SOCIOLOGY

Social Scientists Wade Into The Tweet Stream

Depending on your perspective, Twitter is a great way to promote a product, keep up with far-flung friends and colleagues, connect with others who share your passion for Korean boy bands, or maybe even start a revolution. The 5-year-old social media Web site now claims that more than 100 million users post 230 million "tweets" (text messages up to 140 characters long) every day. In that torrent of data, some social scientists see an unprecedented opportunity to study human communication and social networks.

"Human interactions are what social scientists are really all about," says Michael Macy, a sociologist at Cornell University. But observing large numbers of spontaneous interactions, which are often fleeting and private, has been an obstacle, Macy says. Until now. "Human beings around the globe are now communicating with each other using devices that record those interactions and have open access," Macy says. "I think this is an extraordinarily exciting moment in the behavioral and social sciences."

On page 1878, Macy and his graduate student Scott Golder report their effort to use Twitter to study the collective moods of millions of people in diverse cultures around the world in real time. Others have been using Twitter and other social media to investigate how information and persuasion propagate in social networks and to study political campaigns and movements, including the recent uprisings in North Africa.

Golder and Macy used a freely available protocol provided by Twitter to download more than 500 million tweets originating from 84 countries between February 2008 and January 2010. They searched these messages for roughly 1000 words on a tried-and-tested list of words associated with positive (agree, fantastic, super) and negative (afraid, mad, panic) emotion.

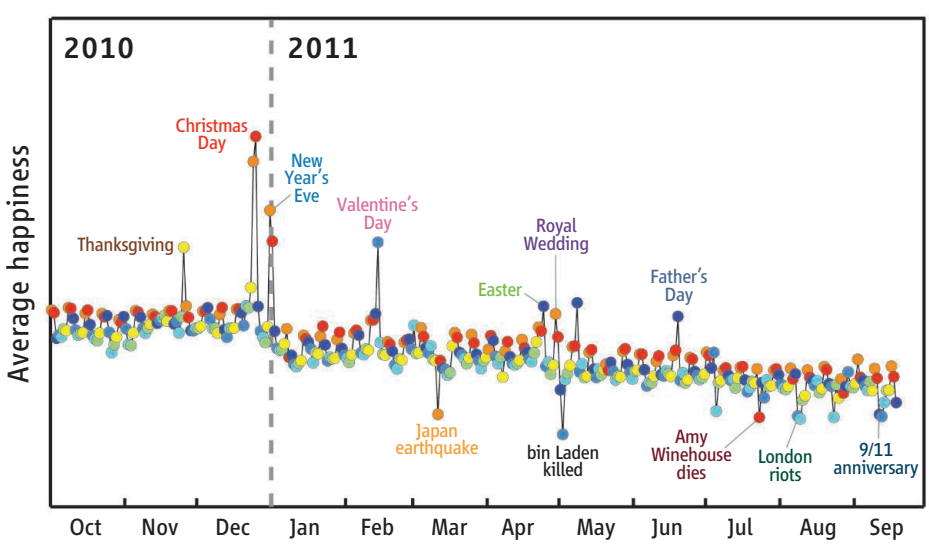
Their findings paint a portrait of humanity's mood swings. Positive emotion runs high in the morning, declines throughout the day, and rebounds in the evening. The same pattern occurs on the weekends, suggesting it's not just work bringing people down, Golder notes. People are happier overall on weekends, but the morning peak in good vibes is delayed by a couple of hours, suggesting they sleep in. Across the seasons, positive emotion increased from late December to late June as the days got longer and decreased during the other half of the year, lending support to other research suggesting that it's the change in day length rather than the absolute day length that determines seasonal mood swings.

Macy finds it remarkable that these patterns were similar across such distinct cultures and regions, once time zones and latitude were accounted for. Overall, the findings suggest that sleep and the biological clock exert a powerful influence on mood, Macy says. He and Golder acknowledge that that's not a new idea, but they note that much of the previous research has been done on college undergraduates, hardly a group that represents the general population when it comes to sleep habits.

Using Twitter to track the mood of nations is analogous to using satellites to track the atmosphere, says Peter Dodds, an applied mathematician at the University of Vermont in Burlington. Dodds concedes that remote sensing of human happiness "sounds a bit Orwellian," but he says his group has a greater good in mind: developing a measure of a society's well-being that policymakers could use in parallel with economic indicators such as gross domestic product. In one recent study (available at http://arxiv.org/abs/1101.5120), Dodds, Christopher Danforth of Vermont, and colleagues examined 4.6 billion tweets over nearly 3 years. They paid people registered with Amazon's Mechanical Turk service to rank the emotion evoked by more than 10,000 common words on a nine-point happy face to sad face scale. Analyzing the frequency with which these words occurred in their massive database of tweets, Dodds and colleagues found several patterns reported by Golder and Macy, including happy weekends and a morning peak in mood followed by an afternoon decline—"the daily unraveling of the human mind," Dodds calls it. The team also examined outlier days: Not surprisingly, unusually "happy" days often coincided with holidays, whereas especially unhappy days tended to coincide with unexpected events, such as the Japanese earthquake and tsunami (see figure). Their findings also hint at a global decline in mood starting in April 2009 that continues at least through the first half of 2011.

Both studies illustrate the power of social media for studying social phenomena on a huge scale, says Duncan Watts, a sociologist at Yahoo! Research in New York City. Watts says it is reassuring that the results generally fit with our intuitions. "It's hard to imagine a result that we could get from these data that we wouldn't subsequently be able to reconcile with what we already know about life," he says. "If your standard for data-driven social science is that it deliver deeply counterintuitive yet still believable results, I'm not sure that's possible."

Watts and others think that social media could help break new ground in resolving questions about how information and influence flow through social networks. One example involves the idea of social contagion. In recent years, a string of high-profile papers has suggested that everything from smoking habits to obesity to happiness can



The year in tweets. Researchers at the University of Vermont created this timeline of global mood as seen through the lens of Twitter. Fridays (orange dots), Saturdays (red dots), and Sundays (dark blue dots) tend to be happier than weekdays. Holidays are often the happiest days, whereas the unhappiest days often coincide with bad news.

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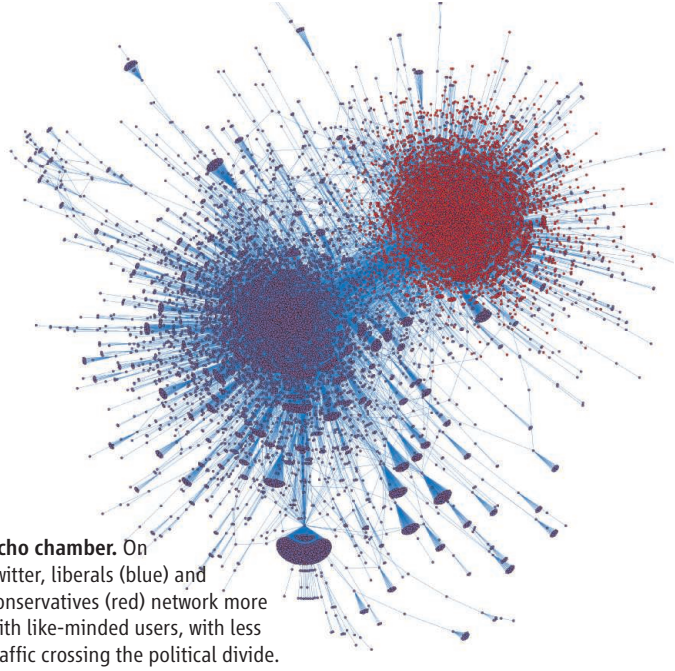
spread through social networks from one person to another like a virus (*Science*, 23 January 2009, p. 454). But critics have argued that these studies can't rule out alternative explanations, such as homophily, the birds-of-a-feather effect whereby people with similar inclinations tend to associate with one another.

In a 2009 study in the *Proceedings of the National Academy of Sciences*, Sinan Aral and colleagues at New York University tackled social contagion in the context of people adopting a new product, in this case a mobile phone application developed by Yahoo! Over the course of the study, roughly 500,000 of the 27 million users of Yahoo!'s instant messaging service adopted the app. Using anonymized data provided by Yahoo! about individual users' demographics, mobile phone usage, the types of Web sites they visited most frequently (sports, news, etc.), and their links to other users, the researchers developed statistical tools to estimate the relative influences of social contagion and homophily in the app's spread. Having data on such a large number of people and their second-by-second interactions enabled a more sophisticated analysis than traditional methods would have, Aral says. And it pointed to a diminished role for social contagion: "Half of what we thought was peer influence was really just homophily and other confounding factors," Aral says.

More recently, his team tried to manipulate social contagion in a randomized trial of viral-marketing features in a group of 10,000 Facebook users. Building features into a new app that allow new users to invite some or all or their Facebook friends to get the app can increase social contagion by up to 400%, the researchers report this month in *Management Science*.

Other researchers have used social media to study the spread of influence and ideas in the political domain. At Indiana University, Bloomington, Filippo Menczer and colleagues have been using Twitter to study devious campaign tactics and political polarization. During the 2010 election season, they developed an automated system for detecting underhanded campaign tactics on Twitter, such as "astroturf" movements, concerted attempts by an organization or individual to create the appearance of a grassroots movement to support a candidate or spread rumors about an opponent. They named it Truthy, inspired by comedian Stephen Colbert's popularization of the word "truthiness" to describe things people feel or wish to be true regardless of the facts. The pattern of Twitter activity generated by an astroturf movement differs from more spontaneous Twitter traffic, Menczer says, and Truthy uses machine-learning algorithms to tell the difference. "Just looking at the structure of the network and how the information propagates, we have information about the nature of the message," Menczer says.



Echo chamber. On Twitter, liberals (blue) and conservatives (red) network more with like-minded users, with less traffic crossing the political divide.

Menczer and colleagues have extended this work to try to classify people's political leanings based on their Twitter network. It's surprisingly easy, Menczer says. Right-leaning users have a strong tendency to "retweet," or propagate, only messages sent by other right-leaning users, and the same goes for those on the left (see figure, above), the researchers reported earlier this year at the Fifth International AAAI Conference on Weblogs and Social Media. The findings don't resolve whether Twitter simply reflects the polarization of American society or actually contributes to it, Menczer says. "Is the fact that these tools make it so easy for us to select our social contacts having a negative effect on our political discourse? This is an important question." He admits it won't be easy to answer.

The influence of Twitter has also been a hot topic in light of the recent uprisings in Egypt, Libya, and elsewhere in North Africa, which are among the first historical events to be chronicled in real time by ordinary citizens. Key questions include the extent to which Twitter has played a role in the coordination and spread of these events, as well as whether Twitter traffic could be used to predict events on the ground before they happen.

One of the largest repositories of Arabic-language tweets is a database started by Laila Shereen Sakr, an Egyptian-born graduate student in cinematic arts at the University of Southern California in Los Angeles. Shereen Sakr says the project originally sprang from an activist impulse to make sure the voices of Arabic speakers were heard. But she's grown increasingly interested in the research potential. She's found intriguing spikes in certain hashtags, the terms used to flag a topic on Twitter, preceding the fall of Zawiya and Tripoli in Libya, for example. Shereen Sakr hopes the project's Web site (www.r-shief.org) will become a hub for researchers. "I would love for people in other disciplines to take this data and make something of it," she says.

Indeed, making sense of the deluge of data from Twitter and other social media will require researchers to employ an interdisciplinary skill set that draws from traditional social sciences, statistics, and computer science (*Science*, 6 February 2009, p. 721). Although some traditionally trained social scientists remain skeptical about whether anything "serious" can be learned from social media and question whether those who use it are representative of the population as a whole, others insist the rewards could be rich. "There was this intriguing paradox where for most of the 20th century we seemed to know more about exploding stars at the edge of the galaxy and the proteome of yeast than we knew about how large human social groups function," says Jon Kleinberg, a computer scientist at Cornell. But the digital detritus of 21st century life online may change all that, Kleinberg says: "Interesting things happen when you can take what was once invisible and make it visible."

Revolutionary. In Libya and elsewhere, Twitter has provided a view of social change in progress.

–GREG MILLER

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