SANTA FE INSTITUTE

March / April 2013

UPDATE

IN THIS ISSUE

Insights from examining multiple ecosystem datasets

Ecological studies typically have focused on a given habitat, such as the food web of "who eats whom" in a forest or coral reef. While this approach offers insights into how each ecosystem is organized, such singular datasets can't answer questions about how the structure, dynamics, and functioning of a given food web vary across changing conditions.

Now, advances in data handling that can examine hundreds of instances of particular types of food webs are providing a new way to study how species resist or adjust to changes in the ecological context.

One such study examines the aquatic ecosystem within a pitcher plant – a carnivorous plant that lures insects to nectar at the bottom of a long, jug-like leaf and traps them. The pitcher plant food web includes detritus (dead insects), midges, mosquito and fly larvae, bacteria, mites, rotifers, and protozoa. A database of 780 pitcher plant food webs, sampled in clusters at sites along the eastern U.S. and Canadian coastline, reveals trends in how the communities within these plants change in relation to environmental factors.

"By understanding how these tiny ecosystems are structured, we can start to see how ecosystem organization changes, or doesn't change, across latitude and climate," explains Jennifer Dunne, SFI's Chair of the Faculty and an expert in ecological network structure and dynamics.

> more on page 4

The carnivorous pitcher plant lures insects to nectar at the bottom of its long, jug-like leaf structure. (www.istockphoto.com)

RESEARCH NEWS

Study: Homer's *The Iliad* dates to 762 BCE, give or take

One of literature's oldest mysteries is a step closer to being solved after a recent study that dates *The Iliad* to 762 BCE and adds a quantitative means of testing ideas about history by analyzing the evolution of language.

Greek manuscript depicting a scene from *The Iliad* (Biblioteca Ambrosiana, Milan)

The epic poem *The Iliad*, set amid the final year of the Trojan War, is attributed to the ancient Greek poet Homer and is foundational to Western literature, but scholars have not reached a consensus about whether it was written shortly after the war or much later. Archaeological and historical evidence have placed the text's origins in the 7th or 8th century BCE, but such records are sparse and often have an uncertain validity.

SFI External Professor Mark Pagel, an evolutionary biologist at Reading University (UK), and colleagues decided to ask what scholars refer to as "The Homeric Question" using a quantitative approach borrowed from the study of evolution.

In determining when species emerged and in gauging their relatedness to others, biologists compare genetic and physical traits along with novel adaptations. Similarly, linguists compare words that share an ancestor (e.g., *water* in English and *wasser* in German both come from the proto-Germanic *wator*), as well as words that supplant earlier terms (the modern English *dog*, for example, largely replaced the Old English *hund*), to pinpoint when a lexicon or language was in fashion.

Pagel's team compared the Greek vocabulary in Homer's *Iliad* to modern Greek, relying on a 200-word lexicon found in every language and contrasting the distantly related Hittite as an indicator of divergence.

Their methods date Homer's language in *The Iliad* to 762 BCE. The statistical model, says Pagel, "is completely ignorant of history – it doesn't know who Homer is and it doesn't know Greek." Accordingly, the potential date ranges from the improbable extremes of 376

> more on page 2

RESEARCH NEWS

Revealing hidden information patterns

If you were to wander the halls of a courthouse during a murder trail, could you predict the verdict from the conversations you would overhear? And what would be the smallest amount of information you would require to make that prediction?

Discovering patterns in information is more than a game of courtroom prescience; it is a serious matter with applications in warfare, stock markets, human health, and other complex systems.

Finding a reliable technique for detecting such patterns, however, is difficult. SFI Research Fellow Simon DeDeo, SFI Graduate Fellow Sara Klingenstein, and undergraduate researcher Robert Hawkins are drawing on information theory and a couple of remarkable datasets for help.

In one example, the researchers analyzed some 250 years of transcripts from the Old

> more on page 3

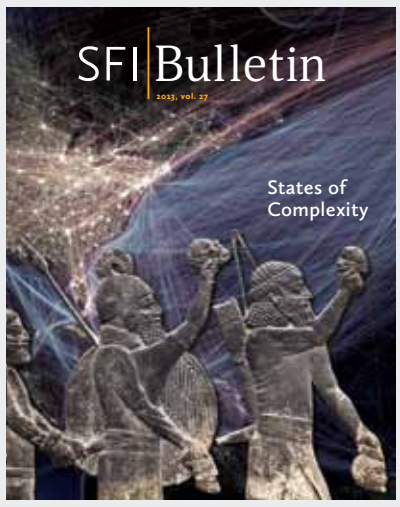
RESEARCH NEWS

Social networks and inequality

In the game of Monopoly® each player starts with equal assets. As the game progresses, time and chance – and a relatively simple set of static rules – determine each player's eventual stature. In real human societies, the game of determining "haves" and "have-nots" is a lot more complicated, and it has been playing out for thousands of years under changing rules that are not well understood.

SFI Professor Sam Bowles, an economist, and SFI Omidyar Fellow Paul Hooper, an anthropologist, have pulled together a team of more than two dozen researchers to unravel those hidden rules. Their approach is to build mathematical models, using ethnographic data from traditional societ-

> more on page 4



SFI's reconceptualized science magazine, the *SFI Bulletin*, debuts in April. To receive email notification of each new issue, visit www.santafe.edu and look for the "Follow Us" menu.

SFI IN THE NEWS

The *Santa Fe New Mexican* on February 21 covered a recent talk at SFI by noted climate scientist James Hansen, who told an overflow crowd that efforts to stem climate change will be ineffectual as long as fossil fuels remain the cheapest form of energy.

On February 1, *The Atlantic's* Richard Florida takes a look at innovation and its relationships with patents and urban living, citing views of SFI External Professor W. Brian Arthur, who has suggested that the U.S. is poised for an era of innovation and growth. Florida also mentions frequent SFI collaborators Deborah Strumsky and Jose Lobo, who are among the authors of a new report by the Brookings Institution that examines historic patent data in relation to cities of origin.

In a lengthy feature article in *Isthmus* (Madison, Wisconsin) on January 30, SFI External Professor David Krakauer, director of the Wisconsin Institute for Discovery at the University of Wisconsin-Madison, outlines the critical need to rethink and remake the university education system.

In a January 25 article in *The Chronicle of Higher Education*, SFI External Professor Jon Wilkins discusses his Ronin Institute, which is providing a platform for unaffiliated academics to contribute to scholarly progress.

The *Txchnologist* on January 22 describes a new SFI research project led by SFI Professor Luis Bettencourt, in collaboration with the nonprofit Slum Dwellers International and backed by the Bill & Melinda Gates Foundation, that seeks to expand the scientific study of urban slums worldwide.

On January 22, NPR's Robert Krulwich reviews a landmark 2007 paper by SFI Distinguished Professor Geoffrey West and collaborators finding that, at the species level, a relatively simple formula – a power law – seems to describe the life spans of all living creatures. Krulwich notes that although the conclusions remain controversial among biologists, the paper has been cited more than 1,500 times since its publication.

Wired on January 8 covered a study by SFI collaborator Tobias Galla and External Professor Doyne Farmer in which they ran thousands of simulations of two-person

Nonlinearities
From the editor

What's the special sauce that makes the Institute such a good place to do science? I believe it has something to do with how its intellectual context shifts continuously. The steady flow of people and the diversity of their disciplines and thought styles mean today I might overhear a discussion between a biologist, an economist, a linguist, and an archaeologist. Tomorrow it might be a physicist bouncing ideas off of a philosopher, a physician, and an ecologist. I've met a mythologist, historians, sociologists, authors, actors, poets, diplomats, bankers, even a tribal leader from Afghanistan – and to all those I've left out, forgive me. When any discussion can lead in so many directions, how could this not be a productive, energizing setting for science. Like every snowflake, every day at SFI is an original.

Evolution seems to play at least a supporting role in most of the discussions here. In this issue, for example, there's an article about a fascinating paper by Mark Pagel and collaborators in which they used an evolution-inspired analysis of language change to date Homer's *The Iliad* to 762 BCE, solving one of literature's longest-running mysteries – no easy task given historians can't even agree that Homer existed as one person. And if you like to think about evolution, don't miss the new online video by Dan Rockmore and collaborators. The 45-minute documentary, *Darwin's Extra Sense*, shows how mathematics-assisted evolutionary theory is opening doors to astonishing insights in the life sciences – from cell biology to population genetics, healthcare, neuroscience, and other fields. It's available through the "Videos" link on SFI's homepage.

Juniper Lovato and I were, the other day, trying to think of all the pop culture mentions of the Institute. The character Ian Malcolm (played by Jeff Goldblum) in *Jurassic Park*, was, of course, an SFI scientist ("Life finds a way"). At least two episodes of *The X Files* include SFI characters. Rumor has it the window writing in the TV series *Numbers* was inspired by a visit to SFI. There are many more. Please lend us a hand. Go to SFI's Facebook page and give us your list of SFI pop culture mentions, verified or unverified. We'll check it out and post a complete list. If you don't use Facebook, just send me an email with as many details as you can muster. ■

– John German, jdg@santafe.edu

CREDITS

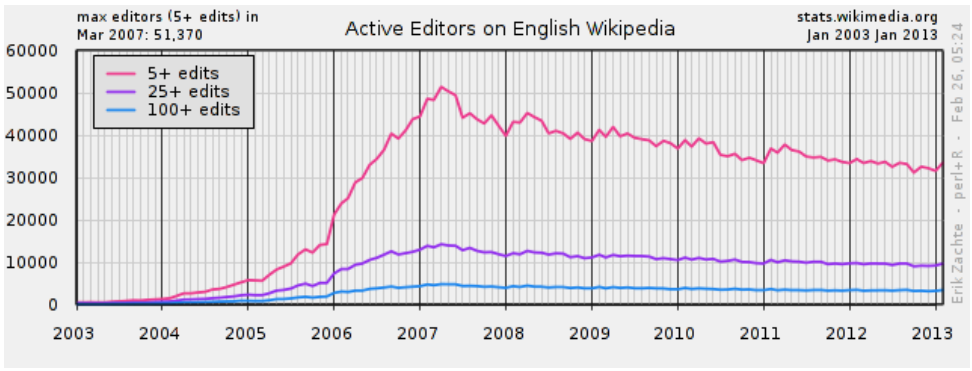
Editor: John German
Contributors: Larry O'Hanlon, Krista Zala, Rachel Miller, Stuart Dambrot, Devon Jackson
Design & production: Michael Vittitow
VP for Outreach: Ginger Richardson

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

Follow SFI online at **www.santafe.edu**

RESEARCH NEWS

Clues to Wikipedia's shared super mind



Wikipedia's remarkable accuracy and usefulness comes from something larger than the sum of its written contributions, a new study by SFI Research Fellow Simon DeDeo finds.

The free, anonymously written and edited online encyclopedia was widely expected to fall prey to cranks and partisans. Instead, it has proven no less accurate than the venerable *Encyclopedia Britannica*, according to several analyses of the quality of its information.

"The question is how?" asks DeDeo, who has studied the 11-year-old online knowledge repository as the product of a particularly cooperative human social system. "Wikipedia is an extremely high-functioning system. How do people create societies that have extremely high cooperation?"

A great example of this cooperative nature is Wikipedia's article on former U.S. President George W. Bush – a contested piece of Wiki real estate that has been edited some 45,000 times.

"Show me a place on the Internet where people agree about George W. Bush," says DeDeo. "But the Wikipedia article reads as if it was written by aliens who didn't care [about Bush] – although we know it was written by people who cared a lot."

Just how Wikipedia manages this collective balance is something DeDeo was able to study in detail because, unlike most other social systems, every Wikipedia edit is recorded.

"It's almost like you had closed circuit cameras running as a society is creating itself," he says, "so every move could be studied and watched."

All these sequences of behaviors create what can be viewed as a historical grammar, like that of a language or even bird song. A human language, for example, has very simple grammar, with few elements and combinations possible – what's called a finite-state system. The historical language that creates and maintains Wikipedia might be expected to follow a rather limited grammar as well, but that's not what DeDeo discovered.

"The big result is that the Wikipedia behavior is what we call non-finite state," DeDeo says. "It's constantly generating new patterns of behavior that haven't been seen before."

One possibility, he says, is that the unbounded source for these behavior patterns in Wikipedia is shared between people – it's the product of everyone's mind. "That's what's really exciting," he says.

DeDeo's study is published online at http://arxiv.org/abs/1212.0018. ■

RESEARCH NEWS

How men and women organize their (online) social networks differently

A new quantitative study of how men and women manage their social networks in the online multiplayer game Pardus finds that gender differences observed in the real world tend to be mirrored in the online society.

"It is fascinating that we maybe see traces of a million years of social evolution in a computer game," says SFI External Professor Stefan Thurner (Medical University of Vienna), who co-wrote the paper with Michael Szell (MIT).

Females have more communication partners, engage in economic activities to a greater degree, attract positive behavior, organize in clusters, reciprocate friendships, take fewer risks than men, and show a preference for stability in local networks. Males try to talk most often with those who talk with many, reciprocate friendships with other males

much less frequently, and respond quite quickly to female friendship initiatives.

In the real world, Thurner says, it can be difficult to study social networks of a set of people at the same time with the same resolution. Online multiplayer games like Pardus, with their detailed data about players' social interactions and networks, allow researchers to quantify interactions on a systemic level.

Their paper was published February 7 in *Scientific Reports*. ■

RESEARCH NEWS

Optimizing optimization

Complex data-rich endeavors like predicting climate change or developing a new heavy-duty material involves running many simulations and comparing their results with observations. Each simulation or experiment is an "information source" whose use has its own pros and cons.

"In trying to optimize something using many sources of information, each source has a different cost to run, both in time and resources, and a different accuracy," says SFI External Professor David Wolpert, an algorithm designer at Los Alamos National Laboratory.

Traditionally, scientists use their intuitions to choose from information sources on the fly. Wolpert wants to let machines do it instead. "Humans aren't designed for this," he says. "Statistical techniques may be far more powerful."

A dozen researchers representing MIT, Stanford, Sandia National Labs, and the Air Force gathered at SFI recently to consider new directions for "Multiple Information Source Optimization (MISO)." As part of the working group, they explored means of finding statistical relationships between cheap but inaccurate sources and accurate but expensive sources.

"The right knowledge allows you to use cheaper, less accurate sources knowing how they correlate to the results of better ones," says Wolpert, who held a similar working group in July 2012, during which organizers introduced standard MISO procedures – what had so far been used in aerospace engineering – to other research communities.

At the follow-up meeting in November they introduced semi-supervised machine learning: an approach to optimize the optimization process by explicitly comparing an information source's cost to the degree it improves the design.

The advances are poised to make a tremendous difference in fields requiring massive simulations, say Wolpert, such as determining the human dosage of pharmaceuticals, fuel yield of algal farms, magnitude of climate change, and severity of extreme weather.

Participants recently presented their findings at the Society for Industrial and Applied Mathematics conference in Boston. ■

> *Homeric dating*
continued from page 1

BCE to 1157 BCE. But the estimate attaches a robust likelihood to the date, and it ties nicely to Nestor's Cup, a clay vase dated to 723 BCE that is thought to carry an inscription from *The Iliad*.

The study reveals "an astonishing regularity in the way languages evolve," notes Pagel. "That we can blindly apply rates of language change to Homeric and modern Greek and come up with 762 BCE tells us language is behaving in a regular and predictive way."

Their study was published in the online edition of *BioEssays* on February 18. ■

economic games, concluding that equilibrium might not be relevant in a complex "game" with many players such as a financial market.

The *Santa Fe New Mexican* on December 29 covers the recent gift to SFI by Eugene and Clare Thaw of their former Tesuque, New Mexico, estate. SFI's new "Tesuque Campus" will become a quiet, contemplative setting for Institute scholars and visitors.

A recent visit by W. Brian Arthur to Singapore's Nanyang Technological University prompted a December 28 interview in *The Straits Times* (Singapore) in which he reviews the history of complexity science and the founding of SFI.

On December 17, BBC.com blogger Gaia Vince reviews the sustainability benefits of dense urban living and cites research by SFI's cities and urbanization team.

In a December 2012 interview in *Alliance* magazine, SFI Distinguished Professor Geoffrey West appeals for a broader, networks-oriented view of problem solving and philanthropy.

To some scientists, the global financial crisis of 2008 looked a lot like the spread of an infectious disease or the demise of a coral reef, according to SFI Science Board member Lord Robert May in a November 19 *Albuquerque Journal* interview.

SFI Online

Multimedia content available at ***www.santafe.edu***

Video: *Darwin's Extra Sense*, a video produced by SFI External Professor Dan Rockmore and collaborators, explores the ways applied mathematics is opening doors to astonishing insights in the life sciences.

Video: SFI External Professor Jessica Green narrates a lesson on microbial diversity on and inside the human body. Source: TED video

Video: SFI External Professor Daniel Dennett asks to what extent – if at all – cultural evolution is governed by "Darwinian" algorithms of natural selection. Source: SFI lunchtime seminar

Video: SFI collaborator Peter Peregrine reviews the evidence for punctuated equilibrium in cultural evolution and posits that reconceptualizing cultural evolutionary typologies as markers of stable evolutionary states might be defensible. Source: SFI lunchtime seminar

Video: SFI collaborator Charles Stanish reviews new archaeological data that suggest theoretical avenues for understanding the evolution of complex chiefdoms and states in the archaeological record. Source: SFI lunchtime seminar

BUSINESS NETWORK NEWS

Managing identity on the Internet

Much of what we do on the Internet – purchasing books and music, banking, interacting with the IRS – requires trusted mechanisms for establishing and protecting our identities. Other Internet interactions often are better supported through anonymity. How do we square these seemingly incompatible goals?

Members of SFI's Business Network will focus on identity and trust on the Internet at the Network's next topical meeting on April 17 at Fidelity Investments in Boston. Speakers will provide an overview of the Obama Administration's National Strategy for Trusted Identities in Cyberspace (NSTIC) and its efforts to bring together the private sector, advocacy groups, government agencies, and other organizations to improve the privacy, security, and convenience of online transactions.

The core of the NSTIC's vision is the "Identity Ecosystem," a process for authenticating the digital identities of individuals, organizations, and devices in the online environment. Like an ecosystem that exists in nature, the Identity Ecosystem will involve a network of interactions among organizations and individuals working toward their own goals, with a defined set of authentication standards forming the structure of the network.

NSTIC's approach is not without its critics; other speakers will challenge some of NSTIC's assumptions and proposed strategies and recommend improvements.

"The challenge of developing strategies for a trusted, secure identity in cyberspace is related to SFI's work on novel forms of computation and computer security inspired by biology," says Chris Wood, SFI Director of the Business Network.

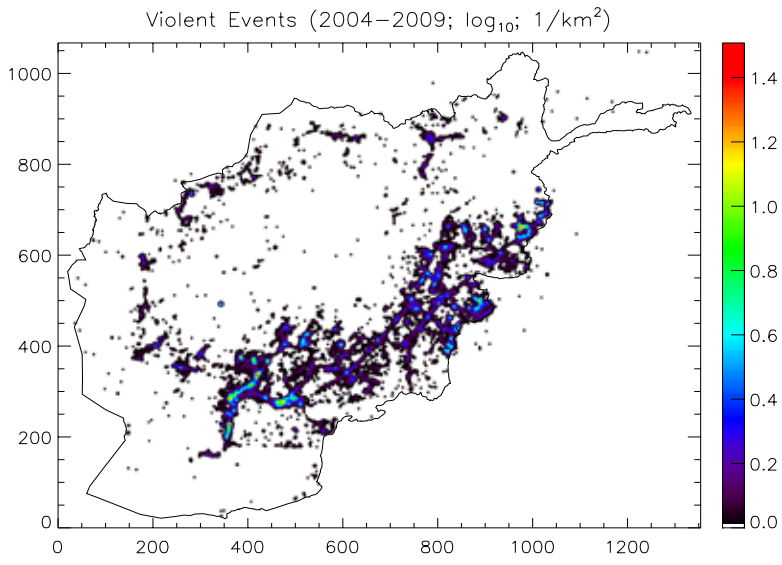
Applying the lessons of biology and natural systems to computers and other human-created systems is a recurring theme at SFI. External Professor Stephanie Forrest and her colleagues, for example, have used the immune system to develop an important new perspective on computer security, one with quite different assumptions and organizing principles than those of conventional computer security.

For more, visit www.santafe.edu/network/. ■

> *Patterns in information* continued from page 1

Bailey criminal court in England to look for patterns in trials that led to guilty verdicts.

"Courthouses are fundamentally an information processing system trying to come to a verdict," says DeDeo.



Violent event density map of Afghanistan from the WikiLeaks dataset. Violence circling the country indicates the frequent use of improvised explosive devices along the ringed road structure. The north-south light blue line in the south-central part of the country traces the contested Helmand River region, with its villages and opium trade. (Simon DeDeo)

In their analyses, which used techniques from information theory to place strict bounds on the predictive ability of their outcomes, the researchers found evidence for different distinct trial patterns: in other words, more than one pathway to a guilty verdict.

"The system is not just processing information, but doing so in a structured fashion," he says, "with separate and non-overlapping pathways through the decision process."

In a second case they studied five years of WikiLeaks-published military reports about insurgent attacks in Afganistan – data about locations, durations, combatants, and more.

"Insurgency is not just about violence," says DeDeo, "but also about signaling and coordination with rivals." An insurgent group's attack is a message to rival insurgent groups, to NATO forces, or to the civilian population.

"In the South, actions in some provinces were predictive of what would happen later in others, but not vice versa," DeDeo explains. This asymmetry suggests an underlying structure to a highly-dispersed conflict.

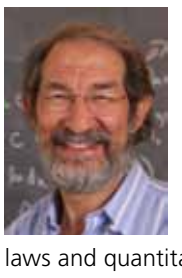
"In contrast to the *ad hoc* and fragile nature of many other methods of analysis, information theory provides an explicit and robust framework of assumptions that help you do the science," DeDeo says.

Their paper is available online at http://arxiv.org/abs/1302.0907. It is soon to be published in a special issue of the journal *Entropy*. ■

ACHIEVEMENTS

SFI External Professor Kazuo Nishimura has received a series of recognitions recently. In November the government of Japan awarded Nishimura its Medal of Honor with Purple Ribbon, which acknowledges his role in introducing methods from complex systems into economics. He founded the *International Journal of Economic Theory* in 2005 and serves on its editorial board. In December Nishimura was elected to the Japan Academy (Nippon Gakushi-in), also for his leadership in complexity economics. The Kyoto Newspaper Company has awarded Nishimura its Grand Award in Academics for his work in complexity economics and education. He also recently has been appointed as a professor at Kobe University. Nishimura is a professor in the Economic Research Institute of Kyoto University.

Two SFI External Professors, Brian Enquist and Herbert Gintis, have been named Fellows of the American Association for the Advancement of Science (AAAS). AAAS Fellowship is an honor bestowed on AAAS members by their peers. Enquist's appointment recognizes his contributions in the fields of ecology, plant biology, theoretical biology, and global ecology, and for pioneering contributions in the origin of biological scaling laws. He is a professor of ecology and evolutionary biology at the University of Arizona. Gintis is recognized for his multidisciplinary research modeling empathy, reciprocity, insider/outsider behavior, vengefulness, and other observed human behaviors not well handled by the traditional model of the self-regarding agent in economics. He is a professor of economics at Central European University.



The American Physical Society has awarded SFI Distinguished Professor Geoffrey West the 2013 Leo Szilard Lectureship Award for his "path-breaking work on the origin of universal biological scaling laws and quantitative models for structural and functional design of organisms, and for theoretical insights about the long-term sustainability of cities." The Szilard award recognizes outstanding accomplishments by physicists in promoting the use of physics for the benefit of society.

SFI Science Board member Martin Rees has been awarded the Isaac Newton Medal of the Institute of Physics. The award recognizes Rees's paradigm-shifting contributions to relativistic astrophysics and cosmology, as well as his mentorship of scientists, his leadership in the scientific community, and the impact of his nontechnical writings on the public understanding of science.

SFI External Professor Steven Frank was among 180 artists, scientists, scholars, authors, and leaders inducted into the American Academy of Arts and Sciences for 2012. Frank is a professor of ecology and evolutionary biology at UC Irvine.

SFI External Professor and Science Board co-chair Marcus Feldman has been named co-director of Stanford University's transdisciplinary Center for Computational, Evolutionary, and Human Genomics. The new center is an effort to harness the vast amounts of genomic data for the benefit of humankind.

A recent paper published in *PNAS* by SFI President Jerry Sabloff and Arizona State University geographer B. L. Turner, "Classic Period Collapse of the Central Maya Lowlands: Insights about Human-Environment Relationships for Sustainability," has been recommended as being of special significance in its field by *F1000 Prime*, an in-depth directory to the top articles in biology and medicine.

SFI Omidyar Fellow alum Nathan Eagle, CEO of mobile phone crowdsourcing company Jana, received the Market Research Society's inaugural President's Medal for his "extraordinary contribution to research." The MRS award citation says Eagle's work is an example of "someone making the most of advances in technology to design innovative research methods that can have an enormous impact on people's lives."

On November 9, Columbia University held a symposium celebrating SFI External Professor Joseph Traub's 80th birthday and his lifelong contributions to the field of computer science. More at www.cs.columbia.edu/symposium/

Trinity College (Dublin) has awarded former SFI Miller Scholar Sam Shepard an honorary doctorate, recognizing him for an "extraordinary body of literary work" that has "inspired a generation of writers, filmmakers, and theatre practitioners the world over." ■

NEW BOOKS BY SFI AUTHORS

Spin Glasses and Complexity (January 2013), by SFI Science Board member Daniel Stein and co-author Charles Newman, offers an accessible introduction to spin glasses, why they are important, and how they are opening up new ways of thinking about complexity. It then explores how spin-glass concepts have found applications in areas as diverse as computational complexity, neural networks, protein folding, immune response, and social network modeling. The book is the latest in the "Primers in Complex Systems" series, a collaboration between SFI and Princeton University Press.

In Decision Making and Imperfection (Springer, 2012), co-authors Tatiana Guy, Miroslav Karny, and SFI External Professor David Wolpert explore how decisions made in both natural and artificial systems often differ from those recommended by the axiomatically well-grounded normative Bayesian decision theory. The book identifies sources of imperfection and ways to decrease discrepancies between the prescriptive theory and real-life decision making. And it considers such questions as how a crowd of imperfect decision makers outperforms expert decisions; how to decrease the decision maker's imperfection by reducing knowledge available; how a human's limited willingness to master available decision-support tools is an additional source of imperfection; and how the decision maker's emotional state influences rationality.

Although animals may have first appeared nearly 700 million years ago with the earliest sponges, their initial diversifications appear to have been modest until a richly diverse fossil fauna appeared 170 million years later. In *The Cambrian Explosion: The Construction of Animal Biodiversity* (Roberts and Company, 2013), Doug Erwin and James Valentine synthesize research from many fields to explain why this period witnessed such remarkable novelty of animal forms. Erwin completed the book while serving as SFI's Chair of the Faculty. ■

> *Ecosystems* continued from page 1

In early March, Dunne convened the first of two SFI working groups on "Gradient-based Ecological Network Research." The meeting brought together ecosystem modelers with researchers who recently have compiled or initially analyzed datasets for mangrove islets, intertidal communities, rock pools, and pitcher plants. Together they began to explore the richness of the data and how best to learn from them.

"We make the most progress when we use data to develop and test theory, and use models and theory to shape new questions and find new ways forward in data collection," she says. "With this group of outstanding empiricists and theoreticians, we are asking questions like: How do trophic organization, species roles, and feeding motifs vary with changing conditions? Are these characteristics the same across time and space or do they shift – and if so, how, and why?" ■

March / April 2013
SANTA FE INSTITUTE

1399 Hyde Park Road
Santa Fe, New Mexico 87501
505.984.8800
www.santafe.edu

RESEARCH NEWS

Clio Andris: Defining 'personal space'

Clio Andris first took an interest in social relationships and geographic space while growing up near Washington, DC. She enjoyed reading school and church directories to see who lived near her and who lived near one another. She realized early in her scientific career that traditional distance- and population-based metrics of social connectivity lacked something important – the recognition that relationships matter.

"Economists and regional scientists have predicted where we will go and the places we care about using population and distance, wages, or climate, but never our personal relationships," she says. "These methods also haven't changed in the past 70 years. With the advent of GPS, flight, migration, phone, and online social network data, we have new evidence about how the individual actually carves out his or her own 'anthrospace' in the world, whether visiting home for the holidays, moving to a new location because of a spouse's job, or meeting up with a group of high school or college friends. The decisions we make rely on other people, and we can represent that spatially."

Now an SFI Postdoctoral Fellow, Andris is part of the Institute's cities and urbanization team led by Geoffrey West and Luis Bettencourt. The group studies relationships between micro-motives and macro-patterns of migration, communications, online relationships, and transportation flows. Currently she is exploring the hidden rules of intercity U.S. migration.

She hopes to show how relationships shape all past, present, and future human movement, and plans to work on a textbook on modeling relationships in geography. She is excited about the prospect of teaching and getting new students involved in this research.

She holds a PhD in urban information systems from MIT, where she was a member of the MIT SENSEable City Lab. ■

> *Networks and inequality* continued from page 1

ies all over the world, to discover what social network structures give rise to inequalities in wealth and political power.

Some of the basics of their analysis look very much like a sort of game and, in fact, use game theory. As Bowles explained during an SFI workshop on "Network Structure and Wealth Inequality" in February, social network models take into account the costs and benefits of connections, as well as the possibility of bargaining between players, in order to make predictions about how network structure and the distribution of wealth change over time.

SFI External Professors and economists Rajiv Sethi and Matthew Jackson presented crash courses in the mathematics of networks for the ethnographers participating in the meeting.

Hooper, who is collecting ethnographic data from the Tsimane, a group of Amazonian hunters and horticulturalists, models the structure of their social networks. Then he compares the results with real world data on the distribution of wealth in those societies. So far the data are consistent with the models, but there is still work to be done to improve the theory so it better represents observed reality, says Hooper.

"The more you can get your models informed by the data, the more you can leverage the models to ask what's going on," says Hooper. "There's a back-and-forth that's really productive."

The February NSF-funded workshop was part of SFI's Dynamics of Wealth Inequality project led by Bowles and UC Davis anthropologist Monique Borgerhoff Mulder. ■

Upcoming events

Science on Screen series returns to Santa Fe March 13

The popular Science On Screen series continues Wednesday, March 13, at 7:00 p.m., with Paula Sabloff's take on *Never Cry Wolf*. Dropped alone into the Arctic Circle to study the hunting patterns of wolves, a biologist discovers the deeper mysteries of the wild. Sabloff, an SFI Professor and anthropologist, brings a natural science perspective, gleaned from years of field work, to Carroll Ballard's 1983 Oscar-nominated classic.

Next screening: Wednesday, May 8 (note revised date), 7:00 p.m., SFI Research Fellow Simon DeDeo presents *Sneakers*.

The Science on Screen series is a joint collaboration of SFI and the Center for Contemporary Arts in Santa Fe. Advance tickets are recommended; for tickets and prices, call the CCA Box Office at 505-982-1338. All showings take place at the CCA (1050 Old Pecos Trail) in Santa Fe.

SFI's 2013 Community Lecture series debuts March 14

When a wildfire, earthquake or hurricane strikes, people typically seek information from authorities. Today, through social computing and networking technology, victims, observers, even "citizen-responders" are innovating ways they can participate in disaster response. On Thursday, March 14, at 7:30 p.m. at the Greer Garson Theater (1600 St. Michael's Drive) in Santa Fe, Leysia Palen will describe these emergent socio-technical phenomena and, using examples from events over the past few years, will discuss the implications for emergency response and society at large. Palen is an associate professor of computer science and project director for the ConnectivITy Lab at the University of Colorado, Boulder.

Next Lecture: Thursday, May 9, 7:30 p.m., James A. Little Theater, "The Minds of Children," Alison Gopnik, professor of psychology and affiliate professor of philosophy, UC Berkeley, and author.

SFI Community Lectures are free and open to the public, but seating is limited. Visit www.santafe.edu for a schedule of SFI's 2013 lecture series. ■