Computer scientists put social network theory to the test

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Ever since 1969, when psychologists Jeffery Travers and Stanley Milgram first explained that everyone was separated by only six connections from anyone else, researchers have created theoretical models of the networks that societies create.

Now, computer scientists at the University of Pennsylvania School of Engineering and Applied Science have devised an ingenious experiment to put such theories to the test.

The findings, which appear today in the journal *Science*, have implications for many forms of social interaction, from disaster management to how many friends connect to your MySpace page. The Penn researchers have found that some of the simplest social networks function the most poorly and that information beyond a "local" view of the network can actually hinder the ability of some complicated social networks to accomplish tasks.

"Travers and Milgram's classic six degrees of separation experiment was one of the first large-scale attempts at studying a human network, but almost 40 years later the interaction between social network structure and collective problem solving is still largely a matter of theoretical conjecture," said Michael Kearns, a professor in Penn's Computer and Information Science Department. "Our goal was to initiate a controlled, behavioral component of social network studies that lets us deliberately vary network structure and examine its impact on human behavior and performance."

To empirically test a number of standard network theories, Kearns and Penn doctoral students Siddharth Suri and Nick Montfort gathered 38 Penn undergraduate students at a time to play a game of color selection on networked computers. The game required each of the students to choose a color that did not match the color of any person who was immediately connected to him or her in the network. The researchers changed the patterns of the networked connections -- that is, who was connected to whom -- in ways that corresponded to the theoretical models.

"This coloring problem models social situations in which each person needs or wants to distinguish his or her behavior or choices from neighboring parties", Kearns said. "A good modern example is choosing a ringtone for your cell phone. You don't want to choose one that is the same as a family member or a colleague in the next cubicle. But if there's a limit to the number of available ringtones, you may have a difficult collective problem of coordination. In our experiments, many of the networks were quite dense with connections, and the colors were very few, so they were hard coloring problems."

The tests allowed Kearns and his colleagues to examine, in real time, how well networks of people work together to solve coloring problems. They performed a number of trials based on each model, looking at the speed at which the trial was completed and varying how much information subjects had about what colors were being selected elsewhere in the network. The Science paper describes six different network models that were tested.

The first three of the tests began with a circular structure, like a 38-member daisy chain. These networks represent a "small world" network that models a local area, such as a small group in a single town, mixed with the occasional cross-town relationship. The simplest of these, a single circular chain, was actually the most difficult for the subjects, but the more connections made across the circle, the faster the test was completed.

The fourth model represented a more engineered or hierarchical structure: a circle with two individuals that have many more connections than the rest. This model proved the easiest for the subjects: once each of the two "commanders" picked a color, everyone else unwittingly fell into place, despite the fact that nobody was told anything about the network structure or could see anything but the colors of immediate neighbors.

The last two tests studied so-called preferential attachment models, well studied networks in which many parties are highly connected. These models look something like maps of the Internet. Unlike the more circular models, here Kearns found that a complete view of the color selections across the entire network actually led to confusion among members of the network.

"We see that social networks with more connectivity aren't necessarily more efficient, but that it depends strongly on the collective problem being solved", Kearns said. "Less connectivity and less information about the network can sometimes make the problem easier. But now we have an experimental framework in which we can systematically investigate how social network structure influences actual human performance."

Source: University of Pennsylvania