An Empirical Study on the Influence of Personalized Recommendation for Internet Users

Chi-Hyon Oh†, Katsuhiro Honda†† Akira Notsu†† and Hidetomo Ichihashi††

† Osaka University of Economics and Law, 6-10 Gakuonji, Yao, Osaka, JAPAN
†† Osaka Prefecture University, 1-1 Gakuen-cho, Nakaku, Sakai, Osaka, JAPAN

Summary
Personalized recommendation is a powerful approach for reducing information overload in Internet surfing and is also useful for avoiding unbalanced situations in network communities when we consider not only the best choice but also the second and possibly the third choices. This paper presents an empirical study on the influence of recommendation style in Internet surfing. The results imply that users can be induced to select alternative choices only after reliable recommendations are provided.

Key words:
Personalized recommendation, Internet surfing, User preference, Alternative choice.

1. Introduction

Personalized recommendation, such as collaborative filtering [1-3], is a powerful approach for reducing information overload and is achieved by filtering information overflows considering user preferences [4,5]. However, the best-choice-only strategy may concentrate only on a specific site if user preferences are heavily biased. In this case, this strategy can cause unbalanced situations (or bottleneck problems) in network communities. To achieve universal content creation and distribution [6], network communities can maintain stable conditions without unbalancing or bottleneck problems by offering alternative choices that contribute to both user satisfaction and network stability [7].

In this paper, an empirical study on the influence of recommendation styles in Internet surfing is presented. Although alternative choices are useful for both network users and network managers, users may not select alternative recommendations that seem unreliable. In a comparative experiment, the influence of personalized recommendation is compared in several situations.

The remaining parts of this paper are organized as follows. Section 2 reviews the experimental design in this study. The results of the comparative experiment and a discussion are shown in Section 3. Section 4 gives the conclusions.

Manuscript received November 15, 2010
Manuscript revised November 20, 2010

2. Experimental Design

This study considers the Internet surfing situation in which users select web contents by referring only to the title tags of web pages. Recommendations by the web browsing system are presented by displaying the titles emphatically in red colors. The goal is to compare the level of influence of the recommendations in several situations.

The experiment consists of two stages and was conducted by using implemental software constructed in Java language. The details of the stages are shown in the following subsections.

2.1 Stage 1: Input of User Profiles

In the first stage, users were required to fill in their profiles, including user-ID and preference ranking of personal interests. In this experiment, web pages were categorized into six categories: *baseball*, *soccer*, *gourmet*, *standardized test*, *game*, and *movie*. Each user ranks the six categories and a web page recommendation is performed based on the preference ranking. Figure 1 shows a screenshot of the input interface.

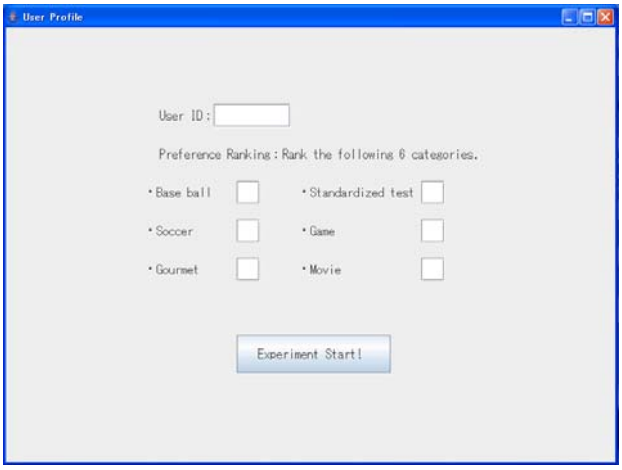

Fig. 1 Screenshot of user profile input interface.

In this experiment, all instructions were presented in the Japanese language and Japanese web pages were used, although all instructions are shown in English in the sample screenshots.

2.2 Stage 2: Web page surfing

In the second stage, users perform web page surfing and access logs are stored. For each category, 15 web pages were collected beforehand, and users selected a web page by referring to the titles.

This stage consists of three phases. In the first phase, users select web pages without recommendations. In the second and third phases, they can depend on recommendations based on different methods of web page filtering. In each phase, the title tags of 30 web pages, consisting of 5 pages for each category (5 pages/category × 6 categories = 30 pages), are displayed and users are required to view approximately 5 pages in 15 minutes. The implemental software stores the logs of the web pages viewed and the length of time the user viewed each page.

2.2.1 Phase 1: Web page surfing without recommendations

In the first phase, users perform web page surfing without recommendations. They can refer only to the title tags of web pages. Figure 2 shows the web page selection interface, where the remaining time (seconds) is presented above the buttons for web page selection.

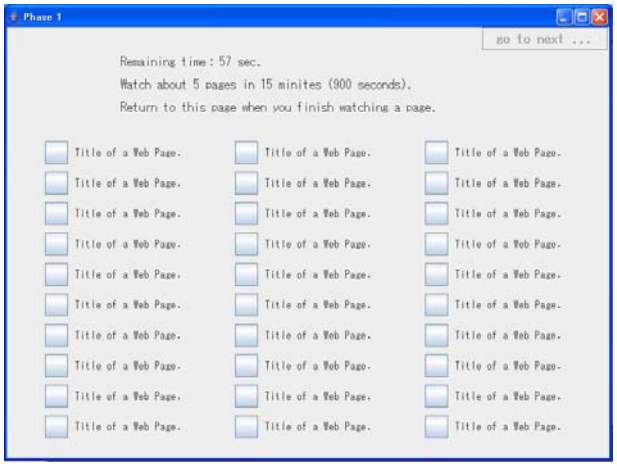

Fig. 2 Web page selection interface without recommendations.

When a user clicks a button to select a particular web page, another window is displayed with its web content. Figure 3 shows a sample of a display window. This display also includes information of the remaining time but has no link to other pages. The user can view other pages only after closing the window by clicking the “Return” button to go back to the page for web page selection. Using this interface, the implemental software can store the exact periods of time that the user views a web page.

Fig. 3 A sample of a web content display.

2.2.2 Phases 2 and 3: Web page surfing with recommendations

In the second and third phases, some web pages are recommended by displaying their titles emphatically in red colors. Figure 4 shows an example of this web page selection interface.

Fig. 4 Web page selection interface with recommendations.

The recommendation methods are classified into two patterns. In the first pattern, a personalized recommendation is correctly performed by recommending the most applicable web pages belonging to the category

that the user selected as the preferred category. However, in the second pattern, randomly selected web pages are recommended to compare the level of influence of the alternative choices with that of the best choice.

By using the implemental software, the two recommendation patterns were implemented in two test cases. In the first case, the best-choice web pages for the user's preferred category were recommended first (phase 2) and then a random recommendation was suggested (phase 3). In the second case, a random recommendation was suggested first (phase 2) and then the best-choice web pages for the user's preferred category were recommended (phase 3). Each of the two cases was randomly presented. Therefore, approximately half of the users were presented with the first case while the remaining users were presented with the second case.

3. Results of the Experiment

This section presents the results of the comparative experiment, in which the number of participants was 94 (students from two universities in Osaka, Japan). Each participant performed web page surfing for 45 minutes, during which the three phases of 15 minutes each were implemented. All of the participants web surfed without recommendations (phase 1) for the first 15 minutes. For the next 30 minutes, 40 participants web surfed according to the first case (best-choice first), while the remaining 54 participants web surfed according to the second case (random-choice first).

3.1 Influence of a Good Recommendation

Table 1 shows the comparative results of the page frequencies ("Freq." (number of times)) and the viewing times ("Time" (sec.)) in the preferred category with/without a recommendation. In this table, "all" means the average values of all 94 participants, "case 1" shows the average values of the 40 participants who saw the best-choice category recommendation first, and "case 2" shows the average values of the 54 participants who saw the best-choice category recommendation second, after the random recommendation.

The table shows that the frequencies and viewing times of the preferred category slightly increases in case 1 but slightly decreases in case 2. So, this table implies that the participants are definitely influenced by the recommendation when a good recommendation is first provided (case 1), whereas they are less influenced when a good recommendation is provided after a random recommendation (case 2).

Table 1 Comparison of page selection frequencies and viewing times of web pages of preferred category with/without a best-choice category recommendation

	without recommendation		with recommendation	
	Freq.	Time	Freq.	Time
all	2.71	239.5	2.62	220.7
case 1	2.78	242.6	3.10	234.7
case 2	2.67	237.2	2.24	209.6

However, neither group of participants was much influenced by the recommendation. This may be because the participants were able to search for their preferable web pages even when they had no additional information, such as a category recommendation, i.e., the title tags included sufficient information about the web pages.

3.2 Influence of a Random Recommendation

Next, the level of influence of the alternative recommendation is compared. Table 2 shows the comparative results of the page frequencies and viewing times in the random recommendation. In the table, the frequencies and viewing times of "the recommended web pages" and "the web pages of the preferred category" (whose web pages were not recommended by the system)" are compared.

Table 2 Comparison of page selection frequencies and viewing times of recommended web pages and non-recommended preferred category with random recommendation

	recommended web pages		web pages of preferred category	
	Freq.	Time	Freq.	Time
all	2.27	192.5	2.61	187.1
case 1	2.95	232.7	2.85	183.3
case 2	1.78	163.4	2.24	189.8

The table implies that, if a reliable recommendation is presented first (case 1), an alternative recommendation (not the preferred category recommendation) can raise the frequencies and viewing times of web pages even when the pages are randomly selected. However, if an unreliable recommendation is presented first (case 2), in which random web pages are first recommended, the participants are only slightly induced to view the web pages.

3.3 Discussion

The above results give us some implementation strategies for inducing users to select alternative choices**.**

- If users have enough information about the contents of web pages, they are not as influenced by good recommendations (best web page recommendations) because they can select preferable pages without recommendations (Table 1).
- Users can be induced to select alternative choices if they rely on recommendations (Table 2, case 1), but unreliable recommendations do not induce users to select alternative choices (Table 2, case 2).
- Recommendation systems should provide appropriate recommendations to users in order to remain reliable even if the users are not much influenced by the recommendations. If recommendation systems can successfully remain reliable, they have the possibility of inducing users to select alternative choices and to avoid unbalanced situations.

4. Conclusions

This paper presented an empirical study on the influence of recommendation styles in Internet surfing with the goal of finding an effective way to operate recommendation systems in which user induction can contribute to both raising the user satisfaction levels and keeping a stable network community.

The experimental results implied that continuous presentation of good recommendations makes it possible to offer reliable recommendations, i.e., recommendation systems can achieve successful inducement accepting alternative choices only when they keep their recommendations reliable.

Future work includes implementation of this study's findings into recommendation software [5] or network simulators [7] that can analyze the stability of network communities.

Acknowledgments

This work was funded in part by the Ministry of Internal Affairs and Communications, Japan, under the Strategic Information and Communications R&D Promotion Programme (SCOPE).

References

[1] J. L. Herlocker, J. A. Konstan, A. Borchers and J. Riedl: An algorithmic framework for performing collaborative filtering, Proc. of Conference on Research and Development in Information Retrieval, 1999.

[2] J. A. Konstan, B. N. Miller, D. Maltz, J. L. Herlocker, L. R. Gardon and J. Riedl: Grouplens: applying collaborative filtering to usenet news, Communications of the ACM, vol.40, no.3, pp.77-87, 1997.

[3] J. L. Herlocker, J. A. Konstan, A. Borchers and J.Riedl: An algorithmic framework for performing collaborative filtering, Proc. of Conference on Research and Development in Information Retrieval, 1999.

[4] K. Honda, N. Sugiura, H. Ichihashi and S. Araki: Collaborative filtering using principal component analysis and fuzzy clustering; Web Intelligence: Research and Development, Lecture Notes in Artificial Intelligence 2198, Springer, pp.394-402, 2001.

[5] K. Honda, A. Notsu and H. Ichihashi: Collaborative filtering by sequential extraction of user-item clusters based on structural balancing approach, Proc. of 2009 IEEE International Conference on Fuzzy Systems, pp.1540-1545, 2009.

[6] Ubiquitous Network Society (UNS) Strategic Program of the Ministry of Internal Affairs and Communications, Japan, available from:
http:// www.soumu.go.jp/joho_tsusin/eng/features/r_d_progrums.pdf

[7] C.-H. Oh, K. Honda and H. Ichihashi: A fuzzy model-based virtual theme park simulator and evaluation of agent action models, International Journal of Computer Science and Network Security, vol.10, no.2, pp.6-11, 2010.

Chi-Hyon Oh received the B.E., M.E., and D.Eng. degrees in industrial engineering from Osaka Prefecture University, Osaka, Japan in 1997, 1999, and 2002, respectively.
From 2002 to 2010, he was an Assistant Professor and Associate Professor at Osaka University of Economics and Law, where he is currently a Professor in the Faculty of Liberal Arts and Sciences. His research interests include multi-agent simulation, fuzzy clustering, and data mining.

Katsuhiro Honda received the B.E., M.E., and D.Eng. degrees in industrial engineering from Osaka Prefecture University, Osaka, Japan in 1997, 1999, and 2004, respectively.
From 1999 to 2009, he was a Research Associate and Assistant Professor at Osaka Prefecture University, where he is currently an Associate Professor in the Department of Computer Sciences and Intelligent Systems. His research interests include hybrid techniques of fuzzy clustering and multivariate analysis, data mining with fuzzy data analysis, and neural networks. He received a paper award and a young investigator award from the Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT) in 2002 and 2005, respectively, and gave a tutorial on “Introduction to Clustering Techniques” at 2004 IEEE Int. Conf. Fuzzy Systems (FUZZ-IEEE 2004).

Akira Notsu received the B.E., M.I., and D. Informatics degrees from Kyoto University in 2000, 2002, and 2005, respectively.
He is currently an Assistant Professor, Department of Computer Sciences and Intelligent Systems, Osaka Prefecture University. His research interests include agent-based social simulation, communication networks, game theory, human-machine interface, and cognitive engineering.

Hidetomo Ichihashi received the B.E. and D.Eng. degrees in industrial engineering from Osaka Prefecture University, Osaka, Japan in 1971 and 1986, respectively.
From 1971 to 1981, he was with the Information System Center of Matsushita Electric Industrial Co., Ltd..
From 1981 to 1993, he was a Research Associate, Assistant Professor, and Associate Professor at Osaka Prefecture University, where he is currently a Professor in the Department of Computer Sciences and Intelligent Systems. His fields of interest are adaptive modeling of GMDH-type neural networks, fuzzy C-means clustering and classifier, data mining with fuzzy data analysis, human-machine interface, and cognitive engineering.