Web Metrics – Design Specifications of Web-based System for Personalization with "Bifurcation"

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ABSTRACT: This paper describes a personalization system aiming a t one-to-one marketing with the ability to support real-time identification, selection, and content creation where the interaction is performed on a web-based e-commerce platform. The personalization system is capable of controlling and presenting the web site in different shapes to different consumers – controlled bifurcation. When combined with the tracking of the visitor's site movements, detailed consumer behavior patterns can be established.

One important means has been to create a system that can later on be used in consumer behavior research. The bifurcation capability means that the system can be used to test the impact of different layouts of the web site – or of different sales offerings – in the same way direct marketing methods work. This system will be able to present different layouts of the site or offerings to randomized groups of visitors. Their responses, in the form of movements within the site, purchase frequencies, etc., can then be measured by the system.

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INTRODUCTION

The Internet's capacity to manage large quantities of information and the potential to establish interactive communication between a selling and a buying part makes it an interesting channel for trading consumer goods. The introduction of the Internet as a channel for transactions of products and services has made the concept of mass customization an actual topic.

The one-to-one marketing potential is particularly in focus in the debate. Peppers and Rogers describe one-to-one marketing in the following way: "The one-to-one future will be characterized by customized production, individually addressable media, and one-to-one marketing, totally changing the rules of business competition and growth." [1].

Today, little is known about what generates customer interest and how the consumer behaves in the e-commerce environment. To establish knowledge in the field, market research conducted by means of Internet technology that can track user behavior can be an efficient method.

In this paper the technical principles for an e-retailing system capable of one-to-one marketing is described. The paper is a further development of earlier research within the field [2].

The case study is an independent sporting goods retailer in Stockholm, Sweden, with no prior activities on the Internet before the time of this study.

OBJECTIVE

The objective of this paper is to describe the design of a personalization system aimed at one-to-one marketing, i.e., a system with the following capabilities:

- Adapting information according to the user's preferences and characteristics

- Presenting the information in real-time in a web-based e-retailing environment

- Evaluating the behavior of the user

Another objective is to describe the creation of a function in the personalization system that can be used in consumer behavior research: bifurcation. The bifurcation capability means that the system will be

able to present two different layouts of the site (e.g., different products, prices, design, etc.) to two different groups of users.

The differentiation of users can either be controlled or randomized. The users' responses are recorded and measured by the evaluation function. The benefit of the bifurcation function is its ability to test and evaluate the impact of different parameter settings.

The process of building the personalization system can be broken down into the following parts:

- formulating the functional requirements
- designing and constructing the system
- evaluating and testing the system

Limitations

The evaluation part of the system is described in a conceptual manner and not in detail. No test runs or trials are accounted for in this paper but will be addressed in further research.

BACKGROUND

The theoretical point of departure for this paper is a model formulated by Peppers, Rogers and Dorf [3], who propose four key implementation tasks that can be used as guides for launching a one-to-one initiative: *identify*, *differentiate*, *interact* and *customize*.

By storing all available consumer data in personal profiles it is possible to direct individual offerings to each customer based on their earlier generated profiles. This process is called personalization. Personalization can be described as "the computer-supported process of adapting an information flow and it's presentation in real time according to each consumer's characteristics or predetermined preferences" [4]. This process involves all steps in the one-to-one marketing model: identifying the visitor, finding his individual profile, differentiating based on prior interactions, and finally, customizing according to the profile.

The one-to-one marketing model has been implemented in the personalization system with the following functions:

IDENTIFY

The objective of the identifying system is to recognize a visitor and recall his behavior and purchases – without threatening his need for integrity.

DIFFERENTIATE

The central idea behind the system is to differentiate the product offerings according to the visitor's previously indicated preferences.

INTERACT

The intention is to make a system that is easily orientated.

CUSTOMIZE

The main objective of the system is to facilitate the presentation of advertisements and offerings - adapted to the visitor's profile – and to measure what impact this can have on sales.

Buyer behavior and relationship categories

When deciding how to implement these steps, it is important to consider the product category and consumer behavior when buying the product. Central to this is recognizing the possibility that identifying a visitor can vary according to the product category. Gummesson's 30R [5] can be used to identify three possible relationships between a company and consumer. Each presents the consumer with three different opportunities to identify himself.

- R1 – the classical relation. This scenario is valid in many instances. Here the visitor is generally unwilling to identify himself and offer personal information in the early stage of the buying process. Therefore, a request for personal data can cause the visitor to leave the site (see for instance Judson, 1996) [6].

- R10 – the monopoly relation. This relation is characteristic of banking and health-care sectors. The customer knows that he must identify himself in the form of a security number, account number, or name and password combination, in order to reach the company's services.

- R11 – the member relation. A good example of this type of relationship is a book club, which is based on a system of

motivating the visitor to identify himself by offering benefits or incentives.

The system described in this paper will deal with the first type of relationship.

Involvement and problem solving

Howard (1994) [7] differentiated between different buyer behavior depending on the importance of the purchase and the buyer's knowledge about the product category, characterized by extensive (EPS), limited (LPS) or routine problem solving (RPS). Sports items mainly belong to the EPS (expensive bicycles and skis) or LPS category. This means a visitor will sometimes search for information simply because he wants to increase his knowledge of a product; he will not necessarily buy what he has looked at.

The personalization system is designed to handle such irregularities by separating the profiles into two categories: browse (exposure) and purchase. In this way, the system has the capability to control its behavior accordingly.

Habitual buying and taste

Assael (1987) [8] distinguished between four kinds of buying behavior, depending on the degree of involvement and perceived difference between brands. For some product categories, such as books and music, habitual or variety-seeking buying behavior makes it possible to predict what a visitor is likely to buy. For instance, can the taste for baroque music, thrillers or memoirs be enduring? In such cases, methods such a collaborative filtering [9] could be a working means. However, the buying behavior associated with sports products makes it difficult to gauge a visitor's interests in new product. For example, does the purchase of three bicycles during the last year mean that you have all the bicycles you need – or that you are especially focused on bicycles and will continue to buy them?

For product categories where simple answers to such questions cannot be expected, the purchase history of products cannot be used for the real-time differentiation algorithms. Instead, an alternative method is to use value-carrying categories associated with the items. The personalization system described in this paper uses the following five criteria:

1. Strength of brand (judged strong, medium or weak)

2. Price and quality level (high, medium or low)

3. Fashion and actuality level (high or low)

4. Suitability of a certain sex (male, female, unknown)

5. Suitability for a certain age (child, junior, senior, unknown)

The classification of products is done manually one-by-one in the administrative interface. The differentiation function then creates and updates a visitor's profile each time he buys or looks at a product based on that product's specific value-carrying categories. In other words, i f you look at an expensive item, your profile is updated to show some interest in more expensive articles. In this way, the customer's selection of products with their inherent values is interpreted as a reflection of the customer's preferred personal values.

PERSONALIZATION METHODS

To carry out the personalization function, many different methods and technologies can be used. The basics steps are to have the system identify the user and adapt information according to the user's characteristics or predetermined preferences [4].

The first step in identifying the user can be performed in two ways. One way is to have the user identify himself by username and password. Another way involves using cookies [10] to obtain the user's identity when he does not actively identify himself. A cookie is a file is written to the user's computer with a unique identification number. However, a drawback with cookies is that a user can choose to disable other systems from placing cookies; in this case, the identification fails.

Second, to adapt the information (including differentiation) it is recommended that a web-site incorporates dynamic publishing tools (e.g., DHTML [11], etc.). A dynamic environment makes it possible to create individual content. To facilitate the personalization, a user management function is preferable, e.g., Microsoft's Membership function in Site Server [12]. To control the dynamic content according to the individual user's preferences or characteristics, rules (or business rules) [13] can be used. The rules are incorporated into the web-site, preferably within the dynamic content creation mechanisms, e.g., ASP

[14]. The business rules can be based on formal logic and use information from the user (actions taken by the user at the time they were taken, IP-number, browser etc.) and stored information about the user. Business rules can be either static or self-learning (adaptive). Self-learning can entail having the system save information about the user and change its behavior based on the user's actions. More sophisticated versions of self-learning are artificial neural networks [15], that can establish patterns and help predict a user's behavior.

Third, the collection of information about the user's actions needs to be stored and analyzed. The analysis can cover a broad scope ranging anywhere from simple statistical analysis to more advanced analytical methods. To analyze vast amounts of data (which can often happen when dealing with personalization), tools in the areas of data mining and on-line analytical processing (OLAP) [16] can be used to establish patterns or profiles of the user.

Some examples of major suppliers of personalization business systems are: Microsoft (Site Server 3.0 Commerce Edition) [12], ATG (Dynamo 4.5) [17], and BroadVision (One-To-One Retail Commerce) [18].

The personalization system described in this paper uses rules to perform personalization and has the capability to save the user's actions and adapt the information accordingly on his next visit.

FUNCTIONAL REQUIREMENTS

The functional requirements for the personalization system are divided into two different categories: 1) basic functionality, e.g., the functionality of a web-based e-commerce site to handle tangible products aimed at the consumer market, and 2) functionality for personalization and bifurcation.

Basic functionality requirements:
- A functioning e-commerce system with a web-based product presentation, shopping cart, user registration, order handling, and administration. No requirements for handling payments, logistics or integration with other business systems are needed.

Personalization functionality requirements:
- Automatic identification and differentiation of users.

- The ability to present personalized information to the users. The content presentation and creation must be on an individual basis. The information to be personalized consists of: offerings (ad-like images), sorting, and listing of product presentations. The personalization needs only to be of implicit character.

- The capability to divide the users into different control groups, each of which receives different personalization.

- The capability to analyze the behavior of a single user or any chosen group of users.

- The ability to collect information on each user and visit in order to analyze behavioral patterns:

  web pages visited and point of time

  time spent on a single web page

  total time spent on the site

  which web page the user viewed previously

  purchases made (purchase amount, type and quantity of items) and point of time

  response to offerings

 which control group best categorizes the user

Capacity:

Because the system is a prototype, no special consideration has been taken regarding the capacity or scalability issue.

SYSTEM DESIGN AND CONSTRUCTION

The system is constructed as a three tier system (figure 1) with a web browser acting as the User Layer. The Application Layer (or business layer) consists of applications written in Java running on JRun [19]). A SQL relational database system (SyBase [20]) acts as the Database Layer.

The system is run on a single PC (Pentium 300 MHz, 196 MB internal memory) with Windows NT and Microsoft Internet Information Server 4.0. NT SAM is used for user verification and authentication.

User Layer	Application Layer	Database Layer
Client side ←→ (Web browser)	System logic ←→ (Java)	Storage (Sybase)

←→   ←→
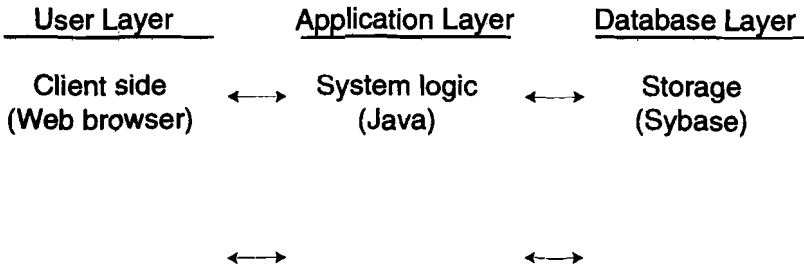
Figure 1. 3-tier model

Overview

The system consists of the following parts (figure 2):

1. User and Product Profiles

2. Bifurcation function

3. Personalization platform

4. Shopping function

5. Evaluation function
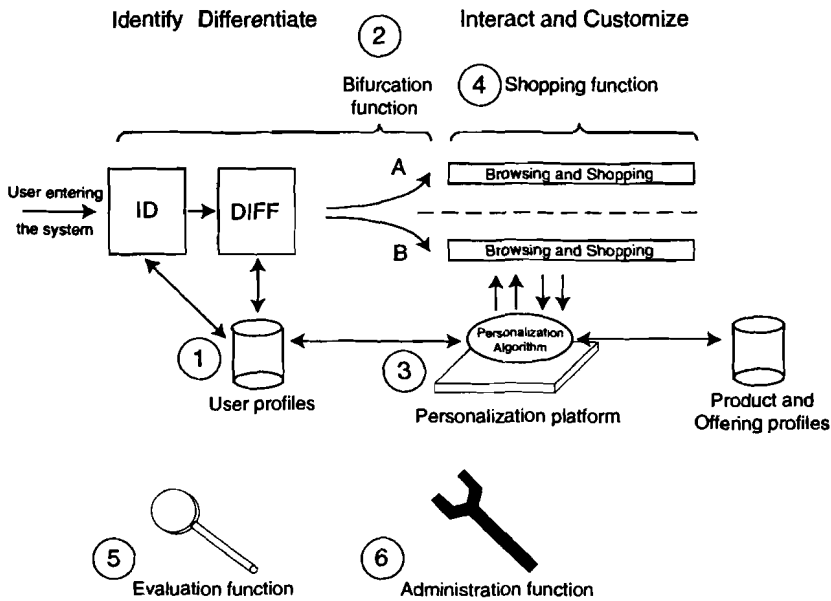
6. Administration function

Figure 2. System overview

Process

1. Identification. The system uses cookies [10] and the User Profiles for identifying the user.

2. Differentiation and Bifurcation. The Bifurcation function divides the users into two different control groups; each receives two different versions of personalization (content). The Bifurcation function can only differentiate users according to their prior control group affiliation.

3. The personalization platform uses a matching algorithm for finding the most suitable products and offerings.

4. Browsing and Shopping. The user browses the products and perhaps makes a purchase.

5. Evaluation function. Automatically measures click frequencies and total amount purchased by each bifurcation group.

6. The administrator uses the Administration function to change system content and parameters or to access the Evaluation function.

User and Product Profiles

The system uses profiles for both the users and the products. The profile represents either the user's preferences or the product's characteristics [21]. The profiles consist of different categories, with one or more sub categories. The representation of the categories is numerical parameters ranging from zero to one.

The sum of a category is always one (compare with probabilities).

Five types of profiles are used. The numbers in the picture below are samples.

The categories defining the profiles, i.e., brand, price, news, sex, and age, were chosen after a careful category management analysis. These were determined to carry the most value in the sporting goods segment. To make the implementation of the personalization function platform manageable, we chose to use a maximum of four sub categories. Other product or service segments will imply other profile building categories.

A division of exposure and purchase profiles was made in order to differentiate between browsing (exposure) and purchasing. This differentiation is useful in order to achieve different results of the personalization function.

Product profiles

I. Product Profile

Describes the characteristics of a product.

Product profile

Brand			Price			News		Sex			Age			
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown
1	0	0	0	1	0	0	1	0	0	1	0	1	0	0

Figure 3. Product Profile

II. Offering Profile

Describes the characteristics of an offering.

Offering profile

Brand			Price			News		Sex			Age			
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Figure 4. Offering Profile

III. Exposure Profile

This profile consists of the accumulated data from the product profiles that the user had chosen plus accumulated visits and page impressions (the number of single products the user had been exposed to). The profile does not consist of any purchase data.

Exposure profile

Brand			Price			News		Sex			Age				Visits	Total hits
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown		
0.61	0.22	0.17	0.23	0.12	0.65	0.36	0.64	0.25	0	0.75	0.1	0.56	0.08	0.26	23	562

Figure 5. Exposure Profile

IV. Purchase Profile

This profile consists of the accumulated data from the product profiles of affected purchases, the number of purchase occasions, and the total value of the purchase.

Purchase profile

Brand			Price			News		Sex			Age				Purchas	Amount
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown		
0.8	0.08	0.12	0.52	0.3	0.18	0.6	0.4	0.5	0	0.5	0	0.6	0	0.4	5	1 250

Figure 6. Purchase Profile

V. Search Profile

This profile is used to find an offering or to sort the presentation of product offerings.

The search profile is created from the Exposure profile and the Purchase profile.

Search profile

Brand			Price			News		Sex			Age			
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown
0.70	0.15	0.15	0.38	0.20	0.42	0.48	0.52	0.38	0.00	0.62	0.05	0.58	0.04	0.33

Figure 7. Search Profile

The profile is used by the personalization algorithm to find the most suitable offerings and sort the products.

The search profile creation algorithm:

If user is known: fetch user's Exposure (EP) and Purchase Profile (PuP) and compute Search Profile (SP):

$$EP \bullet w_1 + PuP \bullet w_2 = SP$$

w_1 and w_2 are parameters set by the administrator.

Otherwise: set Search Profile to generic (GP)

SP = GP

Updating procedure

Updating of the profiles is triggered either by a purchase or by the ttl-function (will be explained later). New values of the profiles are calculated and stored in the User Profile.

First, a calculation takes place of all (i = 1 to n, n = total number of exposures or purchases in the session) the session's Exposure Profiles (EP_i) and Purchase Profiles (PuP_i). A summation of the profiles of the exposed products goes into a new Exposure Profile ($EP_{session}$). The same goes for eventual purchases.

$EP_{session} = \Sigma(EP_i)/n$

$PuP_{session} = \Sigma(PuP_i)/n$

Second, the old Exposure and Purchase Profiles in the User Profiles are updated with weighting parameters.

$EP_{new} = EP_{old} \bullet w_3 + EP_{session} \bullet w_4$

$PuP_{new} = PuP_{old} \bullet w_5 + PuP_{session} \bullet w_6$

w_3, w_4, w_5, and w_6 are parameters set by the administrator.

Bifurcation function

The bifurcation capability means that the system will be able to present two different shapings of the site (e.g. different products, prices, design etc.) to two different groups of users. The differentiation of users can be controlled or randomized. The users' responses are recorded and measured by the Evaluation function. The benefit of using bifurcation is its ability to test and evaluate the impact of different parameter settings. Figure 8.

The system tries to identify and collect as much information about the user as possible. The system asks for and sets cookies. The present design of the system is such that it only actively uses cookies. Information such as IP-number, operating system, browser version, etc., are not taken into consideration, but could be saved in the log file for evaluation purposes.

The bifurcation function uses two separate views or presentations of the web site: A and B. These can have different parameter settings or present different product offerings. The distribution of the two alternatives can be presented to the population in variable steps, i.e., 50% to each group or 1 to 10 between the two population groups. It is also possible to use this function to randomly select participants for a market research study.

The bifurcation function controls the division of the users into two different groups who will receive different offerings and personalization. The division is controlled by a probability factor, whereby the bifurcation designates a user a group affiliation. The group belonging to A is $P(A)$, with the equivalent for B. $P(A)$ is controlled via the system parameter interface and the probability for B is $P(B) = 1 - P(A)$. The default setting for $P(A)$ is 1. The bifurcation uses a start and stop date code for an alternative setting of the probability $P(A)=P(A_{alternative})$ in conjunction with another date code, "Prior belonging", that tells the bifurcation which date range to use if there is prior user group affiliation.

"Prior belonging" is used to choose whether the bifurcation function should take the user's old (if any) group affiliation into consideration when the user enters the system a second (third, etc.) time.

If on or within the date range, bifurcation uses the customer database to set the proper group settings.

If outside of the date range, bifurcation treats the user as a new user.

The bifurcation function supports three different situations of personalization: entry offering, category offering, and product sorting, which are duplicated with different settings for the different groups. Two sets of parameters are used: one for test group A and one for test group B. The total number of purchases and exposures are measured for test group A and B separately and presented in a web interface.
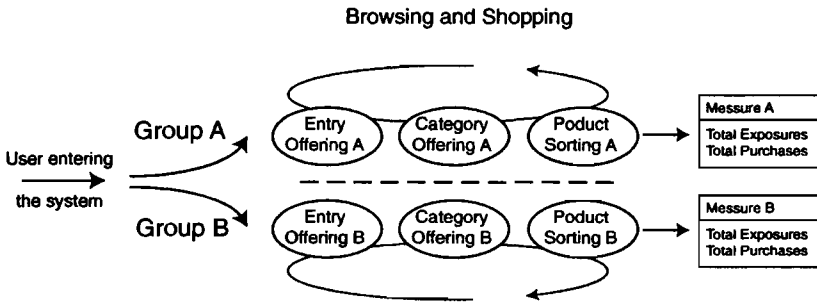
Browsing and Shopping

Figure 8. Bifurcation

Personalization Platform

The Personalization system platform consists of an exchangeable profile-matching algorithm that is used for presenting offerings and product listings to the user. The principle of the personalization system is to compare the user's Search Profile with the Product Profiles (or Offering Profiles) to find the optimal product.

The user browses the products and receives offerings according to their individual preference profile. Three different types of browsing situations can occur where the personalization is used:

1. Entry offering. The personalization is used to find the best offering according to the algorithm in use. The Search Profile is compared and matched to the Offering Profiles.

2. The user chooses a category. The same procedure as the Entry offering takes place with the difference being that the user's action is taken into consideration. The user has chosen an explicit category.

3. The user chooses to look at specific products. The products are sorted and listed according to the personalization algorithm in use.

Personalization Algorithm

The Search Profile is used to find an offering or to sort the presentation of product offerings. Adjustable parameters are used to set the discrimination levels for the profile criteria. Shown in the following example:

1. Brand, discrimination level any (High, Medium or Low) = 0,6. In the example, a High Brand offering would be chosen, because 0,71 ≥ 0,6.

2. Price, discrimination level any (High or Low) = 0,5.

3. No special price level will be crucial because all price subcategories are less than 0,5.

4. News, discrimination level High = 0,3. A High News offering will be chosen because 0,48 ≥ 0,3.

Search profile

Brand ①			Price ②			News ③		Sex			Age			
High	Medium	Low	High	Medium	Low	High	Low	Male	Female	Unknown	Child	Junior	Senior	Unknown
0.71	0.15	0.15	0.38	0.21	0.42	0.48	0.52	0.38	0.00	0.63	0.05	0.58	0.04	0.33

Figure 9. Example of Search Profile

In this example, the algorithm will present an offering based on High Brand and High News. The system will choose offerings randomly based on price.

The offering database can contain 18 different offerings (figure 10) when looking at the Brand, Price and News levels. The offering database can also contain more offerings, those directed to Sex or Age, which will only be used when the personal profile indicates a certain interest in a specific sex or age category.
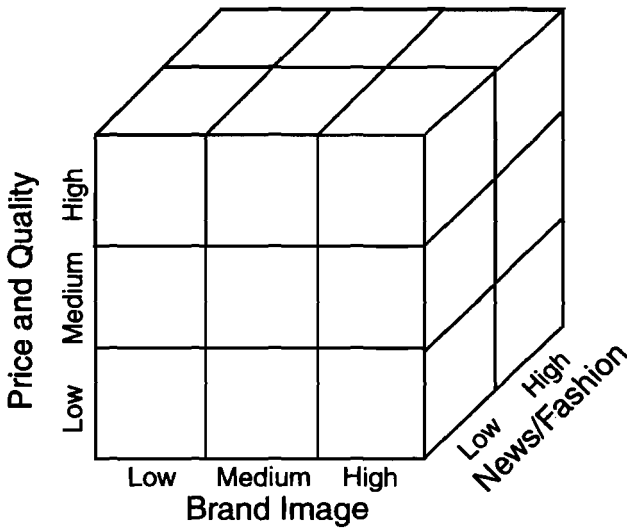
Figure 10. Offering categories

The personalization algorithms are written in Java. The replacement of the algorithm has to be done by reprogramming. Self-adaptive parameter settings will be implemented during the future development of the system (see section 8).

Shopping Function

The personalization system uses a traditional shopping cart function.

The user browses the products and offerings in the system and the user can choose to browse products by category or to use a free text search on product name, article number, or product description.

The procedure for purchasing is as follows:

1. The user proceeds to the check out.

2. The user is asked to either log on with user name and password or to register as a new user.

3. New users are asked for name, address, email, etc.

4. The user gets a summation of the products, quantity ordered, price, freight cost and total cost with an opportunity to change the quantities.

5. The user verifies and approves the order.

6. The system verifies the user's credit limit.

7. The user gets a" thank you and welcome back" message.

8. An email is sent to the system's order administrator, notifying them that an order has been placed.

Evaluation Function

In its current state, the evaluation module of the personalization system is limited to measuring click frequencies and the total amount bought in the different bifurcation groups. In future implementations, a standardized OLAP-tool will be used to create reports using both real-time and post-time data from the web server, application server, and the database server.

Administration Function

The Administration function consists of web-based interfaces for administrating orders, products, users, etc., and supportive algorithms.

Supportive Algorithms

"Time-to-live" limit (ttl_p) for user profilesDue to finite memory capacity, it is necessary to put a "time-to-live" limit on user profiles to eliminate inactive profiles.

Erase user profile from database if:

User profile time inactive $\geq ttl_p$

Update trigger

A timer measures the inactivity of the user and decides whether the user has left the system.

Triggering events:

Completed purchase

The session's inactive "time-to-live" limit expires; inactivity $\geq ttl_{update}$

CONCLUSION AND DISCUSSION

The personalization system has two features that makes it suitable for personalization: 1) a flexible platform for interchangeable personalization algorithms and 2) a tool for testing hypothesis by the use of control groups (bifurcation).

A starting point in the design-work process of the personalization system has been to build the system on an open platform. We felt this was necessary in order to integrate new functions into the system in the future and so not to influence or inhibit our objectives based on the restrictions of an existing system. The functions can consist of modules that integrate the personalization system with mercantile support systems, e.g., point-of-sale systems, etc. The functions can also consist of different personalization algorithms adequate for different situations. The functionality of bifurcation is developed as a tool to make research efficient not only in the field of Internet marketing, but also to determine which type of algorithms supporting the system are the most suitable.

FUTURE WORK

The bifurcation capability, in combination with the possibility to change parameter settings in the administrative interface, will be used in future research to investigate questions such as:

- Do personalized offers give better responses than non-personalized offers?

- Are the optimal value-carrying criteria chosen?

- Which parameter settings work best?

One important question is how to weigh the influence of "what you are looking at" in relation to "what you buy". To handle this, the weighed factors can be modified through the administrative interface. One problem is that a visitor's movements on the site can be given several interpretations. For example: 1) Interest in purchasing the article in question. 2) Building knowledge about a product category before purchase (EPS in the Howard model). 3) Seeking knowledge and confirmation after a purchase (dissonance-reducing buyer behavior in the Assael model)

For a visitor that often buys from articles he has browsed earlier, the weighed factor for the exposure profile when creating the search profile should be rather high. For other visitors this weight would be much less. This indicates that a function that can create individual search profile weight parameters and also store and update these parameters in the personal profiles should be developed.

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