A STUDY ON VARIOUS CLASSIFICATION ALGORITHMS IN DATA MINING

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Abstract.

Data mining is that the method of analyzing data from completely different views and summarizing it into useful information. Classification could be a data processing technique supported machine learning which is employed to classify each item in a set of data into a group of predefined categories or teams. Classification is process of simplifying the data reliability according to different instances. There are number of major kinds of classification algorithms including k-nearest neighbor, naïve bays, support vector machines and neural network. This paper provides a comprehensive survey of various classification algorithms and their advantages and disadvantages.

Keywords: Classification, NB, SVM, K-NN.

1. Introduction

Data mining could be a method of extracting or mining the useful pattern or information and relationships within massive amounts or huge volumes of data. The term data processing is additionally referred to as "Knowledge mining from data" [1]. The general goal of the data mining method is to extract information from a information set and associated it into an comprehensive structure for future use. These tools can contain mathematical algorithm, statistical models, and machine learning strategies. Consequently, data processing consists of more than collection and managing data, it also includes analysis and prediction. Classification technique is efficient in processing a huge variety of data than regression and is growing in popularity [4]. The well-known classification algorithms are naive bayes, k-nearest neighbor, neural network and SVM. There are several applications for Machine Learning (ML), the foremost and vital of that is data mining [5]. People are often prone to making mistakes throughout the analyses or, possibly, once making an attempt to ascertain relationships between multiple options. Machine learning can frequently be theoretical to these problems, improving the effectiveness of systems and the designs of machines [3]. Classification is that the organization of information in given classes and also referred to as supervised classification, the classification uses given class labels to order the objects within the data collection.

2. Classification algorithms in data mining

2.1. C4.5 Algorithm:

C4.5 is an algorithm is used to produce a decision tree. It is a correlate extension of Quinlan's earlier ID3 algorithm. The decision trees that are generated by this algorithm can be frequently used for classification, so C4.5 is usually renowned as a statistical classifier one limitation of ID3 is that it is too responsive to features with massive numbers of values. This should be overcome if you are about to use ID3 as an Internet search agent. I label this problem by borrowing from the C4.5 algorithm, an associate ID3 extension.ID3's sensitivity to options with massive numbers of values is illustrated by Social Security numbers. Since this security numbers are unique for each and every individual, testing on its value can always acquiesce low conditional entropy values. However, this is not a useful test. To overcome this problem, C4.5 uses a metric called "information gain," which is defined by subtracting conditional entropy from the base entropy; that is,

Gain (P|X) =E (P)-E (P|X). Eq.(1)

This computation does not, in itself, produce anything new. However, it permits you to measure a gain ratio. Gain ratio, defined as

Gain Ratio (P|X) =Gain (P|X)/E(X), Eq.(2)

Where (X) is the entropy of the examples relative to the attribute. It has an enhanced method of tree pruning that reduces misclassification errors due noise or excess amount of details in the training data set. Like ID3 the data is sorted at every node of the tree in order to determine the best splitting attribute. It uses gain ratio impurity method to evaluate the splitting attribute. Decision trees are built in C4.5 by employing a set of training data or data sets as in ID3. At every node of the tree, this algorithm chooses one attribute of the data that most successfully splits set of samples into subsets developed in one class or the other. Its criteria are that the normalized information gain (difference in entropy) that results from selecting an associate attribute for rendering the data. The attribute with the best normalized data gain is chosen to make the decision.

2.2. Iterative Dichotomiser 3 (Id3) Algorithm:

ID3 algorithm begins with the first set because it is the root node. Each and every iteration of the algorithm, it iterates through every unused attribute of the set and calculates the entropy IG(A) of that attribute. Then select the attribute that has the small entropy (or largest information gain) worth. The set is S then split by the chosen attribute (e.g. age < 50, 50 <= age < 100, age >= 100) to provide subsets of the data. The Id3 algorithm persists to repeat on each and every subset, which considers exclusive attributes that are not preferred earlier. Recursion on a subset might stop in one of these cases:

- All elements contained by the subsets belongs to the similar class (+ or -), then the node is distorted into a leaf and labeled with the class of the examples.

- There are no supplementary attributes to be chosen, but the examples still does not match in to the identical class (some are + and some are -), then the node is changed into a leaf and labeled nodes with the foremost common class of the examples in the subset.
- If there is no example in the subset, then the parent set was found to be matched as a selected value from the chosen attribute and then the tree is formed based on it with non-terminal node in the place of chosen attribute, on which the data was divided, and terminal nodes representing the class label of the decisive subset of the branch.

2.3. Naive Bayes:

Bernoulli Naive Bayes is used on the data that is distributed according to multivariate Bernoulli distributions that is it consists of multiple features, in which each one is assumed to be a binary-valued variable. [1] These classifiers are a family of easy probabilistic classifiers supported by applying bayes theorem with sturdy independence assumptions among the choices. Bayesian classifier is implementation on the needy events and as a result the probability of a occurring inside the future that may be detected from the previous occurring of the constant event [2].

The naive bayes classifier may be effortlessly applied to statistical algorithm which provides surprisingly higher results. Bayesian filter has been used widely in building spam filters. The Naïve Bays classifier is predicted on the Bays' rule of conditional probability. It makes use of all the attributes contained within the data, and analyses them on an individual basis like they are equally important and independent of each other. The rule for conditional probability is as follows [2]:

$$P(H \mid E) = P(E \mid H)\, P(H) / P(E)$$

Where P(H|E) is that the conditional probability that hypothesis H is true given an evidence E; P(E|H) the conditional probability of E given H, P(H) the prior probability of H, P(E) the previous probability of E[2]. Evidence split into two parts they are:

$$P(B/A) = P(A1/B)P(A2/B)\ldots\ldots..P(An/B) \qquad \text{Eq.(3)}$$

Where

A1, A2, A3…….An are totally independent priori.

2.4. Support Vector Machine:

SVM has develop as one of the most standard and helpful techniques for data classification [7]. It will be used for classify the both linear and non linear data. [3] The target of SVM is to supply a model that predicts the target value of data occurrence in the testing set in which only attributes are given .[8] The classification goal in SVM is to separate the two classes by means of a function prepare from available data and thereby to produce a classifier that will work well on further unseen data. [8] The simplest form of SVM

classification is the maximal margin classifier. It is accustomed to solve the foremost classification drawback, namely the case of a binary classification with linear separable training data. [1] The aim of the maximal margin classifier is to find the hyper plane with the largest margin, i.e., the maximal hyper plane, in real-world problems, training data are not always linear separable. In organize to handle the nonlinearly diverse cases few limp variables are initiated to SVM, so to bear some training errors, with the pressure of the unwanted data in training sets are decreased. This classifier with limp variables is noted as a soft-margin classifier.

2.5. K- Nearest Neighbor:

Nearest neighbor classifiers is a lazy learner's method and is based on learning by analogy. It is a supervised classification technique which is used widely. Unlike the previously described methods the nearest neighbor method waits until the last minute before doing any model construction on a given tuple. In this method the training tuples are represented in N-dimensional space. When the given unknown row, k-nearest neighbor classifier searches the k- training rows, that are closest to the unknown sample and these samples are placed in the nearest class.

The KNN is easy for applying to small sets of data, but when applied to huge varieties and volumes of data and high dimensional data it results in slower latency and performance. The algorithm is sensitive to the value of k and it affects the performance of the classifier. New Field Programmable Gate Arrays (FGPA) architectures of KNN classifiers have been proposed in [6] to overcome this difficulty of classifier to easily adapt to different values of k. Efficiency in data classification is a main concern in data mining and in order to improve the efficiency and accuracy of classification, enhancements have been made to the KNN method. Weighted nearest neighbor classifier (wk-NNC) is one such method which adds a weight to each of the neighbors used for classification. Hamamoto's bootstrapped training set can also be used in its place of the training patterns, in which the pattern is substituted by a weighted mean of a few of its neighbors from its own class of training patterns. This method proves to improve the accuracy of classification. However the time to create the bootstrapped set is O (n2) where n is the number of training patterns.

K- Nearest Neighbor Mean Classifier (k-NNMC) proposed in [9] finds k nearest neighbors for each class of training patterns separately. The classification is done based to the nearest mean pattern. This inventiveness proves to show higher accuracy rate in classification when compared to other techniques this training set.

2.6. Neural Network:

A neural network could be a set of connected input/output units within which every association contains a weight related to it. During the training phase, the network learns by adjusting the weights thus an able to predict the right class label of the input. Neural Network learning is also referred to as connectionist learning due to the connections layers units [2].

2.6.1. Types of models

Many models are used; defined at different levels of abstraction, and modeling different aspects of neural systems. They range from models of the short-term behavior of individual neurons, through models of the dynamics of neural circuitry arising from interactions between individual neurons, to models of behavior arising from abstract neural modules that represent complete subsystems. These include models of the long-term and short-term plasticity of neural systems and its relation to learning and memory, from the individual neuron to the system level.

Error Back Propagation Network (EBPN) cold be a quite feed forward network (FFN) in which Error Back Propagation Algorithm (EBPA) is employed for learning which one in every of the foremost is wide used training algorithm where training is perform in 2 phases:

- Forward phase: During this phase input is presented and output is calculated supported on activation function and at last error is calculated at outer layer.
- Backward phase: During this phase error is send back to the inner layers to regulate the weights.

ALGORITHMS	ADVANTAGES	DISADVANTAGES
C4.5 Algorithm	1. It produces the correct result. 2. It takes the less memory to massive program execution. 3. It takes less model build time. 4. It has short searching time.	1. Empty branches. 2. Insignificant branches. 3. Over fitting.
ID3	1. It produces the high accuracy result than the C4.5 algorithm. 2. ID3 algorithm typically uses nominal attributes for classification with no missing values. 3. It produces false alarm rate and omission rate decreased, increasing the detection rate and reducing the	1. It has long searching time. 2. It takes the more memory than the C4.5 to large program execution.

	space Consumption	
Naive Bays Algorithm	1. To improves the classification performance by removing the unrelated options. 2. Good Performance 3. It is short computational time	1. The naive bays classifier requires a very large number of records to obtain good results. 2. Threshold value must be tuned
Support Vector Machine Algorithm	1. Less over fitting, robust to noise. 2. Especially popular in text classification problems	1. SVM is a binary classifier. To do a multi-class classification, pair wise classifications can be used 2. Computationally expensive, thus runs slow
K-Nearest Neighbor Algorithm	1. It is an easy to understand 2. Training is very fast. 3. Robust to noisy training data	1. Memory limitation. 2. Being a supervised learning lazy algorithm
Neural Network	1. Capable of producing an arbitrarily complex relationship between input and output	1. Do not work well when there are many hundreds or thousands of input features and difficult to understand the model

Table: 1 Advantages and disadvantages of Classification Algorithms

3. Conclusion

Data mining is a wide area that integrates techniques from various fields including artificial intelligence, machine learning, statistics and pattern recognition and used for the analysis of large volumes and varieties of data. Classification methods are significantly efficient in modeling interactions. Each of these methods can be used in various situations as needed where one tends to be useful while the other may not and vice-versa. Each technique has got its own advantages and disadvantages. Based on the required situations each one of the technique can be applied and needful one can be selected. Based on the performance, the classification algorithms can be applied to various detection progressions.

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