Difference in emotional transitions between tweets about COVID-19 and other natural disasters revealed by emotional evolution trees

Keywords: Emotional evolution tree, Sentiment analysis, Information diffusion, Social media, Twitter

Extended Abstract

With the development of big data analysis, tweets posted on Twitter can be analyzed as social data. Among social networking services, Twitter is superior in terms of spreading information quicker, but there are some problems, such as fake news and misinformation spread quickly by bots. Regarding information spreading, emotion is one of the major factors motivating users. Recent studies by Matalon et al. [1] and Stieglitz et al. [2] have revealed that users' emotions have a significant impact on the diffusion of information. However, it is still unclear how people's emotions shift during the diffusion process. This is because the networks used to represent the diffusion were built mostly based on retweets and follows.

In this study, we construct a network from Twitter data based on the similarity of posted sentences, called an evolution tree [3], instead of retweeting or following. Furthermore, we add an emotional value to each node on the network to represent the spread of information with emotion. This emotional evolution tree allows us to reveal the information spread triggered by emotion and how emotion shifts. This study aims to analyze the impact of emotions on information diffusion. We especially focus on the diffusion process of information that includes people's emotions in two types of disasters: COVID-19 and natural disasters.

We collected tweets about COVID-19 in Japan from 2019 to 2022 and tweets about earthquake disasters that occurred in Japan. COVID-19 tweets were obtained from the first wave (March-June 2020), third wave (January-March 2021), and seventh wave (July-September 2022). The obtained tweets contain either of the keywords "COVID-19, corona." Earthquake disaster tweets were obtained from tweets about the massive earthquake in Kumamoto, Japan in 2016 (April 14-21, 2016). The keyword used to obtain the tweets was "Kumamoto earthquake." We also collected tweets (January 15-22, 2022) regarding the eruption of an underwater volcano off the coast of Tonga in the South Pacific Ocean. The obtained tweets contain either "Tonga" or "undersea volcano."

First, we performed a sentiment analysis on all collected tweets using a sentiment dictionary called ML-Ask. Then, we conducted the following procedure to construct an evolution tree. The construction of the tree requires computing the similarities between all the tweets. TF-IDF and cosine similarities were used to calculate them; TF-IDF is used to vectorize sentences and can also be used to vectorize features of sentences by comparing the number of common words in two sentences. By using cosine similarity, the sentence similarity is calculated by the size of the angle between the vectors. Next, the sentence similarities between tweets are compiled into a matrix, and an evolution tree is constructed based on this matrix. Evolution trees are constructed by connecting those with the highest sentence similarity in order, from the oldest tweet posting date and time. Finally, emotional values are assigned to the nodes in the evolution trees based on the sentiment analysis results. By visualizing the diffusion processes of information using the emotional evolution tree, we compare how people's emotions change

during disasters. Emotional bias and switching frequency are analyzed using the mean value and the amount of change in the emotional values assigned to the nodes on the path of the tree.

We first found that negative tweets outnumbered positive tweets by about twice from the results of the sentiment analysis of tweets during the months before and after the peak of the 7th Wave of COVID-19. Positive tweets about COVID-19 showed enthusiasm and optimistic feelings against COVID-19. It was also found that tweets about COVID-19 tended to increase in positive sentiment over the holidays, and there was a cyclical pattern where negative sentiment was highest on Monday, when work began. In contrast, negative tweets were three- to four-times more common than positive tweets in general disasters such as earthquakes. Positive tweets during earthquake disasters were often tweets of "relief" from those who had already been able to evacuate.

The results of the emotional evolution tree pathway analysis showed that in the first and seventh waves of COVID-19, people's emotions frequently switched from positive to negative content (and vice versa), even on a single pathway on the network (Fig. 1, top-left). In natural disasters such as earthquakes, on the other hand, such switching was less frequent on a single pathway, and negative and positive content tended to persist for longer periods of time (Fig.1, bottom). One possible reason for the frequent switching of emotions in the COVID-19 emotional evolution tree is the slow speed at which negative emotions spread. In earthquake disasters, fear surges after the occurrence of an earthquake, but in a pandemic such as COVID-19, negative emotions also increase gradually as the number of infected people gradually increases. Therefore, we have seen a frequent switch between negative and positive emotions in the COVID-19 tweets. These results may also suggest that COVID-19 is heterogeneous in its diffusion compared to other disasters.

References

[1] Y. Matalon, O. Magdaci, A. Almozlino & D. Yamin. (2021). Using sentiment analysis to predict opinion inversion in Tweets of political communication. Scientific Reports, 11, 7250.

[2] S. Stieglitz & L. Dang-Xuan. (2013). Emotions and information diffusion in social media - sentiment of microblogs and sharing behavior. Journal of Management Information Systems, 29, 217-248.

[3] S. M. Jang, T. Geng, J. Q. Li, T. Xia, C. Huang, H. Kim & J. Tang. (2018). A computational approach for examining the roots and spreading patterns of fake news: Evolution tree analysis. Computers in Human Behavior, 84, 103-113.

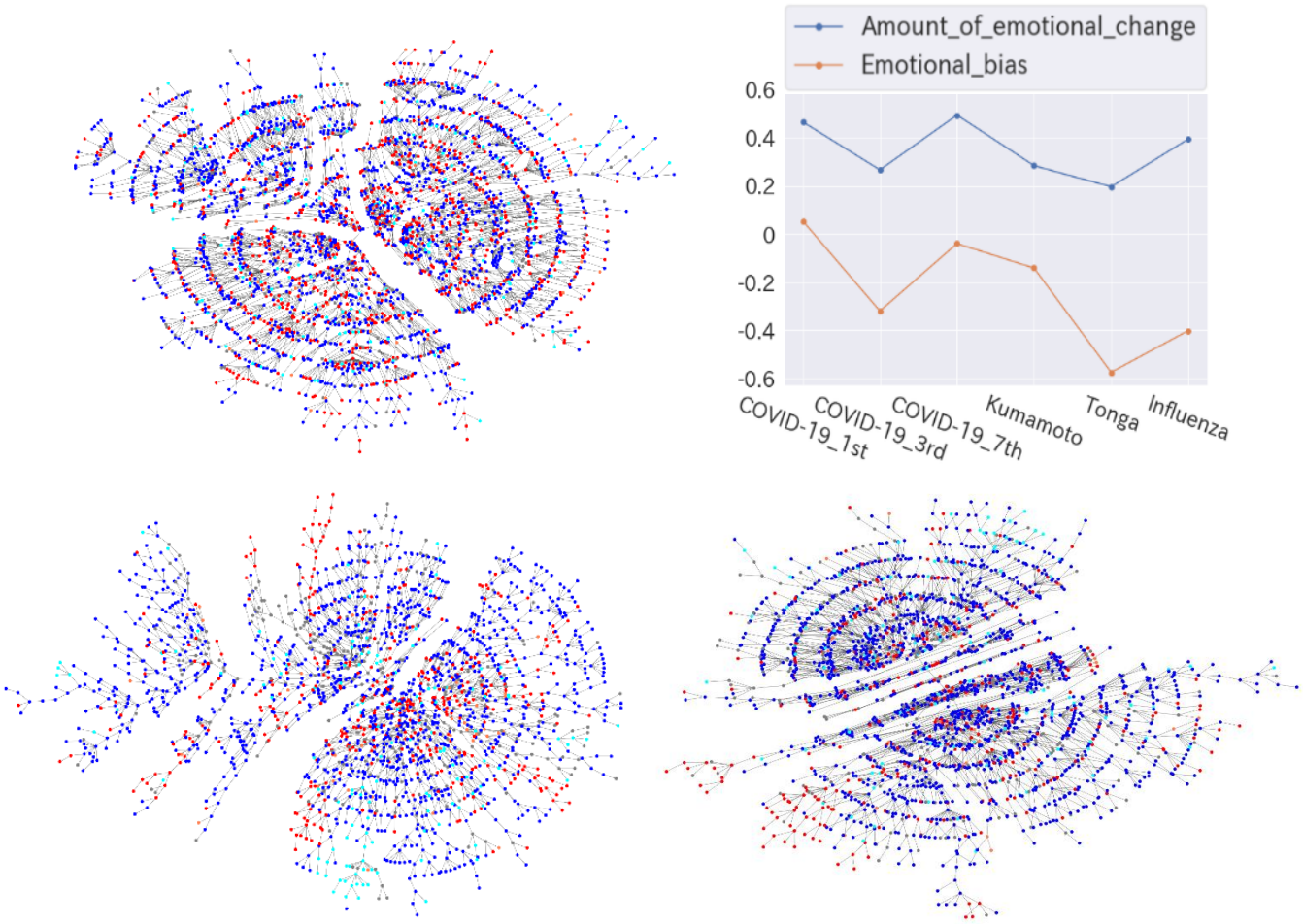

Figure 1: Comparison of the emotional evolution tree for the 7th wave of COVID-19 (top left), for the Kumamoto earthquake (bottom left) and for the undersea volcanic eruption off Tonga (bottom right). Quantified comparison of emotional transitions of the COVID-19 waves with other natural disasters (top right).