



Update

March / April 2012



IN THIS ISSUE

- > From the editor 2
- > Humans as predators 2
- > A step ahead of diseases 2
- > SFI In the News 2
- > Evolving cooperation 3
- > New Omidyar Fellow 3
- > Achievements 3
- > SFI Online 3
- > 2012 Bulletin is here 3
- > DTTL's Phil Moyer 4
- > Book news 4
- > Girls with GUTS 4
- > Upcoming events 4

RESEARCH NEWS

Working group: What gives rise to social monogamy?

Why some societies favor monogamy over other norms is a matter of continued debate among scholars of cultural evolution. A recent working group at SFI explored the cultural processes that give rise to social monogamy and examined a number of different explanations for its persistence.

SFI External Professor Rob Boyd, an anthropologist at UCLA who organized the February meeting, believes monogamy helps keep the peace.

Thousands of years ago, small hunter-gatherer societies often accepted polygamy morally, but few men had more than one
> more on page 4

RESEARCH NEWS

Understanding financial markets, trend by trend

A market behavior known as herding is not as important a trend as economists previously assumed – which comes as a “big surprise” – say SFI Professors Doyne Farmer and Fabrizio Lillo and their colleagues in a recent paper.

The agent-based models the researchers are developing can give economists another tool to

explore policy scenarios and avoid a repeat of the financial crisis that began in 2008, which traditional economic models failed to predict. Their new models evaluate the relative contributions of herding and other behaviors. Data they analyzed from the London Stock Exchange did not shore up the assumption that herding plays a major role.

“There is some herding, especially for very short time lengths,” says Fabrizio in describing the intraday persistence of order flow, a trend in which buy orders follow buy orders or sell orders follow sell orders. “But the dominant component is *order splitting*,” he concludes, “at least at the broker level.”

> more on page 2

RESEARCH NEWS

Turning HIV's evolutionary acumen on itself

HIV is a multifarious, shape-shifting foe. The RNA of two HIV viruses in two different people may differ by as much as 30 percent. That's why developing a vaccine has been so difficult: A traditional vaccine might teach the body to go after a single form, but HIV's variants are so different that the immune system won't recognize it.

SFI External Professor Bette Korber (Los Alamos National Laboratory) and her team may have created a vaccine that could teach the immune system to wipe out many different forms of the virus. They've done so by turning HIV's chief weapon, its rapid evolution, against it.

Their approach has been to design artificial proteins that are a kind of mosaic, put together from pieces of natural proteins produced by all the different strains. Then, if the body learns to kill off cells that produce any bits of that artificial protein, it may be able to protect against the full variety of HIV viruses.

The tricky part is to put the bits together in a way that still looks to the immune system like

a real HIV protein, says Bette. “To do that, we evolved the virus in the same way it evolves itself in people.”

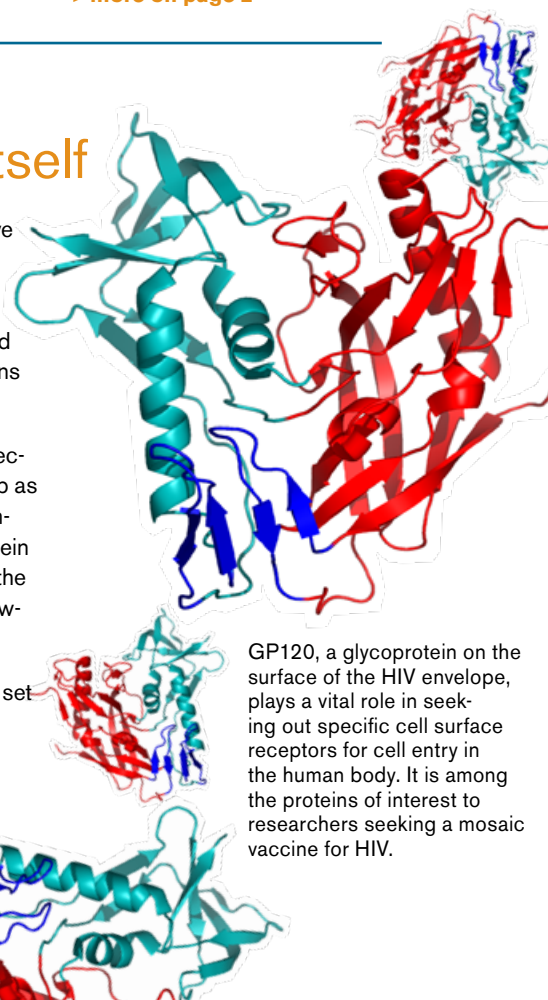
Their petri dish was a computer. They started with a database of known natural HIV proteins and then “mated” them by swapping parts.

Next, they performed an artificial natural selection: The computer chopped each protein up as the body would, and if the resulting bits commonly occur in natural HIV proteins, the protein was considered highly fit. They then “bred” the high-scoring proteins more often than the low-scoring ones.

After many generations, the highest-scoring set of proteins was chosen for the vaccine.

Trials of the vaccine in monkeys have been promising. This year, the vaccine will go into Phase 1 clinical trials in humans.

Read the full story in the SFI Bulletin at www.santafe.edu. ■



GP120, a glycoprotein on the surface of the HIV envelope, plays a vital role in seeking out specific cell surface receptors for cell entry in the human body. It is among the proteins of interest to researchers seeking a mosaic vaccine for HIV.

INSIDE SFI

SFI, complexity science at Davos

For the second year, SFI brought complex systems thinking to the World Economic Forum in Davos, Switzerland. Four sessions of the mega money meeting in January 2012 included speakers affiliated with the Institute.

In one session, “Managing Complexity with the Santa Fe Institute,” three SFI speakers described ways the latest research in complex systems might lead to improved resilience and control of economic, social, and cyber systems. The panel, introduced by SFI Distinguished Fellow Murray Gell-Mann, included External Professor W. Brian Arthur (Palo Alto Research Center); Science Board Co-chair and External Professor Stephanie Forrest (University of New Mexico); and External Professor Scott Page (University of Michigan).

> more on page 4

SFI IN THE NEWS

The complex network of predator-prey relationships in the Adriatic Sea have shifted, suggesting human harvesting of sea life has taken a toll, according to research by SFI Professor Jennifer Dunne and colleagues highlighted in an infographic in the March issue of *Scientific American*.

The February 27 *Santa Fe New Mexican* describes author Brian Christian's experiences as a human "confederate" in a 2009 Turing test, and his ideas about the ways computers are reshaping our notions about what it means to be human – the topic of Christian's February 29 SFI Community Lecture.

Newsweek's cover on February 20 calls SFI "the smartest place on earth," describing how the convergence of scien-

tists, humanists, and other thinkers fosters the Institute's signature freestyle form of collaboration. In a similar article, *Newsweek's* online publication *The Daily Beast* calls SFI "America's smartest lunch."

SFI Trustee Cormac McCarthy has acted as a volunteer editor for two recent books about science, according to the February 20 *New York Times*.

SFI Professor Sam Bowles takes on the New Mexico minimum wage in an editorial in the February 12 *Santa Fe New Mexican*.

In the February 13 *Santa Fe New Mexican*, SFI Omidyar Fellow James O'Dwyer argues that mathematics, combined with an ecological way of thinking, might help

humankind better understand diversity in both ecological and human settings.

SFI External Professor Nina Fedoroff argues for global collaboration in seeking solutions to humankind's toughest problems in the February 9 *Vancouver Sun*.

SFI External Professor Mark Pagel discusses the acquisition of culture as the defining moment in human history in an online Q&A in the February 18 *The Guardian* (U.K.), and on CBC Canada on January 31.

A January 27 *physorg.com* article describes a paper co-authored by SFI Professor Fabrizio Lillo in which researchers analyzed market transaction data from thousands of Finnish stock trades,

producing new insights about investor behaviors that may lead to stock valuation.

A January 29 *Scientific American* blog mentions SFI External Professor Jessica Green's research suggesting that Florence Nightingale's advice was right: Hospital patients are better off with fresh (outdoor) air.

SFI External Professor Mercedes Pascual and colleagues have created a model that can forecast cholera outbreaks nearly a year before they happen in Bangladesh, giving public health officials more time to prepare, according to the January 25 *R&D Magazine*.

SFI External Professor David Krakauer and SFI Omidyar Fellow alum Nathan Eagle

FROM THE EDITOR

In this detail-addicted society of ours we often get so focused on transmitting information that we don't take time for perspective. This newsletter is sufficient evidence that I'm guilty of it too. SFI is much more than its science. Yes, there are human beings doing all this gee-whiz. So in an effort to capture a pinch of the Institute's mojo, here is the *Update's* first editor's column. Ideally it will be qualitative, subjective, conversational. I want to hear from you. By next issue I promise to have a catchy title. If you can think of a good one, by all means let me know. Here goes.



My friend Nathan Collins can always be counted on to bring movies into the conversation at afternoon tea. His passion for classic film is surpassed only by his fashion courage. (If you don't know him, he

has more bowties than a bowlful of farfalle.) Nathan, now at UC Irvine, is one of four scientists offering commentary this spring as part of the SFI-CCA "Science on Screen" series in Santa Fe. He is next up, putting an election-year spin on "Blade Runner." And Murray Gell-Mann's May 17 screening of Groundhog Day will be what's known in particle physics as a "strange hoot." See page 4 for details.

SFI scientists have been pushing the envelope of economic theory for two decades. Today, the economics community is beginning to take note. (See "SFI at Davos" on page 1.) In another first, SFI and the Krasnow Institute are putting on a three-day course for policy makers on complexity and economics May 16-18 near Washington, D.C. Details at www.santafe.edu/rethink. Probably not an election issue, but it should be.

Finally, a very important science question from my teenager: Can a vampire get the zombie virus? He insists they can, as evidenced by a movie we watched recently in which...well, I won't ruin the ending for you. I'm inclined to think they can't. Who can resolve this for us? ■

– John German, jdg@santafe.edu

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The *SFI Update* is published bimonthly by the Institute to keep its community informed. Please send comments or questions to John German at jdg@santafe.edu.

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RESEARCH NEWS

Humans as predators in marine food webs

Although ecologists have studied food webs, the networks of who eats whom in the natural world, for decades, they have rarely asked how humans fit into the picture.

SFI Professor Jennifer Dunne and her colleagues are the first to examine the detailed feeding habits of human hunter-gatherers in relation to other species. She presented the work at the American Association for the Advancement of Science meeting in Vancouver, B.C. in February.

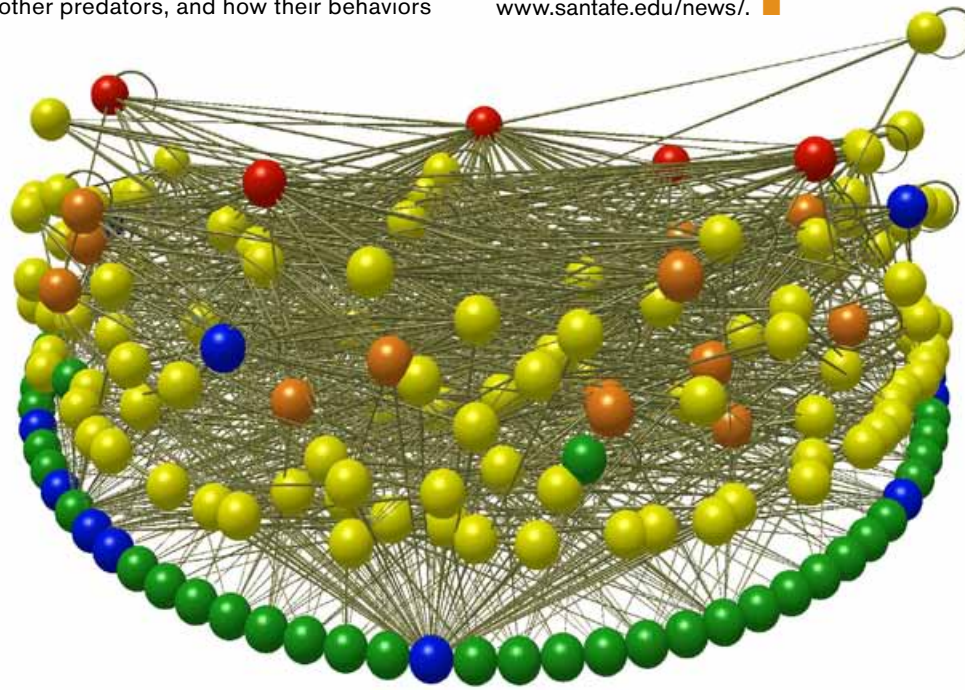
By synthesizing 5,000 years of biological, archeological, ethnographic, and other data from marine systems in the North Pacific, Jennifer and her collaborators have characterized how humans fit into complex marine food webs, how they compare to other predators, and how their behaviors

might have affected long-term ecosystem sustainability.

Their results are surprising: Despite being "super-generalist" predators that fed on more species than other predators, the Aleut of Sanak Island, Alaska frequently switched among their many food sources, a flexibility that likely helped stabilize the entire ecosystem.

At AAAS she said she believes it is important to make sense of human impacts within an ecological framework, rather than treating humans as external to natural systems. "This type of network-based research provides new ways to understand human roles and impacts within complex ecosystems," she said.

More about the research is available at www.santafe.edu/news/. ■



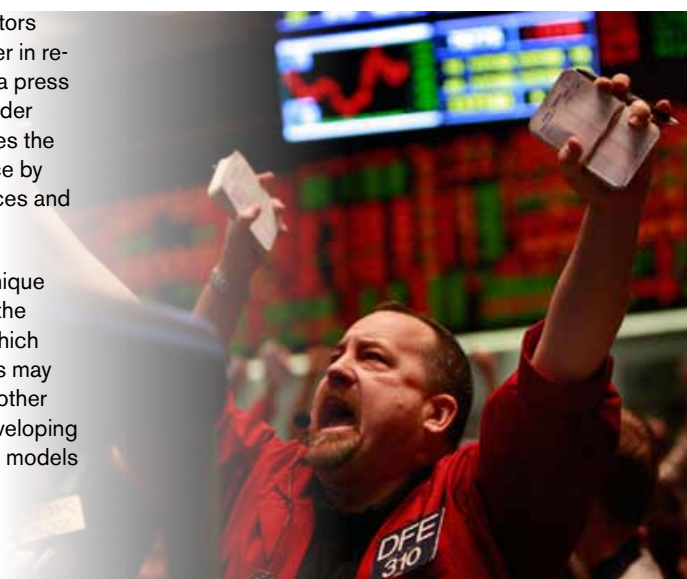
In this depiction of the intertidal food web of Sanak Island, Alaska, spheres represent species or groups of species, and the links between them show feeding relationships. The colors of the spheres indicate taxa: green shows algae; blue shows seagrass, lichen, protozoa, bacteria, and detritus; yellow shows invertebrates such as snails, crabs, mussels, and octopus; orange shows fishes; and red shows mammals (Aleut), who fed on 50 of the 171 species in the intertidal food web. Image created by Jennifer Dunne with Network3D software (Williams 2010).

> Market trends continued from page 1

Herding occurs when investors imitate others or act together in response to a signal such as a press release or price change. Order splitting by brokers minimizes the impact of big orders on price by splitting the orders into pieces and gradually executing them.

The researchers' new technique for distinguishing between the behaviors and identifying which is dominant in market trends may be important for examining other data sets as well, and in developing more accurate agent-based models of the economy.

A preprint of their paper is published on arXiv. ■



RESEARCH NEWS

Staying a step ahead of diseases

Few people think of flu season as much more than sniffles and sleepless nights. For two SFI External Professors, it's a chance to study how human epidemics develop.

"The spread and control of infectious diseases in human populations is an enormously complex system, driven by non-trivial interactions between continually evolving pathogens, diverse host immune systems, and individual and organizational decision-making," says External Professor Lauren Ancel Meyers (University of Texas at Austin).

In 2009 she helped track the emerging H1N1 virus, and worked with the CDC and other public health agencies to mathematically model its movement through the population.

"Understanding the dynamics of human contact networks and health-related behavior is critical to making good predictions and designing effective interventions," she says.

Classical models assume that diseases spread through a homogeneous human population, where all people are equally susceptible to the virus and no one changes their behavior in response to a pandemic.

"Such models are ill-suited to capturing complex social networks," wrote External Professor Joshua Epstein (National Center for the Study of Preparedness and Catastrophic Event Response at Johns Hopkins University) in a recent opinion piece in *Nature*. He and Lauren are among the scientists developing new modeling strategies to analyze disease dynamics.

Lauren has been developing an approach called contact network epidemiology. In her models, individuals or susceptible populations are represented by nodes, which are connected by edges that represent contacts that can lead to disease transmission. The network models can account for varying social behaviors and varying levels of vulnerability, and can even help reveal the likely efficacies of intervention strategies such as vaccinations, quarantines, and distributing antiviral medications.

Joshua is using agent-based modeling methods, in which each member of the population is represented as an agent and imbued with sets of complex properties. Supercomputers simulate the interactions between agents, and can model distinctly human reactions to pandemics. One such reaction is fear, which can lead people to migrate from their population centers and cause absenteeism among health care workers.

"We're learning a lot about infectious diseases from the growing volumes of data produced by surveillance systems and high throughput laboratory methods," Lauren says. "Innovative modeling techniques have become indispensable to this interdisciplinary field as we seek to advance in our understanding of epidemics and improve public health." ■

are among *Wired* magazine's "2012 Smart List" of 50 people who will change the world.

Statistical analyses of recent elections by SFI External Professor Stefan Thurner and colleagues reveal possible election fraud in recent Russian and Ugandan elections, according to *Science News* on January 24.

SFI External Professors Herbert Gintis and Jessica Flack weigh in on the challenges of understanding self-regarding versus cooperative behavior in *Social Evolution Forum* on January 11.

A December 28 *InformationWeek* article compares the lifespans of cities to those of corporations and cites SFI studies

of biological and social systems that decrease or increase in efficiency with scale.

SFI President Jerry Sabloff tells readers of the December 26 *Santa Fe New Mexican* what the Institute does, and why 2012 is a year for asking big questions at SFI.

SFI External Professor W. Brian Arthur argues in the December 19 *Santa Fe New Mexican* that a deep, slow, and silent transformation of our economy is taking place as a second digital economy supplants the physical one we are familiar with. The op-ed is an abridged version of an article that appeared in *McKinsey Quarterly* in October 2011.

Multimedia content available at www.santafe.edu/news



Video: SFI Distinguished Professor Geoffrey West says cities are a source of problems as well as solutions. Source: Ericsson



Video: SFI Distinguished Fellow Murray Gell-Mann discusses supersymmetry, the Higgs field, simplicity vs. complexity in physics, and SFI-style collaboration. Source: CERN



Video: SFI President Jerry Sabloff says the language of mathematics has prompted researchers from half a dozen fields to ask new questions about social complexity. Source: National Institute for Mathematical and Biological Synthesis



Audio: SFI President Jerry Sabloff describes SFI's signature style of scientific collaboration and what scientists are learning about the evolution of intelligence, cities, and social complexity. Source: KSFR's Santa Fe Radio Cafe



Video: SFI Science Board member and External Professor Nina Fedoroff says scientists should be concerned about the resources available to opponents of science, and speak up when they see science being corrupted for political ends. Source: 2012 AAAS conference keynote lecture



Study: Cooperative behaviors evolve when group members exhibit 'flexible' behaviors

Biologists have long observed that groups of animals can coordinate their actions so tightly that each animal does what is best for the group rather than what is best for itself – even when group members are unrelated. But explaining how such genetically selfless behavior could have evolved has long been just beyond the reach of scientists seeking to employ standard evolutionary theory.

In new theoretical research, Erol Akçay (Princeton) and SFI Omidyar Fellow Jeremy Van Cleve demonstrate the crucial role flexible behaviors might play in the evolution of high levels of cooperation. Such behaviors can include simple negotiations involved in food sharing and the social norms that prevent an individual's cowardly retreat when a group must defend itself against hostile outsiders.

By incorporating flexible behaviors into standard biological theory that describes how cooperation evolves based solely on genetic kinship, the researchers suggest that high

levels of cooperation can evolve even in groups not composed of close relatives.

Specifically, they find that cooperation can evolve to group-optimal levels when individuals match each other's actions closely, regardless of the relatedness between individuals.

But kinship does matter. They also find that whether a psychology that enables such behavior-matching evolves or not depends on the relatedness of between-group members.

"Relatedness and behavioral responses can interact synergistically and promote much higher levels of cooperation together than each of them can sustain by themselves," explains Akçay.

Jeremy says an exciting characteristic of their approach is that it can be used to study the evolution of mechanisms that generate specific behaviors. They demonstrate this by studying how prosocial preferences – i.e.,

intrinsic motivations to help others – can evolve to maximize group benefit.

Although popular in economic theories, prosocial preferences have received little attention by biologists. How easily prosocial preferences evolve depends on the kinds of activity in which animals might cooperate.

"When animals hunt cooperatively, they can capture much larger prey than when alone, which is good for all, and this can make high levels of cooperation easier to evolve," says Jeremy.

For activities where adding additional co-operators makes less of a difference, such as emitting alarms calls when predators are nearby, high levels of cooperation are harder to evolve.

Their work appears in the February issue of *The American Naturalist*. ■

INSIDE SFI

SFI selects 2012 Omidyar Fellow



The Institute has named one new Omidyar Fellow for 2012, selected from more than 200 applicants.

Evolutionary anthropologist Paul Hooper in September 2012 will join

the nine Omidyar Fellows now at SFI.

Paul holds a PhD in anthropology and integrative biology from the University of New Mexico. His research centers on the co-evolution of human economic systems, demography, and social structure. He combines demographic and game theoretic modeling with ethnographic research to explore the natural history of human economics, reproduction, and sociality; the structure of human social networks; and cross-societal variation in social and reproductive inequality. At the Institute, he plans to continue his work toward historically accurate models of social evolution.

A gift from Pierre and Pam Omidyar in 2008 established the Omidyar Fellowship, which aims to attract to SFI early-career scholars from the social, physical, and natural sciences. Omidyar Fellows spend two to three years at SFI as postdoctoral fellows pursuing the research questions of their choice. ■

ACHIEVEMENTS



SFI External Professor Daniel Dennett has been selected to receive the 2012 Erasmus Prize, for a person who has made an exceptional contribution to culture, society, or social science. He will receive the award in

November in Amsterdam.



The Academy of Athens has selected SFI External Professor Constantino Tsallis for the Aristio ("Excellence" in Greek), for contributions in "complexity in the physical sciences." The Aristio is given to one scientist or

artist annually. Constantino will receive the award in Athens in March. ■



The 2012 SFI Bulletin is here

SFI's 2012 *Bulletin* is now available at www.santafe.edu. SFI Faculty Chair Doug Erwin leads off the issue in exploring why long time scales and the roles of contingency can make scientific progress in the historical disciplines difficult. A Q&A with SFI President Jerry Sabloff explains why it is important for scientists to ask big questions. Also covered: emerging theoretic insights about the origin of life of Earth; how the disconnected approaches of several disciplines might one day converge on an improved grasp of human migration; how scientists seeking a vaccine for HIV might have found

that killer's Achilles heel; what individuality means in human and biological systems that feature complex interrelationships among individual actions and collective behaviors; a unique experiment that is tracking evolution in (so far) 54,000 generations of *E. coli*; and the new quantitative field of historical study cliodynamics. In a special guest article, SFI Science Board member Lord Robert May argues that the very features of ecological systems that lead to system robustness can teach us much about banking, and possibly help avert future financial crises. ■

CORRECTION

The January-February issue of the *Update* failed to acknowledge the Sydney and Andrew Davis Foundation for its generous sponsorship of the October 2011 SFI-Santa Fe Symphony "Voyages III: Bach On the Brain" event. Without such generosity, cultural events such as Voyages III would not be possible. A special thank you to the Davis's for their support. ■



DTTL's Phil Moyer: Expect the unexpected



It is satisfying to find someone who can answer a question. But it is more exciting to find answers to questions you had not thought to ask yet.

Philip Moyer, Deloitte Touche Tohmatsu Limited's (DTTL) global security strategist, first got involved with SFI seven years ago. Prior to joining DTTL, and after reading Duncan Watts' work on the evolution of social networks, Moyer was able to apply Watts' social network theory to build an intrusion detection system, which he then replicated for DTTL's computer network.

After that program proved successful, Moyer convinced his boss to let him join SFI's Business Network, a relationship he says has far outweighed its cost.

When Moyer first joined the Business Network, he went to the meetings with a specific work-related problem in mind. "Interestingly, in the last couple of years I've experienced an 'SFI-y' change in the way I approach these meetings," he says.

Now he comes to the meetings without an agenda, even when the speakers and the topics may not seem to apply to his work.

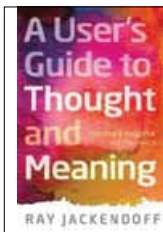
"Those meetings tend to be more productive, because instead of listening to apply it to your problem, you just listen," he says. "You're not constrained by your preconceptions of what you want to get out of the lecture."

This new approach, he says, has resulted in unexpected knowledge and new approaches to solving problems. ■

BOOK NEWS

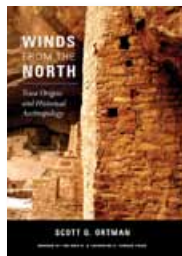


In *Wired for Culture* (Norton, February 2012), SFI External Professor and evolutionary biologist Mark Pagel (Reading University) tracks the emergence of human culture through 80,000 years of human evolution, revealing how an innate propensity to contribute and conform to culture is more important to our success as a species than our genes, enabling rapid human progress.



A User's Guide to Thought and Meaning (Oxford, March 2012) by SFI External Professor Ray Jackendoff (Tufts University) presents a new account of the relation between language, meaning, rationality, perception, consciousness, and

thought. He suggests that what we experience as rational conscious thought in fact rides on a foundation of unconscious intuition.



Despite a century of research, no consensus exists on how, or if, the abandonment of Mesa Verde and the formation of the Rio Grande Pueblos are related. In *Winds from the North: Tewa Origins and Historical Anthropology* (University of Utah Press, February 2012), SFI Omidyar Fellow Scott Ortman proposes a compelling solution to this problem through an investigation of the genetic, linguistic, and cultural heritage of the Tewa Pueblo people of New Mexico. Scott's dissertation, which served as the basis for this book, won the Society for American Archaeology Dissertation Award in 2011. ■

> Monogamy continued from page 1

wife, he says. Later, when complex agriculture made some people rich and others poor, men who could afford it acquired more wives, which created a faction of unmarried men which, according to a recent paper Rob co-authored, may have led to more murder, robbery, and assault.

Monogamy got trendy again in ancient Greece, spread throughout the Roman Empire, and remains the dominant system today among societies of European descent.

"Today, the wealth inequality is bigger than it has ever been, yet our moral systems prescribe monogamy," he says. "Evidence suggests monogamy benefits complex societies, but what's the process to get there?"

Participants in the February meeting included Ruth Mazo, a specialist in quasi-marital unions in medieval Europe; economist Shoshana Grossbard; Greco-Roman expert Walter Scheidel; Kyle Harper, a historian studying early Christianity and monogamy; Omidyar Fellow Laura Fortunato, whose research investigates how kinship and marriage affect social organization; and SFI Professor Sam Bowles,



an expert on the economics of property inheritance.

By gathering historians with such diverse knowledge of approaches to studying ancient Rome and late antiquity, Rob hopes to determine how to address the gaps in the historical record sufficiently to posit a rigorous argument for the mechanisms of monogamy's spread. ■

Girls with GUTS



Maggie, an 8th grader at Monte del Sol and a current GUTS y Girl, creates her own web page on the program's private online social network. GUTS y Girls is a science, technology, math, and engineering outreach program for middle school girls in New Mexico designed to engage them in and prepare them for future careers in science and technology. The SFI program features a series of once-a-month Saturday workshops.

> SFI at Davos continued from page 1

In another session, "Risks in a Hyperconnected World," Stephanie offered insights about cybersecurity, drawing inspiration from biological systems. She pointed out that as the Internet becomes an increasingly critical system of commerce, a major systemic failure might precipitate its own far-reaching economic failure.

In "Human Network Dynamics," Scott was among panelists describing how enormous datasets now being harvested from websites and social networks, mobile phones, GPSs, and banking are giving scientists powerful new tools to understand and predict human

behavior. He explored how big data could have profound impacts on politics, marketing, infrastructure design, and other spheres, but cautioned that the risks of abuse are high.

In "The Future of Economics," Brian was among panelists who explored how major changes in theory and in practice are driving the rehabilitation of economics. He offered insights about the impact of technologies that have the ability to disrupt economic systems.

More about SFI's Davos participation is available at www.santafe.edu/news. ■

UPCOMING EVENTS

SFI Community Lecture, "Appealing to Intuitions: Why We Can't Get Along Without Them," April 9, 7:30 p.m., James A. Little Theater. Author and SFI Miller Scholar Rebecca Goldstein will consider intuitions as an essential part of our moral and philosophical thinking, describe how mathematicians of the last century attempted to eliminate all appeals to intuitions, and show how Gödel's Incompleteness Theorems can be viewed as proof that we can't get along without them.

SCIENCE ON SCREEN

Santa Fe Institute-Center for Contemporary Arts "Science On Screen" series. SFI scientists screen their favorite films, offering perspectives from their own research and the world of science. (For tickets and prices, call the CCA Box Office at 505-982-1338.)

Blade Runner, March 29, 7:00 p.m., CCA. SFI Omidyar Fellow Alumnus Nathan Collins, a political scientist, takes an election-year-inspired view of Ridley Scott's classic. What might these cyborgs teach us about voter education and preferences? Generously sponsored by Global Ecotechnics.

Future Cities, April 26, 7:00 p.m., CCA. Filmmakers have long imagined future cities. How much of their predictions

are visionary, and how much sensationalistic? Can their imaginings help deepen our understanding of cities? SFI Distinguished Professor Geoffrey West merges theories of cities being developed at SFI with clips from memorable films. Generously sponsored by the Livingry Foundation.

Groundhog Day, May 17, 7:00 p.m., CCA. SFI Distinguished Fellow Murray Gell-Mann gives this classic comedy a novel spin: Can Bill Murray help us understand the essence of scientific practice? Gell-Mann and screenwriter Danny Rubin discuss one of cinema's most enjoyable mind-bending films. Generously Sponsored by Ringo and the Tanoroadgang.

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