

# Research on Intelligent Marketing Methods Based on Big Data in the Internet of Vehicles and Association Rules

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**Abstract:** With the rapid development of the Internet of Things, big data, artificial intelligence and other technologies, the Internet of vehicles industry is booming. The massive big data generated by the Internet of vehicles has brought new opportunities and changes to the intelligent marketing of the automobile industry. This paper deeply studies the intelligent marketing method based on the big data of the Internet of vehicles, elaborates the characteristics and sources of the big data of the Internet of vehicles, and constructs the accurate user portrait through in-depth analysis using the Apriori algorithm, and then develops the intelligent marketing plan including personalized product strategy, differentiated price strategy and accurate promotion strategy. The aim is to provide theoretical support and practical guidance for automobile enterprises to improve marketing efficiency and effect by using big data of the Internet of vehicles.

**Keywords:** Internet of Vehicles, Big data, Intelligent marketing, User profiling.

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## 1. Introduction

### 1.1. Research Background and Significance

In today's digital age, the automotive industry is undergoing unprecedented and profound changes. As the crystallization of the deep integration of automobile and information technology, the Internet of Vehicles technology has successfully built a bridge of efficient information exchange and sharing between vehicles, drivers, road infrastructure and other relevant parties by closely connecting vehicles with cutting-edge technologies such as the Internet, cloud computing and big data. With the rapid popularization of the Internet of Vehicles, many multi-source heterogeneous data such as vehicle driving data, user behavior data and vehicle status are collected and transmitted in real time. As a result, these data converge into the massive and highly complex big data of the Internet of Vehicles.

The marketing model of traditional automotive enterprises mainly rely on experience and limited data, which makes it extremely difficult to accurately grasp consumer demand. This, in turn, leads to many problems such as poor marketing effectiveness and serious waste of resources. However, the efficient processing and application of big data of the Internet of vehicles will open up a new path for automobile enterprises to deeply understand the inner needs of consumers, and make intelligent marketing become reality from imagination. With the deep mining and accurate analysis of the big data of the Internet of vehicles, automobile companies can accurately insight into consumers' needs, preferences, driving habits and other rich information, so as to formulate more targeted and personalized marketing strategies, significantly improve marketing efficiency and effect, and effectively enhance market competitiveness.

From the scientific theoretical level, in-depth research on intelligent marketing methods based on big data of the Internet of vehicles not only helps to further enrich and

improve the marketing theoretical system, but also provides a new research perspective and method in the field of digital marketing. From the perspective of engineering practice, it can effectively help automobile enterprises better adapt to the wave of market changes in the digital era, make full use of big data technology to achieve marketing innovation, create greater social benefits while improving the economic benefits of enterprises, and effectively promote the transformation and upgrading of the entire automobile industry to a higher level. For example, Tian Rundong [1] and other scholars have explored data processing, analysis and visualization methods in multiple application scenarios based on the spatio-temporal big data of vehicle passage, focusing on holiday traffic flow prediction, data visualization and vehicle audit system. Conducting trend, seasonality, and periodicity analyses on historical traffic volume data, and processing and correcting abnormal data, have enabled precise predictions of future holiday traffic volumes. Data visualization tools and vehicle audit systems can integrate and mine multi-source heterogeneous traffic big data, and provide support for highway operation management and traffic safety. In order to summarize and analyze the development history and related impacts of Shenzhen's "three-wheel" control policy on non-local vehicles, Yu Fengquan [2] and other scholars proposed a pre-processing method of license plate recognition basic data and a GIS-based method for analyzing the characteristics of non-local vehicle traffic. The license plate recognition data was deeply mined from multiple dimensions such as time, space, vehicle attributes and vehicle use, and the overall characteristics and temporal and spatial distribution characteristics of the use of overseas vehicles were quantitatively analyzed, and the impact of vehicle control policies on the travel characteristics of overseas vehicles was deeply studied and evaluated. The relevant conclusions provide data support for the formulation and adjustment of Shenzhen's non-local vehicle control policies, and also provide reference for the analysis of non-local vehicle travel

characteristics in other cities. Therefore, it is of great practical significance and profound theoretical value to carry out research on intelligent marketing methods based on big data of the Internet of vehicles.

To sum up, in order to provide automobile enterprises with targeted and personalized marketing strategies, this paper proposes a study on intelligent marketing methods based on big data in the Internet of Vehicles and association rules. The aim is to help enterprises significantly improve marketing efficiency and effectiveness, and promote the healthy and stable development of China's automotive industry.

## 1.2. Research Status at Home and Abroad

### 1.2.1. Foreign research status

Foreign research in the field of big data in the Internet of Vehicles and intelligent marketing started earlier, and some automobile enterprises and scientific research institutions in developed countries have made remarkable achievements in the research and development of Internet of vehicles technology and data application with advanced technology and rich resources. Take the American Tesla company as an example, through the carefully constructed car networking system, it continues to collect massive vehicle driving data, user usage habits data, and skillfully use these data to optimize product design, and formulate accurate and effective marketing strategies. Tesla can recommend personalized vehicle Settings and intimate services for users according to their unique driving habits. It can also accurately predict users' car purchase needs through data analysis, and carry out precise marketing activities in advance. As a result, Tesla has gained a favorable position in the market competition. In addition, some European car manufacturers are also actively exploring the innovative application of big data in the marketing of the Internet of vehicles. By building user portraits and behavior analysis models, they have successfully realized precise advertising and personalized product recommendations, effectively improving the marketing effect.

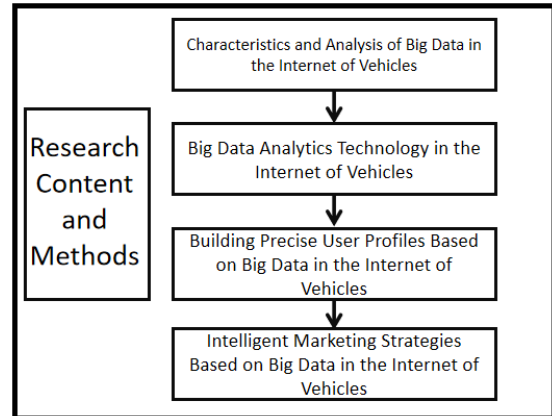
### 1.2.2. Domestic research status

Domestic research on intelligent marketing of big data in the Internet of vehicles has shown a rapid development trend in recent years. With the strong rise of the domestic car networking industry, many automobile companies, Internet companies and scientific research institutions have actively engaged in related research fields. Domestic scholars have carried out in-depth and fruitful research on data mining and analysis technology of the internet of vehicles, user portrait construction method, intelligent marketing strategy formulation and other aspects. For example, some scholars [3] have innovatively proposed a user portrait model based on big data of the Internet of vehicles. This paper analyzes and researches from the four dimensions of speed preference, driving style, time preference and proficiency, and uses K-means clustering to output speed preference labels, driving style labels, time preference labels and proficiency labels respectively, and construct and extract characteristic variables of different dimensions. Experimental results show that this method can effectively describe user portraits. However, there are still some shortcomings that need to be solved in the current domestic and foreign research. On the one hand, the deep mining and comprehensive utilization of big data of the Internet of vehicles is still insufficient, and the great value contained in the data has not been fully released. On the other hand, there is still much room for improvement in the systematization and operability of intelligent marketing

methods, and more empirical studies and rich case studies are needed to further validate and optimize relevant methods.

## 1.3. Research Content and Methods

This paper focuses on the intelligent marketing method based on the big data of the Internet of vehicles to carry out in-depth research, including the following aspects, the research content and methods are shown in Figure 1 below.



**Figure 1.** Research contents and methods of this paper

(1) Characteristics and analysis of the big data of the Internet of Vehicles: The unique characteristics of the big data of the Internet of vehicles are elaborated in detail and comprehensively, such as the huge amount of data, rich and diverse types, high real-time requirements and low value density, and the data sources are deeply explored, including vehicle sensor data, on-board application data, user social data and other dimensions.

(2) Internet of Vehicles big data analysis technology: In-depth study on how to flexibly use advanced technologies such as data mining, machine learning and deep learning to efficiently process and accurately analyze big data of Internet of vehicles, extract valuable information from it, and lay a solid data foundation for intelligent marketing.

(3) Accurate user portrait construction based on the big data of the Internet of vehicles: In-depth analysis of how to build accurate user portraits through the organic integration and in-depth analysis of multidimensional data such as user behavior data and vehicle use data, to provide a key basis for the formulation of subsequent personalized marketing strategies.

(4) Intelligent marketing strategy based on big data of the Internet of vehicles: In-depth discussion on how to scientifically formulate personalized product strategy, price strategy, channel strategy and promotion strategy according to the results of user portrait and data analysis, to achieve the goal of precision marketing.

## 2. Research Content and Methods

### 2.1. Characteristics of Big Data of the Internet of Vehicles

(1) Huge amount of data: With the wide popularity of vehicle networking technology worldwide, massive vehicles continue to generate various types of data. Each car in the process of driving, its driving track, speed, fuel consumption, engine status and other data will be generated continuously, coupled with the vehicle sensors, cameras and other equipment high-frequency data collection, as well as the user in the use of vehicle applications in the process of the operation data, the amount of data showed an exponential

growth trend.

(2) Rich and diverse types: car networking data covers structured data, semi-structured data and unstructured data and other types. Structured data, such as the basic information of the vehicle, driving record, fault code, etc., has a clear and clear format and structure, which is easy to store and analyze; Semi-structured data, such as XML, JSON format configuration files and log files, etc., its structure is relatively flexible; Unstructured data, including video captured by car cameras, audio generated by voice interactions, text messages related to cars posted by users on social media, is more complex and diverse.

(3) High real-time requirements: Car networking data has strong real-time requirements. In the process of vehicle driving, its driving status, location information and other data must be transmitted and processed in real time, in order to provide drivers with accurate safety warning, efficient navigation assistance and other key services in a timely manner. For automobile enterprises, real-time access to users' driving behavior data and vehicle status data can help them

gain timely insight into user needs and vehicle operating conditions, and provide strong support for real-time marketing decisions.

## 2.2. Big Data Analysis Technology of Internet of Vehicles

Association rule mining aims to discover the hidden association relationship between different data items in the Internet of vehicles data. By in-depth analysis of vehicle driving data and user driving habits data, it is possible to find intrinsic links between users' behavior during certain time periods, such as weekends, and in specific locations, such as near shopping malls, when using in-car navigation apps to search for certain types of businesses, such as restaurants. Based on these association rules, automotive companies can develop highly targeted marketing strategies.

Apriori algorithm is a classic association rule algorithm [4-5], and its main idea is shown in Figure 2 below.

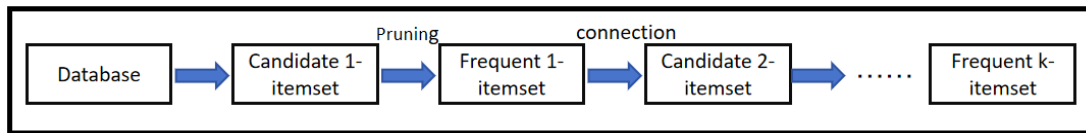


Figure 2. Main ideas of Apriori algorithm

Algorithm flow [6-8]:

(1) First of all, the database is scanned, and the number of occurrences of each item is counted to form a candidate 1-item set;

(2) Filter out frequent 1-item sets according to threshold values;

(3) Combine frequent 1-item sets to form candidate 2-item sets;

(4) The database is scanned for the second time to count each candidate 2-item set and screen out frequent 2-item sets;

(5) Repeat the above process until the candidate item set is empty;

And (6) Generate management rules by calculating the corresponding confidence levels based on the generated frequent item set.

If the item set contains k distinct items, it is called a k-item set. Candidate k-item set notation, frequent  $C_k$  k-item set notation.

The basic premise of frequent pattern mining is:

If a set is a frequent itemset, then all of its subsets are frequent itemsets.

If a set is not a frequent item set, then all of its supersets are not frequent item sets.

## 2.3. Accurate User Portrait Construction Based on Big Data of the Internet of Vehicles

With the support of the big data of the Internet of Vehicles, through the construction of accurate user portraits, automobile companies can gain in-depth insight into the details of users' needs, preferences and potential desires. The user profiles constructed based on this will accurately depict users from multiple dimensions.

A User Profile is a labeled user model abstracted and constructed according to multidimensional data information such as a user's social attributes, living habits, and

consumption behaviors. With the support of the big data of the Internet of vehicles, automobile companies can gain in-depth insight into users by building accurate user profiles.

From the social attribute dimension, it covers the user's age, gender, occupation, income level, family status and so on. Age and gender can directly affect the user's preference for car design and color. Younger consumers may prefer a sleek, dynamic look and bright color scheme, while mature users may prefer a calm, atmospheric style. Occupation and income level are closely related to car purchase budget and brand choice, so enterprises can recommend products according to this, such as luxury brand models for high-income business people, and cost-effective economic models for young office workers.

In terms of life habits, users' travel rules can be mastered with the help of vehicle networking data, such as commuting distance, travel time, and frequent destinations. If the user's daily commuting distance is long and most of them travel in the morning and evening peak hours, the enterprise can recommend models with good comfort and efficient power system to cope with congested road conditions; If users often go to outdoor places, they can recommend SUVs with large space and off-road performance to meet their needs for loading equipment and coping with complex road conditions.

In terms of the dimension of consumption behavior, by analyzing the user's past car purchase history, brand loyalty, consumption frequency and amount, the enterprise can understand the user's consumption habits and decision-making mode. Enterprises provide exclusive discounts and value-added services to users with high brand loyalty to strengthen their loyalty.; According to the consumption frequency and amount to judge the user's consumption power, enterprises formulate appropriate price strategy and product portfolio recommendation.

## 2.4. Intelligent Marketing Strategy Based on Big Data of Internet of Vehicles

The intelligent marketing strategy based on the big data of the Internet of vehicles is carried out in accordance with the personalized product strategy, differentiated price strategy and precise promotion strategy [9-10]. The specific plan is as follows.

### (1) Personalized product strategy

**Customized product development:** With the help of big data of the Internet of vehicles, automobile companies can deeply understand the personalized needs of users. For example, by analyzing users' preference data on vehicle performance, configuration, interior style and other aspects, they can provide users with highly customized automotive products. For example, an automobile company uses the Internet of vehicles to collect a large number of young users' needs for technological interior and high-performance power, and launches models that can customize the interior atmosphere light color, seat material, and different power adjustment packages to meet the personalized needs of users.

**Product innovation and optimization:** Based on the analysis of the big data of the Internet of vehicles, the unmet needs of users are mined, and product innovation is carried out on this basis. For example, by analyzing users' pain point data during long-distance driving, such as high risk of fatigue driving and insufficient entertainment facilities, car companies have developed new products with more advanced fatigue monitoring systems and rich in-vehicle entertainment functions to improve user experience.

### (2) Differentiated price strategy

**Dynamic pricing mechanism:** flexibly adjust prices according to real-time data such as market supply and demand, user purchasing behavior, and vehicle inventory in the big data of the Internet of vehicles. Moderately raise the price during peak sales season or when the demand for specific models is strong; Lower prices to boost sales when inventory is overstocked or sales are low. For example, a car company finds through big data analysis that a certain model has a high demand for air conditioning performance in a specific region in summer, and raises the price of models equipped with high-performance air conditioners in the summer of this region, while reducing the price of basic models to promote sales.

**Pricing based on user value:** Analyze user consumption history, brand loyalty, potential consumption power and other data, and formulate differentiated prices for different value users. For high-value and high-loyalty users, exclusive offers and discounts are provided; For new users, by setting exclusive price packages for new users to attract purchases. For example, luxury car brands give additional car purchase subsidies to users who have bought their products for a long time, and provide low-interest loans for new users to buy cars.

### (3) Precise promotion strategy

**Accurate grasp of the timing:** Through the analysis of the big data of the Internet of vehicles in the user's car purchase intention change, vehicle service life, mileage and other data, accurate grasp of the promotion opportunity. When the user's vehicle service life is close to 5 years and the driving mileage is high, it will judge the need to change the car, and push the promotion information of new models in a timely manner; In the user's birthday, holidays and other special periods, send exclusive offers to stimulate the purchase.

**Real-time evaluation and adjustment of promotion effect:** Use the big data of the Internet of vehicles to monitor the

effect of promotion activities in real time, and timely adjust the promotion strategy according to the data of user engagement, conversion rate and purchase amount. If the conversion rate of a promotion is low in a specific area, adjust the content of the activity or the channel of delivery after analyzing the reasons; If the sales volume of a certain configuration model in the promotion of a certain model is high, increase the promotion and preferential efforts of the configuration model.

## 3. Conclusion

This research focused on the intelligent marketing method based on the big data of the Internet of vehicles and association rules, and achieved a series of results through in-depth exploration in various aspects. Through the construction of accurate user portraits, enterprises can have a deep insight into the multidimensional characteristics of users, such as needs, preferences, driving habits and consumer behaviors, and provide a solid basis for the formulation of personalized marketing strategies. In terms of product strategy, customized product development, product innovation optimization and product portfolio customization have been realized to meet the diversified needs of different user groups; The price strategy is differentiated according to the user value and market dynamics, which improves the flexibility and effectiveness of the price strategy; Channel strategy through online and offline accurate layout and integration, improve the coverage and efficiency of marketing channels; The promotion strategy designs personalized activities according to user characteristics and purchase timing, and evaluates and adjusts them in real time, which enhances the attraction and conversion rate of promotional activities.

However, this study also recognizes that there are still some shortcomings. On the one hand, the degree of deep mining and comprehensive utilization of big data of the Internet of vehicles needs to be improved, and the processing and analysis technology of some complex data still needs to be further optimized to mine the data value more comprehensively; On the other hand, in terms of the universality and scalability of intelligent marketing methods, more empirical studies and case verification are needed to ensure that these methods can be widely used in different sizes and different types of automobile enterprises.

Looking forward to the future, with the continuous development of the Internet of vehicles technology and the continuous innovation of big data analysis technology [11-12], intelligent marketing based on the Internet of vehicles big data and association rules will have broader prospects for development. Future research can further explore how to combine emerging technologies, such as using blockchain to ensure data security and privacy, and leveraging artificial intelligence to enhance the accuracy and efficiency of association rule mining, so as to perfect the intelligent marketing system. At the same time, interdisciplinary research should be strengthened to integrate multi-disciplinary knowledge such as marketing, computer science and data science, so as to promote the deep application of big data of the Internet of vehicles in the field of intelligent marketing and inject new vitality into the development of the automotive industry.

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