

Prediction of Mobile Coupon Use: Data Analytics of Influencing Factors

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Abstract

As the Online to Offline (O2O) business model has entered a stage of rapid development, mobile coupons have attracted the attention of scholars and the industry as a preferential means to attract customers to pay online. This research uses algorithms and models in machine learning to explore the consumption records of the mobile coupon data set. Our results show that the characteristics of merchants and coupons significantly affect the use of mobile coupons. Based on our findings, a Customer CRM system architecture suitable for merchants to manage coupons was designed to optimize the business management of coupons and users.

Keywords

Mobile coupons prediction; XGBoost; Model; Influencing factors; CRM

1. Introduction

With the latest development in mobile technologies, m-commerce has entered a stage of rapid development [1]. For example, the e-commerce information, transaction, and technology service companies in China continue to emerge, with e-commerce transactions reaching 28.4 trillion Yuan in 2018 (equivalent to US\$4.5 trillion in 2018), with a year-on-year increase of 17.8%. Online to Office (O2O) business, as one of the emerging e-commerce business models, entered a rapid development stage in 2013, beginning to integrate and improve localization and mobile devices [2]. Therefore, the O2O business model has attracted the attention of researchers and practitioners. Mobile coupons play an essential role in the O2O business model as a mobile marketing method. It is observed that O2O merchants use coupons more favorable than offline payments to attract customers to pay online.

Mobile coupons are usually presented in text, images, audio, and video. Customers can get cash discounts or rebates by showing them when paying. At the same time, they can be used as a carrier of information activities to drive customers into the store for future purchases [3]. Mobile coupons also improve customer satisfaction and retention, leading to an increase in the stores' profit. With the help of big data technology, these mobile transaction data can be easily analyzed by researchers.

O2O is an emerging e-commerce business model that combines the Internet with offline services, and the Internet serves as the front desk for transactions. Offline physical stores in this model can attract customers through the Internet, and customers can search for the services they need. Transactions can be completed online, quickly forming a scale. The most important feature of this model is: the service effect can be checked, and every transaction can be tracked and recorded. Thus, this study explores the influencing factors of mobile coupon use behavior, verifies the influence of coupon discount rate and reduction on consumers' willingness to use, and shows that consumers with higher price-sensitive demand elasticity are willing to pay search costs to reduce the use of mobile coupons.

Under this premise, mobile marketing plays an essential role in facilitating transactions [4]. Mobile marketing attracts customers to consume by sending service information to customers' mobile devices. With the rapid development of network technology and mobile devices, personalized marketing has

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taken shape, and mobile marketing has developed rapidly. Customers search for and understand product information through various third-party software on mobile phones and tablets, official accounts on social platforms, text messages, mobile websites, etc., deeply participate in the entire service process, and finally make a purchase. Mobile coupons are one of the mobile marketing methods under the O2O business model.

2. Methodology

The data for this research comes from Alibaba Cloud [5] “O2O Coupon Usage”. This data provides the actual online and offline consumption behavior of a certain platform user between January 1 and June 30, 2016. For research, we selected a data set of users’ offline consumption and coupon-receiving behaviors. The information in the data set includes coupon ID, merchant ID, user ID, discount rate, the distance between the user’s frequent activities and the nearest portal of the merchant, coupon collection time, and consumption time. There are 1,754,884 records in the original data set, including 8,415 merchants, 539,438 users, and over 1 million coupons.

We used the data set to construct a prediction model for using mobile coupons to predict users’ use within 15 days after receiving the coupons. We considered three algorithms to conduct our predictive classification algorithms, i.e., logistic regression, random Forest, and Xgboost [6][7]. In the case of a single model, Xgboost performs better than the other two methods, and the prediction results are more accurate (see Table 1).

Table 1

Model score

Model Name	Random Forest	Logistic Regression	Xgboost
Result	0.6932	0.7074	0.8093

3. Influencing factors of the use of mobile coupons

3.1. Analysis of the feature importance score of each module

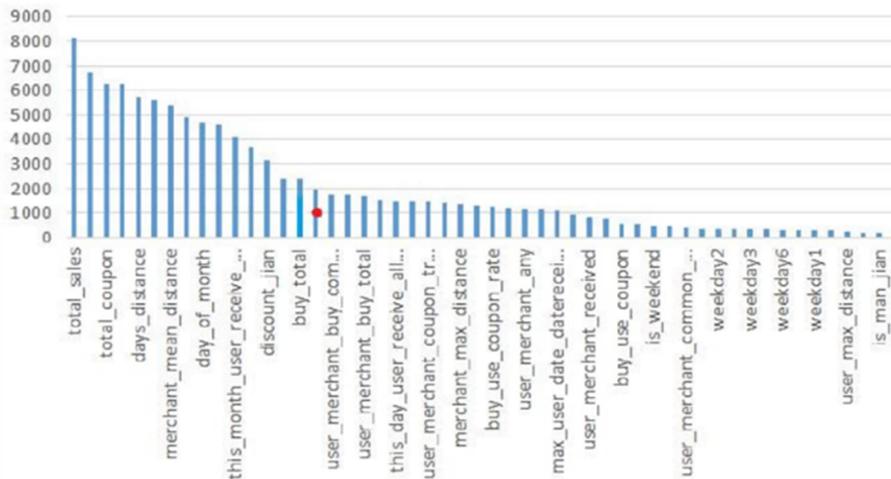


Figure 1: Histogram of feature importance scores

As Xgboost can more accurately predict the use of coupons, we used it to build a model of whether mobile coupons are used or not under 52 features. XGboost calculates the number of splits of each feature in each tree to obtain a feature importance score, indicating the importance of each feature to model training. Figure 1 shows the result, with the horizontal and vertical axis as the order of the 52 features and the feature score, respectively. Notably, the broken line has a rapid downward trend in the first sixteen features but declines slowly after the fifteenth feature. This feature is the turning point of

the overall trend of the broken line, and the subsequent feature scores are low, and the effect on the use of mobile coupons is relatively weak. Therefore, the higher scores, mainly for the first fifteen, have a more significant impact on mobile coup use.

3.2. Analysis of influencing factors of mobile coupon use

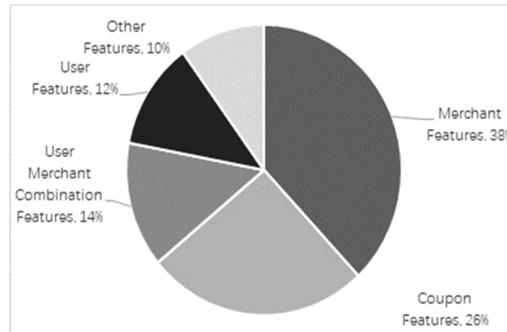


Figure 2: Example figure

Table 2
Feature score ranking

Ranking	Name of Feature	Type of Feature
1	The total number of historical merchandise sold by the merchant	Merchant feature
2	The merchant's historical coupon usage rate	Merchant feature
3	The total number of coupons issued by the merchant in the history	Merchant feature
4	Discount rate	Coupon feature
5	Coupon collection time and feature set deadline time interval	Coupon features
6	Proportion of coupons used in the merchandise sold by this merchant	Merchant feature
7	The average value of the distance between the merchant and the user	User-merchant combination feature
8	Fully reduce the minimum consumption of coupons	Coupon feature
9	The month when the coupon is collected	Other Features
10	The number of commodities that the merchant has used coupons to consume	Merchant feature
11	The total number of coupons received by users in the month	User features
12	The distance between the user and the merchant	User-merchant combination feature
13	Fully reduce the amount of discount coupons	Coupon feature
14	The probability that the user buys goods at the merchant	User feature
15	The number of commodities that the user has used coupons to consume	User feature

After exploring the first fifteen characteristics, it reveals that merchant and coupon characteristics account for a large proportion of the characteristic score. Table 2 reports the details and ranking and details of the first fifteen characteristics, and Figure 3 shows the proportion of various characteristics. The characteristic score accounted for the most significant proportion of merchant characteristics,

accounting for 38%, twice as large as other characteristics with a minor proportion. The coupon characteristics accounted for the second largest proportion, 26%. User merchant characteristics, user characteristics, and other characteristics account for relatively small proportions.

The total number of coupons, the proportion of coupons used in the products sold by the merchant, the average distance between the merchant and the user, and the number of products consumed by the merchant using coupons. These features are merchant characteristics and indicate the size of the store. Strength and past sales will significantly affect the use of coupons, indicating that coupons depend on most regular customers.

Discount rate, coupon collection time and feature set deadline time interval, minimum consumption amount of full discount coupon, the month of coupon collection time, and full discount coupon discount amount are features of mobile coupons. The discount rate ranks fourth in the ranking of influencing factors, indicating that users still pay attention to discounts when using coupons and from the analysis of consumer psychology. Thus, the greater the discount, the greater the perceived benefits for consumers and the possibility of using mobile coupons. The factor of coupon collection time and feature-set deadline time is ranked fifth, indicating that consumers pay attention to the deadline when receiving mobile coupons. Coupon verification avoids missing the expiration date, so this information can reflect that a specific store will reach a small climax in sales within a few days of a specific coupon's expiration date.

The feature of the total number of coupons received by users in the month belongs to other features in the analysis. This feature is extracted from the prediction set and ranks thirteenth in the importance ranking. It shows how many coupons the user received in the month compared to using a certain coupon. The more coupons users receive, the more time and energy spent on coupon searching and the need to use coupons to reduce costs.

The distance between the user and the merchant and the probability that the user purchases goods at the merchant belong to the combined characteristics of the analysis. They are in the twelfth and fourteenth positions. Generally speaking, the greater the probability of a user buying goods at the merchant. Therefore, the closer the user and the merchant are, the more trust the user has in the merchant, thus the higher the possibility of using the merchant's coupons. The characteristics of the distance between the user and the merchant indicate that geographic factors will also affect the use of mobile coupons.

The number of products consumed by the user using coupons and the total number of coupons received are user characteristics, ranking fifteenth and sixteenth, respectively. The user's usual coupon use behaviors also affect the current discounts received. If users use mobile coupons when shopping, they can save time and energy in coupon search and use and are thus more willing to use received coupons.

3.3. In-depth exploration of influencing factors of mobile coupon usage behaviors

After analyzing the factors that affect the use of mobile coupons, we found that these two types of factors, merchant characteristics and coupon characteristics, affect the behavior of mobile coupons to a greater extent. Based on the existing data set, we conducted a survival analysis model of merchant and coupon characteristics. According to the statistical results, mobile coupons with fewer than 30 days of survival were selected as the research object.

Then, we divided each feature into different groups according to their size. The survival analysis results differ when the boundary values are different during the grouping process. The median survival time was used as the observation standard. The group with the most significant change in the median lifetime was recorded as the grouping result in the table.

Finally, we used Python and SPSS to process survival analysis data. According to the grouping results in Table 3, each feature was divided into groups with the control group in the survival analysis. Then, the average survival time of each group's mobile coupon was obtained, yielding the median survival time, the significance test results of the adjacent two groups, and the survival curve. After such repeated steps, the survival analysis of each feature was completed, the numerical experimental results

were recorded in the table, and the survival curve generated by the control group of each feature was depicted on the same graph.

Table 2
Feature grouping and analysis results

Data Group	Data Group Content	Records	Average	Median Survival	Significance
<i>Proportion of coupons used in sold products (Merchant Features)</i>					
#1	0-0.03	5,934	9.93	7	< 0.001
#2	0.03-0.06	1,585	7.91	6	< 0.001
#3	0.06-0.16	2,251	7.06	5	< 0.001
#4	0.16-1	941	5.71	3	< 0.001
<i>Use rate of historical coupons (Merchant Features)</i>					
#1	0-0.03	1,724	8.92	7	0.004
#2	0.03-0.14	2,246	8.25	6	< 0.001
#3	0.14-0.25	1,890	6.81	5	< 0.001
#4	0.25-1	1,136	5.76	4	< 0.001
<i>The discount rate is different, and the amount of the full discount coupon is the same (Coupon Feature)</i>					
#1	5-1	636	6.98	5	< 0.001
#2	20-1	8,248	8.42	6	0.001
#3	50-10	309	9.93	8	0.001
<i>The discount rate is the same, but the minimum consumption amount for full discount coupons is different (Coupon Features)</i>					
#1	5-1	636	6.98	5	< 0.001
#2	50-10	1,214	9.32	7	< 0.001
#3	100-20	1,000	10.61	9	< 0.001

4. O2O coupons CRM system design

The architecture of our O2O coupon CRM system is classified according to user characteristics and life cycle management and follows the alert-driven approach to push relevant coupons to potential customers [8]. Customers are divided into new and regular customers according to their amount, consumption time, coupons, frequency, and consumption amount. Regular customers are divided into high-frequency and high-value users, low-frequency and high-value users, silent users, and lost users. According to different users, businesses can use different strategies.

The O2O coupons use a prediction platform. The current functions are relatively simple, including four functional modules: user management, coupon management, coupon use prediction, and result analysis, as shown in Figure 4.

1. User management: This functional module manages users who use this forecasting system, including adding user registration information, setting account passwords, editing and modifying user information, and granting user permissions. The system contains two roles. One is the manager, who can authorize the general user and control the functions that the general staff can access and use by restricting the menu that the general staff can see. The other is general personnel, who use customer coupon forecasting and other services within the scope of authority given by the administrator.
2. Customer management: Edit and enter the customer's coupon receipt and usage status, and provide the delete function. These data are the data source for coupon usage prediction.
3. Coupon usage prediction: This functional module predicts the use of coupons, starts to analyze the data of customers receiving and using coupons, gives some charts for display, improves user experience, and preprocesses the data in the background, including the processing of missing data,

standardized data, data cleaning, etc. According to the prediction model selected by the user, model prediction is performed to obtain the prediction result.

4. Result analysis: This module displays the predicted results of customer coupon usage and compares the real customer coupon usage with the forecast data for users to consult and analyze.

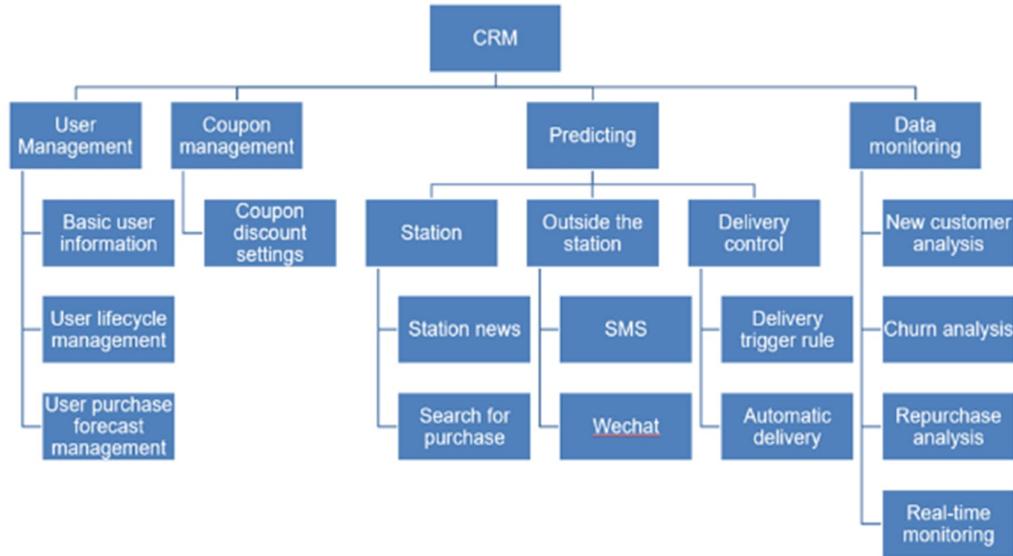


Figure 3: CRM system architecture diagram

5. Conclusion

Starting from user characteristics, merchant characteristics, user merchant combination characteristics, coupon characteristics, and other characteristics, this research has explored mobile coupon usage behavior. Based on previous research on mobile coupons, we have constructed a predictive model and system architecture of mobile coupon use and explored the influencing factors of mobile coupon use based on the characteristic analysis model.

The research results show that Xgboost has the best effect on predicting results; merchant characteristics and coupon characteristics significantly affect mobile coupon usage behavior; user merchant combination characteristics, user characteristics, and other characteristics have an impact on mobile coupon usage behavior. This research uses supervised machine learning and survival model analysis methods to compare offline consumption records within half a year. However, there are some limitations to the research.

1. Due to the limitations of objective conditions, this study's sample data may be insufficient, and the sample is not sufficiently representative. The research data shows users' offline consumption and coupon receipt behaviors between January 1 and June 30, 2016, but the sales of many other products are affected by the season. The conclusions obtained from this data sample apply to the mobile coupon usage behavior in the first and second quarters. In future research, the sample size can be further expanded to make the sample more representative and scientific.

2. Many factors affect the behavior of using mobile coupons. This research mainly explores the perspectives of user characteristics, merchant characteristics, coupon characteristics, etc. In contrast, the existing research on mobile coupon use intention mainly starts from the psychological characteristics of consumers, such as the perception of usefulness, gender, perceived ease of use, trust, etc. Future research should include psychological characteristics of consumption to obtain more comprehensive and practical.

3. The data studied is a data set of users' offline consumption and coupon receipt behavior, ignoring online users' mobile coupon usage behavior. Future research can collect online data to enrich and triangulate the results.

4. This study combines domestic and foreign mobile coupon research results to explore domestic consumption data. There is no comparison with foreign data of the same type. When conducting related research in the future, it is necessary to overcome the limitations of geographic factors and collect comprehensive data. , To compare the influence of different cultures on the behavior of using mobile coupons.

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