Sentiment Analysis of Participants Interactions in a Hackathon Context: The Example of a Slack Corpus

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ABSTRACT

This paper presents the analysis of participants' interactions during an online hackathon using Natural Language Processing (NLP) techniques. In particular, we explored the communication of groups facilitated by Slack focusing on the use of emojis. Our findings suggest that most used emojis are positive, while negative emojis appeared rarely. Sentiment of written messages was overall positive and could be linked to topics such as motivation or achievements. Topics about participants' disappointment regarding their progress or the hackathon organization, technical issues and criticism were associated with negative sentiment. We envision that our work offers insights regarding online communication in group and collaborative contexts with an emphasis on group work and interest-based activities.

CCS CONCEPTS

• **Human-centered computing** → **Computer supported cooperative work**; **Human computer interaction (HCI)**.

KEYWORDS

hackathons, sentiment analysis, natural language processing, emojis, slack, online communication, collaboration

1 INTRODUCTION

Hackathons are time-bounded events during which participants typically form teams and engage in intensive collaboration to complete a project that is of interest to them [21]. Hackathons are organized in various contexts to support the development of innovative technology [6], foster learning [8], tackle civic and environmental issues [13] and initiate or expand communities [20]. The growing popularity of hackathons led to an increased interest in research focusing on specific aspects like the organisation of hackathons [21] or the sustainability of hackathon results [20]. Still, we know little about how participants interact during hackathons beyond interview- and observation-based studies of a small number of events [26].

During online hackathons we deal with short-term virtual teams using web-based technologies – such as Slack, WhatsApp and Zoom – to communicate, coordinate and work together towards their common goal. Research suggests that sentiment (that is, the expression of feelings, opinions and points of view [24]) is an important component of team building and that emotional ties between group members contributes to increasing group effectiveness [12]. Thus, the question arises if and how emotions are expressed in their written communication, and particularly, with emojis. To explore this, we studied the interactions of hackathon participants as recorded by Slack, focusing on the analysis of written texts and the use of emojis. Related literature in computer-mediated communication

indicates that emojis and emoticons can be useful predictors of sentiment and can be perceived as sentiment labels [4]. Moreover, emoticons can enhance, reduce, change and add sentiment to a written text [24]. Our aim was to explore whether related research regarding emotion and the use of emojis apply to short-term group collaboration. The contribution of this paper is twofold. First, we show how sentiment and emoji use are related in a highly dynamic time-bounded collaborative context. Second, we created a first proof of concept approach to utilize NLP for studying online hackathons.

2 RELATED WORK

As the volume of opinionated data on the Internet is constantly growing, Sentiment Analysis (SA) methods are of growing importance as well. SA makes use of Natural Language Processing (NLP) techniques to determine the attitude of a speaker or a writer [14]. There are three different levels of SA: document, sentence, and feature level. While SA on feature level tries to discover sentiments on entities and their aspects, SA on the sentence and document levels attempts to determine whether each sentence or the whole document expresses positive, negative or neutral sentiment [18].

Hu et al. [15] analysed emojis and their context, suggesting that different types of emojis (for example positive, negative or neutral) can have an impact on message sentiment. Their results indicate that positive emojis significantly increase the sentiment of neutral and negative messages, while negative emojis decrease the sentiment of positive and neutral messages but have no impact on negative messages.

In the context of online collaborative work, Wang et al. [27] explored how people communicate using Slack and showed that different Slack groups use different communication styles; for example, more files were exchanges in project groups and project groups generally used less emojis than social and general groups. In addition they found more messages with emoji reactions in social channels than in project channels. Previous studies also showed that the usage of emojis varies based on the recipient of the text. For example, in cross-generation communication (communication between people of different generations) and secondary relationships (formal, temporary and less personal relationships such as colleagues), emojis are often positive and simple in order to minimise the risk of misunderstanding. In private and less formal communication, emojis are more positive than in working groups [2]. In socio-emotional communication settings, some individuals tend to use positive emojis frequently to create a positive atmosphere to boost group rapport [17]. In complex task-oriented communication positive emojis are reported to significantly enhance emotions [23].

2.1 Research Questions

Existing studies analyse emoji sentiment and text sentiment separately while the impact of emojis on the sentiment polarity of texts is not fully explored. Although there is a high interest in online communication and SA in general, existing research in the context of hackathons is rare [19]. Moreover, hackathons – due to their time-bounded nature – introduced additional challenges that have not been sufficiently explored.

Our work aimed to contribute to research regarding online communication in group and collaborative contexts with an emphasis on interest-based activities, such as hackathons. Specifically, we aimed to explore the use of emojis use its impact on sentiment in short-term group work. We thus formulated the following research questions:

- **RQ1:** Which emojis were used in each channel type and how often?
- **RQ2:** Which topics caused positive/negative sentiment?
- **RQ3:** Did emojis fit the sentiment of the sentence they are used in?

3 METHODOLOGY

We analyzed a Slack dataset collected during an online, COVID-19-themed hackathon. The hackathon lasted for 48 hours over 3 days, and the language of communication was English. However, most participants were from a specific geographical context (South Asia) and not all messages were in English. The event was open for participation but the target audience was young entrepreneurs and students.

A total of 326 Slack channels were analysed: 39 were project and 287 general channels. Each team had their own project channel while general channels were used for random conversations or for communication with the hackathon organizers. General channels contained 4662 messages overall and project channels about 7529 messages. The corpus included messages from all roles: hackathon organizers, mentors and participants. However, we did not differentiate the analysis based on roles.

To extract information about messages exchanged in Slack, topics, emojis and their context, we conducted the following approach:

(1) We performed topic analysis for all Slack channels using KEYbert;

(2) We classified emojis into three categories: positive, neutral, and negative [15]. Sentiment categorization of emojis was based on the Emoji Sentiment Ranking [16] and on the approach by Fernandez-Gavilanes et al. [11] who used Emojipedia, Emojis.wiki, CLDR emoji character annotations and iEmoji. To assign the appropriate sentiment to each emoji, we compared emoji labels with emoji names in the four aforementioned classification lists and the Emoji Sentiment Ranking. Additionally, we compared the assigned categories from the different sources for each emoji as well. Since emoji names in the categorization lists differed from the names in our Slack data, we used Emojipedia to compare the names. There were also emoticons used in Slack which are usually automatically translated into the respective emojis unless the user chooses to specifically opt out. We used the Slack Emoji List in Emojipedia to find the emojis that these emoticons represent and analysed them like remaining emojis.

(3) We conducted SA of written messages focusing on positive and negative polarity. Input data were emojis and texts from general and project channels as well as the emoji categorization as textual input. For this step, we used NLTK since it can easily tokenize input data. We developed an algorithm (1 to scan each word of the messages to find the category it belongs to. Then, we calculated the total number of positive/negative words and positive/negative/neutral emojis, based on that, we examined the channel sentiment.

(4) Additionally, we qualitatively analyzed a random subset of messages from the six largest channels. We used the Vader Sentiment Lexicon to categorize a sentence's sentiment as positive, negative or neutral. Furthermore, we searched for emojis that were positive, negative or neutral according to our emoji categorization. We then compared the sentence's sentiment with the emoji sentiment. In total, we analysed 41 random messages which overall contained four negative, five positive and five neutral emojis.
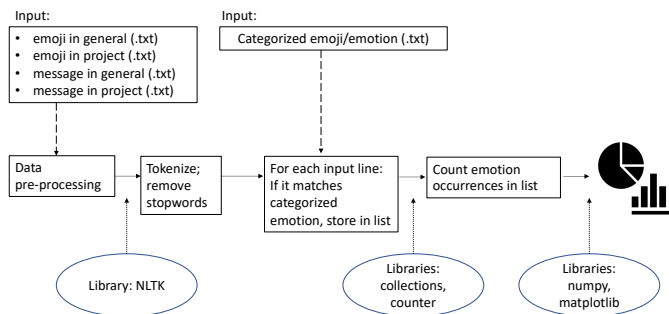

Figure 1: A diagrammatic representation of the algorithm that was developed to analyze the input data and to categorize words and emojis.

4 RESULTS

Addressing RQ1, we found that there are more emojis in general channels (928) than in project channels (717). The share of emojis in relation to the number of messages is higher in general channels (20%) than in project channels (10%) as well: 93 unique emojis were used in general channels, and 66 in project channels (Table 1). The polarity of most emojis was positive. In general channels, the percentage of positive emojis was higher (79%) than in project channels (71%). Regarding the sentiment, our analysis indicates that in both channel types, the general sentiment is positive. Nevertheless, there are few more negative messages in general channels than in project channels.

In both channel types, the most used emoji was "slightly smiling face" (🙂). Besides that, mostly non-facial emojis were used like "exclamation" (❗) or "boom" (collision) (💥). These were all present in messages for highlighting purposes. One example would be: "❗ IMPORTANT HACKATHON ANNOUNCEMENT! ❗". A breakdown analysis of most popular emojis is presented in Figures 2 and 3.

Related to RQ2 we found that negative sentiment was triggered by topics regarding organisational issues such as delays, criticism of rules or organisers (e.g. "*height of unprofessionalism, you guys should have been more proactive, first they say that you were not selected and 4 hours later we get an email that sorry for the mixup, your team has sailed through*"), disappointment regarding winning teams (e.g.

"*[...] One of the team had just crappy animated video but made it to top. Also some companies already had good support from various institutions. I think these entities should not be part of hackathon [...]*") and technical difficulties such as hardware problems and malware (e.g. "*Please confirm if you are able to access. We worked super hard all night! Wouldn't want to let go because of a tech. Glitch* 🥺"). Other topics causing negative sentiment were failures or time pressure. Positive sentiment in comparison was caused by motivation and enthusiasm regarding the hackathon (e.g. "*Hi all, Thank you for the support and the initiative. Fully enjoyed the 48hrs of this event [...]*"), and achievements like approval of mentors and gratitude (e.g. "*Thanks to the mentors for giving us all the required assistance* 🙌 *[...]*").

Regarding the fit of the emoji to the sentiment of the sentence they were used in (RQ3) we found that negative emojis mostly matched the content and sentiment of sentences, e.g "*No we are not in top 30* 🙁*...*" or "*and on another note, model has not really learnt much!* 🥺". We did not find examples where negative emojis were used in a positive context. Overall, only few negative emojis were used. Neutral emojis were mainly used in positive contexts, e.g. "*Super heroes all of you in true essence, congratulations again* 💥 👑". Context and positive emojis mostly matched. They were mostly used for motivation (e.g. "*To all the nice people here, applause the effort every one of You has put into this and appreciate the opportunity to be part of this!* 🙂" or "*So nice to see you all here!* 🙂 *It's going to be a great weekend!*"). However, positive emojis were sometimes used in negative contexts as well (e.g. "*Sorry* 🙂" or "*It is Friday. Still now you can't organise certificate for the teams who have participated* 🙂 *thank you*").
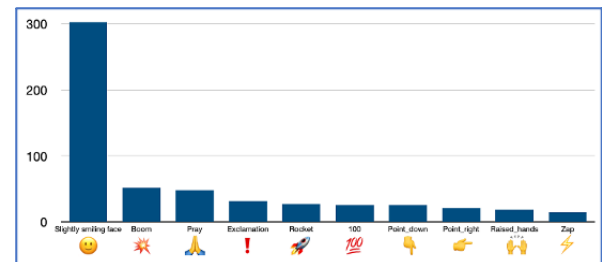

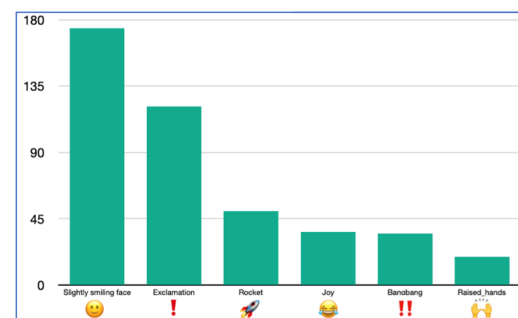**Figure 2: Most used emojis in general channels.**

Figure 3: Most used emojis in project channels.

Channel Type	Number of messages	Number of emojis	Number of unique emojis
General	4662	928	93
Project	7529	717	66

Table 1: Number of messages, emojis and unique emojis in general channels and in project channels.

5 DISCUSSION

We examined the influence of emojis on the overall sentiment of Slack channels during a hackathon. We first examined which emojis were used most in general and project channels (RQ1). For both channel types, most of the used emojis were positive. Negative emojis were rarely used. Literature suggests that people tend to use positive emojis to boost group rapport and create positive atmosphere in working groups [17]. This may be a reason for the rare usage of negative emojis. Emojis might not be a proper way to express negative emotions as they are mostly used in a positive context and do not increase negative sentiment [15]. Previous studies suggest that communication in project-related groups is more formal and there are less positive emojis used than in social groups [2]. Thus, we expected less positive sentiment in project-related than in general channels (RQ1). Our findings show that the sentiment was overall positive in both channel types, but participants used more negative messages in general than in project channels.

Regarding the topics that caused positive or negative sentiment (RQ2), our findings suggest that negative messages mostly addressed organisational problems. Also, participants talked about negative topics more in general channels since such topics affected everyone. Positive sentiment was caused by less specific messages and usually contained motivational content or messages of gratitude addressing all participants. Another interesting finding was the discrepancy between emoji usage and sentiment which might be attributed to sarcasm and its more frequent usage in general channels (RQ3). Sarcasm in written communication is indicated by mixed messages, mostly a negative message combined with a positive emoji, which might be one of the reasons why "slightly smiling face" 🙂 was used more frequently than others [7, 9, 28]. Previous research already identified specific emojis that are commonly used in sarcastic comments, but still, sarcasm is hard to detect in written and verbal communication and can lead to potential misunderstanding [7, 22, 25]. Furthermore, emojis are not always a direct reflection of emotional content but work as intentional communicative signals of emotion. Therefore, emojis are not necessarily representing real emotions and the usage of a positive emoji might rather be a matter of politeness or serve to complement an otherwise negative message [1, 10]. Nevertheless, the differences between general and project channels in our dataset were very small and the emojis used typically fit the sentiment. This complements prior studies which suggest that emojis enhance text comprehension if they are congruent to the content of a message [5] and do not change its meaning but predict and complement its sentiment [4].

6 CONCLUSION

We envision that our findings can support organisers and mentors of hackathons, or other similar project-based and interest-based collaborative activities, to gain better understanding of sentiment in communications as they unfold (for example, less emoji usage might indicate a more negative sentiment). Mentors might even attempt to influence sentiment by using specific emojis to boost group rapport and create a positive atmosphere. Overall, this project provides a foundation for further research regarding emoji usage and sentiment during hackathons and similar events. To the best of our knowledge, our project is the first to analyse hackathon-based interactions with NLP techniques and, as such, it provides a foundation for further research. Our approach however also has inherent limitations. The dataset we utilized only contained messages from a hackathon that took place in a specific geographical context. It is thus questionable to what extent our findings can be generalized beyond this context since emoji usage is influenced by demographic characteristics and individual psychological characteristics [3]. Especially for the emoji categorization, it is difficult to consider cultural differences; future research could thus focus on methods to implement a standardised emoji categorization. To detect influences of demographic and individual psychological or cultural characteristics, hackathons from different countries could be compared. Moreover, the usage of emojis and their influence on working quality in teams could be examined. It should also be considered that our data was limited since some groups might have used other communication platforms instead of Slack during the hackathon. For emoji usage (RQ1), it should be mentioned that some messages, especially announcements, were posted multiple times in different channels, meaning emojis that were used in those messages were not actually used that much in different contexts. Also, emoticons turn into emojis automatically on Slack which presumably led to the high number of "slightly smiling face" 🙂. Regarding RQ3, due to manageability and to detect e.g. sarcasm, not all sentences containing emojis were analysed. A broader and systematic comparative analysis of emoji and text messages is thus necessary.

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