Machine Learning in Python

Supervised Learning - Classification and Metrics

Cristian A. Marocico, A. Emin Tatar

Center for Information Technology
University of Groningen

Friday, July 4th 2025

Outline

1. Introduction to Classification

2. Classification Basics

Introduction to Classification

Classification

Definition

Introduction to Classification

Classification

Definition

Classification is a type of supervised learning where the model learns from labeled data to predict the class of new observations based on past data.

Introduction to Classification

Classification

Definition

Classification is a type of supervised learning where the model learns from labeled data to predict the class of new observations based on past data.

Classification vs. Regression is a key distinction in supervised learning:

- In classification, the target variable is categorical (e.g., "spam" or "not spam").

Introduction to Classification

Classification Definition

Classification is a type of supervised learning where the model learns from labeled data to predict the class of new observations based on past data.

Classification vs. Regression is a key distinction in supervised learning:

- In classification, the target variable is categorical (e.g., "spam" or "not spam").
- In regression, the target variable is continuous (e.g., predicting a price).

Classification Types

Classification Types

Definition

Classification Types

Classification Types

Definition

Classification can be broadly divided into two types:

- Binary Classification: The target variable has two classes (e.g., "yes" or "no", "spam" or "not spam"). Numerically, this can always be represented as 0 and 1.

Classification Types

Classification Types

Definition

Classification can be broadly divided into two types:

- Binary Classification: The target variable has two classes (e.g., "yes" or "no", "spam" or "not spam"). Numerically, this can always be represented as 0 and 1.
- Multiclass Classification: The target variable has more than two classes (e.g., "cat", "dog", "weasel"). In this case, the model predicts one of several possible categories.

Classification Algorithms

Classification Algorithms

Definition

Classification Algorithms

Classification Algorithms

Definition

Classification algorithms are designed to learn from labeled data and make predictions about the class of new, unseen data. Some common algorithms include:

- Logistic Regression: Despite its name, it is used for binary classification. It models the probability that a given input belongs to a particular class.

Classification Algorithms

Classification Algorithms

Definition

Classification algorithms are designed to learn from labeled data and make predictions about the class of new, unseen data. Some common algorithms include:

- Logistic Regression: Despite its name, it is used for binary classification. It models the probability that a given input belongs to a particular class.
- k-Nearest Neighbors (k-NN): A non-parametric method that classifies a data point based on the classes of its nearest neighbors in the feature space.

Classification Algorithms

Classification Algorithms Definition

Classification algorithms are designed to learn from labeled data and make predictions about the class of new, unseen data. Some common algorithms include:

- Logistic Regression: Despite its name, it is used for binary classification. It models the probability that a given input belongs to a particular class.
- k-Nearest Neighbors (k-NN): A non-parametric method that classifies a data point based on the classes of its nearest neighbors in the feature space.
- Decision Trees: A tree-like model that splits the data into subsets based on feature values, leading to a decision about the class label.

Classification Algorithms

Classification Algorithms

Definition

Classification algorithms are designed to learn from labeled data and make predictions about the class of new, unseen data. Some common algorithms include:

- Logistic Regression: Despite its name, it is used for binary classification. It models the probability that a given input belongs to a particular class.
- k-Nearest Neighbors (k-NN): A non-parametric method that classifies a data point based on the classes of its nearest neighbors in the feature space.
- Decision Trees: A tree-like model that splits the data into subsets based on feature values, leading to a decision about the class label.
- Support Vector Machines (SVM): A method that finds the hyperplane that best separates the classes in the feature space.

Classification Algorithms

Classification Algorithms

Definition

Classification algorithms are designed to learn from labeled data and make predictions about the class of new, unseen data. Some common algorithms include:

- Logistic Regression: Despite its name, it is used for binary classification. It models the probability that a given input belongs to a particular class.
- k-Nearest Neighbors (k-NN): A non-parametric method that classifies a data point based on the classes of its nearest neighbors in the feature space.
- Decision Trees: A tree-like model that splits the data into subsets based on feature values, leading to a decision about the class label.
- Support Vector Machines (SVM): A method that finds the hyperplane that best separates the classes in the feature space.
- More advanced algorithms like Random Forests, Gradient Boosting, and Neural Networks.

Logistic Regression

Logistic Regression

Definition

Logistic Regression

Logistic Regression Definition

Logistic Regression models the probability that the target variable y belongs to a particular class. The logistic function (sigmoid) is used to map predicted values to probabilities between 0 and 1. The decision boundary is determined by the threshold (commonly 0.5) for classifying observations into different classes.

Logistic Regression

Logistic Regression Definition

Logistic Regression models the probability that the target variable y belongs to a particular class. The logistic function (sigmoid) is used to map predicted values to probabilities between 0 and 1. The decision boundary is determined by the threshold (commonly 0.5) for classifying observations into different classes.

The sigmoid function is defined as:

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

where z is a linear combination of the input features.