ISSN 2409-2665
Journal of Logistics, Informatics and Service Science
Vol. 10 (2023) No.2, pp.79-90
DOI:10.33168/JLISS.2023.0206

Online Recommendation Method of Malaysian Medical Tourism Products Based on Collaborative Filtering Algorithm

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Abstract. Conventional online recommendation methods for medical tourism products mainly use the SVD (Singular Value Decomposition) matrix decomposition method to obtain the recommendation feature vector, which is vulnerable to the sparsity of the interaction matrix, resulting in poor online recommendation results. Therefore, it is necessary to design a new online recommendation method for Malaysian medical tourism products based on collaborative filtering algorithm. That is to say, the Malaysian medical tourism products are modularized, the subsequent user preference similarity calculation is carried out through effective user modeling, and the online recommendation of tourism products is realized by using the collaborative filtering algorithm. The experimental results show that the online recommendation method designed for Malaysian medical tourism products has a good recommendation effect, and the product hits of several different types of tourism products are high after recommendation, which proves that the online recommendation method designed is reliable, has certain application value, and has made certain contributions to improving the comprehensive profits of tourism products.

Keywords: Collaborative filtering algorithm; Malaysia; Medical care; Travel; Product; On-line; Recommend

1. Introduction

In recent years, the rapid development of medical tourism in Malaysia has brought huge benefits to the local area. Research shows that in 2018 alone, the revenue of medical tourism in Malaysia has exceeded 1.5 billion ringgit (Yang & Gao, 2022), and is on a steady upward trend. In addition, in 2018, the number of medical tourists in Malaysia exceeded one million, and its internal market scale is growing. Malaysia's medical tourism is unique (Zheng, 2021). First, its medical technology is relatively advanced, and tourists have good medical experience. Second, the government optimizes its internal medical tourism industry in combination with the problems of medical tourism (Mozingo, 2021), so Malaysian medical tourism has been recognized by tourists from all countries.

Malaysian medical tourism has its own characteristics (Talwar et al., 2021). Its main business projects include orthopedics, Liaoyang, assisted reproduction, etc., so it has gradually become the preferred base for medical care tourism at home and abroad. At present, Malaysia has established two major medical tourism centers, namely, Hope Asia Fertility Center and Asian Hepatitis Treatment Center. Their cost performance ratio is very high (Gan et al., 2021), and the charging standards of various medical items are low, which can effectively save patients' medical expenses.

In recent years, medical tourism has gained widespread attention and developed rapidly around the world. As medical standards continue to improve globally and people place more emphasis on healthy living, more and more people are combining tourism with medical treatment for better medical services and travel experiences. As one of the major developing countries in the medical tourism industry, Malaysia, with its rich medical resources and superior natural environment, is increasingly being chosen by tourists for medical tourism.

However, with a large medical tourism market and a wide range of products to choose from, it is often difficult for tourists to quickly and accurately find the most suitable medical tourism product for them. At this point, an efficient and accurate online recommendation system becomes an essential tool. With the continuous development and application of big data technology, online recommendation systems based on collaborative filtering algorithms have gradually become a hot research topic in the field of recommendation systems.

The collaborative filtering algorithm is a recommendation algorithm based on user behaviour data, which analyses the user's historical behaviour data and explores the user's preferences and interests to recommend relevant products for the user. This algorithm has become one of the most commonly used algorithms in online recommendation systems because of its good recommendation effect and wide application scenarios.

In the field of medical tourism product recommendation, the collaborative filtering algorithm can use the user's historical browsing and purchasing behaviour of medical tourism products to predict the user's future interests and needs, and recommend the most suitable medical tourism products for the user. Therefore, the online recommendation method of Malaysian medical tourism products based on collaborative filtering algorithm has important research value and practical application significance.

With the development of digital informatization, Malaysia's medical tourism has also been impacted to a certain extent. The medical field has begun to replace the original general medical mode (Shi & Lee, 2021) with the digital medical mode. At present, the medical industry is also upgrading rapidly. In this context, although Malaysia has proposed a blueprint for the medical travel industry from 2021 to 2025 and optimized the existing medical tourism model, it is unable to provide patients with medical services that keep pace with the times due to the lack of digital medical technology (Khalid et al., 2021). Therefore, from 2021 to 2022, Malaysia's medical tourism output value will decline significantly, which will have a huge impact on Malaysia's economic development. Medical tourism products are the products of Malaysian medical tourism, which have less limitations (Yang et al., 2021) and can meet the requirements of digital medical development, create revenue for

Malaysian medical tourism and promote its further development. Therefore, it is necessary to study an effective online recommendation method for Malaysian medical tourism in combination with the digital economic background (Chen et al., 2021). Relevant researchers have designed several conventional online recommendation methods for Malaysian medical tourism products according to the characteristics of Malaysian medical tourism products, but they all use SVD to obtain recommendation feature vectors, and the recommendation effect is relatively poor. Therefore, this paper designs a new online recommendation method for Malaysian medical tourism products based on collaborative filtering algorithm.

2. Methodology

2.1.Modularization of Malaysian Medical Tourism Products

Malaysia is rich in medical resources, which makes it a highly sought-after medical tourism destination. Malaysia's medical tourism business is growing rapidly economically and it has a wide range of medical tourism businesses including medical tourism, health tourism and welfare tourism. Medical tourism is one of Malaysia's key pillar industries and is a key focus for Malaysia's future development. Medical tourism in Malaysia is growing rapidly, but as the medical tourism business continues to expand, the question of how to provide personalised and customised services to potential customers has become a key issue. Existing medical tourism products are usually a holistic package with multiple services and products, lacking flexibility and customisability. In this context, breaking down medical tourism products into different modules, where customers can choose the module that suits their needs, helps to increase the attractiveness and market competitiveness of medical tourism products. Therefore, modularisation of medical tourism products has become a new trend in the development of medical tourism business. Modular medical tourism products have the following advantages: firstly, they can offer a greater range of choices to meet the needs of different customers; secondly, customers can choose to purchase only the modules they are interested in, saving unnecessary costs; and finally, modular medical tourism products can also be quickly adapted and updated according to customer feedback and market demand. However, research into the modularisation of medical tourism products is not yet sufficiently advanced, especially in terms of how to design and implement modular solutions. Further research is therefore needed on how to modularise medical tourism products and to explore the impact of modularity on the development of medical tourism businesses. This will help to improve the quality and market competitiveness of medical tourism products and provide important support for the sustainable development of medical tourism business.

In order to effectively divide the recommendation module of Malaysian medical tourism products, the online recommendation method designed in this paper has been modularized in advance, that is, search online recommendation keywords according to the described user interests to obtain the vector space model. At this time, the similarity of different concepts in the model has a certain deviation (Qin et al., 2022), so it is necessary to capture relevant keywords to complete the modularization. The recommendation query ontology (Zhang & Dong, 2021) can be updated based on the current online recommendation principles of medical tourism products, and the modular set obtained at this time $PersonalInterest$ as shown in (1) below.

$$PersonalInterest = \{C, A, R\} \quad (1)$$

In formula (1), C represents a collection of user interest concepts, A represent user interest concept attribute, R represents the user interest attribute. At this time, modular processing (Cui, 2021) can be performed according to the weight value of the above modular set. The generated processing framework is shown in Figure 1 below.

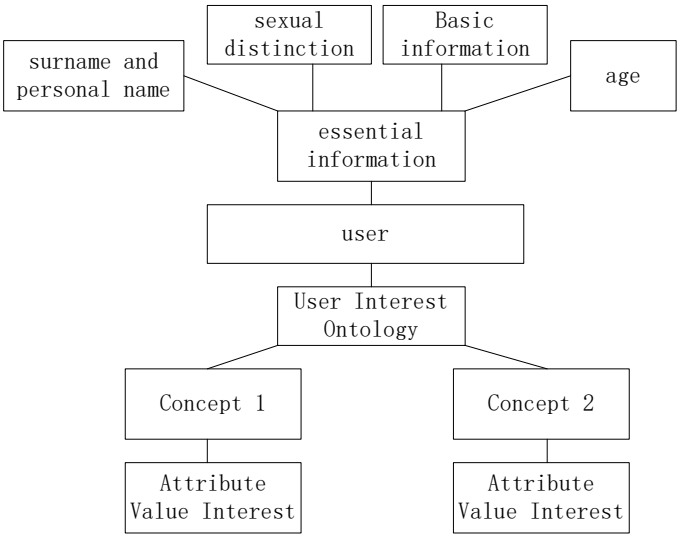

Fig. 1: Modular processing framework

It can be seen from Figure 1 that using the above modular processing framework can effectively obtain different attribute values of Malaysian tourism products, thus laying the foundation for subsequent user interest modeling (Shi et al., 2021).

2.2.User Interest Modeling

In combination with the modular processing framework built above, user interest modeling can be further carried out. First, effective user information (Huang & Stakhiyevich, 2021) needs to be obtained according to user behavior and user preferences, and keyword retrieval needs to be carried out. Second, modeling needs to be carried out according to the source of user interest information. The main sources of user information include mouse click content and browser access content (Bhoi et al., 2021), access track dwell time. The accuracy of user preference acquisition is the key to the effectiveness of user modeling (Jin et al., 2021), and is also of great significance to the final modeling effect. The online recommendation method of Malaysian medical tourism products designed in this paper uses the automatic user modeling method to model and effectively predict the user interest distribution (Ma et al., 2021). The user modeling process at this time is shown in Figure 2 below.

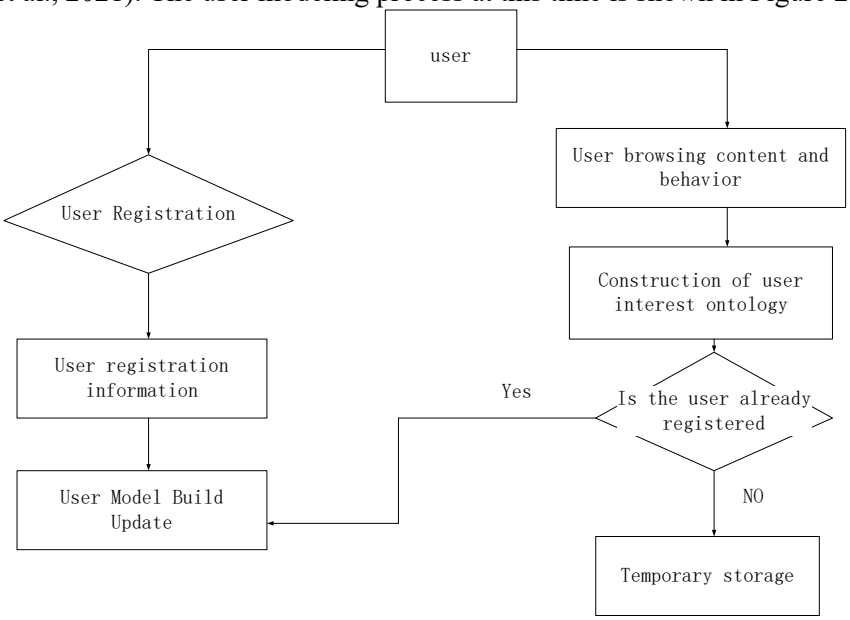

Fig. 2: User Modeling Process

It can be seen from Figure 2 that combining the above user modeling process can modify the user interest ontology, divide the tourism product keywords that users are interested in, and complete user model learning (Zhao et al., 2021).

The user's interest is always changing, so it needs to be updated in time when building the user interest model, that is, update the weight of each ontology (Bhuvaneshwari & Rao, 2021) in combination with the changes of tourism product attributes, judge the attenuation relationship of user interest, and the attenuation factor at this time a as shown in (2) below.

$$a = 10^{-passedTime \backslash \sec ondsInMonth} \quad (2)$$

In formula (2), ^{passedTime} represents the recommended time, in s, $^{\sec ondsInMonth}$ represents the interest change constant (Sun, 2021), which usually refers to the time of one month. According to the above attenuation factor, the calculation formula of user interest change can be effectively obtained I , as shown in (3) below.

$$I = I_S * a \quad (3)$$

In formula (3), I_S represents the original interest degree (Shi et al., 2021). Combining the above user change formula, we can further analyze the past relationship of user interest, judge the recommendation weight, and obtain an effective user interest model R , as shown in (4) below.

$$R = \frac{a \times R_N + f(x)}{a + \sum f(x)} \quad (4)$$

In formula (4), R_N representative, $f(x)$ on behalf of, using the above user interest model can effectively determine the recommendation weight and realize intelligent recommendation.

2.3.Calculation of User Preference Similarity

In collaborative filtering algorithms, the calculation of user preference similarity is one of the key steps. This calculation method is based on the user's historical behaviour data and determines the similarity between users by calculating the user rating vector and comparing the similarity, thus realising personalised recommendations for the user. Common methods for calculating user preference similarity include Pearson correlation coefficient, cosine similarity, Euclidean distance, etc. The similarity of user preferences is related to the similarity measurement of medical tourism products. Therefore, the similarity data of user preferences (Zhong et al., 2021) first obtained by the tourism products designed in this paper is shown in Figure 3 below.

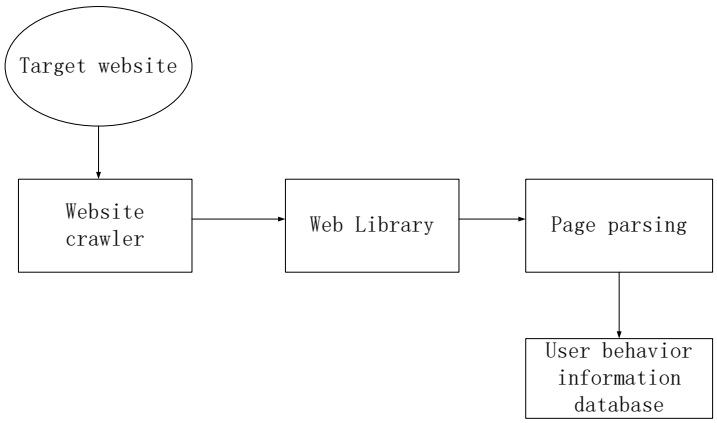

Fig. 3: Acquisition of user preference similarity data

It can be seen from Figure 3 that the user preference similarity coefficient can be calculated after the above steps are completed $p(a,b)$, as shown in (5) below.

$$p(a,b)=\frac{\sum_{k=1}^{n}(x_{ak}-x_a)(x_{ak}-x_b)}{\sqrt{\sum_{k=1}^{n}(x_{ak}-x_b)}} (5)$$

In formula (5), x_{ak} represents Manhattan distance (Ifada & Nayak, 2021), x_a represents the value of vector a dimension, x_b the value of the representative vector b dimension can be calculated using the above formula to effectively analyze the sensitivity of recommended values, and further obtain the difference of products, so as to obtain the final similarity recommendation result.

2.4.Recommendation based on Collaborative Filtering Algorithm

Collaborative filtering algorithm refers to using the user's interest relationship to filter information through the specified cooperation mechanism, so as to improve the efficiency of online recommendation (Boujemaa et al., 2021). Therefore, this paper proposes online recommendation of tourism products based on collaborative filtering algorithm. Considering the difference of users' daily behavior habits, we can first build a recommendation category preference formula $pref$, as shown in (6) below.

$$pref=\partial\sum\frac{c_i}{R_W}+\beta\frac{C_j}{|R_W|} (6)$$

In formula (6), ∂ represents the scoring preference index, c_i represents the dispersion coefficient, R_W represents the preference score, β number of representative scores, C_j represents the user scoring standard value. According to the user scoring relationship, an effective original scoring matrix can be generated. In order to reduce the impact of time on user recommendation results (Xu et al., 2021), time weighting factors need to be quoted t_{ij} , as shown in (7) below.

$$t_{ij}=e^{-|t_{ui}-t_{uj}|} (7)$$

In formula (7), e represents the time weighting factor, t_{ui} 、 t_{uj} they represent the scoring time respectively. At this time, the collaborative filtering algorithm can be used to improve the similarity, normalize, and recommend collaborative filtering $rsim$ as shown in (8) below.

$$rsim=\frac{\sum u_{ij}\left(r_{ui}-r^r\right)\left(r_{uj}-r^r\right)}{\sqrt{r_{ui}}\sqrt{r_{uj}}} (8)$$

In formula (8), u_{ij} represents the similarity of i and j scores, r_{ui} represents the recommended weighting factor, r^r represent product preference scores of i and j, r_{uj} on behalf of the user set, effective user preference scores can be obtained at this time, so as to complete online recommendation of medical tourism products, which maximizes the effectiveness of recommendation.

3. Experiment

In order to verify the recommendation effect of the online recommendation method designed for Malaysian medical tourism products, this paper has set up a reasonable experimental environment according to the experimental needs, and compared it with the conventional online recommendation method for medical tourism products. The experiment is as follows.

3.1.Experiment Preparation

In combination with the experimental needs of medical tourism online recommendation, this paper selects Hadoop as the experimental platform to conduct subsequent online recommendation experiments. The experimental platform has 1 master node and 5 slave nodes. The CPU of each node is Intel (R) Xeon (R) CPU E5-2650 v4 @ 2.2GHz, the memory is set to 32GB, and the hard disk capacity is 500G. After the layout of each experimental node is completed, the software environment of the test server needs to be debugged. The operating system of the test server is Ubuntu 16.04, JDK version 1.8, MySQL version 5.7.28, Redis version 3.0.6, Hadoop version 2.6.1, and Rabbit MQ

version 3.7.17.

The experimental test process belongs to the API test process, so an independent test engine needs to be equipped. After the recommended API of the test engine is deployed, the recommended result set can be generated. In order to improve the effectiveness of the experimental results, the recommended result set uses MovieLens-1M for pre calculation. The data set parameter information obtained at this time is shown in Table 1 below.

Table 1: Parameter information of experimental data set

data set	Types of medical tourism products	Number of users	Item Quantity	Number of user ratings (10000)
Tourism products -1M	Cardiac surgery	6000	4000	100
Tourism products -2M	dentistry	6000	3000	100
Tourism products -3M	Plastic and plastic surgery	5000	1000	200
Tourism products -4M	Vertebral osteosynthesis	8000	5000	100
Tourism products -5M	reduce pressure	7000	4000	150
Tourism products -6M	Joint modeling	6000	3000	200
Tourism products -7M	Surgical transplantation	5000	2500	150
Tourism products -8M	obstetrical department	7000	6000	200
Tourism products -9M	Skin dressing	6000	5000	100
Tourism products -10M	Physiotherapy apparatus	5000	4100	100
Tourism products -11M	Physical perimeter	8000	7210	150
Tourism products -12M	Chinese medicine recuperation	9000	7450	200

It can be seen from Table 1 that the above experimental data sets are uniformly processed by consistency algorithm, so as to meet the experimental requirements to the greatest extent. During the experiment, it is necessary to constantly determine the comprehensive recommended hits of different products. Therefore, it is necessary to use the Postman experimental tool for support. At the initial stage of the experiment, it is necessary to conduct unified calculation for the current recommendation list, and input the calculated results into Redis. After the above steps are completed, it is necessary to obtain the current unauthorized access results according to the access status of the API. If the access results at this time are correct authorization results, it proves that the experimental results at this time are reliable, otherwise, it is necessary to conduct the experiment again, so that the final experimental results meet the expectations. The use cases selected in this experiment should meet the actual recommended requirements, as shown in Table 2 below.

Table 2: Selected Cases for Experiments

item	describe
Primary Use Cases	
Use Case Purpose	Test the home page recommendation function of medical tourism products
Preconditions	Interface authentication passed
import	bizCode=1，recNum=10，userId=1，start=1
Desired output	10 Recommended items
10 recommended items	10 Recommended items，ID Respectively 2864，1995，65，421，7630，757，468，4457，2708，9670
Advanced Use Cases	
Use Case Purpose	Test the recommended features of the medical tourism product details page
Preconditions	Interface authentication passed
import	bizCode=1，recNum=10，userId=1，start=1
Desired output	10 Recommended items
10 recommended items	10 Recommended items，ID Respectively 9355，8058，7254，523，1472，2864，1995，65，421，7630

It can be seen from Table 2 that the above experimental cases meet the requirements for online recommendation of medical tourism products. At this time, the experimental hardware and software structures can be connected, as shown in Figure 4 below.

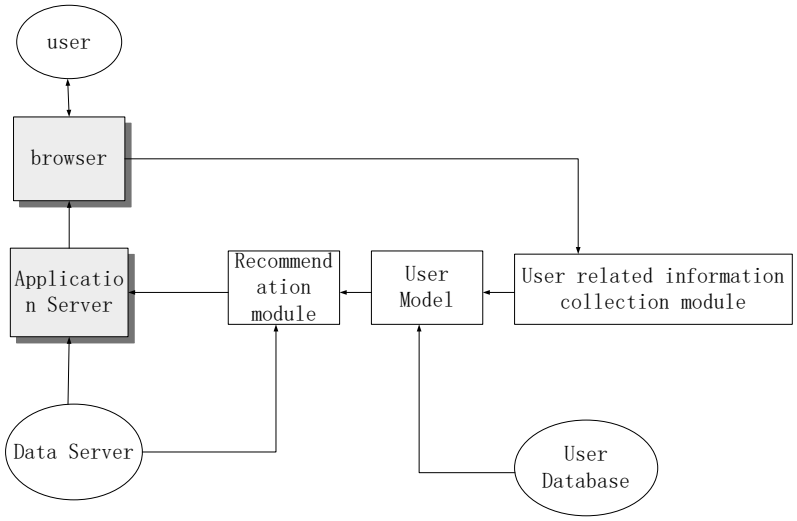

Fig. 4: Connection structure of experimental software and hardware

It can be seen from Figure 4 that the above experimental hardware and software structure needs to be supported by IE6.0 and above browsers, and the experimental results should be processed using the B S three-tier processing structure. The three processing layers are data server layer Web application layer client browsing layer. The tasks of different processing layers are different, and the final experimental results can be obtained through the Internet only after the three processing layers have completed processing. Through analysis, it is found that the recommendation process of various products in the experimental process is complex and prone to redundancy, so it is necessary to plan the recommendation attribute reduction process, as shown in Figure 5 below.

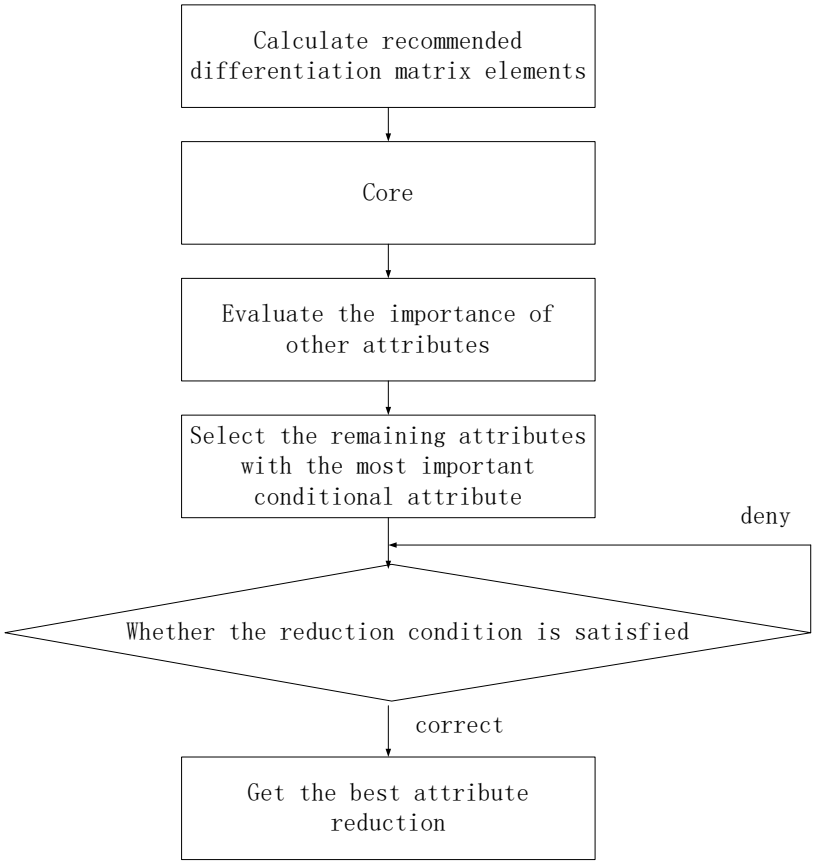

Fig. 5: Recommended attribute reduction process

It can be seen from Figure 5 that experimental recommendation data reduction can be effectively completed through the above recommendation attribute reduction process. After the above process is completed, the ontology concept attribute interest degree of each medical tourism experimental product can be calculated, as shown in Table 3 below.

Table 3: Interest degree of ontology concept attribute

Types of medical tourism products	User-1	User-2	User-3
Cardiac surgery	0.12	0.06	0.13
dentistry	0.15	0.08	0.13
Plastic and plastic surgery	0.13	0.05	0.14
Vertebral osteosynthesis	0.23	0.09	0.13
reduce pressure	0.12	0.04	0.12
Joint modeling	0.12	0.11	0.12
Surgical transplantation	0.14	0.12	0.10
obstetrical department	0.11	0.11	0.11
Skin dressing	0.10	0.10	0.11
Physiotherapy apparatus	0.12	0.19	0.11
Physical perimeter	0.13	0.18	0.09
Chinese medicine recuperation	0.14	0.08	0.07

It can be seen from Table 3 that the following online recommendation experiments of Malaysian medical tourism products can be conducted using the above ontology concept attribute interest degree.

3.2.Experimental Results and Discussion

Combined with the above experimental preparations, the subsequent online recommendation experiment of Malaysian medical tourism products can be carried out in the above experimental platform. That is, the online recommendation method of Malaysian medical tourism products based on collaborative filtering algorithm and the conventional online recommendation method of medical tourism products designed in this paper are used to recommend, and the daily product hits of different types of tourism products are recorded. The experimental results are shown in Table 4 below.

Table 4: Experimental Results

Types of medical tourism products	Daily product hits of the online recommendation method for Malaysian medical tourism products based on collaborative filtering algorithm designed in this article (times)	Daily product hits for conventional online recommendation methods for medical tourism products (times)
Cardiac surgery	154551	12053
dentistry	125126	15123
Plastic and plastic surgery	144785	28471
Vertebral osteosynthesis	232596	32885
reduce pressure	522341	13965
Joint modeling	149665	44472
Surgical transplantation	254141	29958
obstetrical department	144143	37471
Skin dressing	198996	52447
Physiotherapy apparatus	258521	68585
Physical perimeter	367456	29663
Chinese medicine recuperation	516699	12545

It can be seen from Table 4 that the online recommendation method of Malaysian medical tourism products designed in this paper based on the collaborative filtering algorithm has a good recommendation effect, and the daily product hits of different types of products are higher than the conventional online recommendation method of medical tourism products, which is reliable and has certain application value. The experimental results of this paper show that the online recommendation method of Malaysian medical tourism products based on collaborative filtering algorithm performs well in terms of recommendation effect. By comparing the daily product clicks recorded for different types of travel products, it can be seen that the daily product click rate of this recommendation method is higher than that of the conventional online recommendation method for medical travel products, indicating that this method can better meet the personalised needs of users and improve the accuracy of product selection and purchase intention of users. In the specific experimental process, a pre-built experimental platform is used to ensure the accuracy and repeatability of the experiment. The platform can support experiments on the online recommendation method of Malaysian medical tourism products based on collaborative filtering algorithm and the online recommendation method of conventional medical tourism products, and can record the daily product clicks of different types of products, so as to evaluate the recommendation effect. Overall, the experimental results of the online

recommendation method for Malaysian medical tourism products based on the collaborative filtering algorithm show that the method has high recommendation effectiveness and can better meet the personalised needs of users, providing a new idea and direction for the development of the medical tourism industry.

4. Conclusion

Malaysia is a famous medical tourism country, with a high total output value of medical tourism and a national pillar industry. Affected by the development of information technology, its internal medical tourism industry has not yet undergone a comprehensive digital upgrade, leading to a significant decline in the tourism economy. Tourism products are the products of medical tourism, which can provide financial support for the digital upgrading of medical tourism industry. Therefore, it is necessary to study effective medical tourism product recommendations in combination with the current characteristics of digital development. Based on the collaborative filtering algorithm, this paper designs an effective online recommendation method for medical tourism products in Malaysia, and conducts experiments. The results show that the online recommendation method designed for medical tourism products has good recommendation effect, reliability, and certain application value, and has made certain contributions to promoting the development of medical tourism in Malaysia.

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