Grant furthers research on science of cities, companies

The Rockefeller Foundation has awarded an SFI research team a $230,000 grant to develop their studies of the quantitative properties and behavior of cities and companies.

The work builds on earlier research by SFI External Professor Luis Bettencourt and his colleagues that found that cities change in predictable ways as they grow. Per capita figures for infrastructure, such as miles of roads and electrical cable, decrease as cities get larger, for example, whereas figures related to social productivity, such as income, patents, and crime, increase with city size.

A team led by SFI Distinguished Professor Geoffrey West is continuing the Institute’s efforts to describe and explain these scaling patterns. The researchers are investigating why some cities outperform others of the same size and extending their studies to companies — which, as the team is beginning to show, also have properties that scale predictably as companies grow. Geoffrey hopes the Rockefeller support will lead to a conceptual umbrella for a wide range of research into institutions past and present, from hunter-gatherer groups and ancient cities to high-tech companies and online societies. The work also might suggest policies to make institutions and communities more robust and sustainable in the face of climate change, population growth, and other challenges.

As a first step towards such a project, the Institute is holding a meeting in Bellagio, Italy, in July to bring together researchers from a number of fields who are working on various aspects of urban life.

Are we flying the economy by the seat of our pants?

The problem is they don’t have reliable models to turn to. Instead, they in large part draw on common sense and loose analogies with past crises, says SFI Professor Doyne Farmer. “The leaders of the world are flying the economy by the seat of their pants,” he says.

Doyne and SFI External Professor Rob Axtell of George Mason University say they have a better way. They want to build an agent-based model of the entire US economy.

Traditional econometric models use past data to forecast future trends, so they fall far short when facing an unprecedented crisis. General equilibrium models, the other kind of traditional model, start by assuming a perfect, static world in which crises don’t happen. Agent-based models avoid these pitfalls because they don’t make assumptions about how the whole economy behaves, instead building that behavior from the actions of individual actors. “It’ll be a huge undertaking,” Doyne says, “but the stakes are enormous.”

Doyne and Rob convened a late-June NSF-sponsored conference on the topic in Washington, D.C. A team led by SFI Distinguished Professor Geoffrey West is continuing the Institute’s efforts to describe and explain these scaling patterns. The researchers are investigating why some cities outperform others of the same size and extending their studies to companies — which, as the team is beginning to show, also have properties that scale predictably as companies grow. Geoffrey hopes the Rockefeller support will lead to a conceptual umbrella for a wide range of research into institutions past and present, from hunter-gatherer groups and ancient cities to high-tech companies and online societies. The work also might suggest policies to make institutions and communities more robust and sustainable in the face of climate change, population growth, and other challenges.

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Why we fight: Explaining conflict

Three SFI researchers have developed a new way to examine the criteria we use to decide whether to fight.

Quantitative studies of conflict traditionally rely on game theory, which seeks to find strategies that maximize payoffs for individuals making decisions in uncertain conditions. Although game theory has been useful for determining which of a predefined set of strategies — for example, “tit for tat” — will be advantageous to the players given certain assumptions, it has not proven as useful for determining what the natural strategy set is, or which strategies individuals are using when conditions are in flux.

Reckoning with multiple reasoners

Managing such complex systems as the stock market or a battlefield is particularly challenging because each agent in the system chooses how to behave, not only by following the rules of the game but also by predicting how all the other agents around them will behave and adjusting their own actions accordingly.

“Decentralized Control in a System of Strategic Actors,” an August 16-18 workshop at SFI, will draw on experts from a number of fields to explore ways to manage multiple-player systems.

“The agents in the system are all using ‘I know what you know what I know’ kinds of reasoning, and we have to try to control behavior starting from that,” says NASA senior computer scientist David Wolpert, who is collaborating with SFI Professor Eric Smith to organize the conference.

Creating something that can take so many factors into account with as little error as possible is a worthwhile undertaking. Beyond the stock market, he says, it could have broad uses for the management of complex systems like the power grid, air traffic, and national economies.
Maping the similarity space of paintings: Image statistics and visual perception; Graham, D.J.; Friedenberg, J.D.; Dan Rockmore; Field, D.J.; Visual Cognition 18 (14), 2010

Biological stoichiometry of plant production: Metabolism, scaling, and ecolodical response to global change; Elser, J.J.; Fager, W.F.; Kerkhoff, A.J.; Swenson, N.G.; Nature 462 (7286), March 2010

Specialization can drive the evolution of modular- ity: Esposti Soto, C.; Andrea Wagner; PLOS Computational Biology 6 (3), March 2010


Gang up on slackers is good for the group. That’s the conclusion, in part, of a recent study by SFI External Profes- sors Robert Boyd (an anthropologist at UCLA) and Herb Gintis (an economist at Central European University), and SFI Professor Sam Bowles. Humans are a coopera- tive species. In even the simplest societies, unit- ed people cooperate. In large groups, bu- gins, by itself, can’t doos – those who take advantage of the cooperation of others and do nothing. Every group also has those individuals who have to be happy to free loaders by shun- ning, gobbling about, ostracizing, or (in some societies) even executing them. Recent theoretical work suggests that because groups with more punishers can sus- tain more cooperation, they are more likely to survive crises and prevail in conflicts. Current models of the evolution of coopera- tion assume that individuals decide on their own whether they are free riders, and do so no matter how many other punishers are around. These models, though, cannot explain the evolutionary emergence of punishment. Sam says, because when individuals who punish are rare, they are outnumbered by their targets and often they – not their targets – suffer heavy costs. This makes it nearly impossible for lone punishers to get started. Research by ethno- graphicrs Chris Boehm

Punishment of the thefts at Maxatocal’s time. Painting by Miilo Sp Padin. (Image: Wiki Commons)

Phone diversity: It’s not just who you know, but who you’ve phoned. Employing the mathematics of network analysis, a team including SFI Omidyar Fellow Nathan Eagle has found that communities in which people have more diverse social networks, at least as gauged by their phone calls, also tend to be more prosperous. Previous research has suggested that individuals with rich social circles tend to find jobs more easily, earn higher salaries, and have more suc- cess as entrepreneurs. But there is a similar link between the diversity of a town’s residents’ social connections and the prosperity of the whole community?

To find the answer the researchers combined data from two sources: a government index of relative prosperity of 32,482 communities in the U.K. and, phone records of most cell phone and landline activity in the U.K. for August 2005. They then developed a vast statistical network, with each of the 85 million nodes denot- ing a phone and each of the 368 million edges denoting phone contact. They calculated two measures of diversity for each phone. Their data show that those communities register- ing more social diversity also tended to have more.

Nathan notes that the researchers cannot tell whether social diversity promotes prosperity or the other way around. “The causality probably works both ways,” he says.

He hopes the results will influence public policy ofﬁcials to consider not just giving aid to poor communities but also supporting ways to help people foster relationships outside their own communities.


Physics and complexity; David Sherrington. Philosophical Transactions of the Royal Society A – Mathematical Physics and Engineering Sciences 366 (1814), March 13, 2010

Identifying the roles of race-based choice and chance in high school friendship network forma- tion; Currarian, S.; Matthew Jackson, Pin, R.; Proceedings of the National Academy of Sciences 107 (11), March 18, 2010

When you think about it, a package’s arrival on your front porch is no simple matter. Your click on the World Wide Web (a network) passed through the physical network of a network that is powered by the power grid (a network), which itself relies on its own private communications network. Finally, your package traveled through the postal network to come to your door.

Had any of those networks broken down, your delivery could never have happened.

“We depend on interacting networks every day, and we’re hugely susceptible if they fail,” says SFI External Professor Raissa D’Souza, who organized a conference on the topic in June at SFI.

Despite our dependence on interacting networks, their emergent properties are hardly understood, even though the science of networks has come of age over the last decade or so, she says. The gathering brought together network theorists and practitioners to develop new tools to understand the unforeseen consequences of these interactions.

“We are developing theoretical techniques to model interdependent networks,” she says. “Bringing theorists and practitioners together will help ensure the models are realistic.”

The Institute has honored eight Santa Fe-area high school seniors and one teacher with its annual Awards for Scientiﬁc Excellence. The prize is co-sponsored by the Santa Fe Alliance for Science.

The winner for 2010 is Anita Gierach, a long-time science teacher and science club sponsor at Santa Fe High School. Her former students have won several national science and math competitions.

Names of the winning students can be found at http://www.santafe.edu/news/.

During the May award ceremony at SFI, Omidyar Fellow Jeremy van Cleve, a former sponsor at Santa Fe High School. Her former students have won several national science and math competitions.

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During the May award ceremony at SFI, Omidyar Fellow Jeremy van Cleve, a former award winner and 1999 graduate of Santa Fe High, gave a keynote talk in which he stressed the importance of “thinking about problems in a big way.” Alliance for Science President Bob Eisenstein also spoke.

SFI’s Prize for Scientiﬁc Excellence was established in 1996 at the suggestion of SFI Distinguished Fellow and Trustee Murray Gell-Mann. The teacher award was begun in 2005. Q

The SFI Update is published bi-monthly by the Institute to keep its community informed. Please send comments or questions to John Guarnas at jlg@santafe.edu.

The Institute is on the web at www.santafe.edu.
The walking behavior of pedestrian social groups and its impact on crowd dynamics; Mousavi, M.; Peron, R.; Gasser, S.; Dirk Helbing; Thiran, G.; PLOS One 9 (10), April 7, 2010

Robust dynamical pattern formation from a multifractal minimal geometric system; Rottluff, G.; Carrera, J.; Santiago Elena; Jaramillo, A.; BMC Systems Biology 4, April 22, 2010

Challenges in experimental data integration within genome-scale metabolic models; Bourgougin, P.Y.; Samal, A.; Kees, F.; Jüergen Jost; Martin, O.C.; Algorithms for Molecular Biology 5, April 22, 2010

Coordination punished of defects sustainer cooperation and can proliferate when rare; Boyard, R.; Herbert Gints; Sam Bowles; Science 328 (5978), April 30, 2010

The bootstrap; Cosma Shalzi; velvet 15 (3), May 2010

Inductive game theory and the dynamics of animal conflict; Simon DeDeo; David Krakauer; Jessica Flack; PLOS Computational Biology 6 (10), May 2010


Advanced Institute of Science and Technology.
Lectures: Terrorism, climate, bias, & the heart

SFI Omidyar Fellow Aaron Clauset spoke to some 400 Santa Feans in a June 16 public lecture. He explored surprising regularities about world terrorism that shed light on the likelihood of future attacks, the differences between secular and religious terrorism, how terrorist groups live and die, and whether terrorism is getting worse. The lecture was underwritten by Los Alamos National Bank and the Peters Family Art Foundation.

Mahzarin Banaji, a professor of Social Ethics at Harvard University, on July 14 described the human mind’s automatic beliefs about gender, class, race/ethnicity, sexuality, nationality, and religion and why well-intentioned people and institutions behave in ways that deviate from their own stated intentions. The lecture was underwritten by Los Alamos National Bank and the Peters Family Art Foundation.

"These results suggest that individual agency has been over-emphasized in social evolution," says Jessica. "We need to re-examine the idea that a single individual or nation can cause turbulent periods in history, and consider the possibility that what predicts long periods of conflict is how we respond to the actions of our friends and enemies in their conflicts."

"This new empirically-grounded approach to conflict is a step towards designing better methods for conflict prediction, management, and control," she says.

The work appeared in PLOS Computational Biology on May 13.

Upcoming Public Lecture

August 18. "Secrets of the Heart: The Electrocardio-gram, Complex Systems Science, and Fundamental Laws of Biology" - SFI External Professor Tim Buckman, Emory University School of Medicine, will show how the 75-year-old ECG is still giving up its secrets. He will turn to complex systems science for hidden structure within the ECG's signals and ways the ECG might point towards fundamental laws of biology. Underwritten by Los Alamos National Bank and Maureen Mos- tas Abrams, Prudential of Santa Fe. The lecture is at 7:30 p.m. at the James A. Little Theater, 1060 Cerillos Road, in Santa Fe. Admission is free, but seating is limited.