EntourageViz: A Visualization Tool for Facebook Friends’ Social Network

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Abstract

Data visualization, at the intersection of art and algorithm, is used to abstract information to bring about a deeper understanding of data, wrapping it in an element of awe. Though the practice of visually representing information is arguably the foundation of all design, a newfound application of data visualization has emerged. The recent upsurge of Social Networking Sites (SNSs), with millions of members publicly displaying their friends’ relationship has opened up new application areas of using visualization to provide a system enable members of social networks to explore their connectedness in a playful and, yet, desired manner. Inspired by the number of people signed-up for Facebook (the largest social network to date), the recorded number of visit to Facebook in a day, and by the fact that information on how users are connected to each other are vaguely implied by shared friends, we have designed and implemented a visualization system called “EntourageViz” for visualizing friends connectedness in an easy and fascinating way. Our design builds upon node-link network layouts and contributes techniques for exploring connectivity/relationship in a large graph structure and supported visual search and analysis. The main purpose of this research is to enhance the social experience of Facebook users and possibly promote participation. The result of the evaluation of this design on ten users not only reveals the importance of such visualization tool for attracting and enhancing users experience in SNSs but also validated some design premise for designing usable and engaging visualization by comparing four difference layout of EntourageViz visualization that presents the same information on the same network.

Keywords: social visualization, social networks, Facebook, graph, online community, exploration, connectedness

1. Introduction

Data visualization is a way of making sense out of the ever-increasing stream of information that we are exposed to everyday. It provides a creative antidote to the “analysis paralysis” that usually results from the burden of processing such a large volume of data/information. “It is not about clarifying data, It’s about contextualizing it” [23].

With the advent of the Internet, many ways of socializing online emerged, including email, blogging, Internet forums and online dating. In early 2003, another type started to gain popularity: online social networking services (SNSs). Social network link organizations, groups, and individuals throughout the world. In addition to allowing members to describe and display personal profiles (e.g. they can publish their personal information, interests, favourite music, movies, books etc.), members can also publicly display relationships with other members. SNSs become a central part of the Internet and a primary destination for many Internet users. Although preceded by many other social networks like Myspace, Friendster, and Hi5. Facebook emerged as one of the most important SNSs provider after a dramatic rise 2008 and as of this year, Facebook claims to serve a user base of over 500 million [33]. It seems like not a day goes by without getting an alert in our inbox for either friendship request or other activities from Facebook. This development has attracted different researchers from different field to explore Facebook and other SNSs provider in different contexts.
While some researchers looked at self-presentation [1, 2], others investigated friendship and group-behavior [3, 4]. So far, the predominant focus has been on online activities and offline integration in special interest networks [5] and on the motivations for using online social networks in a work setting [6]. Only few researchers [10, 24] have attempted creating any form of visualization for the social network in general probably because of the inherent difficulty imposed by the network designers on integrating any form of applications especially those that require some higher degree of friends data. To the best of our knowledge, no specific research has been conducted on the usefulness of any form of visualization on Facebook in particular. There exist a visualization tool called “social graph” [32], which displays only particular friends network but gives no further information like friends of friends moreover, there is no evaluation of this system to determine the impact of such design on the end-users or the reaction of the end-users of the system.

Though users of social networks automatically have a massive graph-like structure of connections, typical interface of these social networks remains relatively plain and simple despite the number of user that are attracted to it on a daily basis. Facebook shows only the network connections of single a individuals in a single person in a linear list. Articulating connections between person’s friends in Facebook are vaguely implied and can be explored only by paging through each friend’s profile page. Viewing higher-level constructs, such as shared patterns of interests and large communities might even be impossible to discern. This poses a problem on users ability to efficiently explore their connections and find out the individuals to whom their self-reported personal information are exposed.

In this paper, we present the design and evaluation of EntourageViz, a visualization system for the exploration of friendship between one’s friends on Facebook. EntourageViz builds on ethnographic research of online social networking services and on previous work in social network visualization to provide a system with which Facebook users can explore relationships in a playful and desired manner. Our system is motivated by research findings that visualizing and modeling personal relations in online communities resulted in increased participation of both active and previously non-active users [20, 21]. Moreover, we are also interested in facilitating better discovery of people, connections, and communities. We also want to provide awareness of community structure at a glance and expose information exposure while maintaining the already existing social and fun aspect of Facebook. From the perspective of information visualization, we are especially interested in developing and comparing different techniques for exploration and analysis of large graph structure visually by the end-user.

The rest of the paper is organized as follows. Section 2 summarizes related work. Section 3 presents an overview of EntourageViz visualization design, technology involved and architecture, and the social computing issues. Section 4 deals with the evaluation methodology while Section 5 present the result of our evaluation and discusses the finding. Finally Section 7 concludes the work, highlighting our limitations, and offering recommendations for future work. Sample questions for our evaluation and work division among group members are provided in the appendix.

2. Related Work

The problem of finding complex patterns in data and making them visible for further interpretation utilizing the power of computers and the power of human mind is as old as the invention of computers. Data mining and data visualization go hand-in-hand, used properly they could enable great combination and can enable efficient and sophisticated data crunching and pattern recognition [16]. One of the first known data visualization was carried out in the 1930s by group of sociologist and ethnographers while doing some data mining experiment. They wanted to find out the social structure of group of women in a small town in the southern United States. They wondered if they can figure out the social structure (today we call it a social graph) of 18 women attending 14 different social events. In those days, identifying network structure normally involves interviews and surveys. Today, this trend has changed. The existence of computer and more importantly Internet has made access to the
information required to determine this structure relatively easy, eliminating the burden of interviewing member to find out their connections.

The idea of information visualization originated from social science, where representing social relations among friend with node-link have been employed as an analytical tool during the 1930s. Linton Freeman documents the history of social network visualization within sociological research. He provided ways of using spatial position like color, size, and shape in encoding information [8]. Since then, color, size, and shape have been used to encode both topological and non-topological properties such as centrality, categorization, and gender.

Nowadays, these approaches have been used effectively in the analysis in domains such as e-mail communication [7], online social network [9, 10]. In addition to social graphs, there have been numerous social visualization projects intended for end-users rather than being research oriented. ContactMap [14] coded various communities within the group using spatial grouping and color within a visualization of a user’s e-mail contacts. TouchGraph [15] uses a force-directed layout to present a network visualization of users of the LiveJournal online community, allowing personal networks to be expanded or contracted by user interactions. BuddyZoo [19] analyzes users’ instant messaging (IM) buddy lists to present a static network visualization of their IM contacts. Boyd and Potter’s Social Network Fragments [18] visualizes personal e-mail archives in a zoomable network view and includes temporal filtering to visualize contacts at various time periods. Vizter[10] is used for exploration of online social networks in Friendster in a pleasant manner. It provides interaction for both user-oriented navigation and interactive community detection. MatrixExplorer [11] and Nodetrix [12] introduced the idea of combining the advantages of both adjacent matrix and traditional node-link visualization to present the social network relationships. Van ham and Van Wijk invented the focus and context techniques to visualize small-world graphs [13]. Though these systems often utilizes techniques seen in analytical domains, they also presents users with visualizations of their world; they are not anonymized and are often perceived with a sense of social place that is different from more detached analytical environments [10].

Despite the existence of this much social network visualization, none has target Facebook (one of the largest networks) specifically. Therefore, there is a need for a research-oriented technique and design of a visualization targeting Facebook end-user. There is a continuous need to articulate and/or explore Facebook to discover different types of relationship and connectedness. Visualization of network structure and connectedness is always a growing need. EntourageViz offers an easy way of visualizing and exploring friends Connectedness in Facebook. It gives the sense of playfulness, increasing user’s social experience and possibly their participation.

3. Social Computing Issues and Design Techniques Involved

In this section, we discuss the social computing issues addressed in this work and present our technique towards addressing them. The core focus of this project is to motivate user participation in Facebook and increase their online social experience. Toward this we developed a visualization system called EntourageViz. Furthermore, to compare the design premise that would be easiest for users, EntourageViz was implemented with four different visualizations, namely: the Arc Layout, the Force Layout, the X-Ray Force Layout and the Matrix Layout. The goal is to discover which visualization is most effective to specific questions/situations. To begin this section, we present a brief overview of Facebook as a SNS and thereafter, describe our visualization system and how it addresses the social computing issues involved in motivating user participation and increasing their online social experience.

EntourageViz not only contributes to research on social network analysis techniques designed to reveal information and maintain playful and increased social experience, it validates the theories on the design of usable and engaging visualization by comparing four different visualizations on the same network. Some of these features include connectivity highlighting and linkage views for users to
explore greater network contexts, X-ray mode, and community analysis for investigating higher-level community structures.

3.1 Historical Background of Facebook as a SNS

Facebook is a SNS that began in early 2004 as a Harvard-only SNS. Unlike previous SNSs, Facebook was designed to support distinct college networks only. To join, a user had to have a harvard.edu email address. As Facebook began supporting other schools, those users were also required to have university email addresses associated with those institutions, a requirement that kept the site relatively closed and contributed to users’ perceptions of the site as an intimate, private community. As these Facebook users graduates from college and joined companies as full-time employees, they continue to use Facebook on a regular basis. As has been demonstrated with college students using the site to keep in touch with current college friends and past high school acquaintances [31], the graduated students use the site mostly to maintain social connections with current coworkers and past college friends.

Beginning in September 2005, Facebook expanded to include high school students, professionals inside corporate networks, and, eventually, everyone. “The change to open signup did not mean that new users could easily access users in closed networks—gaining access to corporate networks still required the appropriate .com address, while gaining access to high school networks required administrator approval” [17]. Unlike other SNSs, Facebook takes a different approach—by default, users who are part of the same “network” can view each other’s profiles, unless a profile owner has decided to deny permission to those in their network. The Profile page is highly customizable page that individual users create to share their pictures, preferences, and other personal information. Another feature that differentiates Facebook is the ability for outside developers to build “Applications” which allow users to personalize their profiles and perform other tasks, such as compare movie preferences and chart travel histories.

3.2 The Visualization Design for Facebook Friends’ Connectedness Display

We now present EntourageViz, the visualization application implemented in this project. EntourageViz is implemented as a Facebook application that reads user information and generates visualization based on this information. To maximize server availability and to avoid the burden of server management, we implemented EntourageViz on top of Google App Engine cloud computing platform [33].

When a user first approach the EntourageViz application from within or outside of Facebook, the user may choose to login to the application with Facebook username. EntourageViz will then ask for permission to access basic user information such as Facebook id, work place, birth, gender, friends list and all other information that user choose to open to public. Once the authentication process is complete, the EntourageViz application gets an access token from Facebook Graph API and uses the token to access further information needed for the visualization. After all necessary information has been gathered; the visualizations are generated with Javascript at the client end.

At the back end, EntourageViz is implemented as a Servlet that takes request from the front end and interacts with the Google data storage infrastructure. The heavy requests in the backend includes getting all unique friends’ information from specific user on Facebook, and computing all unique connections between friends and user and between friends of friends. Due to the quota/limits imposed on Google App Engine Servlet requests, we have to complete each servlet request within 30 seconds [34]. In other words, such rule leaves us no room to compute all friend data and connections in server memory by one servlet request. To work around this technical problem, we chose to store all user information and connections to Google App Engine Datastore. Each person within the data store is identified with Facebook ids.
In all the visualizations, we used the color red to represent female friends, while the blue color represents male friends. If the individual chose to leave the gender information to be private, it is colored with grey. For each type of visualization, we applied two sets of network data. The first type is the first-degree friend network, which has original friend data of the user “Yudi Xue” from Facebook. Since all individuals are connected with “Yudi Xue” in the network, we will define the user as root of data. The first-degree network depicts all connections between friends and root, as well as all connections between friends of friends. The second-degree network depicts all connection between friends of friends except for the root and connections between other individuals who has no more than one degree of connection.

Figure 1: Arc Visualization with First Degree Friend Network.

Figure 1 shows the static arc visualization with first-degree friend network. Along the X-axis are the names of friends. The nodes are connected by arc-shaped lines that overlap where nodes have one or more connections. The nodes are ordered by number of friends/connection, and the size of each node is relative to the number of friends connected to. By this first-degree network, it is easy to tell that “Yudi Xue” is a male and has the highest connection. His connections forms a “wing-like” shape spreading to both left and right, and covers end to end of all nodes. Our goal in this visualization is to provide a pattern of how the most popular (with most connections) individuals are connected within the network. However, such pattern may make particular information-finding task impossible, such as how two specific persons are connected (whether they are connected, have any shared friends, etc).
Figure 2: Arc Visualization with Second Degree of Friends Network

Figure 2 shows the arc visualization based on the second-degree friend network. Compare to the arc visualization based on first-degree friend network, this visualization is much smaller in size and has a less clear pattern of friend connections. It is easy to tell that more connections are originating from female groups to the rest in the network, as well as smaller interconnections between male friends, but this visualization overall has a less clear pattern of individual connections than the first degree arc visualization.
Figure 3 is the force layout visualization that uses the force-directed algorithms [35]. In this layout, the individuals are represented by their avatars on Facebook. The avatar position is determined by the node, which are connected based on friend relationship. The connection of each node specifies a gravity parameter, which describes how one node can affect or can be affected by neighboring nodes. Within the force layout, all nodes are dynamic and react to mouse dragging. Once a node is being dragged with mouse, all neighboring nodes will be affected based on the gravity of the dragged node and the affected node. After the dragging is done, the network will slowly re-arrange the node distribution according to their gravity. From layout screen shot, we notice a distribution pattern where nodes with higher gravity (connections) are closer to the center. The root individual “Yudi Xue” has significantly more connections than other individuals within the network; therefore, it occupies the center of the layout. Compare to arc visualization, it is easier to answer certain information finding questions such as shared friend between two particular people. However, it is still a clutter to reveal information based on friends of friends connections, since the first-degree connections (connections between root and other nodes) are most dominant in the visualization.
Figure 4 shows the force layout visualization based on the second-degree friend network. The network is separated into three independent networks. The groups of people in each sub-network are related to the user through different affiliation such as high school or university. Compare to the first-degree force layout, although it is impossible to find information about the root individual, it is much easier to ask friend of friend information questions.

Figure 5: Force Graph X-Ray Layout with First Degree Friends Network
Figure 5 shows the X-Ray force layout with first-degree friend network. The X-Ray design is inspired from the Vizster visualization project [36]. It replaces the avatar with the colored nodes which size is reflected by the connections an individual has. Compare to the previous force layout visualization, the edges are clearer to form a pattern of distribution. As well, the color that indicates gender information can be very helpful in combining other information such as number of connections, which makes it easier to find answers to questions such as how many female friends are shared between particular individuals. However, some small nodes are overlapped due to the calculation, which requires extra effort to locate certain individual within the network.

Figure 6 shows the X-Ray force layout with second-degree friend network. Compare to the second-degree network force layout, the individuals are easier to locate within the network. It is much easier to find friends of friends’ related information.
Figure 7 shows a static matrix visualization with the first degree friend network. The names of individuals are arranged along the top row and the left most column of the matrix. This forms the square of total number of friends’ cells in the matrix. The cell color depicts the connection between the row and column that represents different individual. If both sides of a connection are females, then the connection is colored in red. If both sides of a connection are male, then the connection is colored in blue. If both sides of a connection are of different gender, then the connection is colored in black. If no connection is shared between the row and column, then the cell is white. From the matrix visualization we notice that root individual had filled connections in both row and column. While there is no obvious pattern about how data is distributed, there are certainly more female connections than male connections in the network.
Figure 8 shows a static matrix visualization with the second degree friend network. Compare to the first-degree network matrix visualization, there is no significant improvement laying out pattern, however, it requires less space to display friends of friends information than in Figure 7.

### 3.3 Obstacles and Ways Around it

One of the greatest challenges in the project is finding out how to design a sustainable solution to store and compute hundreds or thousands of Facebook individuals and the relationship between them. We worked around this with a Servlet that takes request from the front end and interacts with the Google data storage infrastructure.

The heavy requests at the backend includes getting all unique friends information from a specific user on Facebook, and computing all unique connections between friends and user and between friends of friend. Due to the quota/limits imposed on Google App Engine Servlet requests, we have to complete each servlet request within 30 seconds [34]. In other words, such rule leaves us no room to compute all friend data and connections in server memory by one servlet request. To work around this technical problem, we chose to store all user information and connections to Google App Engine Data store. Each person within the data store is identified with Facebook ids.
4. Evaluation Methodology

In order to evaluate our systems and their applications, an experiment with Facebook users was carried out. This section presents the survey instruments used for the evaluation of our system and the participants in the evaluation.

4.1 Survey Instrument

We used three different techniques in this evaluation: think-aloud, observation and self-administered questionnaire. In the think-aloud method, firstly, we provided the participants with an explanation of our work and our visualization systems. Secondly, we provided them with the visualizations. The experiment consisted of displaying to each participant the different visual representations (as discussed in the previous sections). We told them to play with the systems, explore it as they saw fit, and talk-aloud about their experiences as they explore the systems. After 10 minutes of exploration, we gave them some specific task to accomplish based on the information provided by the visualizations. For each visualizations, a total of five different tasks were given to the user to perform (E.g how many friends is a particular friend connected to? How many friends of the same gender does a named friend have?). We asked them to talk aloud about their experience as they try to perform the tasks. We varied the subjects of the questions from one visualization to another to avoid memorability or familiarity effect though the questions remained the same. Meanwhile, we observed the participants and recorded their experiences both from the talk-aloud and from the difficulties we noticed as they try to perform the task. Though we did not explicitly record the time taken to complete the tasks but we were able to observe if a particular participant spent more time in trying to perform a given task using one visualization compared to the others. We also asked the participants to compare the visualizations in terms of easiness in finding information needed to answer a particular question. The participants expressed their likes and dislikes about a particular visualization and also gave some suggestions for improvement. Lastly, after the think-aloud and the observation questions which took an average of 20 minutes approximately, the participants were given a link to respond to an online questionnaire that consist of a total of 15 questions to determine users experience with the visualization in general. Each participant used and responded to the questions about the four visualizations tested. These three evaluation approaches ensure holistic evaluation of finding out the utility, usability, relevance and people’s social and affective reactions to the visualization

Initially, we thought of dividing the participants into four groups and using different group for testing different visualization but this was deemed inappropriate due to the following limitations/reasons:
- The participants in one group might differ in experience and expertise than participants in the other group thereby affecting the validity of the comparison and result.
- Due to time constraint we couldn’t recruit more participants
- The participant pool will be small (10/4)

4.2 Survey Participants

Participants consisted of 10 graduate students of computer science department from various labs at university of Saskatchewan. The summary of participant’s information is as shown in Table 1 below.
Table 1: Summary of Participants’ Profile

<table>
<thead>
<tr>
<th>Participant’s ID</th>
<th>No. of years on Facebook</th>
<th>No. of friends on Facebook</th>
<th>Frequency of Visit to Facebook in a Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>&lt;1</td>
<td>55</td>
<td>At least once</td>
</tr>
<tr>
<td>102</td>
<td>1</td>
<td>80</td>
<td>At least once</td>
</tr>
<tr>
<td>103</td>
<td>&gt;2</td>
<td>180</td>
<td>At least 10 times</td>
</tr>
<tr>
<td>104</td>
<td>4</td>
<td>350</td>
<td>At least once</td>
</tr>
<tr>
<td>105</td>
<td>&gt;3</td>
<td>132</td>
<td>At least 4 times</td>
</tr>
<tr>
<td>106</td>
<td>&lt;1</td>
<td>100</td>
<td>At least twice</td>
</tr>
<tr>
<td>107</td>
<td>5</td>
<td>219</td>
<td>At least once</td>
</tr>
<tr>
<td>108</td>
<td>2</td>
<td>121</td>
<td>At least 2 hours daily</td>
</tr>
<tr>
<td>109</td>
<td>4</td>
<td>280</td>
<td>At least Once every hour</td>
</tr>
<tr>
<td>110</td>
<td>4</td>
<td>375</td>
<td>At least Once per week</td>
</tr>
<tr>
<td>Average</td>
<td>≈ 3</td>
<td>≈ 189</td>
<td></td>
</tr>
</tbody>
</table>

All the participants are in there early-to-late twenties and have used Facebook for some while. The participants are evenly distributed in terms of the number of years they have used Facebook, frequency of visit per day and the number of friends that they are connected to. On average, each participant is connected to 189 friends, which somehow represent the average connection of Facebook users. All participants but one visit Facebook at least once per day and spend at least one hour on Facebook in a week. This shows that the participants are experienced in Facebook usage and the variation in the frequency of visit and the number of friends connected to ensure that those participants are representative of Facebook users.

5. Results Analysis and Discussion

The evaluation of our systems reveals rich set of results and some interesting discovery contrary to our expectations. In this section, we present the result from the evaluation of the individual visualization systems and discussed the implication to the design of visualization in general and specifically to the design of visualization for any social networking systems.

5.1 EntourageViz with Force Graph Layout Visualization Layout

From the analysis of the data gathered from the observation of the participants, think-aloud section, and from the interview, we discovered that initially, the participants appreciated and liked EntourageViz with the force graph layout visualization more than the other three visualizations. This is not contrary to our expectation since the picture added more visual appeal that raises the curiosity of the participants by making them to look with keen interest in attempt to identify their friends from the pictures. However, this feeling drastically reduced during the interview session when the participants were asked to perform some task (E.g How many female friends does a particular friends have?) using the information provided in the visualization. At this point, almost all the participants complained that the visualization is confusing and complex, as it’s hard/takes time to find the information needed to answer the questions. However, they were able to perform the task and respond to the five questions asked during the visualization though some questions were answered guessing. Another problem that the participants complained about and we also observed is how hard it is to separate some of the nodes. This is to an extent a problem inherent in most of the SNSs visualizations that uses force-directed graph, which makes the visualization move as an entity and also tends to recoil back after dragging. For example participant P101 said, “it’s difficult to separate the nodes in some of the visualizations.
because the entire graph moves as a single entity”. One participant suggested popping-up a node with its picture and their direct connections/links on-click to increase the usability and possible eliminate the need of dragging the nodes.

5.2 EntourageViz with Force Graph X-Ray Layout

As already explained, in this particular visualization, the pictures were removed, colors were used to indicate gender of the friend, and the size of the nodes used to indicate the number of friend connected to a node. Unlike the EntourageViz with the force graph layout, initially, this particular visualization was less attractive to the participants as they were more interested in exploring the pictures in the EntourageViz with the force graph layout than the force graph X-Ray layout. However, performing tasks, finding information made user to explore this X-ray layout visualization. Interestingly, it received 100% acceptance from the user as the best way they would prefer the visualizations to be displayed. Participants did not just perform the task and answered the questions but they spent lesser time; in some instances, they took as low as half of the time they spend in the EntourageViz with the force graph layout visualization. The acceptance rate was contrary to our expectation. Some of the participants in response to why they preferred this particular visualization, said p110, “I don’t like pictures, they are deceptive, one could use someone else’s picture as a profile picture”, p107 said, “Picture is not good, makes the visualization clumsy... ”, p106 said, “It’s very simple, less detail information makes it easy to find people. The background and the visualization line is distinct, it is easy to differentiate, and I like it!” One participant suggested displaying picture only as an alternative on-click of a particular node; another said it would be interesting if we can also include the ages of friends.

5.3 EntourageViz with Matrix Visualization Layout

Only few people preferred the matrix visualization especially for some task that have to do with identifying friends of the same gender. This is basically because they were able to figure out the gender by mere looking at the color. The color distinction makes it easy to spot out the gender without necessarily doing much work with the visualization itself. On average, all participants but one performed the tasks and answered the questions using the matrix visualization. The participant who was unable to perform the given task using the matrix visualization has phobia for mathematics and therefore hated the visualization so much because according to her, matrix visualization has close resemblance with mathematics. She said, “Matrix is not easy to use at all, it’s something like mathematics which I hate”. Another participant really rated matrix so high and preferred it because it involves just a simple mathematical concept of counting. He said, “It’s easy, in overall, I think it’s better because I just need to count the number of dots no need to move the visualization”. Though we did not specifically ask the users questions to reveal their notion/feelings toward mathematics, the revelations from these two participants made us think that there might be some correlation between interest in mathematics and users perception about a particular visualization. We recommend exploring this relationship. In general, two participants suggested that highlighting and popping-up the row and column of interest on-click by the users will increase the usability of this particular visualization.

5.4 EntourageViz with Arc Visualization Layout

The Arc visualization appealed to almost all the participants because of its distinct nature. Unfortunately, despite all the enthusiasm to use it, it scored the least, as participants were not able to find the information needed to perform the specified tasks and respond to the questions. Out of the five
tasks that we gave the participants, they were able to perform only one and that is basically the question that has to do with finding friend with the least/highest number of connections. This is the easiest for answering this question as shown in Table 2. This is expected because despite the fact that the node size represents the number of connection a particular friend has, the visualization sorted the friends in decreasing order of number of friends they are connected to.

5.5 The Visualizations in General

Table 2: Summary of the preferred Visualization(s) for each question.

<table>
<thead>
<tr>
<th>Task Questions</th>
<th>Preferred Visualizations</th>
<th>EntourageViz with Force Graph Layout</th>
<th>EntourageViz with Force Graph X-ray Layout</th>
<th>EntourageViz with Matrix Layout</th>
<th>EntourageViz with Arc Layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many friends is a named person connected to?</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many friends of the same gender is a named person connected to?</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Which male/female has the most/minimal friends?</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Is a selected friend a male or a female?</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Does a friend A and friend B have a common/shared friend? If yes how many shared friends are male/female?</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

As shown in Table 2, EntourageViz with force graph X-Ray layout is all round winners as almost all participants preferred it and were able to perform the five-assigned task with it. Some of the desired characteristics that enable ease of use are, the distinct background color, absence of picture by default, clear and tiny links to the nodes, and the use of color. On the other hand, EntourageViz with the force graph layout visualization is preferred equally for finding the number of connection a particular node has and in finding common/shared friends. EntourageViz with Matrix layout however, is preferred for questions that involve determining gender. The reason being that matrix visualization as aforementioned uses color to differentiate male from female thereby making it easy to identify at a spot a friends gender, this is also applicable to EntourageViz with force graph X-Ray layout and EntourageViz with Arc layout. But Arc visualization is not good for all question that has to do with tracing connection basically because the lines are blurred and confusing, however, it’s good for comparing size friends and gender following the use of color and the arrangement of the nodes based on their sizes.

As shown in Figure 9, 80% of all the participants said that the visualization is useful/necessary and only 10%, which correspond to the participant that has used Facebook for just four months, said the visualization is not useful. A post interview with this participant to find out why he think the visualization is not useful lead to this response “I think that it’s not useful because I don’t want to know my second degree friends, mutual friends or their genders”. It’s obvious that this particular participant is not a committed user of Facebook.
Figure 9: Response to the usefulness of the visualization

Again, as shown in Figure 10, 90% of all the participants gave the visualization a rating equal or greater than 7 based on their satisfaction, where 10 donates most satisfied and 1 the least satisfied. On average the visualization received a rating of 8 out of 10 approximately. This shows that the participants were actually satisfied with using the visualizations. The visualizations did not get an extreme rating of 9 and 10 probably because of the amendments to the systems suggested by the participants. Again 90% of the participant said that the visualization is necessary and they will prefer to use it as opposed to the Facebook conventional search method. This clearly shows the potential of integrating this type of visualization to SNSs especially Facebook. 60% of the participants said they discovered new information from the visualization. For example, p105 said “The gender-wise friends visualization is a new thing...” p106 said, “I found who is the most connected person in my network” p107 said, “I found Male to Female ratio of friends” and p110 said, “Rita has fewer mutual friends in the studied community. Amazing finding! ”.

Users also played with the various interactive features, often without pursuing a specific task. In particular, users enjoyed zooming navigation and experimenting with the real-time layout, whether dragging items around to separate clusters apart or dragging item around to build up some sort of community and then watch them recoil back to the network upon release. One participant suggested adding mechanism to view friends profile on click.

In all, we found that the visualization was used by participants to both explore and play with their networks by expanding the network to larger depths, exploring community structure, and performing visual analyses while simultaneously maximizing their social experiences. Although more formal comparative and longitudinal studies will be required to fully assess the utility of the individual visualizations with their introduced features, the engaging yet playful exploration and discovery we observed helps validate our design assumptions. As one participant said “…I can see the cluster of my
friends and find the person who have the highest connections so I can ask him to help me find a job or future wife (maybe)"

6. Conclusion and Recommendations

In this paper, we have described the design and implementation of EntourageViz visualization systems for exploring friends’ relationships/connections in Facebook connection. The design of EntourageViz was motivated by the increasing need to encourage user participation in SNS and increase their online social experience. EntourageViz visualization is an experiment in applying the fruits of information visualization for end-users visualization of their connectedness with their friends rather than for network analysis. Therefore, EntourageViz not only contributes to research on social network analysis techniques designed to reveal information and maintain playful and increased social experience, it validates the theories on the design of usable and engaging visualization by comparing four different visualizations on the same network. Some of these features include connectivity highlighting and linkage views for users to explore greater network contexts, X-ray mode, and community analysis for investigating higher-level community structures. Observations of usage show that users found these features both useful and enjoyable for exploring the online networks.

Contrary to some of the practices of information visualization experts, pictures are not always preferred. In fact, more than half of the participants disliked the EntourageViz with force graph layout visualization having pictures. According to the report from one participant, “picture makes the visualization complex and clumsy”. Another interesting finding is that the background of the visualization contributes to the understandability of the visualization. The significant lesson from limit themselves to one particular type of visualization design but should vary their visualization design choices based on the information they want to convey to the users. In fact, we suggest combining best (preferred) features from different visualization designs (see Table 2) to produce a usable and comprehensive visualization that are more likely to be accepted. “That some applications succeed and others fail is not based on pure chance; success can be learned and replicated.” The main problem, which visualization design experts might have to battle with, is providing all the necessary features needed while maintaining the usability (easy of use) and simplicity of the system. With minimal effort, we recommend using customization in visualization design. This will enable users to explore both the simple visualization and, if desired, the complex features.

The main limitations of this work revolve around the number of participants used in the evaluation of the design. Ten participants maybe too small a size to claim generalizability of the results of this finding. Moreover, all participants have the same background (computer science graduate students) and might not be representative of average Facebook users. These limitations are solely caused by the time constraint of a single term and the University requirement for ethics approval for any human subject research thereby limiting the scope of recruitment of participant to people in the same department.

In the future, we hope to include some of the features suggested by the participants (like age and pop-up/highlighting of node on-click) and to explore the extension of these techniques to the analytical domains, where a more rigorous evaluation will be carried out on more and diverse participants to validate the system. This work advances our understanding of how to best provide better visualization support to end-users in social networks.
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References

[7.] Steele, J and Iliinsky, N. Beautiful Visualization: Looking at Data Through the Eyes of Experts.. O’Reilly publication Canada, 2010, 103 – 173
[8.] Freeman, L. Visualizing Social Networks. Journal of Social Structure, 1, 2000
[15.] http://www.touchgraph.com/


Appendix

Team Responsibility

Rita:

- Project idea and Proposal write up
- Visualization design
- Application evaluation strategy development
- Application evaluation
- Result analysis
- Final report write up
  - Main idea and functionality
  - Literature review
  - Social computing issues and technique involved
  - Results Discussion and Conclusion
  - Project report integration

Yudi:

- Project idea and Proposal write up
- Visualization design
- Project code implementation
- Application evaluation
- Final report write up
  - Architecture of implementation
  - Technology used
  - Obstacle reflection
Sample Tasks Performed by the Participants using The Systems

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many friends is a named person connected to?</td>
<td></td>
</tr>
<tr>
<td>How many friends of the same gender is a named person connected to?</td>
<td></td>
</tr>
<tr>
<td>Which male/female has the most/minimal friends?</td>
<td></td>
</tr>
<tr>
<td>Is a selected friend a male or a female?</td>
<td></td>
</tr>
<tr>
<td>Does a friend A and friend B have a common/shared friend? If yes how many shared friends are male/female?</td>
<td></td>
</tr>
</tbody>
</table>
Sample Online Questionnaire

EntourageViz - A facebook visualization interface to help user browse friend connections
Please answer the following question to help us evaluate the system and possibly improve on the design.

* Required

Identification *
Evaluator ID

If you are a facebook user: *
How many friends do you have on facebook

If you are a facebook user: *
Describe how often do you check your facebook status (such as once per day)

If you are a facebook user: *
How long have you been using facebook?

1.*
Is the visualization method adopted in the system useful for you?
☐ Yes
☐ Neutral
☐ No

2.*
Please give a reason why the visualization is useful or not

3.
Can you give any suggestion for improving the visualization.

4.
How can you rate your satisfaction with using the system

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Satisfied</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Most Satisfied</td>
</tr>
</tbody>
</table>

5.*
What do you think about integrating a system for visualizing friends connection (connectedness) in Facebook?
☐ Not Necessary
☐ Necessary
☐ Neutral

10.*
Would you prefer using this type of visualization over Facebook conventional search method in checking out connectivity
☐ YES
☐ NO
☐ NEUTRAL

13.*
Is there any new information you discovered from this visualization
☐ YES
☐ NO
☐ NEUTRAL

14.*
If "Yes" can you please comment on that?