Rings: a Visualization Mechanism to Enhance the User Awareness on Social Networks

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Abstract. Users of social network sites, such as Facebook, are becoming increasingly overwhelmed by the growing number of "friends" and the "tsunami" of updates generated by them. It is very easy to miss potentially interesting updates, if one does not frequently check her news feed. Also it is hard to get a sense of which friends are active and especially, which are passive or completely gone. Awareness of friends and friends' activities, or the lack of them, is important to build trusted social networks. However, the current social network sites provide very limited cues to support these two kinds of awareness.
This paper proposes a method to visualize the activity level of friends. It creates a time- and an activity-pattern awareness for the user, as well as an awareness of the lurkers. It also offers options to filter activity streams regarding particular time periods and friends.

1 Introduction

Social Network Sites (SNS) have experienced an explosive growth in recent years. There are more than 874 million active users on Facebook as of September, 30 2013 of which 727 million login daily[3]. A large proportion of these users share updates of their status with friends, including messages about their thoughts, their current location, links to interesting articles or videos, statements of activities (e.g. they have befriended other users, or the messages generated as a side effect of playing games). Such status updates will be called "social data" in this paper. A large amount of social data is generated every day, which triggers an information overload for users. For example, the average user on Facebook has 130 friends, but teenagers have more than 300[4]. These friends normally generate

[3] http://newsroom.fb.com/Key-Facts
[4] http://expandedramblings.com/index.php/by-the-numbers-17-amazing-facebook-stats/#.Uq4yaGRDtF8

a rich stream of social data available to the user whenever she logs in to her homepage on Facebook. However, it is very easy to miss something important or interesting, if one has not logged in for one or two days, and a lot of updates were shared by her friends during this period. Also it is not easy to find out if a particular user has posted something recently, or who is generally active on Facebook and who is just a lurker. Therefore, it is necessary to provide a better way to organize and present social data to make users aware of the pattern of online social activities. Information visualization technology can provide effective approaches for presenting large amounts of data intuitively, which can help users to get insights into the data, discover patterns and find information of interest easily.

Facebook is currently the most popular social network. It provides the user with the opportunity to monitor and comment on social data from her friends, and share her own social data. However, Facebook does not provide a way for the users to easily find amongst her friends:

- who are active users,
- who post many popular updates and who do not,
- who was active recently and who some time ago,
- who posted recently but whose updates have been missed by the user,
- who stopped sending updates and became a lurker or stopped using Facebook altogether.

This paper proposes an intuitive and easy to understand visualization method that creates the needed awareness for the user about her social network on Facebook providing answers to these questions. Additionally, the implemented visualization application provides navigational and interactive methods to access posts of all the user's friends, so she can browse the social data shared by her friends more easily and selectively.

The rest of the paper is organized as follows: section 2 presents an overview of existing social visualization tools. Section 3 describes the conceptual design and implementation of the proposed approach. The evaluation of the proposed tool is presented in section 4. Section 5 concludes the paper.

2 Related Work

In 2012, Facebook announced a search engine for the immense amount of data shared: Graphsearch. Graphsearch allows users (but not any users, only those with English language setting of their FB, after special request and a waiting period), to make deep queries of the entered preferences, interests, locations and posts of their friends to find answers to questions like: Who of my friends has been in New York, friends who have particular interests and live in particular location, etc. This is not an awareness tool, but a tool that allows users to treat their social nework's posts as a searchable database, in case they have specific queries.

Recently Facebook updated the presentation of its Newsfeed and now presents at the top the posts that it evaluates as the most interesting for the user. Their algorithm, sometimes referred to as EdgeRank, is not known to the public but uses the affinity between the poster and the user, the type of content posted and the time elapsed since its posting to determine to position it should occupy into the user's newsfeed. This new presentation suffers from the same drawbacks as the classical newsfeed, to few news are presented on the screen at any given time and it is nearly impossible for a user to locate the last activity of a given user without going to check her page.

Social visualization can be defined as the visualization of social data for social purposes [4]. In other words, social visualization uses information technology and focuses on people, groups and their conversational patterns, interactions and relationships with each other and with their community [4]. Social data may be collected from different sources such as online communities (e.g. IM logs, email archives, discussion threads, updates on social networks, etc.) and also the physical world (e.g. movement and location data captured by camera, GPS, mobile devices, etc), and then be processed to generate visualization. Visualizations of these kinds of social data can be used for increasing awareness of one's social activities, motivating users to participate in social communities, and coordination. There are various social visualization approaches and techniques that have been proposed.

The Babble system [2] is one of the first approaches integrating the social visualization technology into an online chat room system. It was designed for a small- to medium- sized group, and to provide clues about the presence and activity of a person in the current conversation. Each person in the system is represented by a dot of different color. A gray circle in the center of the visualization represents the proxy of the current chat room. All users, who have already logged in to the system, but not in the current chat room, will be positioned outside the gray circle. The dots located inside the circle denote users who are in the current room. When people are active in the conversation, meaning they either "talk" (type) or "listen" (click and scroll), their dots move to the center of the circle, and then drift back out to the edge when they stop talking for 20 minutes. This way, everyone in the system is able to get the awareness about others' activities, which is good for the group coordination. This approach has also been used for some other online activities, such as online lectures and auctions.

Data portrait is another useful method for social visualization. For example, both PeopleGarden [8] and another floral representation [9] use this method to present social data. PeopleGarden is designed for online interaction environments such as web-based message boards, chat rooms, etc. In PeopleGarden, a flower metaphor, including magenta petal (for initial post) and blue petal (for response) has been used for each user in the system. Dots on the petal indicate the number of answers to this post. The height of the flower reflects how long the user has been in the system. Faded petals are used to indicate old posts. To visualize a group of users, all the flowers representing the users in this group can be drawn together on the canvas, which looks like a garden. In this way the current state of

posts could be easily seen at a glance the visualization. For example, a healthier-looking garden with more bright flowers indicates a discussion group with more new posts. And the number of petals can also reflect how active the group is. Additionally, people may be motivated by the visualization to post more, and in this way get more petals for their flower.

IBlogVis [3] uses the digital footprints method to help a user find interesting articles when she is browsing blog archives. In IBlogVis, according to the time of posting, each blog entry is displayed as a point on the time line located in the middle of the page. A vertical line above each point (each blog entry) represents the length of each entry, and a second vertical line below each point represents the total length of comments this entry has collected. The circle's radius on the end of this line indicates the number of comments for each entry. A user can also click on an entry to view its content. This visualization application provides a rich overview of a blog. The history of social interaction (footprints) can help users identify potentially useful/interesting entries in a blog.

Motivational social visualization is an important category in social visualization. Its main purpose is using social visualization to motivate participants to contribute more or make higher quality contributions. For example, Comtella [7] is a peer-to-peer file-sharing community. The visualization in Comtella uses a metaphor of a night sky in which every user is represented by a star. The size of the star indicates a user's number of contributions (files shared in the Comtella community). A reddish coloured star represents a user who has shared more new files than the number of downloaded files from other users, and a blueish coloured star represents a user who downloaded more files than she has shared in the community. The big yellow star represents the "best user" who shares more than everyone else and has contributed new things to a community. Therefore, the visualization encourages social comparison among users to increase the diversity of resources in a community.

In general, the social visualization approaches discussed above have been applied to various online communities for different purposes. Facebook, as one of the most popular online communities, also has some visualization applications to help its users to explore their social data.

Facebook Social Graph[5] is one of the most popular social network visualization applications. The visualization in Facebook Social Graph shows how a user's friends connect to each other forming interconnected clusters (only the direct friends of a user are shown, but not the friends of friends), and it lets a user explore her social network by zooming in and out and panning the canvas. In this visualization, each node represents a user, and the line between nodes shows the relationship. All the nodes and connections are organized in a force layout. Placing the mouse pointer over a node can highlight all the mutual friends of the selected person and the current user. A pink circle emphasizes a social cluster (a group of mutually interconnected users) in the user's social network. This visualization can increase the user's awareness of the structure of her social network, which is more difficult to find out by exploring the list of friends of one's friends

[5] `http://www.mihswat.com/labs/app/facebook-social-graph`

using Facebook's interface. Furthermore, being aware of social clusters can help the user predict how information flows among her friends.

Facebook Friend Wheel[6] takes a user's friends, then links and groups them together to form a colorful circular graph. Each node represents one friend, and a line connecting two nodes means that they are friends with each other. Nodes of different colors reflect different social clusters in the user's social network. All the nodes are organized in a wheel style, which can display the relationships more clearly. Similar to Facebook Social Graph, Facebook Friend Wheel only reveals the network of the user's direct friends, and provides the social map for getting social network awareness.

Facebook visualizer[7] is a tool to graphically discover the social network with a filter functionality including gender and relationship status. The major difference with the previous two Facebook visualization applications is that the application is interactive and allows the user to define filters to customize the display of a user's friends, so a specific group of friends can be hidden or shown to reduce the graph's complexity.

Nexus[8] calculates friend similarity by parsing profiles (through the Facebook API), and highlights links between friends who share the same interests and groups. This visualization in Nexus aims at classifying friends with same interests and groups, increasing the awareness of a user about the people in her social network.

Most of these third-parties' visualization tools focus on reflecting the social network structure. There is still no effective way to allow users to find some important posts that they may have missed, if they have not logged in for a couple of days, to find out whether a particular user has posted something recently, or who is generally active on Facebook and who is just a lurker.

This kind of awareness is useful not only for a user to build a trusted social network, but also for a community to understand its members' participation. Therefore, this paper proposes an interactive visualization approach that allows discovering the time patterns and the main current contributors, as well as the lurkers. It also allows users to browse their Facebook streams in an alternative way.

3 Proposed Visualization

Facebook presents all the user's friends' social data in a stream, organized in a reverse-chronological order. Users log in periodically and browse the updates of their friends going back in time. However, this way of browsing has limitations:

1. It is often overwhelming to view the posts, especially if the user has not logged in for a long time, or if her friends have been very active during her offline period.

[6] T. Fletcher. Friend Wheel. `http://thomas-fletcher.com/friendwheel/`, 2009.
[7] `http://vansande.org/facebook/visualiser/`
[8] `http://nexus.ludios.net/`

2. It is very easy to miss posts that could be potentially interesting, i.e. from the friends the user cares about. While Facebook provides the option to check the updates of a specific friend, it is not easy, since only a few friends are presented at a time on the screen, and to find a particular friend, a user has to search for him/her. This does not fit in the casual browsing pattern in which users normally explore Facebook, and the result from such a search would often be disappointing, since the friend in question may not have posted anything recently.
3. It is impossible to get an overall picture of who has posted updates recently, how recently, how many updates, and which of the friends have not been active. The focus of attention of a user falls naturally on the friends whose updates can be seen in the current stream, with perhaps one or two clicks back in history.

For these reasons, it is important to make users visually aware of:

1. Who has posted and at what time;
2. The number of posts, i.e. how active the user has been recently;
3. How popular the posts are, i.e. how many likes and comments were received by each post.

The goal of the proposed visualization, called Rings[9], is to ensure an alternative way of browsing the stream of updates on Facebook, which allows the user to see which of her friends has been active recently and to check selectively the latest updates posted by her friends (instead of scrolling down through all the updates in the stream). This will reduce the cognitive overload of the user and will allow her to quickly check posts by particular friends, to be aware of (and possibly ignore) the most active users, and also to be aware of the users who are not posting and may be lurkers.

There are several requirements that have to be considered in the design. It is important to consider the scale of the visualization, i.e. how many friends it has to display. From the official statistics of Facebook, the average user has about 130 friends. Therefore, the visualization should be capable to arrange and display at least 200 users at the same time on the screen.

Additionally, the visualization should provide the option to easily locate a friend (since it could be challenging to identify a particular individual among 200 others) by providing a "search friend" option. A user should be able to see the most recent posts of each friend in such a way that it does not obstruct viewing the visualization as a whole. Jumping to the Facebook page of a friend when a user clicks on her profile picture or one of her posts, should also be supported, so that a user can interact with her friends on Facebook in the usual way, by posting comments to their friends' updates etc.

The design includes each individual user's representation in the visualization (for simplicity, it will be called "avatar"), visualization layout, functions, and application user interface. The avatar focuses on how to reflect the number of

[9] `http://rings.usask.ca`

posts from a user during last 30 days in the visualization. How to arrange a large quantity of avatars in a neat and appealing way is a challenge that the visualization layout has to address. Rings' user interface and functions aim at providing an easy way for the user to navigate in the visualization and access the usual Facebook content through it.

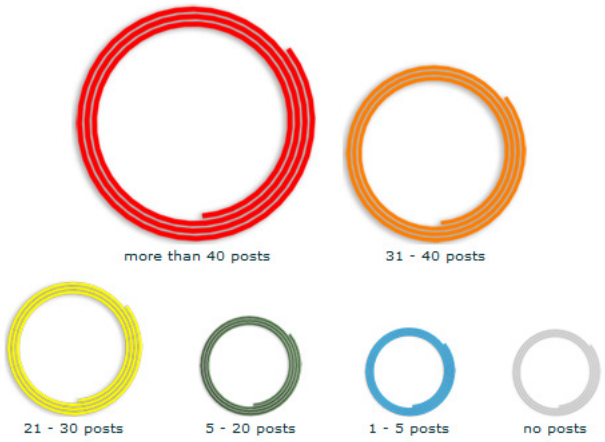


Fig. 1: Each level of quantity is indicated with a specific color and size.

Avatar Visualization. In Rings, each user is represented as a spiral (also called "screw"). The number of the posts in last 30 days is scaled into one of the six different levels of contribution (from level 0 to level 5). To visualize these levels, different sizes of spirals are applied to represent the six levels (see Fig. 1). Considering that it would be hard to distinguish six different sizes of spirals on a screen possibly crowded with many spirals representing hundreds of users' friends, it was decided to use an additional symbol variable - color, to differentiate the level of contribution of the user represented by an avatar. The color variable duplicates the meaning of the size variable, but it is easier to distinguish the different levels of contribution.

Yet, there is obviously a risk with overloading the representation of just one feature (the level of contribution), since it may lead to confusion in some users. For this purpose, a legend is provided, so that users can find at any time the meaning of the different sizes and colors of their friends' avatars. In addition to this, the related usability research shows that approximately 10% of human males, along with a rare sprinkling of females, have some forms of color blindness[10]. Thus, the six colors are carefully chosen and tested under all the forms of color blindness on Colblindor (http://www.colblindor.com). In

[10] A. Wade. Can you tell red from green? `http://www.vischeck.com/info/wade.php`, 2000

Fig. 2: The profile picture and the username are displayed in the spiral.

order to help users recognize their friends more easily, the profile picture and the username of each user on Facebook are displayed in the spiral, along with the number of posts the user has contributed during the last 30 days as shown on Fig 2.

Fig. 3: Opacity levels for posts

In order to see the posts made by one of her friends, the user only has to hover the mouse over her friend's avatar to see a detailled list of her friend last 30 days activity. To reflect how interesting/popular posts are, the numbers of likes and comments they receive are used. Obviously, the more likes and comments a post has, more interesting it is. According to the total number of likes and comments, each post is classified into 5 different popularity levels displayed with different emphasis on the screen by means of different shades of gray. All the 5 levels are presented with 5 different gray colors [1]. For example, a post with many likes and comments is shown in solid black color, while a post with no likes or comments is shown in light-gray color. Additionally, to indicate the exact numbers of likes and comments, a bracket with two numbers is added at the very beginning of each post in the floating window if there are some likes and comments for this post. For instance, [L:4 C:3] means there are 4 likes and 3 comments on this post (see Fig. 3).

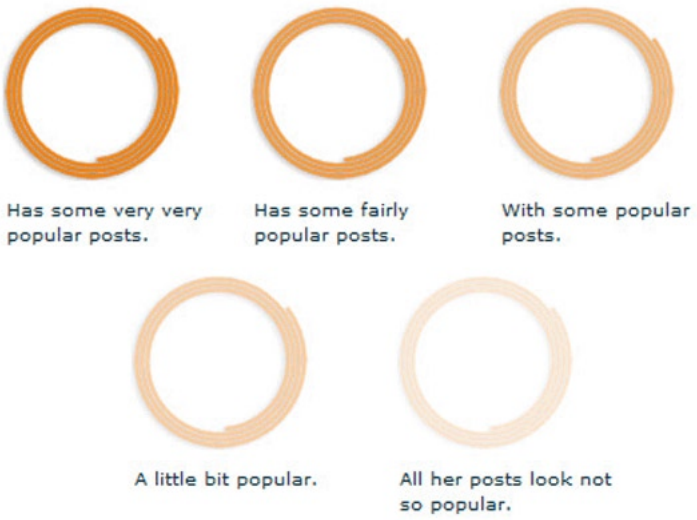


Fig. 4: Opacity levels for avatars

This strategy is also applied to the avatar visualization (spiral/screw) on the screen to provide awareness for the user to see at a glance which Facebook friends have some interesting/popular posts. As discussed in the last paragraph, each post is classified into one of the five different popularity levels according to the total number of likes and comments. Similarly, the avatar visualization is also classified into one of the five different levels according to the highest popularity level of posts that the user has got and five different opacity levels are used to present the five different popularity levels of that user as shown on Fig. 4. For example, if a user has a post at the most interesting level (in black color), her avatar visualization will be displayed in the highest opacity level of the corresponding color of the avatar (will look most solid). If all the posts of the user have no comments or likes at all, that avatar will be shown in the most transparent opacity level.

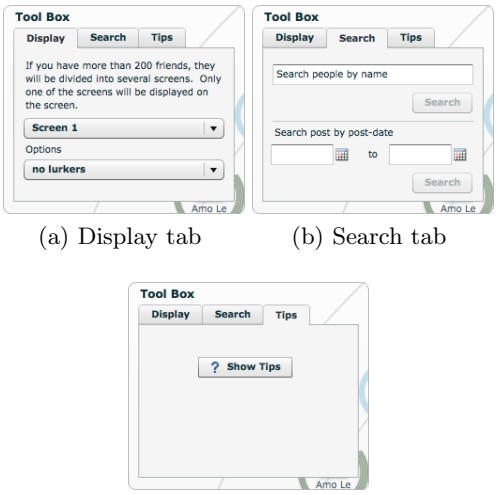
Layout. The number of friends varies drastically among Facebook users. For example, there are quite a few users with over 1000 friends. Considering the acceptable loading time, the unavoidable timeouts of the Facebook API, and the resulting crowded screen, it is impossible to display all the friends of such a user on the screen at the same time. Therefore a restriction was introduced in the design on the number of friends that can be displayed in one screen. If a user has more than 200 friends on Facebook, they will be separated in groups of equal size $k < 200$. The user can select any of these groups to display. Then the visualization will only display these selected k friends after an acceptable loading time.

Fig. 5: Layout of the visualization

In order to represent how much time has elapsed since the latest post by a specific friend, the background layout was designed as a set of concentric rings, where the friends who have posted most recently are displayed in the center, and people who have posted long time ago will be shown at the periphery. There are several rings on the screen to indicate different time periods in the past. The rings, from the center to the periphery, show the last 3 hours, last 12 hours, last 24 hours, last 3 days, last week, last 30 days, and no posts. Each avatar (spiral) representing a Facebook friend is placed on a specific ring according to the post-time of her latest post as represented on Fig 5. For example, a user will show up at the very center in the visualization if she posted something in the last 3 hours. If she stops posting anything from then on, her spiral will keep drifting to the periphery in the visualization over the next 30 days and will finally settle somewhere on the outmost ring.

Since research shows that humans naturally tend to focus their attention to the center of an image, the user's attention will focus on the most recently active users, similar to the default display option in most streams (the most recent at the top). This design also naturally focuses the attention of the user to the center (the "Bull's Eye"), where the action is, and the most recent posts are. By exploring the visualization, the user will become aware of who among her friends were active during the last 30 days (avatars inside the outmost ring), who posted recently (avatars close to the center) and who has been active several days ago, who has stopped posting updates and has possibly become a lurker (avatars on the outmost ring with 0 posts), who posts regularly many updates and who tends to post only occasionally.

The concentric rings design allows for scalability, since the time periods represented with concentric circles grow "exponentially" (although not in the mathematical sense of the term). There will be fewer people who posted very recently and the space in the center is limited, while there will be many more people who have posted in the past, the more distant the past, the larger the ring and more space available to accommodate more avatars without being crowded.



(a) Display tab (b) Search tab

(c) Tips tab

Fig. 6: Tool box presentation

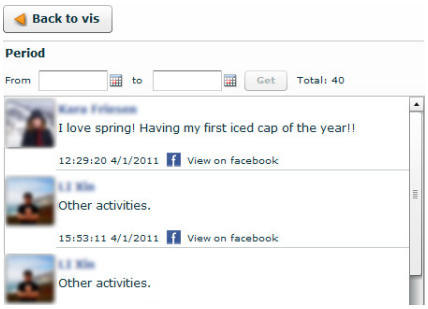


Fig. 7: Posts search results presentation

Functions. All the functions available to the user in Rings are in the Tool box, which is made of three tabs as seen on Fig. 6, one for each function.

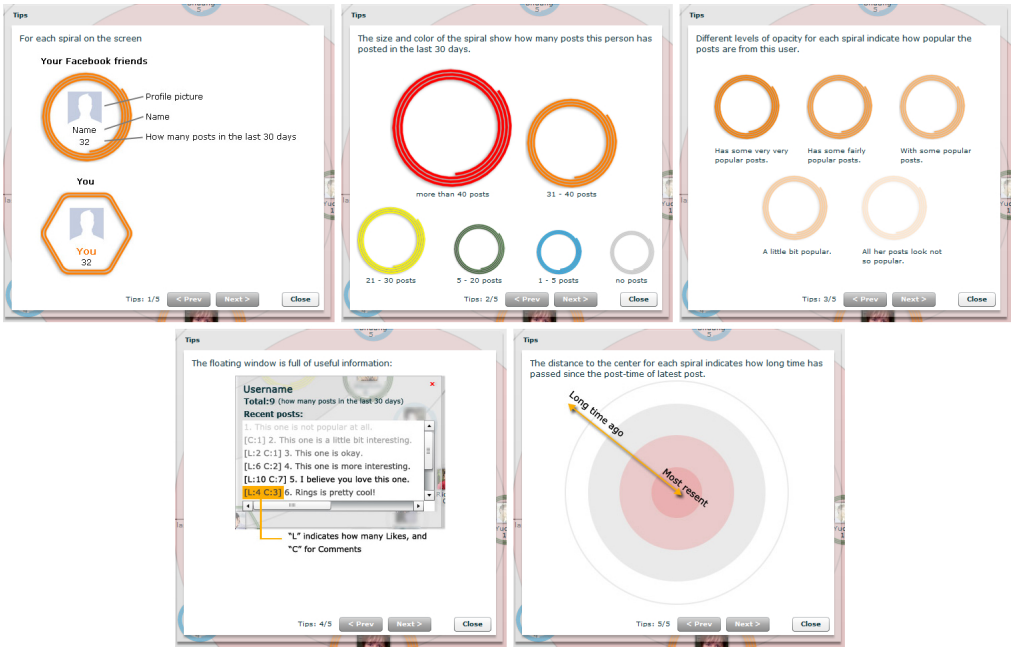


Fig. 8: Tips window

The display tab allows the user to navigate between the different groups of friends if she has more than 200. Also she can filter the layout by only displaying a specific group of friends or removing the lurkers (users without any activity in the last 30 days).
The search tab allows the user to highlight a friend in the layout to identify her position faster. The selected friend avatar will blink for some time to help the user find her. Also it is possible to search for activities posted in a certain timeframe. The activities that happened in the specified timelapse will appear in a list as shown on Fig. 7
The tips tab allows the user to see Rings' tips as depicted on Fig. 8.

4 Evaluation

Rings was evaluated through two user studies. The first study was done in a lab under the observation of one of the authors. The second study was a continuous remote user study.

4.1 First user study

This first study aims at testing the following three research questions.

1. Whether the information provided by the vizualisation in Rings allows an increased awareness of specific friends' Facebook activities (*i.e.* who is an active user, who is a lurker, etc.) or not?
2. Whether the information and functions provided by the vizualisation are useful for the user's daily Facebook browsing or not?
3. Whether the user interface is convenient and usable and the performance of Rings is good or not?

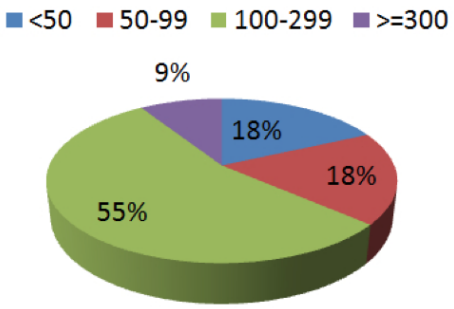


Fig. 9: The number of Facebook friends of study participants

Sample Testing the research questions mentioned above is not the only goal in the first study. Professional suggestions about the user experience and the visualization layout are also desired. Therefore, email invitations were sent to students of two research labs, the MADMUC Lab and the Human Computer Interaction Lab, at the Department of Computer Science, University of Saskatchewan. Additionally, two graduate students from other labs were willing to participate in the user study. Finally, there were eleven participants recruited, including six (6) students from the MADMUC Lab, three (3) students from the HCI Lab, one (1) from the Bioinfomatics Lab, and one (1) from the Agents Lab. All of them had strong computer background and advanced computer skills.

Because Rings is designed and implemented as a Facebook application, a diversity of participants in terms of Facebook experience was obtained to allow a better sense of how they use Facebook normally with their variety of Facebook experience levels. Two parameters were used to identify the Facebook experience level for each user: the number of Facebook friends they have, and the daily number of hours they usually spend on Facebook. Among all the participants in the first user study, more than half of the participants (6 out of 11) have 100-299 friends, followed by two (2) participants who have 50-99 friends and two (2) participants who have less than 50 friends. One (1) participant has more than 300 on Facebook (Fig. 9).

For the number of hours spend daily on Facebook, eight (8) participants browse Facebook less than one hour per day. One (1) participant spends 1 to

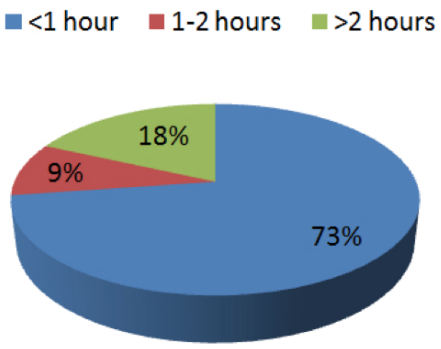


Fig. 10: The daily Facebook using hours of study participants

2 hours, followed by two (2) participants who use Facebook more than 2 hours daily (Fig. 10).

Procedure All the participants were invited to a quiet and small office to avoid unwanted interruption. They were asked to fill a brief questionnaire about personal information, including gender, number of Facebook friends, daily Facebook browsing hours, and computer skill. After that, the researcher introduced some terms, features (i.e. "lurker", friend-list feature on Facebook) that participants may not know, matters that needed attention, the flow of this study, and informed participants that the entire study would be captured with audio and screen recording.

During each study session, a participant needed to complete two sets of tasks: tasks to be completed on Facebook and tasks to be completed using Rings (Appendix .1). The whole process of task completion was observed by one of the authors. To avoid differences in the amount of information that they had to tackle, which would have been unavoidable if the participants were to use their own Facebook accounts, all the participants were asked to use the same example Facebook account (it was a real account with 198 Facebook friends), for both sets of tasks (the Facebook task set and the Rings task set).

Among these two sets of tasks, there is one section, which comprises the seven core tasks, in the task set for Facebook. Three sections, the task about the login of Rings, tasks about the user interface, and the seven core tasks, were included in the task set for Rings (Fig. 11).

The goal of the seven core tasks was to evaluate and compare the user performance on each of these tasks using Facebook and Rings, along three parameters: time needed to complete the task, rate of correct response (task performance), and level of difficulty (a subjective user measure of how difficult the task is). The result of the comparison can be used to test the first research question. After completing these seven tasks using Facebook, the participants were asked to state how useful or related each task was (level of usefulness) to their daily Facebook browsing, which can answer the second research question.

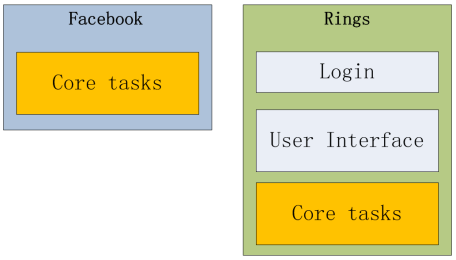


Fig. 11: The task sections in the two sets of tasks

One complication arises due to order effects (the order in which the participants perform the two sets of tasks), which can confound the accuracy of the results. There was one kind of order effect expected for the first user study: the experience, as well as the answers that a participant got from the first part of the experiment (using Facebook or Rings) might affect the result when she was working on the same task in the second part (using Rings or Facebook). For example, a participant was asked to find 3 users who had never posted anything in the past 30 days, which was anticipated to be hard to finish with the normal Facebook interface, but was much easier to do if the participant used Rings. If the participant first completed the set of tasks with Rings, she might remember the answer to each task, and take a shorter time to finish the same task using Facebook.

To deal with the order effects, a balanced within-subjects design was utilized in the first user study [13]. All the participants were divided into two groups. The first group completed the 7 core tasks using Facebook first, and then finished the same tasks with Rings. For the other group, participants completed all the tasks in Rings first. In the task set for Rings, the sections about login and user interface were used to test the third research question (Appendix .1, Tasks for Rings). Following and working on these tasks could also help participants to get familiar with the interface and fuctions provided by Rings.

After each session during the first study, a questionnaire related to the tasks was provided to collect general opinions about how easy it was to finish each part of tasks, comments, and suggestions. Some questions in the questionnaire were open ended, which enables participants to describe their own ideas or suggestions without any restriction. Additionally, the Questionnaire for User Interaction Satisfaction 7.0 was used to collect feedback about the overall user reactions, screen, terminology and system of information, and system capabilities.

A pilot study with two volunteers was conducted before the actual experiment to find shortcomings and issues of the designed study, as well as bugs of Rings. The bugs and issues collected from the pilot study were fixed before the formal study started.

Results

Task	Group1 (Facebook (FB) first, then Rings) 7 participants							
	Time with FB (s)		Time with Rings (s)		Accuracy with FB		Accuracy with Rings	
	Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV
T1	83.29	29.36	46.29	18.55	0.77	0.29	1.00	0.00
T2	135.57	45.03	78.14	21.26	0.77	0.27	1.00	0.00
T3	187.57	84.62	38.14	13.61	0.86	0.38	1.00	0.00
T4	294.00	167.03	80.43	23.11	0.86	0.15	0.94	0.15
T5	180.14	71.83	109.57	55.48	1.00	0.00	1.00	0.00
T6	109.29	30.10	52.57	16.08	0.89	0.13	1.00	0.00
T7	1,000.00	0.00	26.14	8.63	0.00	0.00	1.00	0.00

Table 1: The mean and standard deviation (STDEV) values of elapsed time and correct rate (accuracy) using Facebook and Rings - Group 1 (Facebook first, then Rings)

Task	Group2 (Rings first, then Facebook (FB)) 4 participants							
	Time with Rings(s)		Time with FB (s)		Accuracy with Rings		Accuracy with FB	
	Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV
T1	27.75	18.95	79.25	32.19	1.00	0.00	0.88	0.25
T2	98.75	33.88	187.25	25.70	0.98	0.04	0.73	0.27
T3	44.75	20.21	199.25	104.04	1.00	0.00	0.92	0.17
T4	103.00	68.88	234.00	210.67	0.85	0.19	0.80	0.28
T5	131.00	27.87	166.25	37.81	1.00	0.00	1.00	0.00
T6	52.75	10.34	135.25	111.31	0.94	0.13	0.94	0.13
T7	34.50	6.45	1,000.00	0.00	1.00	0.00	0.00	0.00

Table 2: The mean and standard deviation (STDEV) values of elapsed time and correct rate (accuracy) using Facebook and Rings - Group 2 (Rings first, then Facebook)

Results for the core tasks

For the seven core tasks, the levels of usefulness for all the tasks were calculated and analyzed to test whether the information and awareness provided by the visualization in Rings are helpful or useful for daily Facebook browsing (the second research question). The level of difficulty, the elapsed time, and the correct rate were compared to test the first research question.

From Fig. 12 we can find that most (six) of the tasks were stated as neutral (level 3) or useful (higher than level 3) for daily Facebook browsing. Only one task, task 3 (the lurker awareness provided by Rings), was rated lower than 3 indicating that most of the participants thought the awareness of lurkers was not so useful for daily Facebook browsing.

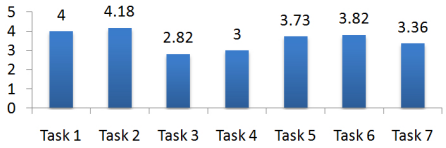


Fig. 12: The level of usefulness (means)

As discussed earlier, one order effect was expected before the first user study: the experience, as well as the answers that a participant got from the first set of tasks (using Facebook or Rings) might have affected the result when she was working on the same task in the second part (using Rings or Facebook). According to the real observation of the first eight sessions of the first user study, the order effect did not appear among the first seven participants (including four participants who completed the seven core tasks using Facebook first, then used Rings, and three participants who used Rings first and then Facebook). However, that order effect was recognized during the eighth study session. That user finished all the seven tasks smoothly using Rings first, but then got trouble on a task using Facebook. Hence, she just wrote down the answer that she got using Rings in the previous section, without actually working on that task using Facebook. Therefore, all the following three participants were asked to use Facebook first then use Rings to complete the seven tasks.

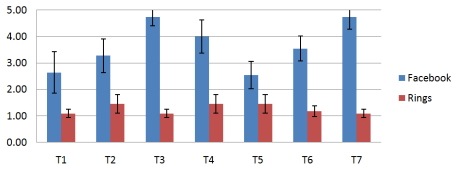


Fig. 13: The comparison of difficulty (means)

Fig. 13 presents the comparison of the level of difficulty (means) for completing each task using Facebook (blue bars) and Rings (red bars). The results clearly show that Rings provides an easier way for participants on searching specific task information.

The elapsed time (mean) and correct rate (mean) for each task with Facebook and Rings are compared to reflect the difference between two methods (Tab. 1 and Tab. 2, Fig. 14 and Fig. 15). From the overview of the data shown in the tables and figures, one can see that the participants used less time to finish each task using Rings, and the correct rates (accuracy) of the answers they found with Rings were higher than those found using the normal Facebook page for most of tasks. The participants got all the correct answers with both methods on task 6, but more time was used to complete that task. All the participants

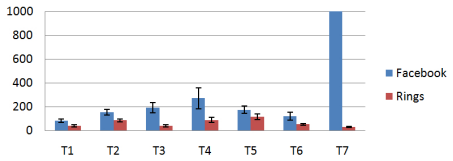


Fig. 14: The comparison of the elapsed time (means)

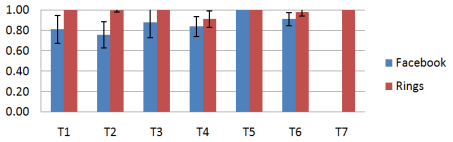


Fig. 15: The comparison of the correct rate (means)

thought it was really difficult to get idea for the answer of task 7, since there is no effective way for users to search posts by post-date on Facebook News Feed page. Therefore, an estimated time, 1000 seconds, and a correct rate, 0, are assigned to all participants for this task.

Testing statistically if these data confirm the research questions can yield a more convincing results. Hence, the t-test method was applied on the elapsed time and correct rate for all the seven tasks. The t-test is one of the most commonly used procedures for hypotheses testing. There are 4 frequently used t-test methods: one-sample location test, paired two-sample for means, two-sample assuming equal variances, and two-sample assuming unequal variances [5]. In this user study, the 11 participants have varied backgrounds (computer skills, Facebook experience, familiarity with tasks), and the samples from participants using Facebook (and Rings) do not follow the same distribution, which means they are not comparable. However, the differences of elapsed time and correct rate between using Facebook and Rings are only caused by the difference between Facebook and Rings. Thus, the difference between the values of elapsed time and correct rate over the different tasks using Facebook and Rings are comparable and the paired two-sample for means method can be applied to test the research questions.

Before applying t-test, the samples of elapsed time and correct rate for each task using the two different methods (Facebook and Rings) from each of the participants should be aligned and listed, which can show the differences between two methods more clearly. For the elapsed time (Tab. 3), column Facebook in the table shows all the times elapsed using Facebook, and column Rings shows the times using Rings. Obviously, the difference in elapsed time between using Facebook and Rings for each task can be calculated by $(t_{Facebook} - t_{Rings})$ and is listed in column "Diff".

Similarly, the difference $(c_{Rings} - c_{Facebook})$ of correct rate for each task between using Facebook and Rings is shown in Tab. 4.

	Facebook	Rings	Diff
T1	81.82	39.55	42.27
T2	154.36	85.64	68.73
T3	191.82	40.55	151.27
T4	272.18	88.64	183.55
T5	175.09	117.36	57.73
T6	118.73	52.64	66.09
T7	1000	29.18	970.82

Table 3: Elapsed times and difference for each task (average values)

	Facebook	Rings	Diff
T1	0.81	1	0.19
T2	0.75	0.99	0.24
T3	0.88	1	0.12
T4	0.84	0.91	0.07
T5	1	1	0
T6	0.91	0.98	0.07
T7	0	1	1

Table 4: Correct rates and difference for each task (average values)

	Elapsed time with FB	Elapsed time with Rings
Mean	285.44	64.25
Variance	95770.17	1690.5
Observations (samples)	77	77
Hypothesized mean difference	0	
df	76	
α	0.05	
t stat	6.05	
$P(T \leq t)$ one-tail	2.5E-08	
t critical one-tail	1.67	

Table 5: t-test result for elapsed time

Two sub-hypotheses, H_{t0} and H_{t1}, are defined to test whether the participants completed the tasks in shorter time using Rings than that using the normal Facebook News Feed page:

$$H_{t0} : mean\_diff_{time} <= 0 \quad (1)$$

$$H_{t1} : \ mean\_diff_{time} > \ 0 \quad (2)$$

H_{t0} represents using Facebook is faster than using Rings to complete each task, while H_{t1}, indicates the opposite opinion, which means using Rings is faster than using Facebook. To test which hypothesis is correct is to calculate the critical value (t $\approx$ 6.05), and to compare t with t critical ($\approx$ 1.67, in the case of $\alpha \approx 0.05$). t is greater than t critical, which means H_{t0} should be rejected and H_{t1} should be accepted. In other words, using Rings to complete all the seven tasks is faster than using Facebook, and the result is significant, or not due to chance, with 95% confidence (Tab. 5).

	Correct rate with FB	Correct rate with Rings
Mean	0.74	0.98
Variance	0.14	0.1
Observations (samples)	77	77
Hypothesized mean difference	0	
df	76	
α	0.05	
t stat	-5.60	
$P(T \leq t)$ one-tail	1.6E-07	
t critical one-tail	1.67	

Table 6: t-test result for correct rate

In the same way, whether completing tasks with Rings can get higher correct rate or not, can be tested by two hypotheses:

$$H_{c0} : mean\_diff_{crate} >= 0 \quad (3)$$

$$H_{c1} : \ mean\_diff_{crate} < \ 0 \quad (4)$$

Tab. 6 shows the t-test result on the parameter of correct rate. t can be calculated as about -5.60, and t critical is about 1.67. Thus, H_{c0} should be rejected, and H_{c1} should be accepted, which indicates using rings to complete tasks can gain higher correct rate.

Results of login

All participants thought it was easy (3 participants) or extremely easy (8 participants) to get connected with Facebook on the login screen (Fig. 16).

Fig. 17 shows the user feedback about the speed of retrieving user data from Facebook on the login screen. The answer options for the level of speed were on a likert scale of 1 (slow) to 9 (fast). Seven (7) out of 11 (63.6%) participants felt

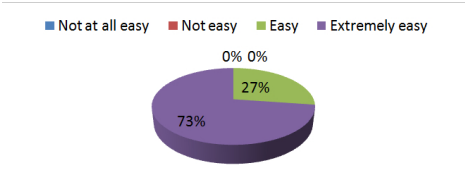


Fig. 16: The level of difficulty for login

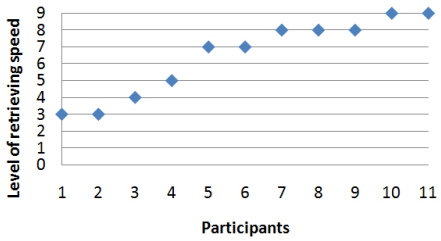


Fig. 17: The distribution of feedback by participants for level of retrieving speed (sorted by level of speed)

retrieving the stream of data about the 198 friends (that the Facebook account they were accessing had) from the Facebook server was fast (greater than or equal to 7). Two (2) participants rated the speed as 3, indicating that they were not so satisfied with the retrieving speed. Another 2 users chose the medium level (4 and 5) for the speed.

Evaluating the user interface

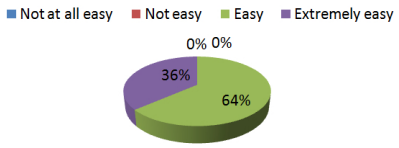


Fig. 18: The level of difficulty to get a sense of user interface

To evaluate the user interface, an initial list of 15 tasks (second part of Appendix .1) involving specific functions of the user interface of Rings, was provided to all participants. The purpose of completing these tasks was to let users get familiar with the user interface, so that they could make a better use of Rings while working on the 7 core tasks. After finishing these 15 tasks, the questionnaire asked each participant how difficult it was to get a sense of user interface. There are four options for this question: not at all easy, not easy, easy, and extremely easy. Four (4) participants (36%) felt that it was very easy to get

sense of the user interface, and the other 7 participants thought that it was easy (Fig. 18).

Other results

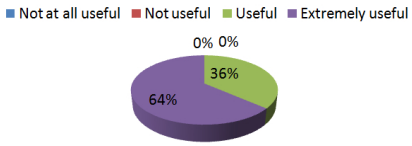


Fig. 19: The level of usefulness

Some overall questions about Rings were asked at the end of questionnaire. Fig. 19 shows that 7 participants (64%) stated that the information and functions provided by Rings are extremely useful while exploring Facebook. The remaining 4 participants considered that information and functions provided by Rings are useful.

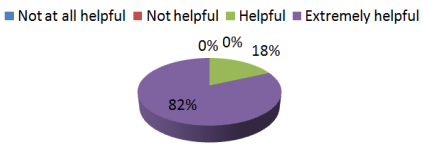


Fig. 20: The level of helpfulness

Furthermore, 9 participants stated that Rings did extremely well in allowing users to do things that could not be done easily with the normal Facebook pages, and 2 persons chose the option of Rings did well (Fig. 20).

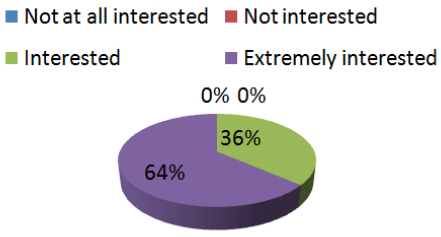


Fig. 21: The level of interest

Finally, when asked whether they would be interested in using Rings if was publicly available on Facebook, 6 participants were very interested, and 5 were interested in using it (Fig. 21).

Results of Questionnaire for User Interaction Satisfaction 7.0

The Questionnaire for User Interaction Satisfaction 7.0 was used to evaluate Rings from 4 different aspects: overall user reactions, screen, terminology and system of information, and system capabilities. The means and standard deviation values for each point in that questionnaire are shown in Tab. 7.

The results show that the participants found it was easier to complete the seven core tasks using Rings than using Facebook. The collected objective data (elapsed time and correct rate for each task) also proves that using Rings to finish the seven core tasks took a shorter time and resulted in a higher correct rate in comparison to using directly the Facebook page. The awareness provided by the visualization, and the functions provided in Rings were found useful by the participants for daily Facebook browsing. Moreover, the feedbacks about the user interface and user interaction show that it was easy to be understood and used, and the performance (speed of retrieval) was satisfactory. So the research questions can all be answered by the results in the first user study:

1. The information provided by the visualization in Rings allows an increased awareness of specific friends Facebook activity (i.e. who are the active users, who are lurkers, etc).
2. Most of the information and functions provided by the visualization are useful for the users daily Facebook browsing.
3. The user interface is convenient and usable and the performance of Rings is good.

4.2 Second user study

In this study, participants used Rings as they would normally use any other application. After each Rings' session, they were asked to fill a brief questionnaire.

Sample The invitation message to the field study was sent via Author1 (224 friends) and Author3 (203 friends) Facebook wall pages, and it was also shared further by some of their friends who invited their own Facebook friends. Another invitation email was also sent to the students of the MADMUC Research Lab, University of Saskatchewan. Since the authors are in the area of computer science, there is a possible bias in the recruitment: some of the Facebook users who received the invitation message have a computer science background. The invitation offered two options: trying out Rings without participating in the study and using Ring as participant in the field study (after accepting a consent form). 21 users, including 7 participants from the MADMUC Lab, 4 from other labs in the Department of Computer Science, and ten unfamiliar Facebook users, agreed with the consent form to participate in this user study.

			Mean	STDEV
Overall user reactions	Overall reactions to the application	Terrible (1) to Wonderful(9)	8.36	0.81
		Frustating (1) to Satisfying (9)	8.20	1.03
		Dull (1) to Stimulating (9)	8.36	1.21
		Difficult (1) to Easy (9)	8.36	0.67
		Inadequate power (1) to Adequate power (9)	7.73	1.27
Screen	Characters on the computer screen	Hard to read (1) to easy to read (9)	7.91	0.94
	The color scheme of the application	Ugly and hard to see (1) to Beautiful and easy to see (9)	8.55	0.69
Terminology and system information	Use of terminology throughout system	Inconsistent (1) to consistent (9)	8.45	0.93
	Messages which appear on screen	Confusing (1) to clear (9)	8.09	1.14
System capabilities	System speed	Too slow (1) to fast enough (9)	7.91	1.04
	The system is reliable	Never (1) to always (9)	8.45	0.52
	Provides useful feedback	Never (1) to always (9)	8.45	0.93
	Ease of operations depends on your level of experience	Difficult (1) to easy (9)	8.27	1.01

Table 7: Mean and standard deviation values for each point in Questionnaire for User Interaction Satisfaction 7.0

Procedure All the participants were informed to use Rings for at least five days (one time each day, and at least 8 minutes for each time). After using Rings for 8 minutes, a button linking to the daily questionnaire appeared at the top-right corner of Rings, and kept blinking to attract user's attention. The user was required to click on that button, and then fill the brief questionnaire. The questionnaire contained 5 statements to which the users had to indicate their level of agreement or disagreement (varying on a scale of 5 levels from "strongly disagree" to "strongly agree"):

1. Rings gives me a good idea of who has posted recently on Facebook.
2. Rings makes it easy to find the most interesting stuff posted by my friends.
3. Rings makes me aware of who is very active on Facebook and who is merely lurking.
4. Rings' interface is easy to understand.
5. I intend to continue to use Rings as an interface to Facebook in the future.

After the participant had filled 5 times the short questionnaire (in different days, after using Rings for at least 8 minutes), a final questionnaire became available, containing 4 open-ended questions provided to solicit further user suggestions or comments.

Results The study involved 21 users and continued for over 3 weeks. Each user was required to use Rings for at least 5 days before completing the study, but there was no requirement that these days be consecutive. Some users stretched their participation for longer than 1 week and some completed the study in 5 days.

After the 3-week study, 5 participants completed all the five daily questionnaires (one questionnaire for each day), 1 participant finished four daily questionnaires, 2 filled two, and 6 filled one daily questionnaire. Totally, 47 daily questionnaires were submitted in the research database. One participant finished nine daily questionnaires, since there is no maximum limitation on the submitted daily questionnaires. A participant could continue with this study and fill the daily questionnaire after she completed all the five daily questionnaires. There are also eight participants who have never submitted any questionnaire.

Question #	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	0	0	0	32%	68%
2	2%	9%	6%	62%	21%
3	0	0	2%	15%	83%
4	0	2%	9%	40%	49%
5	2%	11%	15%	36%	36%

Table 8: Results of the daily questionnaires

The results obtained for the short daily questionnaire with 5 daily questions are presented in Tab. 8. The rationale for making the participants answer

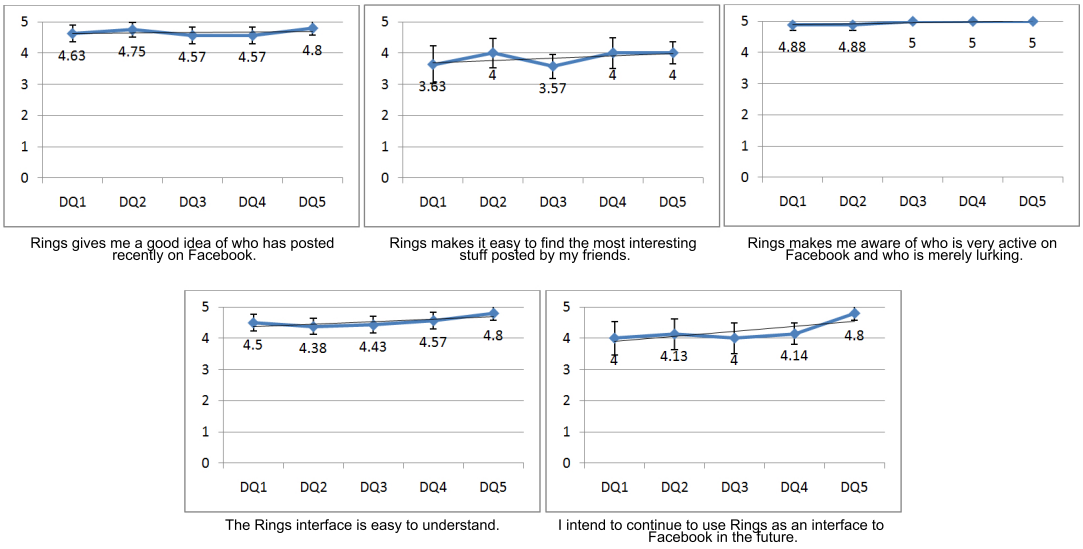


Fig. 22: Attitude changes on the five statements over the five daily questionnaires (DQ1, . . . , DQ5) (means)

daily these 5 questions is that we expected to see their attitude change, as they gradually explore the functionalities of Rings and became familiar with the system. Therefore, the analysis regarding attitude change was conducted among the eight participants who submitted more than 2 daily questionnaires. Looking at Fig. 22, some attitude changes can be easily recognized according to the feedback from all five statements. Attitude change is most evident with respect to the second statement (Rings makes it easy to find the most interesting stuff posted by my friends) due to lack of familiarity with Rings at the beginning of the study. However, after the third time of using Rings, the attitudes of the participants with respect to statement 2 changed towards "Agree" and "Strongly Agree." This pattern of attitude change can be also seen with respect to the other statements.

On the final questionnaire, four further questions about Rings were asked, which aimed at collecting further suggestions and comments from participants to improve Rings. These four questions asked the users about:

1. possible information they expected to find but which was not shown in Rings,
2. possible functionalities that were expected, but not provided,
3. anything that users felt inconvenient or uncomfortable,
4. other comments and suggestions.

Four out of five participants who finished all the five daily questionnaire filled the final questionnaire. The submitted feedback, revealed one limitation of the visualization, that it cannot provide information about interactions among the

user's Facebook friends at a glance, since it is focused on the posting status. For example, it does not reveal that user A has commented/liked user B's post. While users can see that a particular post has generated interactions with other users (comments or likes) by the color and the header of the post in the floating window, users have to click on a specific post and then jump to the Facebook page to view the particular interactions with other users related to this post, which is not convenient.

Another limitation is that currently the information in the floating window is all textbased, and the user cannot visually scan for the types of things that they are interested in, as they are used to doing in the Facebook stream of updates. Customizing the avatars of friends was suggested by one participant as the functionality that she had expected but was not provided by Rings. Facing a lot of avatars on the screen makes it hard to locate the friends whom the user is interested in. So the user suggested providing a simple way to customize friends by clicking on the profile picture and to set the friend's spiral visible in the visualization or invisible. So that user can easily hide the friends she does not want to view by scanning the visualization.

There are still some usability issues remaining in Rings. First, the friends names are not shown properly in the visualization, which makes users uncomfortable. Currently, the user's full Facebook name is cut if the length of the name is longer than a certain limit. For example, "Tina Hang" will be displayed as "Tina H", since the limit of the name string is set as 6 characters. This display issue is more severe when displaying longer user name (e.g. "Andrew Verylonglastname"). Second, the search functionality is not implemented perfectly. Rings just scans all the usernames and picks the first one that contains the typed keywords, which can lead to wrong results when there are several matches. For example, if a user wants to search "Ian Jordan" among her friends, she types "Ian" as the search keyword. Then Rings provides another person named "Liankuan Bin" as the search result, because "Liankuan Bin" contains the keyword "ian", and coincidently "Liankuan Bin" is listed before "Ian Jordan" in the user array. Search recommendation is not provided in the current Rings either. Finally, Rings cannot resize the visualization (i.e. zoom in or out) automatically according to the number of spirals on the screen to fit best the screen space. These issues need to be resolved in future versions of Rings.

With these two studies we evalutated Rings alog different dimensions. The first study shows that Rings is a practical, easy to use and awareness enhancing visualization tool that provides advantages over Facebook classical stream view. The second study shows that Rings has a very short period of adaptation and that users find it more efficient in order to gather information from their social network.

5 Conclusion

This paper introduces an intuitive and interactive visualization creating an increased awareness in the user about her social network on Facebook and allowing

her to get insight about the level and pattern of posting activities of her friends. It provides an alternative way to browse Facebook's social data stream.

It is really important to provide social networks users with a greater awareness of their friends' participation. It helps them not to be overwhelmed by the huge quantity of "uninteresting" information and easily find the high quality information. Others visualization tools for social networks focus on increasing the user's awareness of the structure of her social network. Rings helps the user getting a better understanding of what is happening in her social network. The approach develop shows great promise. There are still several directions for the development of Rings.

First it will be really interesting to explore the angle in the visualization to position the avatars in proximity to each other, depending on different criteria, e.g. if they are friends with each other (in this way, it will create awareness of the structure of social network, something that is addressed already by other Facebook visualizations), or if they belong to the same organization, or share similar interests (addressed by other social graph visualizations, e.g. for LinkedIn). Various criteria for proximity can be used. In order to keep the main focus of the visualization on the time pattern of posts, the proximity would be secondary to the time pattern of posts, which is the main criterion for arranging the avatars on each ring.

Also Rings should take into account evidence of other user activities, such as liking, commenting, or just logging in or scrolling, to represent, rather than just number of updates and recency of updates. This would require enhancing the visual language to distinguish visually the different forms of activity. It would be an important extension since many online community users don't consider themselves lurkers, if they read, comment or rate [6]. However, this extension has to wait, as currently the Facebook API does not provide data on these activities for users.

Finally, applying a similar visualization to other social network sites, such as Twitter or LinkedIn and create a mash-up for all the users' social network sites is a natural extension of this work.

Acknowledgement. This work has been supported by Natural Sciences and Engineering Research Council (NSERC) through the Discovery Grant program and the Discovery Accelerator Supplement Program.

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.1 List of Tasks

*Term "Active" is defined as "Post Frequently (more than 15 posts in last 30 days)" in this research.

Tasks for Facebook

1. Please try to tell all the users who have posted in last 3 hours
2. Please try to tell all the users who have posted in last 24 hours
3. Please try to tell 3 users who have never posted anything in the past 30 days
4. Please try to tell 5 users whom you think they are active users, and what are the post-dates of their latest posts
5. Please try to search Wendy Zhao, Lilia Li, and Jingyang Peng, count how many posts have been posted in last 30 days, and how long has passed since her last post for each person
6. Please only show the friend list named "U of S" on Facebook News Feed page, then tell 4 active users among them.
7. Please try to find all the posts between April 14, 2011 and April 15, 2011

Tasks for Rings

Login

1. Please connect to Facebook account using Rings

User interface

1. Please point out the control panel (comprises the "Tool Box", update timer, and scale slider) on the top-left corner, and visualization part (each friend is represented as a screw) in Rings

2. Please tell when Rings is going to check updates next round
3. Please point out the "Scale" slider, and scale the visualization
4. Please hide the "Tool Box", then show it again
5. Please tell the information contained in each screw
6. Please move mouse pointer on a screw, and tell the information inside the floating window
7. Please click on a post in the floating window to jump to that post on Facebook. Then back to Rings
8. Please click on a friends profile picture to jump to his/her profile page on Facebook from Rings. Then back to Rings
9. Please go to "Display" tab in "Tool Box", and determine all the friends will be divided into several groups if there are more than 200 friends on Facebook. And only one of the groups can be displayed on the screen
10. Please hide all the lurkers with the "No lurkers" option under the "Display" tab
11. Please display the visualization with the "U of S" (friend list) option, then choose the "All" option
12. Please go to "Search" tab in "Tool Box", and search "shey", then find where is the result
13. Please search posts by post-time
14. Please go to "Tips" tab in "Tool Box", and click on the "Show Tips" button, then determine the meaning of different screw colors and sizes. Close the tip window when you are done
15. Please determine what the layout of the users' screws represents

Visualization

1. Please try to tell all the users who have posted in last 3 hours
2. Please try to tell all the users who have posted in last 24 hours
3. Please try to tell 3 users who have never posted anything in the past 30 days
4. Please try to tell 5 users whom you think they are active users, and what are the post-dates of their latest posts
5. Please try to search Wendy Zhao, Lilia Li, and Jingyang Peng, count how many posts have been posted in last 30 days, and how long has passed since her last post for each person
6. Please choose the "U of S" option under the "Display" tab, then tell 4 active users among them.
7. Please search all the posts between April 14, 2011 and April 15, 2011, and tell the number of those posts you got.