



November / December 2013

UPDATE



View of an island harbor by William Hodges, painted in 1774 during Cook's second voyage to the French Polynesians. (Source: Royal Museums Greenwich, Wikimedia Commons)

Why some Polynesians lived sustainably, others didn't

Humans arrived in what is now known as French Polynesia around one thousand years ago. Since then, people have lived sustainably on some islands but not on others. New NSF-funded research led by SFI Chair of Faculty Jennifer Dunne seeks to understand why.

The four-year, \$1.3 million project will apply methods from ecology, hydrology, oceanography, archaeology, demography, and economics to study relationships between initial ecological and environmental conditions and subsequent trajectories of human cultural development on four well-studied French Polynesian islands.

The researchers will use computational

models to test theories regarding long-term human-ecology-environment feedbacks. They are particularly interested in the dual roles humans played as subsistence consumers and market-driven exploiters of resources.

As part of the project, they plan to develop a comprehensive network model of coupled natural-human systems, including their robustness and resilience to external and internal changes; to apply the model to, and test it against, the introduction, persistence, and dynamics of Polynesians on the four islands; and to explore how the development and application of the model might support further advances in our understanding of diversity and complexity and their interactions with

ecosystem management.

"Such advances are vital for addressing critical problems at the intersection of social and natural sciences, including resource over-consumption, climate disruption, and catastrophic transitions in ecological and human systems," says Dunne, the project's principal investigator. Co-principal investigators include Neo Martinez (University of Arizona), Patrick Kirch and Neil Davies (both UC Berkeley), and Jennifer Kahn (College of William and Mary).

The research is among 21 new NSF-funded projects intended to promote a better understanding of how humans and the environment interact. ■

RESEARCH NEWS

30-year patent study: Energy innovation is booming

Innovation in energy technology is booming, according to an October 14 paper in *PLOS ONE* that examines what factors set the pace for energy innovation.

The analysis – co-authored by SFI Professor Luis Bettencourt, SFI External Professor Jessika Trancik of MIT, and graduate student Jasleen Kaur of the University of Indiana (Bloomington) – examines worldwide and regional trends in translating research into technology, and it models the relationship between patent production, funding, and markets.

"Patents reveal early stages of technology development, as they tell of the nature of innovative activity, and who's doing what where," explains Trancik, who notes that energy patents are growing faster than patents overall.

To see what's driving innovation, the researchers examined a dataset of more than 73,000 energy-related patents issued in 100-plus countries between 1970 and 2009. They used keyword searches of the patents themselves rather than the classifications assigned by patent offices.

Their analysis showed that the number of energy patents has risen dramatically over 30 years; that patenting of renewable energy technologies now outpaces that for most fossil fuels; that regions are beginning to specialize in certain kinds of energy technology innovation; and that both research and market growth are significant factors, acting together to drive innovation.

The team uncovered these results by creating [more on page 3](#)



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RESEARCH NEWS

Rethinking power grid science

Network theorists usually assume blackouts spread the same way diseases do – by close contact – but for power grids the relevant network is not the physical network of lines and towers and transfer stations, says SFI Professor Cris Moore.

The cascade of failures in a blackout can jump from one power line to another line hundreds of miles away as the flow of power in the network rearranges itself, says Moore, who hosted a workshop at SFI September 9-12 to explore ways to adapt network science to better model critical infrastructure networks such as power grids.

[more on page 4](#)

RESEARCH NEWS

Emergence meeting revisits original SFI theme

Electron clouds, cornfields, and societies all have one thing in common: the whole isn't just the sum of its parts. How that whole emerges from its parts – and whether there are common, fundamental principles guiding emergence across the sciences – has been a driving question for SFI scientists since the Institute's beginning. As the Institute approaches its 30th year, a group of scientists recently took time to revisit and build on questions of emergence.

Gateways to Emergent Behavior in Science and Society, a three-day workshop at SFI September 23-26, sought to develop an "informal network focused on the origins of emergent behavior," says SFI cofounder and Institute for Complex Adaptive Matter (ICAM) Founding Director Emeritus David [more on page 4](#)

On October 14 on the public radio show/ podcast *Big Picture Science*, SFI Research Fellow Simon DeDeo explains how and why emergence abounds both in nature and in human social systems.

In an October 14 piece in the *Santa Fe New Mexican*, SFI Research Fellow Simon DeDeo describes the promise of working with large datasets that capture human experience in an age of computation.

An October 14 paper in *PLOS ONE* co-authored by SFI Professor Luis Bettencourt, External Professor Jessika Trancik, and collaborators attracted coverage in *USA Today* and numerous other publications. The paper examines trends in and drivers

for energy innovation (see story on page 1 of this issue).

In *Wired* on October 9, SFI Research Fellow Simon DeDeo leads an article on the challenges of analyzing large, noisy, unstructured, dynamic datasets such as those that chronicle human affairs. The article was reprinted from *Quanta* magazine, and mentioned in the *National Review Online* and *Scientific American*.

On October 9 on BlogTalkRadio, SFI Research Fellow Simon DeDeo spoke with science journalist Jennifer Ouelette about new ways to study and understand complex social systems.

A September 27 article in the *Albuquerque Journal* noted that some 200 5th-8th grade girls were to spend a Saturday with New Mexico women who have chosen careers in science, technology, engineering, mathematics, and computing. The hands-on event was this year's Expanding Your Horizons Santa Fe conference, co-sponsored by SFI's GUTS y Girls program.

Newsweek on September 20 mentioned an SFI Community Lecture in which Steven Pinker and Rebecca Newberger Goldstein asked whether human moral progress is a gift of empathy and emotion or of reason and logic.

In a September 10 column in *Forbes*, SFI Trustee John Chisholm asks whether the

theoretical, scientific study of complex systems can inform the hardscrabble world of start-up firms.

A September 9 article in *The Guardian* about ways to build sustainable cities offers advice from several experts, beginning with SFI Professor Luis Bettencourt.

SFI Omidyar Fellow alum Laura Fortunato is among researchers studying changes to languages – and cultural practices – much as biologists study how living organisms evolve, according to a *New Scientist* cover story on September 5.

In a September 2 piece in the *Santa Fe New Mexican*, SFI External Professor and Science

Nonlinearities From the editor

By the time you read this, *The Counselor*, featuring a screenplay by our own Cormac McCarthy, will have opened on the American big screen. I'm certain "Rated R for violence, grisly images, sexual content, and language" doesn't come close to describing this flick, which I suspect will be as haunting as much of Cormac's other work. He tells the back-story like this: Surprised to learn that a Pulitzer Prize-winning author had never written a successfully produced Hollywood screenplay, he accepted the project as a personal challenge. Cormac McCarthy writes, Ridley Scott directs, and Brad Pitt stars – a promising equation, to be sure.

Lest you assume that's the only Institute arts and culture news this month...on the credits page of Sam Shepard's latest play *Heartless*, Sam graciously thanks SFI. *Heartless* opened on stage in New York late last year, but the printed edition was released in October.

There's more! *Blowback*, a just-released novel by SFI's Valerie Plame Wilson and co-writer Sarah Lovett, stars fictional Vanessa Pierson, a CIA operative who tracks a rogue nuclear arms dealer. Valerie, a former CIA agent herself with a fiction-mimicking career story, says she wanted to 1) address nonproliferation issues and 2) improve on the clichéd female spy character.

A hearty congratulations to Irene Lee, Director of SFI's Learning Lab, and her team for its national impact award from the Afterschool Alliance and the Noyce Foundation, which recognizes SFI's Project GUTS (Growing Up Thinking Scientifically) after school program. This award is the culmination of some top notch, innovative work over many years to rethink K-12 science education. More at www.santafe.edu.

Sadly, Joy Covey, a former Amazon.com exec and member of SFI's Board of Trustees from 2000 to 2009, died September 18 in a bicycle accident near Palo Alto. She was 50. I did not know her, but by all accounts she was a remarkable person. Our deep sympathies go out to her family and friends. What an incredible tragedy.

Now for a brief, related safety message: On behalf of all my cyclist friends and their families, please be careful out there, riders and motorists. And remember: In Santa Fe (and many other cities), drivers are required to give cyclists at least a five-foot safety margin. Please, slow down, wait, pass...especially on the particularly dangerous Hyde Park Road. We two-wheelers appreciate it. ■

– John German, jdg@santafe.edu

CREDITS

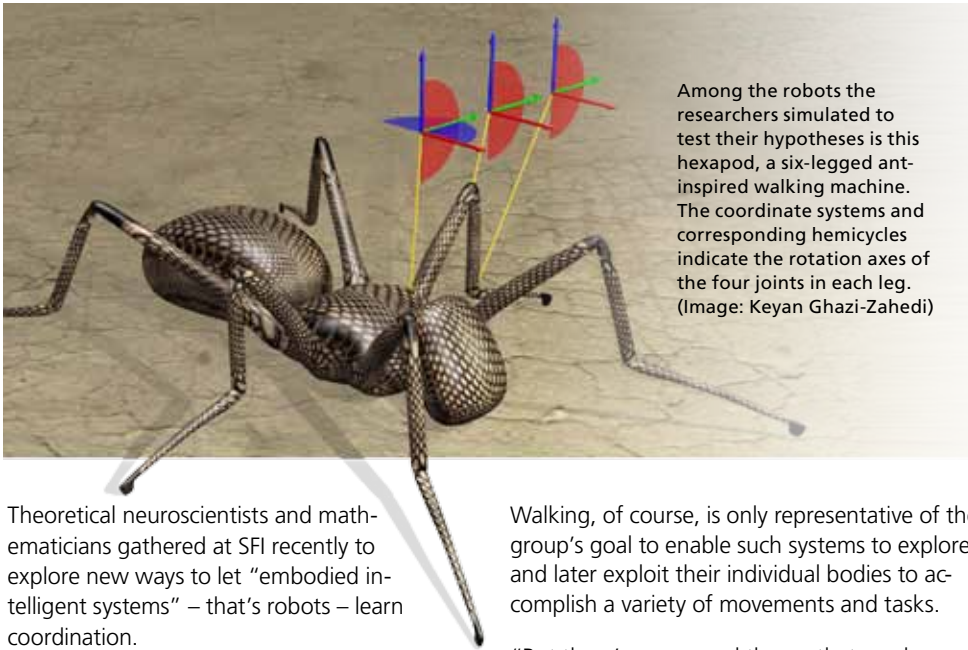
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The *SFI Update* is published by the Institute six times a year to keep its community informed. Please send comments or questions to John German at jdg@santafe.edu.

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RESEARCH NEWS

Working group: Let the robot learn



Theoretical neuroscientists and mathematicians gathered at SFI recently to explore new ways to let "embodied intelligent systems" – that's robots – learn coordination.

At the small working group October 8-11 at SFI, nine researchers began hammering out a new theoretical approach for enabling robots to learn to walk, for example, in much the same way infants do.

"It saves computational power," explains SFI External Professor and working group co-organizer Nihat Ay, "because you let the intelligent system express its own walking behavior specific to its own body" rather than try to copy another's walk. Just as people learn to walk with various body shapes, levels of agility, or injuries, the idea is to give intelligent systems coupled with their mechanical selves the algorithms they need to learn their own bodies.

Walking, of course, is only representative of the group's goal to enable such systems to explore and later exploit their individual bodies to accomplish a variety of movements and tasks.

"But there's no general theory that can be used to design intelligent systems that exploit their bodies," says Ay, who proposed the working group along with co-organizer Fritz Sommer of UC Berkeley in an effort to combine their two groups' complementary algorithmic approaches and so start generating such a theory.

By the conclusion of the meeting, participants had combined the two approaches and implemented them in a virtual environment. The next step, says Ay, is to test the combined approach and publish the findings.

The German science foundation DFG supported this event within its Autonomous Learning program. ■

RESEARCH NEWS

Complex societies in Bronze Age Europe

As the means to smelt ores and produce bronze began to spread through Europe around 3,000 B.C. or soon thereafter, the new technology was one small part of broader sweeping changes in agriculture, animal husbandry, warfare, traditions of construction and settlement, and trade.

In Mesopotamia and across much of the Mediterranean, these changes occurred alongside a corresponding increase in social complexity. In the Aegean, Minoan, and later Mycenaean regions, palace-based rulers used writing and accounting systems to monitor economic production, for example.

But to the north, in present-day Hungary and Romania, tribes kept simpler political systems despite having a rich farming base, all the components of bronze technology, and some evidence of trade contact with their southern neighbors.

The advent of the Bronze Age clearly affected different cultures differently, despite similarities in their situations. Whether, and in some cases how, such complexities arose was the theme of a mid-October working group at SFI.

"It's an unevenly explored subject from a continental point of view," says anthropologist

and archaeologist Eric Rupley, an SFI Postdoctoral Fellow who co-organized the meeting with SFI President Jerry Sabloff.

Participants considered questions such as how certain cultural configurations promoted social leveling mechanisms and prevented more complicated social hierarchies from arising, how much environment shapes regional economics, and how these leveling mechanisms were overcome in instances where economic political hierarchies evolved.

Archaeologists with specialization in Mesopotamian, Aegean, and Minoan societies and in regions in central Europe, Scandinavia, and Spain brought their insights into the drivers and constraints of social evolution. Experts on Oaxacan, Peruvian, and Venezuelan polities brought a comparative New World perspective, in which similarly administered political economies evolved independently of the European cases.

"There's no single way these states happen on the surface, as there is significant variability. But there's possible patterning below the surface," says Rupley. "We aim to explore the possibility that such hidden patterning existed." ■

RESEARCH NEWS

Finding intuitively shortest paths?

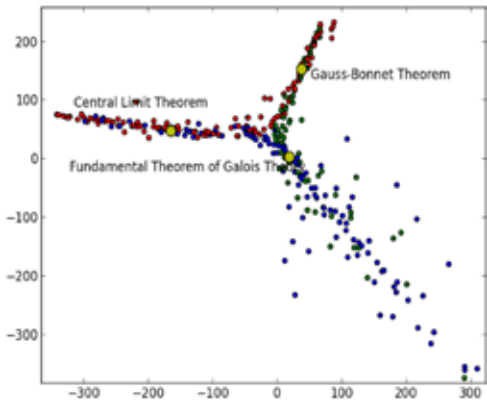
What's the shortest path from point A to point B? If your junior high geometry teacher is to be believed, the answer is a straight line. But what if you start from current Hollywood blockbusters and want to introduce yourself to the films of the French New Wave?

Whether it's movies, Wikipedia pages, or Amazon product recommendations, "the Web gives you an efficient way in terms of clicks to get from one place to another [but] not necessarily the best way" if an intuitive rather than speedy path is the goal, says Dartmouth mathematician and SFI External Professor Dan Rockmore. "Given what you already know, the best path might be one that allows you to move in a gradual way."

Rockmore and colleague Greg Leibon, chief technology officer at Coherent Path, Inc., believe the key is understanding the particular geometrical structure of a knowledge or product network. "It was clear...geometry was being underutilized," Leibon says, but less clear what that meant for networks.

Leibon and Rockmore's solution, recently published in *PLOS ONE*, was to identify a set of directions and then use the connections between adjacent points in the network to construct a sort of geometric "space" for representing and visualizing the underlying network.

Using Wikipedia's math pages, or WikiMath, as a test case, the first step was to define directions. In place of north, south, east, and west, the two chose math's major subjects – algebra, calculus, and so on. Next, they identified "minimum energy" steps in terms of the likelihood of clicking on particular links, which they used to generate WikiMath's geometry and its geodesics – essentially the most intuitive paths connecting two concepts.



Example multidimensional scaling plot of the conceptual distances between different WikiMath pages along the three directions, with the three theorems highlighted. (Image courtesy Dan Rockmore)

For walking around Seattle, that might mean avoiding steep hills. For WikiMath, it means taking small, intuitive steps – rather than jumping from algebra to calculus; it's smarter to check out mathematical functions and their limits first. Future work, Leibon says, will address how user feedback could improve an organization's understanding of its network's geometry. ■

Board member Stephanie Forrest notes that software systems have become so complex and interconnected – even evolving – that we should look to biology for insights.

An article in the September issue of *Harper’s* magazine pans 40 years of dubious, mainstream economic policies and reviews the history of “alternative economics,” starting with SFI Professor Sam Bowles’s move from Harvard to UMass Amherst in 1972.

Wikipedia acts a bit like one big brain, its editors working independently, yet somehow together performing an enormous cooperative computation, according to an August 30 *Science News* article about SFI Research Fellow Simon DeDeo’s work.

An August 27 article in the Science Careers section of the journal *Science* describes the challenges of cross-disciplinary collaboration, mentioning SFI as a research center that has successfully formalized the practice of working across disciplines.

SFI Omidyar Fellow Rogier Braakman, in an August 1 commentary in *Proceedings of the National Academy of Sciences*, reviews two scientists’ recent progress in simulating prebiotic chemistry at deep-sea hydrothermal vents and puts the research in the context of what we know, and what we still need to learn, about life’s beginnings.

PEOPLE

Wolpert, Lachmann join SFI faculty

Physicist and External Professor David Wolpert joined SFI’s resident faculty on a half-time basis on September 9, 2013. Biologist Michael Lachmann will join the Institute’s resident faculty on a full-time basis next summer. Both additions were announced in early September, following an August announcement that physicist Sidney Redner will join the resident faculty full time next summer.



Wolpert joins SFI from Los Alamos National Laboratory’s Information Sciences Group. His research extends far beyond the so-called No Free Lunch Theorems for which he and his collaborator William Macready

are best known. Over his 24-year career, Wolpert has studied the foundations of physics, problems in statistical inference and machine learning, methods for distributed optimization, and the intersection of information theory, economics, and social science, all topics he continues to study today.

“There’s just too much stunning stuff in all the sciences for me to restrict myself to just one of them,” he says. As a result, he has “worked at the junctions of fields that usually don’t talk with one another,” he says. “That’s where a lot of the breakthroughs of modern science have been, in my opinion, and where lots of future ones will lie. And those junctions are what SFI is about.”

Wolpert left UC Santa Barbara in 1989 with a PhD in physics, having studied neural networks and how best to generalize from the inferences such networks make. He attended one of SFI’s first summer schools on complex systems in 1988 and, following a prestigious Director’s Fellowship at Los Alamos, came to SFI as a postdoctoral fellow from 1991 to

1996. After 14 years at NASA’s Ames Research Center, he returned to Los Alamos in 2010 as an Ulam Distinguished Scholar in the lab’s Center for Nonlinear Studies.



Michael Lachmann, an assistant professor at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, has longstanding ties to SFI, having attended the Institute’s Complex Sys-

tems Summer School in 1994 while studying at Stanford University under Science Board member and External Professor Marc Feldman. After receiving his PhD in 1998, Lachmann came to SFI as a postdoctoral fellow and worked with SFI Professor Cris Moore and External Professor Mark Newman, among others. Lachmann left SFI for a postdoctoral fellowship at the Max Planck Institute for Mathematics in the Sciences in 2002.

His interests have broadened, but evolution continues to be a focus. “I am interested in understanding the process of evolution itself – how it gathers information, how it originates, how it creates adaptation and function,” Lachmann says.

In addition to studying the origins and functions of evolution, Lachmann says he plans to continue research on the connections between information and evolution, the evolution of biological differentiation, and the population genetics of early humans.

“We are very pleased to have David and Michael join us,” says SFI Chair of the Faculty Jennifer Dunne. “They both bring unique, needed skills and perspectives that will complement those of our current research faculty.” ■

> **Energy innovation** continued from page 1

a model based on a two-stage process that captures how technology innovation generally develops.

“Most technological knowledge requires a long incubation period, often relying on public R&D investments, but then things can suddenly take off if ‘virtuous cycles’ of innovation and market expansion kick in,” explains Bettencourt. “This has happened with many familiar tools, such as the internet and cell phones, so we wanted to better understand if it may be about to happen among new energy technologies.”

The paper notes that public support for in-

novation in low-carbon energy technologies is typically required for lengthier time periods than in many other sectors, as carbon emissions are an aspect of performance that is not apparent to consumers nor included in the price of energy.

Perhaps the most important study outcome, Trancik says, is the confirmation that the benefits of knowledge created, either from basic R&D or from market growth, persist and tend to ripple through new ideas and technologies for many years to come: “A dollar invested early on, even back in the energy crisis in the 1970s, is still useful today,” she says. ■

SFI Online

Multimedia content available at www.santafe.edu



Audio: SFI External Professor Elisabeth Wood describes her research of the systematic rape, torture, and other civilian abuse by soldiers during wartime. Source: Santa Fe Radio Café interview



Audio: SFI External Professor W. Brian Arthur explores how new technology is created, and how closely evolutionary processes in technology mirror those from biology. Source: Santa Fe Radio Café interview



Video: SFI External Professor and Science Board member Stephanie Forrest, in a series of three lectures, reveals surprising commonalities between computers and organisms, then describes research that blurs the distinction further. Source: SFI 2013 Stanislaw Ulam Memorial Lecture Series



Audio: SFI External Professor Doyne Farmer discusses his choice of the campy but prescient *Zardoz* as his movie pick for the recent Science on Screen presentation in Santa Fe. Source: Santa Fe Radio Café interview

Upcoming events

Saturday, November 2, 7:30 p.m., The Majesty of Music and Mathematics. SFI Professor Cris Moore and The Santa Fe Symphony take their audience on a journey, from the rhythms of molecules and planets to the harmonies of dolphins and the dissonances of the “devil’s interval,” from the music of Strauss to the theme song of *Harry Potter*, from the earliest bone flutes 40,000 years ago to the soundtracks of modern cinema. This fourth concert in the SFI-SFO Voyages of Discovery series takes place at the Lensic Performing Arts Center in Santa Fe. Tickets are available through The Symphony box office at (505) 983-1414. This event is generously underwritten by the Andrew and Sydney Davis Foundation.

Wednesday, November 6, 7:30 p.m., SFI Community Lecture, Turing’s Cathedral: The Origins of the Digital Universe. The two most powerful technologies of the 20th century – the nuclear bomb and the computer – were developed in New Mexico at the same time and by the same group of young people. But while the history of the Manhattan Project has been well told, the origin of the computer is relatively unknown. In his book *Turing’s Cathedral*, historian George Dyson tells the story of how a small band of geniuses not only built the computer but also foresaw the world it would create. Dyson is an author and historian of technology. This final lecture in the 2013 SFI Community Lecture series takes place at the James A. Little Theater (1060 Cerrillos Road) in Santa Fe.

SFI’s 2013 Community Lectures are made possible through the generous support of Los Alamos National Bank. Lectures are free and open to the public, but seating is limited. Visit www.santafe.edu for more information.

Lectures are now broadcast live online. To watch a lecture as it happens, visit SFI’s YouTube page. Participate in the discussion live on Twitter at #sfi_live. ■

INSIDE SFI

Five selected for journalism fellowship

Five journalists have been selected for the new Santa Fe Institute Journalism Fellowship in Complex Systems Science.

The fellowship is generously supported by SFI Board of Trustees Chair Emeritus Bill Miller. It identifies accomplished reporters who have demonstrated an interest in complex issues and offers them an immersive experience in complex systems science at SFI.

The inaugural fellows represent diverse backgrounds and career stages, notes SFI President Jerry Sabloff. “These exceptional journalists get our Fellowship off to an outstanding start toward its goal of offering one of the world’s signature news media fellowships,” he says.

The five inaugural fellows are:



Sandra Blakeslee is a science correspondent for *The New York Times*. In four-plus decades with *The Times* she has covered nearly every topic in science. She has authored or co-authored nine books, her most recent on the human microbiome and the deleterious effects of antibiotics on our health (with Martin Blaser at NYU). She tentatively plans to spend November 2013 at SFI.



Veronique (Nikki) Greenwood’s freelance reporting spans the spectrum of scientific disciplines. She has contributed



to such publications as *Discover*, *Scientific American*, *Popular Science*, *The New Yorker*, *TIME*, and *The Atlantic*. She plans to spend May through June 2014 at SFI.

Guy Gugliotta is a free-lance science journalist contributing to *The New York Times*, *The Washington Post*, *Smithsonian*, *The Atlantic*, *Wired*, and other publications. He is co-author of *Kings of Cocaine* and author of *Freedom’s Cap*. He plans to be at SFI from February through early May 2014.



Julie Rehmeyer’s science and mathematics reporting has appeared in *Science News*, *Discover*, *Wired*, *New Scientist*, *Science*, and *Technology Review*. She also writes the popular math column in *Science News*, Math Trek, and *Wired’s* occasional math column, Equation. She plans to spend January 2014 at SFI.



Alexandra Witze is on the staff at *Nature* as a contributing correspondent and is a regular contributor to *Science News*. She has freelanced for such publications as *The Economist*, *American Archaeology*, *New Scientist*, *Technology Review*, and *Sky & Telescope*. She plans to spend February 2014 at SFI. ■



Sande Deitch: Life infused with science



Spend five minutes with SFI donor Sande Deitch and you'll know that "lifelong learner" doesn't quite describe her. Her insatiable curiosity and enthusiasm are what both define her and energize her work in the arts and the sciences.

An artist by training who studied at Juilliard and the Santa Fe University of Art and Design, Deitch was for two decades affiliated with the Pittsburgh Center for the Arts, first as an artist, then as director of exhibitions and programs, and finally as executive director. Later, as executive director for the Bayer Foundation, she was the architect of its award-winning science literacy outreach

program for children called Making Science Make Sense. Her goal was to help kids see that science is infused in everyday life.

"Science is something people think is so *highfalutin*," Deitch says, laughing, "yet it's all around us."

After a five-year sojourn in Mexico, she moved to Santa Fe in 2003, where she settled just down the road from the Institute. Her daughter suggested that she attend an SFI Community Lecture that fall at the Lensic, and with that Deitch was enthralled.

"I wanted to know more about what they were doing up there," she says.

She is excited to be more involved with SFI and is particularly interested in the Institute's new Science Club for President's Circle donors. Deitch also sits on the board of SITE Santa Fe and is a commissioner with the Santa Fe Arts Commission. ■

> Power grid continued from page 1

Rethinking such critical infrastructure networks as "virtual or effective networks of dynamic connections" is a promising approach, he says, with possible insights to come from studying other highly dynamic networks such as food webs.

"A lot of what we were focusing on in the workshop," says workshop co-organizer Matthew Koehler, MITRE's Complexity Sciences Area Lead and a member of SFI's Business Network, "was trying to figure out what is the next step in the development of the tools and techniques of network science to get it past its current limitations."

Participants, including co-organizer Paul Hines of the University of Vermont, agreed that the next step was overcoming four challenges:

getting more data to better understand the complexity and heterogeneity of critical infrastructure systems, understanding tradeoffs between detailed but slow physics-based models and abstract and quick network-based models of such systems, validating models once they are identified, and translating the output of validated models into information that is useful to decision-makers.

This was the second recent SFI workshop on the topic organized by Moore. He says he is pleased with this workshop's results but recognizes the problems of protecting critical infrastructure as long-term challenges. He adds that he is hopeful that the coming year will bring sabbatical visitors to SFI "so we'll have critical mass in-house to make some major progress." ■

Complexity MOOC under way

SFI is re-offering its popular massive open online course (MOOC) in complex systems science, "Introduction to Complexity." The course session opened on September 30; you

can begin taking the class at any time says SFI External Professor Melanie Mitchell, the course's instructor. For registration information, visit <http://complexityexplorer.org>. ■

> Emergence continued from page 1

Pines, who organized the meeting with fellow SFI Science Board members John Holland, Simon Levin, and Donald Saari.

A diverse cast of participants focused on identifying what Pines calls "gateways" – concrete scientific principles that explain how a particular system's behavior emerges from its constituent parts – and whether those gateways might have relevance across traditional scientific boundaries.

Pines says the workshop's goals required both young and established scientists from many fields that included biology, physics, mathematics, and ecology. "We all know that almost all of the exciting problems in emergent behavior we work on require input from a number of disciplines," he says. "You begin breaking barriers down by exposing

people to a wide variety of exciting perspectives from different disciplines."

In addition to expanding SFI's and ICAM's network of researchers interested in gateways, another outcome will be to engender a Gateways Registry: a Wiki-based repository where members of the scientific community can describe approaches to emergence that have proved successful in their own research.

The workshop also addressed ways to use the gateways concept in science education and public engagement. ICAM has developed a website, emergentuniverse.org, aimed at younger adults, Pines says, and a number of workshop participants agreed that emergence would be a good way to introduce middle schoolers to science. ■



Statistical models helping examine cultural evolution

Does culture evolve like plants and animals, or is it immune to the pressures of Darwinian-style natural selection? Archaeologists have long pondered how designs painted on pottery, for example, change over time. One possibility is "cultural evolution," where different designs live on or die out based on what people like, with those preferences serving the same role as evolutionary fitness in biology. The alternative is neutral evolution, in which people's preferences are irrelevant, and designs change essentially at random.



Broken pot patched and decorated with pitch and bark, found inside a Linear Pottery Culture well in Germany (Image: Wikimedia Commons)

SFI Omidyar Fellow alum Anne Kandler (University College London) and archaeologist Stephen Shennan are taking a quantitative tack, building statistical models describing how cultural artifacts change over time, an approach that helps make better use of scant data, they say. As a test case, the pair studied pottery decorations from the Linear Pottery Culture – a 7,000-year-old central European culture with an unusually complete archaeological record – and found that natural selection-like pressures probably drove the decorations' evolution. They want to extend their methods to deal with much less complete archaeological records and to problems beyond archaeology, such as questions in anthropology and linguistics.

Analysis: Gender disparities persist in academia

Although gender disparities appear to be decreasing in academia according to a number of metrics, a recent large-scale analysis that examined more than eight million scientific papers reveals a number of subtle but persistent ways gender inequities remain.

The authors of the study, including SFI External Professor Carl Bergstrom, note that even where raw publication counts seem to be equal between genders, close inspection reveals that, in certain fields, men predominate in the prestigious first and last author positions. Moreover, women are significantly underrepresented as authors of single-authored papers. Academics should be aware of the subtle ways that gender disparities can occur in scholarly authorship, they say. The paper was published July 22 in *PLOS ONE*.

Socially influential people can boost microloan programs

In a recent paper in *Science*, SFI External Professor Matthew Jackson and collaborators show that microloan programs in India were more successful when well-connected people helped spread the word. To test this hypothesis, they developed a new measure of social influence they call "diffusion centrality" that incorporates not only how many friends a person has but how well connected a person is to other people who are well connected.

Looking at a program in 43 villages outside Bangalore, the researchers found that participation in microloan programs increases by about 11 percentage points on average when well-connected local residents are the first to gain access to the programs. Jackson described the research as a unique opportunity to witness how social network structure affects human behavior. ■

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UPDATE

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