



Alcohol Consumption Behavioral Contextualizer

A Major Qualifying Project Report

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Abstract

Excessive alcohol consumption is a growing public health problem in the United States. There are many smartphone applications that track user's drinking habits in order to solve this problem; however most do not provide contextual information such as recurrent drinking locations, times and people, which might make them more inclined to change his/her behaviour. This Major Qualifying Project focused on researching and developing a smartphone application that displays visualizations of contextual information of a subject's alcohol drinking habits. Three important drinking contexts our application visualized were drinking locations, drinking times, and people the user drank with. Data visualization presents data in a visual or graphical format to users in a way that users can easily discover recurrent patterns and understand information that is not obvious. Research steps included first identifying alcohol context and researching different types of charts to visualize those contexts. Surveys and focus groups were conducted to narrow down and compile an ideal set of visualizations, which were implemented into the mobile application AlcoContextualizer.

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1. Introduction

Alcohol abuse has been a growing public health problem in the United States (Drug Addiction Statistics [10]). According to a fact sheet from the Centers for Disease Control and Prevention (CDC), one of the most common patterns of excessive alcohol use is binge drinking (Fact sheets - Binge Drinking [11]). The National Institute on Alcohol Abuse and Alcoholism defines binge drinking as a pattern of drinking when men consume 5 or more drinks, and when women consume 4 or more drinks, in about 2 hours (NIAAA [22]). The CDC mentions that one of six U.S. adults binge drinks about four times a month, consuming about eight drinks per session. The CDC lists some of the health-related problems associated to binge drinking in its facts sheet. This list includes alcohol poisoning, sexually transmitted diseases, liver disease, unintentional injuries (e.g. car crashes and drowning), and intentional consequences (e.g. sexual assault and domestic violence). The cost of drinking too much in the United States, according to the CDC, was \$249 billion in 2010 from losses in productivity, health care, crime or other expenses, and binge drinking was responsible for 77% of these costs, or \$191 billion. The CDC recommends moderation and control over alcohol consumption to reduce the problem.

Mobile applications have become a popular means for tracking health or activity data of users. Tracking is a proven method to change many bad or unhealthy behaviors. An activity that many users to keep track of in order to change or moderate, is their alcohol consumption. Users record their drinking activities over time to monitor the amount of alcohol consumed. There are many mobile applications that currently help users keep track of their alcohol intake such as AlcoDroid and the Stop Drinking Alcohol app. Even though the goal of most of these applications is to make their users drink alcohol responsibly or at least decrease their consumption amount, they only do it temporarily by helping you keep track of your alcohol consumption to calculate your blood alcohol content per drinking session. What these applications lack is the ability to monitor users drinking pattern and provide feedback to the user over long term. Most applications do not analyze context behind the occurrence of drinking either. They merely track alcohol consumption and lack the ability to visualize the context in a way that users can see patterns in their consumption behavior.

Alcohol context involves external factors that cause a user to drink. There have been many related studies in the area of alcohol drinking context. **Context** is defined as

circumstances that form the setting for a particular event. (The Definition of Context). We investigated what enabling factors and cues influence alcohol consumption and found that contexts that can be potentially useful in an alcohol consumption tracker application include where the person drank (location patterns), what time did they drink (temporal patterns), who were they with when they drank (social patterns). An application that incorporates all this information would record and visualize the context behind the user's alcohol consumption. It would provide visualizations of the data in a way that users could easily recognize recurrent patterns of drinking context, visualized through carefully designed graphs and images. An application like this would assist users in better understanding causes and reasoning behind why they chose to drink. It will provide relationships between drinking to external factors that users may not even realize. We envision a mobile application can display visualizations of recurrent drinking contextual patterns so that the user can self-reflect and self-correct, mitigating problematic binge drinking longer term unlike any other applications currently in the market.

The goal of this MQP: The goal of this project is to create an Android application that visualizes the context that influence smartphone users' alcohol consumption. The application itself would display glanceable visualizations and graphics that are easily understandable, informative, and visually appealing to the user. The users should be able to identify their patterns of alcohol consumption behavior through the visualizations. Another sub-goal of this project involves creating an interactive mobile application that provides a great user experience and will keep the user engaged in the information provided by the application. This project will utilize user-centered design principles involving iterations that are presented to users for feedback, wherein the first iteration is to determine an initial set of design visualizations that additional iterations will revise implemented visualizations.

The following tasks will be performed to accomplish the goals of this MQP:

1. Review literature on alcohol drinking contexts.
2. Create a list of information visualizations that can present these contexts effectively.
3. Conduct user surveys and focus groups to assess effectiveness of the selected visualizations.
4. Develop an Android application using the best visualizations for each context
5. Evaluate the application through additional user testing.

2. Literature Review

2.1 Context

With regards to alcohol consumption, context can be further divided into the fields of psychology and technology.

2.1.1 Context in Psychology

Psychological context looks more into the factors that influence a person's mentality or emotional state. These are factors that are not typically quantifiable, and need to be observed and explored in order to identify a relationship with alcohol consumption. Simone Pettigrew performed a study that modeled how behavior changes can influence the consumption of alcohol. Factors such as emotional state, social upbringing, and cultural environment can influence when a person decides to drink. The study states that the decision to drink is heavily determined by the person's response in situations involving these factors. Thus, it is difficult to measure and record the psychological contexts that influence a person when consuming alcohol using a mobile application (Pettigrew [26]).

2.1.2 Context in Technology

However, there are other measurable contextual factors that can be captured and tracked by a mobile device. In regards to technology, applications can analyze and visualize contextual information. Context is either a factor that determines the behavior or is relevant to an application. Guanling Chen and David Kotz have generally defined context in mobile computing as, "Context is the set of environmental states and settings that either determines an application's behavior or in which an application event occurs and is interesting to the user."(Chen and Kotz [7]). Some examples the authors give of context are user location, time of day, nearby people and devices. The authors further categorize the types of context into active and passive. Active context influences the application by causing the application to automatically adapt to the context and change its behavior. An example of active context application awareness is adapting to location. At certain locations, such as at work, users will be notified on their device such as reminders of a meeting. A passive context aware application

presents the new or updated context to the user, or makes the context information persistent for later use. In a similar example of location, the context information of the user would be stored at a location without changing the application behavior. Thus, the user may decide to look at the list of locations traveled to in the day, where the context information would be recorded in the background, keeping track of information such as time of day.

For this MQP, this application would be classified as passive context aware. The context being displayed to the user are in regards to the user's alcohol use. The application will look to display and persist the context of alcohol consumption to the users. The context displayed would be the environmental factors (e.g. location of having a drink) and drinking information (e.g. amount drank at a given point in time) of alcohol consumption. Contextual factors for alcohol can range from the number of drinks, to the locations of drinking. Our mobile applications, which we call AlcoContextualizer, uses these external factors to establish a correlation to the behavior of alcohol consumption.

2.1.3 Related Studies

A Vietnamese study explored student drinking motives and context as predictors for alcohol consumption. (Diep, Tan, Knibbe, and Vries [9]) The study looked to see what contexts would lead to alcohol consumption, as well as if the context affected the amount of alcohol consumed. The study asked students to fill out information when drinking regarding the amount of alcohol, duration of drinking, occasion, location, amount of people drinking with, date and time, and the relationship to those people. The study resulted in finding that drinking duration had the strongest association with alcohol consumption. There was more alcohol being consumed when context variables of duration of drinking and amount of people present were greater. From this study, we should focus on drinking variables of the duration of the drinking occasion, the time and date of the occasion, and the number of additional individuals drinking with during the occasion.

Another study looked into underage drinking at college campuses (Foster [12]). The study looked at environmental variables, such as access to alcohol, price of local alcohol, and location of alcohol distributors. It concluded that there was a correlation where cheaper prices and easy access to alcohol correlated to more occasions of binge drinking. From this study, it can be seen that environmental factors can influence alcohol drinking behavior. Thus, it is important to note that context should include environmental variables to be tracked in the

application.

A third study looked at how a workplace drinking culture can affect an individual's drinking habits (Amick [4]). The study researched how individuals that tend to associate or work with others that frequently drank also followed suit. It concluded that there is an association between drinking behavior and the people that an individual drink with. Thus, alcohol context should also include the people drinkers drink with and possibly how they are associated with the individual.

Based on these studies, we have compiled a list of criteria factors that are relevant to drinking context seen in Table 2.1.

Context Variables	Study
Where: Location of Drinking session	<i>Foster [12]</i>
How frequent: The frequency of drinking in a set time period	<i>Diep, Tan, Knibbe, Vries [9]</i>
How much: The amount of drinks per session	<i>Diep, Tan, Knibbe, Vries [9]</i>
Who with: The relationship to the people drinking	<i>Amick [4]</i>

Table 2.1: Context Variables Derived From Related Studies

2.2 Visualization

2.2.1 What is data visualization?

Data visualization is simply the method of consolidating data into one collective and illustrative graphic (Vaidya and Chavan [30]). Although it is common to think of data visualization as a relatively modern development in statistics, the notion of using pictures to communicate has been around for centuries, from maps and graphs in the 17th century to the invention of pie chart in the early 1800's (Elsa Wong [32]). Data visualization is closely related to areas such as information graphics, information visualization, scientific visualization and statistical graphics. In recent days, data visualization has become an active area of research, teaching and development.

2.2.2 Why use data visualization?

“The main goal of data visualization is to communicate information clearly and effectively through graphical means. It doesn't mean that data visualization needs to look boring to be functional or extremely sophisticated to look beautiful. To convey ideas effectively, both aesthetic form and functionality need to go hand in hand, providing insights into a rather sparse and complex data set by communicating its key-aspects in a more intuitive way (Friedman [13]).”

2.2.3 Characteristics of effective data visualization

According to Dr. Edward Rolf Tufte's “Data Visualization”, an American statistician and professor emeritus of statistics, and computer science at Yale University, a powerful data visualization consists of complex ideas communicated with clarity, precision and efficiency. Graphical displays should:

1. show the data
2. be simple yet powerful
3. induce the viewer to think about the substance rather than the design
4. avoid distorting what the data has to say
5. present many numbers in a small space
6. encourage the eye to compare different pieces of data

2.2.4 Benefits of visualization:

SAS (Statistical Analysis System [8]), one of the leaders in innovative analytics, business intelligence and data management software and services states that data visualization:

1. Provides visual access to huge amounts of data in easily digestible visuals
2. Identifies relationships and new patterns
3. Pinpoints emerging trends
4. Distinguishes exceptions and outliers
5. Quickly analyses data over time
6. Makes grasping difficult concepts easier

2.2.5 Some visualization technique examples

The following list provides some common visualization techniques that are candidates for visualizations to be used in our application to represent user contexts. They were presented to users as mockups on which we received feedback. Results gathered from user surveys and focus groups determined their effectiveness and whether to include them in our final application. These charts have been divided using visualization types into three categories based on a taxonomy from Schneiderman[25]. The taxonomy is heavily weighted toward the more abstract information visualization techniques and is less representative of scientific visualizations, which can be highly specialized by domain and are more difficult to generalize. Example charts are provided for each category below.

2.2.5.1 2D/Planar

According to Shneiderman [25], 2D area types of data visualisation are usually geospatial, meaning that they relate to the relative position of things on the earth's surface. He defines that user tasks for these types of visualization are typically to “find adjacent items, containment of one item by another, paths between items, and the basic tasks of counting, filtering, and details-on-demand.”

2.2.5.1.1 Choropleth Map:

Choropleth Maps display divides geographical areas or regions that are coloured, shaded or patterned in relation to a data variable. This provides a way to visualize values over a geographical area, which can show variation or patterns across the displayed geographic region (locations). Figure 2.1 is an example of a choropleth map, which shows US states where baseball players were born in since 1870.

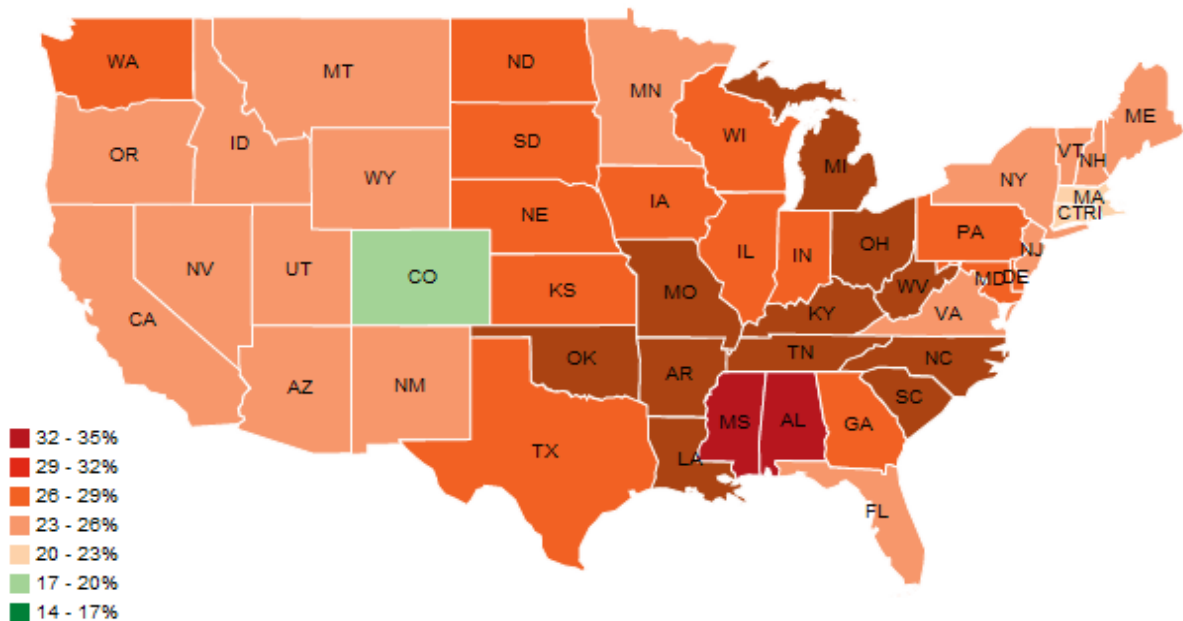


Figure 2.1: A Choropleth map mapping Major League talent over time (Mapping Major League Talent over Time [21])

2.2.5.2 nD/MultiDimensional

According to Schneiderman, for multi-dimensional visualizations, data elements involve multiple attributes that correspond to points on a multiple dimensional space. User tasks for these types of visualizations include “finding patterns, clusters, correlations among pairs of variables, gaps, and outliers.” (Schneiderman [25])

2.2.5.2.1 Line Graphs:

A line graph is multidimensional visualization type that shows the relationship between one variable and another and is most often used to track changes or trends over time (The Data Visualization Catalogue [28]). Figure 2.2 is an example of a line graph, which shows variation of speed over time.

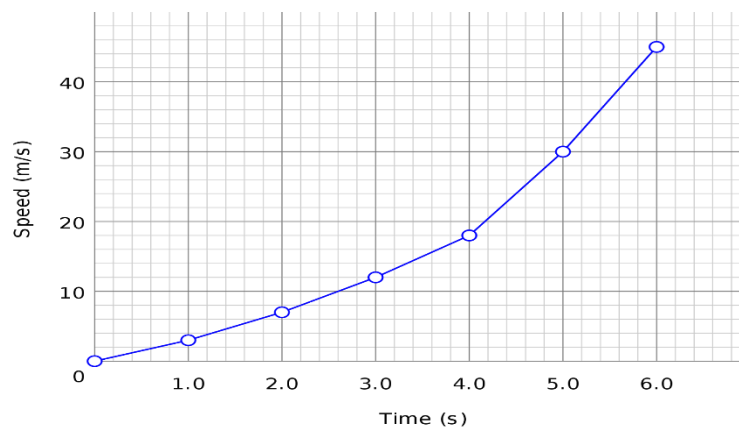


Figure 2.2: Graph showing speed over time (Sharma [24])

2.2.5.2.2 Bar Charts

A bar chart is most commonly used for comparing the quantities of different categories or groups by providing different colors to bars (Sharma [24]). Figure 2.3 is an example of a bar chart, which compares quantity of blue and green over several categories (A, B, C, D, and E).

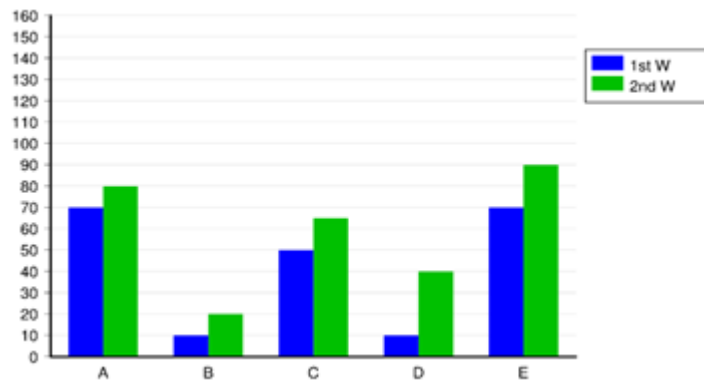


Figure 2.3: Bar chart comparing two quantities

2.2.5.3 Tree/Hierarchical

According to Schneiderman, hierarchical visualizations involve data sets that are orderings of groups in which larger groups encompass sets of smaller groups. Tasks can include identifying the number of levels in the hierarchy, number of children per item, and links to each item. (Schneiderman [25])

2.2.5.3.1 Tree Map

Tree Maps provide a way to visualize hierarchical structure while also displaying quantities for each category via area size. Subcategories are represented as rectangles that are nested inside of categories and are displayed in proportion to that quantity and to the other quantities within the same parent category. Figure 2.4 is an example of a tree map, which visualizes pets within a shop with the four parent categories, namely birds, mammals, fish and reptiles, along with zebra finches, dogs, goldfish, and geckos as the largest subcategory of the respective parent categories.

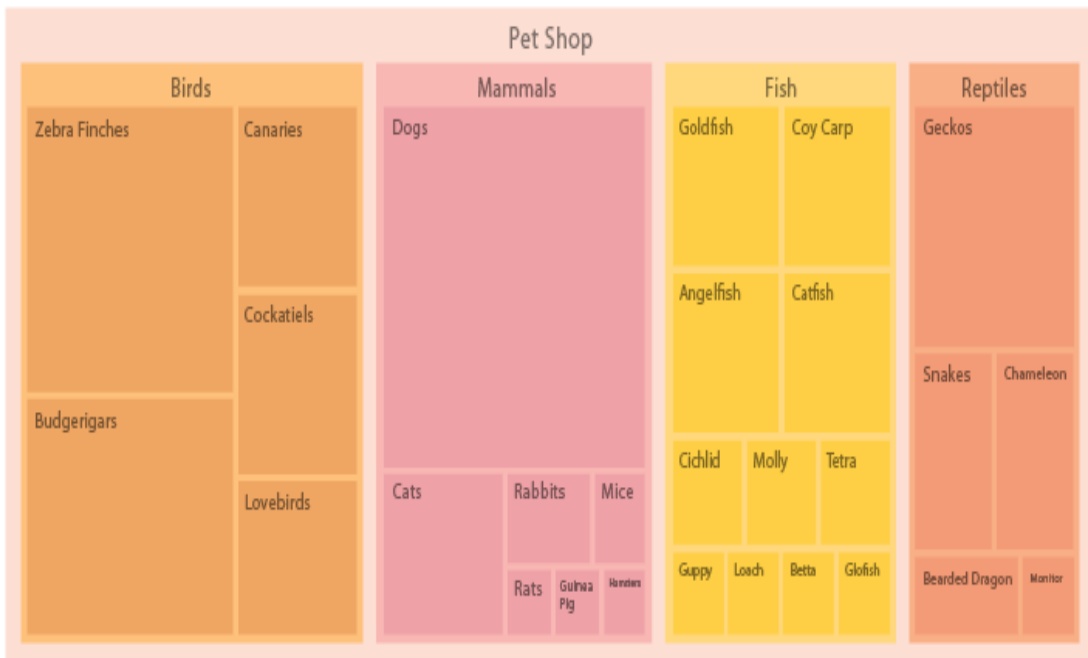


Figure 2.4: A Tree Map visualizing number of pets in a shop (Data Visualization Catalogue [28])

2.2.5.3.2 Quantified Self Spiral Visualization

Quantified Self (QS) is defined as the use of personal data to improve one's health and well-being (Kurt [19]). The concept involves tracking sleep patterns, diet and other factors and making lifestyle changes based on the results. A QS spiral aims to capture the periodic properties of quantified self-data and lets user explore those recurring patterns (Larsen, Andrea, and Sune [20]). Figure 2.5 is an example of a quantified self-spiral visualization, which shows a week view that shows the geolocation data captured over a 4 month duration. According to Larson, Andrea, and Sune, the interactive visualization display is separated in three parts with the QS Spiral in the center. On the top is a tag cloud showing the most frequently visited places in colors corresponding to the colors shown in the spiral. The bottom of the display contains time series of places with map segments showing the places visited.

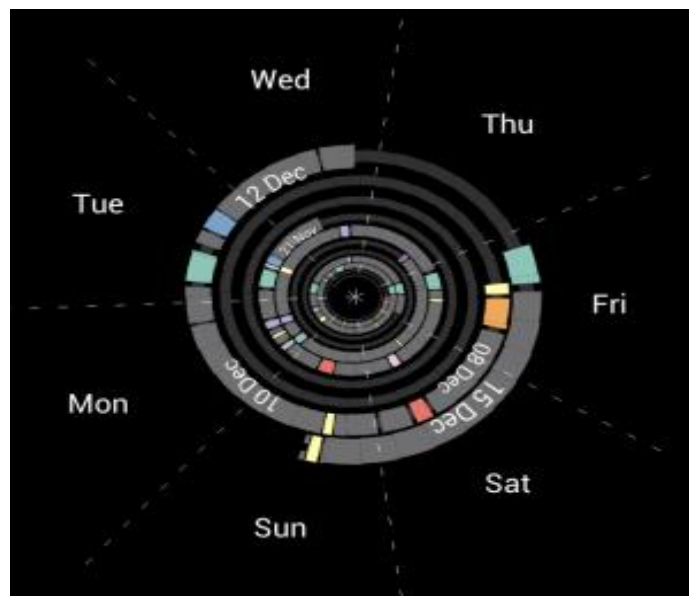


Figure 2.5: A week view showing geolocation data (Larsen, Andrea, and Sune[20])

2.3 Related Applications

There are a number of applications available today in the Google Play Store for tracking habits and monitoring alcohol consumption. Some of these applications include: AlcoDroid Alcohol Tracker¹ and Stop Drinking Alcohol App². In the context of this project, each of these apps offer some unique features that could be useful in helping the user break out of their alcohol consumption habits.

2.3.1 AlcoDroid

Alcodroid is a popular application that allows its users to be able to track alcohol consumption. The user first sets up a profile in which permanent information such as body weight and sex can be stored. This information can later be used to estimate the blood alcohol level (BAC) of the user. The user can then log drinks. That can range from a light beer to a shot. Once drinks are added, data can be viewed in multiple views. By default, the BAC is displayed in big letters and the color is dependent on the BAC level as seen below in figure 2.6-1. Figure 2.6-2 is a graph that shows a timeline of the estimated BAC which you can scroll through. However, some additional views are available to see the recorded data. The first one is a simple summary of the how much the user has drunk over different periods of time. It shows the current day's alcohol consumption, over the last 7 days etc. Alternatively, a combination of bar graphs and line graphs shows money spent and the amount drunk over time. The user is able to select whether the time is daily, weekly or monthly.

In addition, the user is able to track the estimated amount of money spent on drinking as well as displaying information about behavior change that can occur when drinking per range of BAC. Finally, the user can also keep track of the number of the sober days.

This application offers a few interesting features. It is worth noting that having multiple views for the user to pick from to view the data is important because it gives the user some sort of freedom over how he or she views and interprets the data. However, the app does not display drinking context. Data about context such as with who, where, when are missing. From our prior research, such contextual variables might be very useful to the user.

¹ *AlcoDroid Alcohol Tracker*. Computer software. *Google Play Store*. Vers. 2.27. Myrecek, 5 Sept. 2016. Web.

² *Stop Drinking Alcohol App*. Computer software. *Google Play Store*. Vers. 1.1. Oristats, 7 Dec. 2013. Web.

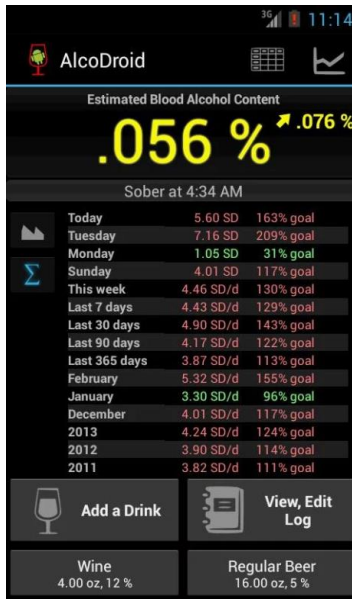


Figure 2.6-1: Alcodroid screen that displays the amount of drinks for certain time frames as well as BAC¹

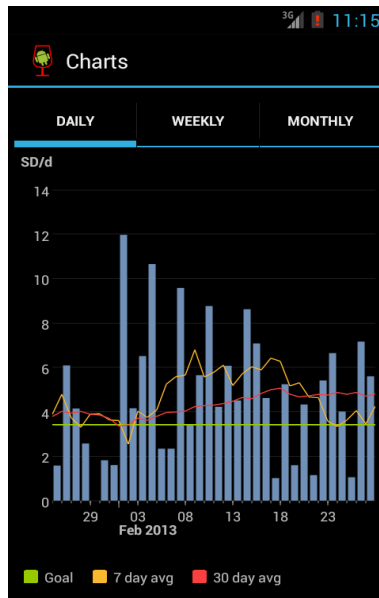


Figure 2.6-2: Alcodroid screen that displays a daily view of alcohol consumption of a certain month using a bar chart¹



Figure 2.6-3: Alcodroid screen that shows graph of an estimate of when user will become sober¹

2.3.2 Stop Drinking Alcohol

This app is geared more towards staying sober. Users are able to add drinks and a calendar shows what days the user has previously drank which makes the app a very simple application. The app also includes motivational quotes that are supposed to motivate the user to stay sober for the day. The quotes are either famous quotes, such as words from Mark Twain (see Figure 2.7-1), or from other anonymous people also trying to stay sober(see Figure 2.7-2). The simplicity of this app could serve as an inspiration for what we are trying to achieve.

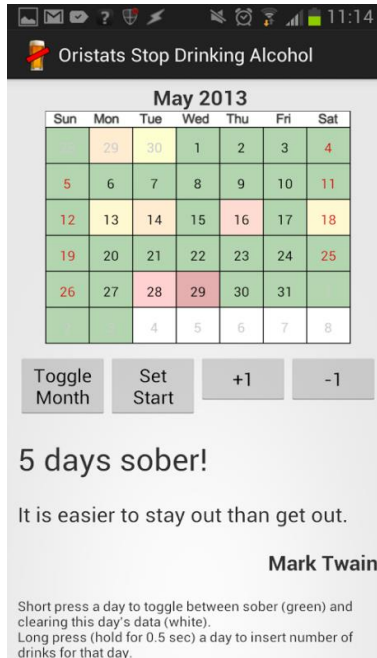


Figure 2.7-1: Stop Drinking Alcohol app screen that shows a color-coded calendar view to indicate how much alcohol the user drank²

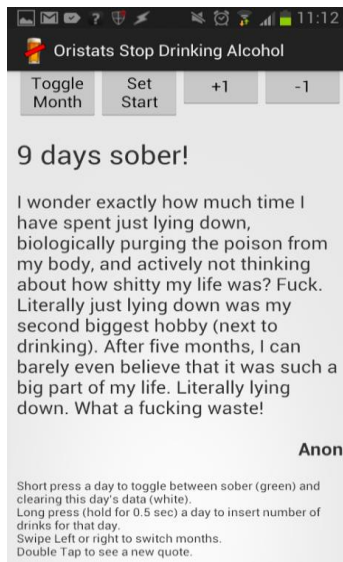


Figure 2.7-2: Stop Drinking Alcohol app screen that tells the user the number of days they have stayed sober thus far²



Figure 2.7-3: Stop Drinking Alcohol app screen that allows the user to add new drinks²

2.4 Final List of Context Variables to Visualize

After researching other studies and applications, we have come up with the following list of contextual variables for alcohol, which we should explore visualizations of and which our app should visualize.

Context Variables	Study
Where: Location of Drinking session	<i>Foster [12]</i>
How frequent: The frequency of drinking in a set time period	<i>Diep, Tan, Knibbe, Vries [9]</i>
How much: The amount of drinks per session	<i>Diep, Tan, Knibbe, Vries [9]</i>
Who with: The relationship to the people drinking	<i>Amick [4]</i>

Table 2.2: Table of Conclusive Criteria and Supporting Study

These contextual variables are similar to contexts that have been explored by other studies that established some correlation. Thus, we believe that these are relevant context to explore visualizations of.

We have further grouped the contextual variables into three main variable groupings regarding alcohol consumption context. The criteria are Location, Time, and People. Each of these contextual variables have been associated with user tasks, which the user will perform using the visualizations. The user will be required to identify certain information within the visualizations in order to understand the contextual information. These user tasks were formulated from the related studies and final list of contextual variables, as seen in the above table Table 2.2.

Main Alcohol Contextual Variables and associated User Tasks:

- Location
 - Most frequently visited drinking locations
 - Most recently visited drinking locations
- Time
 - Amount of drinks in a month (standard drinks)
 - Amount of drinks in a day (standard drinks)
- People
 - People user drinks most with
 - Groups of people user drinks with

3. Methodology

Having finalized the set of contextual variables as defined in the literature review, the next step was to begin identifying the best way to visually present the data in a meaningful way that is understandable to the user. There are many ways to present data, such as tables, charts, and other graphics. Looking at several different studies of visualization techniques, it became evident that using charts and using graphic oriented interfaces might be the ideal way to create the application. Thus, this MQP focused on visualization techniques that could capture information in a visually appealing way and is also easy for users to understand.

For each contextual variable, we defined a set of tasks (see table 3.1) that the visualization should assist the user in performing. For task that we derived for each contextual variable, we began researching different ways to visually represent them. Initially, we referred to and gathered information from two well-renowned books for visualization techniques, *Visualization of Time-Oriented Data* (Aigner, Miksch, Schumann and Tominski [2]) and *Interactive Data Visualization* (Aigner et al and Ward [31]). Using these books, we were able to understand the “family” to which different charts and visualizations belonged. For example, we discovered that a heat map belonged under the “Location” family and a calendar belonged under a “Time” charts family and so on. After understanding the chart categories and relationships between them, we were able to gather multiple example images of visualization techniques for each task using *The Data Visualization Catalogue* and *Google Charts* gallery (The Data Visualization.. and Charts Gallery). The top three charts that we felt were good candidates for each task are displayed below, and rationale for all gathered charts obtained from the books mentioned above are summarized in Tables 3.2, 3.3, 3.4, 3.5, and 3.6. Although the final design would consist of charts that are fully coded, displayed and interactive on an Android device, to speed up survey development, we chose to simply super-impose images of the selected visualizations on an Android device for now. This decision was made solely to save time and speed up the process of getting user feedback for picking the best charts that represent each task. To converge on a final design, two separate methods to gather user opinion were utilized, a survey and a focus group.

Contextual Variable	Tasks
Location	<ul style="list-style-type: none"> ● Most frequently visited drinking locations ● Most recently visited drinking locations
People	<ul style="list-style-type: none"> ● People you drink most with ● Groups of people you drink with
Time	<ul style="list-style-type: none"> ● Amount of drinks in a day (standard drinks) ● Amount of drinks in a month (standard drinks)

Table 3.1: Shows the different contextual variables associated with their tasks.

Table 3.2 provides rationale for charts representing most recently and frequently visited locations gathered from two books for visualization techniques, namely *Visualization of Time-Oriented Data* and *Interactive Data Visualization* (Aigner et al and Ward [2]). The charts mentioned in the table are shown in Figures 3.1-1, 3.1-2, and 3.1-3 in the same order following the table.

Charts	Description	Rational
Bubble Map	Provides feature of using bubbles to rank different locations depending on their size	Easy to identify most frequent drinking locations through size of bubbles on a map
Geo Chart	Provides feature of using colors to rank different locations	Easy to identify most frequent drinking locations through shades of colors on a map within a set of boundaries
Heat Map	Similar to a geo chart, but instead of different colors, densities of different colors can be used to rank different locations	Easy to identify most frequent drinking locations through densities of colors on a map, using one color to represent higher frequency and another for lower

Table 3.2: Description and rationale for charts for showing frequent drinking locations, taken from Data Visualization Catalogue[28] (Figures 3.1-1, 3.1-2, and 3.1-3).

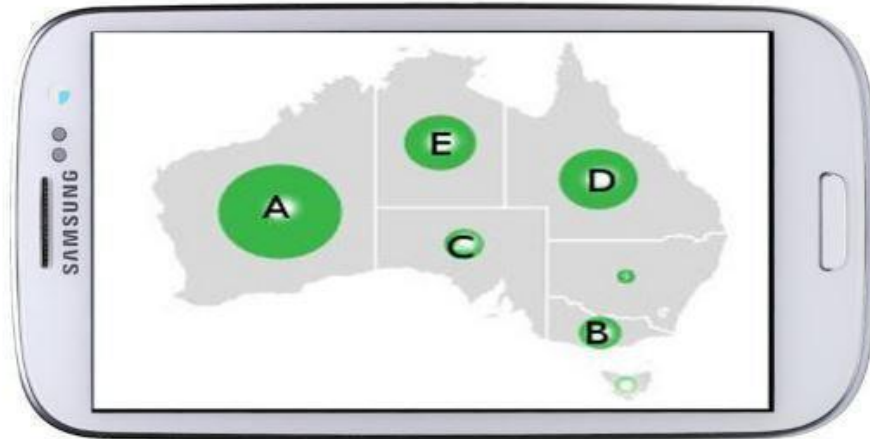


Figure 3.1-1: Bubble Map showing frequently visited drinking locations. The size of the circle represents how frequently the user visits that location to consume alcohol, with A being the most and C being the least frequently visited drinking locations. In this case, the color doesn't represent anything. (adapted from Data Visualization Catalogue [28])

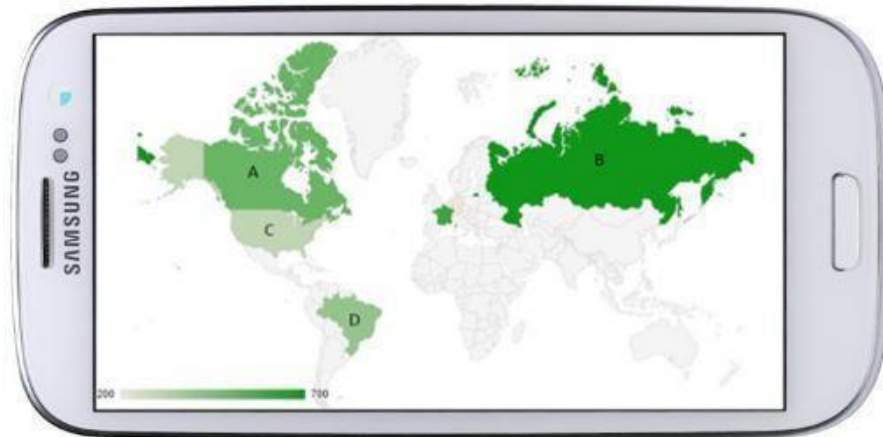


Figure 3.1-2: A Geo Chart showing the frequently visited drinking locations. The shade of green overlaid on locations represent how frequently the user visits that location to consume alcohol. Darker green means more drinks were consumed at that location, with B being the most and C being the least frequently visited drinking locations (adapted from Data Visualization Catalogue [28])

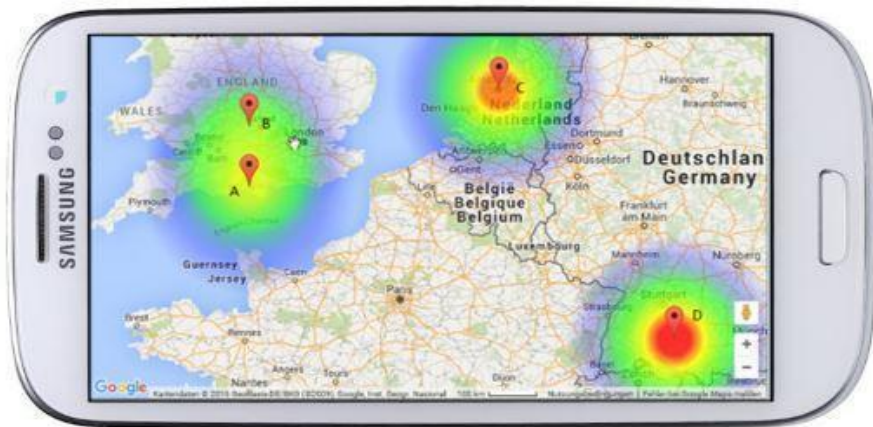


Figure 3.1-3: A Heat Map showing frequently visited drinking locations. The density of the color represents how frequently the user visits that location, with darker shades of red representing higher visits. Additionally, the radius also represents how frequently the user visits that drinking location, with a larger radius representing higher visits. In this chart, D is the most and B is the least frequently visited drinking locations (adapted from Data Visualization Catalogue [28])

Table 3.3 provides rationale for charts that we considered for representing the amount of drinks the subject had consumed in various months. The charts mentioned in the table are shown in Figures 3.2-1, 3.2-2, and 3.2-3 in the same order following the table.

Charts	Description	Rationale
Heat Calendar	Shows each day of a month/year in a color-coded scheme to represent quantity	Most commonly used technique for visualizing amount of days in a month
Radial Plot	An aesthetic way of representing a bar chart	Makes it easy to see the highest amount per month in a list of months
Bar Chart	Shows discrete, numerical comparisons across categories	Most commonly used chart to compare quantities among various categories (month, in this case)

Table 3.3: Description and rationale for charts for showing how many drinks the subject consumed in a month, according to the Data Visualization Catalogue [28] and Google Charts [6](Figure 3.2-1, 3.2-2, and 3.2-3)

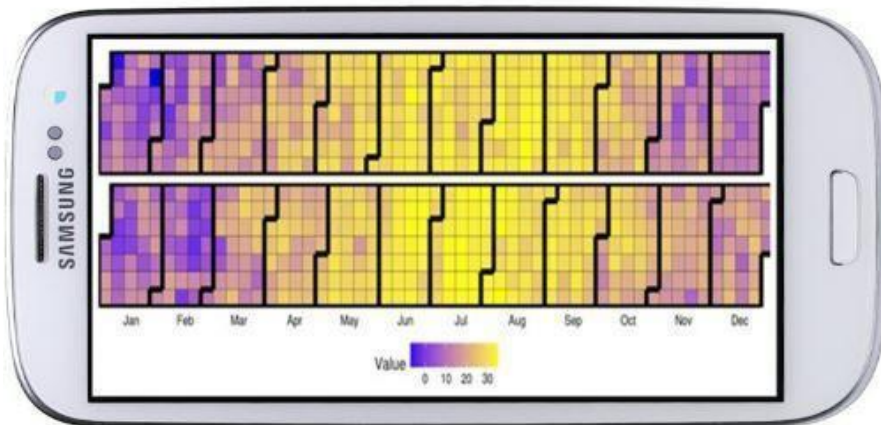


Figure 3.2-1: An example of a Heat Calendar showing amount drank in each month. The lighter shade of yellow represents a higher amount of alcohol drank in that day. (adapted from d3[5])

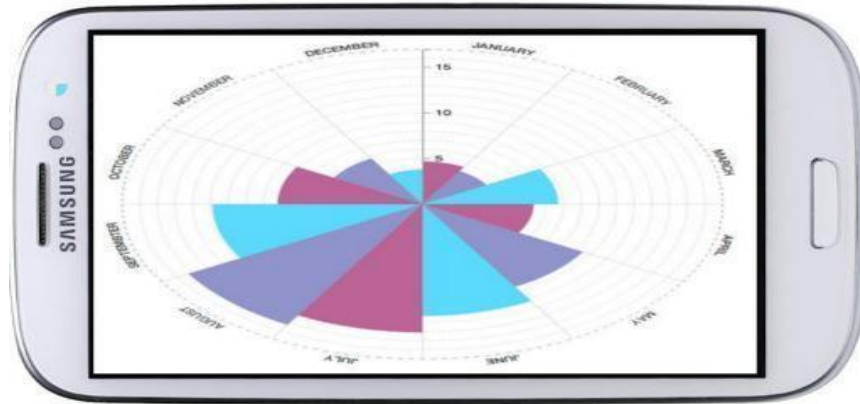


Figure 3.2-2: An example of a Radial Plot showing amount drank in each month. The length of each bar represents the amount of drinks in each month by a user, with a taller bar representing a larger amount of drinks that month. In this chart, color does not represent anything. (adapted from d3[5])

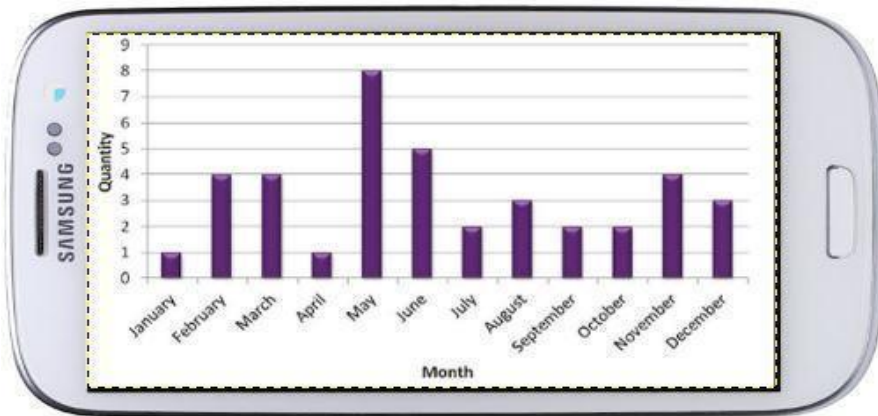


Figure 3.2-3: An example of a Bar Chart showing amount drank in each month. The length of each bar represents the amount of drinks in each month by a user, with a taller bar representing a larger amount of drinks that month. In this chart, color does not represent anything. (adapted from d3[5])

Table 3.4 summarizes our rationale for considering certain charts for representing amount of drinks the subject has consumed in each hour in a day. The charts mentioned in the table are shown in Figures 3.3-1, 3.3-2, and 3.3-3 in the same order following the table.

Charts	Description	Rationale
Line Graph	Shows information that is connected in some way (such as change over time)	Can see exact quantities of alcohol consumed relative to time and can also see trends, such as increases and declines as time goes by
Circular Heat Map	Color coded scheme used to represent quantity over hours of a day	Gives more detailed alcohol consumption details for each hour and also incorporates color to identify relative quantity
Colored Arc	Represents a clock orientation with different colors to represent quantity	Although less specific, one can easily notice difference in quantity relative to time (based on the thickness of the bars) at a glance.

Table 3.4: Description and rationale for charts to show how many drinks the subject consumed for each hour in a day, taken from Data Visualization Catalogue[28] and d3[5] (in Figures 3.3-1, 3.3-2, and 3.3-3).

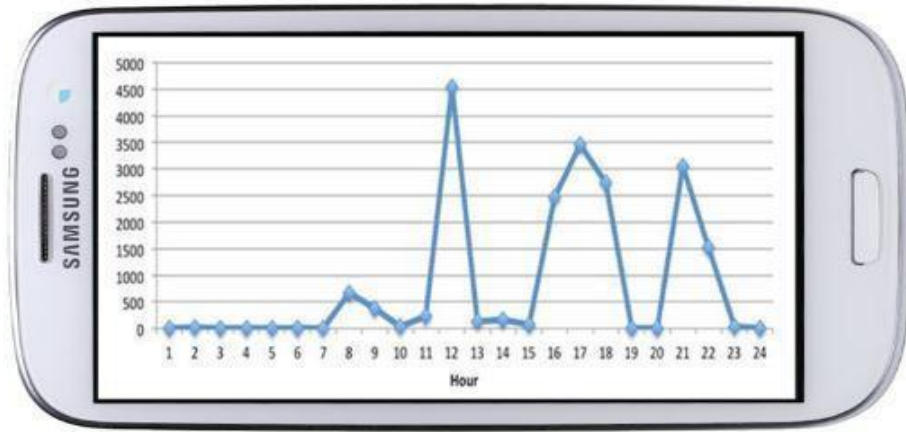


Figure 3.3-1: An example of a Line Graph showing the number of drinks at each hour of the day. The higher the point in the graph, the more amount of alcohol consumed at that hour. (adapted from Database Visualization Catalogue[28])

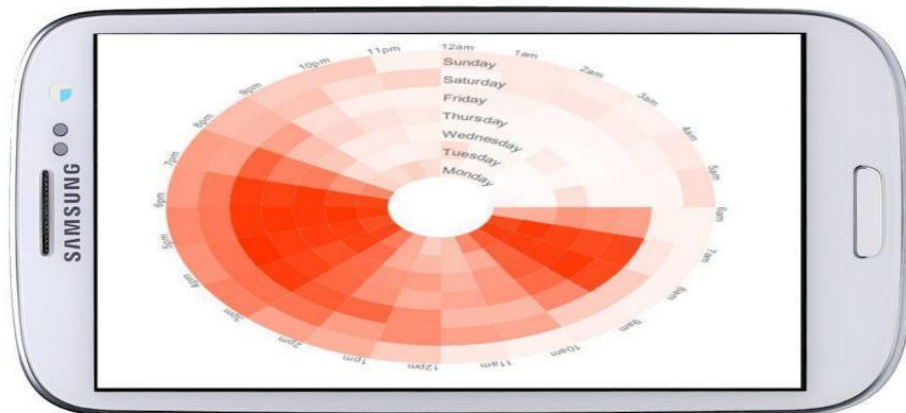


Figure 3.3-2: An example of a Circular Heat Map showing the number of drinks at each hour of the day through color. The darker shade of red represents a larger amount of alcohol consumed at that hour of the day. (adapted from d3[5])

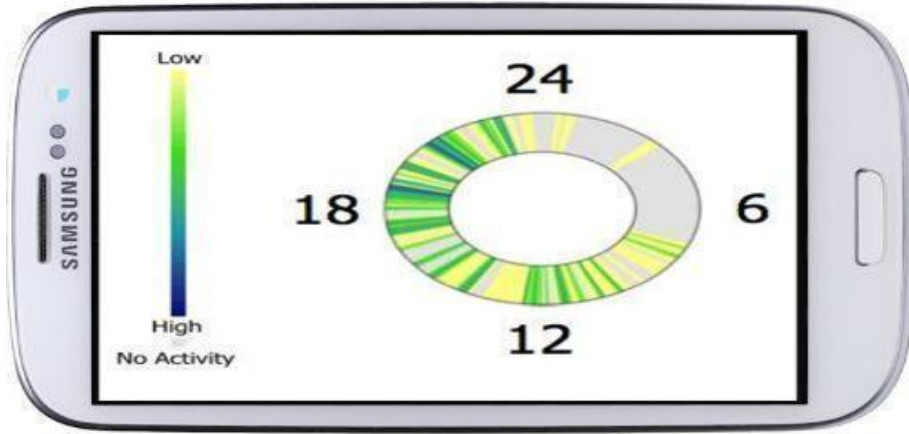


Figure 3.3-3: An example of a Colored Arc showing the number of drinks at each hour of the day through color. The color represents the amount of alcohol at that hour within the day. The darker shade of blue represents a higher amount of alcohol consumed, while the lighter shade of yellow represents a lower amount of alcohol consumed. (adapted from d3[5])

Table 3.5 summarizes our rationale for considering certain charts for representing individual people that the subject drinks most with. The charts mentioned in the table are shown in Figures 3.4-1, 3.4-2, and 3.4-3 in the same order following the table.

Charts	Description	Rationale
Bubble Chart	Shows the relationship between labeled/categorized circles, by the use of positioning and proportions	Can see larger size proportional to amount of times the subject drank with someone
Bar Chart	Shows discrete, numerical comparisons across categories	Most frequent person drank with stands out and can easily compare quantities with others
Pictogram	Images used as quantifiable amounts to easily be compared	Similar to bar chart, but visually appealing as the virtual items in the graph represents units of items in real life which are alcohol bottles

Table 3.5: Description and rationale for charts considered to show who subjects drink with, taken from Data Visualization Catalogue[28] and d3[5] (Figures 3.4-1, 3.4-2, and 3.4-3).

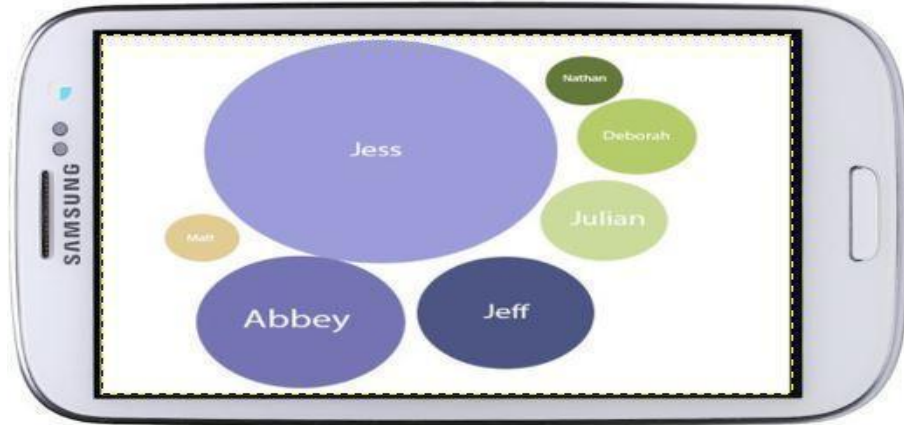


Figure 3.4-1: An example of a Bubble Chart showing the group of people. The size of each bubble represents how many drinks the user has consumed with that person. The larger the bubble size, the greater the amount of drinks consumed with that person. In this chart, color does not represent anything. (adapted from d3[5])

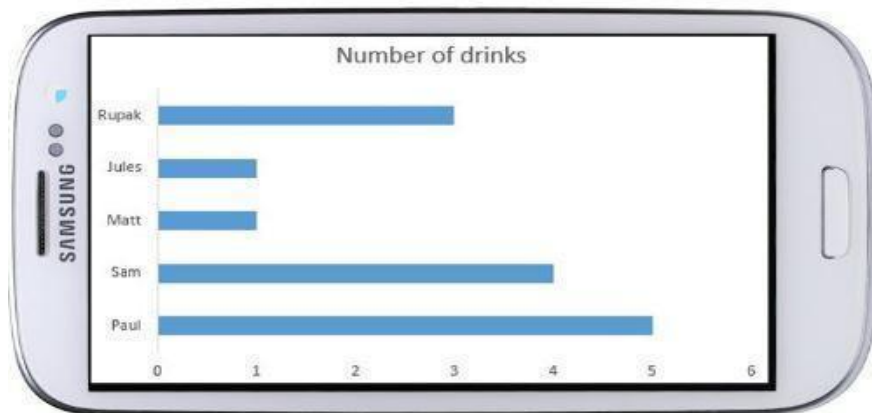


Figure 3.4-2: An example of a Bar Chart showing the number of the drinks with other people. The length of the bar beside each person represents how many drinks the user consumed with that person. In this chart, color does not represent anything. (adapted from d3[5])

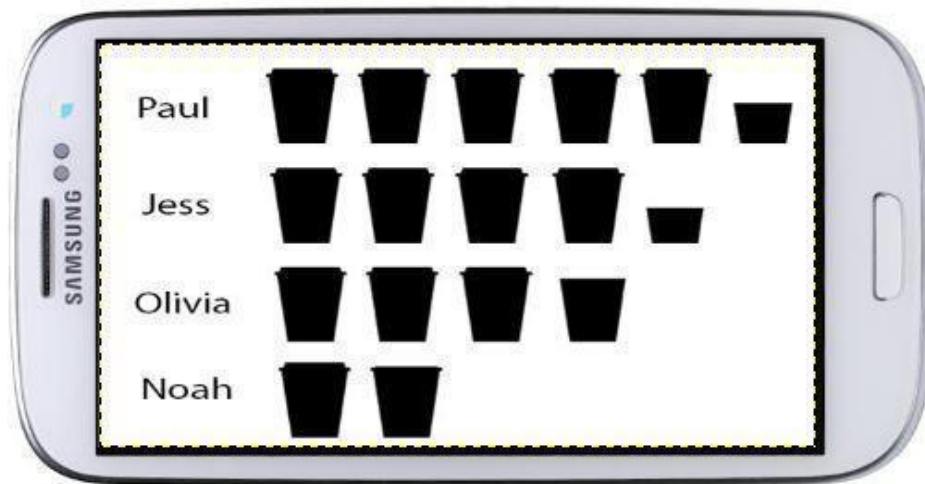


Figure 3.4-3: An example of a Pictogram showing the number of drinks the subject has had with other individuals. Each item in the visualization represents one drink (adapted from d3[5])

Table 3.6 summarizes our rationale for considering certain charts for representing different groups of people that the subject drinks most with. The charts mentioned in the table are shown in Figures 3.5-1, 3.5-2, and 3.5-3 in the same order following the table.

Charts	Description	Rationale
Tree Map	Provides a very clean structure, and nested functionality to show groups and sub-groups of people subjects drink with	Size of the elements can be used as a way to associate quantity of drinks, additionally the groups of people can be subdivided into individuals, which are further ranked based on size of their elements
Circle Packing Diagram	Area of each circle can be used to represent quantity and colors may also be used to assign categories	A variation of tree map but uses circles instead of rectangles. Colors may also be used to assign categories via different shades
Network Diagram	Nodes can be highlighted to distinguish higher amount to provides flexibility in connecting nodes to establish relations	Connection of node to node would be easier to identify relationship, potentially using color to highlight desired associations or higher quantities of drinks

Table 3.6: Description and rationale for charts for showing groups of people the subject drinks with, taken from Data Visualization Catalogue[28] (Figure 3.5-1, 3.5-2, and 3.5-3).

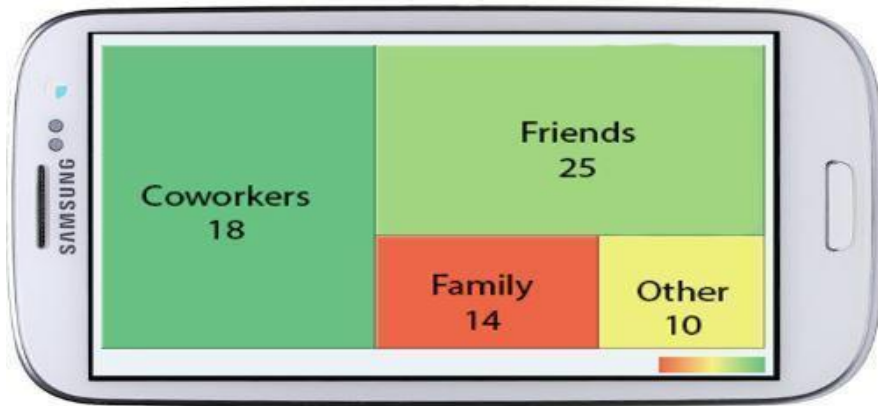


Figure 3.5-1: An example of a Tree map showing the number of drinks per group of people. The size of the rectangles represents the amount of drinks consumed within that group. In this case, color does not represent anything. (adapted from Database Visualization Catalogue[28])

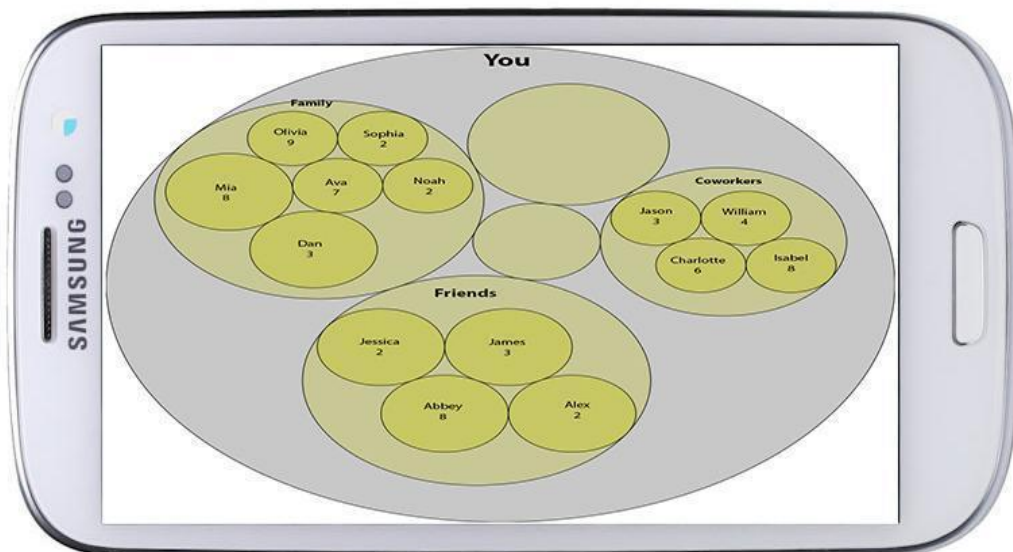


Figure 3.5-2: An example of a Circle Packing Diagram showing the number of drinks with each person within a certain group. The larger circles represent subject's different categories of groups, and the smaller circles represent individuals within those groups. In this chart, color, does not represent anything. (adapted from Database Visualization Catalogue[28])

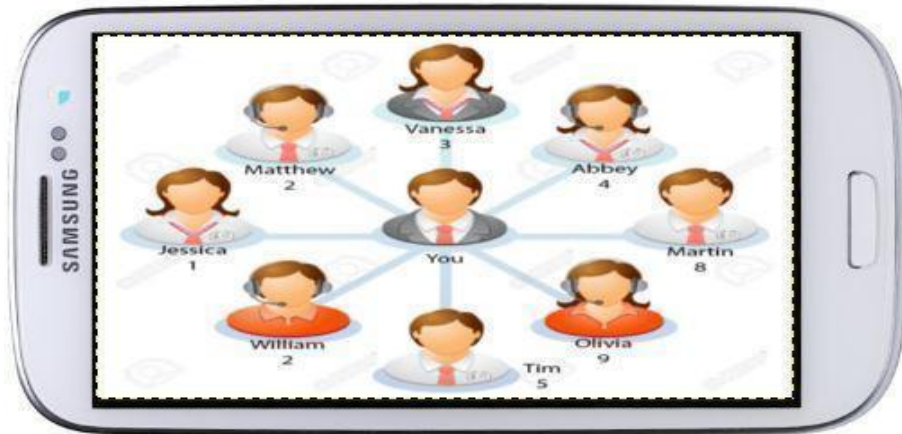


Figure 3.5-3: An example of a Network Diagram showing how the subject is related to other people and the number of drinks he/she has had with the them. The diagram represents the subject's friend group. Within the group, the subject has drank 9 (max) drinks with Olivia, for example. (adapted from Database Visualization Catalogue[28])

3.1 Initial Hypotheses:

1. Complex charts displaying too much information are too difficult to comprehend.
2. Simple charts are too boring to be effective.
3. Misuse of color can be confusing to users.

3.2 Survey

3.2.1 Purpose:

In order to narrow down the selection of charts for an initial design, we would require user feedback before a final selection. We surveyed subjects in order to gather feedback and measure the effectiveness of our proposed visualizations. Surveys were conducted online, which allowed us to reach a larger range of users while obtaining quantifiable results. The purpose of the survey is to obtain user responses regarding the evaluation metrics of functionality, complexity, visual appeal, and task representation of each chart.

The functionality of each chart is defined as its utility for displaying particular information about our contextual variables. Complexity measures how complex or simple a chart can display information, while also being understandable to the user (Gulbis [15]). Complexity can typically be related to how much data is trying to be visualized. Having too much information displayed in one chart can lead to more complex charts, requiring higher user effort in order to comprehend and decipher the chart. Visual appeal is a measure that looks to find charts that stand out to the user in order to keep users engage with the graph instead of distracted by the visuals (Hullman, Adar, and Shah [16]). Task representation looks to identify if each chart is appropriate or logical to the user to perform the intended task (Peebles, David, and Cheng [23]).

3.2.2 Survey Type and Sample Audience:

We used Google Forms in order to distribute the surveys. This allowed us to distribute the survey to a larger amount of people, while also automatically tallying responses and statistics of the responses.

A sample size of 30-50 was adjudged as adequate to conclude that the survey results were a valid representation of the target audience. In terms of demographics we were particularly targeting students, undergraduates and graduates, regardless of drinking age. We were also looking to identify additional demographics and patterns within sub-populations, which could factor into the subjects' comprehension of visualization. Some of these questions included the subject's major, to see if their area of study influenced their comprehension of visualizations. Cell phone usage was requested, in order to judge the subject's technical competence in regards to mobile device as a potential factor. Since the charts themselves require analytical skill, we asked additional background questions that had the participant identify his/her own statistical ability as well as knowledge of visualizations. These background questions would help correlate survey responses with the type of user, their strength on technological comprehension and analytics or weakness in those areas.

3.2.3 Questions:

For each chart on the survey, there was a question regarding its functionality, complexity, visual appeal, and task representation. Each question was formulated to be asked on a likert scale of 1-5 in order to quantify response for later analysis. The actual survey distributed can be seen in Appendix A.

3.2.4 Pilot Group:

An initial pilot group of 7 participants were selected in order to pilot test the survey before mass distribution. The participants were undergraduate friends in a variety of class years and majors. The pilot group would help uncover ambiguity within the survey and recommendations to enhance user experience. Some of the notable changes from the initial survey included the following:

- rewording of questions for clarity
- isolate and make prominent the user's task before each chart
- enlarging charts that were too small.

With this initial feedback, we eliminated any potential problems that might have occurred later after mass distributing the final copy of the survey.

3.2.5 Distribution of Survey:

As mentioned the target audience for the survey were undergraduates and graduates students at WPI. Students were assumed to be the ideal users, as campus students would ideally be active drinkers while also technically competent in the use of mobile applications. We were ideally looking for a diversity in terms of technical competence, prior visualization and statistical knowledge, and different majors. Thus, we focused on recruiting participants that spanned these categories, most importantly finding participants that were smartphone users as this was important to understand the application. The survey was distributed to friends, classmates, fraternity members, trying as best to cover most of the demographics. After distributing the survey, we had about 30 responses.

3.2.6 Analyzing results:

In terms of demographics, the following was the distribution of the demographics portion of survey participants:

Gender

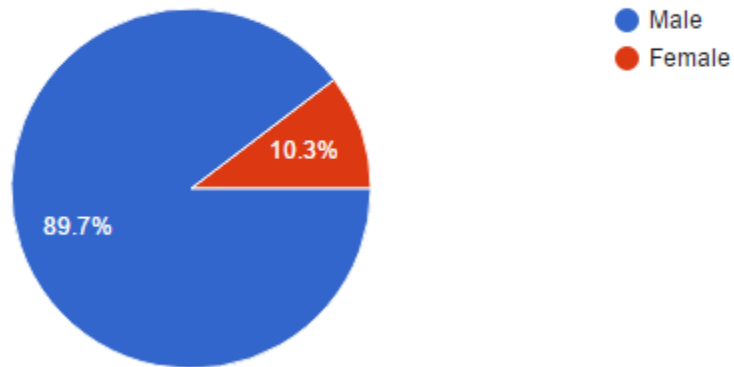


Figure 3.6-1: Gender Demographics of Survey Participant

Academic Year

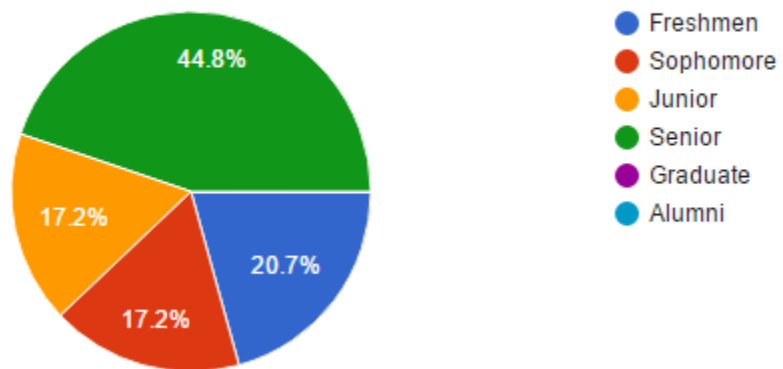


Figure 3.6-2: Academic year demographics of Survey Participant Class

Major

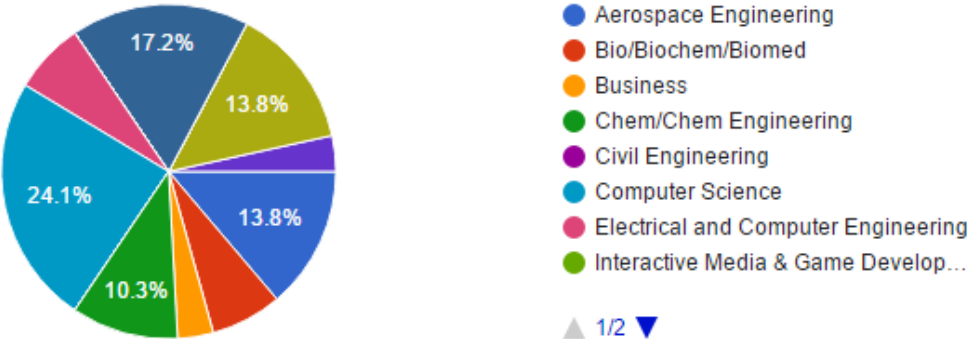


Figure 3.6-3: Majors of Survey Participants

How knowledgeable do you consider yourself in terms of statistical analysis?

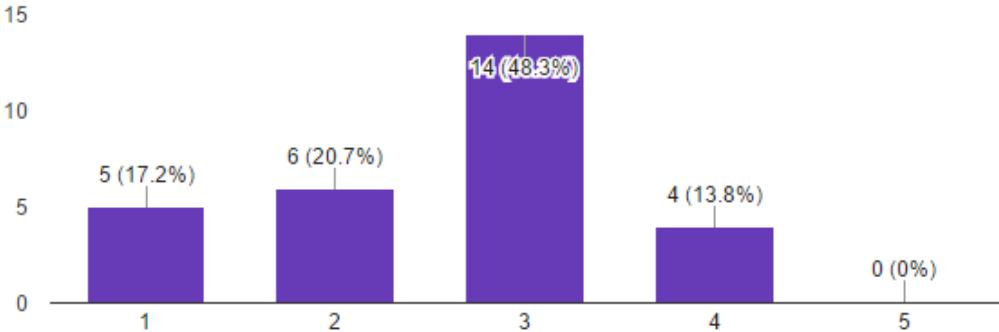


Figure 3.6-4: Statistical Analysis Knowledge of Survey participants
 (1 = Not Knowledgeable, 5 = Extremely Knowledgeable)
 (mean = 2.59, standard deviation = 0.95)

How knowledgeable do you consider yourself in terms of graphical visualization?

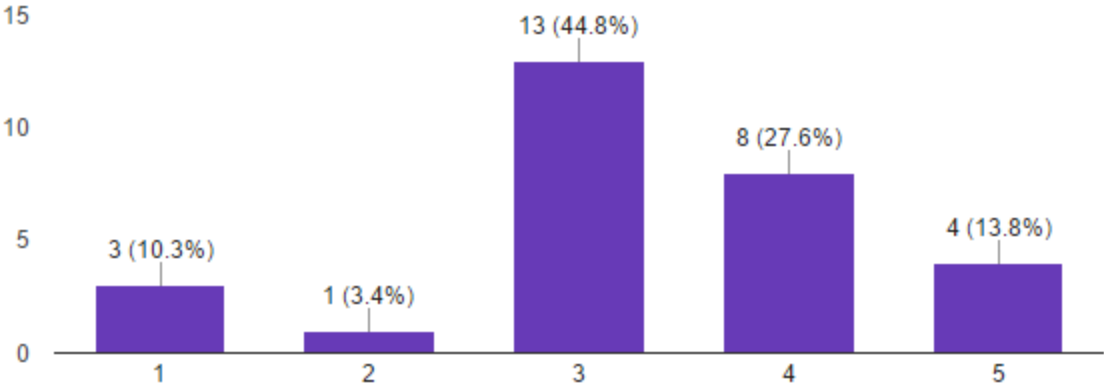


Figure 3.6-5: Graphical Visualization Knowledge of survey participants (1 = Not Knowledgeable, 5 = Extremely Knowledgeable) (mean = 3.31, standard deviation = 1.11)

Approximately how many hours do you use your smartphone in a day?

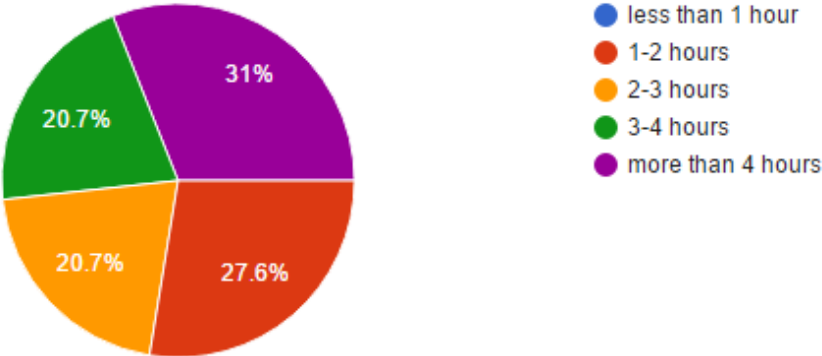


Figure 3.6-6: Smartphone Usage

To pick the best chart for each task, we first examined the responses from our participants in the Google Survey Form. Although Google Forms does a great job of visualizing responses for each question (all visualization results from google forms are in Appendix C), it lacks the ability to compare responses in two or more separate questions. So, we collected data for different tasks we asked subjects to perform depending on the type of question, and presented responses in Table 3.7 and Table 3.8. Each response has a value from 1 to 5 (1 being the lowest and 5 being the highest). The specific tasks involved asking the subject to identify the following contextual variables:

Task 1: Most frequently visited drinking locations

Task 2: Most recently visited drinking locations

Task 3: Amount of drinks in a month (standard drinks)

Task 4: Amount of drinks in a day (standard drinks)

Task 5: People you drink most with

Task 6: Groups of people you drink with

The charts with the highest average value is highlighted in green and is the best chart for each category according to the survey results.

	Task 1			Task 2			Task 3		
	Bubble Map	Geo Chart	Heat Map	Geo Chart	Bubble Map	Heat Map	Radial Plot	Heat Calendar	Bar Chart
Functionality (Scaled to 5)	4.7	4.7	5	4.8	4.8	4.7	5	5	5
Ease (Out of 5)	3.7	3.9	3.5	3.2	2.9	3.1	4.1	2.6	5
Visual Appeal (Out of 5)	2.9	3.8	3.2	3.8	2.9	3.2	3.6	2	3.8
Task Representation (Out of 5)	3.2	3.5	3.1	2.8	2.1	2.8	4.2	2.7	4.7
Mean:	3.6	4	3.7	3.7	3.2	3.5	4.2	3.1	4.6
Standard Deviation:	0.79	0.51	0.88	0.87	1.15	0.85	0.58	1.32	0.57

Table 3.7: Survey results for charts in tasks 1, 2, and 3

	Task 4			Task 5			Task 6		
	Circular Heat Map	Line Graph	Colored Arch	Pictogram Chart	Bar Chart	Bubble Chart	Circle Packing	Network Diagram	Tree Map
Functionality (Scaled to 5)	4.8	5	5	5	5	5	4.5	5	4.2
Ease (Out of 5)	3.6	4.7	3.1	4.8	4.7	4.2	3.1	3.6	4.1
Visual Appeal (Out of 5)	3.3	3.3	2.7	4.2	3.8	3.4	2.7	2.7	3
Task Representation (Out of 5)	3.4	4.2	2.8	4.5	4.8	3.3	3.3	3.2	3.7
Average:	3.8	4.3	3.4	4.63	4.57	3.98	3.4	3.6	3.8
Standard Deviation:	0.69	0.74	1.08	0.35	0.53	0.79	0.77	0.99	0.54

Table 3.8: Survey results for charts in tasks 4, 5, and 6

Results and conclusion of the survey are drawn in section 3.4 and 3.5 below.

3.3 Focus group

3.3.1 Purpose:

Dr. Anita Gibbs, a research officer at the Probation Studies Unit, Centre for Criminological Research, Oxford University, defines the purpose of a focus group as drawing upon “respondents' attitudes, feelings, beliefs, experiences and reactions in a way which would not be feasible using other methods such as a survey”(Gibbs [14]).The focus group will ideally provide further rationale to feedback we have received from the surveys. Thus, we are using focus groups as a complement to the distributed surveys. Having a group of interacting people rather than individual interviews would promote discussion. We wanted discussion in hopes that we could extract patterns that we could use to improve our visualizations.

Our focus group was conducted with three participants for 45 - 60 minutes. These participants fell within the target demographic, being a 22-year-old male senior mechanical engineer (subject 1), a 22-year-old male senior robotics engineer (subject 2), and a 20-year-old male sophomore chemical engineer (subject 3). We felt these participants were experienced enough with smartphones to provide constructive feedback on the application. Each member of the team had a role, either as the main presenter or an assistant/note taker, to run the focus group. We used the following methodology to conduct the focus group:

3.3.2 Focus Group Methodology:

Our focus group was conducted in five pre-defined steps to achieve optimal results and feedback from our participants within the time interval. The steps included:

- a. Brief introduction of the team members to the participants
- b. Project explanation to the participants
- c. Explanation of participants' role
- d. Presentation of graphs and tasks followed by discussion
- e. Overall feedback

3.3.3 Focus Group Questions asked:

Firstly, the participants were shown the candidate graphs (see section 3) without any explanation of the task that it represents. Then, they were asked to comment on the chart, including its color, size, and visual appeal or about the kind of information the chart could be used to display. Secondly, the task for each chart was explained. After that, participants were simply asked a question about whether or not the graph makes sense now for the given task. Thirdly, participants were asked questions regarding good and bad things about the charts, or what they liked and disliked. Fourthly, they were asked a question regarding the suitability of the charts being displayed on a mobile device. Lastly, they were asked to provide general feedback on how we could make the charts better.

3.3.4 Responses:

Feedback was recorded during the session. The main points discovered are now summarized:

Colors should have meaning that is consistent:

One of the main areas of feedback was with regards to the use of colors in the graphics. Specifically, in the location and time graphs, where the use of colors was inconsistent. One of the comments include “not going against the logical color gradient” (i.e. red being a negative or indicative of higher frequency color vs green a more positive or indicative of lower frequency color). The other participants agreed with the fact that there needs to be a “consistent meaning” of colors when used, and Subject 1 was quoted saying, “Having several colors in the same chart made it confusing.”

Complex charts were too confusing:

Another theme throughout the session was the idea of complex charts versus simple charts. Participants found more complex charts, such as the Time: Calendar Heat Map, to be too confusing to understand the information that the graph attempted to represent. This was opposed to simpler visualizations such as a generic bar graph, which they found informative but too bland and simple for a mobile graphic. There was a general consensus that graphs such as pictograms were very informative but also visually appealing without being too complex.

Participants agreed that a middle ground was ideal: graphs needed to have a bit of visual appeal or complexity without overshadowing the information and being challenging to comprehend. Additionally, there were aspects of particular complex charts that the participants liked and thought should be better utilized in other graphs. In the case of the location charts Subject 1 stated, “the color gradient would look better with the use of lighter to darker shading in the location heat map”.

3.4 Results and Discussion:

After analyzing results from the survey, which were also backed up by our results from focus group, we found out that the charts that were voted the easiest by our participants resulted in the best chart for every task. On top of that, charts that were voted the easiest were also the most visually appealing charts for every single task. This result was contrary to our hypotheses because it suggests that **the simplest of the charts does not always have to be boring and can still be visually appealing**. Additionally, the confusion regarding some of the more complex charts affirms the hypothesis that **complex charts displaying too much information can be confusing to users**. Also, based on the participants’ comments regarding color, it confirms our hypothesis that the **use of colors should be meaningful and consistent across all graphs**. The focus group results table were tallied again and are summarized in Tables 3.9 and 3.10. This time the best charts are highlighted in green, the charts that are easiest to understand are in yellow, and the most visually appealing charts are in orange. You will notice that for every task, the best, the easiest, and the most visually appealing charts are in the same vertical column.

	Task 1 (Most frequent locations)			Task 2 (Most recent locations)			Task 3 (Drinks per month)		
	Bubble Map	Geo Chart	Heat Map	Geo Chart	Bubble Map	Heat Map	Radial Plot	Heat Calendar	Bar Chart
Functionality (Scaled to 5)	4.7	4.7	5	4.8	4.8	4.7	5	5	5
Ease (Out of 5)	3.7	3.9	3.5	3.2	2.9	3.1	4.1	2.6	5
Visual Appeal (Out of 5)	2.9	3.8	3.2	3.8	2.9	3.2	3.6	2	3.8
Task Representation (Out of 5)	3.2	3.5	3.1	2.8	2.1	2.8	4.2	2.7	4.7
Mean:	3.6	4	3.7	3.7	3.2	3.5	4.2	3.1	4.6
Standard Deviation:	0.79	0.51	0.88	0.87	1.15	0.85	0.58	1.32	0.57

Table 3.9: Focus group results for tasks 1, 2, and 3 with the best, the easiest and the most visually appealing charts highlighted.

Green - Overall best charts, Yellow - Easiest to understand, Orange - Most Visually Appealing

	Task 4 (Drinks per day)			Task 5 (People subject drinks with)			Task 6 (Groups subject drinks with)		
	Circular Heat Map	Line Graph	Colored Arch	Pictogram Chart	Bar Chart	Bubble Chart	Circle Packing	Network Diagram	Tree Map
Functionality (Scaled to 5)	4.8	5	5	5	5	5	4.5	5	4.2
Ease (Out of 5)	3.6	4.7	3.1	4.8	4.7	4.2	3.1	3.6	4.1
Visual Appeal (Out of 5)	3.3	3.3	2.7	4.2	3.8	3.4	2.7	2.7	3
Task Representation (Out of 5)	3.4	4.2	2.8	4.5	4.8	3.3	3.3	3.2	3.7
Mean:	3.8	4.3	3.4	4.63	4.57	3.98	3.4	3.6	3.8
Standard Deviation:	0.69	0.74	1.08	0.35	0.53	0.79	0.77	0.99	0.54

Table 3.10: Survey results for tasks 4, 5, and 6 with the best, the easiest and the most visually appealing charts highlighted

Green - Overall best charts, Yellow - Easiest to understand, Orange - Most visually Appealing

3.5 Conclusion:

Based on the combined results of our survey and feedback from the focus groups we narrowed down the charts to be implemented in our Android app as the following selection.

Task 1: Most frequently visited drinking locations - Geo Chart

Task 2: Most recently visited drinking locations - Geo Chart

Geo Chart - This chart is good to associate a weighted value with a location. It allows a user to get a visual of which locations the user has been to or drank the most at, compared to a tabular format.

Task 3: Amount of drinks in a month (standard drinks) - Bar Chart

Bar Chart - This chart is a good visualization technique when trying to compare data. Familiar to most users, it allows users to easily compare drinking occasions from month to month.

Task 4: Amount of drinks in a day (standard drinks) - Line Graph

Line Graph - A line graph is good to display continuous values over time. Displaying hours of days and the amount of drinks associated with each hour will help users see alcohol consumption over the course of a day.

Task 5: People subjects drink with the most - Pictogram Chart

Pictogram Chart - The pictogram helps give a sense a quantity without having to use numbers and scales. There could be many people a user could possibly drink with, its easy to get a sense of quantity using symbols of a pictogram than other numerical charts.

Task 6: Groups of people you drink with - Tree Map

Tree Map - When trying to display grouping, the tree map allows the ability to display multiple groups while using different sizes to further reflect quantity.

According to the survey results, these charts averaged the highest point values in the following categories of functionality, complexity, visual appeal, and task representation. These charts ranked the highest in each of their respective tasks, and thus were selected.

Task #	Description	Visualization
Task 1	Most frequently visited drinking locations	Geo Chart
Task 2	Most recently visited drinking locations	Geo chart
Task 3	Amount of drinks in a month (standard drinks)	Bar Graph
Task 4	Amount of drinks in a day (standard drinks)	Line Graph
Task 5	People subjects drink with the mos	Pictogram
Task 6	Groups of people you drink with	Tree Map

Figure 3.11: Table showing all of the tasks and the visualization chosen for each one

3.6 AlcoContextualizer Mobile Application Design

We implemented the visualizations adjudged the best fit for each task into an Android application that subjects could use. The Android application design is based on the general categories of our context criteria: location, time and people. Each criterion will have its own sub-screen containing their respective context visualization.

3.6.1 Screen Navigation

The design features a main screen which allows the user to navigate to different context categories in order to view the visualization. There are two ways of navigating through the application, using the navigation drawer or using the tiles on the main screen. The navigation

drawer features each of the context categories as menu options to navigate to the respective context screen. The drawer is accessible on all screens of the application. The main screen features tiles that are previews to the category of visualization. Each tile is clickable and is an additional form of access to the respective visualization screen. Figure 3.7 shows the screen flow from the main screen to each of the sub screens.

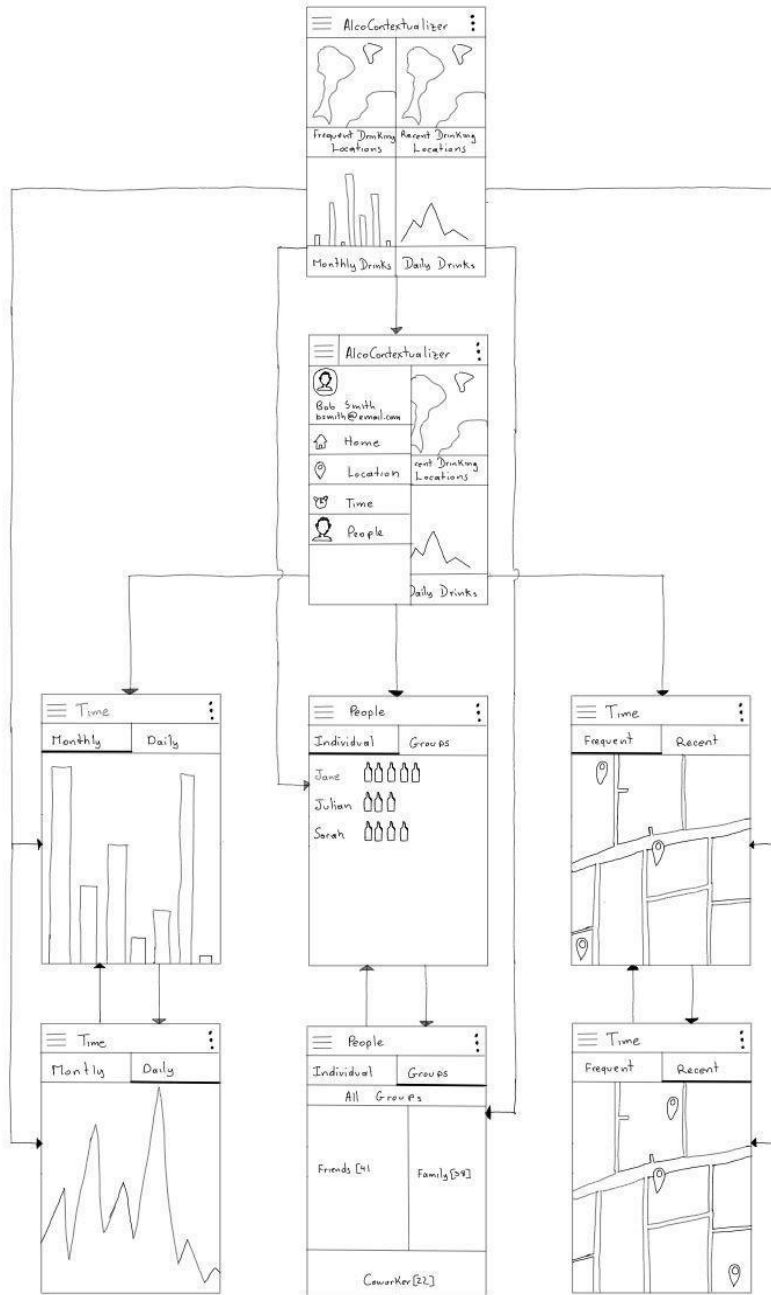


Figure 3.7: Screen Flow Application Design

3.6.2 Location Screens

The location screens are in a tabular format. There is a tab for frequent drinking locations and recent drinking locations. Each tab displays the respective geochart. Each chart has markers to indicate the drinking location, as well as the use of color to surround each marker for the weights of frequent drinks and recent drinks. Each marker is also clickable to view additional contextual information about the location. (see Figure 3.8-1 and 3.8-2)

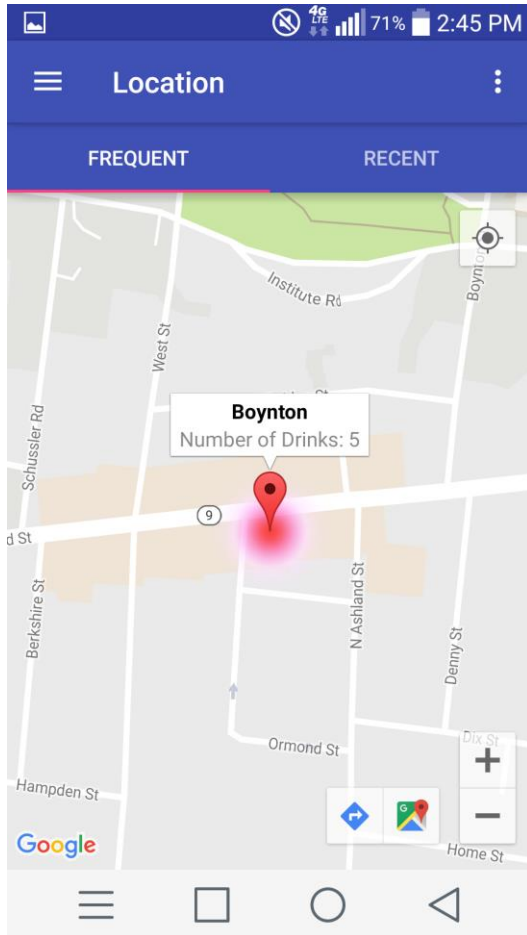


Figure 3.8-1: Map that shows frequent drinking locations

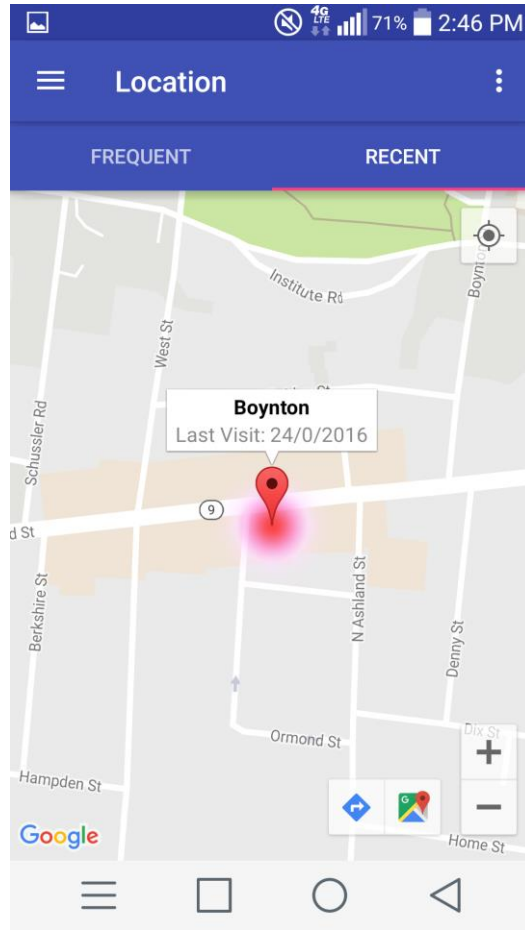


Figure 3.8-2: Map that shows recent drinking locations

3.6.3 Time Screens

The time screens feature a monthly and daily chart describing the user's amount of drinks in the respective time interval. The monthly chart has a bar chart that displays the amount of drinks a user has had in each month. The daily chart will be a line graph to show the hours of a day. The line graph keeps track of the number of drinks over the course of the day and specifics about the number of drinks at each hour. (see figure 3.9-1 and 3.9-2)

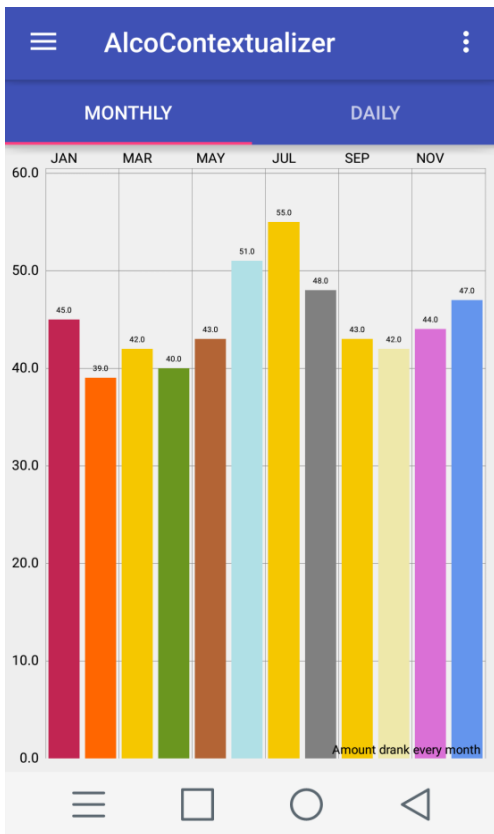


Figure 3.9-1: Bar chart showing the monthly drinking habits with the y-axis displaying the number of drinks per month.

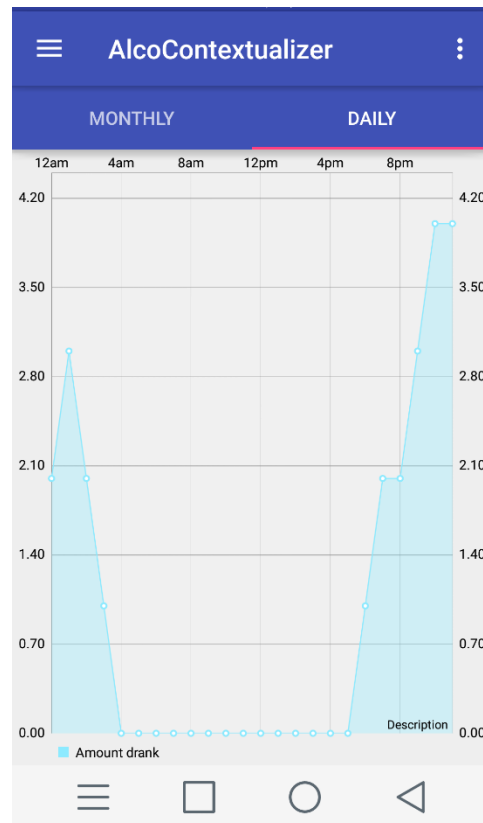


Figure 3.9-2: Line Chart showing daily drinking habits with the y-axis showing the number of drinks

3.6.4 People Screens

For the people screens the tabular format divides the screen into two sections: individuals and groups. For the individual person tab, it features a pictogram to represent each person the user has drank with. Each symbol next to a person's name represents having a single drink with that person. For the group of people tab, it will feature a tree map to represent different groups of people. These groups would be determined by the user to organize the people the user has drank with into one the groups. Each group is a section of the tree map, which upon click will display the people in that group with respective information about the amount of drinks with that person (see figure 3.10-1 and 3.10-2).

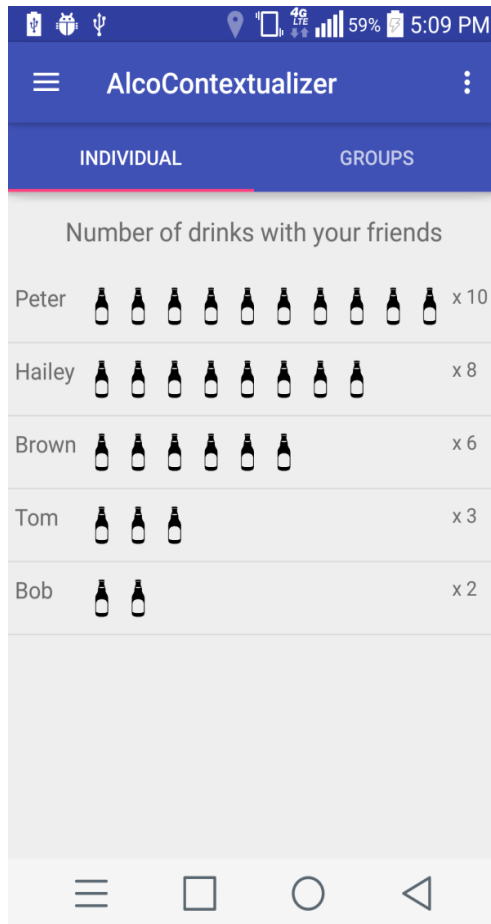


Figure 3.10-1: Pictogram chart showing the number of drinks consumed with each friend overall

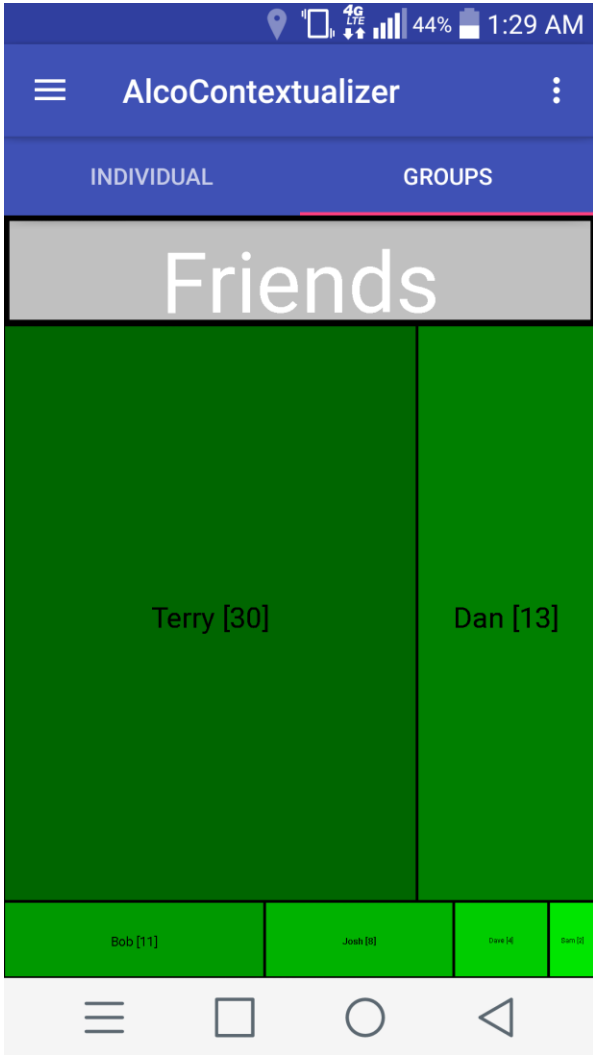


Figure 3.10-3: Figure showing the friends category and how much the user has drink with the people in this category

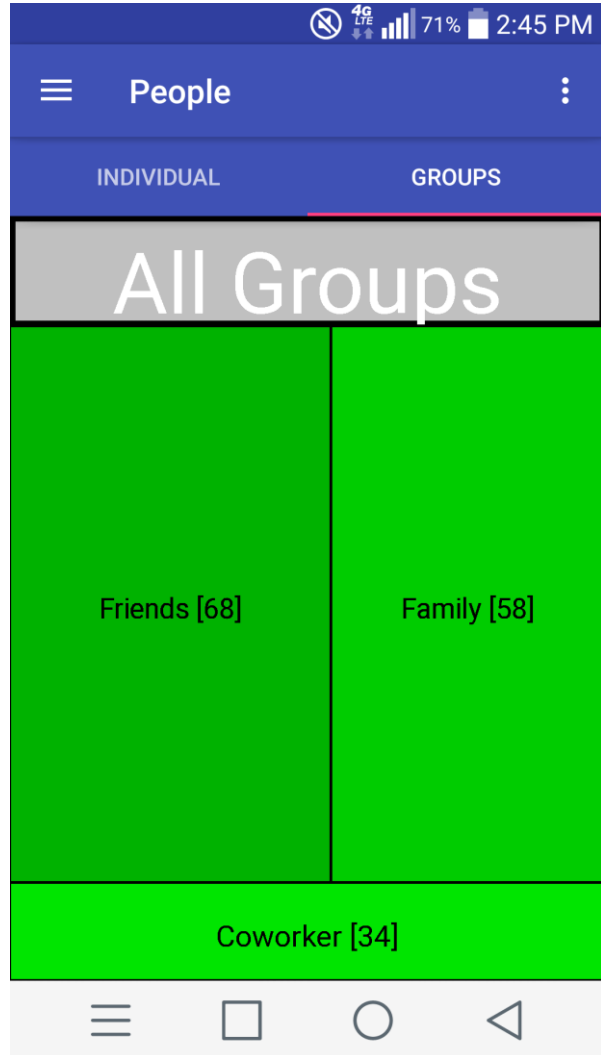


Figure 3.10-2: Treemap chart showing groups of people and how much the user has drink with them

3.6.5 Database design

The database for Alco-Contextualizer application consists of four tables, Location table, Time table, People table, and a DrinkingInstance table. Location table contains all the required information about the location that the subject drank in such as location name, location longitude and latitude. Time table contains the month, day and hour along with the amount drank during that time. People table contains information about people that the subject drank with, such as people's name, amount and the group's name, for example, "family". Drinking Instance table contains id's of all the other tables so that each table has a reference to another.

Using this reference, we can provide contextual information to the user. The class diagram of this database model is shown in Figure 3.11.

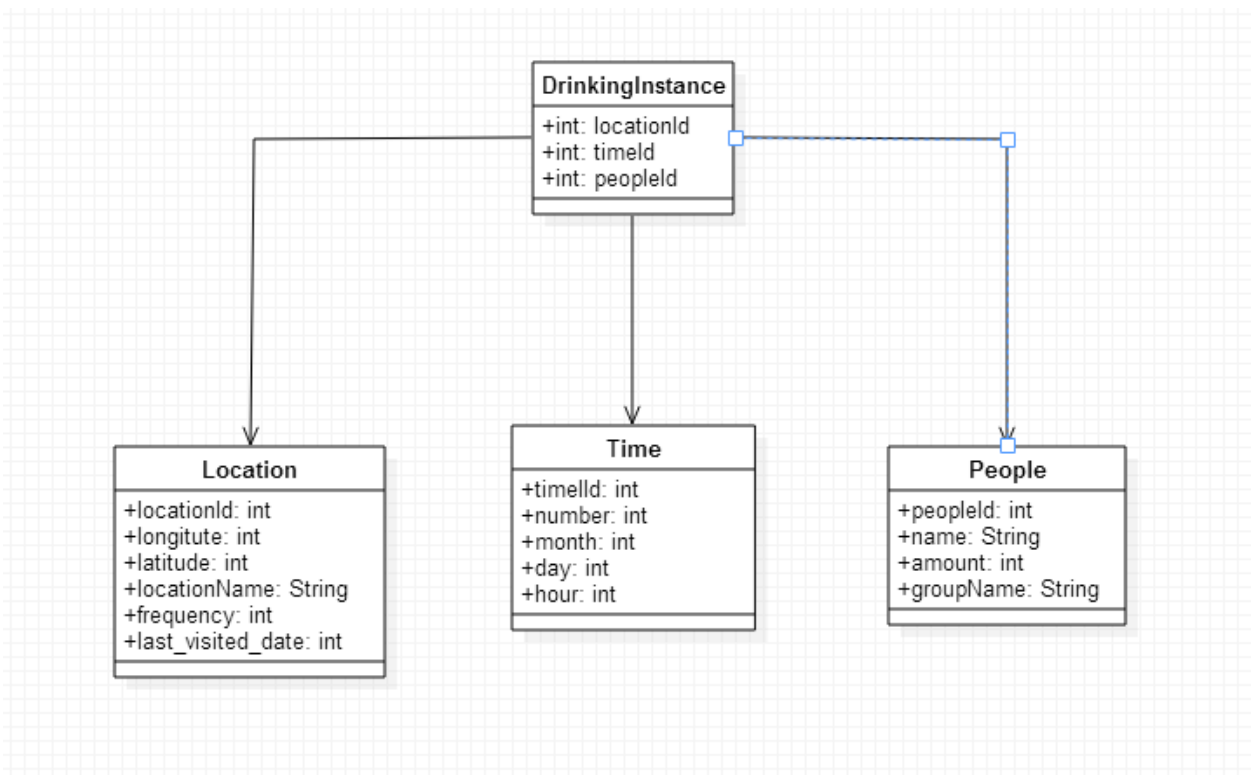


Figure 3.11 : Database class diagram

4. AlcoContextualizer App Implementation

The application was implemented in Android using Android Studio. As this application is designed to be a mobile application, Android was selected since it is one of the more major mobile devices. Google also provides a lot of support to Android, as well as there being many third-party libraries available for Android. Thus, there was a lot of flexibility in terms of how the visualizations were implemented. Physical devices and Android emulators were used in order to test functionalities. This implementation section contains screenshots, code snippets, and code explanation of the screens mentioned above in the application design section.

4.1 App Layout

The app is designed in a way where there's only one Activity, the MainActivity, and fragments are loaded into it. There are three main fragments that can be loaded, one for each of the categories, People, Time and Location. Each of those fragments are made up of tabs. Each tab is a fragment of its own. Users can swipe left or right to switch between tabs. In order to achieve this, a TabPagerAdapter was created, which extends FragmentStatePagerAdapter that has a list of fragment objects. This adapter allows the parent fragment, for instance a LocationFragment, to be able to retrieve its children tabs, namely Frequent and Recent Drinking Location and display them.

4.2 Home Fragment

Home Fragment is the main fragment that is visible when the user first opens the application. Figure 4.1 shows the screenshot of the final design.

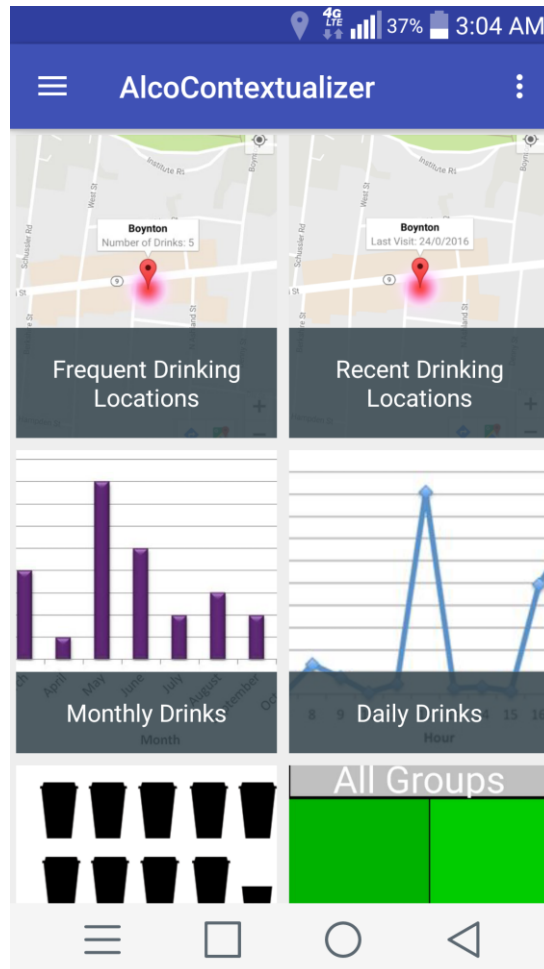


Figure 4.1 : Screenshot of the scrollable main screen

This screen provides an alternative way to navigate between the charts as opposed to the navigation drawer. Clicking on any one of the tiles navigates the user to the specific chart

described in the tile in question. To implement this design, we first needed a viewholder class that contains the related image and text description as shown in Figure 4.2.

```
class ViewHolder extends RecyclerView.ViewHolder {
    // Views
    private ImageView mImageView;
    private TextView mNameTextView;

    private ViewHolder(View itemView) {
        super(itemView);

        // Get references to image and name.
        mImageView = (ImageView) itemView.findViewById(R.id.imageView);
        mNameTextView = (TextView) itemView.findViewById(R.id.textView);
    }

    private void setData(int imageResId, String name) {
        mImageView.setImageResource(imageResId);
        mNameTextView.setText(name);
    }
}
```

Figure 4.2: Code snippet of view holder class that holds the image and description of a chart

To present several viewholders alongside each other, we needed to use a RecyclerView Adapter. A recyclerview adapter class simply inflates a pre-defined layout that contains an imageview and a textview and binds data onto those views when the user clicks on a view holder object. By setting a grid layout manager with a size of 2, we were able to align the content to tiles per row as shown in Figure 4.3.

```
final RecyclerView recyclerView = (RecyclerView) view.findViewById(R.id.recyclerView);
recyclerView.setLayoutManager(new GridLayoutManager(activity, 2));
recyclerView.setAdapter(new RecyclerViewAdapter(activity));
```

Figure 4.3 : Code snippet showing how tiles were placed next to each other

4.3 Location Fragment

The location fragments feature the use of the Google Maps API. Enabling permissions in the Android manifest file as well as acquiring an API key allows the use of Google Maps API. A map view is loaded in the fragment. The class pulls location information from the database to create markers on the map. Each marker is highlighted by a color range to signify higher values, either frequency or recent values. Both the frequent location map and recent location map are similar in structure, differing in assigning the color ranges to the markers.

The map settings enable the features for current user location, type of map view, clickable markers, and zoom control. The map settings can be viewed in Figure 4.4.

```
//additional map settings
mGoogleMap.setMyLocationEnabled(true);
mGoogleMap.setMapType(GoogleMap.MAP_TYPE_NORMAL);
mGoogleMap.setOnMarkerClickListener(this);
mGoogleMap.setBuildingsEnabled(true);
mGoogleMap.getUiSettings().setZoomControlsEnabled(true);

addHeatMap();
setUpMarkers(googleMap);

// Zoom in on location set
// padding between map edge and point
int padding = 200;
CameraUpdate cu = CameraUpdateFactory.newLatLngBounds(makeMapLocationBounds(getLocations()),
    padding);
googleMap.moveCamera(cu);
```

Figure 4.4: Application Map Settings

The markers are set at each of the indicated locations based on the longitude and latitude pairs pulled from the database. Each marker is clickable and set with information relevant to the location, such as the location name and amount of alcohol drank by the user there. This information is also pulled from the database.

```
private void setUpMarkers(GoogleMap gMap) {
    List<Location> list = getLocations();
    for(Location location : list) {

        LatLng latLng = new LatLng(location.getLatitude(), location.getLongitude());
        gMap.addMarker(new MarkerOptions()
            .position(latLng)
            .title(location.getLocationName())
            .snippet("Number of Drinks: " + location.getFrequencyAmount())
            .icon(BitmapDescriptorFactory.defaultMarker(BitmapDescriptorFactory.HUE_AZURE)));
    }
}
```

Figure 4.5: Marker Initializer Method

The visualizations use the heatmap library for android of Google Maps API. The library provides the ability to place a heat map tile over the existing map view. This allows color intensity defined by weights for the map to use around each marker. The weights for this application are defined by the number of drinking occasions at a location for the frequency map, and the most recent date visiting a location for the recent map.

```

// Create a heat map tile provider, passing it the latlngs
private void addHeatMap() {

    // Create the color gradient.
    int[] colors = {
        Color.rgb(255, 225, 255), // white
        Color.rgb(255, 0, 0)     // red
    };

    float[] startPoints = {
        0.2f, 1f
    };

    Gradient gradient = new Gradient(colors, startPoints);

    mProvider = new HeatmapTileProvider.Builder()
        .weightedData(makeMapDataFromLocation(getLocations()))
        .gradient(gradient)
        .build();

    mProvider.setRadius(45);

    // Add a tile overlay to the map, using the heat map tile provider.
    mOverlay = mGoogleMap.addTileOverlay(new TileOverlayOptions().tileProvider(mProvider));
}

```

Figure 4.6: Heat Map Initializer Method

4.4 Time Fragment

Time fragment is a simple fragment class created to hold visualizations of subject's monthly and daily drinking data. It contains two tabs, namely Monthly and Daily, which are fragments of their own.

4.4.1 Monthly Fragment:

A fragment class that visualizes subject's monthly drinking data using a bar chart as shown in the screenshot in Figure 4.7.

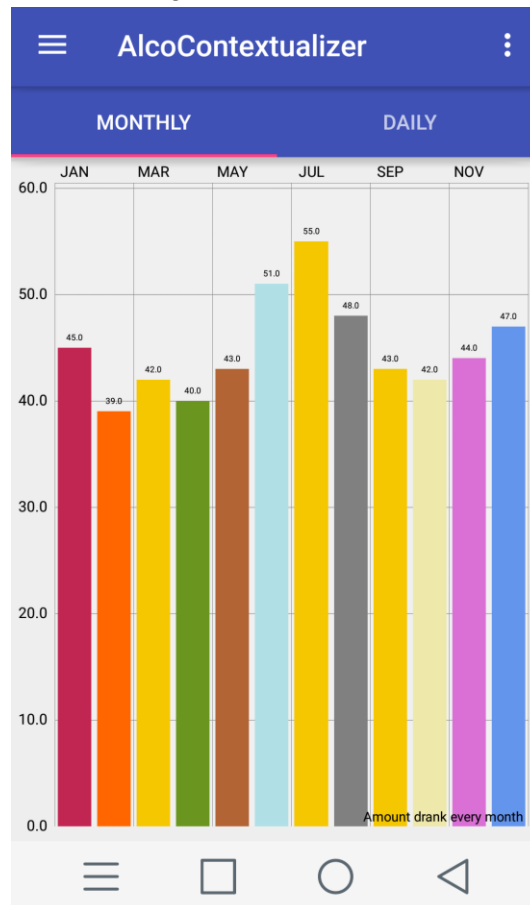


Figure 4.7: Bar chart showing the monthly drinking habits with the y-axis displaying the number of drinks per month

To create this bar chart, we used a powerful and easy to use chart library created for Android called MPAndroidChart (Jahoda [18]). In order to use the library, we had to add the library dependency in the project level build.gradle file in our project and then compile it. After our project included the sdk provided by MPAndroidChart, we used the data from our database, which is discussed later in the section, to create an animated bar chart using the following code as shown in Figure 4.8.

```
BarChart chart = (BarChart) view.findViewById(R.id.chart);
BarData data = new BarData(getXAxisValues(), getDataSet());
chart.setData(data);
chart.setDescription("Amount drank every month");
chart.getAxisRight().setDrawLabels(false);
chart.getLegend().setEnabled(false);
chart.animateXY(2000, 2000);
```

Figure 4.8: Bar chart implementation

4.4.2 Daily Fragment:

Similar to monthly fragment, daily fragment included visualization of subject's daily drinking data using a line chart as shown in the screenshot in Figure 4.9 followed by the code snippet in Figure 4.10.

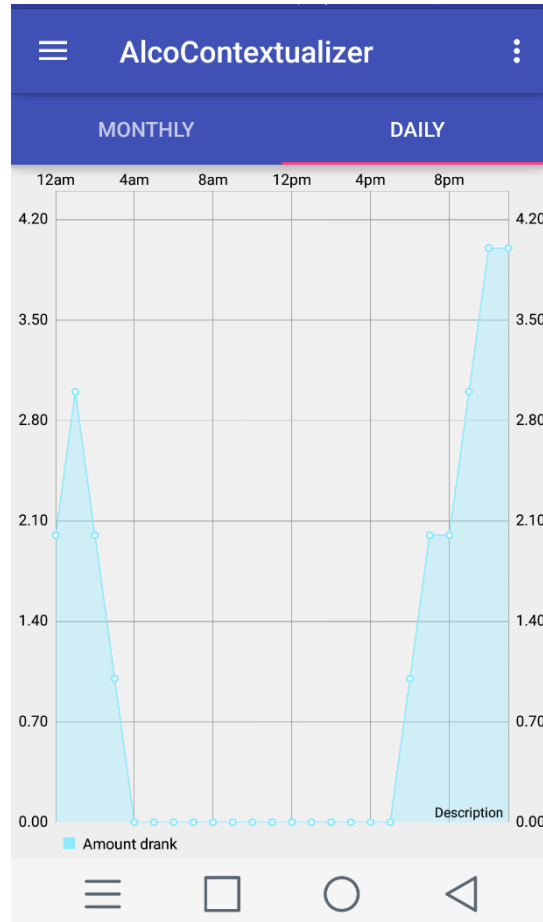


Figure 4.9: Line Chart showing daily drinking habits with the y-axis showing the number of drinks


```

LineChart lineChart = (LineChart) view.findViewById(R.id.lineChart);
lineChart.animateY(5000);
lineChart.getAxisRight().setDrawLabels(false);
lineChart.getLegend().setEnabled(false);

LineData data = new LineData(labels, dataSet);
lineChart.setData(data);
lineChart.setDescription("Amount drank every hour");

```

Figure 4.10: Line chart implementation

The daily chart defaults to the current day on the device. The date selector allows the user to navigate to other dates in order to see the respective day's chart. This data is pulled from the database upon selection of a date.

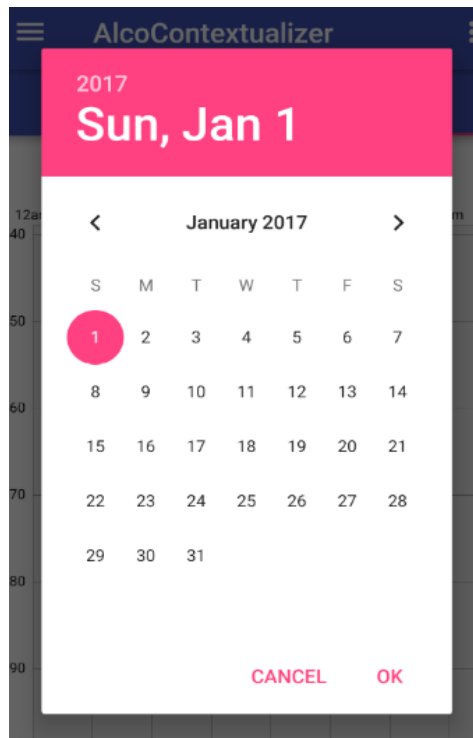


Figure 4.11: Date Selector Dialog

4.5 People Fragment

4.5.1 Individual Fragment:

The individual view of the people category is one of the two tabs available for People. It displays a pictogram graph of all the people the user has drink with as shown in Figure 4.12.

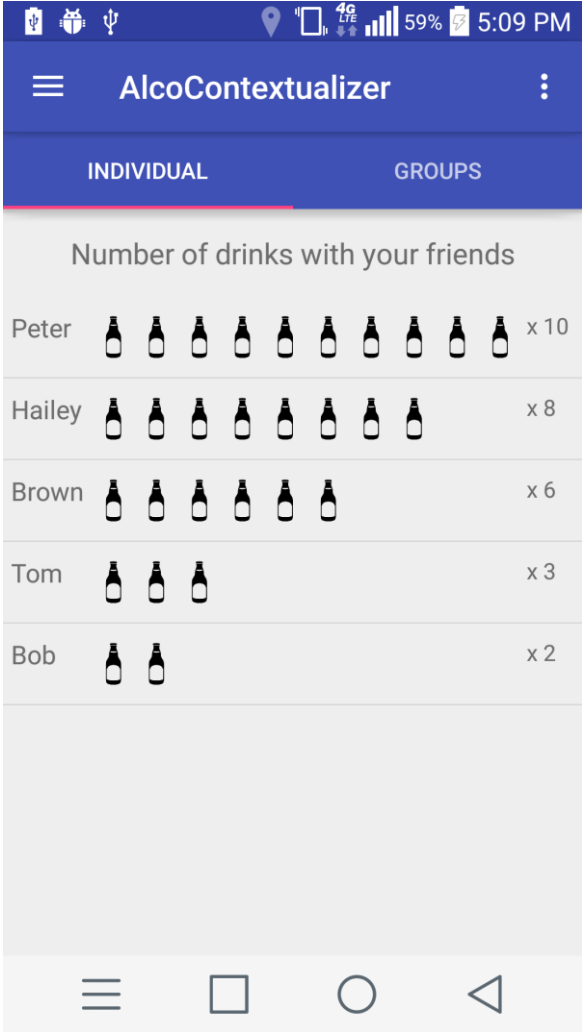


Figure 4.12: Pictogram Chart showing the number of drinks consumed with each friend

In order to create a pictogram chart, a listview adapter (Figure 4.13) was created in order to show a single row of the pictogram chart. This row contains the name of a person and the number of drinks the user has had with that user and the number of drinks is represented by a picture of bottle contained in an ImageView. This adapter is used to retrieve a single person with the amount of drinks to display from a list.

```
public class PictogramListAdapter extends ArrayAdapter<Person> {  
  
    public PictogramListAdapter(Context context, ArrayList<Person> people) {  
        super(context, R.layout.item_pictogram_row, people);  
    }  
  
    @NonNull  
    @Override  
    public View getView(int position, View convertView, ViewGroup parent) {  
        if (convertView == null) {  
            convertView = LayoutInflater.from(getContext()).inflate(R.layout.item_pictogram_row, parent, false);  
        }  
  
        Person person = getItem(position);  
  
        TextView name = (TextView) convertView.findViewById(R.id.textView_pictogram_title);  
        LinearLayout imagesContainer = (LinearLayout) convertView.findViewById(R.id.linearlayout_pictogram_images_container);  
        //   
        ListView listView = (ListView) convertView.findViewById(R.id.listView_pictogram_row_items);  
        name.setText(person.getPersonName());  
  
        for (int i = 0; i < person.getDrinkAmount(); i++) {  
            View bottleView = LayoutInflater.from(getContext()).inflate(R.layout.item_pictogram_row_item, parent, false);  
            bottleView.setLayoutParams(new ViewGroup.LayoutParams(75, 75));  
            imagesContainer.addView(bottleView);  
        }  
  
        return convertView;  
    }  
}
```

Figure 4.13: Shows how the PictogramListAdapter is implemented

Upon navigating to the Individual fragment of the people category, a call is made to the database to get a list of people that the user has a drink with. The ListView that will contain each person and amounts is retrieved. The adapter of that ListView is set to a new instance of a PictogramListAdapter and the data is displayed, as shown in Figure 4.14.

```
ListView pictogramListView = (ListView) view.findViewById(R.id.listView_pictogram);  
pictogramListView.setAdapter(new PictogramListAdapter(getContext(), getPeople()));
```

Figure 4.14: Setting an adapter to the pictogram ListView.

4.5.2 Group Fragment:

A fragment class that visualizes subject's drinking habits with different groups using a tree map as shown in the flow diagram in Figure 4.15. In the diagram, red dot shows the space that is touched, which in turn creates another variation of the tree map. To navigate from a root object to a child object in the tree map, the user can click on any space within the rectangle. To go back, user can click on the heading part that is colored in gray with bigger font to stand out from others. The new tree map screen that is created is shown by the arrows in the diagram.

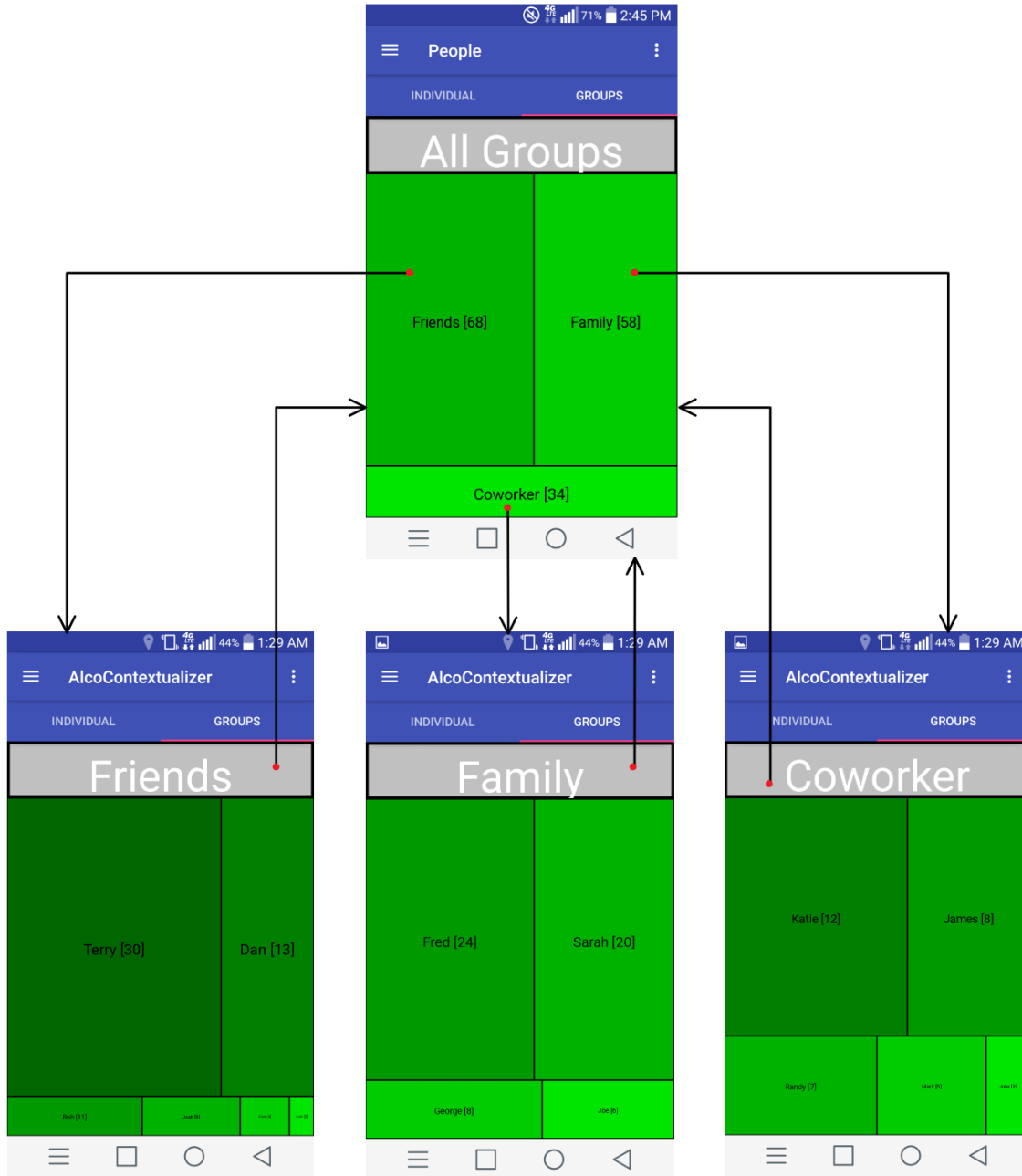


Figure 4.15: Tree map flow diagram

To create this tree map, we used a treemap algorithm software provided online by University of Maryland. The algorithm creates proportional sizes of parent and children rectangles depending on their value. To use the algorithm along with our application, we implemented a MapLayoutView class that extends a View class in Android. This class overrides the onDraw method and uses paint and canvas to draw rectangles and text on the screen as shown in Figures 4.16 and 4.17.

```
float textSize = Math.max(Math.max(rectF.width() / 20, rectF.height() / 20), 12);
mTextPaint.setTextSize(textSize);
mTextPaint.setTextAlign(Paint.Align.CENTER);

canvas.drawText(text, rectF.centerX(), rectF.top + textSize / 2 + rectF.height() / 2, mTextPaint);
```

Figure 4.16: Draw text

```
Paint rectBorderPaint = new Paint();
rectBorderPaint.setColor(Color.BLACK);
rectBorderPaint.setStyle(Paint.Style.STROKE); // outline the rectangle
rectBorderPaint.setStrokeWidth(20);

// Draw the rectangle's background
canvas.drawRect(rectF, rectBackgroundPaint);
// Draw the rectangle's border
canvas.drawRect(rectF, rectBorderPaint);
```

Figure 4.17: Draw rectangle

4.6 Database

To create the database, we used Android's SQLite database, and used SQL commands to create, and insert data into the database. The data we visualized was based on a study reported by Christopher Ingraham on the average alcohol consumption per week of an American adult (Ingraham [17]). According to the report, the top 8 percentile of adults consumed about 10 drinks per week. Based on this statistic, we formulated our data to represent this value. We included an upper range of 15 drinks per week, which represents the top 9 percentile of American adults. This provided a range for our data to be realistic in terms of an adult American drinker. The code snippets for these commands are shown in Figures 4.18 and 4.19. A database helper class was also created that contained helper methods such as Figure 4.20 to retrieve required data from the database.

```
@Override
public void onCreate(SQLiteDatabase db) {
    String CREATE_LOCATIONS_TABLE = "CREATE TABLE " + TABLE_LOCATIONS + "("
        + LOCATION_ID + " INTEGER PRIMARY KEY," + LOCATION_NAME + " TEXT,"
        + LOCATION_LATITUDE + " DOUBLE," + LOCATION_LONGITUDE + " DOUBLE,"
        + FREQUENCY_AMOUNT + " INTEGER," + RECENT_DATE + " TEXT" + ")";

    String CREATE_TIMES_TABLE = "CREATE TABLE " + TABLE_TIMES + "("
        + TIME_ID + " INTEGER PRIMARY KEY," + MONTH + " TEXT,"
        + DAY + " INTEGER," + HOUR + " INTEGER,"
        + DRINK_AMOUNT + " INTEGER" + ")";

    String CREATE_PEOPLE_TABLE = "CREATE TABLE " + TABLE_PERSON + "("
        + PERSON_ID + " INTEGER PRIMARY KEY," + PERSON_NAME + " TEXT,"
        + PERSON_DRINK_AMOUNT + " INTEGER," + GROUP_NAME + " TEXT" + ")";

    db.execSQL(CREATE_LOCATIONS_TABLE);
    db.execSQL(CREATE_TIMES_TABLE);
    db.execSQL(CREATE_PEOPLE_TABLE);
}
```

Figure 4.18: Creating database (contract)

```

// Location(id, name, lat, long, freqAmt, RecDate)
db.execSQL("INSERT INTO locations VALUES (1, 'Boynton', 42.2709, -71.8074, 5, 1453680000 );" );
db.execSQL("INSERT INTO locations VALUES (2, 'Sole Proprietor', 42.27, -71.81, 2, 1463072230 );" );

// Time(id, month, day, hour, drink amount)
db.execSQL("INSERT INTO times VALUES (1, 'January', 1, 20, 5);");
db.execSQL("INSERT INTO times VALUES (2, 'January', 2, 10, 3);");

// Person(id, name, drink amount, group name)
db.execSQL("INSERT INTO persons VALUES (1, 'Fred', 24, 'Family');" );
db.execSQL("INSERT INTO persons VALUES (2, 'Sarah', 20, 'Family');" );

```

Figure 4.19: Inserting data

```

/**
 * Creates a map item as a root for a tree model that represents the total
 * amount of drinks for all groups and individual groups
 *
 * @return treemodel with the root item as the total drinks for all groups
 * and children as total for individual groups
 */
public TreeModel getGroupTreeModel(){
    SQLiteDatabase db = this.getReadableDatabase();

    int allGroupsTotal = getDrinksAmountTotal(db, "");
    int familyTotal = getDrinksAmountTotal(db, FAMILY);
    int friendsTotal = getDrinksAmountTotal(db, FRIENDS);
    int coworkersTotal = getDrinksAmountTotal(db, COWORKER);

    AndroidMapItem rootItem = new AndroidMapItem(allGroupsTotal, ALL_GROUPS);
    TreeModel treeModel = new TreeModel(rootItem);
    treeModel.addChild(new TreeModel(new AndroidMapItem(familyTotal, FAMILY)));
    treeModel.addChild(new TreeModel(new AndroidMapItem(friendsTotal, FRIENDS)));
    treeModel.addChild(new TreeModel(new AndroidMapItem(coworkersTotal, COWORKER)));
    return treeModel;
}

```

Figure 4.20: Database Helper Method Example

5. Evaluation

5.1 User Testing - Questionnaire

Following the initial implementation of the AlcoContextualizer Android app, we needed to identify how understandable the application is for other users. In order to accomplish this, we found users who were interested in using the application and provide feedback by responding to a questionnaire.

5.1.1 Demographics

We gathered 6 participants (4 male, 2 female) for user testing, 3 of the participants were from the previous focus group and 3 were new participants. The target demographic is a wide range of majors who were undergraduates and active smartphone users as shown in the Figures 5.1-1 to 5.1-6. These participants fell within the target demographic, who were experienced enough with smartphones to provide constructive feedback on the application.

The first part of the questionnaire contained a set of questions to identify the demographics of the participants. The first three questions targeted general demographics of age, academic year, and major, as seen in Figure 5.1-1, Figure 5.1-2, and Figure 5.1-3.

Gender

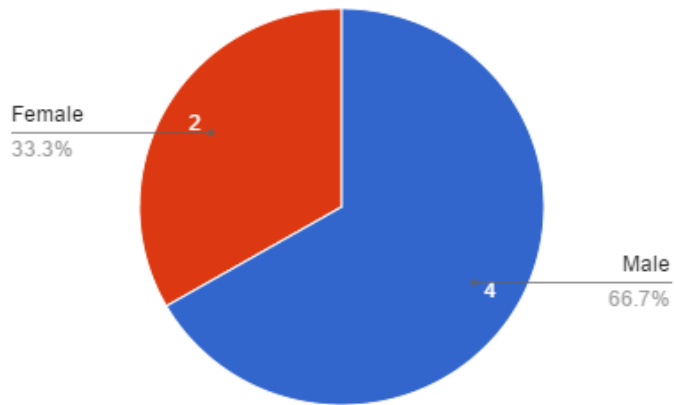


Figure 5.1-1: Participant's gender distribution

Academic Year

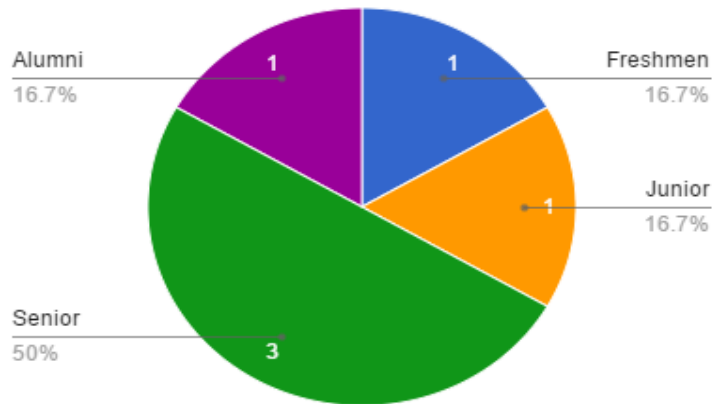


Figure 5.1-2: Participants' academic year distribution

Major

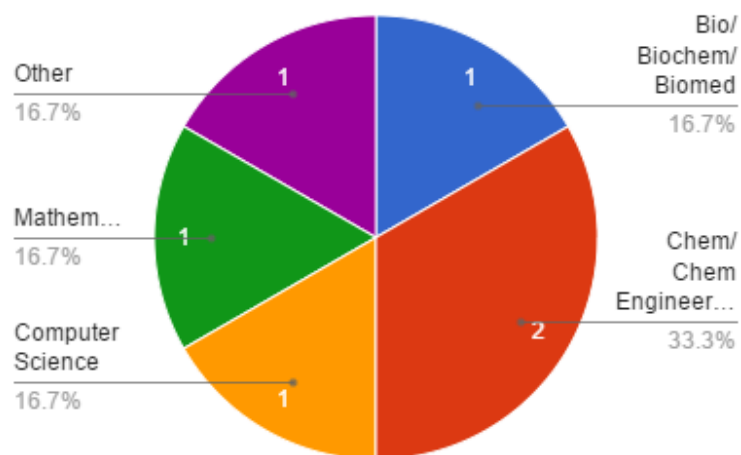


Figure 5.1-3: Participant's major distribution

The next question looked to identify participants' knowledge of statistical analysis. This would allow us to see how capable participants were in understanding statistical data beforehand, and if it had a correlation to being able to analyze our presented data on our charts. The results of the question can be seen in Figure 5.1-4. The question was asked on a scale of 1-5, with 1 being not knowledgeable of statistical analysis and being extremely knowledgeable in statistical analysis.

How knowledgeable do you consider yourself in terms of statistical analysis?

(6 responses)

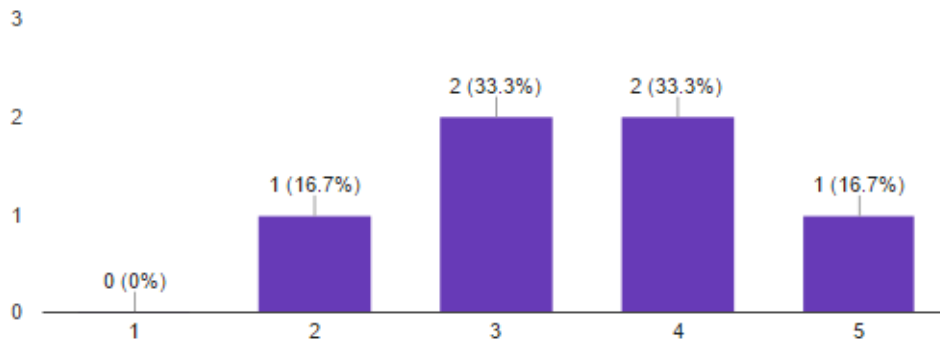


Figure 5.1-4: Participant's distribution in terms of statistical understanding (1 = Not Knowledgeable, 5 = Extremely Knowledgeable) (mean = 3.5, standard deviation = 1.05)

A similar question was asked in regards to participants knowledge in graphical visualization. This would allow us to see if any prior knowledge would correlate to how well the participants were able to understand the information the visualizations were trying to present. The results of the question can be seen in Figure 5.1-5. The question was asked on a scale of 1-5, with 1 being not knowledgeable in graphical visualization and being extremely knowledgeable in graphical visualization.

How knowledgeable do you consider yourself in terms of graphical visualization?

(6 responses)

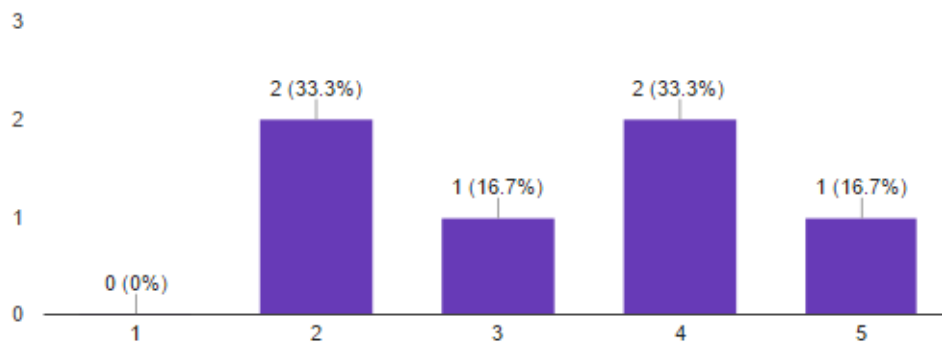


Figure 5.1-5: Participant's distribution in terms of visualization understanding (1 = Not Knowledgeable, 5 = Extremely Knowledgeable) (mean = 3.33, standard deviation = 1.21)

The final question was to determine how experienced participants were with smartphones. As a mobile application, it is important that users be able to navigate through the application on a mobile device. This was to see if there was a correlation to if lack of smartphone usage had an effect on usability of the application, or vice versa. The results can be seen in Figure 5.1-6.

Approximately how many hours do you use your smartphone in a day? (6 responses)

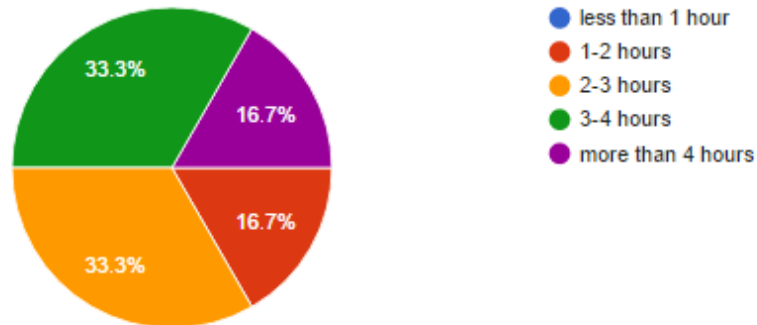


Figure 5.1-6: Participant's distribution in terms of smartphone usage

5.1.2 Questions that Subjects were asked

A set of questions would be asked of the users from the questionnaire after being presented with the application. Subjects were shown each chart within the application before handling the device on their own. Subjects used the app for 5 minutes, where they were able to navigate through the application themselves, before responding to questions. The purpose of the questions was to gauge the effectiveness of how understandable the information on the charts are to the users. We also wanted to get feedback on improvements that we could make in terms of the visual display, in order to make adjustments to have a more visually appealing application that users may use.

Questionnaire

For each chart:

1. Is the graph visually appealing? (Y/N)
2. Can you tell what kind information the graph is trying to convey? (Y/N)
3. Do you you like the colors of the graph? (Y/N)
4. Do the colors make sense? (Y/N)

Additional Comments:

Post Survey:

1. Would this be an application you would use if you were frequent alcohol user? (Y/N)
2. Did you understand the purpose of the application? (Y/N)

Figure 5.2: User Testing Questionnaire

5.1.3 Responses

The users were presented with a physical device (Smartphone) on which the AlcoContextualizer app was installed, so that they could have hands on use of the application. The initial four questions (Figure 5.3) followed by user responses (Figure 5.4), and post-survey questions (Figure 5.5) followed by responses to these questions (Figure 5.6) are shown below:

Question 1: Is the graph visually appealing? (Y/N)
Question 2: Can you tell what kind information the graph is trying to convey? (Y/N)
Question 3: Do you you like the colors of the graph? (Y/N)
Question 4: Do the colors make sense? (Y/N)

Figure 5.3: Questions asked during the survey

Chart		Question 1	Question 2	Question 3	Question 4
Location: Geo Chart	Subject 1	Y	Y	Y	Y
	Subject 2	Y	Y	Y	Y
	Subject 3	Y	Y	Y	Y
	Subject 4	Y	Y	Y	Y
	Subject 5	Y	Y	Y	Y
	Subject 6	Y	Y	Y	Y
	Percentage "Yes":	100%	100%	100%	100%
	Percentage "No":	0%	0%	0%	0%
Time: Bar Graph	Subject 1	Y	Y	Y	Y
	Subject 2	Y	Y	Y	Y
	Subject 3	N	Y	Y	Y
	Subject 4	Y	Y	Y	Y
	Subject 5	Y	Y	Y	N
	Subject 6	Y	Y	Y	Y
	Percentage "Yes":	83.33%	100%	100%	83.33%
	Percentage "No":	16.66%	0%	0%	16.66%
Time: Line Graph	Subject 1	Y	Y	Y	Y
	Subject 2	Y	Y	Y	Y
	Subject 3	N	Y	Y	Y
	Subject 4	Y	Y	Y	Y
	Subject 5	N	Y	Y	Y
	Subject 6	Y	Y	Y	Y
	Percentage "Yes":	66.66%	100%	100%	100%
	Percentage "No":	33.33%	0%	0%	0%
People: Pictogram	Subject 1	Y	Y	Y	Y
	Subject 2	Y	Y	Y	Y
	Subject 3	N	N	Y	Y
	Subject 4	Y	Y	Y	Y
	Subject 5	N	Y	Y	Y
	Subject 6	Y	Y	Y	Y
	Percentage "Yes":	66.66%	83.33%	100%	100%
	Percentage "No":	33.33%	16.66%	0%	0%
People: Treemap	Subject 1	Y	Y	Y	Y
	Subject 2	Y	Y	Y	N
	Subject 3	Y	Y	Y	Y
	Subject 4	Y	Y	N	N
	Subject 5	N	N	Y	N
	Subject 6	Y	Y	Y	Y
	Percentage "Yes":	83.33%	83.33%	83.33%	50.00%
	Percentage "No":	16.66%	16.66%	16.66%	50.00%

Figure 5.4: Responses for the questions asked during the survey

Post Survey:

Question 1. Would this be an application you would use if you were frequent alcohol user? (Y/N)

Question 2. Did you understand the purpose of the application? (Y/N)

Figure 5.5: Post-survey questions

Post	Question 1	Question 2
Subject 1	Y	Y
Subject 2	Y	Y
Subject 3	Y	N
Subject 4	Y	Y
Subject 5	Y	N
Subject 6	Y	Y
Percentage "Yes":	100%	66.66%
Percentage "No":	0%	33.33%

Figure 5.6: Responses to post-survey questions

Following the questionnaire, the participants were asked for further comments regarding the application. These comments were for clarification in terms of removing ambiguity about the application and potential improvements.

One of the participants commented that, "I like the colors in the application but I think they could be a little more consistent instead of random." In charts like the bar graph and tree map, the colors are randomized. To fix this we would have a consistent color scheme throughout each chart and the application. In addition, we could add more meaning with the use of colors. An example of this would be in the tree map, we would use a single color with various shades of that same color to represent the different number of drinks. In this case the darker shade of the color would represent a higher amount of drinks, conversely the lighter shade would represent fewer drinks.

Another comment from one of the participants was, "I think it'd make more sense if the initial tiles were the same as the actual graphs." This refers to home screen with the tiles not

truly representing their respective charts. In order to fix this, we would take screenshots of the final implementation of an example chart to be used as the tiles. This would make the tiles a better representation of the chart as they would be the charts themselves. This would provide consistency in users' expectations when selecting a tile to be directed to its respective chart. An example is the tiles for frequent and recent drinking locations. They use the same tiles, but should use their respective charts, with contextual information provided, to better represent and differentiate between the two.

An additional response from a participant was that, "It's difficult to understand what the application is trying to show until you described the graphs." The way the application is currently set up requires the user to understand the purpose of our application first before he starts using the application. We would fix this with a two step approach. Our first step would be to use better naming schemes, provide titles and labels to charts to further explain the visualization. Our second step would be to have a skippable tutorial when the user first opens the application, which would explain the purpose of the application and each chart in further depth. By using these two approaches, we can eliminate any confusion a user may have while using our application.

6. Conclusion and Future Works

6.1 Conclusion

Binge drinking is a common problem in the US. Using mobile phones as an attempt to tone down drinking habits by visualizations that show contextual information is an innovative approach that can prove to be highly effective. During our project, through literature research, users studies and focus groups, we were able to identify 6 charts to visualize contextual information. Additionally, we were able to build and user-test a prototype Android application that consists of those 6 charts(Geo Chart, Bar Graph, Line Graph, Tree Map, Pictogram) . We believe this application succeeded in conveying contextual alcohol information in a way that users could identify patterns and view pertinent information regarding their alcohol consumption habits. From our user testing responses, we found a general interest from participants in using this application. They were exposed to how using contextual information to visualize user's drinking patterns could be an effective means to monitor recurrent patterns of drinking and potentially decrease the amount of alcohol consumed. This helped us to further conclude the importance of using contextual information for drinking purposes.

6.2 Future Work

Needless to say, this application has some room for improvements. There are some ideas that could be implemented in order to add more features to the application. Ideas could include having a user input feature that allowed users to record drinks they consume, and adding more complex charts.

Allow user to enter drinks: Currently the app simply displays drinking patterns, such as how much the user drinks, who he/she drinks with, where the drinking is happening. This data is hard coded in a database; however, the user cannot add or modify any info. Therefore, a useful feature would be to allow users to be able to insert drink entries. An entry would contain information such as the number of drinks, the people involved in the drinking, and the location of

the drinking. Those changes would be saved and then be reflected in the app.

More user testing: The initial user testing proved to be very useful. It allowed us to make some changes in the application. Some of the changes included adding a tutorial screen, changing some of the colors throughout the app and more. However, more user testing should be made with different subjects in order to get more feedback and improve the app even more.

Implement more complex appealing visualizations: Lastly, while the app makes use of some interesting charts such as the treemap, it would be a good idea to implement some more complex charts, such as the quantified self-spiral chart. This would help attract users who prefer more complex charts.

All future recommendations mentioned above would help improve this app and gauge the interest of more users.

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8. Appendix A

Contained in this section is the survey created to identify the best visualizations for contextual information of alcohol consumption. The survey was created using Google Forms.

Charts Survey

The following survey consists of images on an Android device that visualize drinking patterns in various ways. Your task is to look at the provided images carefully and answer the questions to the best of your ability. The survey will take you 15-20 minutes to complete. Click on 'next' to begin

Background Information

Description (optional)

Gender *

- Male
- Female

Academic Year *

- Freshmen
- Sophomore
- Junior
- Senior
- Graduate
- Alumni

Major *

1. Aerospace Engineering
2. Bio/Biochem/Biomed
3. Business
4. Chem/Chem Engineering
5. Civil Engineering
6. Computer Science
7. Electrical and Computer Engineering
8. Interactive Media & Game Development
9. Mathematics & Statistics
10. Mechanical Engineering
11. Management Sciences and Information Systems
12. Physics
13. Other
14. Robotics

How knowledgeable do you consider yourself in terms of statistical analysis? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely

How knowledgeable do you consider yourself in terms of graphical visualization? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely

Approximately how many hours do you use your smartphone in a day? *

- less than 1 hour
- 1-2 hours
- 2-3 hours
- 3-4 hours
- more than 4 hours

Task 1: Most frequently visited drinking locations

Description (optional)

Image 1



Which one appears to be the most frequently drinking visited location in this map? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about frequently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 2



Which one appears to be the most frequently visited drinking location in this map? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about frequently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 3



Which one appears to be the most frequently visited location in this chart? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about frequently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Task 2: Most recently visited drinking location

Description (optional)

Image 1



Which one appears to be the most recently visited location in this map? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How well does the chart represent the information about recently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 2



Which one appears to be the most recently visited location in this map? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How well does the chart represent the information about recently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 3



Which one appears to be the most recently visited location in this chart? *

- A
- B
- C
- D

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

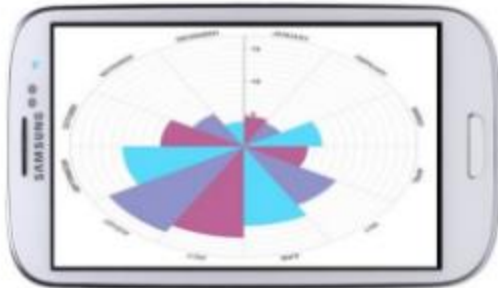
How well does the chart represent the information about recently visited drinking locations? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Task 3: The following charts display the amount of drinks you have had in different months.

Description (optional)

Image 1



Which month appears to have the highest amount? *

- January
- June
- August

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

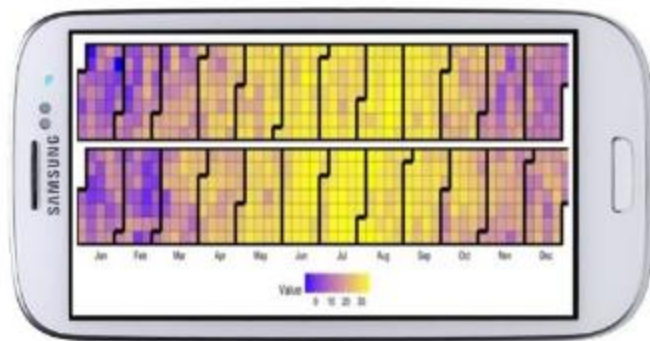
How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about the amount of drinks * in a month?

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 2



Which month appears to have the highest overall value? *

- Mar
- Jul
- Oct

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

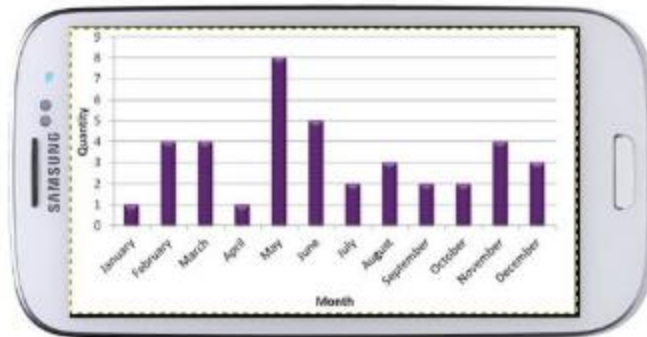
How visually appealing is this graph to you?

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about the amount of drinks in a month? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 3



Which month has the highest amount? *

- June
- July
- May

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

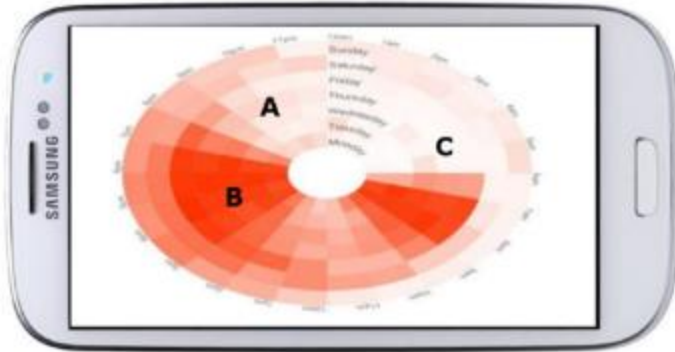
How well does the chart represent the information about the amount of drinks in a month? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Task 4: The number of drinks you have had during each hour of a day.

Description (optional)

Image 1



Which time frame appears to be the highest amount? *

- A
- B
- C

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

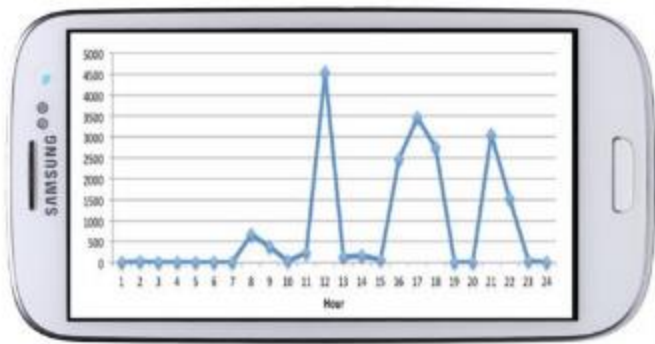
How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about the amount of drinks * in a day?

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 2



Which hour has the highest amount? *

- hour 8
- hour 12
- hour 21

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

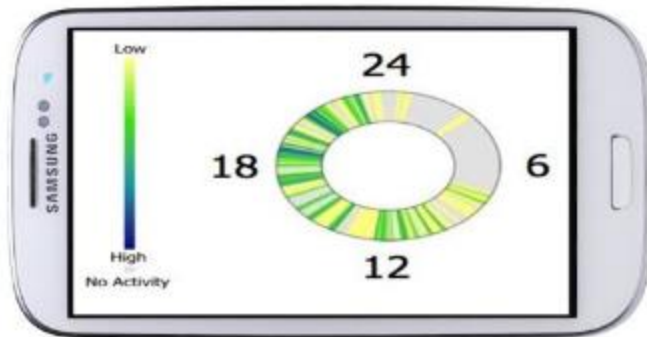
How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart represent the information about the amount of drinks in a day? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 3



Which time frame has the highest activity? *

- hours 6-12
- hours 12-18
- hours 18-24

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

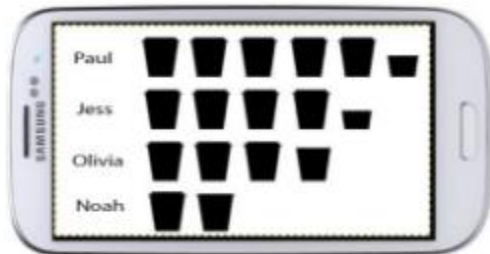
How well does the chart represent the information about the amount of drinks in a day? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Task 5: Person you have had the most amount of drinks with.

Description (optional)

Image 1



Which person have you had the most amount of drinks with? *

- Noah
- Jess
- Paul
- Olivia

How easy was it to understand the information presented? *

1 2 3 4 5

Very Difficult Very Easy

How visually appealing is this graph to you?

1 2 3 4 5

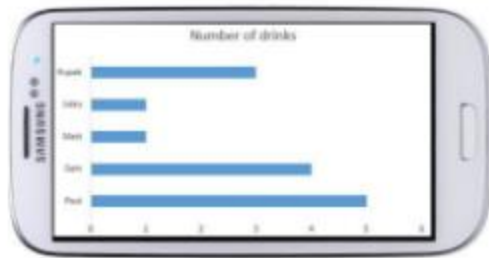
Not at all appealing Extremely appealing

How well does the chart represent the information about the amount of drinks * with each person?

1 2 3 4 5

Not at all Extremely well

Image 2



Which person have you had the most amount of drinks with? *

- Paul
- Sam
- Matt
- Jules
- Rupak

How easy was it to understand the information presented? *

Very Difficult 1 2 3 4 5 Very Easy

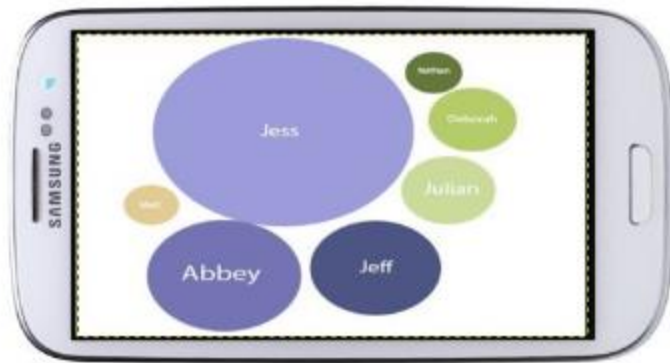
How visually appealing is this graph to you?

Not at all appealing 1 2 3 4 5 Extremely appealing

How well does the chart represent the information about the amount of drinks * with each person?

Not at all 1 2 3 4 5 Extremely well

Image 3



Which person have you had the most amount of drinks with? *

- Matt
- Jess
- Julian

How easy was it to understand the information presented?

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

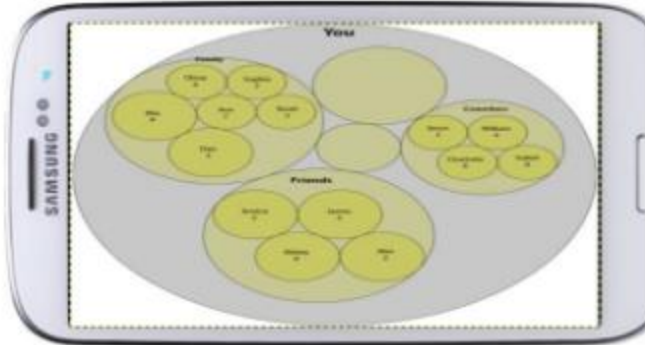
How well does the chart represent the information about the amount of drinks with each person? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Task 6: Identify different groups of people you drink with.

Description (optional)

Image 1



Which group has the most amount of people you drink with? *

- Friends
- Family
- Coworkers

How easy was it to understand the information presented? *

Very Difficult 1 2 3 4 5 Very Easy

How visually appealing is this graph to you? *

Not at all appealing 1 2 3 4 5 Extremely appealing

How well does the chart categorizes different groups of people you drink with? *

Not at all 1 2 3 4 5 Extremely well

Image 2



Which person have you drunk the most with? *

- Jessica
- Tim
- Olivia

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

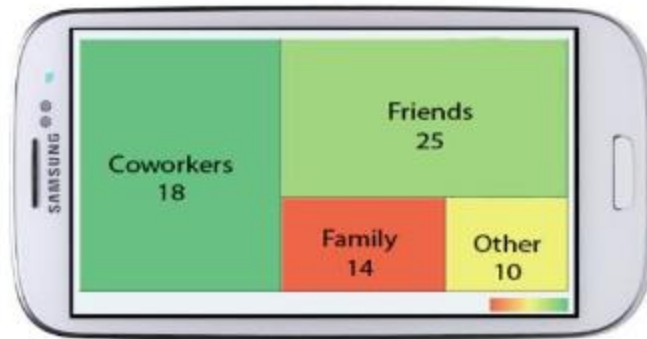
How visually appealing is this graph to you?

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the diagram represent the network of people you drink the most with? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

Image 3



Which group of people has the most number of drinks? *

- Coworkers
- Friends
- Family
- Other

How easy was it to understand the information presented? *

	1	2	3	4	5	
Very Difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very Easy

How visually appealing is this graph to you? *

	1	2	3	4	5	
Not at all appealing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely appealing

How well does the chart categorize different groups of people you drink with? *

	1	2	3	4	5	
Not at all	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely well

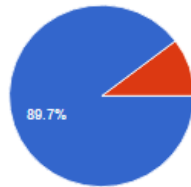
9. Appendix B

Contained in this section are the results for the survey for best visualizations of contextual information of alcohol consumption (Appendix A).

Summary

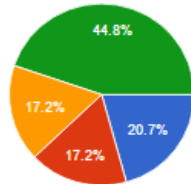
Background Information

Gender



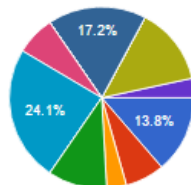
Male	26	89.7%
Female	3	10.3%

Academic Year



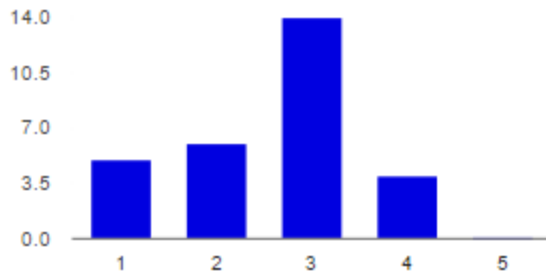
Freshmen	6	20.7%
Sophomore	5	17.2%
Junior	5	17.2%
Senior	13	44.8%
Graduate	0	0%
Alumni	0	0%

Major



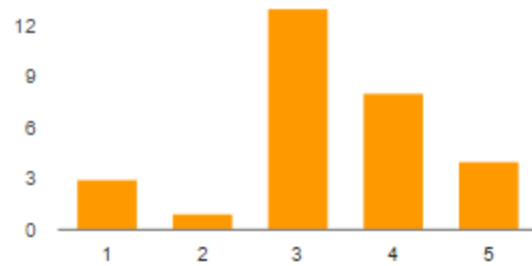
Aerospace Engineering	4	13.8%
Bio/Biochem/Biomed	2	6.9%
Business	1	3.4%
Chem/Chem Engineering	3	10.3%
Civil Engineering	0	0%
Computer Science	7	24.1%
Electrical and Computer Engineering	2	6.9%
Interactive Media & Game Development	0	0%
Mathematics & Statistics	0	0%
Mechanical Engineering	5	17.2%
Management Sciences and Information Systems	0	0%
Physics	0	0%
Other	4	13.8%
Robotics	1	3.4%

How knowledgeable do you consider yourself in terms of statistical analysis?



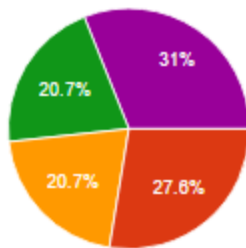
Not at all: 1	5	17.2%
2	6	20.7%
3	14	48.3%
4	4	13.8%
Extremely: 5	0	0%

How knowledgeable do you consider yourself in terms of graphical visualization?



Not at all: 1	3	10.3%
2	1	3.4%
3	13	44.8%
4	8	27.6%
Extremely: 5	4	13.8%

Approximately how many hours do you use your smartphone in a day?

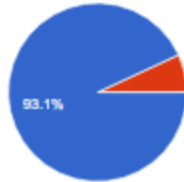


less than 1 hour	0	0%
1-2 hours	8	27.6%
2-3 hours	6	20.7%
3-4 hours	6	20.7%
more than 4 hours	9	31%

Task 1: Most frequently visited drinking locations

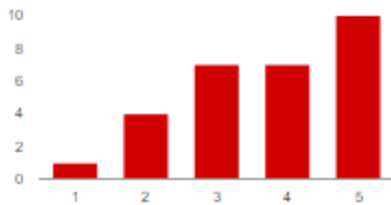
Image 1

Which one appears to be the most frequently drinking visited location in this map?



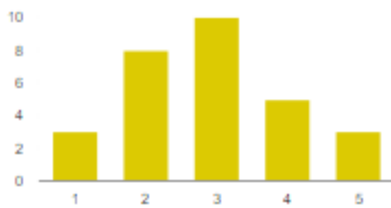
A	27	93.1%
B	2	6.9%
C	0	0%
D	0	0%

How easy was it to understand the information presented?



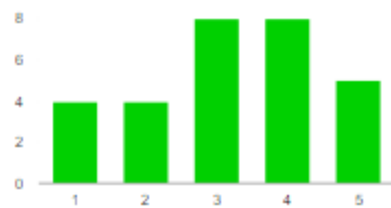
Very Difficult: 1	1	3.4%
2	4	13.8%
3	7	24.1%
4	7	24.1%
Very Easy: 5	10	34.5%

How visually appealing is this graph to you?



Not at all appealing: 1	3	10.3%
2	8	27.6%
3	10	34.5%
4	5	17.2%
Extremely appealing: 5	3	10.3%

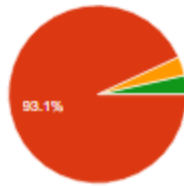
How well does the chart represent the information about frequently visited drinking locations?



Not at all: 1	4	13.8%
2	4	13.8%
3	8	27.6%
4	8	27.6%
Extremely well: 5	5	17.2%

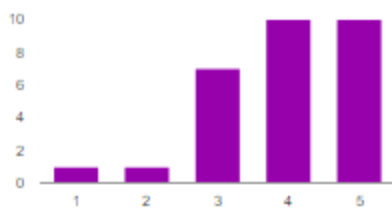
Image 2

Which one appears to be the most frequently visited drinking location in this map?



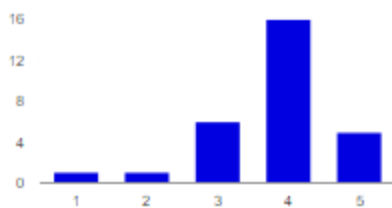
A	0	0%
B	27	93.1%
C	1	3.4%
D	1	3.4%

How easy was it to understand the information presented?



Very Difficult: 1	1	3.4%
2	1	3.4%
3	7	24.1%
4	10	34.5%
Very Easy: 5	10	34.5%

How visually appealing is this graph to you?



Not at all appealing: 1	1	3.4%
2	1	3.4%
3	6	20.7%
4	16	55.2%
Extremely appealing: 5	5	17.2%

How well does the chart represent the information about frequently visited drinking locations?



Not at all: 1	2	6.9%
2	2	6.9%
3	8	27.6%
4	14	48.3%
Extremely well: 5	3	10.3%

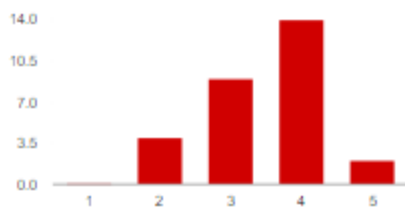
Image 3

Which one appears to be the most frequently visited location in this chart?



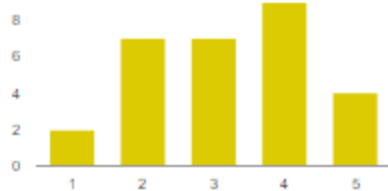
A	0	0%
B	0	0%
C	0	0%
D	29	100%

How easy was it to understand the information presented?



Very Difficult: 1	0	0%
2	4	13.8%
3	9	31%
4	14	48.3%
Very Easy: 5	2	6.9%

How visually appealing is this graph to you?



Not at all appealing: 1	2	6.9%
2	7	24.1%
3	7	24.1%
4	9	31%
Extremely appealing: 5	4	13.8%

How well does the chart represent the information about frequently visited drinking locations?

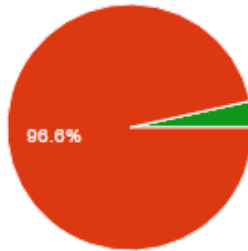


Not at all: 1	3	10.3%
2	6	20.7%
3	7	24.1%
4	11	37.9%
Extremely well: 5	2	6.9%

Task 2: Most recently visited drinking location

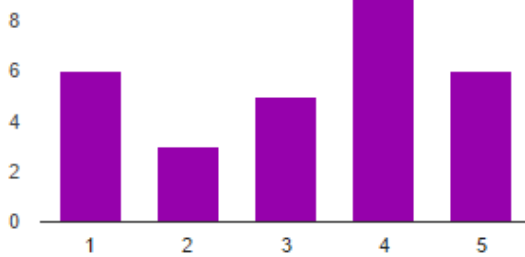
Image 1

Which one appears to be the most recently visited location in this map?



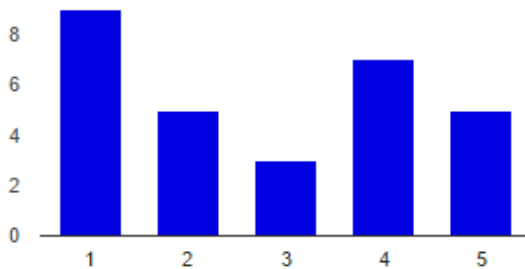
A	0	0%
B	28	96.6%
C	0	0%
D	1	3.4%

How easy was it to understand the information presented?



Very Difficult: 1	6	20.7%
2	3	10.3%
3	5	17.2%
4	9	31%
Very Easy: 5	6	20.7%

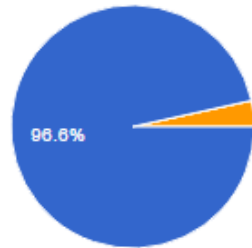
How well does the chart represent the information about recently visited drinking locations?



Not at all: 1	9	31%
2	5	17.2%
3	3	10.3%
4	7	24.1%
Extremely well: 5	5	17.2%

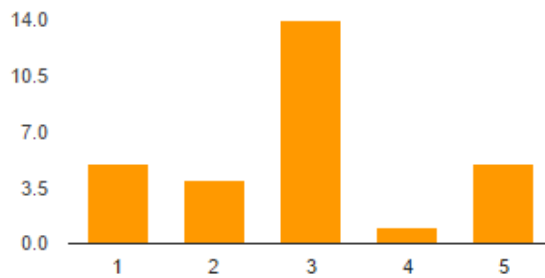
Image 2

Which one appears to be the most recently visited location in this map?



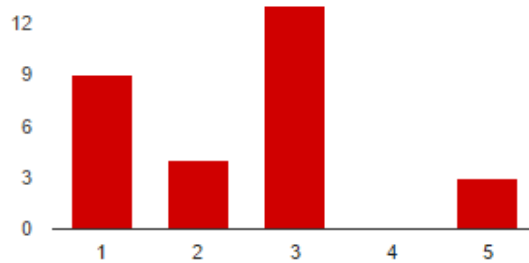
A	28	96.6%
B	0	0%
C	1	3.4%
D	0	0%

How easy was it to understand the information presented?



Very Difficult: 1	5	17.2%
2	4	13.8%
3	14	48.3%
4	1	3.4%
Very Easy: 5	5	17.2%

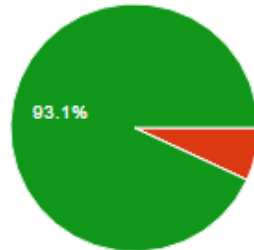
How well does the chart represent the information about recently visited drinking locations?



Not at all: 1	9	31%
2	4	13.8%
3	13	44.8%
4	0	0%
Extremely well: 5	3	10.3%

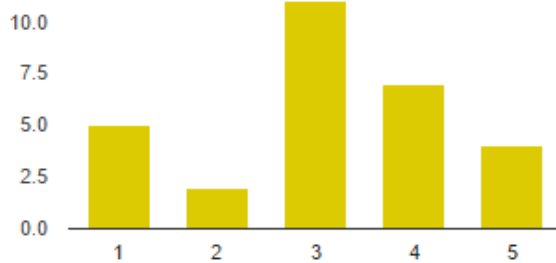
Image 3

Which one appears to be the most recently visited location in this chart?



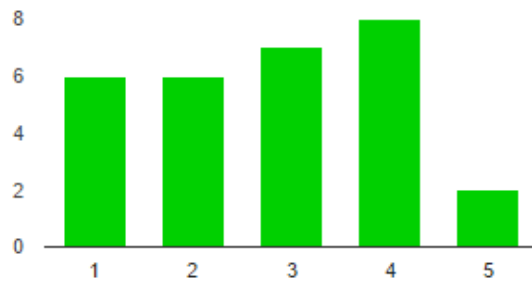
A	0	0%
B	2	6.9%
C	0	0%
D	27	93.1%

How easy was it to understand the information presented?



Very Difficult : 1	5	17.2%
2	2	6.9%
3	11	37.9%
4	7	24.1%
Very Easy: 5	4	13.8%

How well does the chart represent the information about recently visited drinking locations?



Not at all: 1	6	20.7%
2	6	20.7%
3	7	24.1%
4	8	27.6%
Extremely well: 5	2	6.9%

Task 3: The following charts display the amount of drinks you have had in different months.

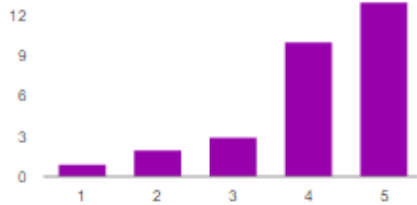
Image 1

Which month appears to have the highest amount?



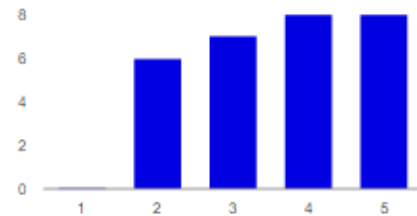
January	0	0%
June	0	0%
August	29	100%

How easy was it to understand the information presented?



Very Difficult :	1	1	3.4%
	2	2	6.9%
	3	3	10.3%
	4	10	34.5%
Very Easy:	5	13	44.8%

How visually appealing is this graph to you?



Not at all appealing:	1	0	0%
	2	6	20.7%
	3	7	24.1%
	4	8	27.6%
Extremely appealing:	5	8	27.6%

How well does the chart represent the information about the amount of drinks in a month?



Not at all:	1	0	0%
	2	3	10.3%
	3	3	10.3%
	4	7	24.1%
Extremely well:	5	16	55.2%

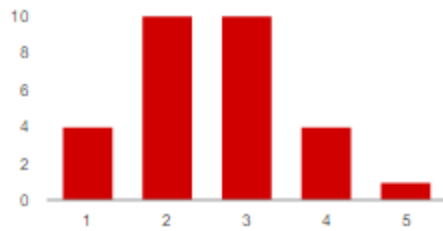
Image 2

Which month appears to have the highest overall value?



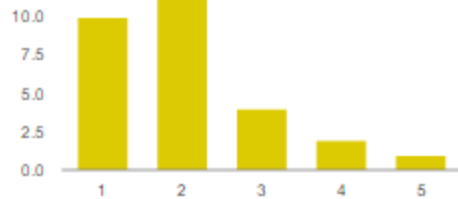
Mar	0	0%
Jul	29	100%
Oct	0	0%

How easy was it to understand the information presented?



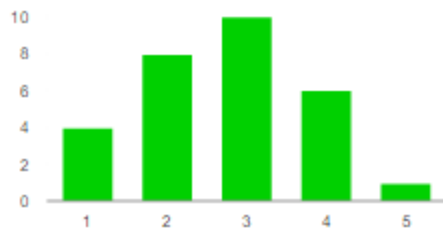
Very Difficult : 1	4	13.8%
2	10	34.5%
3	10	34.5%
4	4	13.8%
Very Easy: 5	1	3.4%

How visually appealing is this graph to you?



Not at all appealing: 1	10	34.5%
2	12	41.4%
3	4	13.8%
4	2	6.9%
Extremely appealing: 5	1	3.4%

How well does the chart represent the information about the amount of drinks in a month?



Not at all: 1	4	13.8%
2	8	27.6%
3	10	34.5%
4	6	20.7%
Extremely well: 5	1	3.4%

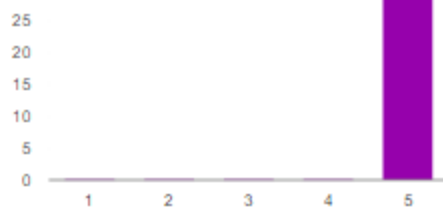
Image 3

Which month has the highest amount?



June	0	0%
July	0	0%
May	29	100%

How easy was it to understand the information presented?



Very Difficult : 1	0	0%
2	0	0%
3	0	0%
4	0	0%
Very Easy: 5	29	100%

How visually appealing is this graph to you?



Not at all appealing: 1	0	0%
2	2	6.9%
3	12	41.4%
4	6	20.7%
Extremely appealing: 5	9	31%

How well does the chart represent the information about the amount of drinks in a month?

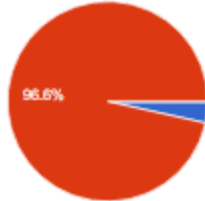


Not at all: 1	0	0%
2	0	0%
3	2	6.9%
4	4	13.8%
Extremely well: 5	23	79.3%

Task 4: The number of drinks you have had during each hour of a day.

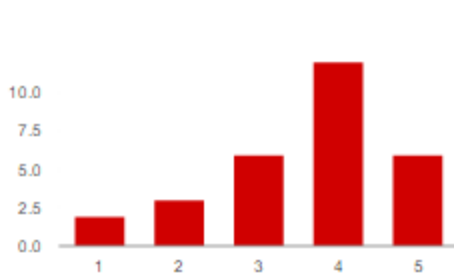
Image 1

Which time frame appears to be the highest amount?



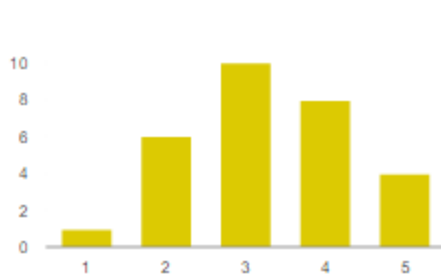
A	1	3.4%
B	28	96.6%
C	0	0%

How easy was it to understand the information presented?



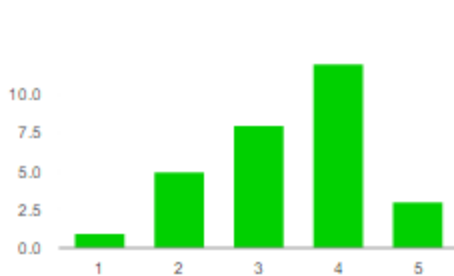
Very Difficult :	1	2	6.9%
	2	3	10.3%
	3	6	20.7%
	4	12	41.4%
Very Easy:	5	6	20.7%

How visually appealing is this graph to you?



Not at all appealing:	1	1	3.4%
	2	6	20.7%
	3	10	34.5%
	4	8	27.6%
Extremely appealing:	5	4	13.8%

How well does the chart represent the information about the amount of drinks in a day?



Not at all:	1	1	3.4%
	2	5	17.2%
	3	8	27.6%
	4	12	41.4%
Extremely well:	5	3	10.3%

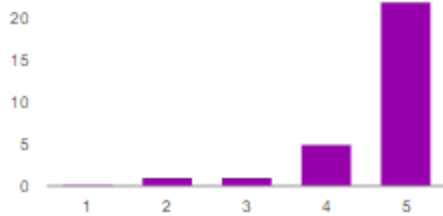
Image 2

Which hour has the highest amount?



hour 8	0	0%
hour 12	29	100%
hour 21	0	0%

How easy was it to understand the information presented?



Very Difficult : 1	0	0%
2	1	3.4%
3	1	3.4%
4	5	17.2%
Very Easy: 5	22	75.9%

How visually appealing is this graph to you?



Not at all appealing: 1	1	3.4%
2	4	13.8%
3	12	41.4%
4	8	27.6%
Extremely appealing: 5	4	13.8%

How well does the chart represent the information about the amount of drinks in a day?



Not at all: 1	2	6.9%
2	0	0%
3	6	20.7%
4	4	13.8%
Extremely well: 5	17	58.6%

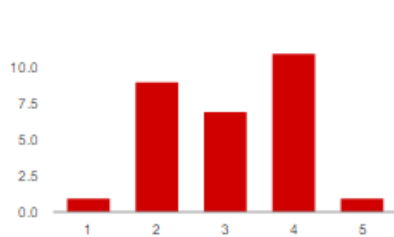
Image 3

Which time frame has the highest activity?



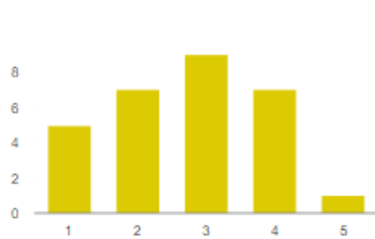
hours 6-12	0	0%
hours 12-18	0	0%
hours 18-24	29	100%

How easy was it to understand the information presented?



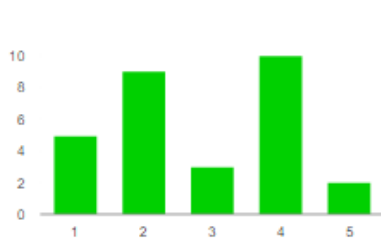
Very Difficult : 1	1	3.4%
2	9	31%
3	7	24.1%
4	11	37.9%
Very Easy: 5	1	3.4%

How appealing is this graph to you?



Not at all appealing: 1	5	17.2%
2	7	24.1%
3	9	31%
4	7	24.1%
Extremely appealing: 5	1	3.4%

How well does the chart represent the information about the amount of drinks in a day?



Not at all: 1	5	17.2%
2	9	31%
3	3	10.3%
4	10	34.5%
Extremely well: 5	2	6.9%

Task 5: Person you have had the most amount of drinks with.

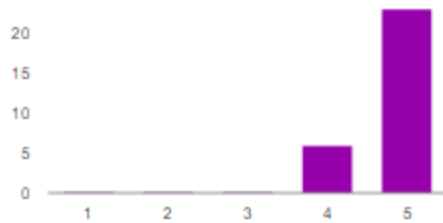
Image 1

Which person have you had the most amount of drinks with?



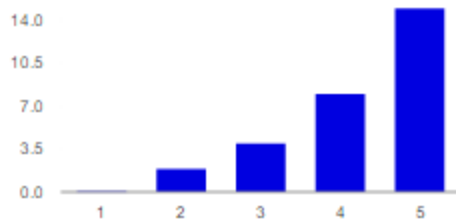
Noah	0	0%
Jess	0	0%
Paul	29	100%
Olivia	0	0%

How easy was it to understand the information presented?



Very Difficult : 1	0	0%
2	0	0%
3	0	0%
4	6	20.7%
Very Easy: 5	23	79.3%

How visually appealing is this graph to you?



Not at all appealing: 1	0	0%
2	2	6.9%
3	4	13.8%
4	8	27.6%
Extremely appealing: 5	15	51.7%

How well does the chart represent the information about the amount of drinks with each person?



Not at all: 1	0	0%
2	0	0%
3	4	13.8%
4	7	24.1%
Extremely well: 5	18	62.1%

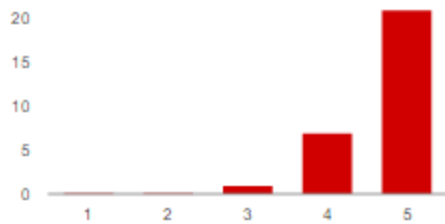
Image 2

Which person have you had the most amount of drinks with?



Paul	29	100%
Sam	0	0%
Matt	0	0%
Jules	0	0%
Rupak	0	0%

How easy was it to understand the information presented?



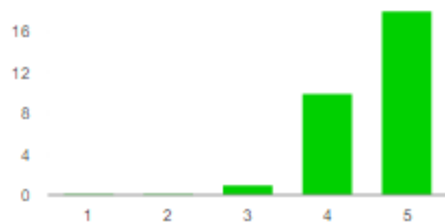
Very Difficult : 1	0	0%
2	0	0%
3	1	3.4%
4	7	24.1%
Very Easy: 5	21	72.4%

How visually appealing is this graph to you?



Not at all appealing: 1	0	0%
2	1	3.4%
3	12	41.4%
4	9	31%
Extremely appealing: 5	7	24.1%

How well does the chart represent the information about the amount of drinks with each person?



Not at all: 1	0	0%
2	0	0%
3	1	3.4%
4	10	34.5%
Extremely well: 5	18	62.1%

Image 3

Which person have you had the most amount of drinks with?



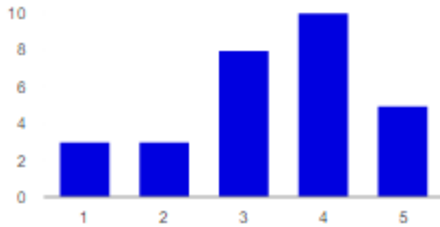
Matt	0	0%
Jess	29	100%
Julian	0	0%

How easy was it to understand the information presented?



Very Difficult : 1	0	0%
2	0	0%
3	7	24.1%
4	9	31%
Very Easy: 5	13	44.8%

How visually appealing is this graph to you?



Not at all appealing: 1	3	10.3%
2	3	10.3%
3	8	27.6%
4	10	34.5%
Extremely appealing: 5	5	17.2%

How well does the chart represent the information about the amount of drinks with each person?



Not at all: 1	2	6.9%
2	10	34.5%
3	2	6.9%
4	7	24.1%
Extremely well: 5	8	27.6%

Task 6: Identify different groups of people you drink with.

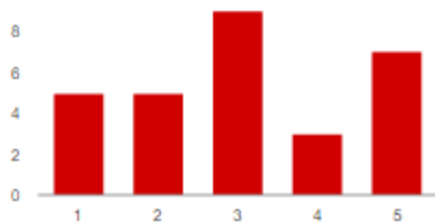
Image 1

Which group has the most amount of people you drink with?



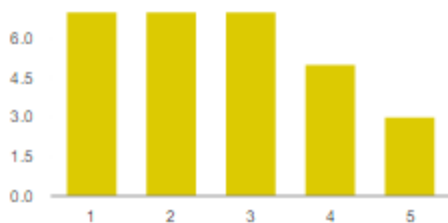
Friends	3	10.3%
Family	26	89.7%
Coworkers	0	0%

How easy was it to understand the information presented?



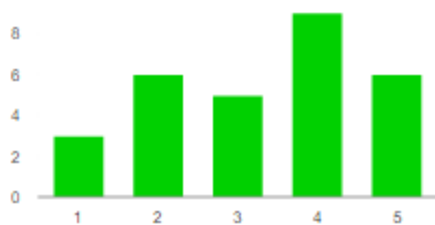
Very Difficult : 1	5	17.2%
2	5	17.2%
3	9	31%
4	3	10.3%
Very Easy: 5	7	24.1%

How visually appealing is this graph to you?



Not at all appealing: 1	7	24.1%
2	7	24.1%
3	7	24.1%
4	5	17.2%
Extremely appealing: 5	3	10.3%

How well does the chart categorizes different groups of people you drink with?



Not at all: 1	3	10.3%
2	6	20.7%
3	5	17.2%
4	9	31%
Extremely well: 5	6	20.7%

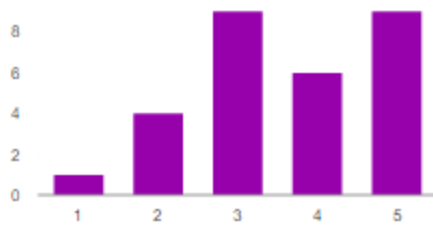
Image 2

Which person have you drank the most with?



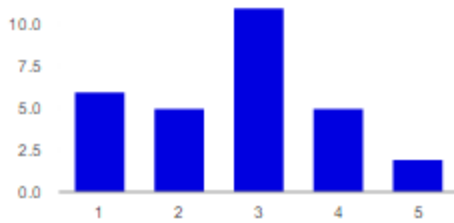
Jessica	0	0%
Tim	0	0%
Olivia	29	100%

How easy was it to understand the information presented?



Very Difficult : 1	1	3.4%
2	4	13.8%
3	9	31%
4	6	20.7%
Very Easy: 5	9	31%

How visually appealing is this graph to you?



Not at all appealing: 1	6	20.7%
2	5	17.2%
3	11	37.9%
4	5	17.2%
Extremely appealing: 5	2	6.9%

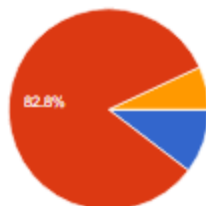
How well does the diagram represent the network of people you drink the most with?



Not at all: 1	2	6.9%
2	5	17.2%
3	10	34.5%
4	10	34.5%
Extremely well: 5	2	6.9%

Image 3

Which group of people has the most number of drinks?



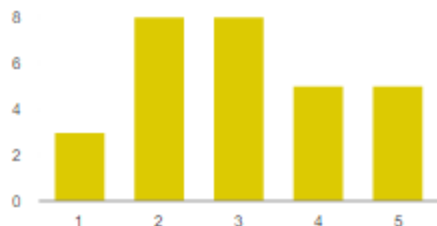
Coworkers	3	10.3%
Friends	24	82.8%
Family	2	6.9%
Other	0	0%

How easy was it to understand the information presented?



Very Difficult : 1	1	3.4%
2	2	6.9%
3	4	13.8%
4	7	24.1%
Very Easy: 5	15	51.7%

How visually appealing is this graph to you?



Not at all appealing: 1	3	10.3%
2	8	27.6%
3	8	27.6%
4	5	17.2%
Extremely appealing: 5	5	17.2%

How well does the chart categorize different groups of people you drink with?



Not at all: 1	2	6.9%
2	2	6.9%
3	8	27.6%
4	9	31%
Extremely well: 5	8	27.6%