



November / December 2012

UPDATE



Santa Fe Institute
Cowan Campus
1399



IN THIS ISSUE

- > **Spotting election thieves** 2
- > **Transition warning signs** 2
- > **SFI In the News** 2
- > **From the editor** 2
- > **Q&A with Doug Erwin** 3
- > **Dunne named Faculty Chair** 3
- > **Solving the matrilineal puzzle** 3
- > **Achievements** 3
- > **SFI Online** 3
- > **BNET profile: Ian White** 4
- > **Grant News** 4
- > **Science On Screen** 4

RESEARCH NEWS

Networks helping bring a big-picture view to physiology

SFI Professor Jennifer Dunne's expertise in ecological networks is contributing to a potentially transformative approach to studying organismal physiology.

Physiology has traditionally taken a reductionist approach, with research focusing on specific organismal subsystems – circulatory, digestive, immune, reproductive, to name a few. But these systems aren't independent; they interact in myriad complex ways to maintain homeostasis and allow organisms to respond to changes in their environments.

Also, particular molecules often play multiple roles in different physiological subsystems. For example, organism behaviors such as the choice of one prey over another can result in differing amounts of vitamin E uptake, which can trigger interlocking cascades of events within and ultimately beyond the organism.

> **more on page 3**

BUSINESS NETWORK NEWS

Taking stock of the human factor in financial risk

SFI Business Network members and their guests gathered recently at Morgan Stanley World Headquarters in New York for "Risk: The Human Factor," a Network topical meeting focused on the human element in financial and economic systems.

Chris Wood, SFI VP for administration and director of the Business Network, says the human component of risk is frequently overlooked.

> **more on page 4**



Symposium explores resilience of complex systems

When Doug Erwin began his appointment as SFI's Chair of the Faculty in July 2011, he wanted to highlight a common theme he observed across the Institute's research.

Upsets to systems in sociology, ecology, computer networks, and other areas can have direct consequences for human society, particularly following such disasters as Hurricane Katrina and Japan's 2011 earthquake and tsunami.

Do those systems' abilities to recover or renew themselves after a disruption exhibit similarities independent of the systems themselves? What can we learn about resilience of complex systems that will help

humankind design better, more reliable systems for the future?

This year's Business Network and Board of Trustees Symposium, November 1-2 in Santa Fe, explores resilience.

"Over the last several years, this symposium has been a chance to draw together a broad range of people talking about a common theme," says Doug. "This year we'll highlight the emerging issue of whether there's similarity in resilience in many types of systems."

In keeping with the tradition of inviting someone not affiliated with SFI as the keynote speaker, foreign policy expert Michael

Mandelbaum will kick off the meeting. Mandelbaum, a Johns Hopkins University professor and former *Newsday* columnist, has written several books on American foreign policy and served as an advisor to President Bill Clinton. His 2011 book, *That Used to Be Us*, written with *New York Times* columnist Thomas Friedman, looks at how globalization, information technology, deficits, and energy use have affected the United States' growth and leadership.

"The theme of the book, on almost a subconscious level, is that of resilience," says Doug. "Given his background, Mandelbaum > **more on page 2**

RESEARCH NEWS

November working group unravels risk

Our perception of risk affects every decision we make. Getting out of bed before turning on the light, driving to work, deleting rather than sending that inflammatory email, investing in mutual funds, and choosing which home to buy each represents a set of real and perceived tradeoffs of convenience, safety, expense, and reward.

But how do we, as individuals and as a society, manage risk? Do seemingly disparate risks share universal features? Are there means to quantify risk? And how can we best reduce risk or mitigate damage?

The Risk Working Group at SFI on November 1 explores these questions. The session is organized by SFI External Professor John Rundle, a physicist and geologist at UC Davis. John is the founder of the earthquake forecasting com-

pany Open Hazards, and he has developed the "Econoquake" model of financial collapse.

"A major assumption that has skewed many investors' sense of risk was how it is distributed," he says. "Rather than likelihood of harm following a bell curve with the usual standard deviations, it in fact follows power laws, with huge fluctuations, meaning potential for extraordinary loss, as was the case in the 2008 financial crisis and the 2011 earthquake in Japan."

One possible strategy in disaster response is to stay small, he says. Neighborhood networks keep resources and expertise easily accessible if nature strikes hard.

Participants in the working group reflect a range of major risk categories.



"I'm looking forward to working with some really bright people to better understand the concept of risk in different arenas," John says. ■

ABCNews.com and CNN.com described a recent *Science* paper by SFI REU participant Amy Wesolowski and SFI Omidyar Fellow alum Caroline Buckee and collaborators recounting how they examined cell phone data from 15 million cell phone users in Kenya to track the spread of malaria and identify interventions.

In a Q&A in the journal *Human Biology*, SFI Omidyar Fellow Laura Fortunato discusses her work to reconstruct past modes of social organization for societies speaking Indo-European languages, focusing on marriage and residence strategies. The interview is conducted by renowned human population geneticist Evelyne Heyer.

An article in *The Atlantic* on October 2 features SFI Omidyar Fellow Alum Nathan Eagle

and Jana, the company he co-founded, that is conducting market research while providing much-needed pay in developing countries.

An October 2 *Huffington Post* article recounts the recent WWW conference at ESRI headquarters in Redlands, California, at which SFI Distinguished Professor Geoffrey West was among discussants who explored “creative courage” and what it takes to be an outlier in any field.

An interview in the October issue of *Discover* magazine with SFI Distinguished Professor Geoffrey West recounts his journey from physics to biology, and describes the genesis of ongoing SFI research with SFI Professor Luis Bettencourt and collaborators to develop new theories in which the two fields converge.

A September 26 Q&A with SFI External Professor Doyne Farmer in *Institutional Investor* covers financial complexity, the shortcomings of traditional economic theory, and the benefits of agent-based modeling.

A September 24 *New York Times* article mentions SFI researchers who are among the dozens of scientists studying the indigenous and isolated Tsimane people of northern Bolivia to gain insights into human health and behavior. One study, the Tsimane Health and Life History Project, is led by frequent SFI collaborators Hillard Kaplan and Michael Gurven. SFI Professor Sam Bowles and Omidyar Fellow Paul Hooper, the article noted, are using data on the Tsimane to examine the inheritance of inequality in premodern societies.

In a review paper published in the September issue of *American Economic Review*, SFI External Professors John Geanakoplos, Rob Axtell, and Doyne Farmer and collaborators questioned weaknesses in the current economic models and asked whether forecasters were using the most telling variables. Their own agent-based model of the U.S. housing market, they wrote, better captures the heterogeneity of agent behaviors.

Drought’s effects on societies are defined in large part by how resilient people are in response and what other economic and environmental stresses are present, according to an August 28 *Albuquerque Journal* article that reviewed SFI President Jerry Sabloff’s recent *PNAS* paper on the collapse of Classic Mayan civilization.

Nonlinearities From the editor

I was struck recently by how fast SFI changes. In my past life I worked in an organization – here held nameless to protect the innocent – so unwieldy that change is either impossible or undetectable. Nearly every day at SFI we enjoy a fresh set of personalities, which infuses new ideas and energy. Even when things seem to be shifting too quickly – such as last fall when six stalwart resident faculty members announced their departures – the community magically produced new top minds with claims long-ago staked at the edge of scientific progress. It’s a remarkable quality for a small institute – the result, I think, of a diverse community that shares a common passion regardless of the day-to-day whereabouts of its individuals.

In a word, SFI is resilient – which, of course, is the theme of this year’s Business Network and Board of Trustees Symposium (see page 1). Resilience, in turn, is a concept featured on SFI’s newly remodeled homepage. I urge you to take a look at this work in progress. Chair of the Faculty Doug Erwin has done a good job of reframing how we talk about SFI’s research by positing three themes and three “cross-cutting foci.” SFI’s work, of course, defies categorization, but if you have to delineate (which users of any website expect), then these categories do a fairly good job. There is more discussion of the three themes and three foci in Doug’s Q&A on page 3.

Speaking of defying categorization, SFI Board of Trustees Chair Jim Rutt will be stepping down before the ink in this issue dries. We’ll have a new top trustee by early November, but I must say before he goes that Jim is a most rare personality. He has a way with colorful euphemisms; it’s said he coined the term “snail mail” to contrast the post with e-mail. In board meetings he knows how to ponder the important and dismiss the trivial, and he’ll not infrequently employ, ahem, colorful language for useful emphasis. His advice is of the highest quality. A lifelong learner, he’s forever reading, thinking, asking, creating, and sharing. By the force of his curiosity he charts new intellectual frontiers. Most important, he is no “bungee boss” (one who springs into our consciousness every so often). He takes a steady, gentle, paternal interest in nearly everything happening at 1399 Hyde Park Road. Thank you, Jim, from all of us at SFI. ■

– John German, jdg@santafe.edu

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RESEARCH NEWS

Finding the fingerprints of election thieves

In a recent paper appearing in *PNAS*, a team led by SFI External Professor Stefan Thurner examined voting data from a dozen recent elections around the world and found statistical evidence for election fraud in two of them.

The team looked for two kinds of rigging: incremental fraud, where votes for one party are kept in the ballot box while those for the other candidates are tossed, and extreme fraud, which shows 100 percent voter turnout in a district, all voting for the same party.

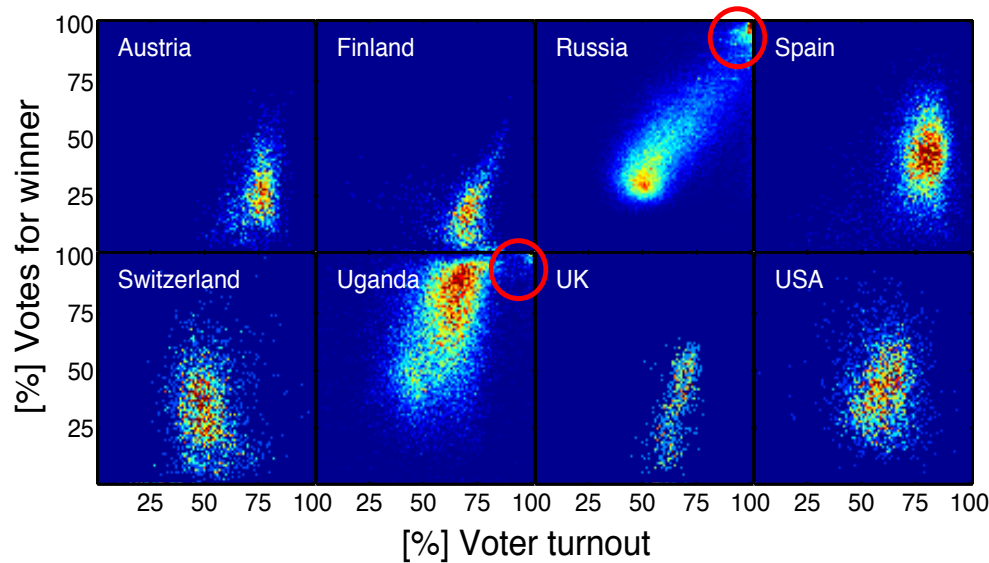
By comparing the distributions of votes for the winning candidate against turnout numbers, they found that rigged elections show a different voting pattern than fair ones.

They also developed a model to detect how much forged or manipulated results affected the outcome, then ran through all possibili-

ties of both fraud types playing 0 percent to 100 percent of a part in the election, and compared those to actual data to determine prevalence.

Among the countries studied, data from recent elections in Russia and Uganda showed both the smear of incremental fraud and the second cluster of extreme fraud, with up to 64 percent of districts being affected in Russia’s 2011 vote and 39 percent in 2012. Other countries’ data showed little to no such trends.

“I think it could contribute to the benefit of democracy if for every nationwide election on this planet, the raw data is made available on say a United Nations or OECD database,” says Stefan. “One could then think of a set of quality standards and checks for any election – like the ones we presented – or better ones.” ■



In fair elections, a nation’s voting pattern tends to feature one cluster, showing a general trend of voter turnout and vote for the victorious party. Rigged elections show a cluster, but with a smear of votes toward the upper right for incremental fraud. Extreme fraud has a second, smaller, completely separate cluster at the top right corner, signifying up to 100 percent turnout and votes for the winner in certain districts.

> Resilience continued from page 1

will have interesting insights on the topic from a point of view different from what we are used to.”

SFI Professor Jennifer Dunne, an expert on species interactions and food webs, will touch on elements of stable networks and approaches to managing systems, be they forests or finances, that minimize disturbance and optimize resilience.

Daniel Schrag, an environmental scientist at Harvard and member of the Presidential Council of Advisors in Science and Technology, will discuss the massive extent and pace of climate change globally. He argues that rather than investing in costly and inadequate attempts to prevent damage, we consider “rebound resilience” – accepting the inevitability of environmental disasters driven by climate change and acting to enhance our ability to recover when they occur.

Mark Newman, a physicist at the University of Michigan, literally wrote the book on networks. He will focus his talk on new

findings in network resilience, particularly how qualities and arrangements of nodes and links can determine a system’s success, be it vaccinating a population or spreading news through a community.

Other speakers include SFI Science Board Co-Chair Stephanie Forrest, who studies resilience in computer networks; and Abhas Jha, program leader for disaster risk management at The World Bank.

Each session includes ample time for discussion after the lecture. “The hope is that by Friday afternoon people will be nodding and saying ‘I see what’s going on here,’ whether it be in financial or ecological systems,” Doug says.

SFI’s Business Network and Board of Trustees Symposium is an invitation-only event. Most lectures will be posted online a few weeks after the event. For more, visit SFI’s website at www.santafe.edu, or connect with SFI on Facebook, Twitter, LinkedIn, or Google +. ■

RESEARCH NEWS

Early-warning signals of critical transitions

In many complex systems, a sudden and significant system-wide change can take place with little or no warning – at least such shifts had long seemed unpredictable.

In recent years, research in theoretical ecology has suggested that the dynamics of critical transitions (popularly known as tipping points) appear to be similar in diverse kinds of systems – from climate to financial markets. More recent research suggests these systems may exhibit early-warning signals (or “leading indicators”) – distinct statistical changes in a system that indicate a critical transition is approaching.

Now a pair of papers published in top journals has posited a set of tools and methodologies for detecting the early-warning signals of such transitions.

In October 2011, SFI and Arizona State University co-hosted a workshop, “Practical Methods for Analysis of Early-Warnings for Regime Shifts,” during which participants examined detection of leading indicators with an eye toward formalizing the relevant theory, tools, and methodologies. The gathering drew a diverse group of ecology and earth system scientists to collaborate on the problem, led by Vasilis Dakos, a postdoc now with the Integrative Ecology Group at Estación Biológica de Doñana CSIC, Spain.

Out of that meeting grew a paper, published this summer in *PLoS One*, “Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data,” in which they applied their methods to simulated time series preceding tipping points.

“Our paper presents a suite of methods for identifying early warnings and provides clear step-by-step examples of how to apply them,” Dakos says. “We want to motivate and assist researchers from different disciplines, in the lab and field, to test these ideas.”

The work was followed by a second paper, “Anticipating Critical Transitions,” in *Science* (October 19, 2012), covering research led by Wageningen University’s Martin Scheffer and several co-authors including Dakos, SFI Science Board member Simon Levin, and SFI External Professor Mercedes Pascual. This recent paper posits that related families of generic early-warning signals exist, and that universal features determine whether complex networks will be robust or fragile.

The work has resulted in an “Early Warning Signals Toolbox” (early-warning-signals.org) – a general-purpose toolkit for identifying critical transitions. “Together with our newly developed Synergy Program for Analyzing Resilience and Critical transitionS (sparcs-center.org), we hope that these initiatives will further enhance our understanding of detecting and preventing critical transitions,” says Dakos. ■



SFI Science Board member Eric Maskin, a Nobel laureate whose work has had widespread impact on economics and aspects of political science, has been named a University Professor, Harvard's highest honor for a faculty member.



The National Institutes of Health has selected SFI External Professor Elhanan Borenstein to be among 81 winners of its High Risk Rewards program's New Innovators Award.

The program recognizes innovative health researchers who have taken risks in areas of research where the potential impact in

biomedical and behavioral sciences is high. Elhanan, an assistant professor of genome sciences at the University of Washington, researches the human microbiome, which has a tremendous impact on human health and is altered in various disease states. He and his team are building a computational toolkit for designing microbiome manipulations and for discovering possible routes for microbiome-based therapy. The work could inform clinical intervention efforts aiming to manipulate an unhealthy gut microbiome and to shift it into a healthy configuration.



SFI Omidyar Fellow Laura Fortunato has won the Gabriel W. Lasker Prize for the best 2011 paper in the journal *Human Biology*. ■



Video: SFI President Jerry Sabloff examines the rise of statehood and why it was a pivotal advance in human social complexity. Source: Principles of Complexity project video



Video: SFI External Professor David Krakauer explores complex life, including intelligent life, and asks how it might have arisen on Earth. Source: Principles of Complexity project video



Video: SFI Distinguished Professor Geoffrey West examines the hidden laws that underlie biological systems and human social systems. Source: Principles of Complexity project video



Video: SFI Omidyar Fellow Scott Ortman explores the critical role conceptualization and metaphor play in shaping culture and human history. Source: 2012 SFI Community Lecture



Audio: SFI External Professor James Hartle offers a cosmologist's tour of the universe – including what we know and what we don't know about its beginnings. Source: Santa Fe Radio Café interview



Video: SFI Omidyar Fellow Simon DeDeo gives three lectures on emergence and complexity. Source: SFI 2012 Complex Systems Summer School lectures

A Q&A with SFI Chair of the Faculty Doug Erwin

Update: In your time as SFI's Chair of the Faculty, you've pushed for several changes. What have they been, and are we there yet?

Doug Erwin: I have tried to encourage some things. One is a clearer presentation of SFI's science on our website and clearer thinking about SFI's research generally. Both the new website and last year's annual report presented SFI's research in terms of the three research themes and the three cross-cutting foci that together describe the important lenses through which we study complex systems. But this is more than presentation. The three themes and three foci convey more of the transdisciplinary approach that is key to how SFI operates. We aren't anthropologists and physicists and biologists. We are looking at broad problems across disciplines.

And it's not that I am trying to impose this structure on SFI. I wanted to come up with something that reflected what was already going on, and I thought it was important to convey in more clear terms how we think about ourselves. And I think some of the meetings we've had – the theme week in August on "information theory meets game theory," which brought together a pretty diverse group of people, and the annual Business Network and Board of Trustees Symposium on resilience – are good examples of broader topics and ways SFI should be addressing problems. The Templeton-funded projects on the Principles of Complexity are

also fairly broad, and these are all good steps toward what SFI is about.

Another thing I had hoped to encourage is the greater involvement of SFI's external faculty in our science activities. The Science Steering Committee, which reviews proposals for SFI science meetings, is seeing more proposals from external faculty or involving external faculty, and that's good. But it's always a process and we still have a way to go.



Update: When you started in this role, SFI faced several challenges, including a dip in funding to support science activities, and a faculty search. What are the statuses of these challenges now?

Doug: When I stepped in last summer, six members of the resident faculty were departing. Not that there's necessarily any correlation [laughs]. So we lost some people who had been here awhile and who were very important. But we added Cris Moore and

Luis Bettencourt, who are very important additions, and we have just begun another faculty search that will likely continue through the winter. At the same time, the external faculty ranks are incredibly strong. We have 116 external professors and I think that's the most we've ever had, or close to it. That's an awful lot of people and it includes some former postdocs and many people who are very central to SFI's research.

Not unrelated to the faculty count is the funding dip. Ideally we'd like to get the budget back up to where it was in 2008. The good news is that the number of science meetings is starting to creep back up. That's a good thing, but we're not near the level of activity we enjoyed in 2007 and 2008. We'd like to support more science. So that challenge is still there.

Update: What will be your focus for the remaining eight months of your term?

Doug: Oddly enough the focus right now is getting ready for next summer, when so much SFI collaboration happens. Soon we will be encouraging external faculty to give us their visit schedules for the summer. Last summer we were beyond maximum capacity in terms of physical space, and we actually had to encourage people to stay away during our peak weeks. Also, housing is less expensive if it is reserved early, and much more expensive if it is arranged in June or July, so it behooves us to make those arrangements soon. If you're external faculty [leans into microphone], don't wait until May to tell us you want to spend some time here this summer. It isn't too early to start solidifying your plans. ■

Jennifer Dunne to be SFI's 2013-2015 Chair of the Faculty



SFI President Jerry Sabloff has announced that SFI Professor Jennifer Dunne will succeed Doug Erwin as SFI's Chair of the Faculty and Vice President for Science. Her term begins July 1,

2013, and ends June 30, 2015.

"David Krakauer and Doug Erwin have set a high standard for this key position, and I am certain that Jen will successfully build on their strong record," wrote Jerry in a recent internal announcement.

Jen's research interests are in analysis, modeling, and theory related to the organization, dynamics, and function of species interactions. Most of her work focuses on trophic interactions, which provide the basic architecture for the flow of energy and resources through ecosystems.

She has been an active member of SFI's resident faculty for five years, and she is a successful grant writer. She began her career at SFI as a postdoctoral fellow. ■

> *Networks in physiology* continued from page 1

A group of physiologists decided recently that it was time to link the many subsystems within organisms into comprehensive networks. But they had limited knowledge of existing bodies of biological network research, so the editor-in-chief of the journal *Trends in Ecology and Evolution* (TREE) suggested they recruit an expert, offering the names of some prominent scientists in ecology and genetics. In the end they chose Jen.

"It was amazing to me that physiologists weren't already using a network approach," she says. She got the team up to speed on network language and methods and helped refine their proposed "physiological regulatory network" (PRN) framework for explicitly linking an organism's subsystems.

The resulting paper, "Physiological Regulatory Networks: Ecological Roles and Evolutionary Constraints," published August 1 in TREE, was among the journal's most downloaded pdfs in August and September.

"This is a niche that needs to be filled," says Jen. "The authors have proposed a useful quantitative framework, a whole-system network approach to studying physiological subsystems in an integrated way. What's

also exciting is that PRNs provide a way to link research at the genetic level to research at the ecological and evolutionary levels. It's been a big gap."

This nascent field will benefit from quantitative approaches, statistical methods, and theory from more established areas of biological network research such as those related to gene regulation and species interactions, she says.

Some physiological subnetworks are already reasonably well described, and the next step is for interested researchers to map more complete physiological regulatory networks.

In their paper the authors point out that this approach will be most productive when particular questions are addressed. For example, how do intracellular regulation of proton gradients, hormonal regulation, dietary intake of micronutrients, the immune system, and other physiological subsystems interact to drive aging and constrain the evolution of life span?

PRNs provide a way to integrate and leverage more piecemeal knowledge of physiological subsystems to address such bigger questions, Jen says. ■

Solving the matrilineal puzzle

To whom a man's possessions go when he dies is both a matter of cultural norm and evolutionary advantage.

In most human societies, men pass on their worldly goods to their wife's children. But in about 10 percent of societies, men inexplicably transfer their wealth to their sister's sons – what's called "mother's brother-sister's son" inheritance.

A new study on this unusual form of matrilineal inheritance by SFI Omidyar Fellow Laura Fortunato has produced insights into this practice. Her findings appear in the October 17 online edition of *Proceedings of the Royal Society B*.

"Matrilineal inheritance is puzzling for anthropologists because it causes tension for a man caught between his sisters and wife," explains Laura, who has used game theory to study mother's brother-sister's son inheritance. "From an evolutionary perspective it's also puzzling because you expect an individual to invest in his closest relatives – usually the individual's own children."

For decades research on the practice of matrilineal inheritance focused on the probabilities of a man being the biological father of his wife's children – probabilities that lie on a sliding scale depending on the rate of promiscuity or whether polyandrous marriage is practiced. (In a polyandrous marriage, a woman takes more than one husband.)

Of special interest has been the probability value below which a man is more closely related to his sister's children than to his wife's children. Below this "paternity threshold" a man is better off investing in his sister's offspring, who are sure to be blood relatives, than his own wife's children.

In her work modeling the evolutionary payoffs of marriage and inheritance strategies, Laura looked beyond the paternity threshold to see, among other things, what payoffs there were for men and women in different marital situations – including polygamy.

"What emerges is quite interesting," she says. "Where inheritance is matrilineal, a man with multiple wives 'wins' over a man with a single wife." That's because wives have brothers, and those brothers will pass on their wealth to the husband's sons. So more wives means more brothers-in-law to invest in your sons.

The model also shows an effect for women with multiple husbands. The husband of a woman with multiple husbands is unsure of his paternity, so he may be better off investing in his sister's offspring.

"A woman does not benefit from multiple husbands where inheritance is matrilineal, however," she explains, "because her husbands will invest in their sisters' kids."

Family structure determines how societies handle relatedness and reproduction issues, Laura says. Understanding these practices and their evolutionary implications is necessary for a comprehensive theory of human behavior. ■



Ian White: Putting on a strategic hat



Ian White is fascinated by SFI's research toward a theory of cities – which makes sense, because his company, Urban Mapping, offers embedded geographic technology to create maps that combine geographic information with statistical data in thousands of categories in any city. This information helps clients in a variety of industries make business decisions.

White says his involvement in SFI's Business Network has given him access to people like SFI's Geoffrey West and Luis Bettencourt, who have taught him to approach problems in novel ways. Network meetings also have broadened his thinking on issues that affect the future of his company. "Those issues

are exciting because they help me put on a strategic hat, which I don't do day-to-day running a business," he says.

Business Network members have the opportunity to participate in (and sometimes help organize) Network topical meetings and SFI symposia, short courses, and summer schools.

White recently hosted a Business Network "birds of a feather" event for Network members and guests at Urban Mapping's San Francisco office. Typical of the informal breakfast meetings, the event featured a talk by SFI External Professor Raissa D'Souza of UC Davis, who summarized her recent work on mathematical models of interdependent networks such as the power grid and the Internet. ■

> **BNET risk meeting** continued from page 1

"Risk management and risk mitigation have been important functions in our financial systems since their inception, and they have obviously received added attention in the wake of the economic crisis of 2008," he says. "Arguably one of the important contributors to that crisis was the human element – our willingness to continue highly risky activities when there was increasing evidence of a bubble that was about to burst."

At the October 10 meeting, leading members of the financial community combined their unique perspectives with those of experts in behavioral economics, cognitive psychology, and neuroscience.

Presenters included Nicholas Barberis, professor of finance at the Yale School of Management; Gregory Berns, professor of economics and neuroeconomics and

director of the Center for Neuropolicy at Emory University; David Laibson, professor of economics at Harvard University; Vincent Reinhart, managing director and chief U.S. economist at Morgan Stanley; Phillip Tetlock, professor of psychology and management at the University of Pennsylvania; Edward Thorp, hedge fund manager, author, former professor of mathematics, and noted blackjack gambler; and Elke Weber, professor of international business and psychology at Columbia University.

Juan-Luis Perez and Martin Leibowitz of Morgan Stanley, SFI Trustee Michael Mauboussin of Legg Mason Capital Management, and SFI External Professor John Rundle of UC Davis co-organized the meeting with Chris. ■

Seven new grants to SFI investigators

The Defense Advanced Research Projects Agency and the Air Force Office of Scientific Research has awarded SFI Professor Cris Moore and External Professors Aaron Clauset and Mark Newman a four-year, \$1,106,911 grant to develop statistical models and methods to automatically identify complex structural and dynamical patterns in real-world networks and highlight anomalous or low-probability structures or events.

The National Science Foundation has awarded SFI Professor Cris Moore a two-year, \$225,664 grant to use nonabelian Fourier analysis to find new ways to "derandomize" algorithms; study the extent to which rich, high-dimensional structures can be embedded in low-dimensional spaces with limited distortion; show that certain problems require a long time even for quantum computers to solve; and study whether new cryptography algorithms will remain secure if and when quantum computers are built.

The National Science Foundation (NSF) has awarded SFI Professor Cris Moore a three-year, \$88,048 grant to examine ways Markov chain Monte Carlo (MC) algorithms are used by theoreticians and practitioners, and to bridge the divide between these two camps.

The NSF has awarded SFI Professor Sam Bowles and SFI Omidyar Fellow Paul Hooper a one-year, \$47,100 grant to examine social network structure, political hierarchy, and economic inequality and to hold a workshop and training program on the topic.

The NSF has awarded Laura Fortunato (an SFI Omidyar Fellow) and Anne Kandler (an SFI Omidyar Fellow alum), a one-year, \$31,581 grant to develop an agent-based model to examine the different pathways for the transmission of cultural information between individuals (such as from parents to children or from peer to peer) by analyzing the varied and interacting effects of demographic and cultural factors on cultural diversity.

The EdLab Group Foundation awarded SFI and principal investigator Irene Lee a \$5,000 grant to fund a three-night event at Agua Fria Elementary School in Santa Fe, "Computación, Creatividad y Comunidad: Family Computer Science Nights at Agua Fria," for 4th-6th grade students and their parents, caregivers, teachers, and administrators. The event was held in September 2012. ■

Program to reach 1,200 New Mexico students

As part of a three-year, \$1 million NSF grant titled "New Mexico Computer Science for All," SFI and the University of New Mexico's Computer Science Department will develop and offer an online course that prepares middle school and high school teachers to teach a new introductory computational modeling and computer science curriculum.

The spring 2013 semester course for 30 teachers will be conducted through UNM's online course system. Next summer, UNM and SFI will co-sponsor a workshop at which the teachers will learn and practice new modeling- and complex-systems-inspired approaches to teaching computer science.

In fall 2013, UNM and the participating teachers will offer a new, dual-credit hybrid course for 600 students. The course sequence will be repeated in 2014, reaching an additional 30 teachers and 600 students.

The project is part of an NSF nationwide effort to attract and prepare 10,000 new teachers of computer science by the year 2015. The New Mexico program is led by SFI's Irene Lee and UNM's Ed Angel and David Ackley, a frequent SFI collaborator. ■

November / December 2012

UPDATE

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SANTA FE INSTITUTE



SFI's Chris Wood offered a neuroscientist's perspective of the film *Memento* on October 17 in Santa Fe.

Science On Screen encore leads with *Memento*

The popular Science On Screen series returned to Santa Fe October 17, with neuroscientist Chris Wood exploring the compelling depictions of human memory in the 2000 art-house crossover *Memento*.

The series is a joint collaboration of SFI and the Center for Contemporary Arts (CCA) in Santa Fe. During each showing, an SFI scientist presents a favorite film, offering personal perspectives from the world of science.

SFI and CCA presented four Science on Screen events early in 2012.

The encore series, presented in conjunction with the Coolidge Corner Theater and the Alfred P. Sloan Foundation, offers six classic films (including *Memento*) selected by SFI scientists.

Still to come:

***Raiders of the Lost Ark* with SFI External Professor George Gummeran, November 28, 2012, 7:00 p.m., CCA**

***The Gods Must Be Crazy* with SFI Distinguished Fellow Murray Gell-Mann, December 13, 2012, 7:00 p.m., CCA**

***Primer* with SFI Professor Cris Moore, February 20, 2013, 7:00 p.m., CCA**

***Never Cry Wolf* with SFI Professor Paula Sabloff, March 13, 2013, 7:00 p.m., CCA**

***Sneakers* with SFI Omidyar Fellow Simon DeDeo, April 24, 2013, 7:00 p.m., CCA**

Dates subject to change.

Visit SFI online at www.santafe.edu for more about these events. Advance tickets are recommended; for tickets and prices, call the CCA Box Office at 505-982-1338. All showings take place at the Center for Contemporary Arts, 1050 Old Pecos Trail, in Santa Fe. ■