CHAPTER 17

Learning Algorithms

In this section, we introduce a variety of supervised and unsupervised machine learning algorithms. The algorithms presented here provide a foundation for understanding other machine learning methods (e.g., linear and logistic regression), and others like Random forests and Extreme Stochastic Gradient Boosting (XGBoost) are widely used in applied machine learning.

We will survey the various learning algorithms from a conceptual level. In general, the discussion will cut across

- What a particular algorithm is all about and how it works.
- How we interpret the results of the learning algorithm.
- What various ways it can be optimized to improve performance in certain circumstances.

Classes of Supervised Algorithms

Supervised machine learning algorithms are broadly classified into

- Linear
- Non-linear
- Ensemble methods

E. Bisong, *Building Machine Learning and Deep Learning Models on Google Cloud Platform*,
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Let's briefly go through them:

- ***Linear methods*** are also known as ***parametric methods*** or algorithms. Linear methods assume that the underlying structure of the data is linear, put in another form, that there exists a linear interaction between the features of the dataset. Examples of linear algorithms are
  - Linear regression
  - Logistic regression
  - Support vector machines
- ***Non-linear methods*** (also known as ***non-parametric methods***) do not assume any parametric or structural form of the dataset. Instead, they attempt to learn the internal relationships or representation between the features of the dataset. Examples of non-linear algorithms are
  - K-nearest neighbors
  - Classification and regression trees (they form the foundation for ensemble methods such as boosting and bagging)
  - Support vector machines
  - Neural networks
- ***Ensemble methods*** combine the output of multiple algorithms to build a better model estimator that generalizes to unseen examples. Two major classes of ensemble methods are
  - Boosting (stochastic gradient boosting)
  - Bagging (Random forests)

As we can see from the preceding list, some algorithms can function as both a linear and non-linear model. An example is support vector machine (SVM) which applies the so-called kernel trick to use it as a non-linear classification algorithm (more on this later).

Supervised machine learning algorithms can also be grouped as regression or classification algorithms. As we saw in Chapter 14 on regression vs. classification, regression is when the target variable is real-valued and classification is when the target variable is class labels.

Unsupervised Algorithms

Examples of unsupervised learning include

- Clustering
- Principal component analysis

In the later chapters, we will survey the preceding unsupervised learning algorithms for learning from non-labeled datasets. Clustering is an algorithm for grouping homogeneous samples into partitions called clusters. Principal component analysis is a method for finding low-dimensional feature sub-spaces that capture as much information as possible from the original higher-dimensional features of the dataset.

This chapter provides an overview of the machine learning algorithms that we'll discuss together with code examples in Part 4 of this book.