Sensing emotions in a crisis

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Algorithms developed by A*STAR researchers have helped to identify public sentiment towards COVID-19 in over 20 million tweets. Credit: A*STAR Research

From Twitter to Facebook to Reddit, billions of people around the world use social media daily to connect with friends and family, as well as to share their stories, feelings and opinions about the state of the world around them. As such, social media has become a prime playground for

social sensing—methods that use humans as "sensors" to gather information.

The wealth of information on public sentiment available from social media is invaluable to governments. "The ability to understand the ground accurately and monitor changes in sentiment in a timely manner can help policymakers and communication professionals achieve greater timeliness, relevance and sensitivity to the nuances of the public's needs," noted Yinping Yang, a Principal Investigator at A*STAR's Institute of High Performance Computing (IHPC). This is especially true and relevant during times of crisis, like the ongoing COVID-19 pandemic.

When COVID-19 first emerged in late 2019 and began spreading around the world in early 2020, social media was abuzz with activity about real-time issues like food hoarding and the use of masks. Yang and an international team of researchers responded to the urgent need to understand public sentiment during the rapidly unfolding health crisis by turning to social media, like many before them. What made their study unique was that it examined the multidimensional nature of emotions embedded in users' messages.

The power of emotions

Several studies performed in the past decade have used social media to track public sentiment and trends in communication during health crises like Zika and the H7N9 avian influenza. However, these studies simply tracked the volume and the positive and negative sentiment counts surrounding common topics of debate. Emotions, on the other hand, are psychological processes and more closely linked to behaviors.

"One thing we know from psychology is that human emotions arise to events that are important to our concerns and needs, be it feeling angry

when being treated unfairly or feeling scared of getting infected by a deadly virus," Yang said. In this way, emotions are more than just feelings; rather, they provide powerful insights into an individual's and the public's underlying concerns that matter to them. As such, government policies are most effective when they take into account the public's emotional state.

Yang's research program on affective and social intelligence has been focused on four distinct human emotions: fear, anger, sadness and joy. The choice is supported by a convergence in psychology literature, where fear, anger, sadness and joy are distinct emotions that are deemed "primary," meaning that they are common across cultures and age groups.

For example, although both fear and anger are unpleasant emotions that arise from uncertainty, fear is caused by circumstances while anger is caused by others. Meanwhile, sadness is a negative emotion that arises from unpleasant, uncontrollable events, while joy is a positive feeling that arises from certain and controllable events. Yang and her team hoped that understanding the deviations in these four basic emotions would provide generally applicable insights across various kinds of emotional experiences and application domains.

Algorithms that make social media emotions crystal clear

The researchers weren't interested in simply extracting categorical information on emotions. "Traditional sentiment analysis treats an expression as a discrete, categorical construct—as either positive, neutral or negative, or either happy or not happy, sad or not sad," she explained. "Such approaches are simply not able to provide insights about the complex, continuous and multidimensional nature of human emotional

experiences."

To gain a fuller understanding of human emotions, the researchers developed CrystalFeel, a collection of five algorithms that simultaneously analyze anger, fear, sadness, joy and the overall emotional valence on an intensity scale. In their research, Yang and her co-Principal Investigator and co-inventor Raj Kumar Gupta, experimented with features extracted from a variety of emotion-related lexicons or dictionaries, including their own in-house "Emotion Intensity" lexicon, to predict the level of intensity associated with the four basic emotions in each sentence or message. "We found that including affective lexicon-based features allowed the system to obtain strong prediction performance, while revealing interesting emotion word-level and message-level associations," said Yang.

In addition to CrystalFeel, Yang and her team also developed Heartbeat, an all-in-one program that collects, analyzes and presents social media data. "A strong and rich algorithm is not enough," explained Yang. "Users need lay user-friendly, end-to-end systems that can help them connect the sheer volume of raw data and well-integrated user interface."

Quantifying emotional responses to COVID-19 worldwide

By using Heartbeat and CrystalFeel, Yang and her team were able to leverage the power of social media to illuminate the change and dynamics of public emotions at a worldwide scale as early as late January 2020.

As their source of data, Yang and her team turned to Twitter. With more than 152 million active users worldwide as of the end of 2019, posts from Twitter—called tweets—provide geographically diverse insights

into local and global events at the ground level. The researchers had collected more than 20 million publically accessible tweets for analysis from 170 countries between January 28 and April 9, 2020.

In their COVID-19 analytic research program, done in collaboration with an international team led by May Oo Lwin, Chair of the Wee Kim Wee School of Communication and Information at Nanyang Technological University, Singapore, the researchers tracked emotions around COVID-19 pandemic trajectory. One of their early findings was that public emotions underwent a strong shift from fear to anger in parallel with notable events, from the emergence of COVID-19 at the end of January to the World Health Organization's pandemic declaration in early March and stay-at-home notices thereafter. While the researchers also observed signs of sadness linked to the loss of loved ones and joy in response to good health, negative emotions dominated the early months of the pandemic, with anger overtaking fear as the overriding emotion.

A continuing collaborative effort

Yang and her team are continuing to collect and analyze data on the public's emotions in response to COVID-19, having now collected more than 100 million tweets. They are conducting more in-depth analyses to understand the differences in emotional responses among countries, and how cultural differences may play a role in this. The researchers are also seeking to make their databases and algorithms accessible to the broader scientific community, to enable researchers from all over the world to perform region-specific analysis. "We believe that fighting the pandemic requires a global-scale effort," Yang said.

In the longer term, Yang and her team plan to extend the capabilities of their emotion-sensing algorithms to extract fine-grained information about long-term changes in the priorities, desires and values of the

public. "We hope that the social sensing tools we developed can be used by more public agencies to help and empower policy analysts and communication professionals to gain more leverage for evidence-based, holistic and timely decision making and communication," concluded Yang.

More information: Raj Kumar Gupta et al. CrystalFeel at SemEval-2018 Task 1: Understanding and Detecting Emotion Intensity using Affective Lexicons, *Proceedings of The 12th International Workshop on Semantic Evaluation* (2018). DOI: 10.18653/v1/S18-1038

May Oo Lwin et al. Global Sentiments Surrounding the COVID-19 Pandemic on Twitter: Analysis of Twitter Trends, *JMIR Public Health and Surveillance* (2020). DOI: 10.2196/19447

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