

A Study on Performance of Machine Learning Algorithms Using Supermarket Dataset

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Abstract:-The performance of classifiers is strongly dependent on the data set used for learning. In KDD (knowledge discovery in databases) process, Data classification is an important task In this paper Machine Learning Algorithms performance are mostly required for the prediction of stock market. We used five popular classifiers considering their qualitative performance for the experiment the dataset is drawn from a supermarket detection-decision context available at UCI machine learning repository.

Keywords: KDD, Data Mining, Naive Bayes, ADTree

I. INTRODUCTION

Data mining is considered to be an emerging technology that has made revolutionary change in the information world. The term 'data mining' (often called as knowledge discovery) refers to the process of analyzing data from different perspectives and summarizing it into useful information by means of a number of analytical tools and techniques, which in turn may be useful to increase the performance of a system. Technically, "data mining is the process of finding correlations or patterns among dozens of fields in large relational databases". Therefore, data mining consists of major functional elements that transform data onto data warehouse, manage data in a multidimensional database, facilitates data access to information professionals or analysts, analyze data using application tools and techniques, and meaningfully presents data to provide useful information. According to the Gartner Group, "data mining is the process of discovering meaningful new correlation patterns and trends by sifting through large amount of data stored in repositories, using pattern recognition technologies as well as statistical and mathematical techniques"[3]. Thus use of data mining technique has to be domain specific and depends on the area of application that requires a relevant as well as high quality data. More precisely, data mining refers to the process of analyzing data in order to determine patterns and their relationships[9]. It automates and simplifies the overall statistical process, from data source(s) to model application. Practically analytical techniques used in data mining include statistical methods and mathematical modeling. However, data mining and knowledge discovery is a rapidly growing area of research and application that builds on techniques and theories from many fields, including statistics, databases, pattern recognition, data visualization, data warehousing and OLAP, optimization, and high performance computing

[1]. Worthy to mention that online analytical processing (OLAP) is quite different from data mining, though it provides a very good view of what is happening but cannot predict what will happen in the future or why it is happening. In fact, blind applications of algorithms are not also data mining. In particular, "data mining is a user centric interactive process that leverages analysis technologies and computing power, or a group of techniques that find relationships that have not previously been discovered" [4]. So, data mining can be considered as a convergence of three technologies -- viz. increased computing power, improved data collection and management tools, and enhanced statistical algorithms. Data and information have become major assets for most of the organizations. The success of any organization depends largely on the extent to which the data acquired from business operations is utilized. In other words, the data serves as an input into a strategic decision making process, which could put the business ahead of its competitors[10,11]. Also, in this era, where businesses are driven by the customers, having a customer database would enable management in any organization to determine customer behavior and preference in order to offer better services and to prevent losing them resulting better business. The data needed that will serve as an input to organizational decision-making process is generated and warehoused. It is being collected via many sources, such as the point of sales transactions, surveys, through the internet logs – cookies, etc. This has resulted in huge databases which have valuable knowledge hidden in them and may be difficult to extract. Data mining has been identified as the technology that offers the possibilities of discovering the hidden knowledge from these accumulated databases. Techniques such as pattern recognition and classification are the most important in data mining [4,5]. The task of recognition and classification is one of the most frequently encountered decision making problems in daily activities. A classification problem occurs when an object needs to be assigned into a predefined group or class based on a number of observed attributes, or features, related to that object. Humans constantly receive information in the form of *patterns* of interrelated facts, and have to make decisions based on them. When confronted with a pattern recognition problem, stored knowledge and past experience can be used to assist in making the correct decision. Indeed, many problems in various domains such as financial, industrial, technological, and medical

sectors, can be cast as classification problems. Examples include bankruptcy prediction, credit scoring, machine fault detection, medical diagnosis, quality control, handwritten character recognition, speech recognition etc. Pattern recognition and classification has been studied extensively in the literature. In general, the problem of pattern recognition can be posed as a two-stage process:

- **Feature selection** which involves selecting the significant features from an input pattern
- **Classification** which involves devising a procedure for discriminating the measurements taken from the selected features, and assigning the input pattern into one of the possible target classes according to some decision rule.

Research efforts dedicated to data mining, which focussed on improving the classification and prediction accuracy, have recently been undergoing a tremendous change [6,7]. The continuous development of more and more sophisticated classification models through commercial and software packages have turned out to provide some benefits only in specific problem domains where some prior background knowledge or new evidence can be exploited to further improve classification performance. In general however, related research proves that no individual data mining technique has been shown to deal well with all kinds of classification problems. Awareness of these imperfections of individual classifiers has called for the emergence of careful development and evaluation strategies of data mining classification models. Association rule mining is a widely-used approach in data mining. Association rules are capable of revealing all interesting relationships in a potentially large database. The abundance of information captured in the set of association rules can be used not only for describing the relationships in the database, but also for discriminating between different kinds or classes of database instances. However, a major problem in association rule mining is its complexity. Even for moderate sized databases it is intractable to find all the relationships. This is why a mining approach defines a interestingness measure to guide the search and prune the search space. Therefore, the result of an arbitrary association rule mining algorithm is not the set of all possible relationships, but the set of all interesting ones. The definition of the term interesting, however, depends on the application. The different interestingness measures and the large number of rules make it difficult to compare the output of different association rule mining algorithms. There is a lack of comparison measures for the quality of association rule mining algorithms and their interestingness measures. Association rule mining algorithms are often compared using time complexity. That is an important issue of the mining process, but the quality of the resulting rule set is ignored. On the other hand there are approaches to investigate the discriminating power of association rules and use them according to this to solve a classification problem. In the

next section, we provide an overview of data mining techniques and their potential applications. In section 3, experimental study and analysis. Finally the paper concludes in section 4 with a glimpse to our future work.

II. TECHNIQUES AND ALGORITHMS

Researchers identify two fundamental goals of data mining: prediction and description. Prediction makes use of existing variables in the database in order to predict unknown or future values of interest, while description focuses on finding patterns describing the data the subsequent presentation for user interpretation. The relative emphasis of both prediction and description differs with respect to the underlying application and technique. There are several data mining techniques fulfilling these objectives. Some of these are classification, clustering, association and pattern discovery.

- **Classification:** Classification is the most commonly applied data mining technique, which employs a set of pre-classified examples to develop a model that can classify the population of records at large. Fraud detection and credit risk applications are particularly well suited to this type of analysis. This approach frequently employs decision tree or neural network-based classification algorithms. The data classification process involves learning and classification [2]. In Learning the training data are analyzed by classification algorithm. In classification test data are used to estimate the accuracy of the classification rules. If the accuracy is acceptable the rules can be applied to the new data tuples. For a fraud detection application, this would include complete records of both fraudulent and valid activities determined on a record-by-record basis. The classifier-training algorithm uses these pre-classified examples to determine the set of parameters required for proper discrimination. The algorithm then encodes these parameters into a model called a classifier. Some well-known classification models are:

- a) Classification by decision tree induction
- b) Bayesian Classification
- c) Neural Networks
- d) Support Vector Machines (SVM)

- **Clustering:** Clustering is a technique for identification of similar classes of objects. By using clustering techniques we can further identify dense and sparse regions in object space and can discover overall distribution pattern and correlations among data attributes. Classification approach can also be used for effective means of distinguishing groups or classes of object but it becomes costly so clustering can be used as pre-processing approach for attribute subset selection and classification. For example, to form group of customers based on purchasing

patterns, to categories genes with similar functionality. Some commonly used clustering methods are:

- a) Partitioning Methods
- b) Hierarchical Agglomerative (divisive) methods
- c) Density based methods
- d) Grid-based methods
- e) Model-based methods

A. Association rules

An Association Rule is a rule of the form milk and bread =>butter where 'milk and bread' is called the rule body and butter the head of the rule. It associates the rule body with its head. In context of retail sales data, our example expresses the fact that people who are buying milk and bread are likely to buy butter too. This association rule makes no assertion about people who are not buying milk or bread. We now define an association rule:

Let D be a database consisting of one table over n attributes {a1, a2, . . . , an}. Let this table contain k instances. The attributes values of each ai are nominal. In many real world applications (such as the retail sales data) the attribute values are even binary (presence or absence of one item in a particular market basket). In the following an attribute-value-pair will be called an item. An item set is a set of distinct attribute-value-pairs. Let d be a database record. d satisfies an item set X = {a1, a2, . . . , an} if X ⊆ d. An association rule is an implication X ⇒ Y where X, Y ⊆ {a1, a2, . . . , an}, Y ≠ ∅; and X ∩ Y = ∅.

The support s(X) of an item set X is the number of database records d which satisfy X. Therefore the support s(X ⇒ Y) of an association rule is the number of database records that satisfy both the rule body X and the rule head Y. Note that we define the support as the number of database records satisfying X ∩ Y, in many papers the support is defined as s(X ⇒ Y) / k. They refer to our definition of support as support count.

The confidence c(X ⇒ Y) of an association rule X ⇒ Y is the fraction c(X ⇒ Y) = s(X ∩ Y) / s(X).

From a logical point of view the body X is a conjunction of distinct attribute-value-pairs and the head Y is a disjunction of attribute-value-pairs where X ∩ Y = ∅. Coming back to the example a possible association rule with high support and high confidence would be i1 ⇒ i2 whereas the rule i1 ⇒ i3 would have a much lower support value.

III. EXPERIMENTAL STUDY AND ANALYSIS

A. WEKA Tool

We use WEKA (www.cs.waikato.ac.nz/ml/weka/), an open source data mining tool for our experiment. WEKA is developed by the University of Waikato in New Zealand that implements data mining algorithms using the JAVA language. WEKA is a state-of-the-art tool for developing machine learning (ML) techniques and their

application to real-world data mining problems. It is a collection of machine learning algorithms for data mining tasks. The algorithms are applied directly to a dataset. WEKA implements algorithms for data pre-processing, feature reduction, classification, regression, clustering, and association rules. It also includes visualization tools. The new machine learning algorithms can be used with it and existing algorithms can also be extended with this tool.

B. Dataset Description

We performed computer simulation on a supermarket dataset available UCI Machine Learning Repository [8, 12]. The features describe different factor for supermarket. The dataset contains 4627 instances and 217 attributes.

C. Results Analysis

We run selected classifiers in different scenarios of the dataset.

Classifier's Performance

Classifier	Avg. Precision	Avg. Recall	Avg. F-Mean
NB	0.637	1	0.778
Logistics	0.637	1	0.778
SMO	0.637	1	0.778
ADTree	0.752	0.828	0.788
J48	0.637	1	0.778
Naive-Bayes Simple	0.637	1	0.778

IV. CONCLUSION

In this paper we conducted an experiment to find the impact of supermarket data on the predictive performance of different classifiers. We select six popular classifiers considering their qualitative performance for the experiment. After analysing the quantitative data generated from the computer simulations, we find that the general concept of improved predictive performance of all above classifiers is equal but ADTree performance are significant.

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