Visualizing Reciprocal and Non-Reciprocal Relationships in an Online Community

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Abstract. Online communities thrive on their members' participation and contributions. There are numerous ways to visually represent information, current status, power, and acceptance of members in an online community. In this paper we present a design of a visualization representing reciprocal and non-reciprocal relationships among users, which emphasizes and hopefully triggers common bond in the community. Our future goal is to see whether the visualization triggers higher participation in an online community called "WISEtales", which currently is mostly based on common identity. If our hypothesis is confirmed, it will present one of the few examples of successful community whose members associate both by common identity and common bond.

Keywords: Information visualization, social visualization, visual design.

1 Introduction

Designing a visualization tool for an online community is a great challenge in the field of visualization research. During its existence an online community produces huge amount of content and it becomes difficult for the user to navigate and find the information that they are looking for. It also becomes complex to understand the evolution and the type of relationships that exist among members. "Social visualizations are one way to "describe" our online environments and make interaction patterns and connections salient" [1]. Any visualization should evoke meaning beyond direct mapping of data otherwise it is said to be misleading. Social visualizations have some evocative quality [2].

WISETales is an online community for Women in Science and Engineering. This community has been developed by a graduate student, Zina Sahib, as one of the projects of the NSERC/Cameco Chair for Women in Science and Engineering for the Prairies, Dr. Julita Vassileva. This community is specially designed to allow women who are underrepresented in these areas to share their personal stories. This is a virtual channel to share emotion, experience and provide support to other women. It helps women to overcome the generation gap and isolation. Generally women in these fields are very busy and achieving active participation is a great challenge. So to motivate their participation is vital for the existence of the community. In order to overcome this problem, we propose to use a visualization of user relationships that can motivate users to contribute and reach a critical mass of active users.

2 Literature Survey

Our research covers the area social comparison and motivational theories in psychology, organizational theories: common identity and common bond theory, and social visualization.

Theories of Motivation in Psychology

According to the cognitive evaluation theory there are two motivation systems - intrinsic and extrinsic - that corresponds to two kinds of motivators. Intrinsic motivators are: achievement, responsibility and competence, motivators that come from the actual performance of the task or job, the intrinsic interest of the work. Intrinsically motivated individuals perform for their own achievement and satisfaction. Extrinsic motivators are: pay, promotion, status, power, better working conditions, feedback that comes from a person's environment, controlled by others [3].

One of the theories from social psychology that is used to explain human motivation is the social comparison theory [4]. Social comparison consists of comparing oneself with others in order to evaluate or to enhance some aspects of the self. Cognitive and emotional responses to comparison have been extensively studied, but less is known about the effects of comparison on behavior. There is very little guidance about how people compare themselves in an online community. Sun and Vassileva [5] examined the effect of making individual reputation visible in an online system for sharing research papers and found out that displaying reputation increased contributions but some users contributed low quality content simply to achieve higher reputation. A study on the MovieLens movie rating system was conducted [6] by sending email newsletters to users indicating whether their contributions to the community were above or below or about average when compared to others which involved men and women. Women reported being motivated to contribute more ratings when they were told they had rated approximately the same number of movies as others and men were motivated to contribute more when they were told they had rated fewer than others. Members who received a newsletter that encouraged social comparison rated more movies than other members who received a newsletter which didn't encourage social comparison. Upward comparisons were most motivational in this system. However, introducing social comparison into a community might be risky. It could work and increase member participation or it might not work and reduce member's contributions. Competitive and gaming members like to be compared with other members, but others may find it discouraging and de motivating. People who are by nature more competitive (stereotypically, men are believed to be more competitive than women) are more likely to be motivated by the upward social comparison condition. It is arguable if women are less competitive, and especially if women in the science and engineering field are less competitive. They may respond very well to social comparison. However, in this research we would like to experiment with creating a visualization that emphasizes relationships, based on the common bond theory. It is generally considered a bad idea to mix motivations (e.g. extrinsic and intrinsic motivation) in the same system. Similarly, we fear that mixing social comparison with common bond may negate each other and it may be

impossible to observe any change in user participation, or it will be hard to attribute the change, if there is any.

Common Identity and Common Bond:

Community design affects how people can interact, the information they receive about one another and the community, and how they can participate in community activities. There are two theories of group attachments that have been linked to design decisions on online communities [7]. The *common identity theory* makes predictions about the causes and consequences of people's attachment to the group as a whole and the *common bond theory* makes predictions about the causes and consequences of people's attachments to individual's group members.

The causes of *common identity* are social categorization, interdependence and intergroup comparison.

Social categorization: it happens when one creates a group identity by defining a collection of people as members of the same social category [8][9]. *Interdependence*: Groups whose members are cooperatively interdependent tend to become committed to group [7]. *Intergroup comparison:* People who define and categorize themselves as members of a group compare themselves with other groups [10] and raising the salience of out-groups intensifies people's commitment to their in-groups. The causes of *common bond* are social interaction, personal information, and personal attraction through similarity.

Social interaction: Social interaction provides opportunities for people to get acquainted, to become familiar with one another, and to build trust. As the frequency of interaction increases, their liking for one another also increases [11]. *Personal Information:* Opportunities for self-disclosure when members exchange personal revealing information about the self becomes a cause or consequence of interpersonal bonds [12]. *Personal attraction through similarity:* People like others who are similar to them in preferences, attitudes and values, and they are likely to work or interact with similar others. Similarity can create common identity as well as interpersonal bonds [7].

Comparison of Common identity and Common bond:

Some identity-based communities shift eventually toward supporting and promoting interpersonal connections among members. For example, Flickr.com was established as an online application for photo management and sharing but it later evolved into a community where people not only share, tag, and comment on photos, but also join groups and interact in its public and private forums[7].

Bond based communities help newcomers to connect with existing members, to join group interactions, and to form lasting relationships with a subset of community members. Bond-based communities care more about people-finding than information finding, making it easy to find and meet specific members through directory or personal profile search page [7]. These communities encourage personal relationships, and their introductory material often encourages participants to post on a wider range of topics [7]. As compared to common identity, in common bond based communities newcomers feel isolated and become confused to see off topic discussions among members. But in our research since all discussions would be based on members stories, newcomers would be able to understand every part of the

discussion once the corresponding story is read and it would not be off putting for them.

Reciprocation

In Common Bond based community people develop relationships with other members and that is what ties them to the community which cannot be expected from Common Identity based community. People often help others with the expectation that their help would be compensated or reciprocated, either by those they have helped or by the group as a whole [13] [14]. Thus reciprocation can happen at a dyadic or at community level. In case of common bond there is direct reciprocity and in case of common identity there is general reciprocity. Social psychologists have found that the urge to reciprocate is deeply ingrained [15]. Sellers and buyers on eBay usually reciprocate in their ratings of each other [16] Voting on web sites is sometimes done in the context of reciprocity [17]: if you rate my story highly I will rate yours highly. Networks of reciprocity are highly motivating, and encourage participants to maintain an awareness of the community that surrounds them [18].A community designed on the basis of common identity is said to be more stable when compared to community designed on the basis of common bond [7]. This is because, in common bond based community, if a member leaves the group, the friends associated with that member would also likely leave the group or become passive. This does not occur in community designed on the basis of common identity. WISEtales is designed on the basis of common identity theory, so we can expect that it would be more stable. Representing relationships in a common identity based community encourages common bond. As very little research has been done on the coexistence of identity-based and bond-based attachment, this encourages us explore combining cues that stimulate both kinds of attachment. According to Milgrams [19] and Zajonc[20], visually representing people in an online group formed personal attachment to them even without communicating with each other. Visualization of actual communication flow among community members can create bond between friends of friends by helping people fill in gaps [7]. Making contributions visible in a community as a whole leads to some extent of recognition of the member's contributions. The nature of online interaction means that helpful acts are more likely seen by the group as a whole. The following features encourage reciprocity: ongoing interaction, identity persistence, and knowledge of previous interactions, since they promote the creation and importance of reputation within a community. So visualizing reciprocal and non reciprocal relationships might help members to recognize their current position in the community.

Social Visualization

Visually representing information enables users to see data in context, observe patterns and make comparisons [21]. Visualization techniques are important aids in helping users and researchers understand social and conversation patterns in online interactions [22]. A data portrait of an online community can give overall information about each other and the overall social environment [23]. **"**Social visualization is defined as the visualization of social data for social purposes" [24]. Social visualization is a sub category of information visualization. It focuses on people, groups, conversational patterns, interactions with each other and relationships with

each other and with their community. Social networks are said to be a form of social visualization because they have two types of organization patterns namely social groups and social positions [25]. There are various techniques to represent a group of people in an online community. Most approaches use nodes to represent individuals and arcs between the nodes to represent connections between them. Real social networks have dense interconnections between people.

Vizster is a visualization system for playful end-user exploration, navigation of large-scale online social networks to increase awareness of the community. Heer et al. [21] found out by observing through Vizster visualization that groups of users, spurred by stotytelling of shared memory spent more time in exploring stories and asked deeper analysis questions than other members. Further Vizster's visual community analysis provided help to users who could construct and explore higher-level structures of their online communities. Visualizations provide not just an analysis tool for social science researchers. Heer et al. [21], through the "sense.us" visualization for group exploration of demographic data found out that combining conversation and visual data analysis helps people to explore data broadly and deeply. When visualizing conversations, it should evoke an appropriate intuitive response to represent the feel of the conversation as well as depict its dynamics [26]. Coterie, a visualization tool for Internet Relay Chat (IRC) shows the activity of the participants and also the structure of conversation. It highlights active participants and conveys the vitality of discussion [26]. PeopleGarden is a visualization tool for representing member's participation on a message board. It uses flower and garden metaphor. From this anyone can easily perceive an individual's active role or long-time lurker [26]. The Loom Project is an evocative semantic visualization for Usenet newsgroups. It is used to depict the leaders and provocateurs. There are people who post frequently and are often replied to in a positive way. This visualization distinguishes them from other frequent posters such as trolls (deliberate troublemakers), automatic newsfeeds, and the excessively verbose [26]. IBlogVis [27] is a visualization tool for browsing blog archives. It provides an overview of posted blog articles over time with their length and number of comments received to help users to find the interesting articles in the blog at a glance and to ease exploration and navigation. Social network visualization for blogspace revealed that topic-oriented blogs had more interconnections and reciprocation than most popular blogs [28]. Webster and Vassileva [29] explored in the context of a discussion forum, if a visualization of the reciprocity of a user's relationships with other users would motivate the user to engage in more reciprocal relationships and showed that it indeed does so for active members, though it doesn't increase the level of participation in general. Chin and Chingel's [30] visualization for blogspace show links for suggesting a social relationship among the bloggers. Social visualization is expected to activate social norms of behavior, encourage social comparison and reciprocity. According to Vassileva and Sun [5] motivational visualization effectively increased awareness of community and encouraged social comparison and as a result contribution to the community increased. We propose to incorporate a motivational visualization to increase participation by stimulating social bond among members and evoking reciprocity among between pairs of users, as well as a gentle social comparison in terms of number of reciprocated relationships.

3 Proposed approach

To achieve the goal of increasing active participation, we propose designing a system which incorporates visualization techniques to motivate user participation by evolving their relationships with other members in the online community.

Motivation

Our hypothesis is that an appropriately designed visualization can stimulate motivational and organizational mechanisms that lead to more active contributions by users to their community. Our approach is to encourage intrinsic motivation (according to the cognitive evaluation theory from psychology) and the common bond theory (from organizational studies). The objective of our research would be to model the evolution of relationships based on data from user interactions, for example reading and writing stories or giving comments and to design a visualization of these relationships which will serve as a tool to motivate users to contribute more towards their group. Our visualization would display these relationships between users so that it would be easy for the user to understand his/her current position in the community.

We have chosen the WISEtales community as a test bed for our approach. In bond-based community people engage in direct reciprocity. So the visualization will reveal which are reciprocal and non reciprocal relationships. Reciprocity increases when members interact repeatedly. People help others with the expectation of having their help returned by that individual or the group as a whole [13] [14]. Returning favors is are acts of reciprocation. Yet it is not clear if being aware of the reciprocity of their relationship, and the direction of non-reciprocal relationships (who "owes" favors to whom) will motivate users to reciprocate more frequently and thus contribute more. This is what we would like to test. In this community, reciprocation happens when a member reads a story or post comments to a story submitted by someone else. Other actions, such as posting a story to one's Facebook profile, forwarding it to a friend or checking the story, author's profile may also be considered as acts of reciprocation.

Visualization Design

To make the visualization more likeable for women, a flower garden metaphor is used (see Figure 1). Each user is represented in circular node with his/her name written in it. The node is surrounded by arcs (visualized as leafs) corresponding to relationships with other users. Each arc (leaf) has the corresponding user names and different color to indicate reciprocal and non reciprocal relationships. The stronger and thicker the color then the reciprocation is said to have happened between the users. This helps the users to understand how many reciprocal and non reciprocal relationships they and the other users are involved in. The node of the viewer will be highlighted among the other circular nodes, so that he / she can compare his/her relationships with those of the other users. If a user has received lot of comments from a particular user and has not been aware of that before, the visualization will make him/her realize that he/she "owes" that user some attention, and that he/she needs to contribute something to the other user. Also the realization that other users are viewing the same visualization and will be aware of the lack of reciprocation from the user to others will add social pressure to behave according to community norms (a form of social comparison).

Thus a social visualization showing the users' relationships with other users could be motivational, if users become aware about the number and balance of their reciprocal and non reciprocal relationships with other users expressed through the visual effects. They would get an overall idea about the other members' contributions, would be interested to read stories contributed by active members, post comments and also spread the word about interesting stories. The visualization will be dynamic – it will change when new members sign in and when new comments are given and reciprocal actions performed. The visualization is intuitive but not interactive since previous research by [5] showed that interactive features were rarely used. It is not customizable by the users.

One can see in Figure 1 that there are three distinct colors used to represent reciprocal and non reciprocal relationships. The more petals a flower has, the more the active the member is. The dark green color leaf is used to represent reciprocation among users; the medium green color leaf is used to represent comments received from other users and the light green color leaf is used to represent comments given to other users. Viewers perceive colors differently but experimental evidence shows that relationships between colors are universal and are free from individual and cultural differences [31]. According to [31], "People can make consistent evaluation of the magnitude of any given experience of colors based on the type of interaction among colors. People respond to the relationship among colors". The colors chosen for this visualization are of analogous ordering. Such kind of ordering is more lively than monochrome and is stable in arrangement than non analogous ordering or complementary parings. Each member is represented as circular node in brown color.

The person who is engaged in most reciprocal relationships is placed in the center and other members are placed surrounding it. According to [32] "Varying shapes of nodes is used to denote different characteristics of members in the graph; the location of the node is used to denote the valuable marker for understanding the structure in the network. Centrality in a group is a useful indicator that the participant plays a key role in the group [33]. Each leaf has a rounded and a very sharp edge. The sharp edge is placed outside and is rotated to point to the direction of the corresponding individual's node whose name is mentioned on the respective leaf (along the arc connecting the nodes representing the users). The reason is to give an easy navigation and sense of direction for the user to find their relationship partners in the visualization.

Reciprocation between two members is currently calculated by the number of views and comments to each other's story. For example, in Figure 1 it can be seen that Karthik's node is placed in the center as it has a higher number of reciprocated relationships when compared to other nodes. The members with fewer reciprocated relationships are placed surrounding the central person. The other members with very few relationships are placed in the outer circle. All nodes in the graph are created using concentric circle algorithm. Placing the leaves in the corresponding direction of the node is not a trivial task. It is done by using some rotation measures and graphics algorithm to generate the graph.

This visualization does not include any connection lines between nodes. "The fewer the number of lines crossing, the better the sociogram" [32]. This is because lines between nodes increases complexity and decreases the beauty of the visualization. The visualization comes with a key to help users indentify which colors represent which type of relationship.

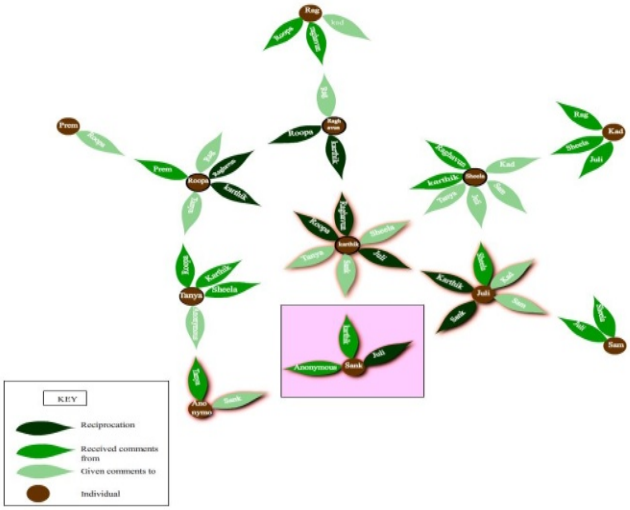

Figure 1: Visualization of reciprocal and non-reciprocal relationships for logged in members of WISETales.

Implementation

The technology used to design the visualization is Flash and Flare. Flare is mainly used for web content visualization and is highly scalable. WISETales is built on Drupal, PHP and MySql technologies. Flash can easily integrate with PHP and MySql. A link to the visualization will be implemented in WISETales website. As soon as the member of WISETales website logs in he/she would be able to click on the link to visualization to see it. In the visualization, the area of the corresponding member who is currently viewing the visualization would be highlighted in pink to show his/her current position in the group. Also when they click on their node all the nodes and leaves that are related to them representing reciprocal and non-reciprocal relationships would also be highlighted in the visualization. User of the visualization can also click on the particular flower to scale to get the information of a particular person clearly.

Prototype Evaluation

A medium fidelity prototype of the visualization using Flash was developed and tested to assess whether the visualization of reciprocal and non-reciprocal relationship conveys the correct information to the user, whether they were able to understand the visualization clearly. The evaluation tool used for the medium fidelity prototype was a questionnaire. The question type used were Scalar-Likert scale because it measures opinions, attitudes and beliefs. Each question asks the user to judge a specific statement on a numeric scale with extremes 4 –indicating agreement and 1 –

indicating disagreement with a statement. I also used open questions to get specific answers and to give room for user suggestions. The questionnaire was implemented using the SurveyMonkey.com tool.

The representative users for the evaluation of the medium fidelity prototype were 12 graduate students from our MADMUC lab at the University of Saskatchewan. The link to the prototype as it ran on a server and a link to the questionnaire were sent to each participant in an email. The most serious concerns users had were related to the scaling of the visualization, as can be seen in Figure 2. We need to work on the scalability, perhaps through creating fish-eye views or a magnifying glass effect.

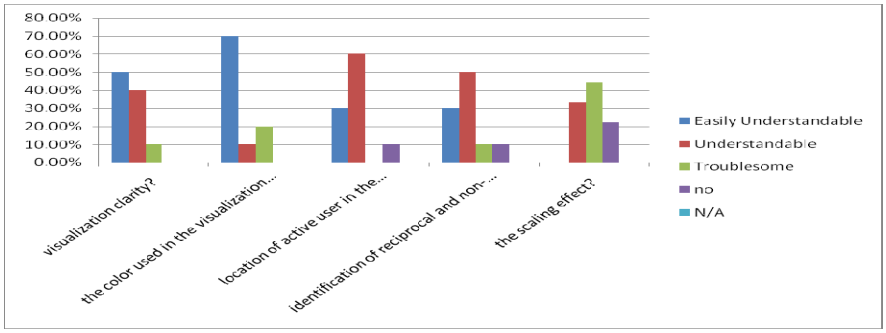

Figure 2: Results of the evaluation of the visualization prototype.

Future evaluation of the visualization

Our hypothesis is that visualizing reciprocal relationships would increase the users understanding of their community, will encourage common bond and will ultimately increase participation. We chose to evaluate the effect of proposed visualization in WISEtales by using three different versions (two control versions and experimental version) of the community with two different groups of users. Fifteen members would participate in each version. The experimental version would have the proposed visualization. The first control version will have no visualization and the second control version will have a different visualization (one developed by Zina Sahib) and based on common identity theory, showing only the type of contributions, not the users. All members would be given a period of one month to use the community with their respective version. In the next two months, the groups will rotate their versions, so that each group gets exposure with each version. The contributions from members in experimental version and members in control version and their reciprocal relationship with other members would be collected and analyzed. A questionnaire will also be used to collect qualitative data about the users understanding of the structure of the community, the importance of individuals in it; as well as their feelings of attachment to particular individual or the community as a whole.

4 Conclusions

We propose to use a motivational visualization aimed at encouraging common bond in a common identity based community and see the effects on user contributions. We want to test if particular visualization design, showing how users are engaged in reciprocal and non-reciprocal relationships with each other could stimulate reciprocation and motivate higher user participation. If our hypothesis turns to be true this may provide empirical evidence about the possibility of successful and stable co-existence of common identity based community and common bond based community within one group.

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