SFI hosted a two-day review in late August of research projects supported by the three-year, $5 million John Templeton Foundation grant, “The Principles of Complexity,” that began in fall 2011.

The grant’s goals were to pursue fundamental understandings of the regularities in complex biological and social systems and to generate new concepts and quantitative methods of general scientific and social value. It supported three major SFI research projects and one major education project.

“This grant has been hugely important to science at SFI,” says SFI President Jerry Sabloff. “It has allowed us to begin to take full advantage of the influx of new data available in multiple fields, and it has allowed our researchers to make important new connections between fields. Together, this has led to significant advances in our theoretical understanding of a variety of complex systems.”

Complex early societies

Sabloff co-leads the “Universal Patterns in the Emergence of Complex Societies” project with former Omidyar Postdoctoral Fellow Laura Fortunato. As part of the project, SFI researchers are developing a database of ar...
Syphilis is on the rise again; nearly 16,000 cases were reported in the U.S. in 2012. Public health officials looking to stem the tide should consider focusing more on identifying patterns of sexual behavior, according to SFI Omidyar Fellow Ben Althouse and SFI Postdoctoral Fellow Laurent Hébert-Dufresne. In a paper published August 6 in the Journal of the Royal Society Interface, the two came to that conclusion while exploring the cycles of syphilis infection since the early 1960s. In the past, researchers assumed that they found that education and awareness campaigns were often a better choice than widespread treatment for mitigating an epidemic. Surprisingly their model suggests that campaigns are most effective at the height of an outbreak, when officials can focus on stopping the next outbreak before it starts. By simulating syphilis epidemics on a computer, they found that simple social behavior could be driving observed syphilis cycles, the researchers turned their attention to how to stop them. Cycles of syphilis incidence due to human behavior.

Templton review continued from page 1

Complex life
SFI External Professors David Krakauer and Jessica Flack co-lead “The Evolution of Complexity and Intelligence on Earth,” which seeks a rigorous way to understand the role information, energy, and environment play in biological complexity. Flack said their approach views biological systems as being part of an information hierarchy in which components with partially aligned interests interact in multiple time and space scales. Information often manifested in rough predictions biological systems make about their future environments serves to couple these multi-scaled systems. The team, Flack said, has begun to develop a computational approach that relies on “effective theories” to make rough, course-grained connections between the microscopic behavior of the components of a biological system and the macroscopic “outputs” that arise from many components interacting in multiple time and space scales.

"We can then ask questions like ‘how tunable or controllable is the macroscopic behavior?’ and ‘can small perturbations at the microscale induce large-scale changes to the macro behavior of the system?’” Team members include David Krakauer, Jessica Flack, Brian Daniels, Philip Poors, Chris Ellison, Eddie Lee, Ivarado Ferrada, and Peter Stadler. More on page 4

Upcoming community events
SFI Community Lecture, Wednesday, October 15, 7:30 p.m., James A. Little Theater (1060 Cerrillos Road) – I get all the news I need from the sports section. Sports players (or teams) are often described as being hot or cold, implying there is something inherently “streaky” about an athlete’s performance that extrapolates to the next try. Using data from ten seasons of professional basketball and more than a century of major league baseball, physicist Sid Redner argues that scoring streaks is a fallacy and that win/loss records in professional baseball teams are similarly memoryless. Finally, he shows that our favorite pastime is getting progressively more competitive – no more dynasties or perennial losers.

SFI’s 2014 Community Lectures are made possible through the generous support of Thornburg Investment Management. Lectures are free and open to the public, but seating is limited. To watch a lecture as it happens, visit SFI’s YouTube page; participate in the discussion live on Twitter at #sfi_live.

Working group tackles public health complexity
Public health and health inequality are embedded in complex systems, and public health researchers stand to gain from a complex systems approach, according to co-organizers of an upcoming working group at SFI. “Complex systems approaches are still new in public health, and they’re quite promising,” says Ross Hammond, especially when it comes to understanding demographic disparities in health outcomes – for example, why physical activity varies so much as a function of age and race.

Hammond, a Brookings Institution senior fellow and SFI External Professor, is co-organizing the late-September working group with University of Michigan professor emeritus George Kaplan. The two-day gathering is the capstone meeting of the Network on Inequality, Complexity, and Health Project, or NICH, a diverse collaboration of North American researchers from epidemiology, economics, computer science, human development, sociology, and other fields, co-founded by Kaplan.

NICH’s diversity is both a challenge and an opportunity, Hammond says. While the team is still working on how to successfully communicate the value of complex systems to different audiences, “for me what’s coming out of NICH are new partnerships, new colleagues, and a more honed sense of where the interesting questions may lie,” he says. The invitation-only meeting will focus on finalizing a number of papers authored by NICH subteams, and on creating a final product summarizing NICH’s work. “We’re trying to figure out how to have a lasting impact,” Hammond says.

Nonlinearities: From the editor
It’s difficult to know how integral urban people are to a group until they are gone. Only then do you become aware of the social gravity they exerted on the system. So it was with Laura (and Harold Morris) – SFI staff member who retired on August 29. All who know Laura consider her a friend.

She offered hundreds of SFI visitors a place at her table. She documented much of the Institute’s history, and with a great deal of visual appeal. The two photos at the top of page one are of Laura (and Harold Morris) and by Laura (rainbow).

I will miss Laura’s relentlessly positive outlook, her willingness to help, her deep knowledge of everything SFI, and her razor-sharp editor’s eye. She’s one person I know will succeed at retirement. We’ll see you on the trails, Laura, and on the slopes, in the gulches, on the bluffs, and in the glow of many glorious sunsets.

One day in January 2019, now-SFI postdoc Christa Brelsford, a rock climber, was in Haiti volunteering on a literacy project. When Christa returned to New York, she was diagnosed with a rare form of cancer. The two came to that conclusion while exploring the cycles of syphilis infection since the early 1960s. In the past, researchers assumed that Syphilis is on the rise again; nearly 16,000 cases were reported in the U.S. in 2012. Public health officials looking to stem the tide should consider focusing more on identifying patterns of sexual behavior, according to SFI Omidyar Fellow Ben Althouse and SFI Postdoctoral Fellow Laurent Hébert-Dufresne. In a paper published August 6 in the Journal of the Royal Society Interface. The two came to that conclusion while exploring the cycles of syphilis infection since the early 1960s. In the past, researchers assumed that they found that education and awareness campaigns were often a better choice than widespread treatment for mitigating an epidemic. Surprisingly their model suggests that campaigns are most effective at the height of an outbreak, when officials can focus on stopping the next outbreak before it starts. By simulating syphilis epidemics on a computer, they found that education and awareness campaigns were often a better choice than widespread treatment for mitigating an epidemic. Surprisingly their model suggests that campaigns are most effective at the height of an outbreak, when officials can focus on stopping the next outbreak before it starts.

Right now, “the front line is a shot of penicillin, a vaccine, or a combination of the two,” says Althouse. “We’re trying to figure out how to have a lasting impact,” Hammond says.

SFI IN THE NEWS

On August 17, the Santa Fe New Mexican featured SFI Learning Lab Director Irene Lee and the nonprofit code.org’s plans to bring SFI’s Project GUTS after-school curriculum to more than 900 students completed “Intro to Dynamical Systems and Chaos” taught by College of the Atlantic professor David Feldman, part of SFI’s Complexity Explorer online course series. “Hanging out at the Santa Fe Institute is like being at a brain spa,” writes weather.com’s David Kushner in a July 11 feature describing the Institute, its research, and its people in the context of a recent workshop at which experts gathered to explore climate and sustainability.

In a July 16 Q&A in Libre Mercado (Spain), SFI Trustee John Chisholm extols the value of online education and complex systems approaches and says the Institute has “profoundly” influenced his thinking about the economy.

Upcoming community events
SFI Community Lecture, Wednesday, October 15, 7:30 p.m., James A. Little Theater (1060 Cerrillos Road) – I get all the news I need from the sports section. Sports players (or teams) are often described as being hot or cold, implying there is something inherently “streaky” about an athlete’s performance that extrapolates to the next try. Using data from ten seasons of professional basketball and more than a century of major league baseball, physicist Sid Redner argues that scoring streaks is a fallacy and that win/loss records in professional baseball teams are similarly memoryless. Finally, he shows that our favorite pastime is getting progressively more competitive – no more dynasties or perennial losers.

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Collective thinking as cognition

On one level, brains are just blobs of neurones; on another, they are the world's most sophisticated computers. A recent meeting at SFI explored the possibility that societies, whether or not human, are computers too.

“There’s a lot of research recently on describing computational cognition,” says Bryan Daniels, a researcher at the University of Wisconsin’s Center for Complexity and Collective Computation, or C4. At the same time, scientists are looking more and more at the collective behavior of groups of organisms.

The late-July working group, “Collective Cognition: Quantifying Distributed Inference,” was organized by Daniels and fellow C4 researchers Chris Ellison, Philip Poorn, and SFI External Professor Jessica Flack, who co-directs C4.

The meeting brought together researchers who study cognitive science, social networks, and animal societies to begin to identify connections in the still-emerging field.

One intriguing topic the group discussed was that cultures serve as a kind of collective social computer: a culture accumulates information over the generations and transforms it into new ideas and new ways of life.

There were points of contention—what, for example, counts as collective cognition—but by the end of the discussions the group had begun talking about a framework for future work, says Daniels.

“Much like the systems we’re studying, connecting with researchers who are developing similar ideas is leading to a broader understanding” of computation in the natural world, he says.

Della Vigil’s straw appliqué wins 2014 Spanish Market honors

Della Vigil won the “Innovation Within Tradition” award at Santa Fe’s 63rd Annual Traditional Spanish Market in July, an internationally renowned art competition sponsored by the Spanish Colonial Arts Society of Santa Fe.

Her “Florecimiento de Amor (Love Blossoming),” a straw appliqué piece, was praised by judges for its “innovative introduction of modern characteristics to a traditional craft while demonstrating a clear connection to New Mexican artistic traditions.”

“Winning an award like this can really help elevate me as an artist,” Ulibarrí says. “It was overwhelming, but it was good because people were interested in an art form that dates back hundreds of years.”

She is an administrative specialist in SFI’s Office of the Vice President for Science.

Straw appliqué is a method of inlaying a golden straw design onto wood and coating it with varnish, yielding a shimmering design with the look of gold but without the price tag. Many colonial-era villagers in Northern New Mexico used this method to decorate precious items with a golden finish. The technique became widely regarded as “poor man’s gold.”

Vigil was first selected to participate in the Traditional Spanish Market in 2008 and has won past awards for her straw appliqué designs. Her work has been exhibited in The Museum of Spanish Colonial Art, sold at the Santos de Chimayá gift shops, and commissioned by collectors. She teaches workshops on the art, and some of her students have won awards too.

For Vigil it is simply a labor of love.

“It’s a great way for me to unwind after a long day,” she says. “I’m fascinated by old things, and it is important to me to keep the traditions of my ancestors alive and pass them on to the next generation.”

For more information on the award and straw appliqué, visit the Spanish Colonial Arts Society website.

> Insect farming continued from page 1

comparing and contrasting them is not productive.”

If, in fact, something along the lines of convergent evolution (the development of similar features in species of different lineages) is happening, Peregrine says that opens questions about how various functional and developmental constraints led to food gathering and production.

“What if some of the effects of agriculture on insect societies help us understand what happened in human societies once agriculture was adopted,” says Peregrine, an archaeologist. “If we can identify some of the causes and consequences of human agriculture as being shared with insects, then think that helps us to build broader theories of cultural evolution based on well-established principles and processes of organic evolution.”

He also hopes to build lasting relationships between groups of researchers, such as biologists who have been bridging the gap between organic and cultural evolution and Peregrine’s fellow archaeologists.

“Food-getting strategies are a basic function of any organism and play a profound role in directing the course of evolution,” says Peregrine. “Understanding the evolution of a rare and unique food-getting strategy—in this case agriculture—might help us in refining or even in developing new approaches to understanding evolution.”

> Innovation continued from page 1

systems to see what progress is possible in developing a general theory,” says Dunne, who initiated the meeting.

The word novelty itself doesn’t really work for Wagner, the workshop’s host; it already has a very specific meaning in economics and evolutionary biology, he says.

But if the participants can settle on an overarching theory that can be applied to various disciplines, he says, “then we’ll have somewhere to go. We’ll have made that step forward. Because theories unify knowledge.”

“Novelty is something that’s really central to human life,” he adds. “It’s intrinsically interesting to study it.”

EDUCATION

2014 REUs work should to shoulder with complexity’s top minds

Some 650 U.S. research centers host NSF-sponsored Research Experiences for Undergraduates (REU) summer programs. Only one offers its participants a chance to work shoulder to shoulder with the leading thinkers in complex systems science.

Juniper Lovato, SFI Education Program Coordinator, says a key motive of the Institute’s REU program is to train the next generation of complexity scholars to one day take over thinkering in complex systems.

SFI 2014 REU Marcus Levine, who is double majoring in astrophysics and philosophy from Columbia University, says his stay at SFI has provided him a unique opportunity to immerse in a topic of his choice – analysis of the human microbe ‘ecosystems’ in the human body that he believes haven’t received enough attention.

“It occurred to me that we really don’t have a good dataset for microbial interaction in the human body,” says Levine. “Something I’m trying to do is identify structures in these interaction networks.”

ACHIEVEMENTS

SFI External Professor and Science Board member Mercedes Pascual has been awarded the Ecological Society of America’s Robert H. MacArthur Award. The award, given every other year, recognizes a mid-career ecologist for “mentorship contributions to ecology with the expectation of continued outstanding ecological research.” Pascual is recognized for her contributions to the theory of food web structure, the ecology, spread, and evolution of infectious diseases; and the development and application of novel computational methods for relating climate to disease.

SFI External Professor Melanie Moses has been awarded the James S. McDonnell Foundation’s 21st Century Science Initiative in Studying Complex Systems – Scholar Award for 2014. She was selected for the award for “furthering the science of complex systems via the continued development of the theory and tools used in the study of complex research.” The award comes with a six year, $450,000 grant, with which Moses says she plans to continue her research of how cooperative behavior emerges in complex systems.
Thirty years of insights at the boundaries

In the three decades since its founding, the Santa Fe Institute has produced some remarkable and influential insights. From illuminating the complexity of life to understanding how cities and societies function and evolve, the Institute has become a beacon for those seeking answers to some of our most perplexing questions. You might say that insights are our stock in trade, produced to benefit society at large and guide the leaders who are making big decisions that impact future generations.

How have we managed to produce game-changing insights so consistently over three decades? We asked SFI Board Member and Pulitzer Prize-winning author Cormac McCarthy to tell us what makes SFI so special.

Having been an integral part of the SFI community for the last decade, Cormac understands the Institute’s potential, and he applies a novelist’s keen observational skills to describe it. “Scientific work at SFI is always pushing creativity to its practical limits,” he says. “We always count a high risk of failure. Above all we have more fun than should be legal.” I can think of no better or more succinct way to describe the SFI community and approach.

Of our special community – and the thinkers we work to attract – Cormac notes, “We are beyond relentless in seeking out the best people in every discipline. We will get you here. No matter what. And we will give you the space and the resources that you need.” I know a significant number of scholars, including our Omidyar Postdoctoral Fellows, who would support that observation, many of whom have gone on to create or join new centers of interdisciplinary study modeled after SFI.

Cormac’s insights spotlight SFI’s unique strengths: the diverse, big-thinking community we’ve built; a tolerance for risk that gives free reign to creativity and innovation (supported by solid science); and the joy and excitement that come from exploring our ever-changing universe. All of these qualitative add up to the kinds of insights that will drive meaningful change in our world, and that’s work – and fun – we can all be proud of.

Warm regards,

Nancy Deutsch, Vice President for Advancement

"The first MacArthur Fellowship meeting in Chicago was sort of like a television show. We were whisked away to a beautiful old house on the lake-shore in private limousines. There were just a handful of us and none of us really knew what the whole thing was about. Just that they were going to give us some money.

We went down in the evening for cocktails and dinner and I made a bee-line for the physicists. Murray Gell-Mann and David Gross and John Schwartz and George Zweig and others. They included me in their group without question. Murray and I became friends and here I am."

SFI@30
MY STORY
Cormac McCarthy
Author
Trustee, Santa Fe Institute

Complex socioeconomic systems

SFI Professors Geoffrey West and Luis Bettencourt co-lead “The Hidden Laws that Per- vade Complex Biological & Social Phenom- ena” project, which draws from biology and physics to understand human socioeconomic complexity.

“What we suggest is that the scaling relationships we are seeing are an outcome of the universality and integration of both social and infrastructural networks in space,” said West.

Bettencourt described recent research that explores how networks relate to urban geography and how increasingly dense social and infrastructural networks give rise to the advantages of scale (a.k.a. scaling) cities create as they grow.

“If we’re all trying to solve the same simple human problem, such as how to survive on this patch of dirt, we will all have roughly the same information to work with,” he said. “But if we’re all trying to solve different problems, our collective knowledge grows. This diversity of knowledge and its interaction is the dynamic in a city that causes increasing returns to scale.”

Former Omidyar Postdoctoral Fellow Scott Ortman, whose recent work with Bettencourt and colleagues suggests that archaeologi- cal data from early cities are a good fit to the scaling models for modern cities, noted that the language SFI uses to describe its cities work has evolved, from a focus a few years ago on describing urban scaling relationships observed in modern cities to “seeking a gen- eral theory of human social organization. For me, this is a stunning example of what SFI can do – bring these teams together and find broad generalities across systems.”

Team members include Luis Bettencourt, Geoffrey West, Jose Lobato, Deborah Strumsky, Clio Andre, Scott Ortman, Andres Gomez-Lievano, Marcus Hamilton, Markus Schlaper, Hyey Jin Youn, and Madeleine Daepp.

SFI is in preliminary discussions with a major university press regarding a possible book series summarizing the key research supported under this grant.

Complexity education

The Templeton grant also supported an education outreach project led by SFI McKin- non Family VP for Education and Institutional Outreach Ginger Richardson and External Professor Melanie Mitchell: creation of the Complexity Explorer (complexityexplorer.org), a central online repository for teaching and learning materials associated with the sci- ences of complexity.

Mitchell offered a tour of the site’s library of ideas, simulations, exercises, definitions, course curricula, syllabi, and other resources, then turned her attention to the centerpiece of the Explorer: its massive open online courses (MOOCs) in complexity. Four MOOCs have been offered so far, she said, with more than 24,000 total students enrolled and some encouraging statistics.

External Professor Liz Bradley spoke of her frustration about teaching one of six Complexity Explorer MOOCs scheduled to begin this fall (“If I make a sign error, a thousand people are going to email me. That’s terrify- ing!”). David Feldman followed with his im- pression of his own just-completed “Dynam- ics and Chaos” MOOC (“It was more difficult than I imagined. It was strangely satisfying.”)

Mitchell described her vision for the future: a greater number of course offerings, much larger participation numbers, a (possible) cert- ificate program, MOOCs as prerequisites for summer schools at the Institute, and “flipped” university courses featuring online MOOC-like lectures as homework and interactive exercises and activities in the classroom.

“I’m even dreaming of Massive Open Online Science,” she said. “I’d like to see online communities doing scientific experiments.”