
Supervised Learning Models

HIGHLIGHTS

Supervised Learning Models and Applications

- Supervised and Unsupervised Learning Comparison

Regression Models

- Linear Models: – Univariate Linear Regression Model $\hat{Y} = w_0 + w_1x$
- Least squares method, interpretation of models, the standard error of estimate, coefficient of determination R^2
- Multivariate Regression Models- n Explanatory Variables
- Ridge Regression, multicollinearity and autocorrelation, effects of multicollinearity
- Non-linear regression (Quadratic Regression),
- Other Types of Regression Algorithms: Lasso and Ridge Regressions
- L1 and L2 regularizations, metrics to quantify performance (MSE, R^2 value, etc.)

Classification Models

- Statistical Binary Classification
- Logistic regression - Binary Response Variable
- Linear Discriminant Analysis (LDA)
- Support Vector Machines – hyperplane and kernelling,
- Classification and Regression Trees (CART), Decision Trees,
- Multivariate classification models
- Naive Bayes Classifier, k-Nearest Neighbor (KNN),
- Random Forest Classifier

Introduction

Machine learning applications revolve around *algorithms*. An algorithm is a set of operations, procedures, or equations used to solve a problem. Algorithms may be seen as input-output processes that process data through a series of well-defined rules. The objective is to produce an output that is often the solution to a problem. The algorithms take input in the form of data and define the output. The input in the algorithms processes the data through a language or computer program that defines and executes functions to come to a solution or produce an output.

Machine Learning algorithms and models are divided into these main categories: (1) **Supervised learning**, (2) **Unsupervised learning**, (3) **Semi-supervised Learning**, (4) **Reinforcement learning**. Figure 6.1 summarizes these models.

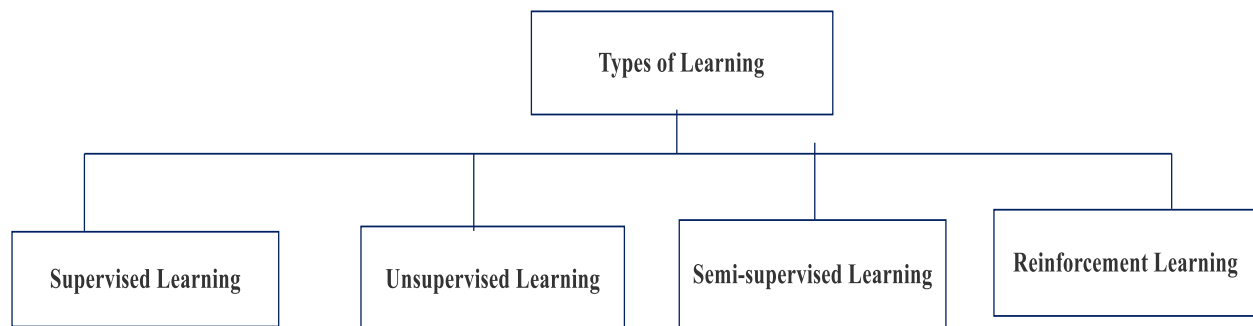


Figure 6.1: Supervised Learning Models.

Supervised learning: In supervised learning, the algorithm learns from example data and the given output or target. The data contains the features or independent variables and the dependent variable, also known as the label or the target. It is a machine learning technique that is widely used in various fields such as engineering, finance, business, healthcare, sales, marketing predictions, and more. In this type of machine learning, the algorithm is trained on labeled data or target to make predictions or decisions based on the features or independent variables. In supervised learning problems, the algorithms learn a mapping between the input and output data.

This mapping is learned from a labeled dataset consisting of pairs of input and output data. The algorithm learns the relationship between the input and output data that is used to make predictions on new, unseen data.

The data consists of input or features and corresponding output labels. The predictions are made using the input features that are attributes or characteristics of the data. The output labels are the desired outcomes or targets that the algorithm predicts.

The two main types of supervised learning are regression and classification problems (Figure 6.2). The target in regression problems is a numeric value, whereas classification problems have targets that are string labels, qualitative or categorical variables, such as class. An example of a regression problem may be to determine the sales for a company based on advertizing dollars and other features. The goal of a classification problem would be to determine whether a loan granted by a bank may result in a default based on the customer's credit history, education level, age, marital status, and other available factors.

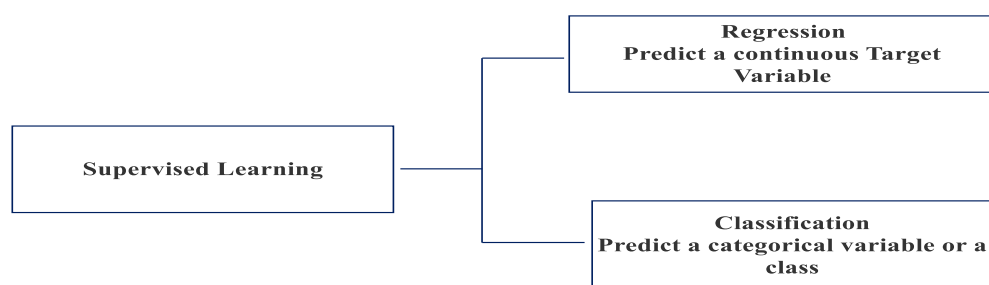


Figure 6.2: Types of Supervised Learning Models

In supervised learning problems, the computer is presented with example inputs and their desired outputs by the analyst, and the goal is to create a model to learn a general rule that maps inputs to

outputs. The supervised learning method is similar to human learning under the supervision of a teacher.

The learning involves creating a model by establishing the relationship between inputs or *features* and the desired output or some *target*. Once this model is established, it can be used to apply labels to new, unknown data to predict future events. The idea is to learn from the past data and apply it to new data to make predictions for future events using the created learning algorithm. The output from the learning algorithm can also be compared to the known output to find the associated error that helps modify the model.

Supervised learning has been used to create complex models that are used to make accurate predictions on new data. The models using supervised learning require large amounts of labeled training data to be effective. The quality and quantity of training data determine the accuracy of the model.

Training the system: The first step in creating machine learning algorithms (including supervised and unsupervised learning models) is training the model. In the training process, the data is usually split in the ratio of 80:20, where 80% of the data is used to train the model and the rest is used as testing data. This 80:20 split is not always used as a definite rule. It is recommended that the data should be split into three sets – training, validation, and test sets. We explained this in Chapter 3.

The model learns from training data, where learning means that the model uses some logic of its own for the learning process. Once the model is trained, the next step is to test the model. For testing, the input uses the remaining 20% of data that the model has never used before. The model makes a prediction using the model which is compared to the actual output, and calculates the accuracy of the model.