ensemble learning classifiers:

It combine multiple base models to make predictions. They often outperform individual models and offer increased accuracy and robustness.

Some ensemble classifiers include:

- Random Forests
- AdaBoost
- Bagging Classifier
- Voting Classifier

How does classification work?

- Data Collection:
Gather a dataset that contains labeled examples, where each example has a set of features and a known class or category.
- Data Preprocessing:
Clean and preprocess the data, which may involve handling missing values, scaling features, and encoding categorical variables.
- Feature Selection/Extraction:
Choose relevant features that are likely to have a strong impact on the classification task. Feature extraction can also be used to create new features.

- **Data Splitting:**
Divide the dataset into training, validation, and testing sets. This is typically done to train the model, tune hyperparameters, and evaluate its performance.
- **Model Selection:**
Choose an appropriate classification algorithm based on the nature of the problem and the characteristics of the dataset. Common choices include logistic regression, decision trees, support vector machines, etc.
- **Model Training:**
Use the training data to fit the chosen classification model. The model learns to make predictions based on the input features and class labels.
- **Hyperparameter Tuning:**
Optimize the model's hyperparameters using the validation set. Techniques like grid search or random search can be employed to find the best hyperparameters.
- **Model Evaluation:**
Assess the model's performance on the testing set using evaluation metrics such as accuracy, precision, recall, F1 score, or area under the ROC curve (AUC).
- **Model Deployment:**
If the model meets the performance requirements, deploy it for real-world use. This could involve integrating it into an application or system.

Learners in Classification Problems:

There are two types of learners:

1. Lazy Learners:

- Lazy Learner firstly stores the training dataset and wait until it receives the test dataset.
 - In Lazy learner case, classification is done on the basis of the most related data stored in the training dataset.
 - It takes less time in training but more time for predictions.
- Example: K-NN algorithm, Case-based reasoning

2. Eager Learners:

- Eager Learners develop a classification model based on a training dataset before receiving a test dataset.
- Opposite to Lazy learners, Eager Learner takes more time in learning, and less time in prediction.

Example: Decision Trees, Naïve Bayes, ANN.

Applications of Classification Algorithm:

- Credit risk assessment
- Medical diagnosis
- Image classification
- Sentiment analysis
- Fraud detection
- Recommendation System