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Big Data Mining Method of Marketing Management Based on Deep Trust Network Model

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Abstract—Through big data mining, enterprises can deeply understand the consumer preferences, behavior characteristics, market demand and other derived data of customers, so as to provide the basis for formulating accurate marketing strategies. Therefore, this paper proposes a marketing management big date mining method based on deep trust network model. This method first preprocesses the big data of marketing management, including data cleaning, data integration, data transformation and data reduction, and then establishes a big data mining model by using deep trust network to realize the research on the classification of marketing management data. Experimental results show that the proposed method has 99.08% accuracy, the capture rate reaches 88.11%, and the harmonic average between the accuracy and the recall rate is 89.27%, allowing for accurate marketing strategies.

Keywords—deep trust network model; marketing management; big date mining method.

I. Introduction

With the continuous maturity and development of China's market economy, the personalized demand of consumers is becoming increasingly fierce, which has become a trend; in addition, the competition between enterprises is also growing day by day, which has become white hot. Therefore, facing the ever-changing and fierce marketing environment, enterprises are facing more and more pressure and challenges in the marketing process. Its traditional marketing methods have been unable to meet the needs of consumers, and its marketing cost is increasing day by day, but the marketing effect is not directly proportional to it. Therefore, how to insight into consumer behavior in this changing marketing environment, formulate accurate marketing strategies, and improve the efficiency of marketing has become the primary consideration of enterprises in the marketing process [1]. In the era of big data, through the acquisition, processing, mining and other technologies and methods of big data, the behavior of consumers has become traceable, which enables enterprises to have a target in the process of implementing marketing strategies and achieve the effect of precision marketing.

Literature [2] combines massive user information data to establish a multi-dimensional value identification of power users based on big data analysis. The model adopts the integrated clustering method of Shanghai power user group thorough, comprehensive, fast and accurate quantitative description and qualitative analysis, make its value is deeply and detailed mining, at the same time with different user groups of power integration and other input cost to analyze the differences between different user groups cost explore potential characteristics of different groups to provide different marketing strategies, realize personalized services. Literature [3] combines the Internet of Things technology, wireless communication technology and big data mining and computing, and puts forward a new power marketing management method, to realize the interconnection, screening and analysis of power marketing management information system data in each region. Using networks with multiple addresses, universal wireless packet business, 2G / 3G / 4G or wireless modem to meet the remote wireless communication of power marketing information data, the data mining algorithm is applied to realize the screening of marketing data in different regions. During screening, by establishing the decision tree algorithm model, calculate the empirical entropy formula, and then determine the root and leaf nodes of the decision tree, so as to build a mathematical model for screening multiple marketing data. We also use the random matrix theory to analyze the connection between the data in different regions, and put forward the marketing optimization scheme.

But the accuracy of mining the data is not high. Therefore, this paper proposes big data mining marketing management methods based on a deep trust network model. First of all, on the basis of mastering some relevant concepts and theories, the relationship between big data mining and precision marketing is studied, and the entry

point of big data mining for precision marketing application is found. Through data cleaning, data integration, data conversion and data reduction, complete the marketing management big data pretreatment; build a deep trust network model of big data mining, and obtain an accurate marketing strategy. At the end of the paper, the application effect of this paper is explained through empirical experiments, and the accuracy of data mining processing is high, which proves that this paper has some practical significance.

II. Big data mining method of marketing management based on deep trust network model

Big data is generated by the Internet, and big data has given birth to the innovation of enterprise business model and created a large number of emerging industries. Many enterprises use big data to constantly bring forth new business and service models. For example, Internet enterprises such as Baidu and Google use big data to continuously launch new service products, while e-commerce enterprises such as Taobao and Jingdong use big data to locate consumer preferences. The value of big data is also reflected in the promotion of the upgrading and transformation of traditional industries. The traditional automobile, finance, telecommunications and other industries also get a lot of benefits from big data. Advanced big data mining technology promotes the promotion of data-based decision-making and operation, makes enterprise decision-making more scientific, production more refined, service more personalized and operation more predictable, and makes great contributions to the improvement of product quality and production efficiency in traditional industries. For example, traditional enterprises such as Xiaomi mobile phone and Haier Electrical appliances have achieved great success by using big data mining technology [4].

Precision marketing is not a new concept or idea. It is derived from the application of modern advanced communication technology and Internet technology in the marketing process in order to adapt to the ever-changing new marketing environment on the basis of previous marketing development. Philip Kotler, who is known as the father of modern marketing, once proposed and explained the concept of precision marketing in his global lecture tour forum. He believes that precision marketing is that enterprises need more effective communication in the process of implementing marketing strategies, and the effect of communication must be able to be measured, and enterprises can get high returns through effective communication. In the era of big data, precision marketing based on big data mining will be more and more precise and accurate in the process of implementation for the precise positioning of the market and the refined management of customers, which reflects the great charm of precision marketing from multiple angles. Nowadays, although there are many researches on precision marketing, most of them focus on a certain application point or application method, lacking a systematic research framework or system [2]. Based on the background of big data era, enterprises can further mine and screen the information with commercial value through the integration and collection of user data, carry out market segmentation and accurate market positioning for these information, and then take targeted marketing strategies for target customers to provide them with differentiated products and services, and finally obtain loyal customers.

(1) Theoretical significance: in this paper, I read the domestic and foreign literature related to the paper, on the basis of mastering a certain theory, combined with the current social development background, take big data mining as an opportunity, through the relationship between big data mining and precision marketing, find the entry point of big data mining applied to precision marketing. And on this basis, we get the precision marketing strategy based on big data mining, which provides a certain degree of theoretical support for other scholars' systematic research in precision marketing [3].

(2) Practical significance: with the continuous change of marketing environment, for enterprises, how to improve efficiency and efficiency through marketing has become the difficulty and focus of enterprises. Data has long been used in marketing, and in the era of big data, the importance of data in marketing is more prominent. On the basis of mastering the concepts and theories of big data, that is, precision marketing, this paper puts forward some suggestions on the precision marketing strategy based on data mining, which has a certain reference basis for the actual operation of real enterprises [5].

A. Big data preprocessing of marketing management

Data preprocessing refers to the necessary cleaning, integration, transformation, discretization and reduction of the original data before the main processing of data mining, so as to achieve the minimum specification and standard of mining algorithm for knowledge acquisition. Real world databases are often vulnerable to noise, loss of data and inconsistent data intrusion, because the database is too large, often up to thousands of megabytes, or even more, and mostly from multiple heterogeneous data sources. Low quality data will lead to low quality mining results [6]. This requires data preprocessing, so as to improve the quality of data, and then improve the quality of mining results.

a. The necessity of data preprocessing

The object of data mining is a large variety of data collected from the real world. Due to the diversity, uncertainty and complexity of real production, real life and scientific research, the original data we collected are relatively scattered, which do not meet the specifications and standards of mining algorithm for knowledge acquisition research. It has the following characteristics:

(1) Incompleteness means that the values of some data attributes may be lost or uncertain in the data record, and the necessary data may be missing. This is due to the defects in the system design or some human factors in the use process. For example, some data is missing only because the relevant data that is considered unimportant at the time of input is not recorded, it may be due to misunderstanding, or the data inconsistent with other records due to equipment failure may have been deleted, and the historical records or modified data may be ignored, etc. [7].

(2) Noisy means that the data has incorrect attribute values, including errors or outliers that deviate from expectations. There are many reasons. For example, the equipment that collects data may fail, and human or computer errors may occur during data input, and errors may also occur during data transmission. Incorrect data may also be caused by inconsistent naming conventions or data codes used, or inconsistent formats of input fields such as time [8]. In the actual use of the system, there may be a lot of fuzzy information, some data even have a certain randomness.

(3) Clutter and inconsistency. The original data is obtained from various practical application systems. Due to the lack of a unified standard definition for the data of each application system and the great difference in data structure, the data of each system is inconsistent and cannot be used directly [9]. At the same time, data from different application systems are often duplicated and redundant due to merging.

Therefore, the existence of incomplete, noisy and inconsistent data is a common feature of large databases or data warehouses in the real world. Some mature algorithms generally have certain requirements for the data set they process, such as good data integrity, less redundancy of data, and small correlation between attributes [10]. However, the data in the actual system generally can not directly meet the requirements of data mining algorithm. Therefore, it is necessary to preprocess the data.

b. Main methods of data preprocessing

Common data preprocessing methods include data cleaning, data integration, data transformation and data reduction. The following is a detailed analysis.

(1) Data cleaning routines usually include filling missing data values, smoothing noisy data, identifying or removing outliers, and solving inconsistencies [11].

(2) Data integration is to merge data from multiple data sources to form a consistent data storage, such as integrating data from different databases into a data warehouse. After that, sometimes data cleaning is needed to eliminate the possible data redundancy [12].

(3) Data transformation is mainly to transform the data into a form suitable for mining, such as scaling the attribute data to a small specific interval. This is particularly important for those distance based mining algorithms. It includes smoothing, aggregation, data generalization, normalization and attribute construction.

(4) On the premise of not affecting the mining results, data reduction compresses the data by numerical aggregation and deleting redundant features, which improves the quality of mining patterns and reduces the time complexity.

It should be emphasized that the methods mentioned above are not independent but related. For example, the deletion of redundant data is not only a form of data cleaning, but also a form of data reduction. After data integration, it is often necessary to clean up the data again. Therefore, this paper proposes a cyclic data preprocessing mode [12].

B. Big data mining and marketing management method based on deep trust network model

At present, the main stream of big data mining modeling includes six stages, namely business understanding, data understanding, data preparation, modeling, evaluation and application.

(1) Business understanding: the purpose of data mining is for application, so data mining should start from application, that is, we must understand the project requirements and ultimate goals from the perspective of application, and translate these requirements and goals into the definitions and goals in data mining [13].

(2) Data understanding: data understanding refers to screening the required data, verifying the quality of data, understanding the meaning and characteristics of data, that is, from the beginning of data collection to getting familiar with the data, and then evaluating and screening the availability of data.

(3) Data preparation: data preparation refers to the processing of the original data into the data needed for the final modeling. This process may be executed many times and is time-consuming, including feature selection, data preprocessing and so on.

(4) Modeling: modeling refers to the use of data mining model technology for modeling. In this stage, different modeling methods are adopted according to different business requirements.

(5) Evaluation: evaluation refers to a comprehensive examination of the established model, that is, to judge whether the model has achieved the established business objectives and whether there is room for improvement.

(6) Application: the establishment of the model is to make data mining more accurate, it is not the ultimate goal of data mining, does not mean the end of the mining process. All the analysis is for business practice. Only when the model is applied to practical activities can it reflect its commercial value [14].

The sequence of the above six stages is not fixed, and it is necessary to cycle among them. Different business backgrounds lead to different circulation modes. In general, data mining is a circular process, that is, through continuous optimization, trying to get the best application [15]. The specific mining process model is shown in Fig. 1:

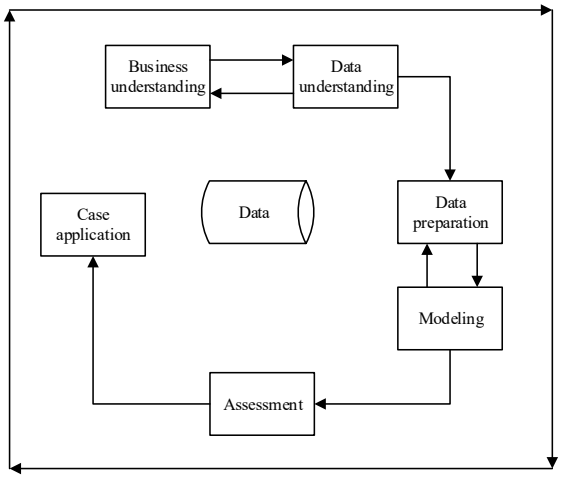

Figure 1. Big data mining process

As shown in Fig. 1, the process of data mining is shown as follows:

(1) Classification analysis

Classification analysis is to divide the data with common characteristics into different types according to a certain classification model. Its main purpose is to get the specific categories of different data through classification. It can be widely applied to the analysis of customer groups, the analysis of customer specific characteristics, the analysis of customers' shopping preferences and so on [16].

(2) Regression analysis

Regression analysis method refers to the use of mathematical statistics principle, a large number of data for mathematical statistics, mainly describes the trend characteristics of data in time series, based on the analysis of the correlation between dependent variables and independent variables, establishes the functional expression of the correlation between variables, which is used to predict the change of dependent variables in the future. It can be mainly applied in various segments of marketing, such as product life cycle analysis, sales trend prediction, customer churn prevention, targeted marketing activities and so on [17].

(3) Cluster analysis

Clustering analysis belongs to unsupervised learning, which is different from supervised learning. It groups data objects according to the information of describing objects and their relationships found in the data. The purpose is to divide a group of data into different categories according to the similarity, so that the data of the same category is as similar as possible, and the similarity between different categories is as small as possible. From the perspective of data mining, clustering can be divided into partition clustering, hierarchical clustering, density based clustering and grid based clustering. It can be mainly applied to customer group classification, market segmentation and customer consumption analysis [18].

(4) Association rules

Association rules are used to describe the relationship and rules between data, and to mine the association and hidden relationship between data, that is to find some rules or connections behind data. In general, association rules are used to mine the massive data of enterprises, analyze the useful associations, and provide scientific decision support for product sales, positioning, pricing and marketing risk assessment of specific customer groups [19].

Based on the above processed marketing management big data, this paper chooses to establish a classification model for data mining, in which the establishment of the classification model is realized by the deep trust network in the deep learning algorithm.

As a new method in the field of machine learning, deep learning has achieved brilliant results in the field of image and speech recognition with its powerful automatic feature extraction ability. By simulating the mechanism of human brain processing data layer by layer, it can automatically extract features from the original data from low level to high level, from concrete to abstract. After nearly a decade of development of deep learning, scholars have put forward a large number of deep learning structures and training algorithms. Through summarizing the literature, although there are many different variants of deep learning models, their essence is that they are evolved from some basic parent structures. There are three commonly used deep learning models: Deep Belief Networks (DBNs), Convolutional Neural Networks (CNN) and Stacked Auto Encoders, sometimes called Deep Neural Networks (DNN) [20-21].

Deep trust network is a probability generating model, which is composed of multiple Restricted Boltzmann Machines (RBM). The bottom layer of deep trust network receives the input data vector and transforms the input data to the hidden layer through RBM. The input of the higher RBM comes from the output of the lower RBM. Its structure is shown in Fig. 2:

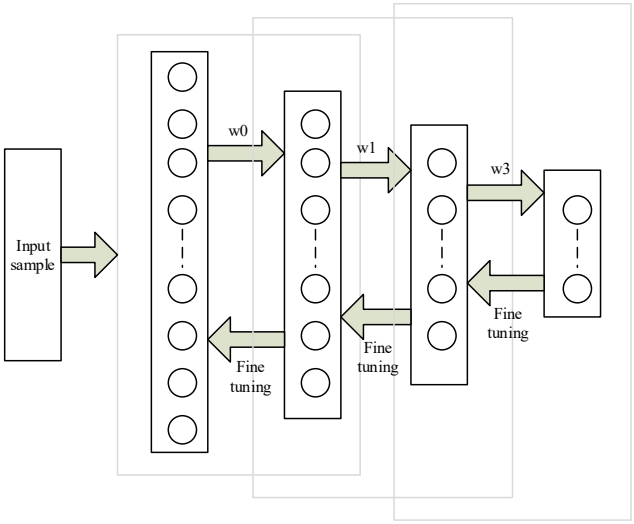

Figure 2. Structure of deep trust network model

As shown in Fig. 2, the big data classification process of marketing management based on deep trust network is as follows:

Step 1: get big data of marketing management;

Step 2: preprocess the big data of marketing management, and it is discussed in Chapter 2.1;

Step 3: build and train data mining model based on deep trust network. The training of deep trust network consists of two processes: unsupervised layer by layer pre training and supervised fine-tuning.

Unsupervised layer by layer pre training is the main difference between deep trust network model and other models. Unsupervised layer by layer learning can learn nonlinear complex functions by directly mapping data from input to output, which is also the key to its powerful feature extraction ability. Firstly, a vector is generated in the visible layer of the first RBM, and the value is transferred to the hidden layer through the RBM network. In turn, the hidden layer is used to reconstruct the visible layer, and the weight between the hidden layer and the visible layer is updated according to the difference between the reconstructed layer and the visible layer until the maximum number of iterations is reached. The method of training RBM layer by layer avoids the complex operation brought by the overall training of deep trust network, which transforms the deep trust network model into a shallow neural network layer by layer.

Fine tuning with supervision. After completing the training phase, the weights matrix of each RBM layer and the weight matrix of the classifier model are used as the initial values and assigned to the DBN network. After initializing the weights, the traditional error back propagation algorithm is used to fine tune the weights of DBN network.

Step 4: input the marketing management big data test samples into the trained data mining model based on deep trust network, and get the results after calculation.

III. Simulation Experiment Analysis

The system version is WINDOWS7 and the processor is Intel (R) Core (TM) i7-2400CPU@3. 5GHz, 8G memory as the experimental platform, using JAVA language to program the experimental method. The Apache server based on WINDOWS2003 is used as the experimental data source.

A. Data selection

The data in this paper comes from XX Telecom Company, which includes the data of broadband users in XX city from May to August 2019. There are more than 4 million original data sets, from which 979902 data are selected. Three tables are selected from CRM system, including basic table, customer complaint table and customer light cat power table. There are 50 features in total, the main features are network access time, main package name, product type, integration, billing income, accumulated debt, call duration, call frequency, broadband traffic GB, Internet access duration, Internet access frequency, SMS number, speed, mobile user call frequency, mobile user call duration, mobile user internet access frequency, mobile user internet access duration, mobile user SMS and so on.

B. Model implementation

After data integration, data cleaning, data specification and data transformation, the quality of sample data has been improved to a certain extent. After processing, the sample data set has a total of 979902 pieces of data, with a total of 29 features, of which 945230 are non-loss customers, and the loss customers account for only 20% 34672, and the proportion of positive and negative samples is as high as 27:1. Therefore, simple random oversampling is used to sample the lost and non-lost customers, so that the proportion of categories reaches 1:1. First, the processed data is put into XGBoost to generate a group of new features, and then the new features and original features are put into DBN to obtain the prediction model. The results are obtained by verifying whether the customers are losing in August.

C. Data mining performance evaluation index

In the face of imbalanced data, it is not accurate to evaluate the performance of classification methods only by the accuracy rate, ignoring the insensitivity to the recognition of a few types of data. Therefore, in order to need an evaluation index that can objectively reflect the comprehensive classification ability of positive and negative samples, we should also consider eliminating the influence of sample skewness, here is F1 value. For the required F1 value, it is necessary to establish the binary confusion matrix. Its basic structure is shown in Table 1:

Table 1. Binary confusion matrix

Confusion matrix		Classification results	
		A case in point	Counterexample
Real results	A case in point	TP	FN
	Counterexample	FP	TN

$$\text{accuracy}=\frac{TP}{TP+FP} \tag{1}$$

$$recall=\frac{TP}{TP+FN} \tag{2}$$

$$F1=\frac{2\cdot \text{accuracy}\cdot recall}{\text{accuracy}+recall} \tag{3}$$

In the formula, F1 represents the harmonic average between accuracy and recall. TP represents the number of real cases, FP represents the number of false positive cases, FN represents the number of false negative cases.

D. Experimental results and analysis

The method proposed in literature [2], and literature [3] is compared with the proposed method, and the comparison results are shown in Table 2.

Table 2. Comparison of performance indexes of various data mining methods

index	The proposed method	Method of reference [2]	Method of reference [3]
accuracy/%	99.08	98.42	98.66
recall/%	88.11	87.99	86.04
F1 /%	89.27	81.27	88.12

According to the comparison of each model index in Table 2, it can be found that:

(1) The accuracy of the proposed method is 99.08%, the accuracy of literature [2] is 98.42%, and the accuracy of literature [3] is 98.66%. The proposed method is better than the other three algorithms.

(2) Recall rate is an important measure. To measure the capture rate of lost customers, the proposed algorithm achieves 88.11%, which is higher than other algorithms, but it is similar. Although the method in literature [2] also achieves 87.99%, it is obtained by sacrificing the accuracy rate.

(3) F1 is the balance of accuracy and recall. The recall rate of the proposed method is 89.27%, which is still higher than that of literature [2], and literature [3], so the algorithm in this paper has achieved good results in the prediction of telecom customer churn.

The proposed method achieved superior results in accuracy, recall and F1, because this paper studies the relationship between big data mining and precision marketing, finds the entry point of big data mining for precision marketing applications, and ensures the balance between accuracy and recall. Through the marketing

management of big data pre-processing, to lay the foundation for determining the accurate data mining results; to build a deep trust network model of big data mining, and finally obtain a high precision marketing strategy.

IV. Conclusion

The role of big data mining technology in marketing can not be underestimated, and it has become an important tool to obtain customer information in enterprise marketing. By using science and technology to analyze these data, enterprises can obtain a large number of customer information that can be used by enterprises, extract the basic information, transaction information and other original data of customers, and then deeply understand the consumer preferences, behavior characteristics, market demand and other derivative data of customers. In order to improve the effect of big data mining and propose more accurate marketing schemes, this paper proposes a marketing management data mining method based on a deep trust network. Moreover, the relationship between big data mining and precision marketing is analyzed, and then the entry point of big data mining for precision marketing application is found. Completed the pre-processing of marketing management, built a deep trust network model of big data mining, and obtained an accurate marketing strategy. The experimental results demonstrate that the high mining accuracy of this method provides the basis for enterprise marketing strategy, enabling enterprises to discover customer needs faster and meet customer needs faster, thus improving customer satisfaction and customer loyalty. However, due to the limited conditions that do not detect the mining time of this method, future research can further improve the mining speed while ensuring the accuracy of the marketing strategy.

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