Chapter 17

WEB PERSONALIZATION BASED ON USER'S TRADE-OFFS

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Abstract. Current e-commerce personalization schemes do not take into account e-shoppers' decision-making processes. Such schemes are typically driven by information from customers' previous preferences or those of their peers. They do not employ any technique to understand how customers value (or perceive the value of) different product characteristics and use it in the personalization scheme. This paper discusses the use of economic theory on utility choices to unveil the e-shopper's decision-making process and employ them to search for products and services with greater chances of being purchased. A methodology is suggested as well as its potential benefits to users and companies. Mainly, the approach has the potential to increase customer satisfaction, site revisits and sales. Additionally, the methodology provides the company with information on customers' choice behaviour that can be used to improve businesses systems (e.g., product design, marketing).

Key words: Personalization, decision-making, discrete choice modeling, knowledge modeling

1. INTRODUCTION

Companies and individuals can benefit from the Internet as a market place. On one side companies can reach and target each customer individually, on the other the easy access to information allows e-shoppers to compare product characteristics from different brands in different online stores without too much effort.

Typically, information about products and suppliers can be accessed from database servers using either list browsing or key word search. However, the amount of information available on the Internet has

substantially increased the cognitive effort for e-shoppers to choose the best option. Browsing large lists, arranged in tree-like structures can be time consuming, while key word search often results in too many items being returned (or none). Thus, instead of facilitating the choice (and the sale), the Internet makes the customer's choice decision-making process more difficult. This might even cause users to abandon the website without buying anything. This is a crucial aspect for e-commerce companies where the customer's needs should be addressed with the best online option, in order to increase revenues, service level and customer's satisfaction.

Personalization is an approach that aims at reducing the amount of information shown to the user in an e-session by taking into account individual characteristics. E-commerce recommender systems (such as Ardissono and Godoy, 2000; Domingue et al., 2002, Kanjas, 2002) address the personalization issue by filtering the amount of non-requested products shown to the e-shopper in a given session. The filtering can be performed using statistical, machine learning, and knowledge-based methods.

Recommender systems are useful when customers do not know exactly what product or service they need, or when the company wants to introduce different products to the user. However, when customers roughly know their needs and the type of product or service to address those needs, the problem is to *find the best available online option*. In this case, recommender systems appear to be of no help. As a comparison, in a physical store, the shopper would be able to use other senses (vision, touch, smell) to recognize available products and compare them before choosing one, or even ask a sales person for advice. On the Internet however, they have to rely on their decision-making skills and the available information to choose the best option.

Given the challenge faced by personalization methods, incorporating an approach that helps e-shoppers to quickly find what they want presents potential benefits to the e-tailor and its customer. For instance, users will tend to revisit the site more often, increasing the chances of sales, as they are satisfied with the level of the online service.

This paper proposes the use of the economic theory on discrete choices (Ben-Akiva and Lerman, 1985) to help shoppers with their choice decision-making process when buying online. Our approach is to refine the search for products and services using the parameters the e-shopper would use in his or her choice decision-making process. We will use the information on what customers want and how they decide between available options to search for the best option. This methodology has been used in the transportation field to forecast travel demand (De Carvalho, 1998; Fowkes, 2001).

This paper is organized as follows. Section 1 presents the motivation for the research; Section 2 describes methods for personalization of web sites.

Then, in Section 3 the proposed methodology is presented. Section 4 discusses the proposed approach's benefits and drawbacks, followed by a conclusion.

2. RELATED WORK

Personalization on web sites is concerned with schemes that select the type and quantity of content that is shown to the e-user, according to the user's profile (Miyahara & Okamoto, 1997). Mainly, they show products and services the user did not ask for, hoping that some of them will catch the users' attention. The main filtering techniques are content-based and collaborative.

Content-based filtering makes recommendations based on comparisons between resources and the user's profile. Results retrieved are based on their similarity to what the e-shopper has previously shown interest.

Collaborative filtering works by showing products or services that are recommended or used by the e-shoppers' peers. One way of accomplishing collaborative filtering is through clustering techniques that group users with similar characteristics and interests.

2.1 Knowledge-based recommendation

Kanjas (2002) describes a range of filtering approaches in intelligent filtering and recommender systems, and also a comparison between the different methodologies. In this paper we will be interested in knowledge-based recommender systems, namely ontology and case based, because they seem to be the perfect host for our approach.

Case-based recommender systems use case-based reasoning (CBR) to make recommendations. CBR uses a knowledge base composed of cases and the methodology consists of finding a previous case that is similar to the new one.

A special application of a knowledge-based recommender system that uses CBR is Dublet (Hurley and Wilson, 2001). It recommends apartments for rental in Dublin, Ireland, based on a description of the user's preferences. Dublet employs information extraction to create cases dynamically by extracting information from the web of apartments for rent and retrieves units that match the user's preference. Dublet performs knowledge synthesis (creation) and extends the power of knowledge distribution of the CBR system by being operational in cell phones.

Ontology-based recommendation systems use ontologies for representing knowledge related to online shopping. An ontology (Gruber, 1993) is an

explicit representation of a view of a domain of discourse (a conceptualisation) usually composed of a set of concepts and relationships. An ontology is usually composed of human-readable text describing a set of terms and formal axioms that constrain the interpretation and well-formed use of these terms¹. Alice (Domingue et al., 2002) is an example of an ontology-based recommender system.

Ontologies describing customers, products, typical shopping tasks and the external context form the basis for the Alice architecture. Ontologies are instantiated as they are linked to the company's databases. The approach in this paper can be used to define slots in the customer ontology (about the customer's evaluation of the product attributes), and in the product ontology (to indicate the range of attributes users might be interested in evaluating, as well as, the way they evaluate them).

An advantage of using ontology is that the coded semantic information can be reused across a variety of applications. For example, those ontologies can be reused to develop decision support systems for companies adopting the personalization methodology suggested in this paper.

3. PROPOSED APPROACH

We propose a personalization approach that is based on the economic utility theory on consumer behavior. The theory provides a means to map the likely implicit choice decision process performed by the consumer when buying a product or service and is based on the following assumptions.

- Products or services are viewed by customers as a vector of characteristics, such as cost, brand, also defined as attributes.
- Customers are optimizers and they compare options based on the value of their attributes.
- Customers make trade-offs between attributes of a product/service to reach their decision. For example, in a transport service, a less comfort can be accepted if the fare is reduced.
- Customers are *maximizers* and they always choose the best-perceived option within a knowledge domain.

The term choice refers to the cognitive process by a consumer who, after evaluating the alternatives in a choice set, decides to select one of them (Louviere, 1988). Discrete choice data reports the values of the attributes characterizing alternative options in a choice set, and the individuals' choices. The main feature of discrete choice data is that the observed response (i.e. the dependent variable) is discrete: we only observe whether or not the customers choose one alternative option.

3.1 Discrete Choice Data Survey

Stated Preference (SP) is a technique used to collect discrete choice data (Pearmain and Kroes, 1990). This can be understood as a simulation game where individuals are asked to state their preferences for a set of possible options (i.e. choice set). A choice set is composed of at least two alternatives (represented by the values of their characteristics, or attributes). For instance, a trip can be characterized by the attributes: cost and in-vehicle travel time. A choice set would consider the transportation modes car and train, each mode being represented by its cost and the travel time.

The design of an SP experiment must consider that the respondents will have to make trade-offs between attributes of the product or service. For example, less travel comfort is acceptable if there is price compensation. Discrete Choice Modeling is the methodology to find those trade-offs for each individual.

Note that to develop a SP experiment we do not need to know exactly which options are available and their exact attribute values. However, it is considered that respondents should be given choice sets with possible options, and use attribute values as close to reality as possible. The knowledge base will support the development of the SP design on the fly. Customers' stated preference data are used to calibrate a mathematical model to unveil the parameters that e-shoppers would use to evaluate and choose one online option.

3.2 Modeling Approach

Discrete choice modeling (Ben-Akiva & Lerman, 1985) allows one to examine the influence that various factors (or attributes) have on the choices people make. Given the modeling assumptions from the economic theory, discrete choice data can be analysed using Logit modeling approach.

Logit models assume that there is an underlying unobserved variable (β_j) which determines the individual's choice. This then, is modeled as a function (U_j) of observed characteristics (X_{ij}) and a random term (ϵ) to account for the unknown influences on the customer choice (See Equation 1). Logit is a mathematical model that employs exponential behavior to explain predicted probabilities (P_i) of a particular response ("buy" or "not buy") regarding an alternative "i" (See Equation 2) belonging to the choice set with "J" options. Thus, the choice likelihood of an alternative is expressed as a function of its attributes and the other options available in the choice set. An optimization procedure such as Newton-Raphson (Ben-Akiva & Lerman, 1985) is employed to estimate the coefficients (β) on the observed characteristics (X_{ij}) in the Utility function (U_j).

$$U_i = f(\beta_j X_{ij}, \varepsilon) \quad (1)$$

$$P_i = \frac{e^{U_i}}{\sum_j e^{U_j}} \quad (2)$$

3.2.1 Analysing the results from Discrete Choice Modeling

An analyst usually evaluates results from the calibration. However, in case of e-commerce, there is the need to perform this task every time an e-shopper is online. To overcome this, case-based reasoning methodology can be employed.

A case-based reasoning system will be used to classify calibration processes, determining whether the results from the SP data are adequate. CBR implements classification via the k-nearest neighbour case-based classifier. It determines the class of a new case as a function of its k most similar cases from its case base. Aha (1998) describes CBR systems as implementing lazy problem-solving, a demand-driven method that performs inexpensive and accurate classification tasks that involve a large number of feature subsets, by omitting the training that decreases the speed of alternate methods. Accordingly, with a memory of calibration processes and their respective classifications, the system can immediately determine whether the process is complete or not (in which case, more data is required and the calibration re-run).

3.3 Framework

We have set the theory to build a refined personalization system that links customers hidden preferences for a product or service and the options available on the Internet. The aim of the system is to reduce the cognitive effort posed to the customer in his or her choice decision-making process given the amount of information available on the web and use the collected data to better satisfy this customer.

The implementation of the proposed approach requires specific data on the customer's choice decision-making process. The data will be obtained from an interactive SP game. The discrete choice data is then used to calibrate a Logit model that will reveal the trade-offs the user employed in his or her choice decision-making process. Calibration results (i.e. weights)

are evaluated using an expert system (rule or case based) while the user is online.

Afterwards, accepted weights are employed to rebuild the customer's utility function for the particular product or service. Then, the task of the web service provider is to search the Internet for the available products or services and calculate their utility values. Those with highest utility are then shown to the e-shopper. Besides helping to identify suitable options for the e-shopper, the personalization based on discrete choice modeling also give companies clues about how to better characterize their products or services according to their customers' information needs.

This approach can be used not only as a stand-alone tool to help anonymous customers with their shopping tasks, but also as a refinement for a personalization system the company uses. A suggested architecture for a knowledge-based application is featured in Figure 1.

Figure 1 - Personalization system suggested architecture

The suggested approach is a knowledge-based personalization system. The system is based on ontologies containing the company's knowledge about its customers, products, etc. E-shoppers' preferences obtained from the SP game are uncovered by using the mathematical module, which contains the discrete choice modeling approach. The outputs from a Mathematical Module are used to improve the knowledge base. A product ontology would contain the knowledge about products such as price, brand as well as the likely customer's decision process when buying it (type of reasoning, utility function, main attributes considered in the decision-making). Current e-business standards (Dörr et. al., 2001) can be used as the base for this ontology, but additions should be made to incorporate attributes relating to the customer decision-making process.

We are illustrating our idea with an online car rental service pictured on a *shopbot* webpage (Figure 2). *Shopbot* is an e-commerce portal where users have access to different web service providers (i.e. companies) and can compare their offers as well as buy them. In the web site the e-shopper begins the search process filling a form with some parameters (e.g., car size,

pick-up day, pick-up location). Those parameters are used to search the server database for available options. Quite often the search is unsuccessful at the first time. There are different reasons for that; the specific supplier may not have branches on the pick-up location, or the requested car size is not available. Eventually, the user has to change the search parameters a couple of times in order to find an offer.

Figure 2 – Online car rental Shopbots

When finally the user manages to find some offers, s/he has to reason and decide for one of them or none. It might be the case that by evaluating the choices available, the user considers that all offers are overpriced compared to the prices of the cars and decide not to buy the service. Therefore, instead of hiring a car, the individual might decide to use local public transport, or a taxi service⁸.

From the car-rental company viewpoint, it is a lost sale. If only the car-rental company knew how individuals evaluate the different attributes of the service (car rental), they would try to show alternative options from the customer perspective. Maybe showing an offer with a better car would give the correct balance between the price of the car and the rental value.

We are assuming that the user evaluates the car rental options considering the price of the vehicle being hired and alternative ways of transport (such as public transport and taxi). Other decision models for this

⁸ Decision processes vary according to the individual and the situation. If the individual is shopping for a company, the decision model might be different.

service would consider car-size within an acceptable price-range. In the car rental business, companies are often bounded to specific carmakers. Therefore, they also have tied prices and conditions down. A web portal offering such services would benefit from our approach by considering the customer's decision-making attributes to evaluate all choices available before showing the best ones to the customer.

4. DISCUSSION

Current personalization schemes are mainly focused on delivering contents, which are either similar to the users' profiles or that are recommended by their peers. Information on e-shoppers (e.g., history, profile) is used to feed the personalization scheme. These schemes do not address ways to improve the company's decision strategies (such as product design), or how it could help the e-shopper's choice decision-making process. Helping the e-shopper in this decisive moment can increase the company's sales. That is often a tactic used in physical stores where the sales person has a decisive impact on the choice.

The implications of not having such personalization approach are the customers' increasing level of dissatisfaction with online shopping causing companies to lose sales and still missing the opportunity of gathering fundamental customer information to run the business.

This paper proposes a theoretical approach of how the problem could be tackled by using customers' choice decision-making process in a personalization scheme. We have based our methodology on the economic theory of customer behaviour and the possibility of getting interactive data on customers stated preference.

The methodology discussed in this paper has the potential to improve substantially the relevance of the results shown to the e-shopper in an e-commerce session. The proposed approach has advantages over current Internet personalization schemes. The first advantage concerns to help the e-shopper in his or her choice decision-making process. It makes a previous evaluation of the alternatives using the parameters the e-shopper would. The benefits of this approach reduce the time the e-shopper is online trying to find suitable offers and evaluating them. The reach of search would be enlarged. The evaluation of the alternatives based on the utility function might prompt advantageous options that the e-shopper would not consider otherwise. We believe that this system would have the potential to reduce disappointments with online shopping. Using the approach shown in this paper it is possible to know the trade-offs individuals make between the characteristics of a product or service and use that to find options that best

suits the e-shopper. Options would be shown on the bases of the likelihood of being chosen.

The second advantage will benefit the companies' decision process without any additional cost. Online companies will be able to know how much the e-shopper would pay for a slightly different product, such as a roomier seat in an airplane or a car with side airbags or all wheel drive. Usually, the information on customers gathered over the Internet is mostly used to feed the Internet personalization system. With our approach it can be used to give substantial insight on the way customers evaluate different characteristics of products and services. Companies can use this information to design their product so as to better target their customer's needs.

However, using the approach presented in this paper may present some challenges. The approach main input is data from an interactive SP game that demands customers' time. Customers have to be convinced that providing answers to the interactive game will give them a better service. An easy-of-use interface can help to overcome this problem by reducing the cognitive effort needed for the task. As an example, an adaptation of the Shneiderman's work on Dynamic Queries (Williamson & Shneiderman, 1992) could be employed.

Additionally, there are situations where the cost-benefit of employing the methodology may vary. First, the customer may not be interested in wasting time to take part in a SP game that evaluates low priced products or services. Second, the company could employ this methodology only to the most profitable or high priced 20% products, which often represents approximately 80% of the company's profit.

Furthermore, to implement the personalization based on discrete choice modeling, companies first need to investigate the usual ways their customers decide buying their products or services, what sort of decision process they perform, which attributes and variables they consider, etc. Consequently, additional research on product specific choice decision-models can be developed in order to fully implement the methodology.

5. CONCLUSION

This paper discusses a methodology that uses economic theory on discrete choices to link e-shoppers' decision-making process to available options. The main input to the proposed methodology is the discrete choice data, which will be collected from an interactive Stated Preference "game" that the e-shopper agrees to participate. The data is then used to calibrate a Logit model that will reveal the trade-offs the e-shopper employed in his or her choice decision-making process. Afterwards, these results are employed

to search for the available options and calculate their values as the customer would. Options with high value utility are then shown to the e-shopper.

The benefits of using the methodology are twofold: it has the potential to increase customer satisfaction and therefore the likelihood of sales and revisits; the information on customer's trade-offs gives the company insights of how to improve the business (such as product design, promotion, forecasting).

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