# OPICO: A PLATFORM FOR COLLECTING AND ANALYZING EMOJI USAGE

BY

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THESIS

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## ABSTRACT

Emojis have emerged as a popular form of digital communication that can quickly convey big ideas or expressions with a single character. Since their creation in 1999, emojis have become a mainstay in the digital lexicography of instant messaging and social media. However, emojis are traditionally used in conjunction with text, as supplemental metadata. This paper explores the feasibility of emoji-only communication and emoji grammars. To gather emoji-only data, we built Opico, an emoji-first, social media mobile app that allows users to share emoji reactions about the places they visit with their friends. Each post in the app is a one-to-five emoji sentence to express an emotion, sentiment, or description about a location. After collecting over 3500 emoji reactions and having over 900 users on the app, the results demonstrate emoji-only communication provided concise forms of expression about various locations across the world. Data analysis has uncovered the various patterns and linguistics of how users construct emoji-only sentences, building the foundation for an emoji grammar.

*To my grandparents, Sharad Khandekar, Nirmala Khandekar, Shrikrishna Bhave, and Jayshri Bhave, for all their blessings.*

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# CHAPTER 1: INTRODUCTION

Emojis have emerged as a popular form of digital communication that can quickly convey big ideas or expressions with a single Unicode character. Since their creation in 1999, emojis have become a mainstay in the digital lexicography of instant messaging and social media users. As of June 2018, Unicode 11.0 includes 2,823 emojis in the specification [1]. The universality of emojis allows them to extend across cultural and generational lines. Facebook revealed that 77% of users between the ages of 56 and 64 use emojis and that 92% of users between the ages of 13 and 18 use emojis [2]. While the ubiquity of emojis has changed the way we communicate, there have been multiple challenges in understanding and using them.

Various platforms have incorporated emojis into their services; however, the emojis are often paired with words or sentences that accompany the meaning of the emoji, and the platform's freeform text inputs do not impose a limit or structure to writing them. Moreover, the emoji's size, placement, and artwork can create varied interpretations. Although the number of available emojis grow each year, it is currently not possible to represent every possible object or emotion with an emoji. Despite these challenges, emojis have the potential to be an expressive, universal, terse form of communication in a world where we type on small, mobile keyboards. While previous studies have shown the effectiveness of emojis as a way to amplify or enhance a text message, we believe standalone emojis can be used to create a proper and complete sentence.

This paper proposes the feasibility of emoji-only communication to better understand how to structure and interpret emojis. In order to study patterns in emoji-only communication, we built our own social media network, focused on creating emoji-only content. We built Opico, a cross-platform, emoji-first mobile application that allows users to share emoji-only reactions about the places they visit with their friends. Opico ("opinion" + "pico") was built as a way to express small opinions as large ideas. Each post in the social network is a one-to-five emoji sentence that can be used to express an emotion, sentiment, or description. The app can be used as a social media app for interactions between communities and friends, as a form of life-logging, a way to plan an upcoming trip, or as a status update or check-in. Through the process of creating the app and receiving user feedback, the app features a variety of different interfaces that have been tailored towards building a social network including a feed, profiles, and the ability to follow other users. The app also enables a new form of exploration and discovery by presenting emojis in a geospatial format through a map. While the usage of emoji-only posts can convey clear, short emotions or descriptions, they can also introduce ambiguity. While this ambiguity may deter comprehension of an

emoji sentence, it introduces new, enjoyable ways to communicate and interact with other users. The data the app has collected allows us to analyze and interpret standalone emoji characters, emoji pairs, emoji triplets, and patterns in emoji input, building the foundation for emoji-only communication.

## CHAPTER 2: RELATED WORK

Previous work has examined the usage of emojis between individuals. Wiseman et al. found that emoji can have their own meanings when personally sharing emojis with other people or small groups, which can differ from the culturally accepted or intended interpretations [4]. Sugiyama et al. discuss the usage of emojis between Japanese teens, as an expression of their taste and "aesthetic self." They argue that their study can be generalized as a study of how young people use emojis globally as a means of maintaining "playful yet controlled social interactions" [19]. Zhou et al. performed a qualitative study among Chinese adults in Southern China to observe emoji and sticker usage in WeChat, where they found that "emoji and stickers could be leveraged to augment existing text, compensate for text that is incomplete either due to concerns around social stigma or because it is tedious to type in certain languages, or replace text altogether" [12]. Hu et al. studied the sentimental effects of emojis from the perspectives of both the sender and the recipient in a conversation [27]. Kelly et al. studied how emojis are used in messaging applications in mediated conversations [28]. Our work hopes to examine the social interactions between users and their emoji usage.

Across different cultures and languages, emoji usage and interpretations can vary. Barbieri et al. studied the semantics of emoji usage and interpretation across many languages and found differences that could be attributed to social and geographical differences [24]. Lu et al. examined a data-set of over 400 million emoji-contained messages and found diverse emoji usage across 212 countries and regions [3]. Differences in interpretation can also occur across devices that render different emoji artwork for the same Unicode character. Miller et al. not only found disagreements between users on the sentiment of the same emoji artwork, but also found disagreements across artworks across different platforms in textual contexts [6]. Miller et al. followed up on this work by studying the emojis in isolation and found roughly similar miscommunications [7]. Tigwell et al. surveyed over 400 individuals and found varying interpretations of the same emoji across different platforms from which they proposed an adaptive system that uses a model of how people interpret each emoji and use Euclidean distance to calculate the appropriate emoji for the receiver's platform [14]. Given the international and cross-platform availability of Opico, we hope to examine these differences as well.

Previous works have studied popular platforms such as Twitter and Venmo for emoji usage. Vidal et al. analyzed over 12,000 food-related tweets that contained at least one emoji to measure food-related emotions [10]. Barbieri et al. created a vector space skip-gram model

for Twitter emojis based on 10 million tweets [20]. Caraway et al. examined the benefits of emoji ambiguity in Venmo, where the usage of emoji in a "social awareness stream" of financial transactions is deemed acceptable, despite the sensitivity of the data [5].

Works have also studied the effects that emojis can have when combined with text. Tauch et al. found how emojis are used in phone notifications as a way to amplify or modify the accompanying message [13]. Lee et al. found that emoticon stickers were not only a means of expressing emotions, but also a strategic means of indicating social status and as a functional means to replace or supplement text [11]. Cramer et. al studied the linguistics of emoji usage in messages and how strategic placement of emojis in messages can affect various aspects of the conversation [25].

Analysis has been done to understand the sentiment and human-perceived meanings behind emojis. Wijeratne et al. created a machine readable sense inventory, EmojiNet, by using official and crowdsourced definitions and sense labels [8]. Following up on their previous work, Wijeratne et atl. used the machine-readable emoji meanings to create a dataset called EmoSim508, assigning "human-annotated semantic similarity scores" to over 508 emoji pairs [9]. Ai et al. used machine learning to find how emojis with clear semantic meanings are more likely to be adopted than unclear ones, and how object-related emojis are often used in place of words [29]. Novak et al. provided the Emoji Sentiment Ranking, a sentiment analysis of emojis used in tweets [26]. Chen et al. studied emoji usage patterns in Android devices and used machine learning to infer gender [23]. Radford et al. attempted a crowdsourced, verbatim translation of Moby Dick and used NLP techniques to compare the translated and original text using statistical methods [15].

While emojis have been widely regarded as a universal form of communication, the end-users have had difficulty using this language. Sutton et al. argue that the end-users are not engaged in the design process of emojis that are ultimately included in the Unicode specification, and they propose an online platform where users can suggest new emojis and offer ideas about interpretations, contexts, and "cross-platform equitability" [17]. Cunha et al. created a "Visual Blending-based system" to create new visually blended emoji based on user-generated ideas [18]. Pohl et. al examine the state of Android emoji keyboards and how they are not optimized for emoji input, and they examine over 21 million tweets with emojis to build an emoji similarity model for proposed, new formats to the keyboard [22].

Our work hopes to expand on previous works by examining emoji usage in the context of emoji-only sentences.

## CHAPTER 3: THE SYSTEM

Figure 3.1: This is the mobile app icon for Opico, a cross-platform mobile app for creating and sharing emoji sentences as descriptions, sentiments, and experiences at locations.

We built a platform that allows users to build these emoji-only sentences as posts in a social network. Since using and selecting emojis in text inputs has been easiest on mobile devices, we decided to build a mobile app. Opico is a mobile application that has been released to the iOS App Store for iOS devices and the Google Play Store for Android devices. The app's main content is emoji reaction posts, which are user-composed emoji sentences that range between one to five emojis in length. The emojis are Unicode characters, and the rendered artwork depends on the user's device and the artwork provided with the operating system, which means that the artwork can vary between devices. The limitation of five emojis per post requires users to be brief and effective in constructing their posts, while also making it quicker and more entertaining for other users to read and decipher. Since each emoji reaction post is tied to a specific location, the post can be aimed at describing the user's description of the location, their experience at that location, or their sentiment about the location. The locations can be vary from restaurants, cafes, shops, monuments, school buildings, exact addresses, and any other type of establishment. The app is a social network where users can interact with other users and their posts through likes, comments, follows, and bullseyes, which will be expanded on in a later section.

The emoji posts can be structured to be as straightforward or as ambiguous as the user intends. For example, a user who wants to express a positive sentiment about a restaurant may leave a simple one-emoji reaction, such as 👍, similar to a Facebook "like." On the

Figure 3.2: Every post in the app is a one-to-five emoji sentence about a location. Since Unicode characters are being used in a post, the rendered artwork can differ depending on the user's device. For this reaction, the top reaction is how the artwork is rendered on an iPhone device and the bottom is how the artwork is rendered on an Android device.

other hand, users may use the five emoji limit to provide an expanded description about their experience. For example, a user on the app expressed 🍻🎶🎉 at a bar, which is interpreted as a someone who describing a musical, festive atmosphere with beer. This freedom allows the posts to range from being reviews, statuses, or check-ins.

## 3.1 LOGIN AND ONBOARDING FLOW

When a user downloads the app, the login screen allows the user to either sign up or login with either Facebook or Google. If the user is new to the app, the app will take the user through multiple on-boarding screens that introduce the user to the app, walk the user through creating their first post in the app, and help the user find other users to follow in the app. If the user has already been through the onboarding process, the app automatically takes the user to the main content feed.

## 3.2 POSTING AN EMOJI REACTION

### 3.2.1 Locations

When the user wants to create an emoji reaction, they need to first select a location to associate with their post. Using the Google Places API, the backend API serves a list of nearby places based on the user's current location. The list includes two search boxes where the users can set their location by address and search for particular locations by keyword. While the list of places initially consisted of restaurants and cafes, the algorithm

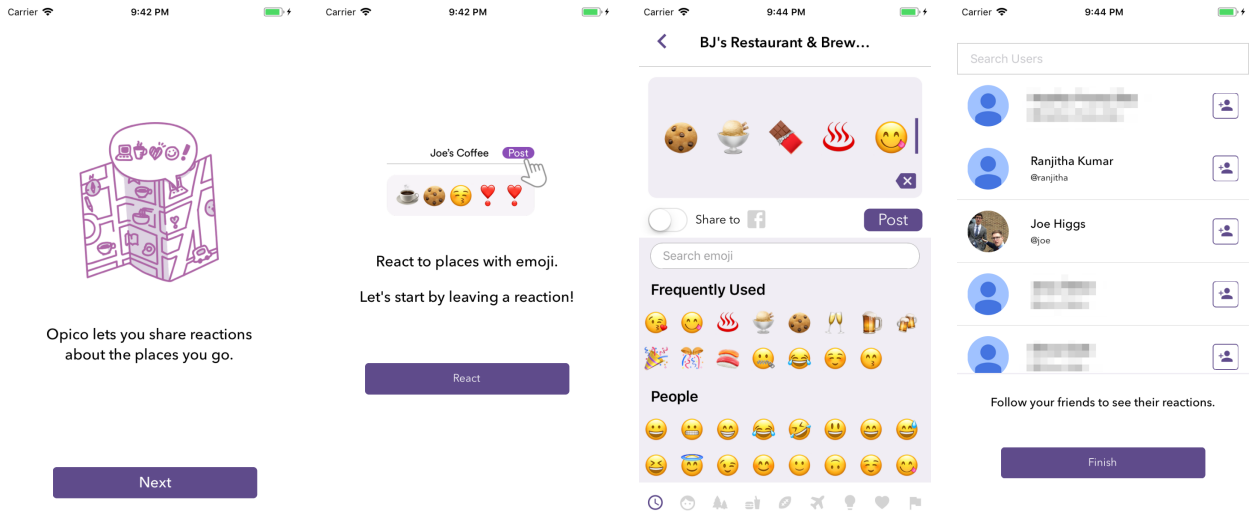


Figure 3.3: The onboarding sequence for when users login to the app for the first time.

has been modified over time to include a variety of locations, including monuments, museums, businesses, standalone addresses, and other entities.

### 3.2.2 Keyboard

To create the emoji reactions, the app needed a method to show only emoji characters that could be inputted by the user. While the mobile keyboards on Android and iOS have emoji support, the keyboards could not be configured to only show emojis and not the plain text characters. Moreover, the experience to input emojis would be inconsistent across platforms. To alleviate this problem, the app has a custom-built emoji keyboard. This keyboard was built was as a standalone, documented React Native component, and open-sourced as "react-native-emoji-input."

The keyboard categorizes all of the emojis in a large, scrollable list, similar to the layout on a standard iOS or Android keyboard. The bottom row of the keyboard displays individual icons for each category and tapping on each icon scrolls to the appropriate category. The keyboard also has a section of the "Most Frequent" emojis that a user has used over time, allowing easy access to emojis the user likes to use.

The keyboard also has a search functionality that allows users to type regular text to find the emoji they would like to use. While Unicode provides official names and aliases for each emoji, we used various synonym APIs and libraries to find better word associations for user searching. To continually improve the search functionality of the keyboard, we implemented

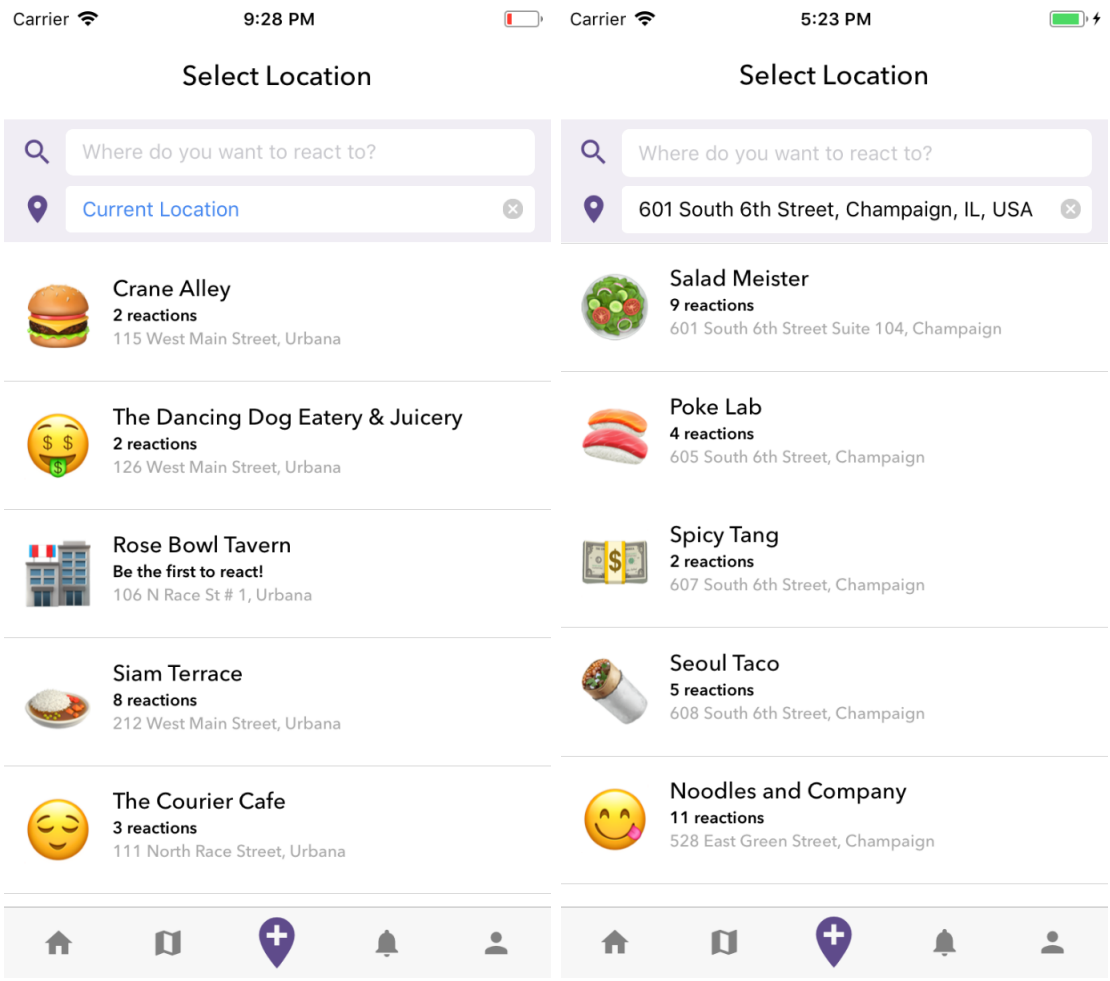


Figure 3.4: Users are shown a list of nearby locations to select for their emoji reactions. They may choose to search based on their current location or they can specify an address.

a logging mechanism that uses two strategies to log search queries. First, if the user enters a search query, doesn't select anything, and clears their query. Second, if the user enters a search query and no results are shown. In both of these cases, the user attempted to find a particular emoji and could not find it. By logging their search query, we can use their data as a way to either fill a missing alias for an existing emoji or keep a running list of emojis that users would like to see in the app or official specification.

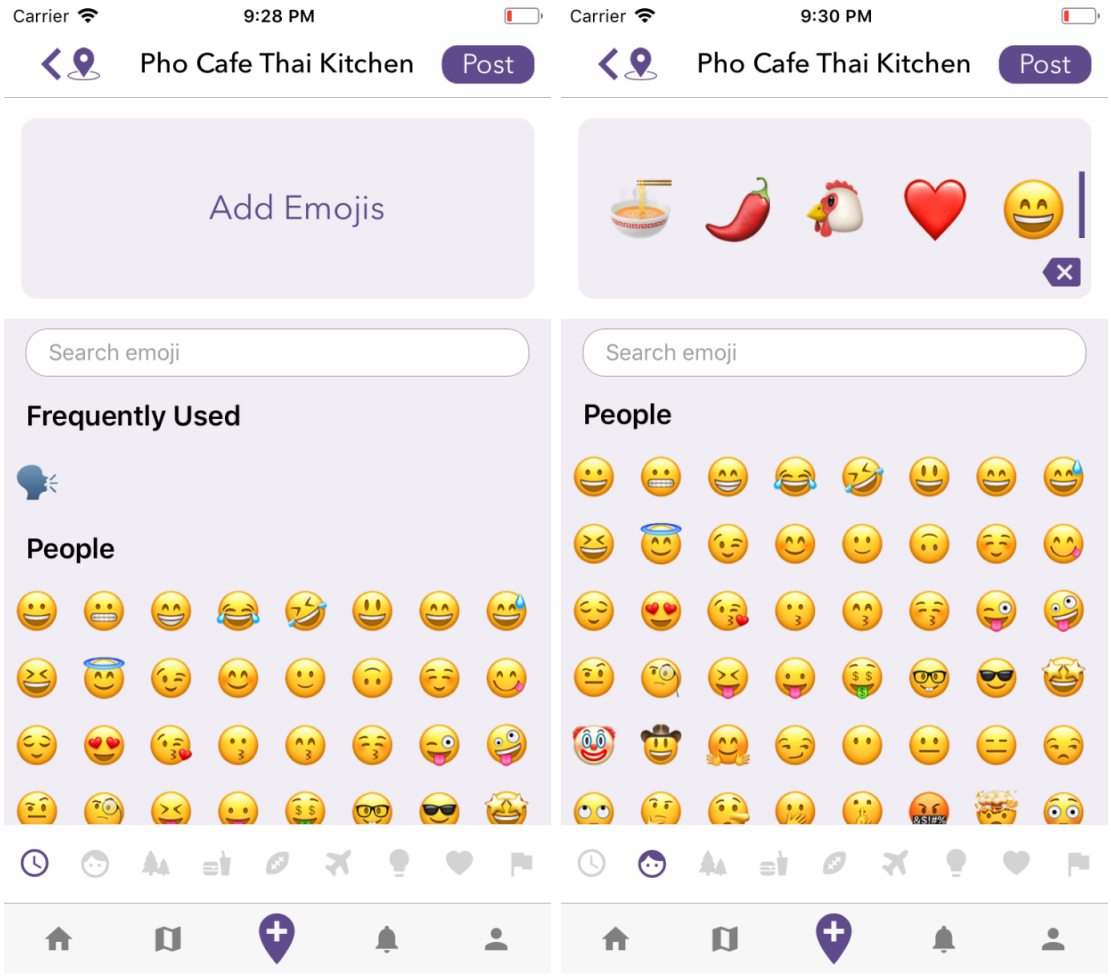


Figure 3.5: After selecting the location, users compose their emoji reaction using our custom emoji keyboard.

## 3.3 SOCIAL INTERACTIONS

### 3.3.1 The Feed

These posts are made available through a feed that is sorted in reverse chronological order to show posts from users that the logged-in user follows. This feed also includes the posts that are "one-hop" away from the user in the network, meaning that they also see posts from friends of friends. This was built to encourage engagement and discovery in the network. Users can also discover other people to find and follow in an accompanying segment tab to the feed.

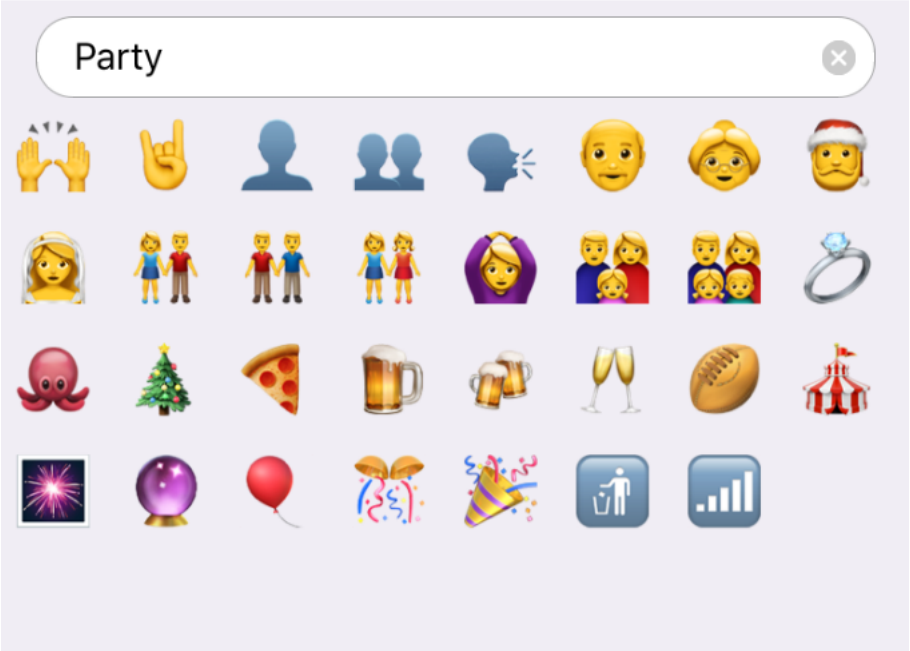


Figure 3.6: Users can search for emojis by text using the search bar. The results are emojis that have matching associated keywords, using official aliases and their synonyms.

### 3.3.2 Profile and Location Screens

All of the emoji reactions that a user posts are added to a profile page. Similar to other social media platforms, the profile shows the number of followers, the number of users that are following them, a unique username, and a reverse chronological ordering of the username. Users often used their own profiles as ways to track their own travels and location check-ins. The location screens are similar to the profile screen by showing all of the posts that have been made at that location.

### 3.3.3 Follows

The app enables users to "follow" each other to see specific posts from the people they choose to follow. The "follow" is a one-way interaction, similar to Twitter and Instagram follow mechanisms. To help facilitate engagement between users through the various actions they can perform, the app also includes an in-app notification system and push notifications so that users can be notified of the various interactions in the app.

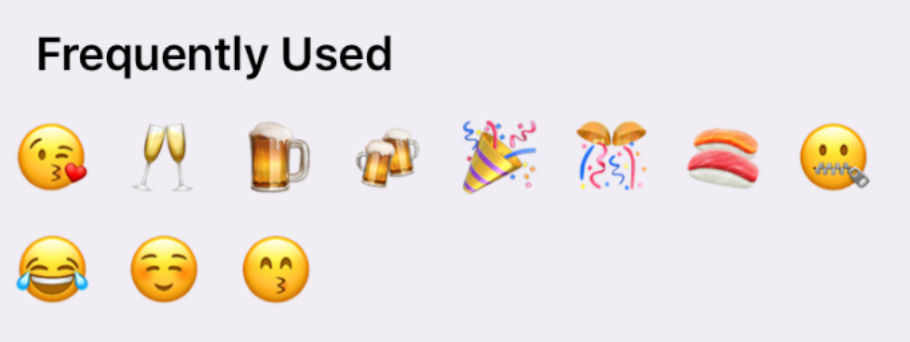


Figure 3.7: As users use the keyboard over time, the keyboard stores the most frequently used emojis at the top of the keyboard for the user's convenience.

### 3.3.4 Likes, Comments, and Bullseyes

Users have the ability to "like" each others' posts. Likes are a simple way of expressing a positive sentiment about the post, similar to other social media apps such as Facebook or Twitter. The comments are freeform text that can be used as means to add additional content to the post or for other users to ask questions or guess the intended meaning behind the post. In the latter case, users who have correctly guessed what the intended meaning behind the post can receive a "bullseye" from the original poster. The "bullseye" is an indicator given to a single comment by the original poster that signifies that the comment captured the meaning of the post. This proved to be an effective and easy way to close the loop on the interactions between a user who posts an emoji reaction and those who try to guess the meaning.

### 3.3.5 Emoji Maps

Since each post is location-based, the posts are also available for viewing in a map format. Using the Google Maps mobile libraries, the app renders a map showing emoji data points to show the locations of the emoji reactions. Tapping on the emoji reveals the most recent emoji reaction for the location in a callout, and tapping on the callout leads directly to the emoji reaction itself. The represented emoji for the map marker is the most frequently used emoji at that location so that the user can have a general sense for what the place is. This visual representation of the emoji reactions was intended as a way to engage users with nearby locations and discover new places.

One of these maps is an in-app "Nearby" map that displays emoji reactions from the users they follow that are restricted to a 50 mile radius of the user's current location. Each user also has their own map available on their profile, which shows all of their reactions on their

profile. An emoji map was also made available on a website at http://opico.io/. The website features all of the most recent emoji reactions from all the users across the platform. The site also has a Socket.io connection to our server to feature live updates of users posting emoji reactions. It also features the ability to filter the map by certain users or to restrict the emojis displayed to a specified radius around a set of coordinates.

### 3.3.6 External Sharing

The app also allows users to crosspost their emoji reaction to their Facebook profile by toggling a button in the posting flow. This generates a URL with an OpenGraph image that can be externally posted to the user's Facebook profile, displaying the emoji reaction on a map with a small description underneath. In the future, we would like to expand this sharing capability to any external platform such as messaging apps.

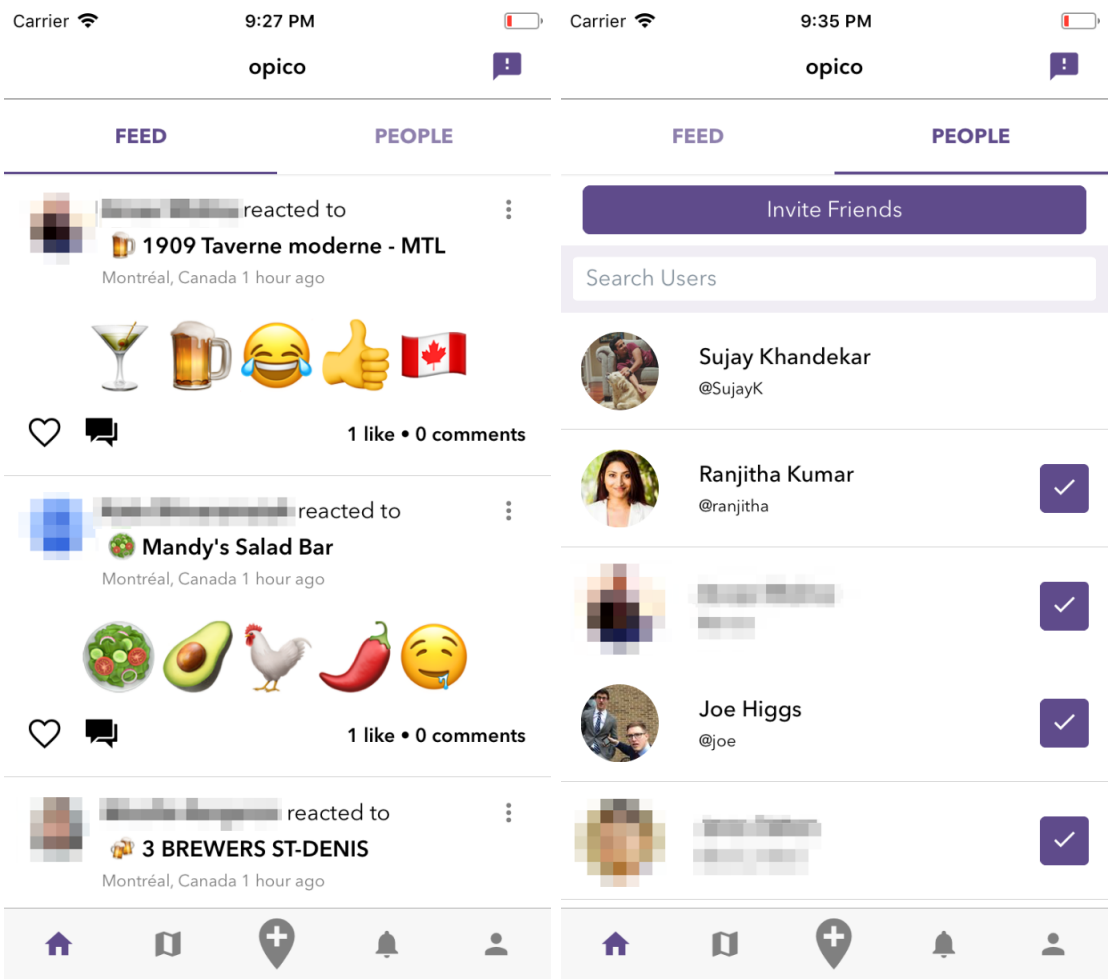


Figure 3.8: On the left, the feed shows a reverse chronological display of all the emojis reactions from the users they follow and the users one-hop away in the network. On the right, the users screen shows all of the users across the app. If the user is following the listed user, a checkbox will appear next to their name. Otherwise, they can tap the box to follow them. The users can also be search through the input box at the top.

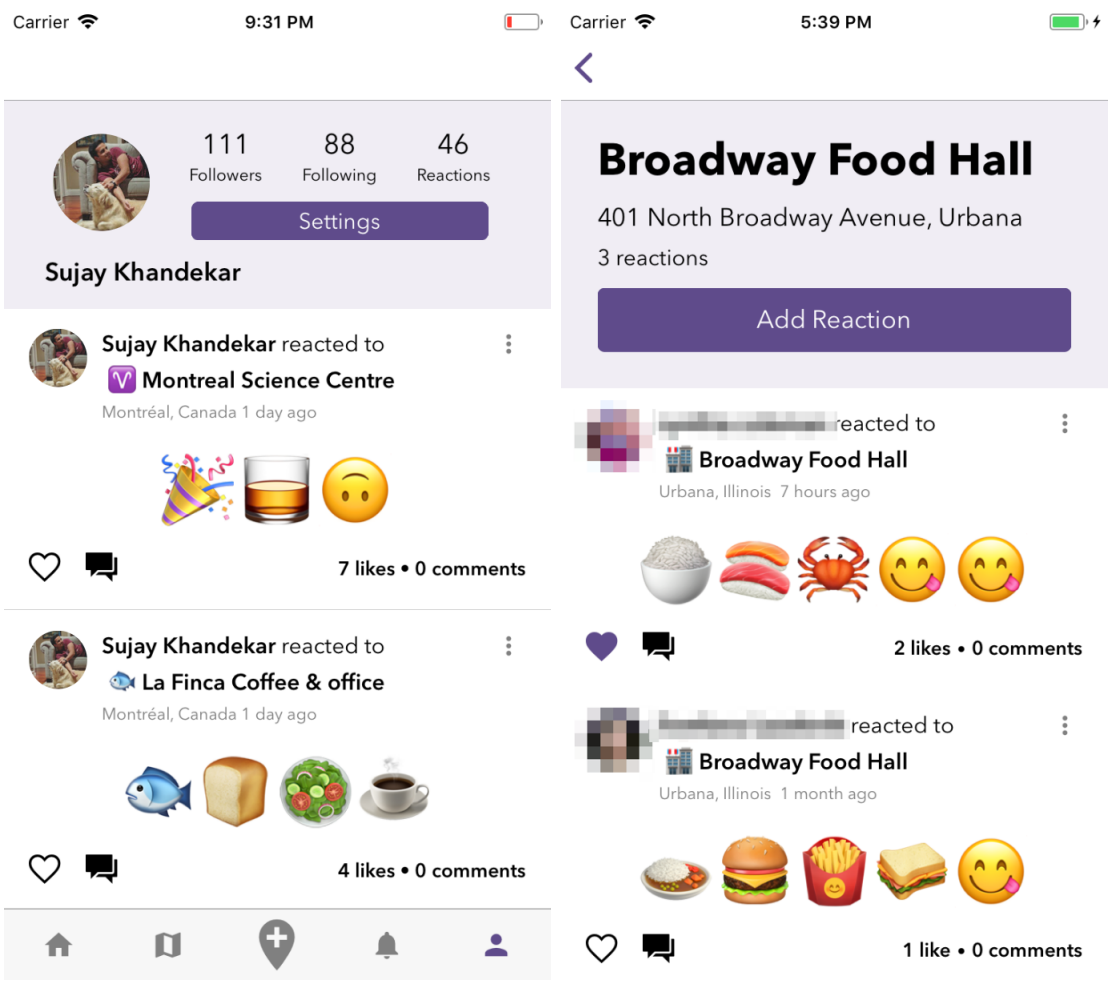


Figure 3.9: The profile and location screens show reverse chronological orders of posts associated with a user or with an location, respectively.

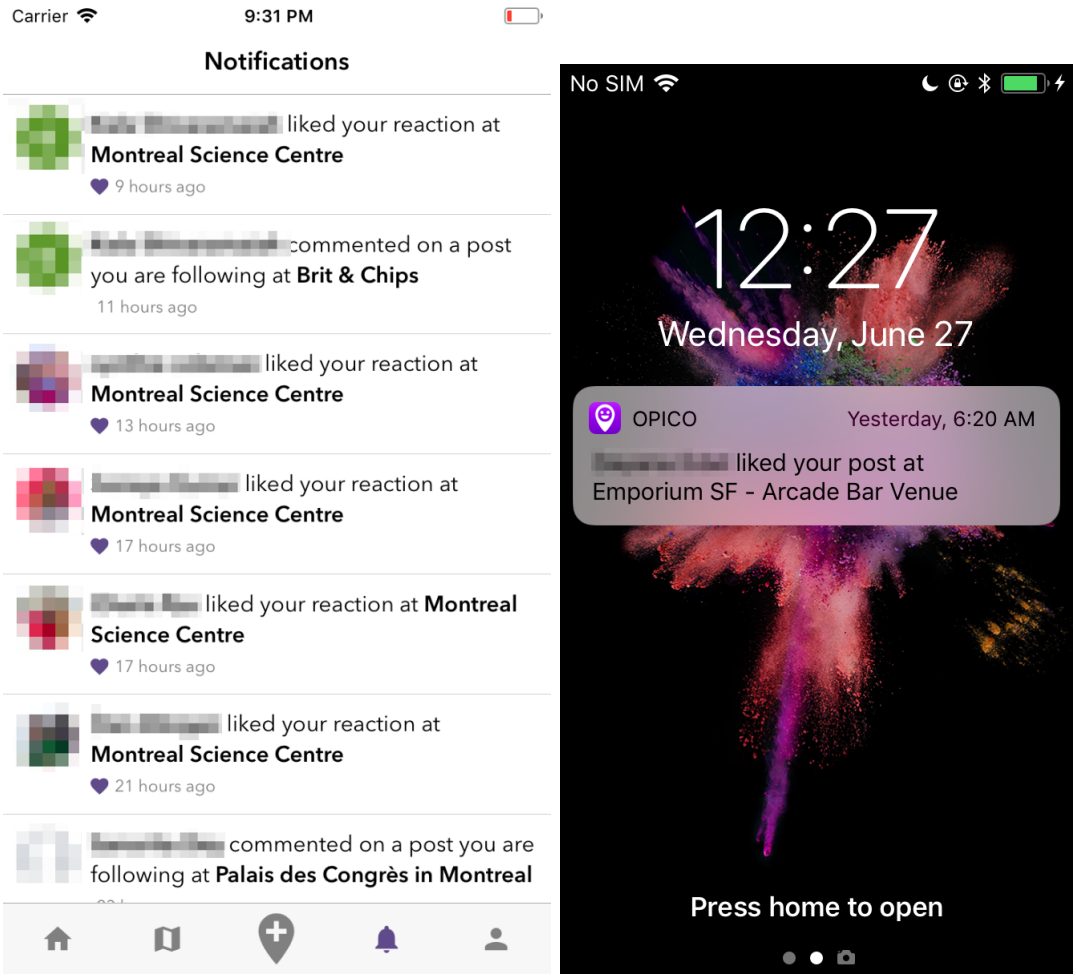


Figure 3.10: The user can receive notifications in the app or through push notifications from activity on their posts or profile.

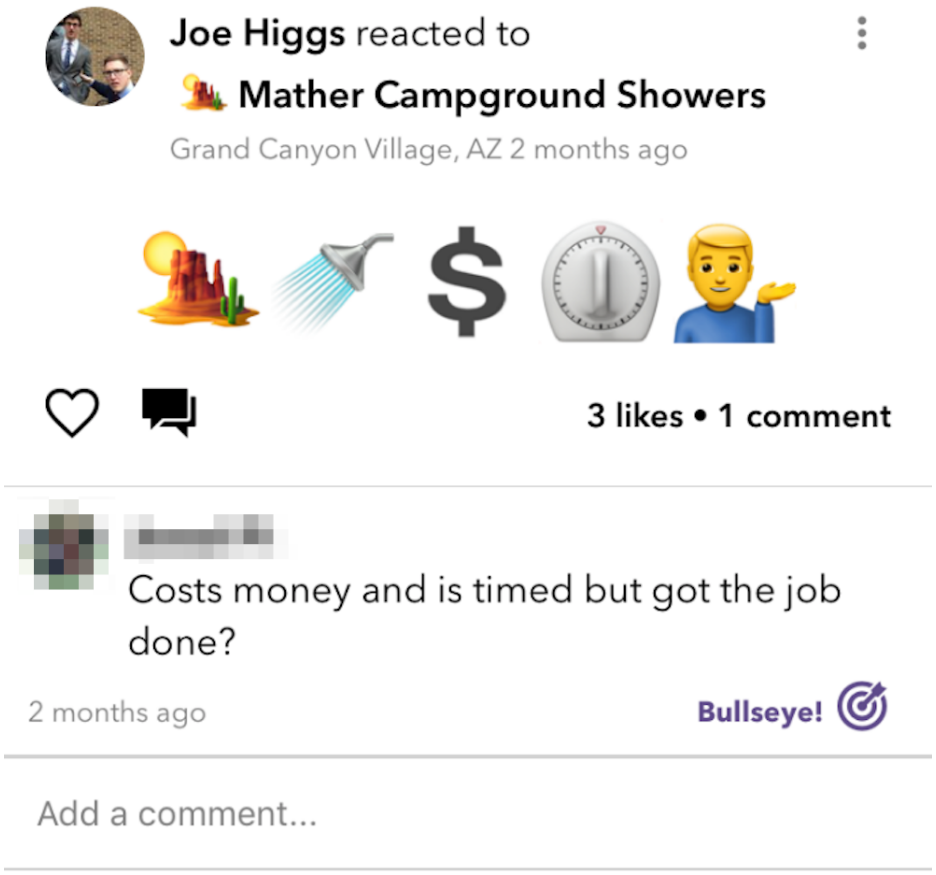


Figure 3.11: Every post can be liked and commented. If another user writes a comment that correctly guesses the meaning behind the user's post, then the original poster can give the user a bullseye.

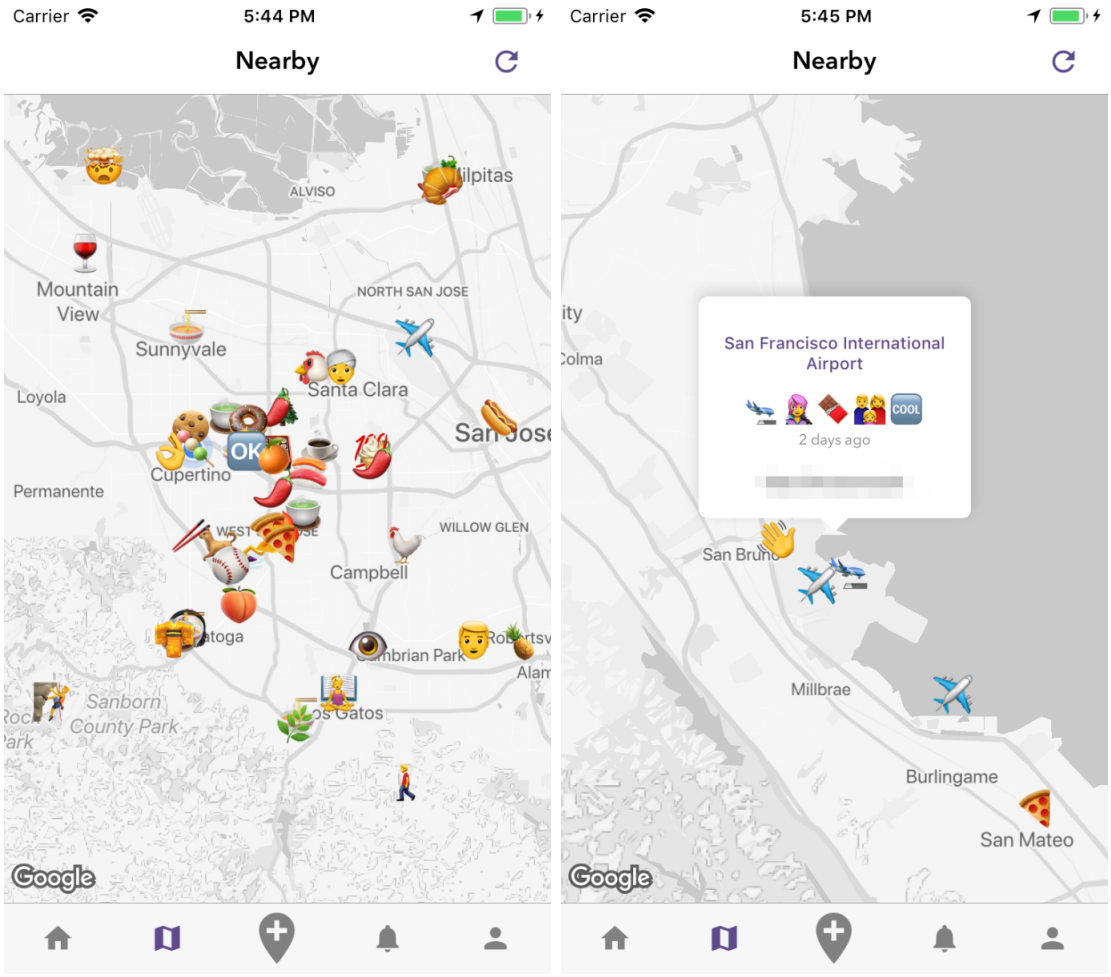


Figure 3.12: The nearby map shows all the emoji reactions from the people the user follows within a 50 mile radius. Tapping on one of the emojis reveals a pop-up that shows the full emoji reaction.

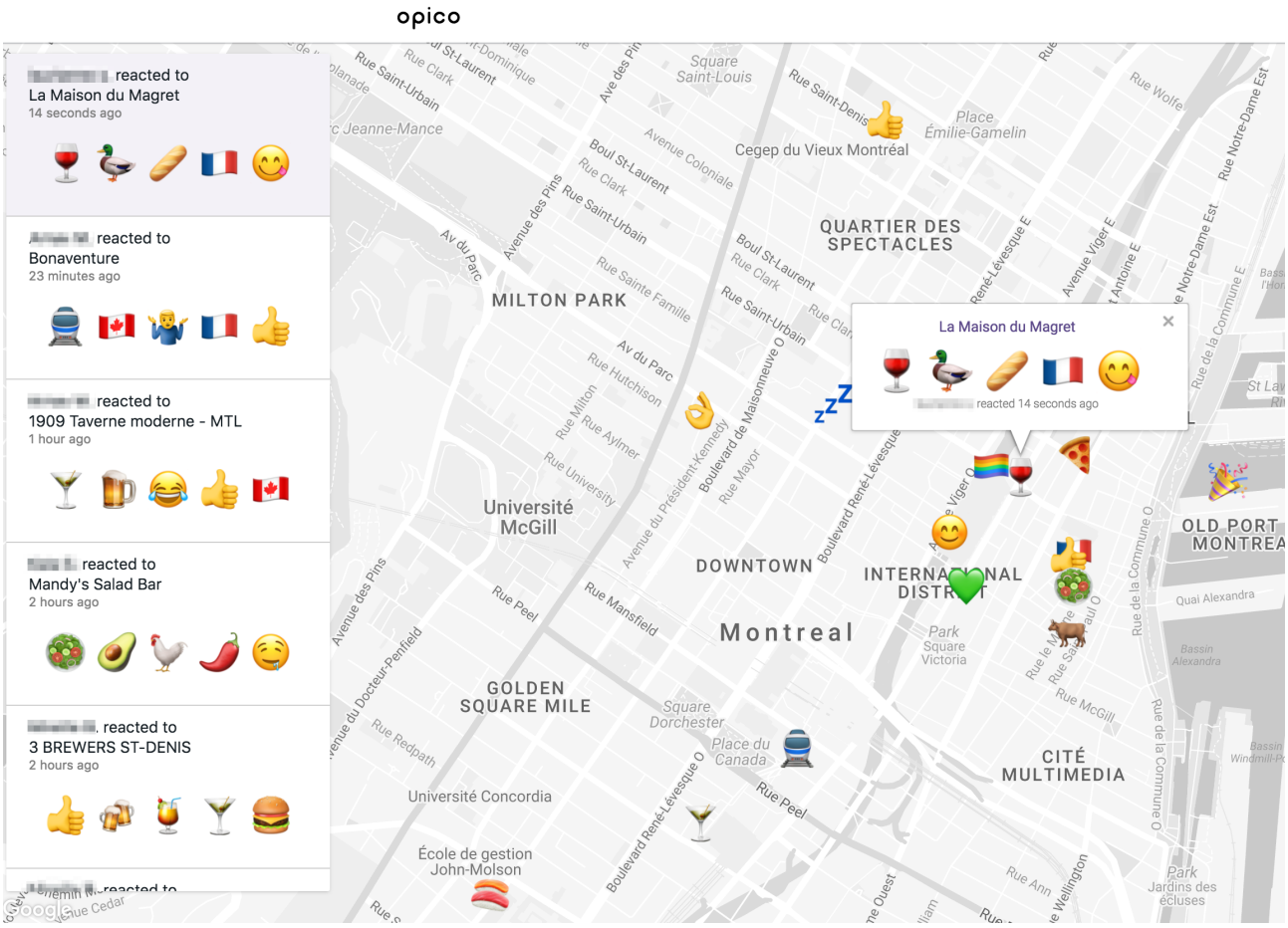


Figure 3.13: The map is also available through a website that shows all the emoji reactions being posted globally.

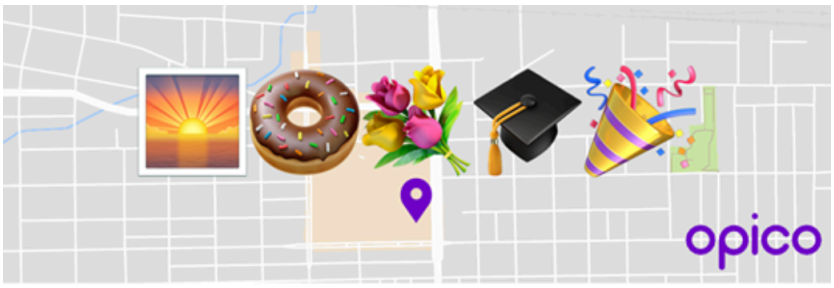


Figure 3.14: When a user externally shares their emoji reactions, this is an example of the OpenGraph image that is shared with the URL.

# CHAPTER 4: RESULTS

Through the course of our work, we have collected over 3500 emoji reactions from over 900 users. On iOS, 67.7% of the platform's users were male and 32.3% were female. By age, 45.42% of the audience was from the 18-24 year old age group, 39.7% was from the 25-34 year old age group, and 14.38% was from the 35-44 age group. By location, 92.5% of the reactions came from users in the United States and the rest were from international locations. On Android, 72.2% of the platform's users were male and 27.8% were female. By age, 62.1% of the audience was from the 18-24 year old age group, 30.56% was from the 25-34 year old age group, and 7.33% was from the 35-44 age group. By location, 88.4% of the reactions came from users in the United States and the rest were from international locations. Across the platform, 84.52% of the emoji reactions were at locations in the United States and roughly 46.83% of the reactions were at locations in the state of Illinois since the initial users were from the University of Illinois at Urbana-Champaign. The most frequently reacted to places were restaurants, stores, bars, cafes, lodging, airports, gyms, universities, stores, and stadiums.

We discovered a variety of different use cases and ways in which users constructed their emoji sentences. Some emoji reactions expressed feelings of happiness by using emojis to describe certain phrases in the english language such as "so happy I could die" or "feeling like I'm in heaven," with reactions such as 🍣🍜😍💀😇, 😍🍩➡️🪶😇, and 🍫🪶➡️👶. Some emoji reactions described certain locations based on experiences or shows that were occurring at locations such as theaters or concert venues. The reactions 🐍🎤👸🐍😁 and 🎤🎟️🐍💋✨ came from a Taylor Swift concert where snake emoji was in reference to a visual element in the concert series. Certain object emojis were also used as adjectives to describe a state of mind. The snail and turtle emoji were used to describe slowness or tiredness, and the mouse emoji was used to express that something was small. At airports, the flag or location emojis were commonly used to describe the start and end destinations of a user's travel. The hourglass and clock emojis often referred to the passing of time or impatience. Colored heart and dot emojis were used as adjectives in combination with other object emojis to denote a different color such as 🍵⚫ to describe black tea.

## 4.1 EMOJI FREQUENCY

We performed an emoji frequency analysis to measure the most commonly used emoji in the platform. By count, the most common emojis were generally positive emojis such as 😍 or 👍. We also noticed a large usage of coffee emojis, which we inferred were correlated to the emergence of new coffee shops in the Champaign-Urbana area where we have the most users. Many of the user interviews confirmed that coffee shops were popular destinations. Users also tended to frequently use the "fire" emoji in a variety of contexts. For example, the fire emoji was used to indicate spiciness, warmth, or that a food or product was excellent. Food and drink emojis held a majority in most frequently used object emojis. In a separate breakdown by category, the most frequently used emojis came from the "People" category and the "Foods" category. This is likely due to the placement of those categories on the emoji keyboard, where these two categories were near the top. This may suggest that users may have not wanted to scroll too far to search the vast collection of emojis to find the ones they wanted to use.

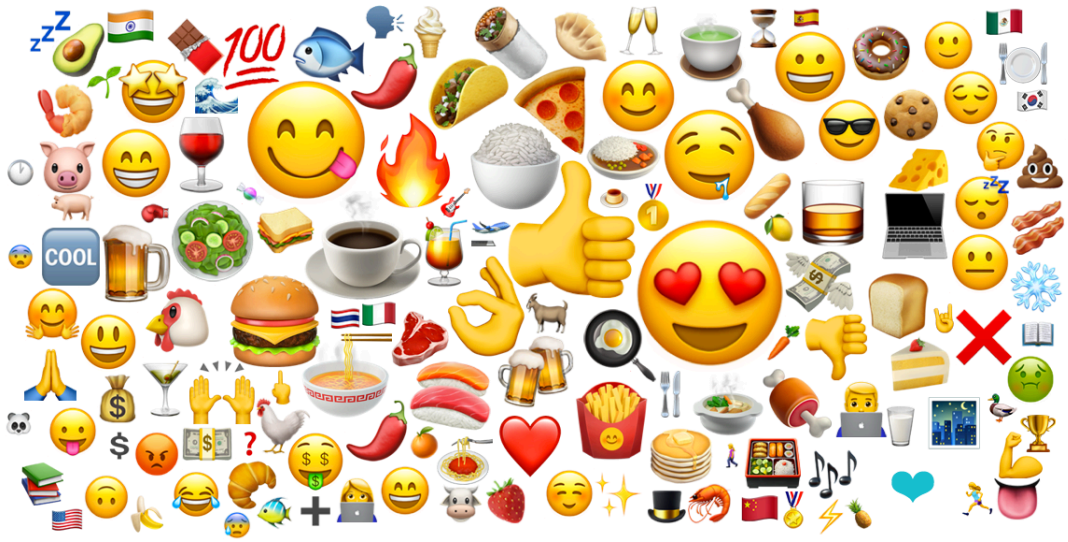


Figure 4.1: A visual representation of the most commonly used emojis in the app. The larger the emoji, the more commonly it was used.

## 4.2 EMOJI SENTIMENT ANALYSIS

We used the data from the Emoji Sentiment Ranking [26] lexicon to do a sentiment analysis over each emoji reaction in our dataset. We categorized each reaction as having either a very

positive, positive, negative, very negative, or neutral sentiment. We split the neutral category into two types that separate reactions that were either completely objective or that contained a mix of positive and neutral emojis. The majority of the emoji reactions contained positive sentiments. This may be that users were often incentivized to react to places they liked as a way to log and remember their favorite places. Users who left neutral reactions that were completely objective may have used their reaction as a way to describe the location without expressing an opinion. Users who left mixed reactions tended to show a positive emotion in one part of their reaction while displaying a negative emotion in another. For example, the reaction 🐓🍔🤮🍟😋 shows how the user did not like the chicken sandwich using the vomiting emoji, but they liked the fries with the happy emoji. Although negative emoji reactions were less common, reactions described particular items and actions to which they were reacting negatively, such as money to indicate expensiveness. The very positive and very negative reactions tended to contain repetitive positive or negative emojis instead of telling a more precise story about why they felt that way. These purely emotional reactions may have come from locations that the users frequented and did not feel the need to provide descriptive or objective emojis.

## 4.3 EMOJI BIGRAMS AND TRIGRAMS

Emoji-only construction of the posts allowed us to examine bigrams and trigrams, adjacent elements of two or three emojis, in our dataset using Point-wise Mutual Information, or PMI. To reduce sensitivity to low frequency pairs, we established a threshold of a minimum of five occurrences for bigrams and three for trigrams.

### 4.3.1 Bigrams

In our analysis, we identified 248 bigrams that satisfied our threshold. Some bigrams were pairs of the same emoji, such as 👫👫, 🐓🐓, or 🌶️🌶️. Bigrams such as 🌮🌮 may be used to indicate the plural form of the emojis that represent discrete values, such as tacos, pizzas, or people. Bigrams such as 🌶️🌶️, 😀😀, and 🔥🔥, represent multiples of non-discrete values, implying emphasis on factors such as spiciness, happiness, and heat. Some emoji bigrams were also used in place of an absent emoji. For example, the bigram 🍞🥑 represents the avocado toast dish, the bigram 🍔🐔 represents chicken sandwich, the bigram ☕🍫 represents hot chocolate, and the bigram 🍵🥛 represents milk tea. Emojis were also coupled with international flags to specify items or food from certain countries or cultures. Some unsurprising associations included 🇲🇽🌮, 🇮🇹🍝, and 🇮🇳🍛, describing

Mexican tacos, Italian pasta, and Indian curry. A surprising association came from 🇮🇳🥞, which we interpret as the Indian savory dish, dosa. Although the pancake's artwork implies the traditional, sweet American breakfast item, the context changes when paired with the Indian flag to a savory Indian pancake-like dish. Food emojis were also paired with each other to specify certain types of dishes or flavors. For sweet foods, reactions such as 🍫🍰 and 🍦🍫 signify that a cake or ice cream are chocolate flavored. For savory foods, combinations such as 🍜🦞 or 🐟🥗 signify a type of food such as a shrimp noodle soup or fish salad. Other bigrams grouped commonly associated items together, such as 🍺🎱 for a bar with a pool table, 🍔🍟 for a burger with fries, ☕💻 for coffeeshops, and 🛫🛬 for airports. They were also grouped with similar types of emojis such as 🍺🍻, 👨‍💻👩‍💻, and 🦀🦐. These particular groups may be the result of the emojis' close proximity to each other on the emoji keyboard. A user who was looking to describe a bar may find it appropriate to use all of the emojis that signify drinks together. Certain emoji objects were commonly associated with certain emotions. The ⏳😡 bigram often had a clock or hourglass emoji paired with an angry emoji, signifying a long wait time.

### 4.3.2 Trigrams

Trigrams also contained similar patterns to bigrams. Many trigrams feature the same emoji repeated three times either to express plurality or emphasis. Reactions such as 😍😍😍 or 😠😠😠 describe an extra emphasis on an emotion, whereas reactions such as 👫👫👫 or 👨‍👨‍👦👨‍👨‍👦👨‍👨‍👦 described lots of people or crowds. Emojis of similar types were also grouped together often. Trigrams such as ☕🍞🍳, ☕🍳🥞, ☕🍳🥓, 🍞🍳🥓, and 🍳🥓🥞 describe different breakfast foods together, 🤸🏋️💪 describes fitness emojis, 🍷🍹🥃 describes alcoholic beverages, and 🍔🍟🥪 describes fast foods. Trigrams were also used to specify types of objects such as 🐔🥑🥗 describing a chicken avocado salad or 🇮🇳🌶️🍛 as a spicy Indian curry.

## 4.4 EMOJI KEYBOARD SEARCH RESULTS

Since our custom emoji keyboard was able to log the search queries that returned no emoji results, we analyzed those logs to find patterns. Our logging mechanism was purposefully verbose to ensure we did not miss any edge cases; however, single characters such as "A" or "I" were logged, suggesting that perhaps the search needs to handle substring searches more elegantly or simply not perform a search query without a minimum number of characters.

While we only recently implemented the logging and retrieved only a month's worth of data, we found interesting patterns in the logged queries. Some of the queries were around words that may not currently appear in the emoji specification. Queries such as "Bage" may be a search for bagel, or "Walle" may be a search for wallet. Queries such as "chex mix," "eid mubarak," "earring," "Mozart," "workout," "yogurt," and "knitting" were some of the inputs that rendered no search results on our keyboard. Using these findings, we can either find or improve some of the associated terms for emojis, or maintain a list of highly requested emojis that we can propose to the official specification.

Other examples of inputs include using multiple numbers such as "200" or "201" as partial inputs for denoting the year. Although individual emojis do exist for each number, users may have expected to write a number sequence and receive all the associated numbers as a search result. Some logged inputs also included actual emojis as part of the input. Users may have either been confused by the interface and not understood the intention of the input box or simply expected to use the native iOS or Android keyboards to find the emojis and search for them on our keyboard. As this data set grows, we hope to find more trends and patterns for how users continue to interface with the custom emoji keyboard.

### 4.5 BULLSEYES

Our "bullseye" feature allowed us to gather emoji reactions that were paired with text-based comments that were selected by the user who created the emoji reaction. We gathered 275 pairings, which was 6.41% of all emoji reactions. The comments that were assigned a bullseye were intended to be an accurate interpretation of the emoji reaction. Our findings showed that users were generally aware of the feature's intention and were able to provide proper reaction-to-text pairings. Some examples were fully able to decipher the entire emoji sentence. For example, the emoji reaction, ⏳😡😋, was paired with "They weren't actually quick but the drink was still good?", which shows how the user was able to combine the hourglass and angry emojis and the drink and happy emojis to understand the full interpretation. Some text comments only interpreted part of the sentence. For example, the emoji reaction, 🥃🌶️🍊👴📗, was paired with "An old-fashioned?", which only attempts to guess the drink in the user's emoji reaction and makes no mention of the notebook emoji. This may be because the user who assigned the bullseye was more focused on other users trying to guess the more ambiguous part of the sentence, the type of drink they were having, more than the straightforward part of the sentence, the notebook or old man emoji.

These pairs were also dependent on particular locations and the timeframe in which the emoji reaction was being made. Some of the emoji reactions were made at movie theaters,

and the emoji sentence and text comment were generally framed around the movie that was watched. For example, the emoji reaction, ⚫🐆👍👍👍, paired with "Black panther!" refers to the Marvel film, Black Panther. This example highlights some important components of the emoji reaction and how context was important in the user properly understanding it. While other examples of movie reactions had input on their opinion of the film and the paired comment took note of the opinion, this comment made no mention of the thumbs ups that expressed that the user liked the film. This may be because Black Panther was a critically acclaimed film and received a lot of press and social media buzz, making it unnecessary to ask if they liked the film. The user may have also chosen not to comment on the thumbs ups, because it was a clear message that the user liked the film.

Another point to note is that the user combined the black dot emoji with the leopard emoji to describe black panther. Although this is technically incorrect, there is no panther emoji in Unicode 10.0, and the user who made the comment was able to still discern that the user was talking about Black Panther. This contrasts with food emoji sentences where certain animals cannot be so easily interchangeable. For example, the emoji reaction 🥪🦃🐐🧀😍, paired with "Turkey and goat cheese sandwich?", is very specific about the animals associated with the reaction and substituting the goat emoji with a ram or ewe emoji may imply a different meaning altogether.

Finally, the timeframe of the emoji reaction was important since the Black Panther film was in theaters at the time. Other reactions also relied on time-sensitive events in order to properly guess the emoji reaction's meaning. The emoji reaction 🍻📺🏀👏, paired with "Warriors!" referred to the Golden State Warriors who were in the NBA Finals. The emoji reaction 👬 👬👔💻🤣, paired with "Crowded career fair?" referred to a career fair being held at a university. Sometimes, the contextual clues were grounded in personal friendships and environments. The emoji pair, "MP was due tonight?" and 2️⃣4️⃣1️⃣🤯😭, describes how one user is expressing stress over a university course with the number 241 and how another user is asking them about an upcoming assignment deadline for the course. Each emoji-text pair was able to provide insight into how users were able to use contextual clues based on location, timeframe, or personal relationships to interpret emoji sentences.

While the feature did work as intended in the majority of the cases, some pairs of data did not make sense, suggesting that the user either used the feature incorrectly, misunderstood its purpose, or likened the feature to a "Like" button. The emoji reaction 🍦🍡🍪🥛☕, paired with "Omg i was there too," shows that the user used the bullseye feature as a way to acknowledge the user's comment and not to assign it the correct interpretation. Another pair of the emoji reaction 🏆🍽️🥃🌃🐓 and "Game room/cherry room is also fun! " shows how users used the feature to acknowledge helpful suggestions from other users about

their location. However, this misunderstanding may be attributed to no explanations in the app regarding how the feature was meant to be used. We did not explicitly want to explain the feature in the app to reduce bias and to observe how users naturally would perceive and use the feature.

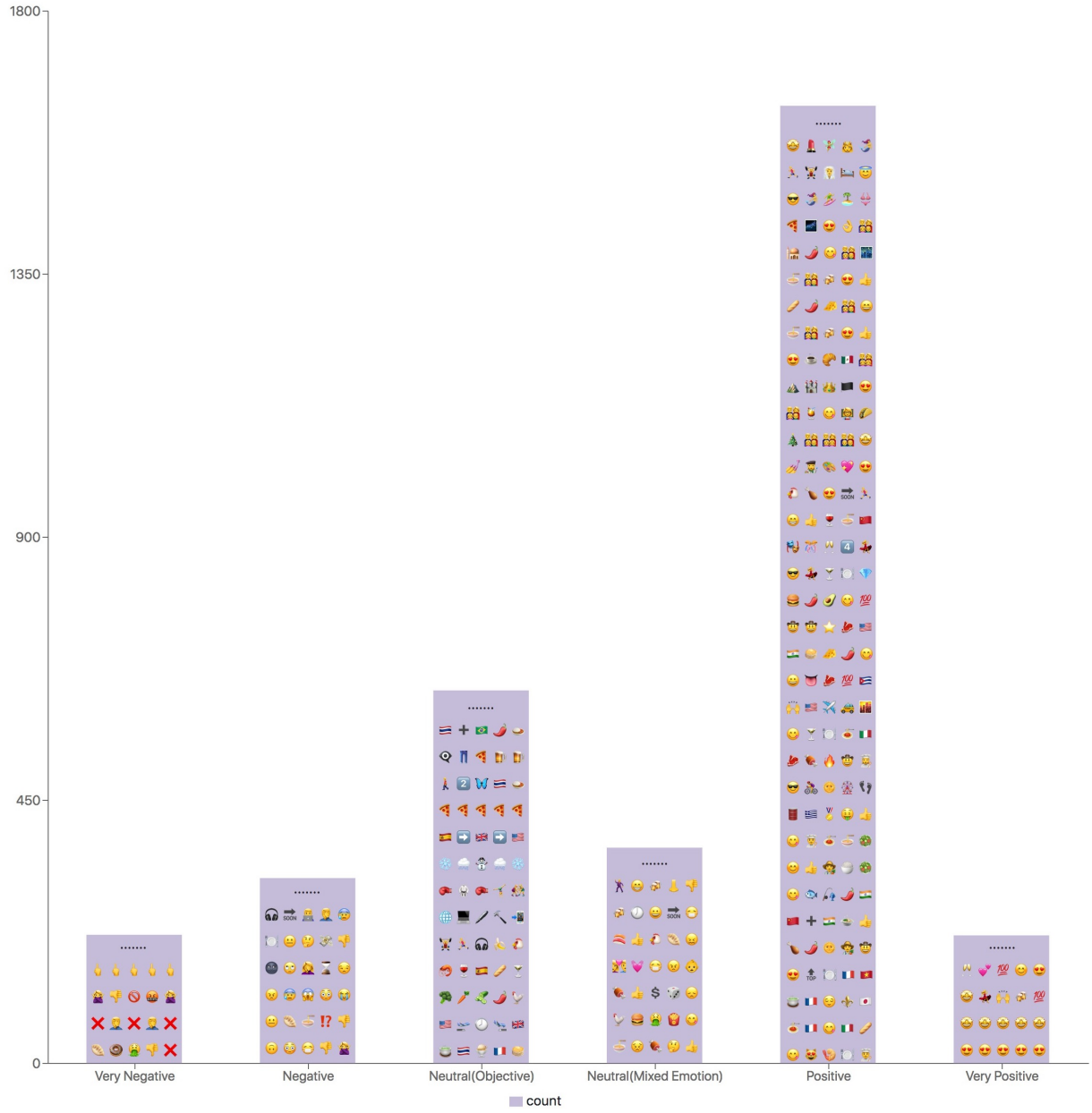


Figure 4.2: The number of emoji reactions that had either a Very Negative, Negative, Neutral (Objective), Neutral (Mixed Emotion), Positive, or Very Positive Reaction. The height of the bar indicates the frequency of the reaction.

# CHAPTER 5: DISCUSSION AND FUTURE WORK

In this work, we have explored the various ways in which emoji-only sentences have been able to convey a lot of meaning using only a few characters. This brings forth a lot of discussion regarding the future of emoji-only communication in social media platforms. The work presented here delineates a future for this emoji-only communication to be a feasible way to communicate big ideas despite some ambiguity. Our users were able to convey their feelings, thoughts, descriptions, and experiences about the places they visited and were able to communicate with other users through likes, comments, and bullseyes.

## 5.1 BULLSEYES IMPROVEMENTS

Our bullseye feature was able to create insightful text to emoji reaction pairings that will allow us to study emoji interpretations as the data set grows. The majority of the data gathered from this feature validates our original motivations for the project. Users were able to successfully discern and understand emoji-only sentences despite their brevity and ambiguity. Some of our data points were not accurate pairings, suggesting that improvements need to be made to the interface to explain the intention behind the feature and how it could be used.

As we discovered in our data, the pairings were often made through contextual clues, such as location, timeframe, and personal relationships. As further work goes into translating emojis into text-based sentences, these factors must be taken into account. Further work can also be explored in encoding, and we hope this growing dataset helps balance the brevity and ambiguity of emoji sentences while still making them comprehensible.

## 5.2 KEYBOARD IMPROVEMENTS

While building and using a custom emoji keyboard gave us full control of the keyboard's layout, features, and search functionality, there are further improvements that can enhance the emoji selection experience. In the "Most Frequent" section of the keyboard, we would like to incorporate a combination of the user's most frequently used emojis and the most frequently used emojis of all reactions at the selected location. For example, a "Most Frequent" section may feature pasta or Italian flag emojis if those emojis were frequently used in other emoji reactions at that location. However, the included emojis from the location would be those that have zero sentiment so as to not bias the user's opinion of the location.

This would help users select descriptive emojis more easily without heavily introducing bias into the emoji selection process.

There are also more opportunities to improve the search functionality to help users find new emojis easily. While we did expand on the possible keywords associated with a specific emoji, the terms can be further expanded to include culturally relevant terms for certain emojis. As our work in identifying emoji bigrams and trigrams progresses, the search suggestions can potentially suggest emoji pairs and triplets that are frequently associated with certain terms. For example, the word "swordfish" is not currently represented by a single emoji; however, it may be represented as an emoji pair of fish and sword. This would help mitigate the effect of missing emojis in the Unicode specification. The search box could also attempt to suggest full emoji sentences based on a text sentence to help transition users who may not be familiar with emoji usage.

Emojis also need to feature diverse representations of people since many of our users wished to describe themselves or the people around them in their emoji reactions. For example, all of the emojis that feature humans or human body parts are a default yellow skin color. In the future, we hope to improve our emoji keyboard to include the skin tone modifier that will allow users to customize any human-like emoji to their preference. We also hope the specification can include more hair colors, eye colors, and other features.

To give the user quick access to certain emoji categories, a row of icons appear at the bottom of the keyboard, which takes users directly to particular sections. The choice of icon for each category was modeled after the iPhone keyboard's icons; however, these icons were not necessarily a perfect representation of their categories. For example, the icon for the "Activity" category is an American football, even though musical instruments and art emojis are in this category. Future work will explore how to give users quick access to the emojis they are looking for while being able to better convey and categorize the emojis.

Finally, the emoji keyboard layout used in our custom keyboard was very similar to the default keyboards available in the iOS and Android platforms, which groups the emojis into topical sections. We decided not to change the layout of the keyboard to present users an interface they were familiar with. However, our results showed that the majority of the inputted emojis appeared near the top of the emoji input's large scrollable list, suggesting that users did not want to scroll too far to browse emojis if they chose not to use the search input. Pohl et. al proposed an alternative to the traditional emoji keyboard by laying out the emoji as a large zoomable space [30]. In the future, different keyboard layouts can be tested for more effective emoji selection.

## 5.3 MITIGATING EMOJI ARTWORK ISSUES

Emojis are pictorial representations of a sentiment, object, or action, but they are defined as code points by Unicode. For each defined code point, vendors such as Apple, Google, Twitter, and others create their own artwork for each emoji based on official short character names and keywords. While the artwork across platforms may generally have similar designs, the differences in style may create renderings that convey different meanings or that are completely different objects altogether. Samsung's TouchWiz 7.0 software featured a saltine cracker for a particular code point, whereas all of the other major platforms displayed a chocolate chip cookie [31]. Google was also criticized for it's rendering of the hamburger emoji in Android 8.0, by having the cheese slide near the bottom of the patty instead of on top [32]. Because each vendor has their own stylistic interpretation of the emoji, the artwork that is presented to the user may differ enough to convey a different meaning or sentiment, especially when emojis are viewed across platforms.

Opico presented the emojis without any modifications or changes to the artwork. We explicitly chose to make this decision because we wanted our users to use and view the emojis with which they were familiar. This decision results in some of the issues with cross-platform emoji artwork and operating system compatibility. Not all the devices are able to support all of the emoji artworks if the device operating system was not up to date. In those cases, the device would render a black box or question mark to indicate to the user that the Unicode character cannot be recognized. This may cause problems for users who cannot see full emoji reactions or cannot view all of the characters on the emoji keyboard.

One possible way to address these issues is to use an open source emoji font or create a custom artwork for each emoji. Twitter recently used their own emoji set, Twemoji, as a replacement for native emojis for all of their Android users to resolve compatibility issues for missing emojis [33]. However, creating artworks for over 1000 emojis is not a trivial task. To add, users may not like that the custom emoji set compared to the native one with which they are familiar. Wiseman et al. explained an example of how iOS users pushed back after Apple attempted to change the image for the peach emoji [4]. Another solution could be to render an emoji on the device as a image, but this may cost extra data overhead for the user.

We would also like to see more technologies by the emoji vendors that can help address issues of backwards compatibility. Android 8.0 was launched with the help of the EmojiCompat library that would create a fallback strategy for any Android phones running version 4.4 and above [34]. We hope to use this library for Opico, and we hope Apple offers a similar library in the future.

## 5.4 MAP IMPROVEMENTS

Although the emoji maps visualized emoji reactions in a unique way, the maps can be improved to provide more utility for the user. We hope to add filters onto the map that will allow users to query their data over different axes such as time, emoji, and locations. For example, if a user wanted to visualize all of the reactions where they had coffee in Chicago during a trip, they would be able to filter by those attributes using the map. An additional extension would be to create exportable and shareable datasets or maps based on the filters. In the previous example, a user may want to share all of the coffee shops they visited in Chicago with a friend or colleague who wanted recommendations. This would make sharing and parsing data easier for the user.

## 5.5 LOCATION AND USER AGGREGATIONS

In the future, we hope to be able to provide meaningful data about the users and locations through aggregations. By analyzing all of the emoji reactions at a particular location, we can draw inferences about the location itself without having to use any other external data beyond its physical coordinates and its name. For example, if the location has received the coffee emoji many times from its posts, we can reasonably infer that it is a cafe or a location that serves coffee. If a restaurant has received many positive emoji reactions, we can infer that the restaurant is generally liked. The same analysis can be done for users to understand the locations they like to go to, understand the sentiment of their reactions, and examine which emojis they use and why. Further work needs to be done to explore how to perform meaningful aggregations that can provide quick insight into locations and users.

## 5.6 ZERO WIDTH JOINER SEQUENCES

While some emojis can be represented with a single code point, others are combinations of two or more code points. For example, the 👩‍❤️‍👩 emoji is a combination of the 👩, ❤️, and 👩 code points. The character that joins these code points together is called a Zero Width Joiner, or ZWJ, and, using ZWJ characters with emojis creates Emoji ZWJ Sequences [35]. One benefit to ZWJ sequences is that vendors can introduce their own artworks for any combinations of emojis without the emojis being formally introduced in the specification. Using the results from our bigram and trigram analysis, our findings can help inform potential future sequences that vendors should supply. For example, two frequently used emojis, such as 🥑 and 🍞, can be combined into a single artwork for "avocado toast."

Moreover, the 🍜 emoji can refer to any sort of noodle bowl, but users may combine this with a flag emoji such as 🇨🇳, and the resulting ZWJ may be a particular noodle dish from Chinese cuisine. They may also combine the bowl with a 💪 emoji, and the resulting ZWJ may display a noodle bowl with shrimp in it. These ZWJ sequences may provide users with an opportunity to be more concise with their emoji usage, and it would allow the vendors to create new emojis without waiting for a yearly update to the specification. We hope that our growing dataset can help inform what ZWJ sequences are the most in-demand.

### 5.7 EMOJI SIZES

Users appreciated the large size of the emoji that was displayed on their devices so they could clearly see what the emoji was attempting to convey. This contrasts greatly with emojis that are often used in combination with text since the size of the emoji is only as large as the text font size. This brings into question the various emoji sizes and fonts that are used on different social media platforms and how the size of the emoji can change its interpretation. Future research with the app can do tests with various emoji sizes to see which emojis elicit the largest changes in interpretation.

# CHAPTER 6: CONCLUSION

This paper explored the feasibility of emoji-only communication by gathering and analyzing emoji sentences. To gather emoji-only data, we built Opico, a social media mobile app that allows users to share emoji reactions about the places they visit with their friends. After collecting over 3500 emoji reactions and on-boarding over 900 users on the app, we performed different forms of analysis to find patterns in usage and interpretation. Our findings with emoji bigrams and trigrams explain the various contexts in which emoji are used together and how they can explain certain words or feelings without needing an explicit, single emoji. Our emoji keyboard revealed commonly searched terms and phrases when users search for emojis. The bullseye feature allowed us compare text and emoji sentence pairings. Finally, our sentiment analysis found mostly positive phrases posted on the platform. As we progress further along into the development and growth of Opico, we hope to maintain and build new and improved features into the platform. As our database of emoji reactions grows, we look forward to expanding on the data analysis to uncover more meanings and interpretations behind emojis.

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