New research model reveals how contagion spreads among network of connected people

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Credit: Pixabay

What do misinformation and disease have in common? They spread easily.

But a new paper titled "Control and spread of contagion in networks" links the two even further by postulating a single model to study both cases. The new model and associated algorithms can be used to understand potential consequences of policies designed to control or spread contagion among a network of connected people.

"We started off thinking about how to model misinformation using decentralized and interdependent decision-making models from game theory," said Tarun Sabarwal, professor of economics at the University of Kansas and director of the Center for Analytical Research in Economics.

"In games with strategic complements, there is a natural incentive for people to move in the same direction as others. That's the underlying foundation, and you see this all over the place. Whether using the same technology to collaborate with others or believing the same things that our friends believe, people have a tendency to coordinate with their colleagues and friends."

Co-written with John Higgins, a KU senior in economics, their model and analysis are applicable to many situations, ranging from regime change to runs on hand sanitizer during a pandemic. But, obviously, two current issues with the most pertinence involve the dispersal of fake news and COVID-19.

Sabarwal explains that if someone wants to sow discord within a country through misinformation, they only need to convince a relatively small minority of citizens to believe an inflammatory piece of information, and this can be enough to influence a larger percentage. The more people convinced initially, the greater the potential sweep of misinformation. It's the same for infectious diseases.

"We expected it to go in this direction, but the speed with which things escalated with virality was very surprising," Sabarwal said.

"Under reasonable assumptions, if contagion has spread to about 40% of the network, then it's almost impossible to stop. Even if people around you are not infected, you will still get infected because of the aggregate effect flowing through communal interaction."

Sabarwal models the proliferation of an action using a network coordination game that is generalized to include a tractable measure of aggregated virality to make it more realistic. These new algorithms study the spread of contagion in scale-free networks with 1,000 players using millions of Monte Carlo simulations.

"One new aspect of our work is an explicit inclusion of an aggregated virality impact, based on the number of non-neighbors who are infected," he said.

Sabarwal emphasizes this is often seen in business, epidemiology and computer science. For instance, marketing-type models ask, "Which people do I need to flip so that I can maximize others who will buy the product?" In epidemiology, researchers will look at the probability of infecting something, then they set up a differential equation to see how this will evolve over time. In computer science, they will study misinformation while also investigating the person-to-person effect.

"We are saying that in social networks, in addition to what my neighbors are doing, I may be affected by global conditions in the network. In the case of misinformation, for example, even if all my neighbors are saying 'no," if many other people are saying 'yes' on Twitter or Facebook, that has an additional impact on me. For infectious diseases, even if people around me are not infected, I may be at higher risk due to travel of unrelated people or interaction with others in anonymous communal markets. Our model captures this effect in a natural manner."

What makes this trickier for contemporary society is the role of aggregated virality in social media/social networks.

"Earlier, you could share something with the whole country through a newspaper or TV. These media have built-in checks and balances so that not everything you say is heard at the national level," said Sabarwal, who has been at KU since 2008.

"In social networks, you send whatever you want to send, and it goes wherever it wants to go. Moreover, the platforms incentivize greater information sharing among more people. A well-coordinated misinformation campaign in this setting can have broad and serious societal consequences."

Sabarwal hopes his model provides more people with new research tools to analyze additional situations.

Also, the professor noted, the model can be read "both ways."

He said, "You can read it in terms of, 'What should we be doing to prevent the spread of something negative?' But you can also look at it in terms of, 'What should we be doing to increase the spread of something positive?'"

More information: Tarun Sabarwal et al, Control and Spread of Contagion in Networks, *SSRN Electronic Journal* (2021). DOI: 10.2139/ssrn.3831245

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