New Emoji Requests from Twitter Users: When, Where, Why, and What We Can Do About Them

YUNHE FENG, University of Tennessee, Knoxville, USA
ZHENG LU, University of Tennessee, Knoxville, USA
WENJUN ZHOU, University of Tennessee, Knoxville, USA
ZHIBO WANG, Wuhan University, China
QING CAO*, University of Tennessee, Knoxville, USA

As emojis become prevalent in personal communications, people are always looking for new, interesting emojis to express emotions, show attitudes, or simply visualize texts. In this study, we collected more than thirty million tweets mentioning the word "emoji" in a one-year period to study emoji requests on Twitter. First, we filtered out bot-generated tweets and extracted emoji requests from the raw tweets using a comprehensive list of linguistic patterns. To our surprise, some extant emojis, such as fire 🔥 and hijab 🧕, were still frequently requested by many users. A large number of non-existing emojis were also requested, which were classified into one of eight emoji categories by Unicode Standard. We then examined patterns of new emoji requests by exploring their time, location, and context. Eagerness and frustration of not having these emojis were evidenced by our sentiment analysis, and we summarize users' advocacy channels. Focusing on typical patterns of co-mentioned emojis, we also identified expressions of equity, diversity, and fairness issues due to unreleased but expected emojis, and summarized the significance of new emojis on society. Finally, time-continuity sensitive strategies at multiple time granularity levels were proposed to rank petitioned emojis by the eagerness, and a real-time monitoring system to track new emoji requests is implemented. To the best of our knowledge, the proposed tracking system is the first to rank the new desired emojis on a large scale and in a real-time manner.

CCS Concepts: • **Information systems** → **Web mining**; **Social networks**; **Information retrieval**; • **Human-centered computing** → *Interactive systems and tools.*

Additional Key Words and Phrases: emoji analysis; emoji mining; emoji petition; relatedness, fairness and equality in emojis; emoji categorization; emoji profiling; emoji tracking; Twitter

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*Corresponding author

Authors' addresses: Yunhe Feng, yfeng14@vols.utk.edu, Department of Electrical Engineering & Computer Science, University of Tennessee, Knoxville, TN, 37996, USA; Zheng Lu, zlu12@vols.utk.edu, Department of Electrical Engineering & Computer Science, University of Tennessee, Knoxville, TN, 37996, USA; Wenjun Zhou, wzhou4@utk.edu, Department of Business Analytics and Statistics, University of Tennessee, Knoxville, TN, 37996, USA; Zhibo Wang, zbwang@whu.edu.cn, School of Cyber Science and Engineering, Wuhan University, Wuhan, Hubei, 430072, China; Qing Cao, cao@utk.edu, Department of Electrical Engineering & Computer Science, University of Tennessee, Knoxville, TN, 37996, USA.

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1 INTRODUCTION

The word emoji comes from the Japanese words e (“picture”) and moji (“character”) and has a history of nearly 30 years since it originated on Japanese mobile phones in the late 1990s. In 2009, a set of 722 emojis were first officially added into Unicode Standard 5.2 [54]. After Apple introduced the iOS emoji keyboard in 2011, the use of emojis grew rapidly [80]. By 2018, more than 2700 emojis have been added into Unicode Standard 11.0. According to a recent survey [80], almost everyone online (92% of the online population) is using emojis. With the popularity of social networks, nowadays, emojis are used extensively on various social networking platforms, such as Twitter, Facebook, WhatsApp, and Instagram. In particular, nearly half of comments and captions on Instagram have emojis [22].

As the usage of emojis (and social media in general) evolves, new emojis are being continuously requested. According to the Emogi Research Team [81], 75% of mobile messaging app users were interested in having more emoji options, and this demand is more intense for those who more frequently use mobile messaging. Every year, the Unicode Consortium[1] updates the official list of Unicode emojis by judging and accepting proposals for new emojis from individuals, organizations and companies. For each candidate emoji, its evidence of frequency from Google Search, Bing Search, Youtube Search, and Google Trends must be submitted, and evidences from NGram Viewer and Wikipedia Search are optional. Besides the substantial efforts needed to collect such evidences, this method has several additional drawbacks. First, objects with higher search frequency does not always imply better fit as emojis. For example, although the word “mascot” is heavily searched, it is unlikely to be an emoji because there exists no specific image that can represent all mascots for different teams, events, organizations and universities. Second, this method completely ignores new emoji petitions directly generated by actual users, whereas users have first-hand information regarding the usage context and could contribute tremendously to generating valuable ideas. These users do not necessarily know how or have the time to make an official request. For example, Figure 1 shows a tweet, in which the poster comments that the daisy emoji does not exist and wonders how to get one.

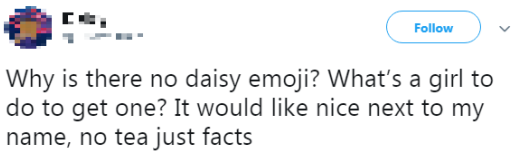


Fig. 1. A sample emoji request

To investigate new emoji petitions, a systematic study on which new emojis are wanted, when, where and why these new emojis are requested, how users feel about the lack of wanted emojis, and where users went for help remains under-explored. Few studies attempted to offer even partial answers to these questions. The emoji satisfaction survey [81] reported mobile message app users always desired more emoji choices, but provided no further detailed answers to the above specific emoji questions. A study showed the emoji usage trend on Instagram from 2010 to 2015 [22] during which a large number of new emojis were proposed, but those new emojis were not studied. Another study analyzed animal emoji requests based on data collected over one day (August 3, 2017) [96] using Twitter’s Search APIs, and demonstrated that the world wanted raccoon and lobster emojis.

[1] https://unicode.org/emoji/

However, it only studied emojis in a single category on a small scale in terms of both the number of tweets and the time span.

To more comprehensively study the emoji requests, this paper investigates more than thirty million tweets mentioning the word "emoji," and proposes a new framework to answers the above questions. Specifically, we performed the following analyses on the tweets collected. First, we extracted the requested emoji descriptions and calculated their corresponding frequencies. After filtering out emojis that already existed (i.e., extant emoji requests) and exploring why they were still being requested, we proposed a WordNet [57] based emoji classifier to cluster requested emojis. Then, we studied spatiotemporal patterns of these requests and explored possible reasons why new emojis were requested. Moreover, after analyzing emotions of users when they cannot find wanted emojis from several aspects (e.g., use of punctuation, emotional words, emoticons, and other emojis), we summarized the common characteristics of requested emojis and advocacy behaviors. In addition, we illustrate the existing relatedness, fairness, and equality problems reflected through emojis, and discuss the positive impacts of new emojis on society. Finally, we develop a web-based interactive emoji tracker, which allows users to analyze petitioned emojis in a real-time manner.

As the first step to conduct a systematic, large-scale study on new emoji requests, contributions of this paper can be summarized as follows:

- It offers new and strong evidence of frequency for Unicode emoji community to evaluate new emoji requests. Currently, when submitting emoji proposals, search results from search engines (Google Search, Bing Search, Youtube Search, etc.) are supplied to infer the request of proposed emojis. But the explicit and accurate evidence like "why is there no *foo* emoji", which our study reveals, are not incorporated.
- We explain why released emojis are still requested by users, and provide multiple suggestions to enable newly released emojis to be available to users as soon as possible.
- We profile new emoji requests from diverse aspects including temporal and geographic distributions, sentiment analyses, advocacy behaviors, factors that inspire requests, etc., which offers a comprehensive understanding for new emoji requests.
- We discuss the issues of equality, fairness and diversity caused by the lack of emojis, and present the potential significance of new emojis in many aspects like business promotion and violence control.
- We propose time-continuity sensitive ranking algorithms to estimate the eagerness of new emojis, and develop a real-time interactive monitoring system for emoji requests.

2 RELATED WORK

We first summarize emoji usage in relevant real-life domains and different contexts. We then discuss the communicative functions and interpretations of emojis. Finally, we present the equity, diversity, and inclusion problems caused by existing emojis and the lack of emojis.

2.1 Emoji Usage in Real Life

As emojis rise to prominence, emojis are having great influence on the real world in many domains including business, politics, religion, entertainment, arts and food, etc. In business, various companies used emojis to enrich their promotions, create awareness and attract attentions from consumers [50, 56]. For example, Domino's Pizza profited from allowing people to text message or tweet a pizza slice emoji to place an order [41]. The outdoor advertising billboard of 💀💩L helped Deadpool break all the box office records for an R-rated movie [5]. Emojis are also being used to engage younger audiences in politics and make policies more approachable [74]. Political leaders from United States [4], Australia [78], and Argentina [39] used emojis in official speech, during

interviews, or on social networks. The White House once released an economic report illustrated with emojis [61]. For religions, some users embedded emojis like the folded hands (the prayer hands) emoji 🙏 into their usernames. Another example is the recycling symbol emoji ♻, which is taking over on Twitter due to its extensive usage by Arabic speakers to represent a shared Islamic *Dua* (supplication or invocation) [73]. In arts and entertainment field, the original set of 176 emojis was considered as art and added to the permanent collection of the Museum of Modern Art (MoMA) in New York [37], and *The Emoji Movie* [89], an animated film based on emoji graphics used in electronic messages, were released in 2017. Recently, many researchers [36, 46, 47, 84] associated foods with emojis, and suggested emojis to be an easy and non-verbal way to measure food-related emotions, especially for children [36].

2.2 Communicative Functions of Emojis

There is rich literature investigating how emojis facilitate communication and social interactions. From the linguistic perspective, emojis are viewed as an emerging graphical language [38, 53]. Its linguistic functions, such as word redundancy [23], and syntactic substitutes for words [17, 48], are widely studied. Recently, Ge and Herring [38] observed that people created innovative usages in the composition of emoji sequences to compensate for the lack of emojis and make the emoji sequences more language-like. From the communication perspective, expressing and strengthening emotions [45, 79, 84], conveying humor [18, 42] and sarcasm [32, 85], and producing communicative diversities [76] are among the main functions of emojis in interpersonal communication. Emojis were also used to manage conversations, such as maintaining a conversational connection, and ending a thread [17, 95]. In addition, emojis served more diverse functions in close relationships. Kelly et al. [48] reported that emojis encouraged playful interactions, and created shared and secret uniqueness between people in mediated close personal relationships. Similarly, Wiseman et al. [94] examined repurposed emojis for personalized communication between close partners, friends and family members. An example is using the shared love of the pizza 🍕 to represent romantic love between partners [66].

2.3 Diverse Interpretations of Emojis

Like other natural languages, emojis can sometimes be interpreted differently, especially when being used for joking or expressing sarcasm. Besides, the emoji renders differently on different viewing platforms, including operating systems (e.g., iOS and Android) and apps (e.g., Facebook and Twitter), which generates more inconsistencies of interpretations [58]. Many recent works examined both semantic [3, 7, 8, 17, 58, 67, 87] and sentiment [12, 58, 59, 65, 82] ambiguity of emojis. Cramer et al. [17] revealed that the interpretation of emojis was highly dependent on the conversational context and there existed no golden standard to infer the precise interpretation of every situational usage of a particular emoji. Wijeratne et al. [86, 87] released EmojiNet, a machine-readable emoji sense dataset for sense disambiguation and sense similarity studies [88]. To further learn the semantic properties of emojis, a vector space skip-gram model [9] and emoji2vec [25] were proposed. For sentiment interpretations of emojis, Miller et al. [58] found people disagreed on whether the sentiment was positive, neutral, or negative 25% of the time for the same emoji rendering. Novak et al. [65] drew a sentiment map of hundreds of emojis by recruiting human annotators to label more than 1.6 million tweets in multiple European languages, and found the sentiment polarity (negative, neutral, or positive) of emojis increased with the distance between the emoji position and the beginning of the tweets.

2.4 Emojis for Equity, Diversity, and Fairness

As emojis are impacting various aspects of real life, problems of equity, diversity, and fairness caused by emojis are drawing more attentions [33]. To promote gender equality through emojis, researchers from Google proposed a set of emojis reflecting a wide range of professions for women (as well as men) with a goal of highlighting the diversity of women's careers [68]. The *person* emoji 🧓, an adult with no gender specified, has become available as a gender-inclusive alternative to the man 👴 or the woman 👵 since Unicode Standard 10.0 in 2017. A recent study revealed that 0.13% of all emojis send by Americans are either a rainbow flag 🏳️‍🌈 (commonly known as the lesbian, gay, bisexual and transgender pride flag), men holding hands 👬 or women holding hands 👭 emojis [43].

Since *"people all over the world want to have emoji that reflect more human diversity, especially for skin tone"* [15], the Unicode Consortium released five different skin tone modifiers, which is based on the six tones of the Fitzpatrick scale [35, 90], to enrich human diversity in Unicode Standard 8.0 in 2015. When a human emoji is immediately followed by one skin tone modifier character, the person(s) or body part will be rendered using the specified skin tone. For example, 👶 + {🏻,🏼,🏽,🏾,🏿} → {👶🏻,👶🏼,👶🏽,👶🏾,👶🏿}. The introduction of skin tones seemed to meet the goal of better representing human diversity [72], but increased the ambiguity of emojis clearly [6]. To depict diverse hair colors and styles, Unicode Standard 11.0 introduced hair components including red-haired, curly-haired, white-haired, and bald components in 2018 [16]. In addition, some emojis enable multi-person groupings, which enhances family-related emojis diversity significantly, such as single-parent families 👩‍👦 👨‍👧 , and homoparental families 👩‍👩‍👦 👨‍👨‍👧.

Besides human-form emojis, emojis in other categories, like country flags and religious symbols are also expressing equity and fairness. The country flag emojis cover every internationally recognized two-letter country code in ISO 3166-1 [91]. Although only subdivision flags of England 🏴, Scotland 🏴, and Wales 🏴 are Recommended for General Interchange (RGI) and supported by major vendors, all 3,681 subdivision or subregion codes under ISO 3166-2 [92] have been specified as valid Unicode sequences and can be supported by vendors regardless of platforms or RGI statuses. For religions, emojis offer generic symbols of the largest religions of both the East and West. The Om 🕉 and the wheel of dharma ☸ are widely used in Jainism, Buddhism, and Hinduism. The star and crescent ☪ represents Islam and the star of David ✡ represents Judaism. Besides, the religious place for Muslims 🕌 🕋, Jews 🕍, Christians ⛪, and Shinto followers ⛩ are supported.

3 IDENTIFYING NEW EMOJI REQUESTS

The proposed framework, as shown in Figure 2, consists of three parts, i.e., data collection, analyzing extant emoji requests, and profiling the requests for new emojis. In this section, we mainly focus on the data curation, emoji extraction using linguistic patterns, analyses of requesting extant emojis, and emoji categorization.

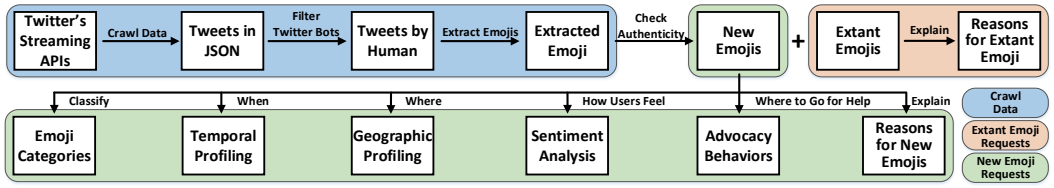


Fig. 2. Framework of crawling and analyzing emoji requests on Twitter. Extant emojis refer to the emojis that have been officially released and available for users. New emojis are the unsupported and unreleased emojis by the Unicode Consortium.

3.1 Data Curation

3.1.1 Data Collection. We choose Twitter as research context for the following three reasons. First, Twitter supports developers to use filters and to retrieve real-time tweets on a large scale. In our experiment setup, we use such filter APIs to obtain twitter messages that are related to emojis, by setting relevant keywords. On the other hand, other social network platforms like Facebook [31] and Instagram [44] prohibit almost all automated content scrapers. Such practical limitations prevent us from getting large-scale user dataset from these websites without their permissions. Second, Twitter is a worldwide social platform that has the fourth most monthly active users, who are generating 500 million tweets per day [77]. Such a large data volume allows us to carry out an in-depth analysis of the tweets that are relevant to emojis. Third, due to the news-oriented nature of Twitter, we find users are more likely to express their needs for new emojis on Twitter than other platforms. For example, we notice some users from other social networks such as WhatsApp switched to Twitter to call for emojis, as shown in Figure 9(a). In our study, we use Twitter's Streaming APIs to crawl all the English tweets containing the word "emoji". More than thirty million tweets of interest are collected in total from October 2017 to October 2018. The collected tweets are formatted in JavaScript Object Notation (JSON) files, which encode the information of tweets using key-value pairs, with named attributes and associated values [83].

3.1.2 Filtering Bot-Generated Tweets. As the bots on Twitter become very popular and generate many tweets of gibberish contents [34, 40], not all these collected tweets are created and posted manually by real Twitter users. To eliminate the side effects of bots, we follow approaches proposed by Ljubesic et al. [51] for analyzing global emoji usages, to filter out those bot-generated tweets. More specifically, we remove users who produced on average more than 10 tweets containing "emoji" per day. Eleven qualified users and their 113,718 tweets are removed, and the No. 1 heavy user posted on average 71 tweets per day throughout a year. For each of users having more than 100 collected postings, we calculate the time (in minutes) between her/his two successive tweets and remove those users if their three most frequent time spans between postings cover more than 90% of their overall production. For example, the Twitter account *@butnoemoji* is detected as a bot since it posted one emoji petition every exactly six hours. This method removes overall 131 users and 43,461 tweets from our JSON dataset. Users with less than or equal to 100 postings are not considered as bots because of their low tweeting frequencies (below 0.3 tweet per day).

3.1.3 Content Extraction. After filtering out bot-generated tweets, we extract information of interest such as user profiles, tweet contents, timestamps, and geo tags, from JSON files. Two datasets, the *complete dataset* and the *unique dataset*, are created for emoji analysis sub-tasks in Section 4 (patterns of new emoji requests) and Section 5 (behaviors of new emoji requests) respectively. The *complete dataset* consists of four types of tweets including general tweets, retweets, quoted tweets and replies. The *unique dataset* only contains the original tweets (general tweets, quoted tweets and replies) produced by users and removes duplicated and re-posted tweets like retweets. Tweets are usually composed of incomplete, noisy and poorly structured sentences due to the frequent presence of abbreviations, irregular expressions, ill-formed words and non-dictionary terms. This phase, therefore, also applies a series of preprocessing steps to reduce the amount of noise in tweets. For example, we removed URLs and non-ASCII characters except Unicode characters reserved for emojis when extracting tweet contents.

3.2 Emoji Extraction Using Linguistic Patterns

Note that not all these collected tweets are petitions for new emojis, e.g., the tweet like "I love this emoji!" is crawled as well since it contains the keyword "emoji". Therefore, we need to identify

emoji-requested tweets and extract wanted emojis. However, Twitter users may use different words and sentence patterns to express their expectations of new emojis, which makes the emoji extraction challenging. Yonatan Zunger [96] assumed that mentions of things like "*foo* emoji" were positive statements about desiring such an emoji. Although this hypothesis was claimed to hold true when validating with spot-checks of the matching tweets, it suffers from false positives, e.g., a tweet like "I hate a *foo* emoji!" is incorrectly recognized as desiring the *foo* emoji.

Inspired by [96], we offer fine-tuned linguistic patterns to detect desired emojis more precisely. Based on our observations, we summarize and propose 49 frequent linguistic patterns and their 2620 variations to match emoji-requested tweets and extract emojis. Twenty linguistic patterns are illustrated as follows, and the whole linguistic pattern list and corresponding tweet screenshots are available through https://call4emoji.org/linguistic_patterns.html.

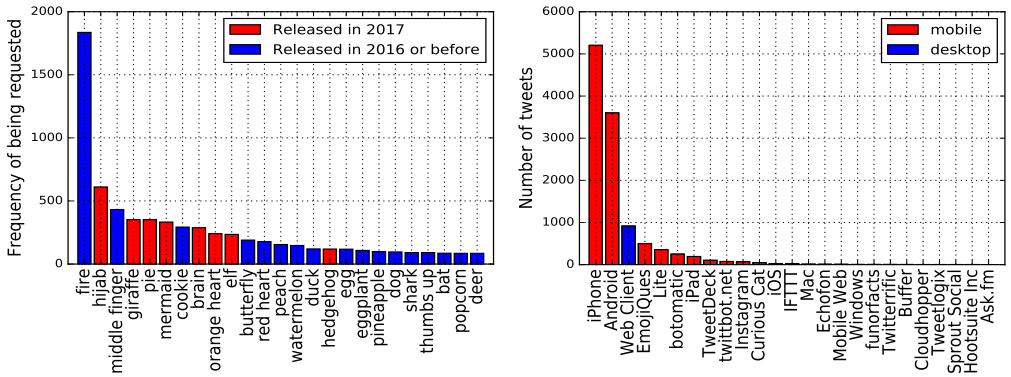
- why is there no *foo* emoji
- there is no *foo* emoji
- where is the *foo* emoji
- need a *foo* emoji
- need to make a *foo* emoji
- cannot find a *foo* emoji
- look for a *foo* emoji
- there should be a *foo* emoji
- demand a *foo* emoji
- can we get a *foo* emoji
- there is not a *foo* emoji
- have no *foo* emoji
- why no *foo* emoji
- why not have a *foo* emoji
- invent a *foo* emoji
- suppose to be a *foo* emoji
- is there a *foo* emoji
- a *foo* emoji is overdue
- still no *foo* emoji
- give us a *foo* emoji

When applying linguistic patterns, we take a series of tricks to ensure matched tweets are not missed. Before checking tweet contents, we first adopt natural language processing techniques, including part-of-speech (POS) tagging, stemming and lemmatization, to broaden matching scopes. For example, "look for a *foo* emoji" will match "looked for an *foo* emoji", "looks for the *foo* emoji", etc. We also consider characteristics of casual English on social networks [14] and fix common problems, such as the punctuation omission/error (e.g., theres → there's), the wordplay (e.g., neeeeeed → need), and the censor avoidance (e.g., shlt, fck, f***). In addition, we take all possible variations on sentence structures of linguistic patterns into account. For example, our linguistic patterns cover not only "need a *foo* emoji" but also "need an emoji of/with/for *foo*".

3.3 Extant Emojis Requested

When examining extracted emojis, to our surprise, we find hundreds of emojis that had already been released by the Unicode Consortium were still requested by many users. Figure 3(a) demonstrates the top 25 most requested extant emojis. Seven out of the top 10 extant emojis comes from Emoji Version 5.0, which was finalized in March 2017 and released on May 18, 2017 [26], while we started to crawl the data in October 2017. It is also interesting to note that the percentage of Twitter users on mobile is about 80% [64], but they contribute more than 91.8% extant emoji requests, as shown in Figure 3(b).

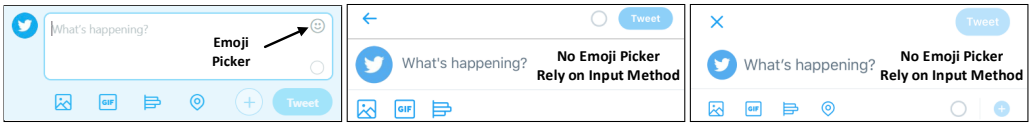
It is intuitive for users to tweet emoji requests as long as their wanted emojis are inaccessible even though these emojis have been released officially already. To explore why users cannot find wanted emojis, we study the different Twitter's post-a-tweet interfaces as illustrated in Figure 4. On Twitter's desktop site, the post-a-tweet interface offers an emoji picker which contains all latest official emojis. By contrast, on mobile devices, post-a-tweet interfaces of both the mobile site and mobile apps have no such an emoji picker. Instead, users have to rely on on-screen keyboards to type emojis, which may cause potential poor user experiences. First, keyboards may not incorporate the latest emojis in a timely manner so that new emojis are unavailable for users. Second, users may not update keyboards to the latest versions to access the recently added emojis, or their mobile



(a) Extant emoji requests (b) Platform distribution

Fig. 3. Requesting extant emojis. Seven out of ten most requested extant emojis were released in early 2017. More than 91.8% extant emojis were requested by mobile users.

operating systems are too out-of-date to be compatible with the latest versions of keyboards. Third, bad emoji keyboard layouts make it difficult for users to find and type intended emojis even if these emojis have been included.



(a) Desktop site (twitter.com) (b) Mobile site (mobile.twitter.com) (c) Twitter apps

Fig. 4. Twitter's post-a-tweet interfaces. Desktop users can input intended emojis using Twitter's emoji picker. Mobile users must rely on third-party input methods when typing emojis.

To improve the user experience of inputting emojis, we have the following suggestions and recommendations for mobile users, keyboard developers, and app developers. Mobile users should update installed keyboard software frequently and select the high-quality keyboard with good emoji arrangements. It is keyboard developers' responsibility to merge newly released emojis into their product as soon as possible and highlight it in "What's New" descriptions of their keyboard apps to remind users new emojis are available. For app developers, they can add the emoji picker or the search bar to enable users to input emojis without totally relying on third-party keyboards.

3.4 Emoji Categorization

The emoji categorization plays a big role in facilitating emoji inputs for both mobile and desktop users. Almost all mobile emoji keyboards, certainly including keyboards from Apple, Google and Samsung, arrange emojis into categories to alleviate the problems of large lists. The emoji pickers on desktop websites of social networks, such as Twitter and Facebook, also group emojis to help users select wanted emojis quickly and effortlessly. When new emojis come, knowing how many of them belong to which categories enables emoji input interface designers to adjust the emoji arrangement, such as increasing the number of emojis per screen. Especially when a large number

of new emojis are requested, an automatic emoji classifier is necessary and helpful. Therefore, we built the following hybrid (keyword searching and semantic matching) emoji classifiers.

The Unicode Consortium officially categorized emojis into eight groups, i.e., Smileys & People, Animals & Nature, Food & Drink, Activity, Travel & Places, Objects, Symbols, and Flags. The category of Flags is the easiest one to be detected, since each emoji belonging to this category contains the keyword of "flag". Therefore, we can simply search this keyword in descriptions of each requested emoji to determine whether it should be classified into the flag group.

However, for the rest categories, the method of searching keywords is obviously ineffective because of the difficulty in summarizing a set of keywords representing a certain category. We instead train a semantic classifier based on WordNet [57], which is a widely-used lexical database for English. (We also attempted to build a classifier based on types of entities extracted from emojis using Google Knowledge Graph, but it had an unsatisfied overall performance.) The details about the WordNet-based emoji category classifier are illustrated in Algorithm 1.

ALGORITHM 1: WordNet based emoji category classifier

Data: Tr: training dataset; C: the set of category labels; e_{tr}: training emoji; e_{te}: testing emoji; Suppose e_{tr} has a category label of c, then $e_{tr} \in Tr[c]$ and $c \in C$.
Parameter : k: the top k highest path_similarity scores
Result: *label*: the categorized label for testing emoji e_{te}

```
label ← None ;
max_sum ← 0 ;                                   // maximum sum of top k similarities
for each c in C do
    S ← [ ] ;                                   // an empty path_similarity score list
    for each e_tr in Tr[c] do
        s ← path_similarity(e_te, e_tr) ;
        append s to S ;
    end
    sort S in descending order ;
    sum ← 0 ;                                   // sum of top k similarities
    for i = 1 → k do
        add S[i] to sum
    end
    if sum > max_sum then
        max_sum ← sum ;                         // update maximum sum
        label ← c ;                             // update label
    end
end
return label
```

One important concept in WordNet is the synset, which is a set of synonyms that share a common meaning. In our study, we only care about noun synsets that words in emoji descriptions belong to. For example, the similarity between two emojis e_1 and e_2 is calculated as the highest similarity score between the two noun synsets containing words in e_1 and e_2. For the similarity score between two synsets, we take the *path_similarity* score, a similarity metric based on the shortest path that connects the senses in the is-a taxonomy, to denote how similar two word senses are. For a testing emoji e_{te}, we calculate its *path_similarity* with each training emoji e_{tr} in each category c. Then, for each category c, we sort its similarity score list and sum up the top k similarity scores to represent the similarity of the unlabeled emoji e_{te} and the category c. Finally, we set the category with

the largest summed similarity as the label for e_{te}. We also tried the k-nearest neighbors (k-NN) algorithm, but it achieved unstable and poor performance.

We collected a category dataset from Emojipedia[2] consisting of 342 Smileys & People emojis, 170 Animals & Nature emojis, 97 Food & Drink emojis, 98 Activity emojis, 125 Travel & Places emojis, 175 Objects emojis, and 258 Symbols emojis. We performed the 5-fold cross validation on this dataset for 50 times and achieved an average accuracy of 71.1% (avg precision = 71.0%, avg recall = 70.5%, avg f1-score = 70.6%) with the top k set as 9. One may argue that the accuracy is too low. However, even the official category labels of some emojis are indeed ambiguous. For example, the monkey face 🐵 (U+1F435) is categorized as animals & nature, but the see-no-evil monkey 🙈 (U+1F648), hear-no-evil monkey 🙉 (U+1F649), and speak-no-evil monkey 🙊 (U+1F64A) are classified as smileys & people. Another example is that the star ★ (U+2B50) and the glowing star 🌟 (U+1F31F) belong to the travel & places, while the eight-pointed star ✴ (U+2734) belongs to the category of symbols and the sparkle ✨ (U+2728) belongs to the category of activities. In addition, prior research studies [62, 67] revealed that ambiguities in emoji categorization were common. So, we think the achieved accuracy is acceptable with so messy data.

4 PATTERNS OF NEW EMOJI REQUESTS

In this section, we illustrate categorization results of requested emojis using the proposed keyword matching (for flag emojis) and WordNet-based classifiers, and visualize their temporal distributions and geographic distributions. More specifically, we answer the following questions:

- How many individual emojis requested per category, e.g., food & drink, animals & nature? How many tweets in total requesting new emojis by category?
- Which emojis are requested at what frequency? When are desired emojis requested? In which month of the year? In which time span of 0:00-24:00 in one day?
- Where new emoji requests occur? What the world-wide geographic distribution looks like? Do the requests distribute evenly after being normalized by population?

4.1 Requested Emojis by Category

We use the keyword matching method to recognize flag related emojis and the WordNet-based classifier to categorize requested emojis into the other seven groups. Considering requested emojis are too diverse, we only count emoji requests larger than 10 times. As shown in Table 1, more than 31.8% wanted emojis are from the Smileys & People category, which might indicate that people show great passions for new emojis to express their emotions. People also desire many emojis, including kangaroos and mangoes, from the Animals & Nature and Food & Drink categories. Surprisingly, the number of tweets requesting symbol emojis is very large. After digging into related tweets, we found one tweet petitioning the anarchy symbol emoji, *"Can we abolish the entire government and start over? is there an anarchy emoji?"*, had been retweeted for over 6,000 times, which accounted for more than 27% of the total tweets in the Symbols category.

It is easy to understand categories of the Activity, Travel & Places, and Flags have relative fewer requests, since most emojis in these categories have been released. In addition, it takes a long time to evolve a new activity like a sports game, a new place like electric vehicle charging stations, or flags for new-born countries or influential social movements. As we use the keyword "flag" to identify emojis in the Flags category, both region flags (e.g., Texas flag and pan Africa flag) and non-region related flags (e.g., transgender flag and pirate flag) are covered.

The different demands of emojis by category may give emoji input interface designers some hints to optimize emoji layouts, such as reserving spaces for new coming emojis, and displaying

[2]https://emojipedia.org/

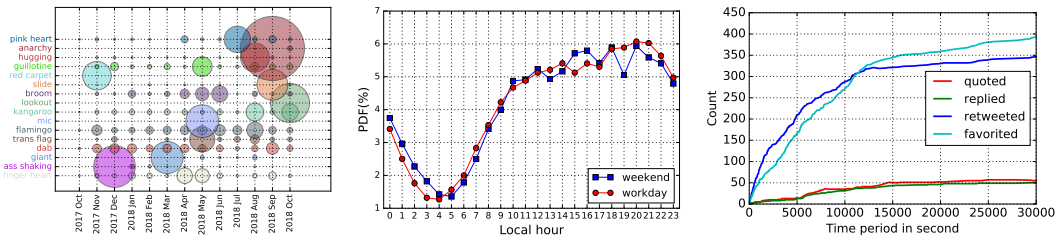
Table 1. Emoji requests by category (We only count emoji requests larger than 10 times)

Category	# emojis	# tweets	examples
Smileys & People	385	36,790	redhead, ass shaking
Animals & Nature	185	18,059	kangaroo, flamingo
Food & Drink	164	12,067	mango, waffle
Activity	42	2,421	slide, softball
Travel & Places	56	1,946	compass, brick
Objects	161	12,229	broom, red carpet
Symbols	170	21,443	anarchy, infinity
Flags	44	3,156	trans flag, Texas flag

more emojis per screen. They can even regroup emojis, as suggested by Na'aman et al [62], to enhance user experience.

4.2 Temporal Distributions

We explore temporal distributions of emoji requests at three different granularity levels: by month, by hour, and by second.



(a) The number of requests per emoji per month

(b) The probability of aggregated emojis being requested per hour

(c) The typical spread of a hot emoji-requested tweet per second

Fig. 5. Temporal distributions. (a) Emojis with over 1000 requests are plotted by months. The circle diameter represents the number of requests. (b) Probabilities of requesting emojis on workdays and weekends demonstrate similar patterns by hours. (c) A hot tweet requesting emojis spread quickly by being retweeted, quoted, liked, and replied.

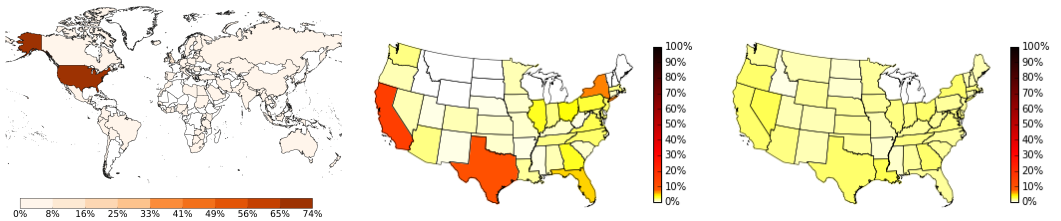
First, we aggregate tweets petitioning the same emoji together by months. Figure 5(a) demonstrates emojis that were requested more than 1000 times over a period of one year (Oct. 2017 - Oct. 2018). The circle diameter represents the number of requests made. Although the overall requested number was not so large, emojis of brooms, flamingos and kangaroos, appeared consistently in all months. In contrast, heavily requested emojis like the lookout and the red carpet mainly appeared in one or two months. The fact that the broom, flamingo and kangaroo emojis are selected as part of Unicode 11.0 in 2018 [28] or Unicode 12.0 in 2019 [27] implies emojis that are requested continuously and by multiple users are more likely to be approved by the Unicode Consortium as they reflect the real needs of the majority of online users. We also find the extensive but relatively concentrated emoji requests are triggered by celebrities or their followers. For example, petitions of the red carpet emoji were retweeted more than one thousand times by fans of BTS, a South Korean boy band, within 24 hours. After that, there is nearly no petition for the red carpet emoji any more.

The time-of-day distribution of emoji requests is shown in Figure 5(b). We aggregate emoji requests on workdays and weekends by hours from 0:00 to 23:00. The two request trends are quite similar, i.e., lowest requests occur at early morning (3:00 am - 5:00 am) and highest requests occur at early night (18:00 pm - 22:00 pm). However, there exist several slightly different patterns. The emoji requested rates on weekends are higher during 0:00 am - 4:00 am and lower during 18:00 pm - 23:00 pm than that on workdays, which might be caused by their different posting patterns between weekends and weekdays.

To study how emoji-requested tweets spread on social networks, we investigate a typical spread of a hot emoji-requested tweet as shown in Figure 5(c). Frequencies of being quoted and replied per second are very similar, which may be explained by the fact that the quoted tweet can be viewed as a special form of replies allowing users to add comments and even modify original tweet contents. The frequencies of being retweeted and liked are much higher than that of quoted tweets and replies. We also observe that on average over 94.8% mentions of the original tweets occur within the first 24 hours, which explains the concentrated distribution patterns of mic (microphone), and red carpet emojis in Figure 5(a).

4.3 Geographic Distributions

In this subsection, we analyze new emoji requests from geographic perspectives. In the *complete dataset*, 2.8% tweets have geo tags. We use these geotagged tweets to profile geographic distributions of new emoji requests at both worldwide and national levels.



(a) Worldwide emoji request proportions per country

(b) Emoji request proportions per state in U.S.

(c) Emoji request proportions normalized to populations

Fig. 6. Geographic distributions. (a) English emoji requests are made from 110 countries, and the United States, United Kingdom, and Canada account for more than 80% emoji requests. (b) States with large populations request more emojis than those having small populations. (c) After normalizing requests using the population, states show similar patterns.

The worldwide distribution of expected emojis is illustrated in Figure 6(a), where people in as many as 110 different countries petition for new emojis. As we collect tweets written in English, English-speaking countries, such as United States (73.6%), United Kingdom (10.9%), and Canada (3.2%), contribute the most of emoji requests. It is interesting that non-native English-speaking countries, such as China, Japan, Brazil and Mexico, also express their desires for new emojis even in English, which might be one evidence of the world's passion for emojis.

Since the most requests were made in the United States, we then focus on the United States to explore the geographic distribution of emoji requests at the national level. Figure 6(b) shows the proportion of new emoji requests per state to the overall number of nation-wide emoji requests. As expected, states like California, Texas, New York and Florida make a large number of requests, while those states lying at the heartland have low requesting percentages. We think this uneven distribution is mainly caused by the different populations in these regions. After normalizing by

state population [71], the geographical distribution as shown in Figure 6(c) is relatively smooth and even across the country, which indicates that people in different states have a similar level of desire for new emojis. Note that we also conduct the national geographic distribution analysis using Twitter users' profile locations, which are the residential locations specified in their public account profiles, and obtain similar results.

5 BEHAVIORS OF NEW EMOJI REQUESTS

In this section, we summarize contexts of emoji requests, conduct sentiment analyses, discuss the relatedness, fairness and equality issues due to unreleased but expected emojis, and explore advocacy behaviors. To be specific, we answer the following questions:

- What scenarios may inspire people to seek new emojis? Holidays & festivals, places of interests, or behaviors of Twitter influencers?
- How users feel when they cannot find wanted emojis? What kinds of words, punctuation, and emojis they prefer to express their emotions?
- What advocacy actions are taken for desired emojis? Will people switch to Twitter to petition for new emojis for other apps?
- Why people believe their wanted emojis should be available? What are the common characteristics of these desired emojis, if any?

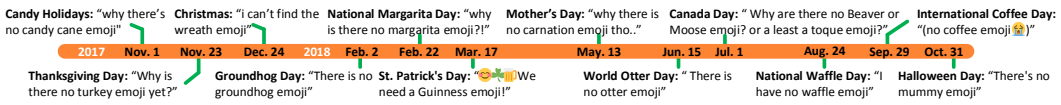


Fig. 7. Emoji requests during holidays and festivals

5.1 Context of Emoji Requests

People need new emojis in various scenarios for different purposes. On Halloween day, one may request a mummy emoji for decorating. When visiting the Empire State Building, one may look for such a building emoji. If Taylor Swift posts a tweet calling for a new emoji, her followers may disseminate this emoji petition very quickly in a short time. We summarize them into three common contexts that may shed light on the problem of why new emojis are requested.

5.1.1 Time-Related Events & Activities. During holidays and festivals, people request time-sensitive and content-related emojis very frequently, such as the candy cane emoji on Candy Holidays, the carnation emoji on Mother's Day, and the waffle emoji on National Waffle Day. Figure 7 shows detailed tweets requesting emojis on holidays and festivals throughout a year.

We also find emoji requests are related to popular entertainment products or events. Different types of popular entertainment including movies, albums and games inspire Twitter users to look for related emojis. Especially when these popular elements begin to become popular, related emojis are requested extensively by many participants such as movie audiences, music enthusiast and game players. For example, shortly after Black Panther, a superhero film, was released in early 2018, hundreds of panther emoji requests emerged on Twitter.

Popular periodic reoccurring events like sports games may promote the expectation of new emojis. For example, during 2018 Winter Olympics, many users asked for the Olympic Rings. The barbell emoji was requested for International Weightlifting Federation Weightlifting World Championships. During 2018 FIFA World Cup, the yellow card (a serious warning sign in soccer) and red card (a sending-off sign) were petitioned widely.

5.1.2 Place-Related Interests. Places of interests at different levels, like a single landmark, tourist attractions and even regions or countries, may encourage users to seek new place-related emojis. Many Twitter users visiting Paris claim for an Eiffel Tower emoji, like "Paris first though!! why's there no Eiffel Tower emoji?!". Similarly, the Mickey and Minnie emoji is requested at Walt Disney World (WDW) Resort like "Guess where I am?!!! WDW (why is there no Mickey and Minnie emoji?!)". People living in Hawaii and Texas asked for their state flag emojis respectively.

5.1.3 Twitter Influencer-Related Behaviors. Emoji requests made by prominent people on Twitter may trigger a widespread discussion of the requested emojis through their huge number of followers. In other words, people are more likely to interact with a tweet created by Twitter influencers than those created by unknown Twitter accounts. For example, Enya Umanzor, a popular YouTuber with over 800,000 subscribers to her makeup channel, tweeted "why is there no ass shaking emoji" and garnered 13,000 likes, 2,600 retweets and 34 replies. However, four non-prominent people tweeting for the same ass shaking emoji before Enya Umanzor only got 3 retweets, no like or reply in total. Another example is JJ Watt, a famous American football player, petitioned for the badger emoji and resulted in 4,503 likes, 491 retweets and 173 replies.

5.2 Sentiment Analysis

In this subsection, we study user emotions by analyzing the use of punctuation, polarized words, emoticons, and facial emojis contained in emoji-requested tweets. All analyses were conducted on the *unique dataset*, which consisted of 131, 592 tweets.

Regarding punctuation, inspired by [2, 11, 60], we focused on the question mark and the exclamation mark, since they convey more emotion information than others, such as the period and the comma. Among all original tweets, 21.5% and 12.7% contained at least one question mark and one exclamation mark, respectively. In the most extreme case, one tweet contained 30 question marks and another tweet contained 21 exclamation marks. To emphasize moods, nearly 10% tweets used sequences of repeated question mark, exclamation mark and mixtures of the both. In particular, 3.6% tweets contained "??", and 5.6% tweets contain "!!", "!?", or "?!". On average, about one in three tweets contained a question mark and one in five used an exclamation mark. The question mark and the exclamation mark ranked the second and third place among all punctuation by frequency, following the period but surpassing the comma. It is easy to understand the huge number of question marks since users are asking why there existed no emoji that they were looking for. Surprisingly, the exclamation mark, which usually expresses a strong statement and indicate strong emotions like surprise and anger [63], also demonstrate an extensive appearance.

Regarding polarized words, we used several lexicons. First, we followed the Twitter-specific lexicons used in [63]. We found that the most common positive terms included "great" (n=772), "like" (n=840), "excellent" (n=37) and "rock on" (n=18), and the most common negative terms included "f**k" (n=2555), "suck" (n=230), "fail" (n=119) and "eww" (n=63). Then, to include more polarized words, we took advantage of the TextBlob [52]. The polarity score of TextBlob is a number in the range $[-1.0, 1.0]$, where -1.0 is the most negative, 1.0 is the most positive, and 0.0 is neutral. We used polarity thresholds 0.5 and -0.5 to identify terms with clear polarity. In other words, a term is considered positive if its TextBlob polarity score is above 0.5, and negative if its TextBlob polarity score is below -0.5. Figure 8 visualizes the polarized words using word clouds. For positive words, Twitter users had diverse choices, including initialisms like "LOL" (laughing out loud) and "LMAO" (laughing my ass off). These positive words demonstrate a relative even distribution in terms of frequency. However, when expressing negative emotions, users preferred words like "f**king", "bad", "mad", and "disappointed".

(a) Positive word cloud (b) Negative word cloud (c) Positive and negative word cloud

Fig. 8. Polarized word cloud. Positive words with a polarity larger than 0.5 and negative words with a polarity less than -0.5 in TextBlob.

Regarding emoticons, we first checked emoticons in tweets reported in [63]. In our dataset, the most popular positive emoticons included ":)" ($n = 332$), ":-)" ($n = 44$), and ";-)" ($n = 20$), and the most popular negative ones included ":(" ($n = 604$) and ":-(" ($n = 37$). To further explore more emoticons, we summarized usage of all positive and negative emoticons in the list of sideways Latin-only emoticons [93], as shown in Table 2. Similar to polarized words, Twitter users preferred a limited set of negative emoticons. For example, the total count of ":(" and ":/" is larger than that of the top six positive emoticons.

Table 2. Emoticons used in emoji-requested tweets

Type	Emoticon Count														
Positive	:) 332	d: 193	;) 102	:p 75	:3 69	:-) 44	*) 30	;-) 20	:b 17	:* 11	8) 10	:] 6	=) 4	;] 3	:^) 3
Negative	:(604	:/ 228	:c 43	:-(37	:o 27	:'(22	: 12	:-/ 8	:[4	:$ 3	:{ 1	:@ 1	:-0 1	:O 0	D: 0

Twitter users also took advantage of facial emojis to express their emotions when they could not find the wanted emojis. We collected and illustrated these emojis in Table 3. The most commonly used facial emoji is the face with tears of joy, which can be used to mock or gloat over misfortunes, or emphasize feeling on ridiculous things [20, 21]. The second most frequently used emoji is the thinking face, which implies users were thinking why there is no the wanted emoji. It is interesting to observe that the majority of neutral emojis in Table 3 demonstrate depression, shame and embarrassment and express negative feelings and moods in fact.

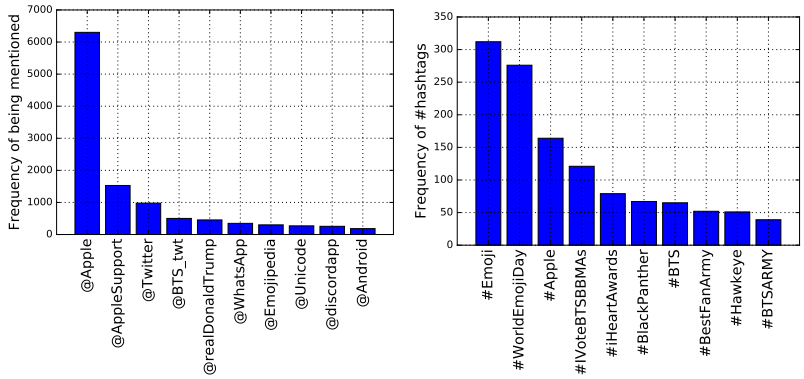
Table 3. Facial emojis used in emoji-requested tweets

Type	Emoji Count												
Positive	962	302	144	135	135	127	106	91	81	68	58	57	57
Neutral	443	305	123	103	87	72	62	59	45	45	45	44	43
Negative	238	104	89	80	64	58	58	57	54	41	37	30	27

5.3 Advocacy Behaviors

When users cannot find the wanted emojis, nearly one in three will use the symbol of '@' to mention some people or organizations for their attention. Figure 9(a) shows the top 10 Twitter accounts being mentioned by users, where eight of them (except BTS_twt and realDonaldTrump) are specific apps or mobile operating system related Twitter accounts. It is reasonable for common users to seek help from the apps or operating systems, because users thought it was these service

providers' responsibility for the nonexistent emojis. The fact that people switch to Twitter to petition new emojis for other apps, e.g., WhatsApp and Discord, can be viewed as a justification for choosing tweet data to study the emoji request.



(a) '@' Mentioning (b) #hashtags Mentioning

Fig. 9. Frequency of '@' Twitter accounts and the created #hashtags

In addition to '@' other Twitter accounts, more than 12% users insert #hashtags in their tweets when wanted emojis are not found. As we can see from Figure 9(b), the #Emoji is the most frequently created by users, which indicates that the main concern of these tweets is about emojis. There are also some hashtagged words similar to those '@' mentioned words, such as the #Apple. According to Twitter, the #hashtags are mainly used for indexing keywords or topics, and hashtagged words that become very popular are often trending topics. In our case, users might attempt to advocate their desire for more emoji options with the aid of #hashtags.

5.4 Relatedness, Fairness, and Equality

An interesting scenario for the emoji request rises when users complain that there exists an emoji for A but no emoji for B. They thought it was unfair or unreasonable because A and B are usually very similar or related to each other. As emojis are ubiquitous in our lives, such concerns appear in diverse domains as shown in Table 4.

The gender, color, similar function and similar looking can cause a sense of unfairness and inequality. The gender equality and diversity in emojis [19] are expected by both women and men. Women claim for the female skier and the woman in tuxedo emojis, while men want male-holding-baby and pregnant man emojis. Also, the transgender flag is requested widely. The color is another factor leading to emoji inequalities. Since the blond hair, purple grape, red wine glass, and red ribbon emojis were released, people thought the red hair, green grape, white wine, and pink ribbon emojis should be available as well. The similar function can also be an excuse to request new emojis, like mobile phone emojis versus iPad/tablet emojis, guitar emojis versus ukulele emojis, alembic emojis versus test tube emojis, and trophy emojis versus Oscar emojis. In addition, the similarity in looks between two distinct objects can also cause unfairness if one of them is unavailable. For example, people who are reluctant to use the tortoise emoji to represent the turtle believe it is unfair to the turtle.

Emerging technologies, recent social movements, and the equality of political symbols motivate people to petition for new emojis. The bitcoin sign was approved in 2017 as a Unicode character,

but not as an emoji. Twitter users want an emoji version of the bitcoin is added. When #MeToo movement reaches 1.7 million, Twitter gave it a custom emoji (three raising hands of different skin shades). However, this #MeToo emoji has not been officially supported by the Unicode Consortium and cannot be displayed across multiple platforms. In politics, the equality of both symbols and flags is considered. For example, as there exists the elephant emoji which can be used to represent GOP (the Republican Party), a donkey emoji representing the Democratic Party is requested. As most social network platforms offer flags of sub-regions (England, Scotland, and Wales) in the United Kingdom, it is reasonable and fair to ask for state flags in the United States. Although the flag for Northern Ireland, which is another sub-region of the United Kingdom, is not currently implemented by any major vendors [30], we did not observe its petition in the format of "there exists an emoji for A but no emoji for B" in our collected data.

It is interesting to note that some Twitter users argue for the emoji fairness and equality in such a way: 1) if there exists no emoji for A, the emoji for B should also be removed due to the fairness. 2) however, it is ridiculous to abandon emojis for B. 3) so, the emoji for A should be kept. One Twitter user argued *"if Apple turned the gun emoji into a squirt gun emoji because it wanted to prevent violence, there's no reason that it should allow hammer and sickle emojis"*. Another user wondered *"Why is there a gun emoji but there's not a 'no guns' emoji?"*

6 REAL-TIME TRACKING REQUESTED EMOJIS

In this section, we first propose and evaluate different ranking strategies for the requested emojis. Next, we implement a web-based real-time requested emoji tracking system, which provides flexible services such as ranking emojis using different policies, and filtering requested emojis by keywords.

6.1 Time-continuity Sensitive Ranking Strategies

As a global language [13, 49], emojis are not proposed for specific individuals, organizations, or companies, but for people all around the world to facilitate effective communication. We argue that highly desired emojis should satisfy the following requirements: 1) it is requested continuously until available; and 2) it is requested by multiple users originally and spontaneously.

To meet the first requirement, we propose time-continuity sensitive ranking algorithms with multiple time granularity levels. We use S_e^g to represent the eagerness score of emoji e at the time granularity level g, which can be expressed as

$$S_e^g = \log_{10}\left(\prod_{t=1}^{T^g}(R_{et}^g + 1)\right), \tag{1}$$

where $g \in \{month, week, day\}$; t iterates over the most recent T^g time slots at the time granularity level g; T^g is the total number of available time slots; R_{et}^g is the count of tweets and retweets requesting emoji e during the t^{th} time slot. For example, when g is set as the $month$ level, T^g equals 14 (we have 14-months' historical tweets in our dataset), and R_{et}^g is the requested count of emoji e during the t^{th} recent month. Note that for each R_{et}^g, we added the constant 1 to avoid a zero multiplier.

To check the reasonableness of the second requirement, we explored the time-series interactions (including being replied, being liked, being retweeted, and being quoted) with emoji-requested tweets. We observed that more than 94.8% interactions occurred within 24 hours after it was posted, over 98.4% within one week, and over 99.1% within one month. This phenomenon implies that the influence of a single tweet spreads within a limited period of time. Thus, if an emoji is only requested by one Twitter user, she/he has to post new emoji-petitioned tweets continuously to emphasize the eagerness of the wanted emoji. However, such behaviors will be recognized as bots

Table 4. Requesting related emojis

Domain	Available Emoji (A)	Unavailable Emoji (B)
Human Diversity	breast-feeding	male-holding-baby
	pregnant woman	pregnant man
	man in tuxedo	woman in tuxedo
	skier	female skier
	blond hair	red hair
Life	pancakes	waffle
	bed	pillow
	Christmas tree	elf
	purple grapes	green grapes
	wine glass	white wine
Science & Tech	fax machine	magnet
	alembic	test tube
	antenna bars	Wi-Fi
	microscope	DNA
	mobile phone	ipad/tablet
Nature	honeybee	fly
	tortoise	turtle
	crab	lobster
Business	curling stone	LEGO
	Unicode (U+20BF) ₿	Bitcoin
	TOP arrow	bottom arrow
	bar chart	pie chart
Society	red ribbon	pink ribbon (for breast cancer)
	#MeToo hashtag	#MeToo in Unicode
	Greenland flag	transgender flag
	red heart	blood donor
Politics	hammer & wrench	hammer-and-sickle communist symbolic
	elephant for GOP	donkey for Dems.
	Guyana/Ghana flag	pan African flag
	in	state flags in
	United States flag	Confederate flag
	water pistol	real gun (AR15)
Entmt. & Arts	trophy	Oscar
	videocassette/DVD	cassette tape
	guitar	ukulele

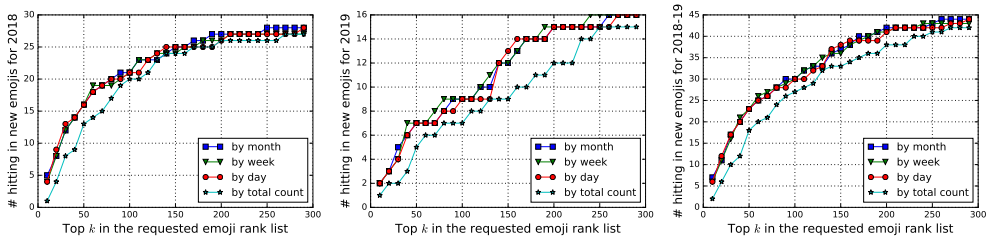
and the posted tweets will be filtered out. If an emoji e is requested by multiple users at different times, its eagerness score S_e^g will remain high.

6.2 Evaluation of Ranking Strategies

We evaluated the performance of our proposed ranking strategies by comparing them with a count-based baseline. For this comparison, we used datasets of newly released emojis for 2018

(n = 157) [28] and newly proposed emojis for 2019 (n = 62) [27] as our ground truth. We reduced the number of 2018 new emojis to 69 by merging those with just gender and skin tone variations.

We measured the number of emojis that were released in the ground truth set (i.e., newly released in 2018 or chosen as candidates for 2019) in the top k ranked list generated by different strategies. Evaluation results of the time-continuity sensitive ranking strategy with different time granularity levels are shown in Figure 10. On both datasets, all of the proposed strategies outperform or have the same performance with the baseline given any k values within 300. The proposed strategies with the granularity of *month* and with the granularity of *week* demonstrate an overall better performance than the rest on the dataset of new emojis for 2018 and 2019 respectively. Figure 10(c) illustrates 66.6%, 46%, and 30% emojis in our top 10, top 50, and top 100 ranked lists can be identified in either of the two new emoji datasets, which demonstrates the effectiveness of our strategies.



(a) Hits in new emojis for 2018 (b) Hits in new emojis for 2019 (c) Hits in new emojis for 2018-2019

Fig. 10. Hitting count of new released emojis for 2018 and the new emoji list (still in draft) for 2019. We rank the requested emojis using different strategies and count the hit emojis in the top k requested emojis in ranked lists.

6.3 Real-time Tracking System

We implemented a real-time monitoring system, which is available via our call4emoji website https://call4emoji.org, to track new emoji requests on Twitter. The system consisted of a backend and a frontend, as shown in Figure 11. At the backend, we keep running Twitter's streaming APIs to crawl emoji-mentioning tweets in a real-time manner. Then, we preprocess the collected tweets by filtering bots, extracting emojis using linguistic patterns, and filtering out extant emojis. Next, the petitioned but non-existing emojis are fed to the rank engine where the proposed time-continuity sensitive ranking algorithms are executed. The rank engine reads historical tweet records from the MySQL database, and writes back both updated ranked lists and the information of recent collected emojis. The frontend is mainly responsible for displaying the updated list of emoji rankings in browsers by querying the dataset. By default, the system automatically recalculates emoji rankings and refreshes the frontend webpage every 10 minutes.

The main user interface of our tracking system is illustrated in Figure 12. We offer the time-continuity sensitive ranking strategies with the granularity of *month*, *week* and *day*, and the baseline strategy by sorting emojis according to their requested counts. Users can click ranking strategy buttons to view the whole corresponding lists of emoji rankings at the displaying zone under the button line. In the ranked list, the first column is the ranking index followed by the emoji name and the corresponding eagerness score. For example, in Figure 12, the "Rank by month" button is pressed and the the ranked list created with a granularity of *month* is displayed.

To enrich the flexibility and interactivity of the tracking system, we provide advanced settings for users to customize their queries. When the "Advanced Settings" button is pressed, three advanced

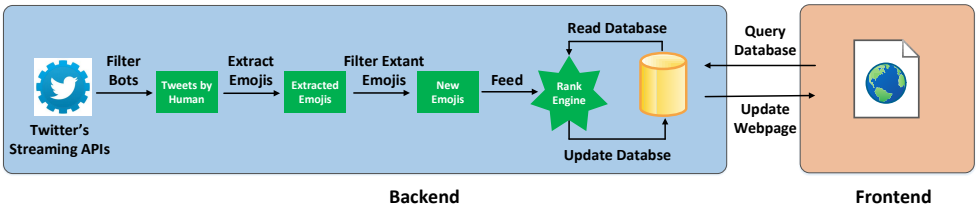


Fig. 11. Real-time emoji requests tracking system

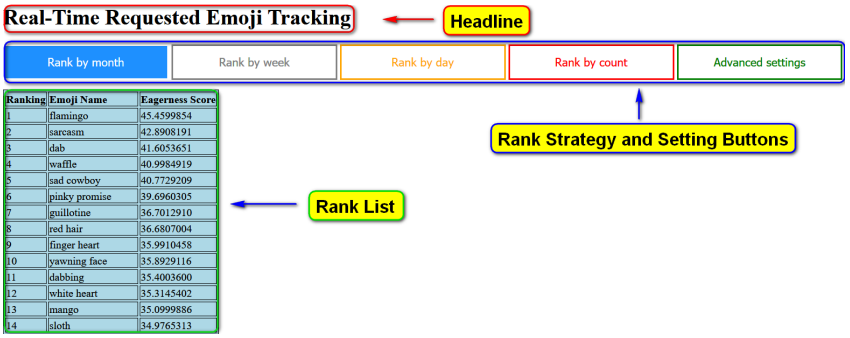


Fig. 12. User interface (UI) of real-time tracking system. It mainly consists of three components, i.e., the headline, the ranking strategy and setting button line, and the display zone for ranked lists.

options appear at the right of the ranked list display zone (see Figure 13). The first one allows users to specify an interval of interest, such as holiday seasons and game days, to check the status of requested emojis. The second option enables users to search requested emojis by keywords, which is very useful for emoji designers. For example, the keyword of "new" will list emojis of which people are desiring for new designs, such as "new gun," "new wink," "new thinking," "new dancing," "new eye rolling," "new pistol," and "new mermaid." Emoji designers can also summarize all desired attributes of the *same* emoji by searching the emoji name. For example, the keyword of "circle" will list emojis of "green circle," "purple circle," "yellow circle," "stone circle," "hand circle," and "2 snaps in a circle." The last option is to display emojis within a specified ranking index range. Note that the above three options are flexible to be used individually or together. Once advanced settings are configured and submitted, the server conducts the customized queries and returns results immediately.

7 SIGNIFICANCE OF NEW EMOJIS

New emojis contain both the unreleased emojis and the emojis needed to be re-designed by tech vendors, like Apple, Google, and Twitter. Identifying and introducing new emojis benefits the society a lot from many aspects, which explains why the Unicode Consortium and vendors update emojis continuously. The newly added hijab (woman with headscarf) emoji 🧕 through the Hijab Emoji Project campaign led by 15-year-old Saudi Rayouf Alhumedhi promotes inclusivity for about 550 million Muslim women on this earth [24, 69]. Researchers from the Johns Hopkins Bloomberg School of Public Health and the Bill & Melinda Gates Foundation proposed a mosquito emoji 🦟 to better explain mosquito-borne illnesses like malaria, Zika, dengue and yellow fever in 2017 [55]. Prior work also suggested creating a set of nursing emojis might facilitate health communications

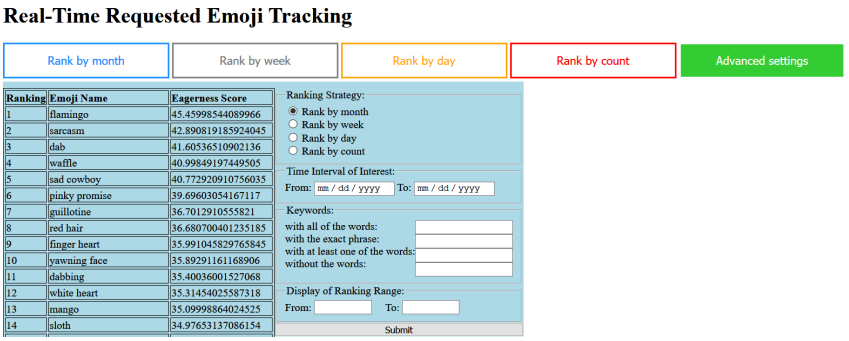


Fig. 13. Advanced settings enabling users to customize their queries.

for patients and allow them to better understand their health data [75]. As branded emojis helped improve the amount of ads receive by almost 10% [70], brands like furniture company IKEA and fast food restaurant Tim Hortons have released app-specific branded emoji to iconize their products [1].

New appearances of emojis are always desired along with fixing design flaws, considering social influence, etc. When people found the original official lobster emoji 🦞 and the one 🦞 designed by Twitter were missing a set of legs, a new anatomically accurate lobster emoji was requested strongly and the four-legged lobster emoji 🦞🦞 was available soon. A more recent example is the Apple's bagel emoji 🥯 released in iOS 12.1 beta 2. Its lackluster appearance caused overwhelming complaints from bagel lovers and birthed the #SadBagel movement for a more appetizing design on Twitter. Apple added cream cheese to its forthcoming bagel emoji 🥯 after the social media outcry [10]. To curb visual representations of gun violence, all major vendors switched the realistic-looking pistol emoji to a toy water gun in 2018, e.g., Apple (🔫→🔫), Google (🔫→🔫), Microsoft (🔫→🔫), Facebook (🔫→🔫) and Twitter (🔫→🔫) [1, 29].

8 LIMITATIONS AND FUTURE WORK

There remain several limitations to be addressed in future research. First, we are relying on Twitter streaming data, which may introduce sampling bias. One possibility is to include other social media as data sources. However, as we mentioned in Section 3.1.1, social network platforms like Facebook and Instagram prohibit almost all automated content scrapers. To handle this challenge, in the future, we plan to provide an address enabling people to directly submit their wanted but unreleased emojis through our call4emoji website https://call4emoji.org. Second, this paper only focuses on the desired emojis from the English speaking world. We are aware that people from different cultural backgrounds may demonstrate significantly different preferences on emojis [53]. It would be interesting to study how cultural factors, such as languages and traditions, affect the requests for new emojis. Fortunately, our proposed new emoji analysis framework and real-time tracking system are flexible to cover the emoji petitions from the non-English speaking background (NESB).

9 CONCLUDING REMARKS

In this paper, we propose a framework for crawling and analyzing emoji requests on Twitter. We collected more than thirty million English tweets containing the keyword "emoji" throughout a year from October 2017 to October 2018. After filtering out bot-generated tweets, we extract emoji descriptions using fine-tuned linguistic patterns. Surprisingly, some extant emojis were still frequently requested by many users, which are probably caused by out-of-date emoji keyboards

or poor emoji keyboard layouts. For non-existing requested emojis, we categorize them into eight groups using a combination of keyword matching and WordNet-based classifiers. We then profile temporal and geographic distributions of new emojis at different scales. Emojis requested consistently in every month and by multiple users are more likely to be approved by the Unicode Consortium. We next summarize three typical contexts of emoji requests, i.e., time-related events & activities, place-related interests, and Twitter influencer-related behaviors. Then sentiment analyses and the users' advocacy channels are studied Moreover, we present the equity, diversity, and fairness issues due to unreleased but expected emojis, and discuss the significance of new emojis on society. Finally, we propose time-continuity sensitive ranking strategies to identify the most desired emojis, and develop a web-based interactive emoji tracking system, which enables the analysis of petitioned emojis in a real-time manner. To the best of our knowledge, this monitoring system is the first to rank the petitioned emojis on a large scale and in a real-time manner, which would be helpful to evaluate the chance of a new emoji being accepted as an official one.

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