

Intelligent Agent for e-Tourism: Personalization Travel Support Agent using Reinforcement Learning

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ABSTRACT

Web personalization and one to one marketing have been introduced as strategy and marketing tools. By using historical and present information of customers, organizations can learn, predict customer's behaviors and develop products to fit potential customers. In this study, a Personalization Travel Support System is introduced to manage traveling information for user. It provides the information that matches the users' interests. This system applies the Reinforcement Learning to analyze, learn customer behaviors and recommend products to meet customer interests. There are two learning approaches using in this study. First, Personalization Learner by Group Properties is learning from all users in one group to find the group interests of travel information by using given data on user ages and genders. Second, Personalization Learner by User Behavior: user profile, user behaviors and trip features will be analyzed to find the unique interest of each web user. The results from this study reveal that it is possible to develop Personalization Travel Support System. Using weighted trip features improve effectiveness and increase the accuracy of the personalized engine. Precision, Recall and Harmonic Mean of the learned system are higher than the original one. This study offers useful information regarding the areas of personalization of web support system.

Keywords: Personalization, Reinforcement Learning, intelligent agent, recommendation algorithm

1. INTRODUCTION

At present information technology (IT) plays an important role in working environments, many organizations use IT as a tool in making their business run smoother and competing faster in the market. In many industries, the Internet and WWW have

significant roles in business processes. Online business is more competitive than traditional one since there are plenty of low cost online stores offering products and services on the Internet. Further, customer royalty for online business is low comparing to traditional market so that it is challenging for a company to attract new and keep customers in e-Commerce. Traditional marketing is not always successful on the Internet, and thus more specific online system such as one-to-one marketing should be helpful. In order to be more competitive on the

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Internet marketing, it is compulsory to offer customers with products or services which match for each customer [1]. During the past few years online massive marketing by using a push technology and informative websites always containing a great deal of information have been introduced to users. The existing search engines do not allow users to find the relevant information easily. Due to these challenging, web personalization and one to one marketing have been introduced to the e-commerce business, including tourist sector, retail, banking and finance, and entertainments [7].

In this study Personalization Travel Support System is introduced to arrange traveling information for users. This system applies the Reinforcement Learning to analyze the customer behaviors and studying customer interests.

2. RELATED WORKS

Joachims et al. (1997) developed Web Watcher Program that analyzed user's interactions with specific websites. In this program, a Reinforcement Learning theory was adopted. The purpose is to offer the most suitable information to user by showing links in HTML.

The WAIR system [3] proposed information filtering techniques, by using reinforcement learning program. The system learnt the user's interests by observing his or her behaviors while interacting with the system. Then personalized information was provided to target users. Comparing with the other techniques, it was found that Reinforcement learning technique was the most efficient in information retrieval.

Yuan introduced the comparison shopping system [6] which supported the personalization system. Comparison shopping feature keeps the record of users, analyzes users' behavior, manage the record and gives the reward to the products based on those records. This method is called Temporal Difference Reinforcement Learning, which is one of the effective Reinforcement Learning process.

3. DESIGN OF PERSONALIZATION TRAVEL SUPPORT ENGINE

The characteristic of reinforcement learning [5] is a trial-and-error feature. A reward will be given when the answer to a question is correct, while the penalty will be awarded when there is an error. This goal-oriented approach is to explore personal interests by maximizing the reward to the item which user concerns and awarding the penalty to the items that user does not concern.

Environment (state): A trip list which users can select

Agent: An agent records data from user behaviors on clicking and reading on the web sites. Then it analyzes users' interests, and gives rewards and/or penalties.

Action: Filtering the travel list according to the agent's analysis.

Reward: Assign a value for the state that a user selects to perform.

Then, the engine offers a trip information to determine the user's interest and records the interactions and behaviors from the last surfing including clicking characteristics in browsing travel information.

Personalization Travel Support Engine Structure

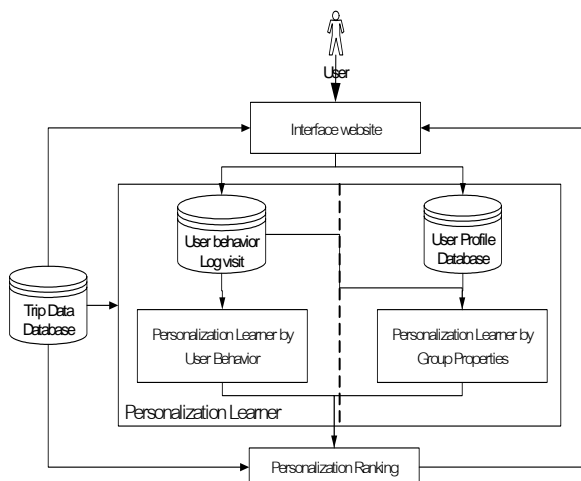


Figure 1. Personalization Travel Support System Structure

In this part, users can surf and view any websites. PTS records the information that the web users always visit, analyzes the user behaviors from each visit. Then system offers the trip information that matches the user's unique requirements.

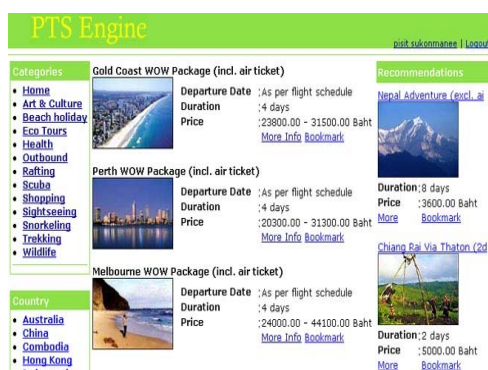


Figure 2. web site provides travel information

The Personalization Travel Support System Structure includes the followings:

1. Personalization Learner is the process of learning and analyzing of website usage behavior to understand user's interest.
2. Personalization Ranking. Its function is to rank the trip information for the web users. The work process

is based on the initial weight of learning and the user's interests on each trip.

3. User Profile Database. This is the database of web users, which is operated for travel management. Depending on the user's behaviors, the database will be processed in mapping the trip list to the user's requirements. Profile database is categorized into two types: User's properties data and User's behavior.

Personalization Learner

To perceive individual user's interests, one has to study user's behaviors by means of the information from the Interface Web Site that records two categories of data.

1. Web user profile includes user name, age, and sex.

2. Traveling Information includes identification number, duration, categories, trip lowest price, trip highest price and destination country.

There are two learning approaches using in this study: personalization learner by group properties and by user behavior.

Personalization Learner by Group Properties: System learns from all users in one group to find the group interests of travel information by using given data on user ages and genders.

Personalization Learner by User Behavior: Recorded data is analyzed with user behaviors and the travel information in order to find the unique interest of each web user. Reinforcement learning algorithm, called Q Learning is applied at this stage.

Q Learning is used to maximize a reward to the item on the list which is clicked and award a penalty to the item that is not clicked, as shown in Eq. (1).

$$\hat{Q}(s_t, a_t) \leftarrow \alpha \left[r + \gamma \max_{a_{t+1}} \hat{Q}(s_{t+1}, a_{t+1}) \right] \quad (1)$$

Whereas max Q is defined as:

- I if user clicks the provided trip information
- $-I/n$ if user doesn't click the trip information on the web site, where n is total number of trips per page
- I/p trips information on the database which are not recommended by the system, where p is the total number of trips in the system

given α is the learning rate valued at 0.2, and it is the discount rate valued at 0.8

Trip features

Trip features associate to user interests in tourist programs, they are as follows: (1) Trip Duration (Qt) is numbers of days offering by each trip. (2) Trip Categories (Qc) is type of trip including shopping, eco tour, scuba diving and trekking. (3) Trip Lowest Price (Qmp) is the lowest prices for trip expenses. (4) Trip Highest Price (Qxp) is the lowest prices for trip expenses. and (5) Trip Destination (Qd) is the country of visitation.

Personalization Ranking

The display area for Personalization Ranking was divided into two parts. Part one is the main box. When a user explores a website to find any travel information, the engine will rank the trip by using reinforcement theory and given data from group

properties, fundamental data that the all user registers such as ages and genders and historical data when visiting the websites.

Part two is the Recommend Box. When a user explores a website to find any travel information, the engine will display trip information randomly at the first visit. After that it will display travel information which has been analysed, and learned from historical user transactions, and trip database. The travel information which is top five ranking will be offered on the web page.

The ranking score is evaluated from the equation:

$$Qr = WtQt + WxpQxp + WmpQmp + WcQc + WdQd$$

The first approach is learning by user behavior. The Q_t , Q_{xp} , Q_{mp} , Q_c and Q_d are calculated by using input data from user transactions on surfing PTS web sites and Q learning equation. W_t , W_{xp} , W_{mp} , W_c , and W_d are weights of each feature obtained from learning. After that the total score (Q_r) is the summation of Q_t , Q_{xp} , Q_{mp} , Q_c and Q_d multiply their corresponded weights. Next Q_r score from each trip is ranked in descending order. The five maximum Q_r scores are selected and recommended for trips to the users on PTS web sites.

For the second approach is learning by group property or clustering users by ages and sex. The ranking of trip provided to users is depended on user profile and user behaviors or web surfing transactions. In this approach users are clustered into group by using age and gender. Then, the value of interesting trip in each group is calculated by using user behavior or transaction on PTS web site. The process of trip ranking in this approach is the same as the above paragraph. The recommended trips are shown in Figure 3. Area number 1 which is in the middle of web page is the main box. Area number 2 which is in the right hand sight is the recommended box.



Figure 3. Travel information provided after learning.

4. EXPERIMENTAL RESULTS

This experiment describes the prototype of the personalization support engine which is implemented for recording, and analysing the user interactions and behaviors. Then this engine presents and recommends interesting trips to user. User profile includes user name, age and gender. The trip list includes Categories (art and culture, diving, shopping, ...and eco tour), Country (Thailand, Nepal, China), Duration (3, 4, 5 days), Minimal Price (400 bahts), and Maximal Price (10000 bahts).

The prototype of the PTS engine implemented in this study include approximately 100 trips. In each transaction, PTS automatically provides five trips in Recommend Box and 10 trips in Main box. In this experiment, there is 115 participants includes 73 males and 35 females. They are undergraduate students in one Thai university.

Table 2. The ranking values of trip calculated by using user transactions as input data of Q-learning equation.

Rank	Trip Name	Qt	Qmp	Qxp	Qc	Qd	Qr
1	Thai Gulf-Koh Tao-Koh Nang Yuan-Chumphon	0.410	0.100	0.522	0.001	0.410	1.421
2	Rafting Kheng River-Kang Song Waterfall-Pitsanulok	0.001	0.410	0.522	0.100	0.410	1.398
3	Mo Koh Surin	0.190	0.100	0.522	0.100	0.410	1.300
4	Discovery Pattaya Package (3D2N)	0.001	0.410	0.522	0.001	0.410	1.299
5	Wonderful Thai: Similan Island	0.190	0.100	0.522	0.001	0.410	1.201
6	Mae Sot Package 3 days 2 nights	0.001	0.100	0.522	0.001	0.410	1.001
7	Loei Package 3 days 2 nights	0.001	0.100	0.522	0.001	0.410	1.001
8	Kanchanaburi Night Safari Tour 2 days	0.001	0.100	0.522	0.001	0.410	1.001
9	Kanchanaburi Good Health 2days	0.001	0.100	0.522	0.001	0.410	1.001
10	Rafting Hin Peang, Winery, Water fall	0.001	0.001	0.522	0.100	0.410	0.990

Table 2 shows PTS analysis for one user. After learning from user transactions by using Q learning, value of trip features are as follows. The first rank ID 43: Thai Gulf-Koh Tao-Koh Nang Yuan-Chumphon which its Duration 4 days is 0.410, Minimal Price 4,500 bahts is 0.100, Maximal Price 4,500 bahts is 0.522, Categories: Beach Holiday is 0.001 and Country: Thailand is 0.410. Total value is 1.421. This trip will be recommended to user firstly.

Users have accessed PST at least two times, given the time different from the first and second access is at least 24 hours. Weights of five features have been calculated from user behaviors and trip profile on PST. Results show that trip destination feature has maximum weight (0.27). The second largest is trip minimum price weight (0.23). The third one is trip maximum price weight (0.19). The fourth is trip category weight (0.19). Lastly, trip duration weight is about 0.14. Then all feature weights have been assembled in the following equation.

$$Qr = 0.14Qt + 0.19Qxp + 0.23Qmp + 0.17Qc + 0.27Qd$$

Evaluation of System Effectiveness

The purpose of this evaluation is to test the performance of the personalization support engine. In this study, we used precision recall and harmonic mean to estimate the system effectiveness. Precision is the ratio of interested trips over the total number of recommended trips. Precision is calculated by dividing the number of trips that users click on the personalization engine by the number of recommended trips. While, recall is the ratio of trip interested users over the total number of clicked trips. Recall is calculated by dividing number of recommended trips by number of clicked trips in user's transaction. Finally, $F1$ is also used to represent the effects of combining precision and

recall via the harmonic mean (*FI*) function. *FI* is calculated from the product of two multiplied by precision and recall then divided by the sum of precision and recall. *FI* assumes a high value only when precision and recall are both high.

Table 3. Average precision and recall of click recommended trips by user before and after system learning

	Unlearn	After learning
Precision	0.34	0.50
Recall	0.50	0.65
F1	0.40	0.57

Accordingly, Table 3 depicts the effectiveness of the engine by comparing precision, recall and *FI* values evaluated from user click stream before and after learning. The precision is 0.34 for the unlearned system (first access). After twenty four hours the system has been learned by using Q learning, then users access PTS for the second time. The precision for the second access has been increased to 0.50 (about 47.06%). This pattern is the same for recall (0.50 for first access and 0.65 for second access) and harmonic mean values (0.40 for first access and 0.57 for second access). Thus, the growth rate for both precision and recall increase about 47% and 30%, respectively.

As well, Srikumar (2004) studied on personalized product selection of user behaviors on the Internet. System performance has been evaluated by using recall which is about 0.64. The recall for Srikumar's system is close to PTS's which is about 0.65. Unfortunately, the former study used only one dimension measurement, recall. So it can not conclude that among the two studies which personalisation systems has better performance in terms of both precisions and recalls.

5. CONCLUSIONS

In this study, the personalized support system that recommends trips for tourists based on user behaviors and group properties has been proposed. The system starts learning from user profile, trip database and user historical transactions in accessing PTS web sites. The learning process is using a Q-learning equation which is based on the reinforcement theory. The main concept of the system is that users can surf on the PTS web site to find out interesting trips. Then the top five trips are suggested for users after all candidate trips are ranked in terms of multiple criteria, these trips may be dynamically changed according to user behavior on PTS sites. Results show that both precision and recall of the system had been improved after the system had learned from user transactions and databases. With recommended trips based on significant data of user surfing

and profile, it has the potential to increase the success rate of product promotion, and user acceptance.

Focusing on user's interest gives the satisfied results since the information offered to the users is based on historical data and statistical analysis. The advantages of Reinforcement Learning Algorithm is due to its simplicity, quickness and easy to implement. Since there is no need to find the best travel list but it provides the most appropriate information at the current time. Comparing to the traditional manual system which takes longer time and needs a lot of user supports.

This prototype can be applied to business intelligent agent for an e-Commerce. This agent can recommend interesting trips to target users by personalized marketing for new trip or product promotions. Enterprises can use this personalized or one to one marketing to increase numbers of sales and services growth through this channel.

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