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Design and implementation of an intelligent recommendation system for tourist attractions: The integration of EBM model, Bayesian network and Google Maps

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ABSTRACT

Selecting tourist attractions and collecting related site information is one of the most crucial activities for a tourist when making decisions for a trip. Although various recommendation systems have been discussed over the last decade, rarely do such systems take individual tourist preference information into consideration. Based on the Engel–Blackwell–Miniard (EBM) model, this study used data published by the Tourism Bureau of Taiwan to develop a decision support system for tourist attractions. The probability of a tourist attraction appealing to a particular tourist is calculated utilizing a Bayesian network, and the accuracy of the prediction is validated by a ROC curve test. Finally, recommended routes and tourist attractions are presented through an interactive user interface using Google Maps. This study confirms that by combining the EBM model with a Bayesian network to propose a decision support system called the Intelligent Tourist Attractions System (ITAS). It has demonstrated good prediction of tourism attractions and provides useful map information to tourists.

1. Introduction

Selecting tourist attractions is a critical problem in planning for a trip (Huang & Bian, 2009). However, when it comes to visiting an unfamiliar place, tourists' travel preferences are not explicitly known and often hidden when they start to plan a trip (Loh, Lorenzi, Saldana, & Licthnow, 2003; Viappiani, Pu, & Faltings, 2002). Although various online travel recommendation systems that provide useful internet resources for users to plan their trips have been developed during the last decade, few systems focus on customized attraction recommendations for individual tourists. In order to recommend satisfactory tourist attractions to individual travelers, this paper provides an outline for an intelligent personalized recommendation system design which can significantly reduce unnecessary additional costs for users in the information search process, and best meet their needs and preferences when selecting tourist attractions.

The EBM model involves six phases to explain a customer's decision process: problem recognition, information search, alternatives evaluation, purchase decision, purchase and post-purchase evaluation (Blackwell, Miniard, & Engel, 2001). This process is similar for most consumers, yet different needs, as well as other internal and external factors, can create indecisive results when studying trends in purchase decision making. A one-to-one personalized recommendation system seeks to eliminate these indecisive results and to present purchasing information more relevant to the individual consumer, ultimately providing a recommendation system that most meets the needs of an individual (Good et al., 1999; Resnick & Varian, 1997). In recent years, online recommendation systems for travel have been able to assist travelers in deciding on suitable travel plans and routes, and have been increasingly brought to the attention of scholars in the tourism field (Huang & Bian, 2009; Loh et al., 2003; Ricci, 2002; Wallace, Maglogiannis, Karpouzis, Kormentzas, & Kollias, 2003). When a traveler selects a travel plan, the process involves several phases, including the selection of destinations and attractions, the choosing of accommodations, plotting routes, etc. A tourist attraction is often the main motivation for a tourist to decide upon a destination (Jafari, 2000; Richards, 2002). However, to build a personalized recommendation system, a wide array of real-time information on tourist attractions must be included (Ardissono, Goy, Petrone, Signan, & Torasso, 2003). This data is collected mostly from providers with

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vastly diverse backgrounds, and therefore cannot be easily integrated. Furthermore, when a traveler begins to consider a trip, he or she has less than evident inclinations, especially when planning to visit a foreign location (Loh et al., 2003). Therefore, the purpose of this study is to eliminate for travelers the uncertainties involved in the information search stage of a buyer's decision process, while also avoiding unnecessary costs. To ensure the integrity, accuracy and practicality of the ITAS, this study follows the following procedure: (1) extract measures from EBM model for tourist attractions; (2) collect data from "2007 Annual Survey Report on Visitors Expenditure and Trends in Taiwan" published by the Tourism Bureau of Taiwan; (3) calculate probability of a tourist attraction appealing to a particular tourist by utilizing Bayesian network; (4) verify accuracy of the prediction by ROC curve test; and (5) present recommended routes and tourist attractions through system with Google Maps.

2. Literature review

2.1. EBM model as a decision model

The whole buying process is a continuous course of actions rather than numerous isolated events from the viewpoint of EBM model to buyer behavior. A buying process is composed of six stages: problem recognition, information search, alternatives evaluation, purchase decision, purchase and post-purchase evaluation, and the buying decision is finally formed by factoring in internal and external influences that affect the consumer (Blackwell et al., 2001). Many scholars argue that consumer's behavior is a process of information processing to make a decision (Blackwell et al., 2001; Peter & Olson, 2008; Solomon, 2007; Walters & Blaise, 1989), and various decision making models have been developed on this basis. Three of the most popular and practical models are the Nicosia model (Nicosia, 1968), the Howard–Sheth model (Howard & Sheth, 1989), and the EBM model (Blackwell et al., 2001). Of the three, the EBM model is currently the most comprehensive behavioral model, and has the following strengths: it has a mature framework, it can be sequenced and factorized, and it is able to easily analyze core problems (Blackwell et al., 2001; Howard & Sheth, 1989; Teo & Yeong, 2003; Traci & Trevor, 2006). Besides, tourist's behavior is also a process of decision making, and the selection of travel destinations or recreational activities is the purchase of an "intangible product" (Chen, Yung, & Chen, 2004; Lin, Sung, & Chen, 2006). Therefore, this study uses the EBM model as a basis to develop a decision support system for tourist attraction selection.

2.2. Recommendation system

A recommendation system is an information filtering mechanism that utilizes machine learning to analyze an item or compare it with the past experiences of others, and suggests or recommends to the user potentially needed information, services, or products. Such a system matches an item to users based on preference, interest, action, or need, and can significantly reduce unneeded additional costs for users in the information search process (Rashid et al., 2002). According to their characteristics, decision support systems with recommendation functions can be generalized into one of the following four categories (Schafer, Konstan, & Riedl, 1999):

1. Non-personalized recommender system: This type of recommender system does not take into account user-provided information or products. It displays all available information to the user and the exact same results are displayed for any given user.
2. Attribute-based recommender system: This type of recommender system provides to the user information or products that matches the user's preferences.
3. Item-to-item correlation recommender system: This type of recommender system analyzes historical data to find connections between frequently purchased items and displays recommendations for correlated items. This study utilizes this type of recommender system.
4. People-to-people recommender system: This type of recommender system classifies users into groups based on preference of products, interests, or needs and recommends appropriate items to users within the group according to peer review of products or information.

The above classification shows that the main purpose of a recommendation system is generally to analyze and compare a user's

Table 1
Inbound tourists to Taiwan in 2007.

Demographic variables		No.	%
Gender	Male	1176	48.4
	Female	1253	51.6
Age	Less than 29	721	29.7
	30–49	1057	43.5
	50 or above	651	26.8
Education	Elementary	53	2.2
	Middle	590	24.5
	College or higher	1769	73.3
Annual income	Less than US$29,999	844	34.7
	US$30,000 to US$69,999	606	24.9
	More than US$70,000	343	14.1
	Unsteady Income	636	26.2
Vocation	Manager	287	11.8
	Technician	756	31.1
	Clerk	553	22.8
	Service marketer	136	5.6
	Housekeeping	209	8.6
	Student	272	11.2
	Other	216	8.9
Nationality	Japan	779	32.1
	China	721	29.7
	Korea	224	9.2
	Europe or U.S.	347	14.3
	Other Asian countries	358	14.7

Table 2
Traveling purpose, information source and traveling type.

Items	Content	No.	%
Traveling purpose	Sightseeing	1772	73.0
	Business	268	11.0
	Visiting family or friend	204	8.4
	Attending international conference or exposition	49	2.0
	Study	31	1.3
	Other	105	4.3
Information source	Television	1906	78.5
	News paper and magazine	1861	76.6
	Internet	1827	75.2
	Light box advertisement on train and bus	1027	42.3
	International travel fair	996	41.0
	Outdoor billboard	934	38.5
Tour type	Group inclusive tour	1167	48.0
	Independent tour	749	30.8
	Flight and accommodation tour booked by agency	313	12.9
	Personally planned tour arranged by local agency	178	7.3
	Tour arranged by local agency after arrival	22	0.9