Collaborative Information Gathering in Social Bookmarking Service

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Abstract

The paper discusses mechanisms to foster collaborative information gathering in social bookmarking service and proposes a new mechanism using awareness information. Browsed users function provides awareness information about to whom a user has browsed into the bookmark library and who browsed the user's bookmark library. An experiment has been conducted to evaluate the effect of this function on information gathering behaviors using an experimental social bookmarking site. The result indicates that the effect of awareness information on information discovery is comparable to other fundamental navigation functions of social bookmarking service.

1. Introduction

Collaborative Information Gathering (CIG) is an approach to solve the problem of Internet Information Overload by organizing cooperation among users [23]. It can yield more undiscovered knowledge than single information seekers [3]. A number of researches indicate that the potential resource can be provided through social interaction [9, 10]. It assumes that cooperative information foraging contributes collaboration in the way of information sharing and gathering. The benefit of CIG confirms the success of social bookmarking service for facilitating information discovering in research communities.

Social Bookmarking Service (SBS) is an appropriated social media tool to support information gathering in research process [15] and contribute Research Collaboration Support System [13]. It offers the possibilities of alternative search tool and assists community building in online spaces[12]. Since SBS assists people to gather information among like-minded communities, people can discover whom else links to them when they locate relevant articles in the way of social navigation [18]. This benefit can ultimately lead to colleagues who share research interests and foster like-minded community building. Although SBS presents its benefit for social search, the knowledge of others' activities still needs to extend in order to take advantage of social navigation for individual information gathering propose.

The importance of knowledge of others' activities has been highlighted as the fundamental to the effective collaboration. A definition of knowledge of others' activities is *Awareness*. In CSCW studies, "Awareness is an understanding of the activities of others, which provide a context for your own activity" [6]. In research communities, awareness of who are the people and what are the information that are interesting for the user make the great decisions to find the potential information. Similarly, awareness of others' activities in SBS foster CIG by providing the probability of finding the useful information resources that are not specified before.

There are some studies on providing the knowledge of others' activities [7, 9]. CiteSeer Collaboratory [7] provides awareness about the potential collaborators to users in order to contribute constructing of collaboratory. TopicMark [9] shows another point of view of providing awareness information to the users. It harvests knowledge of user, based on users' preferences, and recommend the specific topic to the users. The results of these studies show the benefit of awareness information for collaboration activity.

The paper describes the design of a new mechanism to foster CIG in SBS by providing awareness information about others' activities. This mechanism differs from the related work since it provides mutual awareness information about browsing behavior. This information eases to interpret; who browsed into the user's library, who has been browsed into his library by the user, and who has mutual interaction with the user by browsing into each other' library.

The paper is organized as follows. Section 2 describes Collaborative Information Gathering in SBS and Section 3 explains awareness information about browsing behavior. Section 4 describes the experiment to evaluate the effect. Section 5 then describes conclusion and future work.

2. Collaborative Information Gathering in Social Bookmarking Service

2.1 Information Gathering Behavior in Social Bookmarking Service

A number of researches studied the users' behaviors for information discovery according to the usage of social navigation [18] and how social navigation can be used to enhance information discovery in SBS [14, 19]. The result of usage pattern analysis [14] shows that tagging system is an effective way for information gathering where users frequently select tags in a bookmark list to find a new bookmark. In addition to navigation through tags, users prefer to explore the bookmark libraries of others to find the related bookmarks around the focused topic and discover frequently bookmarks in the bookmark libraries of the selected users. Users prefer to navigate through others' bookmark libraries to gather the useful information for their interest. Due to the information gathering behavior, SBS should provide the presences of others' activities to the users to facilitate social interaction as well as CIG in online spaces.

2.2. Literature Review on Collaborative Information Gathering

Among the researches on the benefits of CIG for search communities, information foraging theory [2, 3] studies the effect of the diversity of information foragers and their hints to individual seekers and community. Its cooperative information foraging model [20] shows the effect of the diversity of information seekers and their footprints to each other for the optimal and equilibrium group size. People can discover knowledge more quickly and thoroughly by foraging and interacting in the optimal group. The benefits of cooperative information foraging confirm the success of social software that allows groups of people to discuss problems and to discover knowledge at a faster speed than the individual information seeker.

Since interaction is necessary for CIG, a literature on online spaces proposes the important elements for fostering social interaction [16].

(1) *Place making* is the spatial metaphors to frame and interpret social information and exploit spatial properties to guide social interaction in an online space.

(2) *Common ground* refers to share understanding of participants in an online space.

(3) *Awareness* refers to the knowledge of the presence of other people including their interaction and activities.

(4) *Interaction mechanisms* enable participants to communicate with others.

These four elements contribute distributed online work groups. In the context of SBS, the fundamental functions of SBS are elements for fostering social interaction that contributes collaborative information gathering and discovering.

2.3 Fostering Mechanism for Collaborative Information Gathering

Based on the role of the four important elements for fostering social interaction in online spaces [16], we can identify these elements in SBS as shared bookmarks, tagging system, others' activities, and social navigation. A number of social bookmarking tools used in the scientific research communities e.g., CiteULike [4] and Connotea [5] offer the fundamental functions for users to (1) create personal collections of bookmarks and instantly shared their bookmarks with others, (2) use the keyword or tags that are explicitly entered by the user for each bookmark, and (3) access to the entire bookmark collection to see other information resources of interest [18]. These functions foster social interaction in online spaces in the following way.

(1) Shared bookmarks as place making

SBS offers shared bookmarks as the metaphor to frame social information to foster information gathering and discovering to users [17]. Shared bookmarks are not only used to organize and present information for users but also offer the great potential to increase social interaction and foster collaborative activities among users in online spaces.

(2) Tagging system as common ground

Tagging system can be used to provide shared understanding for users in SBS and is a convenient way of navigating one's own bookmark library and determining his characteristic [17, 18]. It can function as common ground in SBS. Newcomers in a like-minded community can understand the special keywords provided as tags and sense about the topics of that community [8].

(3) Others' activities as awareness

Others' activities in SBS can be provided in several ways i.e., posting behaviors or browsing behaviors. Current function of SBS provides information about recent activities [12] for the users to aware of others' posting behavior. Although providing recent activities is a kind of awareness element in SBS to contribute CIG [9, 15], there is another effective way of providing presences of others' activities to users such as awareness information about browsing behavior that is proposed in this paper.

(4) Social navigation as interaction mechanism

Social navigation is one of the efficient ways to enhance information discovery in SBS [18]. Since shared bookmarks can be valuable information for others, individual seekers tend to navigate through others' bookmark libraries to find the new useful

bookmarks. Clicking a tag or a username shows a new bookmark list that might be useful for the user.

Although the general functions of SBS are the elements for fostering social interaction in online spaces in particularly, it is needed to extend awareness element in order to extend the boundary of individual information gathering and contribute CIG in online spaces. Since browsing behavior leaves footprint to a user whom was browsed, it can increase the way of using social navigation, not only from related tags or users in generic SBS but also from the information about browsing behaviors. Providing awareness information about browsing behavior allows individual user to know who interacts with him as well as aware of the like-minded people.

3. Awareness Information about Browsing Behavior

3.1 The Effect of Awareness Information

Awareness is widely applied to increase collaboration opportunities and efficiency in CSCW and CSCL [24]. It is found that information about other's activity is one of the most important factors of successful collaboration. Although SBS provides the fundamental functions for fostering CIG, it still lacks sufficient awareness information about other's browsing behavior [15]. Awareness information about others' activities in current SBS provides information about posting behaviors, which is appeared in Recent Activities function. Researchers need to know who may has the similar research topics by examining the awareness information about their browsing behaviors, which is the information about to whom a user has browsed into the bookmark library and who browsed the user's bookmark library. We named this awareness information about browsing behavior as *Mutual Awareness* information. It is the information about browsing behavior informing to each other. Individual user can know two-way information about who browsed into his library whereas whom was browsed by the use.

3.2 Mutual Awareness about Browsing Behavior

Mutual awareness about browsing behavior is useful for fostering collaborative activities and community building based on the benefit of social interaction, since individual information seekers should aware of other's presence through social interaction in order to form a community. By providing awareness information of browsing behavior in SBS, the user can aware of who may has similar research interest and might browse other's bookmark library through this information. This mechanism extends

the search ability of individual information seekers since that an effective way to discover useful bookmarks coming from exploring others' bookmark libraries.

Figure 1 depicts how mutual awareness about browsing behavior contributes to discovering the useful bookmarks in the way of collaborative activities. The scenario can be separated into 3 phases. Beginning phase starts when user A browsed into user B's library and copied a bookmark in user B's library. By this action, user B can acknowledge that user A browsed into his bookmark library and copied a bookmark. In Intermediate phase, there are 2 types of situations that can occur; (1) user B may want to examine user A's library and browse into user A's library, (2) although user B does not give any response with user A's action, user A still browse into user B's library to monitor for the new bookmarks. These behaviors in the Intermediate phase affect the browsing behaviors in the next Collaboration phase. When user B posts a new bookmark, this action is notified to user A. If the new bookmark is valuable for user A, then it may foster new research and result in a new post of user A, and so on.
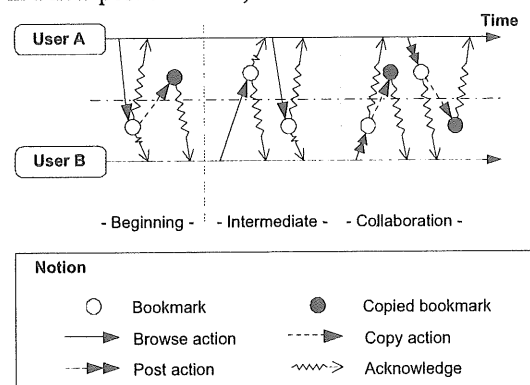

Figure 1. The mutual awareness about browsing behavior for CIG in SBS

A scenario for fostering collaboration in SBS is described as the following three phases in detail.

(1) Finding an interesting user phase

When a user browsed into other's bookmark library, the action is recorded in the top of browsed users list and frequently browsed usernames are displayed in the upper area. A user can find an interesting other user in the browsed users list.

(2) Mutual browsing phase

When a user browsed into other's bookmark library, the action is also recorded in the top of the other's browsed users list and frequently browsed other usernames are displayed in the upper area. The other user can find an interesting user and they start mutual browsing.
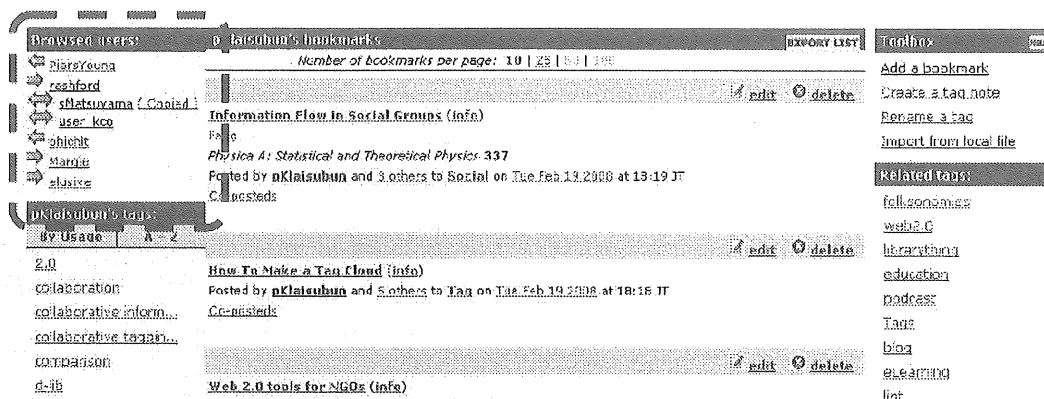
(3) Collaboration phase

Figure 2. Browsed users information in a social bookmarking service

When a user posted a new bookmark, the event is notified to other users who have browsed the posted user's bookmark library. If the new bookmark is valuable for another user, it can foster the other's research and result in posting of a new bookmark from others. The interaction through SBS can encourage collaboration in online space.

3.3 Design of Mutual Awareness Function

A new function to foster CIG in SBS is designed to provide mutual awareness information [15]. The aim of this function is to provide information about browsing behaviors, i.e., whose library is browsed by a user and who browsed into the user's bookmark library. By aware of other's browsing behaviors, users may browse into other's bookmark library that seems to be the like-minded and discover useful bookmarks in other's libraries.

The mutual awareness function can be implemented with the user interface as shown in Figure 2. The Browsed users list appears as a global navigation after logging to SBS. Usernames in the list presents others who have interaction with the user. It is classified into 3 types according to the direction of arrow that represents users' browsing behavior: Forward direction ($\rightarrow$) means user browsed other's library whereas backward direction ($\leftarrow$) means other who browsed into user's library. Mutual direction ($\leftarrow\rightarrow$) is the information about both users browsed mutually into each other library. By clicking a username in this list, user can browse into the library of that username.

4. A Case Study of ReMarkables

4.1 Objective

The development of a prototype Social Bookmarking Site, named *ReMarkables* [11, 22] has been conducted to evaluate the effect of awareness information about browsing behaviors on information discovery in CIG. ReMarkables offers a new function of providing awareness information about browsing behaviors to the users. The effect of providing awareness information about browsing behaviors is measured by the conversion rate for click-through [1] Browsed users list. The conversion rate is classified into 2 actions: (1) the ratio of copying a bookmark from others' bookmark libraries and (2) the ratio of accessing to original resource by clicking a bookmark title.

4.2 Method of Evaluation

We present the empirical study on quantitative and qualitative evaluation for the effect of awareness information about browsing behavior. The behaviors of 21 subjects (12 professional researchers and 9 graduate students) were recorded in the web server logs over the period of two months. The subjects were asked to use *ReMarkables* for their information gathering purpose. The criterion of information discovery in this experiment is either the found user clicked the bookmark title in order to access to the original resource and copied into subject's library.

The effect of awareness information about browsing behaviors is analyzed by comparing click-through and conversion rate for each navigation function including *Mutual Awareness Function*. During the period about 2 months, the users' activities were recorded in the web server logs and database. There were 52,295 bookmarks data that were imported from other SBS for the tags that the subjects have interested in. The analysis of the effect was based on 3,087 users' actions recorded in the ReMarkables database. The navigation functions for information gathering in ReMarkables were classified into 3 types described below.
1. Global Navigation: navigation through main functions of the system.
   - By keyword (*Search*)
   - By frequency (*Popular Links*)

Table 1. Results of Navigation Type

Navigation Type	#Click through	Conversion		Conversion rate	
		#Copy	#Access	%Copy	%Access
Global Navigation					
Search	210	35	138	17%	66%
Popular Links	18	10	5	56%	28%
Recent Activities	33	9	11	27%	33%
Browsed users	*60*	*13*	*20*	*22%*	*33%*
Forward Direction	58	13	20	22%	34%
Backward Direction	2	0	0	0%	0%
Total	321	67	174	21%	54%
Local Navigation					
Users' Tags	37	4	16	11%	43%
Related Tags	55	24	35	44%	64%
Tag used in the bookmarks	75	13	99	17%	132%
Users who posted the bookmarks	13	4	13	31%	100%
Total	180	45	163	25%	91%
Bookmark Links					
Tag	9	3	2	33%	22%
User	7	4	1	57%	14%
Total	16	7	3	44%	19%
Grand Total	**517**	**119**	**340**	**23%**	**66%**

- By time (*Recent Activities*)
- By awareness information (*Browsed Users*)

2. Local Navigation: exploring through a bookmark collection.
- By tags of others (*Users' Tags*)
- By tags used by others (*Related Tags*)
- By Tags describing the bookmarks in the list (*Tag describing these bookmarks*)
- By users who posted bookmarks in the list (*Users who posted these bookmarks*)

3. Bookmark Links: exploring through a bookmark
- By users who posted a bookmark in the list (*Users*)
- By tags used for a bookmark in the list (*Tags*).

4.3 Result of Evaluation

The effect of mutual awareness information on information discovery is evaluated by comparing the conversion rate of click-through Browsed users lists with other navigation functions that are the general functions of the current SBS. The conversion rate provides an estimate of the usefulness of the result of click-through [22] including Browsed user list function. By considering the result of information gathering through Global navigation functions, the conversion rate of accessing to the original resources shows that the ratio of clicking the bookmark titles for click-through Browsed users list (33%) is greater than the existing functions of SBS such Popular Links (28%) and equivalent to Recent Activities (33%). The ratio of clicking the bookmark titles provides the opportunities to discover the valuable information as the consequence. The result shows that

the conversion rate of copying bookmarks for click-through Browsed users list (22%) is equivalent to Popular Links (27%). It implies that the effect of mutual awareness information about browsing behaviors is comparable to other global navigation functions.

In addition to quantitative analysis, qualitative data has been examined by a user survey. Questionnaires for the user survey were asked to the subjects in order to evaluate the validity of the experiment and the function of Browsed users list for their information gathering. We collected users' experiences from 11 subjects (52.4% of the subjects; 5 subjects are professional researchers whereas 6 subjects are graduate students). The result shows that 64% of the subjects agree that using SBS provides the chances to discover the like-minded users and found the useful bookmarks from others' libraries. Concerning with browsing behaviors, 82% of users agree that they browse into others' libraries because their bookmarks are interested. From the validity of providing mechanisms for CIG can be explained as that: 55% of users agree that CIG yield more undiscovered bookmarks than individual information gathering. This result confirms that users prefer to use SBS in order to discover the like-minded people and gather information efficiently from others' bookmark library.

4.3 Discussions

The results of the evaluation show how mutual awareness information foster collaborative activity among uses for their information gathering process. The quantitative result shows the positive effect of

mutual awareness information on information gathering in SBS. The conversion rate for click-through Browsed users list is comparable to the existing functions of current SBS. Although the conversion for click-through Browsed users list with Backward direction shows zero effect, the result does not implies that awareness information about users who browsed the user's library has no effect, because the result of user survey provides another evidence that users prefer to use SBS to discover others who may has similar interested topics. Awareness information about browsing behaviors increases probabilities of finding the potential information to the user. It does not increases the chance of social interaction by clicking the usernames in the Browsed users list, but also provide awareness about the like-minded people to the user. Users who have mutual interaction by browsing each other's bookmark libraries provide benefit (potential information) to each other's. Due to the positive effect of providing mutual awareness information about browsing behaviors, we argue that providing mutual awareness information about browsing behavior is an effective way to support CIG in SBS in the respect of expanding the boundary of gathering information as well as recommend the potential collaborators to the users.

5. Conclusion and Future Work

The paper describes a new mechanism to foster collaborative information gathering in social bookmarking service by providing knowledge of others' activities as mutual awareness information about browsing behavior. The Browsed user list has been implemented in an experimental social bookmarking service *ReMarkables*. The empirical study on the effect of providing mutual awareness information about browsing behavior shows the positive result for Collaborative Information Gathering.

We have interested in the effect of providing awareness information as the hints for information gathering purpose. The future study includes the study of Agent Based Simulation to understand why mutual awareness information about browsing behavior increases the chance of information discovery in social bookmarking service. The experiment on Agent Based Simulation will be conducted

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