The Cluster Algorithm by View Degree Matrix and the Application for the Recommend of Tourism Product Marketing

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Abstract

Today, the tourism industry is booming, and the development of the mobile Internet is entering a new track. The popularity of mobile devices makes public life more convenient, the combination of tourism and mobile Internet can effectively promote the development of tourism products. In this paper, considering the development of tourism industry in the mobile Internet era and the status quo of the theory of tourism product marketing, in according to the characteristics of mobile Internet and the actual situation of tourism product marketing at home and abroad, under the premise of the tourists demands, the paper builds the matrix about tourism product view degree, and through a series of mathematical method, the paper uses the k-means clustering algorithm to realize the tourists clustering, to get the tourists' demand and then to realize the intelligent push. The paper mainly researches the tourism product marketing mix in the mobile Internet era based on the intelligent push algorithm, for the purpose of tourists' demand, and tourists can get the better product experience through mobile Internet.

Keywords: intelligent push algorithm, mobile Internet, clustering analysis, similar matrix, tourism products

1. Introduction

The Internet is all over the world nowadays, in recent years, with the upgrading and updating of smartphones, the position of the mobile Internet is more important. The mobile Internet has been become the efficient, timely and convenient service medium for us, serving for our shopping, entertainment, tourism and other aspects of life. In other words, the mobile Internet is changing people's life, and has already permeated every aspect of public life.

As an important carrier of the tourism industry today, in recent years, the mobile Internet is rapidly developing, and it gives tourism products a new appearance to show. The combination of mobile Internet and tourism products develops a new road for the development of tourism products. Some data show that the search that is used mobile wireless terminal by China users has reached 42%. Because the traditional tourism industry is restrained by time and space, so it gives much more inconvenience to the public. When the smartphones spread all over the world, all aspects of the public life cannot leave the mobile Internet. Through the mobile and tablet computer, people realize the different functions, such as palm reading, online video, games. So with the improvement of people's material life, the requirement of leisure entertainment life also improves. Tourism industry in today's entertainment projects is the most important, the demand of tourism products is increasing. As a medium of the development of tourism products in the mobile Internet era, the usage of smartphones is increasing. Many tourism companies and Internet companies try to develop and the combination of mobile Internet and tourism products can meet the some needs about tourism for public. With the help of the mobile Internet, tourism industry helps tourists to distribute travel related resources reasonably, makes the travel virtual integration under the mobile Internet, solves the

various problems in the journey for tourists and promotes the development of the tourism industry group to a certain extent.

Information is the key to tourism products, the mobile Internet is more convenient and smart, and it can be the bedding. However, facing the extremely complicated online information resources, tourists are difficult to obtain satisfactory related tourism products in the limited time. So a method that tourists can get high quality and practical choice from numerous choices will become very necessary. Information push technology is a kind of new information method that reduces information overload, the information will be automatically transferred to tourists by push technology, so as to achieve the purpose of saving tourists search time, and this technology can help tourists get valuable information according to the demand of tourists. Intelligent push is that, through artificial intelligence, database storage and many other technology, the combination of these technologies is applied into a process of information push in order to timely give useful information of meeting the tourists' demand to tourists. The working principle of intelligent push is depending on tourists type to find matching information, or pushing information to tourists with similar interests to find matching information. Intelligent push technology can analyze tourists psychology, and can effectively manages tourists' needs, and can provide personalized service to tourists. This paper provide tourism products marketing method in mobile Internet era based on intelligent push algorithm, this method can provide more convenient services for tourists and also can bring new development space for tourism industry.

2. The Analysis of Mobile Internet Era and Tourism Industry Development Era

2.1. The Development of Mobile Internet

From the 1860s to now, the development of information technology has been going on for more than fifty years. Smartphones and tablet computers are the symbol that mobile Internet era has come. The United Nations Internet reports show that in recent years, tourists using mobile Internet 3g and more than 3g is growing with forty percent. This growth trend is steady. Experts predict that by the end of 2016, China mobile Internet tourists will reach 1 billion.

As three major telecom operators in Japan award 3G licenses, 3G is widely used, at the same time mobile Internet market is pushed to the peak because of 3G.

Since 2007, the level of development of mobile Internet in the United States is higher than that of other countries. From June 2007 to June 2008, the number of users of mobile Internet account for 29% in total mobile phone users, reaching 64.2 million. By 2011, the number of users of mobile Internet account for 31% in total mobile phone users, reaching 100 million. Then the United States has always been ahead of other countries in the mobile Internet industry, its development speed is very fast.

Since January 2009, the mobile Internet industry is growing rapidly in China. In 2015, three major operators complete investment and its expected will reach or exceed 435 billion RMB. 4G network construction investment is more than 900 billion RMB, the base stations reach 1.771 million, covering major cities in China. The pace of the light into copper is acceleration, there are 269 million FTTH ports, accounting for 56.7%, over 80% of urban households have MB access ability. Sichuan province and Shandong province successfully built province of all-optical networks. International communication network layout has been formed, the international export total bandwidth is 12.4 Tbps.

2.2. The Characteristics of Mobile Internet

Mobile Internet exists everywhere in today's life. Through the mobile and tablet computer, people realize the different functions, such as palm reading, online video, games. Because of network experience and service with high quality, the status of mobile network is promoting in public, and people can get to experience and service anytime and anywhere. So there are four characteristics about mobile Internet:

(1) Convenience

When tourists experience Internet service, people can use mobile equipment anytime and anywhere, it is convenience for tourists. Facing a lot of trivial spare time, people always meet their needs with mobile equipment. According to the survey, using mobile phone to surf the Internet in spare time has become the habit of modern people, the time of surfing the Internet with mobile phone is greater than the time of surfing the Internet with computer.

(2) Privacy

As carry-on things, mobile phone usually have high personal attribute. Therefore, the privacy requirement of tourists is higher than computer users. When people surf the Internet with mobile Internet, the content surfed by tourists and service requirements need higher privacy, such as mobile payment and so on. Through tourists identity authentication and encryption, mobile Internet ensure the safety of tourists information, and it is safer than traditional Internet, so the tourists Internet information is not easily stolen.

(3) Intelligent

The characteristics of mobile Internet is that the tourists location is accurate and it can quickly get the information of the other things. Nowadays there are intelligent devices that can feel the surrounding environment through touch, temperature and odour.

(4) Individuation

Mobile Internet reflects its individuation from three aspects: mobile terminals, mobile networks and content and application. First of all, mobile terminals tie up tourists individual, the tourists personal characteristics can be reflected by more personality way. Secondly, mobile networks accurately extract and reflect the requirement of tourists and behavior information. At last, the personality of content and application reach maximum by the combination of mobile terminals and Internet individuation.

2.3. The Tourism Industry is Influenced by Mobile Internet Era

Different from other industry chain, tourism industry chain is horizontal, so the tourism industry association between each other is weak, so enterprises can only separately offer the related tourism services for tourists. Because the technology is not mature and the relationship of chain is less with own reason, the traditional tourism industry can not timely allocate tourism resources and cause the serious waste phenomenon in tourism resources. At the same time, industry chain can't form integration management, so time isn't reasonably arranged by tourists and it brings travel burden for tourists.

But in the mobile Internet era, tourism industry realizes integration management through Internet, tourists can complete "eat, live, travel, transportation, shopping" and other activities at the same page, tourism resources and time can be reasonably allocated. Mobile Internet era ensure the information communication among the industry chain, can also further promote virtualization of tourism industry. Mobile Internet closely links with the entity, and it is better for the cluster development of industry chain. At present, most of the tourism activities is done through the computer and mobile Internet has not been fully utilized. The travel agency business still rely on entity. This way not only consumes lots of cost but also is difficult to manage. So tourism industry should adapt to the development of mobile Internet to develop tourism electronic commerce and other business development direction. Mobile Internet related applications about tourism

products have been known for tourists, related applications in the following table:

Table 1. Mobile Internet Applications in the Product

Type	Content
Shoot-of	Uploading to the Internet to share with others the crowd.
Audio guide	It allows visitors to upload their own version of the guidebook, enhanced communication and interaction with visitors.
Synchronous Virtual Community	Customer service via chat rooms to graps the dynamic tourism.

3. The Application of Intelligent Push Algorithm in the Tourism Product Marketing Mix

3.1. The Construction of Tourism Products View Degree Matrix

In the process of using mobile Internet, because visitors browsing information data reflect the topology structure, so the site's topology structure is not needed. It can be directly obtained from the server log files by effective pluripotent mining algorithm. The incidence matrix is built, the matrix row is web page, the matrix column is tourism product attribute, the elements are the number of visitors to browse. The similar properties group is built by column vector, the web pages that is associated with attributes is got by row vector, so the frequent access paths can be found. Although this algorithm is simple and is easy to operate, tourists browsing time is ignored, and the wrong operation and web practical problems are not considered. So the number of tourists browsing is not a standard that evaluates this property is popular or not. By the analysis of tourists browsing time, the web pages with useful content are selected.

Based on the above analysis, the paper proposes a k-means clustering algorithm based on tourism products view degree matrix to tourists clustering, and tourists can get the better product experience. Because visitors browsing data is very large, so the number of visitors browsing web pages is large. Therefore, the paper proposes a method that tourists browsing matrix is built by tourism product view degree matrix to solve sparsity problem of matrix. The row vector of analysis matrix is the view degree of tourism products, accumulating of unified property page view degree. If the number of web pages browsed by a tourist is n, and these n pages belong to one kind of attributes, the view degree of this attribute is got

$$M_i.surf = \sum_{k=1}^{n} m_{ik}.surf = \sum_{k=1}^{n} Int\left(\frac{m_{ik}.time}{m_{ik}.size} \times 1000 \right) \quad (1)$$

In the formula, $m_{ik}.time$ represents the time that visitors stay on this page (the unit is second). $m_{ik}.size$ represents the size of visiting page (the unit is byte). Int is integral function. If a visitor browses the same page with many times, so the maximum of

$$Int\left(\frac{m_{ik}.time}{m_{ik}.size} \times 1000\right)$$

(2)

is the view degree that visitors browse this page. The web pages can be matched and discerned by the column vectors of the matrix. The column vectors can be got by fuzzy clustering method. All the points in the matrix matches with information in the attribute matching library to recognize the category. The attribute of web pages can be classified through the above method, then the view degree of tourism products can be computed by this method, the tourism products view degree matrix is established.

$$R^{*}_{m \times n} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2j} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} & \cdots & r_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mj} & \cdots & r_{mn} \end{bmatrix}$$

(3)

In the matrix $R^{*}_{m \times n}$, row vector represents a tourist browses all tourism product attributes, column vector represents all tourists browse a tourism product attribute. $r_{ij} = 0$ represents tourists don't browse the web page with this attribute. $r_{ij} > 0$ represents the view degree that tourists browse this attribute, in other words, it is a size that tourists browse the tourism products with this attribute.

3.2. The Standardization of Original Data

According to tourism product view degree matrix, the fuzzy similar matrix is built. Standardizing data structure fuzzy similar matrix, if there are n objects, $I_1, I_{2,...}, I_n$, there are m indexes in each object, $y_1, y_2, \cdots, y_m$, x_{ij} represents j index of i object.

The average value of j index of i object is

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_{ij}$$

(4)

The standard deviation is

$$S_j = \left(\frac{1}{n} \sum_{i=1}^{n} (x_{ij} - \bar{x}_j)^2\right)^{\frac{1}{2}}$$

(5)

The standardization of original data is

$$x'_{ij} = \frac{(x_{ij} - \bar{x}_j)}{S_j}$$

(6)

Through extreme value, the standardization data is compressed into $[0,1]$. In other words,

$$\bar{x}_{ij} = \frac{x'_{ij} - x'_{\min j}}{x'_{\max j} - x'_{\min j}}$$

(7)

$x'_{\max j}$ is the maximum value of $x'_{1j}, x'_{2j}, \cdots x'_{nj}$, $x'_{\min j}$ is the minimum value of

$x'_{1j}, x'_{2j}, \cdots x'_{nj}$.

3.3. The Construction of Similar Matrix and Cluster Analysis

The fuzzy similar matrix H^F is built.

$$H^F = \begin{pmatrix} h_{11} & h_{12} & \cdots & h_{1n} \\ h_{21} & h_{22} & \cdots & h_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ h_{n1} & h_{n2} & \cdots & h_{nn} \end{pmatrix}$$

(8)

h_{ij} is similarity variable of two objects E_1 and E_2, then using the Hamming function,

$$h_{ij} = \begin{cases} 1 - a \sum_{k=1}^{m} \left| x_{ik} - x_{jk} \right| & i \neq j \\ 1 & i = j \end{cases}$$

(9)

The constant $a \in [0,1]$, the appropriate value is selected.

After construction of fuzzy similar matrix, tourists are classified by fuzzy k-means clustering algorithm and then the similar tourists groups are got.

n $x_i (i = 1,2,3 \cdots n)$ classify a fuzzy groups. When value function reaches the minimum value, the clustering center of each fuzzy group is got. Because of the fuzzy classification of fuzzy k-means clustering, the value function of the dissimilarity index is the minimize. The fuzzy partition is properly introduced, the value of V is $[0,1]$. The summation of membership in the data set is 1. $\sum_{i=1}^{c} v_{ij} = 1$, $\forall j = 1,2, \cdots n$. The objective function is

$$J(V, a_1, \cdots a_n) = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c} \sum_{j}^{n} v_{ij}^m b_{ij}^2$$

(10)

v_{ij} is between 0 and 1, a_i is the clustering center of fuzzy group i, $b_{ij} = \left\| a_i - x_j \right\|$ is the i clustering center, and is an *Euclid* distance to j data. $l \in [1, \infty)$ is weight index. $l = 1$, it is a degradation of k- means clustering. The best value range of l is $[1.5, 2.5]$. Suppose that $l = 2$.

The construction of new objective function, the necessary condition that the above objective function reach the minimum value is obtained.

$$\bar{J} = (V, b_1, \cdots b_a, \lambda_1 \cdots \lambda_n) = J(V, a_1 \cdots a_n) + \sum_{j=1}^{n} \lambda_j \left(\sum_{i=1}^{a} v_{ij} - 1 \right)$$

$$= \sum_{i=1}^{a} \sum_{j}^{n} v_{ij}^l b_{ij}^2 + \sum_{j=1}^{n} \lambda_j \left(\sum_{i=1}^{a} v_{ij} - 1 \right)$$

(11)

From λ_j, $j = 1$ to n , the derivation of input parameters makes the necessary condition of minimum value is

$$a_i = \frac{\sum\limits_{j=1}^{n} v^l x_j}{\sum\limits_{i=1}^{n} v_{ij}^l} \tag{12}$$

$$v_{ij} = \frac{1}{\sum\limits_{k=1}^{c} \left(\dfrac{b_{ij}}{b_{kj}}\right)^{\frac{2}{(l-1)}}} \tag{13}$$

The steps of determining the cluster center a_{ij} and membership matrix V:

Step 1: the random values in $[0,1]$ initialize membership matrix V, and then the matrix meets the above constraint condition.

Step 2: the clustering center a_i of a, $i = 1 \cdots a$

Step 3: the value function is computed, if the value is less than the uncertain threshold value, or the change of function value that compared to the former one is less than a certain threshold value, so the algorithm stops.

Step 4: the new membership matrix is calculated, step 2 is returned.

When the algorithm is convergence, all kinds of clustering center are got and all memberships of each sample value are got. So the the target of fuzzy cluster analysis is reached. Through clustering the tourists, the similar tourists group with a certain attribute is got. According to different membership value, people can get more accurate results.

3.4. The Instance Analysis

The part of results with preprocessing is as an example, Table 2 is a size of the web page, Table 3 is browsing time that visitors browse the web pages.

Table 2. Page Size

Page	URL1	URL2	URL3	URL4	URL5
Byte	18931	23122	15637	14367	11002

Table 3. User Browsing Time

Property	URL1	URL2	URL3	URL4	URL5	URL6
Property r1	564	40	192	426	252	64
Property 2	224	116	644	578	106	203
Property 3	732	78	42	622	180	240
Property 4	262	210	320	56	678	134
Property 5	104	346	62	732	206	120

According to Table 2 and Table 3, the tourism browsing degree Property-URL matrix $M_{5 \times 6}$ is got.

$$R_{5 \times 6} = \begin{pmatrix} 28 & 2 & 12 & 44 & 8 & 6 \\ 14 & 4 & 40 & 58 & 8 & 20 \\ 38 & 4 & 2 & 64 & 14 & 22 \\ 14 & 8 & 20 & 6 & 50 & 12 \\ 6 & 14 & 4 & 80 & 16 & 12 \end{pmatrix}$$

URL_i matches the attribute matching rule library, the attribute of URL_i is recognized, and it is merged with the same attribute. After matching, people can get $\{(URL1,URL3),(URL2,URL5,URL6),(URL4)\}$. The tourism browsing degree matrix $R^*_{5\times3}$ is built.

$$R^*_{5\times3} = \begin{pmatrix} 40 & 26 & 44 \\ 54 & 32 & 58 \\ 40 & 40 & 64 \\ 34 & 70 & 6 \\ 10 & 42 & 80 \end{pmatrix}$$

After data standardization, according to Hamming distance function (parameter is 0.05), the fuzzy similar matrix is got.

$$H^F = \begin{pmatrix} 1 & 0.95 & 0.95 & 0.86 & 0.90 \\ 0.95 & 1 & 0.94 & 0.90 & 0.91 \\ 0.95 & 0.94 & 1 & 0.85 & 0.87 \\ 0.86 & 0.90 & 0.85 & 1 & 0.93 \\ 0.90 & 0.94 & 0.87 & 0.93 & 1 \end{pmatrix}$$

The k-means clustering algorithm is applied to the clustering, the result is as follows:
$Property = \{(Property1),(Property2),(Property3,Property4),(Property5)\}$.

4. A Research on Tourism Product Marketing Mix Strategy in Mobile Internet Era

4.1. The Data Statistical Analysis

The data statistical analysis mainly uses SPSS software. The specific method is as follows:

The frequency of sample, means, standard deviation, variance are the research indexes to analyze the structure of samples. The paper uses data statistical analysis to analyze the foundation information of tourists, the interest of visitors about tourism products and browsing degree. Frequency analysis means the products that tourists are interested are classified by the above classification. According to the frequency analysis, we can get that tourists mainly focus the quality of products and price. Mean value is used to analyze the center degree of tourism products attributes and the number, tourists focus on the quality of the tourism products. Standard deviation analysis reflects the discrete degree, and it is the average value of the degree of deviation from the tourists average data.

4.2. The Scale Analysis

Through the above fuzzy k-means clustering method, in the process of tourism product sales, the main factors that influence the product sales are as following table:

Table 4. Factors Influencing the Tourism Product Marketing and Main Indicators

Combination of elements	Main indicators
Product	Quality, brands, services and after-sales service
Channel	Location、accessibility
Sale	Propaganda、personal selling

Price	Discounts、terms of payment、pricing
people	Attitude、other customer

In the Table 4, the most influential factors of five factors is the combination of product, price and sale. The study of 10 index factors of five elements is used to analyze the correlation coefficient and reliability coefficient about influence measurement table of tourism products marketing. Through literature analysis and research, the measurement scale is following:

Table 5. Affect the Tourism Product Marketing Scale

Common factor	Item	Index to explain
Product	Quality	Reflect the effects of product quality
	Brands	Reflect the brand of product
	Services	Reflect product service satisfaction
	After-sales service	For the product after the satisfaction
Price	Discount	The change of the product price
	Terms of payment	The payment of the product
	Pricing	Reflect the price of products
Sale	Propaganda	Reflect changes in the product publicity
	Personal selling	Reflect changes in the staff service attitude

On the premise of Table 5 formation, the questionnaire survey is adopted. Through the related model to comprehensively evaluate, the following Table is got:

Table 6. Tourists Perception of Tourism Products of Variations of Descriptive Statistics

Item	The degree of charge（%）					Mean	standard deviation
	Greatly reduce	Reduce	Same	Increase	Greatly increase		
Quality	1.5	0.0	30.7	44.0	233.8	3.885	0.8701
Brand	1.2	1.8	28.0	48.8	20.2	3.849	0.8437
Services	1.2	6.00	10.7	64.9	17.3	3.910	0.8039
After-sales service	0.0	0.6	19.6	63.7	16.1	3.952	0.6163
Discount	0.0	8.9	33.3	44.6	13.1	3.619	0.8236
Terms of payment	0.6	1.8	15.5	66.1	16.1	3.952	0.6630
Pricing	0.6	2.4	10.7	58.9	27.4	3.910	0.7219

| Propa ganda | 0.0 | 4.2 | 23.2 | 55.4 | 17.3 | 4.101 | 0.74 34 |
| Person al selling | 0.3 | 3.0 | 12.5 | 68.2 | 16.1 | 3.857 | 0.67 26 |

Table 6 shows that in the product marketing, products, promotion, price are the main factors that consumers focus on in the process of consumption.

5. Conclusion

The paper mainly research the mobile Internet tourists browsing degree, based on tourism product marketing mix of intelligent push technology. Through the construction of tourists browsing degree matrix, using fuzzy k-means clustering method to realize the tourism products clustering, the paper realizes the intelligent push system. By data statistical analysis and scale analysis, the elements that affect tourism product marketing contain three projects and ten factors. Specifically, products refer that in the product quality aspect, the high tourism product quality is needed to make tourists feeling that the products are worth their value, products are need a good brand, and product after-sale meets the requirements of tourists as much as possible; Promotion is a series of appropriate promotional activities such as discount, it not only can achieve the purpose of publicity and attract visitors' attention, but also can increase product sales; Product price is that the price is in an acceptable range, price formulation is a key factor and has selected power and need flexible management, the tourism products with high cost performance attract attention of consumers.

The continuous development of tourism products in the mobile Internet era brings much convenience for tourists and opens up a new development path for the whole tourism industry. Although the Internet technology is not perfect enough, there are many problems to be solved, the promotion of mobile Internet will the tourism products to be more perfect, and will broaden more development space for tourism industry.

Acknowledgments

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