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A Study of Recommended Model of Aeronautic Products based on Collaborative Algorithm

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The particularity of aeronautic products results in the difficulty of prevailing product recommendation algorithm in the industry to be applied to civil aviation e-commerce. This paper, in combination of big data technology on the basis of clustering technology and collaborative filtering algorithm, proposes a multi-level abstract computing method of similarity based on the scene. It has solved the difficulty that aeronautic products have encountered in terms of precise recommendation in the civil aviation industry. As indicated by the precise marketing of an aviation company, this method can promote ROI by three times.

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1. Introduction

With the advent of the Internet era, the pluralism of customer demand and information diversification, the traditional search technology has no longer been able to meet customer demand for information discovery[1]. Furthermore, the emergence of the recommendation engine can help customers to grasp the potential needs of information, to assist them to obtain richer and more meaningful information. The rapid development of e-commerce in recent years has promoted the recommendation algorithm to gradually extend to the traditional industry from the internet industry[2], and has brought new models for the e-commerce and customer services in the traditional industry.

Compared with e-commerce in terms of the diversification of product types and the richness of styles, the main products of aviation companies of traditional transport enterprises are still air tickets and a small amount of value-added services such as hotels, car rentals and visas. However, there is a significant difference between tickets and goods sold on Taobao, Jingdong: ticket is the only evidence that passengers can achieve their geographical displacement, and the attribute of ticket is very single. In this case, the traditional product recommendation algorithm is hardly to apply to the e-commerce of aviation industry.

However, there is no essential difference between airline business and other electrical businesses. Admittedly, due to the development status of domestic aviation industry, the size of passenger groups in the industry is relatively narrow, and the diversity of passenger data available to aviation companies themselves is insufficient. Through extensive cooperation with other industries, the application of the recommended algorithm in big data environment[3-5] can make up for the shortage of aviation companies from the aspect of passenger data.

The recommended algorithm is to model the product or users by means of a data algorithm. It can divine the product that users are most favorable. Currently, there is no uniform standard for the classification of recommended algorithms. However, in the continuous evolution [6], many scholars have divided it from different angles [7-9]. The mainstream recommended methods include: Content-based recommendation[10], collaborative filtering recommendation[11, 12], recommendations based on association rules [13], recommendations based on utility[14], knowledge-based recommendation and combination recommendation.

Based on the coordinated filtering algorithm, this paper designs a recommendation algorithm suitable for aviation industry in combination with the actual conditions of the industry and products to support the precise marketing practice of aviation companies.

2. Recommendation Model of Aeronautical Products Based on Collaborative Filtering Algorithm

Collaborative filtering algorithm is divided into two categories, the collaborative filtering algorithm based on users and the coordinated filtering algorithm that is object-based. This paper will study from two perspectives, the air ticket and the passengers respectively, and then design a recommendation model for the aeronautic products.

2.1 Aeronautic Products Modeling

2.1.1 Aeronautic Products & Data

Air tickets, as well as travel-related hotels, car rental, airport transfer, visas and other additional services are the main aeronautic products. Additional services such as seat selection service, which are closely related to air tickets, need to be abstracted as an attribute of the ticket rather than a separate product. Classification and elements of aeronautic products (product attributes) are listed in the following table:

Name of Products	Classification of Products	Attributes of Products
Ticket	Main Product	Destination/Flight Date/Flight Number/Cabin/Price/Departure Time, etc.
Airport Transfer/Upgrade/ Lounge Exchange/Excess Luggage/Meals/in - flight wifi	Flight Add-on Products	Price/Type/Flight/Taste/Preference
Hotel/Car Rental/Visa	Travel Additional Services	Brand/Destination/Travel/ Time/Purpose, etc.
Duty-free Products	In Flight Products & On Board Services	Category/Brand/Price/Origin/Flight, etc.

The model of aeronautic products modeling in this paper is to model the special product namely the air ticket by improving the collaborative filtering algorithm.

2.1.2 Multi-level Abstraction Modeling based on the Scene

In consideration of the particularity of tickets, the product attributes of tickets need to be abstracted, which is difficult. In view of the destination of tickets: the abstract of the same destination for different passengers is not the same, and it is also different for the same passenger at different times, which requires a multi-level abstraction for the destination, that is: abstract several different levels of elements for each same attribute and calculate the similarity between tickets through such elements.

In addition to destination, the flight date also requires a multi-level abstraction: the date of flight is often not freely available for business reasons, even if it is a holiday or other matters can't be decided by the actual situation on the travel date. The shipping space (physical space) may also be due to the relevant provisions of official travel restrictions can't be optional. Therefore, in different scenarios, the Euclidean distance of tickets can be expressed as:

$$d(x, y) = \sqrt{\sum(\delta_i X_i - \theta_i Y_i)^2} \quad (\delta_i, \theta_i > 0) \tag{2.1}$$

The complexity of the formula is recorded as $O(n^2)$. Where, δ_i and θ_i are the m × n order probability matrix of two tickets in different scenarios:

$$\delta_i/\theta_i = \begin{bmatrix} S_{11} \times R_{11} & S_{12} \times R_{12} & \cdots & S_{1n} \times R_{1n} \\ S_{21} \times R_{21} & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ S_{m1} \times R_{m1} & S_{m2} \times R_{m2} & \cdots & S_{mn} \times R_{mn} \end{bmatrix} \tag{2.2}$$

Where, $S_{mn} \times R_{mn}$ is the selected weight of passenger Rn in the scene of SM in which he/she purchases ticket. The matrix shows the distribution of the product attributes of a ticket for different passengers and scenarios.

2.1.3 Calculation of the Similarity between Products

Assess the similarity between ticket X and ticket Y based on the Euclidean distance, expressed as the formula below:

$$\mathrm{sim}(x,y) = \frac{1}{1+d(x,y)} \tag{2.3}$$

Subsequently, the similar products can be identified according to the fix-size neighborhoods method.

The collaborative filtering recommendation method based on goods can be applied in the process of a passenger landing the self-operating channel of aviation companies to purchase a ticket and place an order. The main purpose of this method is to forecast the possibility of ticket purchase of the passenger according to this or some retrieval behaviors, and it has certain effect on actual marketing. However, this kind of marketing effect is one-sided, lacks the overall analysis to the passenger's behavior, and therefore also needs to carry on the further modeling analysis from the dimension of passenger.

2.2 Air Passengers Modeling

2.2.1 Air Passengers Label

The collaborative filtering algorithm for air passengers is to find similar people from the users' point of view, thus to recommend the product (ticket). In big data environment, similarity of passengers can be modeled according to the user portrait- label. Users labeling system has guiding significances for studying of the repurchase behavior of passengers[15].

The passenger-related data in the aviation field is abundant, which generally includes the passenger access data, order data, flight data, check-in data, passenger basic information data, some aviation companies also have additional service data such as meals, reservations, etc., hotel rental and other non-aviation partner data, as well as the respective website of WeChat and microblogs and other social media data. By analyzing and processing these rich and varied data through big data related technology, to establish visual data model of passenger behaviors, and realize the deep understanding of passengers and their social network for aviation companies. As the centralized embodiment of the passenger visualization data model, the label comprehensively reflects the whole feature from his/her basic attribute to the behavioral attribute to the social attribute, so the passenger similarity model is established in this paper with the help of airline label to guide the marketing practice.

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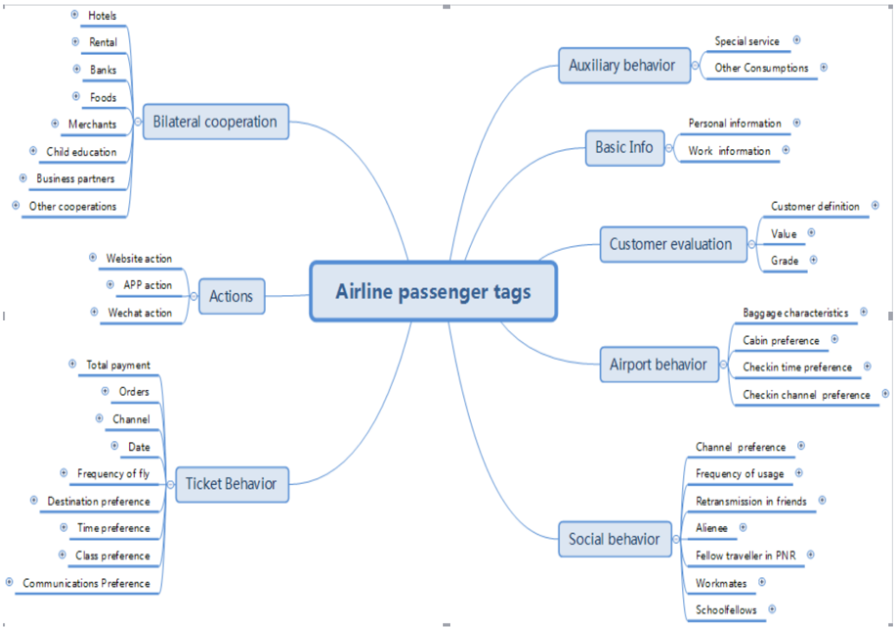

Figure 1 : Air Passengers Label Model

2.2.2 Analysis of Weight and Similarity of Labels

In the label model, the effect of each attribute on the similarity between passengers is different: social behavior has a significant and direct impact on passengers' similarity, and the weights of different social behaviors are also different. The similarity between passengers is also weighed, and the weighted Euclidean distance is calculated according to:

$$d(p,q) = \sqrt{\sum t_i (q_i - p_i)^2} \quad (2.4)$$

The complexity of the formula is recorded as O (n). Where, t_i is the weight coefficient of a label. Passenger similarity and similar population calculation still adopt the calculation of the similarity between aeronautic products. In the aforementioned labeling model, such coefficient follows the general rules: social behavior ＞ ticketing behavior ＞ attachment service, airport behavior>operational behavior ＞ bilateral cooperation behavior ＞ customer evaluation ＞ basic attribute. In this rule, the main reason why the weight of bilateral cooperation is not high is that the aviation companies generally can't directly obtain the details of the behavior of passengers, but through the integration of the indirect consumption data. Of course, the bilateral cooperation of the brand, consumption capacity, frequency and other data are also important factors to judge the similarity of passengers.

Compared with the recommendation method based on tickets, the user-based collaborative filtering algorithm is recommended for precise marketing of passengers, which is a more accurate and more suitable way for the passenger's potential demand in the aviation industry. But this kind of recommendation needs to have a more in-depth understanding to passengers - to build the passengers' label model through the big data platform.

2.3 Practical Effect of Aviation Precision Marketing

As indicated by the precise marketing of an aviation company, the marketing level can be effectively improved by using the recommendation model of this paper. The level of ROI before and after practice is as follows:

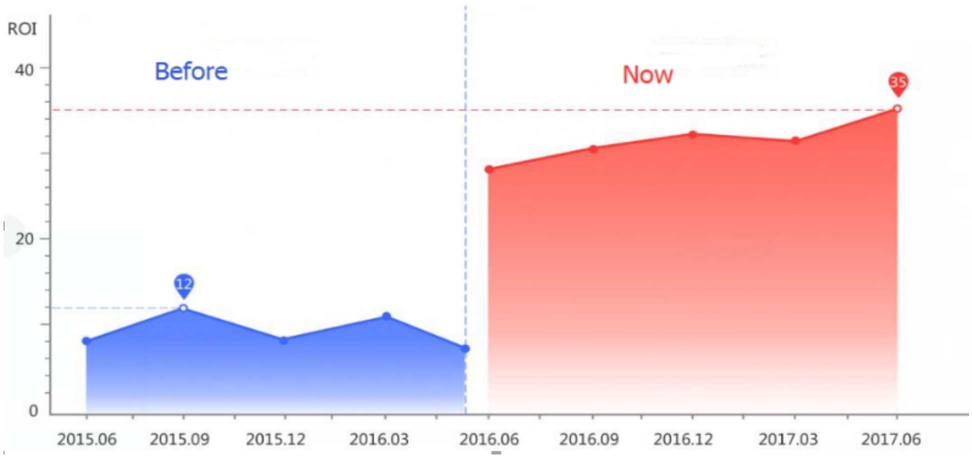

Figure 2 : ROI before and after practice of the product recmomendation model

From two years of ROI statistics, after the application of the product recommendation model, the ROI has been raised about 3 times.

3. Conclusion

This paper studies the particularity of air ticket in aviation industry and proposes a multi-level abstract computing method of similarity based on the scene between aeronautic products to improve the application method of collaborative filtering algorithm in the industry. The result of practice shows that the collaborative filtration analysis model proposed in this paper has certain application effects on the aviation industry.

However, the timeliness of airline tickets also has a special limitation: whether the similarity calculation is based on product or passenger, it is not allowed to recommend expired tickets to passengers-this is completely different from that of other e-commerce product marketing. Therefore, in the practical application of the above model, the scope of the recommended products should be initially qualified. On the other hand, although the method of this paper is effective, how to evaluate the effective degree of the weights of different scenes in the algorithm is still a worthy subject.

Reference

[1] Guo Wenjun, Chang Guiran, Qiao Shidong. *Research on Multi-Agent Engine Technology* [J]; Computer engineering & Software; 2017, 38(3):136-139 (in Chinese)

[2] Lu Yixuan. China Telecom Is Gaining Momentum in “Internet + Industry ”: *Equip the Old Industry with New Engines* [J]; Communications World; 2016(19):34-35 (in Chinese)

[3] Meng Xiangwu, Ji Weiyu, Zhang Yujie. Recommender Systems in Big Data Environment. *Journal of Beijing University of Posts and Telecommunications* [J]. 02, 2015 (in Chinese)

[4] Li Wenhai, Xu Shuren. *Design & Implementation of E-commerce Recommendation System Based on Hadoop* [J]. Computer Engineering and Design. 01, 2014 (in Chinese)

[5] Mao Guojun, Hu Dianjun, Xie Songyan. *Big Data Classification Model and Algorithm Based on Distributed Data Flow* [J]. Chinese Journal of Computers. 01, 2017 (in Chinese)

[6] Xu Hailing, Wu Xiao, Li Xiaodong. *Comparative Research on Internet Recommendation System* [J]; Journal of Software; 2009, 20(2) 350-362 (in Chinese)

[7] Balabanovi, Marko, Y Shoham. *Content-Based, Collaborative Recommendation*[J]; Communication of the ACM, 1997, 40(3):66-72

[8] L Terveen, W Hill. *Beyond Recommender Systems: Helping People Help Each Other*[C]. Hci in the New Millennium, 2001:487—509

[9] P Han, B Xie, F Yang, R Shen. *A Scalable P2P Recommender System based on distributed Collaborative Filtering*[J]. Expert Systems with Applications, 2004, 27 (2): 203-210

[10] Xing Chunxiao; Gao Fengrong; Zhan Sinan; Zhou Lizhu; *Collaborative Filtering Recommendation Algorithm Adapted to Changes of Users Interest* [J]; Journal of Computer Research and Development; 02, 2007 (in Chinese)

[11] Wei Suyun; Ye Ning; Yang Xubing; *Collaborative Filtering Algorithm Combining Project Category & Dynamic Time Weighting* [J]; Computer Engineering; 06, 2014 (in Chinese)

[12] Abecker, A., Bernardi, A., Hinkelmann, K., Kuhn, O., Sintek, M.: Context-Aware, Proactive Delivery of Task-Specific Information: *The Know More Project* [J]. Information Systems Frontiers. 2, 253–276 (2000)

[13] Cai Xingxing, Huang Xiaoqin. *Research on E-commerce Recommender System* [J] Computer Engineering & Science, 2004, 26(5):7-10 (in Chinese)

[14] Li Zhongjun; Zhou Qihai; *Shuai Qinghong. Recommender System Model Based on Isomorphic Integrated to Content-based and Collaborative Filtering* [J]. Computer Science, 12, 2009: (in Chinese)

[15] Zhang Wei, Zeng Rui, Zhang Wenhao. *Analysis and Research on Customary Repurchase Habit Labeling Based on RFM Model under Big Data* [J]. Communication Management and Technology, 2016(2) (in Chinese)