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CRM Hotel Management System and Intelligent Information Push Based on Bp Neural Network

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Abstract: This paper takes hotel CRM as the main research object, on the basis of understanding its basic business process and organizational structure, comprehensive consideration of various factors, to develop a suitable for its development of hotel information management system. On this basis, the customer relationship management module is added. By effectively sorting out the hotel customer resources and deeply analyzing the customer relationship, a customer segmentation model based on hotel CRM is proposed. A data warehouse based on hotel is constructed, and BP neural network algorithm is used to cluster and analyze the data sets in the data warehouse. The data sets in the data warehouse are visualized on the Web page in the form of graphs, including customer satisfaction analysis, customer value analysis, customer segmentation results and targeted information push. It aims to provide a basis for hoteliers to make correct decisions and promote the steady and rapid development of hotels.

1. Introduction

With the development of the Internet industry and information technology, the challenges and opportunities facing the hotel industry are constantly changing. Today, with the rapid development of information technology, customers are the foundation of enterprise development. Without sufficient customer resources and good interaction with customers, the hotel may lose its competitive advantage in the market, which is not a sustainable development. In this sense, customer relationship management should be the focus of the hotel business. And customer relationship management (CRM) this kind of new management mode, is by studying a lot of customer information, and use the advanced technological means to analyze the data, thus to customer demand for better understanding and judgment, and targeted to provide personalized service, guarantee the customer satisfaction and loyalty of hotel service is good, relationship to promote the hotel and customers realize a virtuous cycle[1].

CRM is an operation and management concept, which was first put forward by GartnerGroup in the 1980s.CRM is not only a modern management concept, but also a set of solutions as well as a set of application software systems. The role of CRM is to promote the positive interaction between enterprises and customers, to maximize the benefits of the hotel. Thanks to the development of information technology, CRM, as a computer technology application, covers such as data mining,

data warehouse, Web application, e-commerce and related hardware technology, and has been widely studied in the telecommunications industry, retail industry, financial industry, e-commerce and other industries.

2. Related Theory and Technology

2.1 CRM Functional Classification

With the development of customer relationship management, CRM system has attracted increasingly people's attention, and increasingly enterprises have begun to use CRM systems. CRM systems are divided into three categories according to their functions: operational, analytical and collaborative. Operational CRM systems can collect a large amount of customer information; Analytical CRM system to integrate sales, services, and business data, and by using computer technology such as data warehouse, data mining, convert information into knowledge, the future trend of development of the enterprise to make necessary and meaningful to predict, at the same time for the entire enterprise to provide strategic and tactical business decisions, improve the competitiveness of the enterprise; The main role of cooperative CRM system is reflected in two aspects: first, customers can get interactive services and comprehensive information through it; Second, it can integrate various customer communication channels, so that customers can get more complete and accurate information. There is a complementary relationship between the three, the operational system for the analysis of the system to provide the necessary data[2].

2.2 Main techniques and methods of data mining in hotel CRM

2.2.1 BP Neural Network

BP neural network is a kind of multilayer neural network composed of an input layer, multiple hidden layers, and an output layer. It can connect different layers of neurons and can be connected according to the weight.Because the BP neural network algorithm is composed of information flow forward transfer and error modified back propagation, therefore, in the time of algorithm for computing, researchers need to start the forward transfer procedure, and will need to deal with the data transmission to the input layer neurons node, and then through the hidden layer of BP neural network to realize the network data processing, the final will be the result of the analysis on the output layer, If there is a large error between the actual output value of the output layer and the expected value of the sample, then the BP algorithm needs to use the error reverse modification to modify the weight of each neuron node. After several modifications and adjustments, the final weight is obtained, As shown in Figure 1.

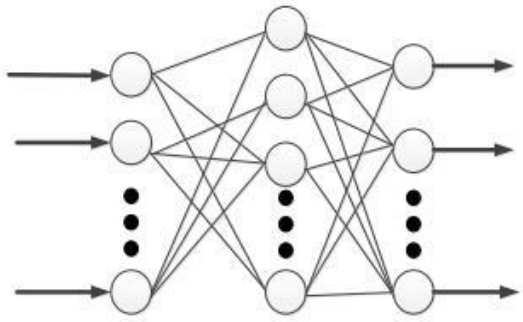

Figure 1: Basic structure of BP neural network.

2.2.2 Association Rules

Association rules were first proposed by R. Grawal in the 1990s to describe the potential relationships between various data items in a database. According to the "if-then" relationship between different attributes in a particular thing according to a certain rule and pattern, the association rule makes an in-depth analysis of related data. This technique is usually applied to transaction databases, and a transaction database constitutes an itemset.By finding all frequent itemsets from the data set, association rules are generated from these frequent itemsets. There are many algorithms in the association rules, including AIS algorithm, Apriori algorithm, DHP algorithm, FP-tree algorithm, etc. Apriori algorithm is the most classic algorithm. Apriori algorithm is a frequent itemset mining algorithm. It mines all frequent itemsets iteratively and uses frequent itemsets to construct the minimum confidence rule that satisfies the user. Apriori algorithm, based on the prior knowledge of frequent itemsets, searches the database layer by layer through continuous iteration, and searches (N +1) itemsets through N itemsets until all frequent itemsets in the database are searched.When all frequent itemsets are found, then determine the specific rules, that is, to meet the needs of the user association rules[3].

3. Requirement Analysis and Design

3.1 System Body Structure (B/S Structure)

The hotel management system developed in this paper is based on B/S(Browser/Server) WEB system, namely, Browser Server mode which is a network structure mode after the rise of the WEB, this mode unifies the client, by the server to complete the core functions of the management system, the browser side is only responsible for interaction with the user, Simplifies the development and maintenance of the system.

3.2 Hotel Business Process Analysis

System business process analysis is from the hotel, actual business operation, from the hotel, each department began to study the actual working program, describe the business management, service between the hotel staff positions sequence and customer information flow chart, through the business flow diagram, system developers to quickly determine the process of the whole system to the hotel.

3.3 Analysis and Design of System Function Modules

The hotel management information system adopts a modular design, which lays a certain foundation for the authority management of the hotel. According to the business process analysis, the design of the following nine functional modules, including front desk management, room management, sales management, engineering department, night audit, CRM management, financial management, report center, configuration center. Each module corresponds to a different management organization, and there are intricate data links between each module[4].

The main purpose of CRM center is to maintain the emotional relationship between the hotel and customers. To achieve the management and analysis of hotel members, the CRM center can not only store the historical customer information of the hotel, but also conveniently and quickly locate customers through simple query conditions, and display the check-in history, consumption and personal information of customers. It can also use marketing means such as member points management or recharge to cooperate with member management, dig deep profits, and subdivide

customers according to customer sources, gender and other factors. In addition, it also realizes the function of sending information to hotel members.

4. Customer Segmentation and Intelligent Information Push Based on BP Neural Network

4.1 Customer Segmentation

The concept of customer segmentation was put forward by Wendell Smith, an American scholar, in the mid-1950s of the last century. The so-called customer segmentation is that enterprises divide customers into different groups according to their different preferences, needs, values and behaviors, and adopt different sales strategies and service promotion for different groups.

4.2 Customer Segmentation Method

Customer segmentation problem is essentially a classification method with its own characteristics, because it is generally in the service of enterprise marketing, so the customer segmentation method must cooperate with the characteristics of the enterprise.

Table 1: Customer segmentation methods.

Segmentation criteria	classification	The characteristics of
Customer Statistical characteristics	Gender, region	Simple and easy
Customer behavior	Value matrix	Widely used
Customer Life Cycle	Loyalty ladder taxonomy	Can maintain and promote customers according to their stage
The interests of	Factor analysis, cluster analysis, neural networks	Strong inclusiveness, simple operation, good effect, and strong flexibility

4.3 Customer Segmentation Model

BP neural network is a kind of classical feedforward neural network. It adjusts the weight of each hidden node through constant and unsupervised self-learning, which has strong generalization ability and accurate prediction ability. However, the learning speed of BP neural network model casting for complex problems is slow and the training time is long. Therefore, to make up for the defects of BP neural network, this paper introduces Logistic regression model and combines the BP neural network algorithm to carry out customer segmentation.

Customer value is analyzed from three aspects of customer current value, potential value, and loyalty value, and the customer lifetime value model is constructed as follows:

$$\begin{cases} CV = w_1 L_1 + w_2 R_1 + w_3 F_1 + w_4 A_1 + w_5 D_1 \\ PV = \sum_{i=1}^{n} P_i \times \overline{\pi}_i \\ LV = \frac{P_l + P_n}{2} \end{cases} \quad (1)$$

Where, represents the current value of the customer, and are, respectively, the normalized values of each indicator of the length of purchase time (L), the most recent purchase time (R), the number of purchases (F), the average purchase amount (A) and the purchase type (D), and are respectively the weight of each indicator determined by the entropy value method. $CVL_1R_1F_1A_1D_1w(i = 1,2,3,4,5)$The improved RFM model not only considers the monetary revenue, but also reflects the value of customer behavior, to measure the current value of customers more comprehensively.

PVRepresents the potential value of the customer, is the prediction probability of product I, namely, the mean of the prediction probability of logistic regression algorithm and BP neural network algorithm;$P_i\overline{\pi}_i$Is the average profit of product I.Since there are many influencing factors of customer potential value in the cosmetics industry, Logistic regression algorithm can not only analyze the influencing factors but also accurately predict the probability of customer buying products.The prediction accuracy of BP neural network algorithm is high, so the combination of the two prediction can analyze the customer's cross-purchase potential and incremental purchase potential, and accurately predict the customer's purchase probability of a product.The average profit of a product can measure the profit that customers bring to the enterprise when they buy the product, and the potential value can be expressed in the form of profit[5].

Based on the analysis of customer loyalty, logistic regression algorithm and BP neural network algorithm are used to predict whether the customer will return to purchase in the next period, and the average value of the two predicted probabilities is regarded as customer loyalty.Therefore, represents the value of customer loyalty, refers to the prediction probability of Logistic regression model, and a refers to the prediction probability of BP neural network model.LVP_lP_n

The above three parts measure customer value from different levels. To comprehensively evaluate the customer lifetime value, the objective entropy method is used to determine the weight of customer current value, potential value, and loyalty value, and calculate the customer lifetime value. The formula is as follows:

$$CLV = \alpha_1 CV_1 + \alpha_2 PV_1 + \alpha_3 LV_1 \quad (2)$$

Where,a , and are the normalized values of customer's current, value potential, value and loyalty, value, respectively and a are their corresponding weights respectively.$CV_1 PV_1 LV_1 \alpha_1 \alpha_2 \alpha_3$

4.4 Customer Segmentation Based on Lifetime Value Model

The data used in this paper is the customer check-in information from a hotel in the last six months, which is stored in table T_CustomerHistory. The customer information includes name, card number, gender, ID number, contact information, most recent check-in date, most recent housing type, days of stay, time of stay, consumption amount, and so on.

4.4.1 Lifetime Value Calculation

(1) Customer current value calculation.Through the improved RFM model, calculate the current value of customers.

(2) Calculation of customer potential value.Firstly, the data of 2021 are selected to establish the logistic regression model and BP neural network model for whether customers buy basic products. Then, the data of the first half of 2022 are used to predict the customers' purchase of the product in the second half of 2022. The mean of the forecast probability is taken as the probability of customers' purchase of the product. And the sum of the product of the forecast probability of each product and the corresponding average profit is taken as the potential value of the customer[6].

(3) Calculation of customer loyalty value.According to the customer loyalty value index, the customer data in the first half of 2021 was selected as the input variable, and whether the customer returned to purchase in the second half of 2021 was taken as the dichotomous output variable. The Logistic regression model and BP neural network model were established.The customer data in the first half of 2022 were selected for prediction, and the mean of the predicted probability of customers returning to purchase in the second half of 2022 was taken as the customer loyalty value.

(4) Calculation of customer lifetime value.According to the current value, potential value, and loyalty value of customers, the final summary of 100878 customer data.The entropy method is used

to calculate the weight of current value, potential value and loyalty value of customers as {0.22, 0.24, 0.54}.Since the calculated value of customer lifetime value is small, it will be converted into a score between 0 and 100 according to formula (4-3), which can reflect customer lifetime value more intuitively.CLV

$$X_i = \frac{x_i - \min(x_1,\cdots,x_n)}{\max(x_1,\cdots,x_n) - \min(x_1,\cdots,x_n)} \times 100, i = 1,\cdots,n \quad (3)$$

4.4.2 Customer Segmentation Based on Lifetime Value

According to the three dimensions of the K-means algorithm is used for customer segmentation.CLVBased on the RFM customer segmentation method, the number of clusters K is determined as 8 categories.The ratio of the sum of squared deviations between groups and the total sum of squared deviations was calculated to be 83%, which verified the rationality of the eight categories of customers.Due to the large amount of customer data, 10 customers from each category were randomly selected and the clustering result chart was drawn, As shown in Figure 2.

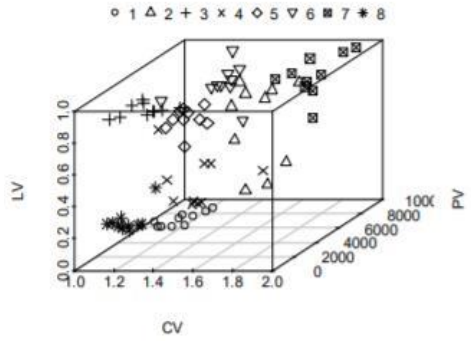

Figure 2: Clustering results.

According to the average customer lifetime value in descending order {7:81.55, 6:69.94, 5:58.2, 2:56.5, 3:53.19, 4:27.11, 1:16.06, 8:8.71}, the seventh, sixth, fifth, second and third class customers are all above 50 points, which are high value customers;The fourth, first and eighth categories of customers are low-value customers.The hotel manager can carry out intelligent push of relevant advertising according to the type of customers.

5. Implementation of the Hotel Management System Based on CRM

5.1 Login Interface

Focus on landing interface beautiful and easy, convenient operation, the user to enter the login interface, enter the account and password, to prevent malicious login, this system sets up the dynamic authentication code input function, and then click "login" button, successfully using the main interface, if the input error, the system will have a corresponding hint, require users to enter login information.

5.2 Front Office Management

The front desk management module is the most frequently operated module by hotel staff and has the most powerful functions.The front desk staff can see the whole hotel's room status, and check-in situation directly through the system room status interface.The room management interface displays room information, including room number, room type, owning building, owning

floor, telephone number and other information.Through the room number, you can query the information of a room, add a new room, change the room information, and delete a room.In a word, through the room management interface, the front desk operator can easily manage the room.

The system room status display is a page with the highest contact frequency of the front desk operators. The room status diagram is drawn according to the actual layout of the hotel rooms. Different colors are used to represent the different states of each room, so that the front desk staff can recognize the current state of each room at a glance and quickly lock the room[7].

5.3 Customer Information Management

The customer information management page usually records many aspects of customer information, including check-in time, historical consumption, etc.,By default, the basic information about all customers is listed below.The hotel management staff can query the basic information of any customer by name or telephone, and can check the category of the customer.If the column of name and phone number is empty, only enter the category of the customer, you can query all customer data under this category.Including name, contact information, means of payment, preferences, time of entry and exit and remarks, etc., provides the data basis for the customer segmentation[8].

5.4 Customer Segmentation

Customer segmentation is mainly the analysis of the customer history information stored in the database, and the statistical results are depicted and displayed by the Highcharts plug-in.

Customer composition analysis plays a great role in hotel marketing. We can clearly see the composition of the hotel's customers by gender and age. These data come from the customer data stored in the database of the hotel in the past two months, which provides a reliable scientific basis for hotel marketing[9].

The index of customer spending amount is essential for hotels, which is closely related to the hotel's profit and profitability. According to the consumption situation in each scope, the hotel can formulate the corresponding intelligent information push strategy and service strategy and implement it for customers in different consumption scopes, to achieve the goal of maximizing the profit of the hotel[10].

6. Conclusions

With the improvement of material life, people have put forward higher requirements for the service level of the hotel industry.Under the condition of relatively limited resource cost, the hotel provides differentiated services through the analysis of customer relationship, which is of great significance to enhance the comprehensive competitiveness of the hotel industry.Based on data mining, this paper analyzes the customer relationship in hotels. On the basis of the analysis of the development status of CRM and the research status of CRM in the hotel industry, the research and application of hotel CRM are carried out.Design and development of the hotel management system are caused by a lack of development experience of himself, and the limitation of development time, the customer relationship management module, this system has realized the small part only, such as customer value, customer satisfaction analysis has not yet had time to study, want to be able to be implemented in the later work.

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