

It's the network: Researchers examine behavior influenced by network structure

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A team of computer scientists at the University of Pennsylvania investigating the political, social and economic struggle between individual self-interest and the need to build a consensus have learned that, depending only on the structure of the network of participants, they can engineer surprising experimental results.

For example, depending solely on the ability of individuals to interact in a network, as well as the number of connections they have to other participants and other structural properties, there are networks that generate the global adoption of minority viewpoints. In addition, the team demonstrated, individuals with extreme behaviors, or a greater awareness of the incentives of others, may actually improve the collective performance of the group. Put simply, stubbornness or extremism may pay off when it comes to social welfare.

Michael Kearns, professor in the Department of Computer and Information Science at Penn, demonstrated in 81 separate experiments that network structure alone can affect outcomes, relationships and behavior.

Kearns' study, published online in the current *Proceedings of the National Academy of Science*, builds on ongoing network science research funded by the National Science Foundation and the Multidisciplinary University Research Initiative of the Office of Naval Research since 2005. The overarching goal of the research is to establish the ways in which network structure and task interact to influence individual and collective

behaviors and performance. For example, a sales team may be organized in such a way to gain consensus quicker.

In Kearns' experiment, 36 human subjects were arranged in a variety of virtual networks, with each experiment differing in the number of neighbors each participant had and could see, but none having a global view of the overall network. Participants were financially motivated to build a global consensus to one of two opposing choices, in this case the color red or blue. If a consensus wasn't reached in 60 seconds, no money was awarded any participant; however, some participants were rewarded greater amounts depending on the color that won the day — red could mean a bigger payout to some, blue to others—which created tensions between private incentives, global unity and the structure of the network.

While the complete methods and results can be found within the study, overall results indicated a strong collective performance by the network. Of 81 experiments, 55 ended in a payout for reaching a global consensus. Experiments were designed to evaluate the ability of the group to find cohesion despite competing incentives, while a second series was designed to determine the potential influence of minority power brokers.

The study revealed that not only could minority groups override the majority but could in fact facilitate global unity easier than a network that was evenly divided among red or blue. Kearns also found that the wealthiest players at the end of the experiments were those stubborn or stable players whose reluctance to change set the tone for the experiment.

In addition, the more aware participants were of the opposing preferences held by their neighbors, the more likely they were to reach a global consensus.

"This is one of the first studies we've seen that includes an incentive toward collective unity, which is a more appropriate model for the types of real-world scenarios that involve social, political or business networks," Kearns said. "In addition, while Gallup polling provides the nation with complete information on the state of a political race, most networks provide individuals far less data and we mimic that here."

The experiments even included a network structure that generated individual participants with greater-than-average influence on the group, akin to lobbyists or curators of popular taste.

Kearns study looked specifically at how the network structure and a sliding incentive scheme would change the group's ability and efficiency in reaching a consensus. Kearns previous study was inspired by the 2008 Democratic national primary. In that political contest, the network of American voters held opposing preference for a single candidate, either Barack Obama or Hilary Clinton; however, once Obama won the nomination, the urge to build consensus and unify the party became strong.

Source: University of Pennsylvania

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