Q&A: Jerry Sabloff on 30 years of complexity

At the turn of the new year, Institute President Jerry Sabloff offers his thoughts about SFI's outlook for 2014 and beyond.

Update: Today, with this interview, SFI begins to mark its 30th year. What are SFI’s top achievements, in your mind, since its founding in 1984?

Jerry Sabloff: The key contributions, I think, are important new insights into the nature of complex adaptive systems and the transdisciplinary methodologies that SFI has used to explore the emergence and continuing development of complexity at all scales, from atoms and cells to human societies. One of the great insights of SFI’s founders – the late George Cowan, Murray Gell-Mann, David Pines, and their colleagues – was that no single discipline could achieve a full understanding of complex adaptive systems. So they instituted, almost into SFI’s DNA, a transdisciplinary approach – anthropologists working with computer scientists and mathematicians and biologists and so on. This methodology has proven to be incredibly successful, and it is now widely adopted in universities and research centers and funding agencies in this country and around the world.

Update: More on page 7.

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Spectral redemption: Finding the hidden groupings in networks

A persistent problem for mathematicians trying to understand the structures of networks is community detection: finding groups of related data points, or nodes.

Detecting communities in real-world network data is important for understanding, for example, how fast a disease will spread in one community and how likely it is for it to cross to another community.

Traditionally, mathematicians find communities in one of two ways: statistical inference, a highly iterative method that reassesses network-wide probabilities at each step, and spectral analysis, a faster “random walk” technique that groups nodes by focusing on the flow of information or probability through a network.

Both techniques work well for networks with dense webs of links between nodes, says SFI Professor Cris Moore.

But in sparse networks where each node is linked to just a few others, as in the case in many real-world networks, classic spectral techniques fail short – meaning that unlike statistical methods, spectral methods often fail to find groupings down to a theoretical limit revealed by Moore and collaborators in a 2011 paper.

The challenge for mathematicians has been, then, to find a spectral method that is computationally efficient and that reliably finds groupings down to the theoretical limit.

In a recent paper in PNAS aptly titled “Spectral Redemption,” Moore and collaborators try out a modified spectral method they call the “non-backtracking operator.” Put simply, it specifies that during analysis, information flowing from node to node may not immediately return from whence it came.

“Traditional spectral methods get stuck on highly connected nodes, rattling back and forth between those nodes and their neighbors,” Moore says. “They get confused.”

Spectrum of the non-backtracking matrix indicating the community structure of the network being analyzed.

How a species stays relevant as it changes its world

How complexity evolved in cells is a question as intriguing as it is difficult to explain. Though we cannot fully solve the puzzle, we can learn how species give themselves time to go from random to programmed development. A new study reveals an optimal switching rate between forms of a species as it makes its environment less livable.

“If you’re a bacterium in a beaker, just by the process of growing and dividing, you’re changing the environment into one that no longer favors you,” explains Eric Libby, an SFI Omidyar Fellow who specializes in mathematical microbial evolution. “You then have two options. One, go extinct. Two, throw off a mutant that’s adapted to the new environment.”

RESEARCH NEWS

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RESEARCH NEWS

January / February 2014

SANTA FE INSTITUTE


1984 – 2014

In 2014, SFI celebrates its 30th anniversary. Watch SFI’s website and publications for a yearlong celebration of the Institute’s storied history, and for opportunities to be an active member of SFI’s community.

SFI’s special 30th anniversary logo (above) was created by graphic designer Michael Vittitow to mark the occasion.

LINKS IN THIS ISSUE

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- > more on page 7
- > more on page 5
In a December 9 essay in New Scientist, SFI Professor Luis Bettencourt explains how cities are like stars — in one sense, both are imposing entities of interaction — and offer four principles for understanding cities.

In a December 2 article in the Santa Fe New Mexican, SFI’s Chris Wood offers perspectives from a recent SFI meeting in Santa Fe about Big Data and predictive analytics and whether they are a gold mine for business, science, and government or a serious threat to privacy and freedom.

In an interview in the December issue of International Innovation magazine, SFI President Jerry Strollhoff discusses the Institute’s history, its contributions to complex systems science, and his hopes for the Institute’s future.

Several publications covered November 28 in the New Statesman about the fortunes and failures of Apple, Google, and Facebook cites Distinquished Professor Geoffrey West and SFI research on the life cycles of companies.

In a November 25 article in Time magazine about the cultural ingredients of inventive-ness, SFI Distinguished Professor Geoffrey West notes that creativity and social interac- tion accelerate in complex systems, the reason they generate so many patents.

In Scientific American on November 6, Jaron Lanier explores the dilemmas of data privacy, citing his work with economist and SFI External Professor Ben-Alihouse, and his interest in understanding what happens when users of personal data pay for that use.

In an October 28 article in the Santa Fe New Mexican, SFI Professor Cris Moore explores the hidden patterns in music and mathematics and discusses a special orchestra concert November 2 at the Lensic Performing Arts Center in Santa Fe.

Nonlinearities
From the editor

With this issue we begin the Insti- tute’s 30th year. SFI’s past is rich with stories and even legends, and we plan to share much of that lore with you over the next 12 months. We start on page 4 of this issue with a peek back into the Institute’s pre-history, when a group of scientists convened at a place where they could do research across disciplinary boundaries, nurture emerging disciplines, and venture into new theoretical territories.

This was revolutionary thinking, and at its core was a character of mythic proportions. What has struck me, as I’ve interviewed many of the people who were there, is just how easily it could have gone wrong without the unifying force of George Cowan and his conviction to see this grand experi- ment through.

We’ve launched a 30th anniversary website at www.santafe.edu, where all year you will find storytelling about SFI’s past.

None of this work has ever been pos- sible, of course, without the generous support of SFI’s community. The only way for the founders to reach the scientific nirvana they sought was to build a truly collaborative fund- ing model, that constrained academic and government research freedom. Our 30th anniversary comes with a campaign, and Nancy Deutsch and her Advancement team have put together a number of compelling opportunities for you to get involved. See page 8.

Tanya Elliot, one of SFI’s first Omidyar Fellows, succumbed to cancer in No- vember. This news sent reverberations throughout the Institute. She was young and talented and she left behind a family. She is deeply missed. To keep the remembrance, please visit SFI’s website.

We held a special tea for Research Fellow Simon DeDeo, another of SFI’s inaugural class of researchers, in December. If there’s one thing about Simon, it’s that he can’t leave data alone, especially about human behav- ior. His brief goodbye speech, appar- ently written on the back of a napkin, featured a quantitative analysis of his own drinking habits. While at SFI he estimates he drank 569 gallons of tea, an average of 400 cups of tea per day, which is 34 gallons a year. It was an excellent science communicator and friend, and I will miss him. Good luck Paul and Tanya.

Congratulations to past Omidyar Fel- low Nathaniel Collins. He and his wife Theresa Buckley were blessed with a boy, Connor Collins, on December 9.

Finally, a recent exchange at SFI:

“You are now a knight?” Female visitor: “February 10, but the standard devia- tion is 10 days.”

— John German, jdg@ santafe.edu

ReSEARCH NEWS

Who drinks withwhom when? Drinking and reciprocity

Some groups keep spirits high by taking turns hosting events or buying the next rounds of drinks. SFI Omidyar Fellow Paul Hooper, SFI Research Fellow Simon DeDeo, and their colleagues have recently explored the patterns of reciprocity vary with people’s closeness, both geographically and geneti- cally, by analyzing who drinks with whom and how often.

Evolutionary biology holds that social rela- tionships can form in a number of ways. One is by virtue of kinship: related organisms, be they slime molds or baboons, have a shared interest in keeping their shared genes going, explains Hooper. Another is simple reciproc- ity: where kindness is repaid, evolution favors the bond of friendship.

During a research trip in Bolivia, Hooper, an evolutionary biologist, his host, and the re- searcher’s partner Annie Holoper Caldwell looked at how reciprocity varied with kinship and distance based on a favorite local pastime. Families in villages throughout South and Central America frequently host parties where friends and relatives gather to socialize over rounds of chicha, a lightly alcoholic beer.

By peeling and boiling sweet manioc (a starch tuber), then chewing boiled pieces to introduce enzymes, women prepare jugs of it every few days.

The pair interviewed household members of a small Amazonian village of the indig- nous Tsimane’ tribe twice a week over four months to see who hosted whom at chicha parties, and how often the favor was repaid. Using computational analysis techniques de- veloped by DeDeo, the team found that the more related the households, the more often they drank together. (As relatedness is also a determinant of living proximity, an indirect effect of kinship emerges where a household ends up partying with neighbors who tend to be kin.)

The study, “Dynamical Structure of a Traditional Amazonian Social Network,” published in the journal Entropy, also found a reciprocity signature among friends and distant relations: one family hosting another doubles the chance the second will host the first within three days. Hooper explains that rules of etiquette appear to apply to more distant bonds, as it’s polite to return the fa- vor promptly, but closer relations don’t keep track.

“It’s a clear test of the theory of reciprocity, which has been beset by a lot of doubt since it was introduced in the early seventies,” says Hooper. The study’s novel analyses make the findings particularly robust and offer new methods for future studies, he notes.

> Spectral redemption
continued from page 1

by localized structures in the network rather than finding the large-scale structures we care about.”

The researchers tested their non-backtracking method on several networks commonly used to test various clustering algorithms. They found that their method succeeds all the way down to the theoretical limit, performing as well as any algorithm can. It also provides an estimate of the number of clusters, helping solve an- other thorny problem in network analysis.

Co-authors include Elishan Mossel, Joe Neeman, and Allan Sly (UC Berkeley); Lenka Zdeborová and Florent Krzakala (ENS, France); SFI Postdoctoral Fellow Pan Zhang; and Moore.
How shifts in behavior shape human institutions

As part of an October 21 Q&A on the Exploring Politics blog, SFI Professor Paula Sabloff says although the ideals of democracy appear to be globalized, how people relate to their governments varies according to particular perspectives.

On October 14 on the BBC Radio program “The Digital Human,” SFI Distinguished Professor Geoffrey West helps explore the hopes and challenges of rapid urbanization including the sustainability of smart cities. In Forbes on October 11, Jonathan Haidt and David Sloan Wilson posit that Darwinian evolution is a good starting point for a grand theory of business, citing research by SFI Professor Herbert Gintis.

Whether they’re incremental or cataclysmic, shifts in behavior often prompt feedback effects through social systems. For example, a wartime labor shortage, post-war economic growth, and a growing sense of gender egalitarianism are a few of the interconnected factors that have led women in Western European countries to work outside the home. Often, drivers of change in attitudes and behaviors among people, social groups, and institutions in turn affect other sources of governance. These reciprocal relationships are what SFI’s Coevolution of Behaviors and Institutions working group has explored since it started meeting in 1998.

The group gathers again in January at SFI, led by SFI Professor Sam Bowles, head of the Institute’s Behavioral Sciences Program. Participants include anthropologist Robert Boyd (Arizona State University, SFI Cowan Professor), and economists Larry Blume (Cornell, SFI External Professor), Peyton Young (Oxford), and Herbert Gintis (Central European University, SFI External Professor). Its members study how the institutions that regulate social interactions—such as economic exchange, marital matching, and cooperation and conflict within and between groups—shape the evolution of individual preferences, norms, and other motivations, and in turn how the resulting individual behaviors shape the evolution of social institutions.

To sharpen the theory-building process, we address such empirical puzzles as the innovation, persistence, and demise of institutions and behaviors working group has explored since it started meeting in 1998.

Among the attendees this January are Diego Gambetta, a sociologist from Oxford with expertise in trust within extra-legal systems such as the Mafia; he will show how collective identity affects trust and cooperation between ethnic groups in his session “The Geography of Ethnic Diversity.”

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Research News

Infectious notions: Applying disease dynamics to ideas

When Ben Althouse and Laurent Hebert-Dufresne attended SFI’s 2012 Complexity Systems Summer School, they began a productive collaboration, developing a model of influenza resistance to anti-viral medications. Later, working with SFI Research Fellow Simon DeDeo, the team applied the contagion model to social dynamics.

“It turns out the models are equally applicable to both systems,” explains Althouse, who recently joined SFI as an Omidyar Fellow.

In the biological case, when someone is treated with antivirals, there’s a chance the viral strain will develop a mutation that makes the antiviral ineffective. The infected person then can have two strains: susceptible and resistant.

In the world of ideas, a person being aware of two complementary or conflicting thoughts simultaneously can result in the ideas boosting each other, or one notion replacing the other. As ideas spread through a population, this phenomenon is repeated, each idea spreading and lingering at various speeds. Idea modeling tracks its own set of complexities distinct from disease modeling, for example, one can harbor dozens of ideas rather than a strain or two of a pathogen.

A recent SFI working group on the topic, From Confection to Cultural Dissonance: New Challenges for Biological and Cultural Evolution, involving the three researchers ran for a month. They looked to perhaps the best high-volume, publicly available, and massively interconnected contemporary network to develop and test its idea models. Twitter. They sampled one percent of all tweets from Twitter users globally for over a year. The amount of data is staggering: a single 30-minute interval can yield 75,000 samples.

“Twitter is vast,” says Althouse. “There are a lot of ideas bouncing around, a lot of memes, ideas that come up quickly, hang around, then go away, so it’s a good place to look at the replacement of one idea with another.”

Following a good deal of brainstorming about the best ways to apply epidemiological models to memes, the group is now running simulations of how contagious ideas spread.

Ruben Andrist: Quantum memory and fragility

Quantum computers offer a radical leap in computing power because quantum bits can exist in parallel states, thus taking on many values at the same time. Theoretically, this means a quantum computer could run all the rows of a multiplication table at once rather than computing it row by row, one factor at a time, as classical computers must.

But there are many obstacles in the construction of a true quantum computing system. With his background in statistical physics and spin glass theory, Andrist’s research focuses on the comparison of quantum memories and how they would allow for error control in a quantum computing system. “It turns out the reason we don’t have quantum computers yet is that the systems you use to build the quantum computer are very fragile,” he says. “If you want to be able to control (a quantum system), you have to fiddle with it, touch it, and deal with any errors.

But to observe any part of the quantum system is to destroy the very property of parallelism that makes it powerful. “There is a trade-off between youisolating the system and you actually being able to control the system — it is an inherent flaw of a quantum computer,” he says.

The method Andrist uses to test the validity of quantum layouts is to deduce, from the interaction of the remaining elements, which qubits in the system might be faulty: in other words, identify faulty elements of the system without directly observing them. This allows him to figure out how many qubits, and in what arrangement, would allow programmers to store information reliably and correct errors along the way.

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Conception to birth: A gleam in one scientist’s eye

By John German

In George Cowan’s telling, the notion for a Santa Fe Institute began to form in the summer of 1956. He had been invited to the Aspen Institute, where prominent intellectuals from the arts, science, and culture gathered for free-form philosophical exchanges. He had just participated as the lone scientist in a discussion of literature. For his part, he had chosen to talk about entropy—the tendency of systems to move toward disorder—and what insights this principle from thermodynamics might offer about the workings of human society. His talk was not well received by the other participants, who were more accustomed to the ideas of Socrates, Aristotle, and Plato than those of Boltzmann. Nor was Cowan fully satisfied. Although he was energized by the mingling of perspectives, as a scientist he thought: “This would be an even greater idea if the discussion were driven by facts rather than essays.”

Science serving society
Cowan had always believed the physical sciences held great promise for solving human problems, and he had good reason. As a promising young chemist before and during World War II, he was among the scientists at the center of the international race with Nazi Germany to be the first to harness the power of the atom and to wield that power for socio-political ends. After the war, the urgency intensified as the U.S. and Soviet Union engaged in a global, nuclear-scale standoff. By the beginning of the 1950s, Cowan took the first tangible steps toward enlisting the physical sciences to serve society.

As a member of the National Academies, Pines knew that Cowan’s idea was well received by the other participants, who were more fascinated by the mingling of perspectives, as a scientist he thought: “This would be an even greater idea if the discussion were driven by facts rather than essays.”

The Manhattan Project to the Santa Fe Institute
The week-long workshops, which took place in late October and early November 1984, were titled “Emerging Syntheses in Science.” They were held at the Institute of Technology, the University of Illinois in Urbana-Champaign.

The prestige of Pines, Gell-Mann, Anderson, Metropolis, and others was important. It made a lot of sense to me.”

The foundress always wanted to name the new center the “Santa Fe Institute.” But a local treatment center for recovering alcoholics already held the name to the name. In May 1984 the Institute was incorporated under the alternative name “Rio Grande Institute.” (Several months later, Cowan purchased the preferred name “Santa Fe Institute” from the struggling treatment center for $5,000 and changed the Institute’s name to the “Santa Fe Institute for Science.”)

In summer 1984 there were still many questions, of course. The founders group knew private funding would be needed to foster the independent nature they envisioned for the new center. They knew it would need a physical presence in Santa Fe, and they wanted an attractive director and a staff. There was little consensus regarding what scientific themes the center would tackle.

“Everybody had their favorite topics,” Pines says. “Mine was to have an institution without frontiers and to find and bring in people like us, but 30, 40, 50 years younger.”

But by far the biggest obstacle, says Pines, was that “we had no audience.”

Bringing in the best
Herb Anderson offered a possible solution. He suggested a workshop in Santa Fe with as many top scientists as would participate. “The idea was to bounce our idea off of people and see what they thought of our game plan,” says Pines.

That plan included developing networks of researchers around particular cross-disciplinary topics of interest to the scientific community. Wrote Cowan: “Herb Anderson said ‘Pick out the best people, bring them in, and ask them to tell us what interests them’…We were picking the people, not the topics.”

Assuming the rate of acceptance would be low, the organizers extended many invitations. To their surprise, says Pines, “about 90 percent of the people we asked accepted.”

To accommodate the larger crowd, the founders asked Santa Fe’s School for Advanced Research for the use of its meeting room, beginning the informal institutional tie that continues to this day. Two workshops were scheduled rather than one.

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The prestige of Pines, Gell-Mann, Anderson, Metropolis, and others would prove to be a key factor in attracting top minds to the fledgling institute. Cowan later wrote.

Pines, whose present-day title is SFI Co-founder In Residence, today calls the founders group the “Cowan Collaborative.” “It was a truly collaborative effort, with George guiding our discussions,” he says. “He practiced true leadership. He had vision, but most of the time he did not talk.”

As the discussions continued in Los Alamos, Cowan secured a post office box in Santa Fe, P.O. Box 9020, and the founders began to reach out to potential backers in Santa Fe, Los Alamos, and Albuquerque. Helene, wife of senior fellow Richard Slansky, volunteered to play an organizational role.

Who were SFI’s founders? Visit www.santafe.edu/sfi30 for more about some of the people who helped define the Santa Fe Institute.

In the March / April issue of the Update: SFI@30 continues with “Something from nothing: SFI emerges and synthesizes.”
Breakfasts serve up eggs, bacon, & science

SFI has been taking a new approach to reaching its far-flung community lately: breakfast.

Most recently, SFI External Professor Raissa D’Souza helped serve up eggs, bacon, and network science to a few dozen Silicon Valley entrepreneurs and researchers at a December SFI event in Palo Alto.

D’Souza, a professor of computer science and mechanical engineering at UC Davis, spoke about the new, often counterintuitive world of network science, a world where more connectivity isn’t always better. “Some networking is good. Too much is overwhelming,” she told the crowd.

Past breakfasts featured such speakers as SFI Distinguished Professor Geoffrey West, then-SFI Faculty Chair Doug Erwin, and SFI Science Board member Dawn Song, who gave attendees a peek at next-generation web security tools the UC Berkeley computer scientist is developing. SFI External Professor and UC Davis geophysicist John Rundle considered what one could learn about financial markets using earthquake prediction models.

Ike Nassi, a former executive at tech stalwarts Apple and SAP, says the latest event was his third or fourth time coming. “I always walk away with more ideas,” he says, and, perhaps, collaborations. Nassi says he’s looking forward to hearing more about D’Souza’s ideas.

For her part, D’Souza told the crowd she’s eager to learn more about the real-world challenges those in the tech industry face when working with interconnected communications, supply, and electrical power networks.

SFI VP for Advancement Nancy Deutsch, who helps organize the meetings, says she hopes to expand the breakfasts to East Coast cities and perhaps overseas. “The breakfasts are great ways to extend the message of what an SFI approach to science is all about,” she says. “They’re more friend-taising than directly fundraising opportunities, although we certainly hope the participants will continue to support SFI in meaningful ways.”

Gell-Mann honored at Caltech’s ‘50 years of the quark’ celebration

SFI Distinguished Fellow and co-founder Murray Gell-Mann was honored at the California Institute of Technology December 9 and 10 as part of an event celebrating “50 years of the quark.”

While at Caltech in the 1950s and 60s, Gell-Mann theorized the existence of and helped establish the characteristics of subatomic particles he named quarks. He was awarded the Nobel Prize in physics in 1969 for his work on the theory of elementary particles.

To see how a species adjusts to the conditions it creates, Libby and colleague Paul Rainey at the New Zealand Institute for Advanced Study looked to Pseudomonas fluorescens. The free-living bacterium has two forms: the smooth type proliferates in a broth, but by doing so uses up the oxygen. A single mutation produces the second wrinkly type, which makes a glue that sticks offspring together.

The resulting bacterial mat rises to the surface – the only place oxygen is available in a beaker choked by the smooth type. (Conversely, as the mat grows and provides stable access to oxygen, wrinkly types randomly produce smooth types.) Eventually the mat collapses, letting oxygen stream back into the broth.

Based on this simple life cycle, the researchers ran simulations where P. fluorescens drove the environment between two states, one state favorable to each population type, to see at what switching rates the species flourished. The results surprised them.

“The best strategy is to produce the kind that’s not good in the current environment about 10 percent of the time,” says Libby. That rate is independent of environmental factors and is three orders of magnitude higher than the researchers expected, he says. Further, letting some of both types survive through an environment switch also led to a surprising response: one organism will thrive, nearly driving the other to oblivion, then will suddenly collapse and die.

Libby reasons that these findings, published December 18, 2013 in PLOS ONE, suggest that a simple relationship between organisms and environments could provide a possible route for the evolution of development programs from random mutation-driven change.
Starting this month, College of the Atlantic physics and mathematics professor David Feldman is offering a free online course: “Introduction to Dynamical Systems and Chaos.”

The course is offered through SFI’s Complexity Explorer (www.complexityexplorer.org) beginning January 6, 2014. You can enroll and begin taking the course any time during the eight-week course.

The course is a continuation of the successful massive open online course (MOOC) series that began with two offerings of SFI External Professor Melanie Mitchell’s “Introduction to Complexity.”

Feldman recently fielded some questions about the new course from the Complexity Explorer’s Erin Kenzie:

Kenzie: Why was this course chosen as a MOOC offering by SFI? How does it fit within the Complexity Explorer project?

Feldman: Chaos and dynamics are core topics for the study of complex systems. They show us that simple, deterministic systems can produce unpredictable and complex behavior. Thus, it is possible that complex or unpredictable phenomena have simple origins or explanations. One of the key themes of dynamical systems is that order and disorder are not mutually exclusive categories; they can exist together in the same system and have the same origins. These are important lessons for the study of complex systems, and so it seemed appropriate that the next online course offered through the Complexity Explorer project was on chaos and dynamics.

Kenzie: What kind of student did you have in mind when you designed the course?

Feldman: I can imagine many types of students who might be interested in this course: someone who has taken Melanie’s “Introduction to Complexity” and who wants to dig deeper into chaos; someone who has heard about the butterfly effect and strange attractors and wants to learn a little bit about the mathematics behind these phenomena; someone with a background in science or social science who is looking for a thematic overview of dynamical systems before launching into more advanced study; someone with an interest in complex systems – or anything for that matter – who thinks chaos and dynamics might relate to their interests and would like to find out if that’s the case.

Kenzie: How much math background is necessary?

Feldman: The course will make use of elementary high school algebra. We will review math topics along the way and help will be available in the online discussion forum. There will be optional assignments for those with a more extensive math background. I think the course will be accessible and of interest to almost anyone who wants to gain a solid introduction to chaos and dynamical systems, regardless of their mathematical levels.

Kenzie: How do you anticipate students will benefit from taking your course?

Feldman: My goal is to present an intellectually honest introduction to the key results and big themes and ideas of chaos and dynamical systems, and to do so in a general enough way so that it is valuable to a wide range of course participants with different motivations and goals.

Kenzie: Have you taught a MOOC before? What interests or excites you about the opportunity?

Feldman: This is my first MOOC. I have, however, taught a course on chaos and dynamical systems at this level for many years at College of the Atlantic. This course has been well received and I have enjoyed teaching it. It has been very satisfying to help students discover the important and fun surprises that dynamical systems hold, and then to see how they apply these ideas in their own areas of interest. I’m excited to bring chaos and dynamical systems to a larger audience and to interact with students of all backgrounds from all over the world. Teaching a large online class will be a challenge. I’m a bit nervous about it, but this is a new experience for me, but I’m also very excited.

The Afterschool Alliance and the Noyce Foundation have recognized SFI’s Project GUTS (Growing Up Thinking Scientifically) with one of two inaugural Afterschool STEM Impact Awards, as part of the nationwide rally for afterschool STEM and computing programs.

The Afterschool STEM Impact Awards recognize outstanding afterschool STEM programs that target students in fourth through eighth grades, serve students from populations underrepresented in STEM fields, and can demonstrate the impact of their programs on students who participate.

“We are thrilled to receive this national recognition and award,” said Irene Lee, who directs SFI’s K-12 STEM programs, including Project GUTS and GUTS 4 Girls, as part of SFI’s K-12 Learning Lab. “Our students have demonstrated that learners as young as middle school age can engage in computational modeling and scientific inquiry to understand and potentially solve problems in their local communities. Through Project GUTS we want to offer them the chance to develop computational and STEM inquiry skills while strengthening the connections they see between computer- ing and solving real-world problems.”

SFI Science Board member Thomas F. Rosenbaum has been named President of the California Institute of Technology. Since January 2007, Rosenbaum has served as provost at the University of Chicago. He is expected to take office at Caltech in July.

2014 SFI education program deadlines

Undergraduate students - Research Experiences for Undergraduates summer internship program, June 8 – August 16, 2014 in Santa Fe: apply by February 7, 2014.

Graduate students - Graduate Workshops in Computational Social Science, Modeling, and Complexity, June 22 – July 5, 2014 in Santa Fe: apply by February 14, 2014.

High school students - Summer Complex Systems and Modeling Program (CAMP), July 13 – 25, 2014 in Groton, Massachusetts: apply by April 21, 2014.
the world. That’s not to say we were the innovator of transdisciplinary thinking. But I think it’s fair to say that the success in understanding complex adaptive systems through transdisciplinary approaches has been the major achievement of the Institute.

This emphasis on complexity, along with the transdisciplinary approach, has led to a number of specific scientific advancements. SFI has played a foundational role, for example, in developing and applying methods for analysis and computational modeling of complex systems such as nonlinear dynamics, agent-based modeling, information theory, machine learning, game theory, genetic algorithms, network community detection, and so forth. Many early and continuing contributions to what is now called “complexity economics” were made here. Foundational work in applying scaling and metabolic theories from biology to cities, both modern and ancient, was accomplished here. The list goes on and encompasses progress in many areas, from evolutionary computation and computational immunology to cultural evolution, inequality, and wealth inequality. In these cases and numerous others, the Institute’s scientists and collaborators played and are playing a major role.

Update: How does the ethos instilled by SFI’s founders connect to the Institute’s future?

Sabloff: SFI has been extraordinarily successful at making connections among top scientists from many fields, giving them the opportunity to gather in Santa Fe and collaborate on important new insights into how our world operates — not only today but also in the past, and even how it might function in the future. These insights, I think, give us hope of finding new ways to cope with many of the challenges the world faces today.

So the simple answer to your question is that the approach and the accomplishments of SFI’s first three decades have given the Institute great credibility and respect, both in the scientific community and in the wider academic community. This credibility, I think, serves as a foundation for the kinds of research the Institute will be doing and the kind of impact it will attain during the next three decades.

In terms of specific directions for the future, SFI’s Board of Trustees has put together a strategic thinking committee, which has produced a set of key questions that all of SFI’s faculty and staff will be looking at in the coming months to help us focus on not only what major questions the Institute should be thinking about, but also what approaches it should adopt in the coming years. In essence, we’ll be asking ourselves whether we should continue along the same path, whether we should modify it, or whether we should significantly change it. I very much look forward to the outcome of that effort, and we’ll be hearing more by the May 2014 board meeting.

Update: How would you characterize the Institute’s health, both scientifically and fiscally, at this milestone?

Sabloff: On the scientific side, the Institute is very strong. We’ve come through a challenging period, given the economic situation since October 2008, a period that has been particularly difficult for nonprofits. We lost some key resident faculty members during that time, but I’m happy to say we’ve just hired three new resident professors. David Wolpert has joined us on a part-time basis from Los Alamos National Laboratory. Both Sidney Redner, currently the chair of the physics department at Boston University, and Michael Lachmann, an evolutionary biologist at the Max Planck Institute, will be joining us full-time this summer. They join the two full-time professors we hired last year, Chris Moore and Luis Bettencourt. This gives me a lot of reason for optimism.

During the economic downturn, we were forced to cut back on support for some of our scientific activities. We’ve seen a significant pickup this past year, under the leadership of Chair of the Faculty Jennifer Dunne, in workshops and working groups, as well as an increase in the number of visitors. The feeling at SFI this past summer was more like the Institute of old, with people, ideas, energy, and a lot of excitement. These are all positive trends.

On the fiscal side, clearly we’re better off than we were in late 2008 and throughout 2009. We’ve been able to pay off the mortgage on our Campus that we took out in 2009 at the beginning of the economic crisis, so it feels good to be debt-free. But there’s still a long way to go. The fiscal environment for SFI in particular, and for nonprofits in this country in general, is still extremely challenging. That’s true in terms of general philanthropy, federal grants, Business Network memberships, and so on. With the economy improving and the market up, I think there is reason to be guardedly optimistic, but the budget is still very tight and there are a number of factors beyond our control that continue to worry us.

Update: Other than financial, what do you see as SFI’s biggest challenges for the next few years and beyond?

Sabloff: By far the major challenge for us is to continue to attract top scientists at all career levels, from undergraduate students and graduate students to postdocs — those in our groundbreaking Omidyar Fellowship and those who come to work with us on specific research programs — to new external faculty and resident faculty and Science Board members. All these indicators are positive in this regard. The numbers and quality of applicants to our Omidyar Fellowship and for our Cowan Chair in Human Social Dynamics have been top notch, for example. So I’m feeling good, but this is going to be a continuing challenge.

Another challenge of a different sort is to continue the integration of our terrific new Yearague Campus, generously donated to SFI last year by Clare and Eugene Thaw. We’ve already used it for small working groups and for housing visitors, but we’re continuing to find better ways to integrate it into the daily life of the Institute.

Update: What can we expect to see in 2014 with regards to celebrating the Institute’s 30th?

Sabloff: You can read all about it in this issue, but the synopsis is that we have launched a 30th year campaign where we hope to raise $30 million in the next several years. This could help improve our financial strength, and on a pragmatic level that is very important. But I think this anniversary is also a good chance to celebrate the people who participated in our first 30 years and the scientific progress the Institute has helped make possible, as well as to call attention to our vision for the future of science. [More about the campaign on page 8]

Update: Your term as president ends in 2015 and you have announced your intention to retire at that time. What is the more on page 8
In 2014, SFI celebrates 30 years of insights on the horizons of science. We’ll look back at the visionary scientists, scholars, and philanthropists who have made the Institute a world hub of complexity science. And we’ll look forward to all that we can accomplish as we continue to explore society’s most pressing challenges through collaboration, conversation, and education.

In the coming months we’ll share stories from our first three decades – from the small group of scientists who conceived of SFI in the days and months leading up to our founding in 1984 to the many innovators who since have built a new approach to science around complex adaptive systems.

The words at right, which anchor our New Science. New Horizons. celebration for 2014, I think perfectly capture the spirit of SFI and our commitment to pushing the boundaries of scientific understanding. SFI is its own complex system that brings together people, connections, opportunity, insights, and hope. As we mark this important milestone, we are also launching the public phase of a comprehensive fundraising campaign that will touch every aspect of the Institute and provide a sustainable and solid financial footing for our next 30 years. We can do this because of the loyal support that we see each year from so many of you, and in the spirit of the Update. We look forward to sharing our memories and our opportunities with you in the coming months.

Best regards,
Nancy Deutsch, Vice President for Advancement

“As SFI turns 30, we reflect on our first three decades in which a signature approach to science was born, a new science based on a revolutionary spirit and a dedication to inquiry without boundaries. We also look ahead to the next 30 years in which we will behold new horizons gained through a renewed commitment to the history and precepts that shaped SFI and made it the intellectual hub of complex systems research worldwide. At SFI’s core are exceptionally curious and talented people — some of the great scientific minds of our day. The connections that our scientists make — connections that link fields, ideas, and each other — result in a distinctive opportunity for innovative thinking about some of our most pressing problems. Our transdisciplinary approach gets to the heart of these issues, helping us gain fresh scientific insights — insights that, if used wisely, offer hope for improving the human condition.”

In early 1983, Nick Metropolis, one of the original Manhattan Project physicists and a future SFI Science Board member, invited me to join the ‘Cowan Collaborative,’ a group of Los Alamos senior fellows led by George Cowan who was trying to found a new kind of educational institution in Santa Fe. A defining moment was a suggestion by Herb Anderson, one of those senior fellows, that we convene a group of distinguished colleagues to explore initial research directions and test our game plan. We agreed, and, George asked Herb, Murray Gell-Mann, and me to organize what became ‘Emerging Syntheses in Science,’ the founding workshops that launched SFI in 1984. **

> **Sabloff Q&A continued from page 7**

status of the presidential search, and what do you think are the most important qualities for an SFI president?

Sabloff: Originally I was asked to come to SFI for a three-year term as president, and then in 2012 the Board asked if I would stay for a second three-year term. I agreed, but with the understanding that I would step down in the summer of 2015, which I intend to do. That will give me a chance to continue my research and writing, which haven’t been my top priority in light of the challenges the Institute has faced during my term.

I’m very optimistic about the search. I think the SFI presidency is a terrific position. The Board has put together a strong search committee headed by SFI External Professor and Science Steering Committee member] Walter Fontana of Harvard Medical School. I think they’ve posied to find the best person available.

It’s not an easy job. In terms of qualities, first and foremost the next SFI president needs to have strong scientific credentials. He or she will have to be widely accepted by the scientific community, both within SFI and beyond. Candidates obviously need to have an interest in the study of complex systems. In addition, the next president needs to be someone with administrative experience, who at least has been a department chair, a dean, or a provost at a university, or who has in a variety of ways gained experience in running an organization. At the same time, SFI needs someone who has had significant success and experience in fundraising, because that’s a key part of the job. And then I think, more intangibly, we need someone who has the people skills to energize a very diverse community of scholars and staff here at the Institute and also in our much broader community. Finally, there are a lot of strong egos in science, and that’s a good thing, but we need someone whose ego is harnessed to the success and development of the Institute. Essentially, it has to be someone who believes we are much more important than I. That’s a tough combination, but as I said, I’m very optimistic that the Board, the faculty, and the staff are committed to finding the best person available to lead us as we begin our next 30 years.

Update: Why is a place like the Santa Fe Institute important in today’s world?

Sabloff: More and more we find ourselves today focused on short-term, and increasingly shorter-term, linear thinking that says if we do A, we’re going to get result B. In the complicated world that we live in, we need a more complex, nonlinear way of thinking. We hear popularly about black swans and tipping points and all kinds of other phenomena that come out of complex systems thinking. In business and government and public policy the focus, instead of being on years or decades, is on time horizons of months or weeks and quarterly reports and so on. As a society we need to take a longer-term view. As SFI’s scientists have argued for years, we need to recognize that if we do A, we might or might not get B, but we also might get unintended consequences C and D and F, and some of those results we might not want. New emergent phenomena arise constantly. The system changes. This way of thinking, I believe, is essential in our world today. SFI has been an important stimulus for complex systems thinking for 30 years. Much of our theoretical advancements can have, and have had, important ramifications in both science and public policy. Because of the challenges we face, that role is more important today than it ever has been. This is the way of thinking we’re celebrating this year, our 30th year. I’m proud to be a part of it.