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Research Article

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Abstract: In order to segment the value of e-commerce customers and implement differentiated marketing strategies, improve the profits of e-commerce enterprises, and enhance the competitiveness of enterprises, promote the high-quality development of the industry, the author proposes an e-commerce customer value segmentation study based on the Internet of Things and the entropy weight method to improve the RFM model. This method uses the entropy weight method to determine the weight of the three score indicators of the RFM model, calculates the score and evaluates the value of e-commerce customers, using the silhouette coefficient as the standard, the optimal K-means clustering model is selected to perform cluster analysis on the value of e-commerce customers. An empirical study is carried out based on the sales data of a merchant on Pinduoduo. Experimental results show that: Most customer value conforms to the characteristics of the 28 principle, that is, 20% of customers create 80% of profits, so it is considered that about 10-20% of customers are high-value customers. 22.53% are high-value customers and 27.17% are low-value customers, which is close to the classic customer value distribution characteristics; The proportion of high-value customers is 0.82%, the proportion of low-value customers is 20.01%, and the proportion of high-value customers is significantly lower. Conclusion: The discrimination degree of each type of customer group is greater, which is more in line with the classic customer value distribution characteristics, and the model effect is good.

Key words: e-commerce customer value; customer segmentation; RFM model; entropy weight method; K-means clustering

1 Introduction

In recent years, with the rapid development of computer network technology, the arrival of the information age has inevitably led to the rise of the new trend of online shopping and the transformation of market competition, different from the consumption mode of the original brick-and-mortar store and the publicity method based on advertising TV and other media, the

Internet-based business model is not only faster and more convenient in terms of time and space, at the same time, to a large extent, it provides efficient performance for enterprises to obtain customer resources and market information. Based on digital and informatized management, the Internet has brought people into an invisible information space, here, people can freely share endless data from the Internet at any time, breaking the original competition mechanism, even if they are separated by thousands of miles, competitors can be as close to each other [1]. In the face of product competition, enterprises must not only consider the ever-changing localization market, but also take into account the impact and tests from the global market. The price and function of products are no longer the capital of competition among enterprises, they also play an irreplaceable role in bringing comfortable service and noble quality to consumers, enterprise competitors have to face the competition of comprehensive factors. On the one hand, for the purpose of increasing sales volume and increasing turnover, enterprises need to improve market satisfaction by improving product quality and improving speed; On the other hand, in order to reasonably and effectively utilize and tap customer resources, so as to take targeted measures for different customers, the enterprise has developed a new business model-customer relationship management, which is a new management mechanism for the interconnection between the market and consumers, Internet-based sharing of information resources, it realizes the informatization process of enterprise sales management and marketing, which greatly improves the efficiency and transparency of consumer group information, and promotes the implementation of various marketing methods for various consumer groups [2]. At present, the key of enterprises is to start from the analysis of customer needs, and use customer segmentation as a means to mine and analyze various consumer groups in the system, so as to provide various types of customers with marketing methods with their own characteristics, improve their satisfaction and loyalty to maintain the core competitiveness of the market.

2 Literature review

Benlahbib built a classification model based on demographic information, and identified customers based on it, which has important guiding significance for the development and operation of enterprises [3]. Cai, W. proposed that customer value should include multiple processes such as identification, evaluation, and realization [4]. Xu, B. further studied the user's

own value and profit-making ability, in order to reflect the profit created by the customer in more detail, the turnover and absorption cost generated by each customer were considered, thus establishing a customer potential value evaluation and analysis system [5] . Shen, L. Through in-depth analysis and induction of customer segmentation, it is of great significance for enterprises to concentrate resources to maintain high-value customers, which is conducive to the completion of higher-revenue resource allocation plans and further enhances the market competitiveness of enterprises [6]. Yadav, R. Aiming at airline customer data, the traditional RFM model is extended to an evaluation index composed of LRFMC, and customer management suggestions are proposed based on the user life cycle theory [7]. Bezerra, G. Using SOM and KMeans method to build LRFM model, research on customer segmentation model for purchasing travel supplies [8]. RG Martínez considered the total profit characteristics, and analyzed the influence of the correlation of model characteristics on the final clustering effect, and summarized the key strategies of the e-commerce industry [9]. Jns, A. established the RFMDR model, introduced discount factors and return costs, and studied the behavioral characteristics of online shopping customers in Taiwan, so as to discover the real value of customers [10]. Hashminejad utilizes user consumption information in Baidu's food delivery industry, an optimization model based on customer consumption behavior is proposed, adding the average single consumption amount, the analytic hierarchy process algorithm is used to calculate and determine the value of customers to the business, so as to adopt targeted strategies. The two use different indicator models, in-depth research from different angles, accurate and effective division of customers, and put forward practical suggestions [11].

The author innovatively constructs an RFM model based on the entropy weight method, introduces the entropy weight method into the RFM model, and takes advantage of the objective weight determination of the entropy weight method to objectively evaluate customer value, the K-means clustering model is used to subdivide customer value, and a reasonable number of clusters is selected based on the silhouette coefficient, finally, Pinduoduo merchant data is used as an empirical study to verify the validity of the model.

3 Research methods

3.1 Traditional RFM Model

The traditional RFM model was proposed by Hughes A M, the model includes three dimensions:

recency R (Recency), frequency F (Frequency), and purchase amount M (Monetary). R represents the span from the customer's last purchase time to a certain deadline, reflecting the customer's activity level; F represents the purchase frequency of customers during the statistical period, which is used to evaluate customer loyalty; M represents the purchase amount of the customer during the statistical period, and evaluates the purchasing power of the customer. By assigning specific weights to the three indicators of R, F, and M, the score and comprehensive score of each customer value subdivision index can be calculated, the higher the comprehensive score, the greater the customer value.

3.2 Entropy weight method

The entropy weight method is an evaluation theory based on information entropy, which can objectively determine the index weight of the evaluated object, and is often used in the evaluation of complex system problems [12]. The author uses the entropy weight method to determine the weight of the three index scores of the RFM model, the specific calculation process is as follows:

Record the score data of the RFM model indicator as $IS = \left(iS_{ij}\right)_{m\times n}$, where m represents the number of samples, n represents the number of indicators, and the j-th indicator value of the i-th sample is denoted as $is_{ij}(i = 1,2,\cdots,m; j = 1,2\cdots n)$.

Calculate the proportion p_{ij} of the i-th sample indicator value under the j-th indicator, and the formula is as follows (1):

$$p_{ij} = is_{ij} / \sum_{i=1}^{m} is_{ij} \tag{1}$$

Denote the information entropy of the jth index as E_j, as shown in the following formula (2):

$$E_j = -k \sum_{i=1}^{m} p_{ij} \ln p_{ij}, \text{among } k = 1/\ln m \tag{2}$$

The weight of the jth indicator is recorded as w_j, as shown in the following formula (3):

$$\text{then } w_j = \left(1 - E_j\right) / \sum_{j=1}^{n} \left(1 - E_j\right) \tag{3}$$

According to the index weight obtained by the above formula, the comprehensive score of customer value can be calculated, which is recorded as S, as shown in the following formula (4):

$$S = IS * W \tag{4}$$

3.3 Improvement of RFM's e-commerce customer value segmentation model based on entropy weight method

The author innovatively proposes an e-commerce customer value segmentation method based on the entropy weight method to improve the RFM model, the model building steps are shown in Figure 1, the method includes the following seven steps.

1) Collect and clean e-commerce customer transaction data. Export relevant transaction data from the e-commerce trading platform, and preprocess the data such as desensitization, missing values, and outliers to ensure data reliability and accuracy.

2) Set up binning. Generally, the transaction data of the three indicators R, F, and M are divided into 5 bins, and each level is assigned 1-5 points respectively.

3) Calculate the raw scores of the R, F, and M indicators. According to the binning results and the transaction data of each customer, the original score of each customer's R, F, and M indicators is calculated.

4) Use the entropy weight method to determine the weights of the R, F, and M index scores, and calculate the index scores. Taking the raw scores of the indicators obtained in the third step as the basic data, the entropy weight method described above is used to calculate the weights of the three indicator scores, and the original scores obtained in the third step are multiplied respectively, obtain the index score based on the entropy weight method [13].

5) Build a K-means model and calculate the silhouette coefficient value. Considering that the RFM model has 3 indicators, each indicator score has two situations, which are greater than (equal to) the average value and less than the average value, there are a total of 2 × 2 × 2=8 situations, therefore, the maximum number of clusters is 8, and the minimum number of clusters is 2. Therefore, 7 K-means models are constructed, and the silhouette coefficient values of each clustering model are calculated separately.

6) Select the number of clusters corresponding to the maximum silhouette coefficient value to establish the optimal K-means clustering model. Compare the silhouette coefficient values obtained in step 5, and take the number of clusters corresponding to the largest silhouette coefficient as the category parameter of the clustering model, build a K-means clustering model to

determine the classification of each sample.

7) Analyze customer characteristics according to the clustering results. Analyze the characteristics of different types of customers, compare the value of different customer groups, and propose differentiated marketing strategies.

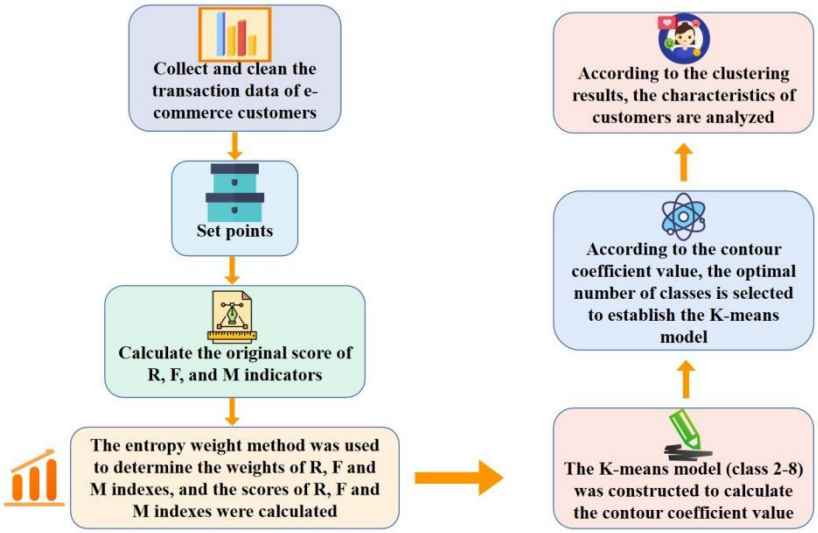


Figure 1 Model construction steps

4 Analysis of results

4.1 Data sources and data preprocessing

The research data selected a Pinduoduo merchant engaged in the sales of cookies and cakes, and the time span was from August 11, 2019 to January 19, 2020. The order data is exported from the Pinduoduo seller sales management system, and the data preprocessing mainly includes the following aspects.

1) Eliminate invalid sample data. It is found from the exported transaction data that there are commodity names in the form of "special commodities for compensation of price difference", and such commodity transactions are invalid purchase data; Samples whose after-sales status is "Processing" or "Returned" are also invalid data. Excluding this type of purchase order data, the final transaction data is 32,692 purchase records, totaling 29,607 buyers.

2) Processing of customer identification signs [14]. The Pinduoduo sales management system desensitizes the customer's mobile phone number, and the exported customer ID is a null value,

which is difficult to identify the customer's logo, therefore, the author uses the logistics list address as the unique identification of the customer.

3) Confirmation of purchase time. Confirming the receipt time is the best way to measure the purchase time, however, because some customers do not take the initiative to receive the goods, the system automatically confirms the receipt, however, there is no automatic confirmation of receipt time recorded in the documents exported by Pinduoduo, so it is considered that the customer's order confirmation time is the customer's purchase time.

4) The purchase amount is processed. Considering that the Pinduoduo e-commerce platform has coupons, full reduction and other activities, platform transaction fees (credit card fees, third-party payment fees, etc.), the purchase amount of the author is the actual credit amount obtained by the merchant after deducting the promotion fee and transaction fee. After preprocessing the data to ensure the accuracy of the research data, it can be used for the next stage of analysis and mining.

The author obtains a large amount of data information through e-commerce website, including customer information Table, product information Table, product category Table and customer consumption information Table. The customer information table records the relevant data of the customer: Customer number, gender, age, educational background, identity information, home address fields. The product information sheet records the relevant data of the product: Product number, product name, product type, price. The product type Table records the basic data of the type of product: Product type number and type name. The customer consumption information Table records the consumption data of consumers: Customer number, product number, product price, consumption and total consumption.

4.2 Binning of index values of RFM model

The quantile method is used to bin the R, F, and M index values, and the detailed interval settings are shown in Table 1. Through the processing of the following Table, the original scores of the three indicators of the value of each e-commerce customer can be calculated [15, 16].

Table 1. Binning processing of index values of RFM model

Score	R	F	M

1	(116, +∞)	[1, 2)	[4.30, 9.70)
2	(93, 116]	[2, 3)	[9.70, 15.70)
3	(65, 93]	[3, 4)	[15.70, 18.81)
4	(29, 65]	[4, 5)	[18.81, 27.50)
5	[1, 29]	[5, 20]	[27.50, 1459.82]

4.3 Use the entropy weight method to determine the index weight and calculate the score

Using the entropy weight method described above, the weights of the three index scores of R, F, and M are calculated as 0.4069, 0.1494, and 0.4437, respectively, and multiplied by the original score of the corresponding indicator respectively, the evaluation results of RFM based on entropy weight method are shown in Table 2, RS, FS, and MS represent the recent purchase score, purchase frequency score, and purchase amount score after binning, respectively. RS_1, FS_1, and MS_1 respectively represent the original score multiplied by the weight of the entropy weight method [17]. S_1 is the comprehensive score of e-commerce customer value, the higher the value, the greater the value of the customer. The calculation formula is as follows (5):

$$S_1 = RS_1 + FS_1 + MS_1 \tag{5}$$

Table 2 Some customer value evaluation results based on entropy weight RFM model

Customer Number	R	F	M	RS	FS	MS	RS_1	FS_1	MS_1	S_1
1	91	1	27.8	3	1	5	1.2207	0.1494	2.2185	3.5886
2	91	1	19.9	3	1	4	1.2207	0.1494	1.7748	3.1449
3	90	1	5.9	3	1	1	1.2207	0.1494	0.4437	1.8140
4	90	1	68.8	3	1	5	1.2207	0.1494	2.2185	3.5888
……	……	……	……	……	……	……	……	……	……	……
29603	121	3	79.15	1	3	5	0.4069	0.4482	2.2185	3.0738
29604	108	2	419.9	2	2	5	0.8140	0.2990	2.2185	3.3313
29605	102	2	910.8	2	2	5	0.8140	0.2990	2.2185	3.3313
29606	101	5	799	2	5	5	0.8140	0.7472	2.2185	3.7795
29607	123	10	1459.82	1	5	5	0.4069	0.7472	2.2185	3.3724

4.4 E-commerce customer value segmentation results

Taking the entropy weight method RFM model evaluation results (RS_1, FS_1, MS_1) as the cluster analysis index, using Python 3.7.4 tool programming to implement K-means clustering model

operation, the number of clusters is set to 2-8, the mean of the above indicators is used as the initial cluster center, the maximum number of iterations is set to 100000 times, and the tolerance is set to 0.00001, Figure 2 shows the silhouette coefficient values corresponding to the models with different cluster numbers, it can be seen intuitively that when the number of clusters is 4, the silhouette coefficient is the largest, so the optimal number of clusters is chosen to be 4.

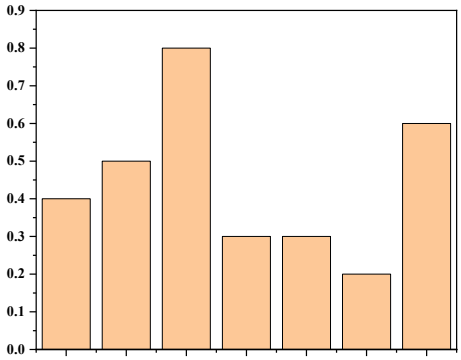


Figure 2. Silhouette coefficient values with the number of clusters 2-8

According to the K-means clustering results, the Pinduoduo e-commerce customers studied can be divided into 4 categories, and the category center and sample distribution are shown in Table 3. The analysis of the value characteristics of each e-commerce customer group and the suggestions for marketing strategies are as follows.

Table 3. Clustering results of improved RFM model by entropy weight method

category	RS_1 central value	FS_1 central value	MS_1 central value	number of samples	proportion(%)	customer definition
1	0.8564	0.1505	0.6588	8045	27.17	low value customers
2	0.5822	0.1776	1.8035	6799	22.97	Important to keep customers
3	1.7473	0.1516	0.9242	8092	27.33	General Development Clients

4	1.6500	0.1846	2.0301	6671	22.53	Important value customers

1) The RS_1 center value of the first type of customers ranks third, the central value of FS_1 is the smallest, the central value of MS_1 is the smallest, it means that such customers have no recent transactions, the least consumption frequency, and the smallest consumption amount, and are defined as low-value customers. For such customers, merchants only need to pay general attention, if such customers do not improve significantly in various indicators within a period of time, they can adopt an abandonment strategy [18].

2) The second type of customer has the smallest central value of RS_1, and the central value of FS_1 ranks second, the central value of MS_1 ranks second, indicating that such customers have no transactions recently, but the consumption frequency and consumption amount are relatively large, which can be defined as important retained customers. It is necessary to focus on analyzing the reasons why such customers have no recent transactions, stimulate customers' desire to consume, and promote conversion into high-quality customers.

3) The third type of customer has the largest central value of RS_1, and the central value of FS_1 ranks third, the central value of MS_1 ranks third, indicating that such customers have recently traded, but the transaction frequency and transaction amount are low, and can be defined as general development customers. Merchants only need to adopt a status quo marketing strategy for such customers.

4) The RS_1 center value of the fourth type of customer is larger, the FS_1 center value is the largest, and the MS_1 center value ranks the largest, it indicates that such customers have recently traded, with the largest transaction frequency and transaction amount, and can be defined as important value customers. Such customers bring great profits to merchants, and merchants need to focus on maintenance, tap customer consumption potential, and enhance customer loyalty.

4.5 Comparison of results

The traditional RFM model needs to set weights for the three parameters R, F and M, calculate the comprehensive score and then use it for customer value evaluation, the author refers to the research results on customer consumption behavior and customer value prediction, and determines

it as (0.6, 0.3, 0.1). Similar to the above analysis, RS_2, FS_2, MS_2represent the scores obtained by multiplying the original score of each indicator by the weight determined by the reference. The K-means clustering algorithm was used for cluster analysis, and it was found that when the number of clusters was 5, the silhouette coefficient was the largest, so the optimal number of clusters was selected as 5. The value characteristics and definitions of various customer groups are listed in Table 4.

Table 4. Clustering results of traditional RFM model

category	RS_2 central value	FS_2 central value	MS_2 central value	number of samples	proportion(%)	customer definition
1	0.8953	0.3339	0.3009	11853	40.03	Important to keep customers
2	2.4	0.3198	0.301	6068	20.49	General Development Clients
3	3	0.3248	0.298	5521	18.65	Important development customers
4	2.7844	1.0216	0.4902	242	0.82	Important value customers
5	1.8	0.3126	0.2598	5923	20.01	low value customers

Drawing on the idea of one-way analysis of variance, the mean square between groups (MSA) is used to evaluate the difference between the groups in the comprehensive value score (S) of different types of e-commerce customers, the calculation formula is as follows (6):

$$MSA = \frac{\sum_{i=1}^{I} n_i \left(\bar{S}_i - \bar{\bar{S}} \right)^2}{I - 1} \tag{6}$$

In the above formula, I is the optimal number of clusters of the K-means clustering model, n is the number of samples, n_i is the sample size of the ith category, $\bar{S}_i = \frac{1}{n_i} \sum_{j=1}^{n_i} S_{ij} (i = 1,2, \cdots, I)$ is the sample mean of the ith class, $\bar{\bar{S}} = \frac{1}{n} \sum_{i=1}^{I} \sum_{j=1}^{n_i} S_{ij} (i = 1,2, \cdots, I)$ represents the mean of all samples.

After calculation, it can be seen that the entropy weight method improves the inter-group mean square between different customer categories in the clustering results of the RFM model, MSA_1=5965.4799; In the clustering results of the traditional RFM model, the mean square between different classes is MSA_1= 5564.6684, which indicates that the difference between the various customer groups in the clustering results of the improved RFM model by the entropy weight method is greater, the higher the degree of differentiation, the better the division of e-commerce customer value.

On the other hand, judging from the current research results, most customer values conform to the characteristics of the 28 principle, that is, 20% of customers create 80% of profits, therefore, it is considered that about 10-20% of customers are high-value customers. From the results in Table 3, it can be seen that, it can be considered that 22.53% are high-value customers and 27.17% are low-value customers, which is close to the classic customer value distribution characteristics; The results in Table 4 show that the proportion of high-value customers is 0.82%, the proportion of low-value customers is 20.01%, and the proportion of high-value customers is significantly lower [19,20]. The reason is that the entropy weight method determines the weight of M (amount) to be 0.4437, which is significantly higher than the amount weight of 0.1 determined in ref. Therefore, from the perspective of classic customer value distribution characteristics, the constructed model is effective for e-commerce customer value segmentation.

Based on the analysis of the mean square index between the groups and the comparison results of the classic customer value distribution characteristics, it can be considered that the e-commerce customer value segmentation model constructed by the author has a good effect.

5 Conclusion

Segmenting the value of e-commerce customers can help guide merchants to develop differentiated marketing strategies, thereby improving profit levels, the author innovatively proposed an improved RFM model based on the entropy weight method, combined with the K-means cluster analysis method, and took the customer value segmentation of Pinduoduo merchants as an empirical study, and obtained the following conclusions: (1) The entropy weight method can objectively determine the weight of the three indicators in the RFM customer value evaluation model, and provide a new method for the RFM model to determine the indicator weight.

(2) Compared with the evaluation results of e-commerce customer value of the traditional RFM model, the improvement of the RFM model by the entropy weight method helps to better evaluate the customer value, from the results of the cluster analysis of e-commerce customer value based on the improved RFM model of the entropy weight method, it can be seen that the difference between each category of customers is greater, and the degree of discrimination is higher, the customer value is closer to the classic distribution characteristics, indicating that the method proposed by the author is effective for e-commerce customer value segmentation. There are great differences in the characteristics of customer value in different industries, the model constructed by the author can be extended to the application of customer value segmentation in other industries to further verify the validity of the model . On the other hand, in the RFM model, the purchase amount M (Monetary) is used as one of the indicators for evaluating customer value, however, the purchase amount and the final profit of the company cannot be simply treated as equals, consider extending the profit index to the traditional RFM model, in turn, the traditional RFM model is optimized. The above content can be used as a follow-up research direction.

Declarations:

The authors declare that they have no known competing financial interests or personal relationships thatcould have appeared to influence the work reported in this paper.

References

[1] Liu, X. , & Kao, Z. . (2022). Research on influencing factors of customer satisfaction of e-commerce of characteristic agricultural products. Procedia Computer Science, 199, 1505-1512.

[2] Liu, G. , Fei, S. , Yan, Z. , Wu, C. H. , & Zhang, J. . (2020). An empirical study on response to online customer reviews and e-commerce sales: from the mobile information system perspective. Mobile Information Systems, 2020(83), 1-12.

[3] Benlahbib, A. , & Nfaoui, E. H. . (2020). Aggregating customer review attributes for online reputation generation. IEEE Access, 8(1), 96550-96564.

[4] Cai, W. , Song, Y. , & Wei, Z. . (2021). Multimodal data guided spatial feature fusion and grouping strategy for e-commerce commodity demand forecasting. Mobile Information Systems, 2021, 1-14.

[5] Xu, B. , Huang, D. , & Mi, B. . (2020). Smart city-based e-commerce security technology with improvement of set network protocol. Computer Communications, 154, 66-74.

[6] Shen, L. , Fan, R. , & Wang, Y. . (2020). Decisions of e-commerce supply chain under consumer returns and different power structures. Mathematical Problems in Engineering, 2020, 1-21.

[7] Yadav, R. , & Mahara, T. . (2020). Exploring the role of e-servicescape dimensions on customer online shopping: a stimulus-organism-response paradigm. Journal of Electronic

Commerce in Organizations, 18(3), 53-73.
[8] Bezerra, G. , EMD Souza, & Correia, A. R. . (2021). Passenger expectations and airport service quality: exploring customer segmentation:. Transportation Research Record, 2675(10), 604-615.
[9] RG Martínez, Carrasco, R. A. , Garcia-Madariaga, J. , Gallego, C. P. , & Herrera-Viedma, E. . (2020). A comparison between fuzzy linguistic rfm model and traditional rfm model applied to campaign management. case study of retail business. Procedia Computer Science, 162, 281-289.
[10] Jns, A. , Kn, B. , Si, B. , Ha, B. , & Rfm, A. . (2020). Analytical body forces in numerical actuator disc model of wind turbines. Renewable Energy, 147, 2259-2271.
[11] Hasheminejad, S. , & Khorrami, M. . (2021). Clustering of bank customers based on lifetime value using data mining methods. Intelligent Decision Technologies, 14(4), 507-515.
[12] Yu, Y. , Jiao, L. , Zhou, N. , Zhang, L. , & Yin, H. . (2020). Enhanced factorization machine via neural pairwise ranking and attention networks. Pattern Recognition Letters, 140, 348-357.
[13] Zhang, J. . (2021). A study on mental health assessments of college students based on triangular fuzzy function and entropy weight method. Mathematical Problems in Engineering, 2021(10), 1-8.
[14] Fei, R. , Yao, Q. , Zhu, Y. , Xu, Q. , & Hu, B. . (2020). Deep learning structure for cross-domain sentiment classification based on improved cross entropy and weight. Scientific Programming, 2020, 1-20.
[15] Liu, H. , Dong, Y. , & Wang, F. . (2020). Gas outburst prediction model using improved entropy weight grey correlation analysis and ipso-lssvm. Mathematical Problems in Engineering, 2020(7), 1-10.
[16] Fan, M. , & Sharma, A. . (2021). Design and implementation of construction cost prediction model based on svm and lssvm in industries 4.0. International Journal of Intelligent Computing and Cybernetics, ahead-of-print(ahead-of-print).
[17] Raj, M & Manimegalai, P & Ajay, P & Amose, John. (2021). Lipid Data Acquisition for devices Treatment of Coronary Diseases Health stuff on the Internet of Medical Things. Journal of Physics: Conference Series. 1937. 012038.
[18]Zhao, X. L. , Liu, X. , Liu, J. , Chen, J. , Fu, S. , & Zhong, F. . (2019). The effect of ionization energy and hydrogen weight fraction on the non-thermal plasma vocs removal efficiency. Journal of Physics D Applied Physics.
[19] R. Huang, X. Yang, "Analysis and research hotspots of ceramic materials in textile application," Journal of Ceramic Processing Research, vol. 23, no. 3, pp. 312–319, 2022.
[20] Zhang, Q. (2021). Relay vibration protection simulation experimental platform based on signal reconstruction of MATLAB software. Nonlinear Engineering, 10(1), 461-468.