Examining the Validity of the Banner Recommendation System

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Abstract. The phenomenon of banner blindness has concerned researchers, advertisers and website publishers during these years. In order to alleviate the phenomenon, this study attempted to develop a banner recommendation system which could arrange banners according the relative salience of keywords on a webpage viewed by a user. The prototypical system are being developed, however, we have made an initial examination on the effectiveness of its banner recommendation functionality. It was found that two recommendation accuracies for the system calculated with two different criteria both were significantly higher than the probability by chance.

Keywords: Banner blindness · Recommendation system · Eye tracking approach

1 Introduction

Currently, the Internet is one of the key channels for advertisements. However, researchers, advertisers and website publishers have observed that web users would intentionally ignore web advertisements and even some of editorial components that resemble online advertisement in shape, without determining the editorial component's content. This phenomenon is referred to as "banner blindness" [1–4]. Researchers and relevant practitioners are generally concerned that the long-term continuation of the status quo would substantially reduce the effectiveness of Internet advertisement communication and hinder efficient market operations. In recent years, numerous studies have examined the causes of banner blindness to identify an effective advertising method for communicating with consumers.

Previous studies have reported that Internet advertisements are ignored because Internet users demonstrate high goal- and task-oriented characteristics. In contrast to traditional media, Internet users often employ the Internet media for completing a specific task. In these circumstances, Internet advertisements frequently interfere with the ongoing work of the users, causing advertising irritation and avoidance [5–8]. Internet users eventually develop a habit of simply ignoring online advertisements. These findings further solidify the importance of personalized advertisements. We assert that if advertisements are arranged based on the current objective or needs of web users, advertisements are likely to provide users with a utility that yields additional benefits. Long-term application of this strategy may gradually reverse the banner

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blindness phenomenon and entice users to pay attention to and understand the messages conveyed in the advertisements.

Personalized advertising has been an attractive concept; however, developing such a system is extremely complex [9]. The first challenge is determining how to automatically detect the purpose, needs, and preferences of browsers and use these data as a basis for advertisement arrangements. This study proposed a solution approach by employing an eye tracker for observing browser's viewing behavior on webpages, and thereby enabling the system to analyze the preferences of browsers as well as to recommend relevant advertisements to be presented to them based on the results of the analyses. The reason for applying the eye tracker is that the eye-tracker has been considered a precision apparatus which can provide real-time and fine-grained eye movement data for investigating underlying cognitive processes [10–16].

In this study, we developed an advertisement recommendation system based on the concept described previously. Furthermore, we conducted an experiment for verifying the accuracy of the advertisements recommended by the system. In the subsequent sections, we discuss our theoretical basis, experimental procedures, and experimental findings.

2 Literature

2.1 Personalization

Personalization has been an important and appealing idea in the development of information systems. Personalization emphasizes that the information systems is capable of adjusting its functionality, screen layout, and content…etc. According users' needs and preferences [17, 18]. Based on the idea, researchers and practitioners have developed various kinds of personalized services on the Internet. For example, Liu etc. [19] developed a news recommendation system, which could recommend readers the news which they might be interested in. Davidson etc. [20] developed a video recommendation system on YouTube, which could suggest users videos that are worth watching. The production recommendation system, which can suggest the productions buyers might like, has been common on todays' shopping sites, such as Amazon and e-bay. However, one general challenge such recommendation systems face is that how to infer users' needs and preferences. Therefore, efforts many researchers have been devoted are to find out potential meanings from traces which users leave when they browse websites.

One general method for inferring user's interests is through analyzing the characteristics of the content of webpages which an user has viewed. The approach is termed the content-based prediction, assuming that the content itself can manifest the interests of users. The approach has been further developed to a collaborative method, which takes into consideration the content which other people have viewed [17, 21].

Another approach for inferring user's interests is through analyzing users' behaviors of using webpages. When viewing webpages, users' explicit and implicit activities can be logged. The explicit activities are users' responses to a questionnaire about "like" or "unlike". The implicit activities includes the duration of viewing a webpage,

scrolling down, zoom in and out, click, etc. [18, 21–25]. Although the explicit activities can be the most immediate relevant to users' interests, they could put much loading on users, thus making it unfeasible. In practice, the usage of the implicit response is more feasible. In this study, the eye tracking technology is applied to capture users' ocular activities, which can be considered as a kind of implicit activity.

2.2 Eye-Tracking Technology

During recent years, the eye-tracking technology has become feasible in our daily life, for example, Semsung S4 smart mobile phone has been equipped the eye-tracking technology using the camera embedded on the mobile phone. This provides several interesting applications, such as detect whether a user is looking at the screen in order to decide whether to continue playing a movie. Similar low-cost and effective eye tracking technologies have been developed with the webcam mounted on the desktop and laptop.

In general, the eye-tracking technology can provide real-time data about a variety of eye-movements, such as the location of eye fixation, the duration of eye fixation, and the pupil size of eye fixation. For the development of personalization system, the eye movement data is valuable in two ways. Firstly, the eye fixation can infer what an individual is processing in his/her working memory. According to the eye-mind assumption of Just and Carpenter [14, 26], what an individual is looking at is what s/he is processing. Their assumption has been supported by following research particularly in the field of reading [15, 16, 27]. In a broader sense, the location of fixation also manifests where an individual gets interested in. In addition, the fluctuation of pupil size is an immediate sensitive index about the arousal state of individuals and reflects individual's preference [28, 29]. Secondly, when viewing a webpage, the eyes generally keep capturing the information on the webpage, even when mouse and keyboard activities are stopped. Therefore, this study considers that the eye movement has a great potential to become an important implicit behavioral cue other than click to improve the prediction of users' needs and preferences. This study contributes to lead a better personalization.

3 Experiment

3.1 Participants

We recruited 56 college and graduate students at National Chi-Nan University, Taiwan, aged between 18 and 25, who voluntarily agreed to participate in this study as our formal study participants. After the experiments were completed, each participant received NT$150 as a reward. In addition, prior to the formal experiments, additional eight participants participated in a pilot test to determine necessary improvements for the system and the experiment process.

3.2 Stimulus

The experimental stimulus was an article that introduces the functions of three brands of digital cameras: Apple, Nokia, and Canon. In this article, the number of times that the three brand names appeared in the article is identical. We presented the contents of this article on six linked subsequent web pages. Regarding the design of web page layout, except for the first Web page that comprised only the main editorial area, web pages 2 to 6 contained an advertisement banner above the main editorial area (Fig. 1).

Fig. 1. The left picture illustrates the layout of the webpage first viewed by the participant, and the right illustrates the layout of the remaining experimental webpages.

3.3 Experimental System and Eye Tracker

We integrated the experimental system with the EyeLink II eye tracker function. The system features a web browsing function and can simultaneously analyze the number of fixations on the three brand names on the web pages. Second, when the participants want to browse the next web page, the experimental system identifies the brand name that received the most fixation points and places the advertisement banner corresponding to this brand on the next web page. Finally, the system records the advertisements that were recommended to each participant.

The EyeLink II is manufactured by SR Research and has an eye sampling rate of 5000 Hz/s. This system has high accuracy, an average gaze position error of $< 0.5°$, and can provide real-time sampling data at a data latency of only 3 ms.

3.4 Questionnaire

In order to estimate the accuracy rates of advertisement recommendation for the experimental system, we designed the following two questions as comparison criteria and asked the participants to answer them after the experiment. Question 1 pertains to subjective experience with the allocation of fixations: “When you were browsing the web pages, the Apple, Nokia, and Canon brands appeared in the pages. Which of these brands did you pay more attention to?” Question 2 pertains to prior brand preferences:

"Among the Apple, Nokia, and Canon brands, which on were you more interested in before you browsed the web pages?"

3.5 Experimental Procedure

Only one participant engaged in the experiment at a time. Before the experiment commenced, a brief description of the purpose and procedure of the experiment was presented to the participants and their questions about the experiment were answered. First, the laboratory assistant placed the headband of the eye tracker on the head of the participant and calibrated the eye tracker accordingly. The entire 5–10 min. The laboratory assistant then give the task instruction to the participant as follows: "Imagine that you wish to purchase a digital camera on the Internet and found an online article that introduces the functions for three brands of cameras. You are about to begin reading the Web pages that you found." The experiment program was then activated, and the participant began reading the Web pages and had to click the "next page" link to read the next page. After all of the Web pages were read, the laboratory assistant assisted the participant with removing the headband of the eye tracker and asked the participant to answer the questionnaire. Subsequently, the reward was given and the purpose of the study was explained to the participant.

4 Data Analyses

Data were collected from a total of 56 participants after the experiment. First, we examined the eye movement data for each participant. If the eye movement data deviation was exceedingly large and could not be calibrated, we deleted the data of this participant. After this process was completed, data from a total of 44 participants were valid for subsequent analyses.

Next, we calculated the system advertisement recommendation hit ratio based on the participants' responses to the questions regarding subjective experience with the allocation of fixations and prior brand preferences. The attained hit ratios was used as an accuracy indicator. The method by which hit ratio was calculated is explained as follows using the prior brand preferences as an example. During the experiment process, the experimental system recommended five advertisements to each participant. If a participant answered "Apple" on the prior brand preferences question, the recommendation correctness was defined as 1, 0.5, and 0 if the system recommended the Apple advertisement three times or more, two times, and one or zero times, respectively. Eventually, we derived the average accuracy for the 44 valid experiments to represent the accuracy of the advertisement recommendation for the experimental system. This method is similar to using a confusion matrix for calculating the hit ratio [30, 31].

The final results obtained are as follows: (a) The recommendation accuracy for the experimental system was 0.488 according to the participants' response to the questionnaire about subjective experience with the allocation of fixations. (b) The recommendation accuracy for the experimental system was 0.443 according to the participants' response to the questionnaire about prior brand preferences. Both of the accuracy were significantly higher than the probability of (1/3) * 1.25 = 0.41 by chance.

5 Discussion and Conclusion

Based on the rationale that people's preference can be manifested in their viewing, this study analyzed participant's fixation on the brand keywords on the web pages to infer participant's current brand preference while viewing the web pages, and used this inference as a basis for recommending web advertisement in a real-time manner. The results of this study indicated that the advertisement recommendation accuracy of the experimental system was significantly higher than that by chance. Therefore, we suggest that this method can serve as a basis for further developing an advertisement personalization system in the future. Several directions are suggested for future research. First, future studies can attempt using other machine-learning methods, such as the neural network, for analyzing the viewing behavior of web page to gain better prediction to user's preference. Second, an instant feedback mechanism can be developed for determining whether recommended advertisements satisfy user's current preference, and the results can serve as a reference for tuning the recommendation system.

This study has several limitations that must be addressed: First, this study only used one scenario (purchasing a camera) to validate the performance of the recommendation system. Second, we did not examine whether the recommended advertisements attract user's attention. Future research can address with the issue on the effectiveness of the recommended advertisements.

5.1 Limitation and Future Research

When interpreting the results, the reader should be aware of certain limitations. First, the layout of the experiment follows the typical webpage design, however, it has a little limitation in ecological validity. Second, in order to increase the ecological validity of our experiment, the brands used in this study, such as, Apple, Nokia, and Canon, are real in our daily life. The reader should be aware of that the manipulation would introduce some unexpected confounding factors into our findings. Thirdly, in the experiment, the eyetracker was mounted on the head of the participants. The participants would have some uncomfortable sensations in their head especially when they took a longer time to finish the experiment. This fatigue factor might confound the experiment results. In future research, we suggest the researchers to replace the mounted tracker with the remote eyetracker, which can be mounted under the screen, in order to decrease the loading of experimental participants. Finally, future research

might develop other index on ocular behavior to validate the effectiveness of the recommendation system. In addition, the triangular validation can be applied to examine the developed ocular index with other traditional advertising measurements.

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