



May / June 2016

## UPDATE



SFI postdocs (from left to right) Caitlin Stern, Caterina De Bacco, Vanessa Ferdinand, and Chris Kempes study beneficial epidemics during 72h(S).

## 72-hour collaboration examines beneficial epidemics

In a unique test of the limits of collaboration, 15 SFI postdocs retreated to a home in the wooded foothills near Santa Fe recently for three days and three nights of intense scientific research.

Their goal: starting from scratch, produce novel, transdisciplinary results in just 72 hours. They called the event 72 Hours of Science, or 72h(S).

It's something the participants say could happen only at SFI.

"It really was the sense of SFI's willingness to take risks that made me feel like the idea would fly and be worth the effort to try, and it was the amazing postdoc community that made me think we could be successful," says Chris Kempes, who says the concept was inspired by the 48-Hour Film Project, in which filmmakers start with a genre, a line of dialogue, and a character and have 48 hours to produce and screen a short film.

The researchers began with even less: a set of ground rules describing how the team would collaborate. Individuals came with their own ideas for paper topics but were prohibited from discussing them widely prior to noon on Monday, April 4, when 72h(S) commenced.

Agreeing on a research question might have been the hardest part, says Caitlin Stern – finalizing the topic and organizing individual tasks took up much of the first 24 hours, she says. An important objective was that the topic be of sufficient breadth to engage many of the disciplines represented by the postdocs – physics, math, anthropology, ecology, evolutionary biology, computer science, sociology, linguistics, and several other fields.

Then the team broke into groups to tackle various challenges, including a review of existing scientific literature to ensure that no one had previously attempted to answer the

chosen question. Three teams worked to come up with computer models and algorithms that would help them study the problem. Others sought real-world evidence, analyzing available data to detect patterns. They came together periodically to compare notes and coordinate, and re-formed into new groups as needed.

"We approached the problem from a number of different angles, starting from different fields, and all came up independently with the same trends," says Brendan Tracey. "That's the most remarkable thing about the work to me."

From the moment of topic selection, everything clicked, says Dan Larremore. "There was enormous camaraderie," he says. "People were asking for more work when they finished something, and everyone had a very dynamic to-do list."

[> more on page 4](#)

## RESEARCH NEWS

## In the loop: How feedback drives the evolution of networks

In recent conversations, two SFI external professors have found their research converging on an emergent process in networks. They call it the "assembly of scaffolding." The phenomenon spans disciplines and refers to a feedback process in which production networks lead to higher-order regulatory networks, which in turn affect the evolution of the production networks.

John Padgett, a political scientist at the University of Chicago, analyzes networks in social science settings, from Renaissance-era Florence to modern-day Silicon Valley. Manfred Laubichler, a theoretical biologist at Arizona State University, stud-

ies regulatory networks from genomes to knowledge systems.

Laubichler sees examples of scaffolding assembly within evolution: Genomic networks assemble phenotypes through development, a process that influences the evolution of the genomic networks. Padgett sees it in social science: Marriage networks and business networks historically lead to political institutions that then regulate the evolution of marriage and business.

"We're interested in how feedback works in these sorts of things," says Padgett.

With colleagues, they hope to develop a theoretical framework, and they are planning a book to collect empirical case studies that show these networks at work in many fields. To build an outline and identify appropriate studies, Padgett and Laubichler coordinated an SFI working group in early May sponsored by the SFI-ASU Center for Biosocial Complex Systems, which Laubichler directs.

The planned book, Laubichler says, will embed the ideas in a broader range of disciplines. "We're trying to accomplish a generative model of networks that applies to both biological and social systems," he says. ■



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## RESEARCH NEWS

## SFI joins extended evolutionary theory effort

SFI is among eight institutions participating in an international research collaboration to explore how environmental and other non-genetic factors might contribute to evolutionary processes.

The \$8 million grant from the John Templeton Foundation is one of the largest ever to be awarded for evolutionary research. SFI will participate through a subgrant.

"The large team of researchers will finally attempt to bring under one roof the various ways information can get from generation to generation," says SFI Professor Michael Lachmann, who will be studying the problem through mathematical modeling and information theory.

Picking up where standard evolutionary theory leaves off, the program aims to account for developmental processes and reciprocal causations that aren't explained by genetic inheritance alone.

Epigenetics – the process through which the genotype of the embryo, with environmental and parental influence, unfolds to an adult organism – is one well-known example of a process not yet fully integrated into evolutionary theory.

The program will test elements of extended evolutionary theory through coordinated experimental and theoretical studies across participating institutions. The University of St. Andrews in Scotland is leading the effort. ■

## PEOPLE

## Goodbye to Harold Morowitz

Harold Morowitz, a leading figure in shaping the scientific and popular understanding of the chemical origins of life on Earth, passed away March 22 in Fairfax, Va.

At the time of his passing Morowitz, 88, was the Robinson Professor of Biology and Natural Philosophy at George Mason University and Science Board Chair Emeritus of the Santa Fe Institute.

Read Morowitz's SFI tribute at [www.santafe.edu/news](http://www.santafe.edu/news). ■



# Beyond borders

It's an honor and a privilege to do what I do – share complexity science with the world – and to spend my waking hours mingling in an idea stew with top intellects. In “Nonlinearities,” heretofore the title of this column, I've tried to give you a sampling of some of the experiences that make the Institute one of the world's best places to think, hands down. The very good news is that I've asked David Krakauer, SFI's president since August, to do the interpreting from here on out, and he's accepted. Without further ado, here is the president's column, “Beyond borders.” As always, feel free to write me with comments and questions.

– John German, [jdg@santafe.edu](mailto:jdg@santafe.edu)

It often comes as a surprise to visitors to the Santa Fe Institute to find so many writers and artists wandering the terraced pods of our complex – not only science nerds but art nerds too. This is because at SFI we share in the belief of William James: “We are like islands in the sea, separate on the surface but connected in the deep.”

Last month Ray Monk, renowned biographer of Ludwig Wittgenstein, Bertrand Russell, and Robert Oppenheimer and one of our 2017 Miller Scholars, spoke on the artistry of facts – how biographers are like novelists without the freedom of invention and akin to naturalists without the constraints of science. Cormac McCarthy – author and resident scholar – relished grilling Monk on the inconsistencies in Wittgenstein's mathematical logic.

Neal Stephenson, another of our Miller Scholars and author of *Cryptonomicon*, *Anathem*, and *SevenEves*, sought out our expertise on swarms and collectives at afternoon tea to improve the chances of his daughter winning the next round of BattleBots, in which she is a competitor.

Artist Lauren Oliver has been showing pieces from her amazing, surreal “Ice Station Quellette” project in Pod A. This includes macabre, modified polar photography with captions such as: “They had no idea what to call it, so finally, it simply became ‘The Device.’ A Swiss Alpine laboratory, high above the sweltering heat and buffered from the angry, diseased hordes, an accident of pure science found while swapping useless binary circuitry for dabs of glistening neural goo.”

And Katherine Lee in her exhibit “Maps, Doors, and Coffins” has chosen to display wooden, free-standing doors with hand painted enameled lettering. On one door is written “Museum of Dark Forces” and on another, “Library of Babel.”

Miller Scholar Laurence Gonzales and author of *Deep Survival*, *Flight 232*, and *One Zero Charlie*, has been stealthily picking our brains for materials in support of a new book on the history and evolution of SFI. I had to ask Laurence why an author who writes so effectively and enthusiastically about death and survival is so keen on SFI? The answer, I am told, will be forthcoming.

From the outside the Institute can seem like a rather forbidding temple of mathematics, computation, and complexity esoterica. On the inside you will find plenty of these things, but you will also find curious minds seeking patterns, artists and scientists exploring the limits of what they know, and all of them enjoying the possibilities of a borderless community.

– David Krakauer  
President, Santa Fe Institute

## SFI IN THE NEWS

*Science* on April 15 covers a recent paper by co-authors Sam Way of UC Boulder, SFI External Professor Aaron Clauset of UC Boulder, and SFI Omidyar Fellow Dan Larremore that examines the persistent gender imbalances in university computer science departments and the complicated role gender plays in hiring decisions.

Despite development of computers that can beat humans in complex games, human minds still outperform them in key ways, says SFI External Professor Melanie Mitchell in April 4 articles in *The New York Times* and in *Science*.

In an April 1 *Washington Post* article on the genetic roots of ancient warfare, research by SFI Professor Sam Bowles is

cited in support of the idea that evolution might have favored internally cooperative but externally violent groups.

Drought repeatedly disrupted ancient human societies, notes SFI External Professor Tim Kohler in a March 31 article in the *Santa Fe New Mexican*.

Fox News on March 29 covers research by former SFI Omidyar Fellows Ben Althouse and Sam Scarpino suggesting that vaccinating children with one dose of the older whooping cough vaccine followed by four doses of the current vaccine would dramatically reduce cases of pertussis.

SFI's essay series with the *CS Monitor* continues with “The Source Code of

Political Power” by SFI External Professor Simon DeDeo on March 24.

SFI President David Krakauer is among six featured leaders in *Entrepreneur* magazine's March issue. In it, he advocates developing a culture of rigor – supporting every idea with evidence, observation, and analysis.

*The Atlantic's* CityLab on February 29 features a mapping app to help slums in their “reblocking” efforts to give slum dwellers access to water, sewer, emergency response, and other urban services. SFI Postdoctoral Fellow Christa Brelsford is quoted. ■

## RESEARCH NEWS

# What drives biological synchrony

Ecologists traditionally attribute population explosions, be they of diseases or animals, to broad environmental conditions. But new data suggest that other factors may drive “synchrony”: rapid, widespread rises and falls in populations.

“[Species] that go into synchrony may be more subject to extinction” because a single driver can trigger a collapse, says Alan Hastings, a mathematical biologist at UC Davis. Understanding synchrony would be of great help in agriculture, he adds, as staggered ripening of fruit trees and other produce is best for suppliers and consumers alike.

To investigate the drivers of synchrony, Hastings, Jon Machta (UC Davis), and Andrew Noble (University of Massachusetts, Amherst) organized a working group at SFI in 2015. Participants explored variations, measures, and early indicators of synchrony.

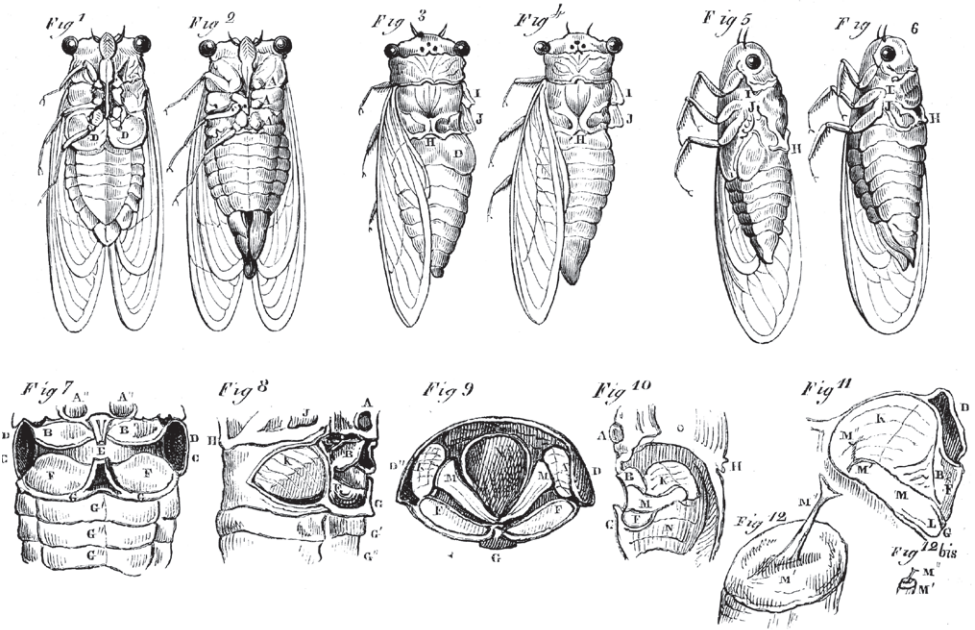
For consequent research, they chose data from periodical cicadas and larch bud moths. The cicadas spend most of their lives as underground nymphs, emerging after 13 or 17

years. The bud moths feed on larch needles in Europe and, of special interest to the project, their recorded history includes dendrochronological samples gathered in Switzerland that indicate outbreaks dating back 300 years.

Once the group confirmed that the data were robust (or at least “good by ecological standards”), they drew from each species' survivorship, predation of adults, and other factors to develop a nonspatial model – one that offers population predictions for a single location.

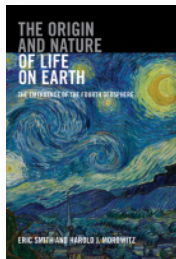
At this year's followup gathering in June, Hastings says the group plans to finish the model and search for ties to statistical physics. They also plan to discuss how to expand their model to population spatial dynamics to analyze and predict boundaries between broods throughout a species' range.

The research has prompted intriguing new questions, among them: How did periodical cicadas manage to establish themselves over so much of North America considering the last glaciation was only 10,000 years ago? ■



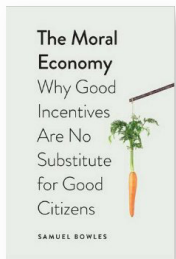
Periodical cicadas spend most of their lives as underground nymphs, emerging in large numbers every 13 or 17 years, which may reduce losses by over-satiating predators. (Image: istockphoto.com)

## NEW BOOKS BY SFI AUTHORS



In *The Origin and Nature of Life on Earth: The Emergence of the Fourth Geosphere* (Cambridge University Press, 2016), SFI External Professor D. Eric Smith and the late Harold Morowitz (see page

1) explore the origin of life as a planetary process. Combining geology, geochemistry, biochemistry, microbiology, evolution, and statistical physics, they create an inclusive picture of the living state, developing the argument that the emergence of life was a necessary cascade of nonequilibrium phase transitions that opened new channels for chemical energy flow on Earth.



In *The Moral Economy: Why Good Incentives Are No Substitute for Good Citizens* (Yale University Press, 2016), SFI Professor Sam Bowles shows how incentives – rewards and punishments that

follow from the assumption that man is amoral and self-interested – may “crowd out” ethical and generous motives, send the wrong message, and thus backfire. Using historical and recent case studies as well as behavioral experiments, Bowles shows how well-designed incentives can instead “crowd in” the civic-minded motives on which good governance depends. ■

## RESEARCH NEWS

# How word meanings evolve

By about 1500 AD, the Middle English word *deere* had lost its original meaning. Once associated with animals or wild animals generally, *deere* has come to mean a very specific animal, relatively small, which we now refer to as a *deer*.

Linguistics offers thousands of documented examples of changes in the associations of words and their meanings. How word meanings evolve, and by which underlying social and cognitive processes, remains unknown, at least in a generalized sense.

Participants in a March SFI working group called for coordinated computational approaches to address the outstanding question of how word-meaning associations change through human history.

“We all agree that this is the time when we should sit down and really try to synthesize the evidence we have, and try to come up with laws of meaning change,” says SFI Professor Tanmoy Bhattacharya, who co-organized the Lexical Semantic Networks and Language Change working group with SFI External Professor Peter Stadler and SFI Professor David Wolpert. “Now that we have a frame of the problem, and participants know that other people are working on similar things, the ideas they share are likely to spark research collaborations.”

Given the distributed and quintessentially complex nature of language, the group has teed up research approaches from complex systems science to initiate their search for laws of meaning change. Similar approaches have already advanced researchers' understandings of how word sounds change over time, and of the similarities in meaning structures across languages.

To approach the mechanisms for how word meanings evolve, the participants propose combining large linguistic datasets with agent-based models and perspectives from information theory, network science, machine learning, and distributed optimization.

Such research could advance the scientific understanding of the evolution of human language – and potentially find application in artificial intelligence – Bhattacharya says.

## ACHIEVEMENTS



SFI External Professor Jim Hartle has been named a member of the American Philosophical Society, an honorary society of some 1,000 scholars from a variety of disciplines. Fellows are nominated by current members and elected annually in April. ■



# Elizabeth Hobson: Strategic behavior among social animals



New ASU-SFI Postdoctoral Fellow Elizabeth Hobson, a behavioral ecologist, wants to understand how and why individuals interact, what individuals understand about

How social animals interact with others in their groups can fundamentally influence their subsequent behavior, reproductive success, health, and survival.

their social worlds, and how these socio-cognitive abilities have evolved. Much of her previous work focuses on sociality in parrots such as the monk parakeet. “Despite their popularity in the pet trade, we know almost nothing about parrot social structure in wild groups,” says Hobson. “When I started working with parrots I got really interested in comparing what I was seeing in parrots with what we find in primates,” she says. “But there just weren’t many rigorous or quantitative methods available.”

As a postdoctoral fellow at the National Institute for Mathematical and Biological Synthesis at the University of Tennessee, Hobson has focused on developing methods to define and compare sociality

in a way that enables comparative analyses across a broad range of species.

One breakthrough in her recent work involves using computational biology techniques to infer the cognition and potential for strategic decision-making that underlies how parakeets manage conflict in their social groups. Parakeets in her studies focus their aggression, in ways that appear to be strategic, on individuals who are likely to be potential challengers.

At SFI, Hobson will continue to develop computational methods for studying sociality. She plans to adapt methods she developed to examine conflict and aggression in parakeet groups to understand generalized patterns in strategic conflict across a broad range of species, including humans.

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

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She holds a PhD in biology from New Mexico State University and has been a postdoctoral researcher in the School of Informatics and Computing at Indiana University.

Hobson plans to join SFI in July 2016. ■

# Josh Garland: Comparative complexity



and useable by constructing a new paradigm in the way the “workhorse” of nonlinear time-series analysis – delay coordinate embedding – is viewed and operationalized.

Along with a Johns Hopkins collaborator, he helped take a new view of how the heart works in which cardiac muscle cells are playing a game of telephone, each cell telling the next cell to fire. Collectively these signals cause the muscles to contract and make the heart pump. Treating these cell interactions as a communication system implies that atrial

New SFI Omidyar Fellow Joshua Garland’s research has been nothing if not diverse. He took a stringent but powerful mathematical theory and turned it into something more agile

fibrillation is a communication breakdown. “From that standpoint, we can use tools from network theory and information theory and come up with treatment protocols that maximize synchronization of the heart,” he says. He also has begun to think about finance and climate. The thread between these seemingly disparate interests? “I’m really interested in how, as you study different systems, you see, in large part, the same thing: the heart does a lot of the same things that traded-financial markets and networks of ice cores do, and I’m interested in what is universally true about the underlying information mechanics of these systems,” he says.

No stranger to the Institute, Garland has taught SFI’s Complex Systems Summer School and the Institute’s Nonlinear Dynamics: Mathematical and Computational Approaches online course.

He expects to earn a PhD in computer science from the University of Colorado Boulder this summer. He holds an MS in applied mathematics, also from UC Boulder. ■

# New algorithms for an old problem

Symmetry appears readily in nature: on the petals of a sunflower or the spires of a snowflake. But not all symmetries are alike.

Flip a square horizontally, vertically, or diagonally – these are reflectional symmetries – and it looks the same. That flipping, though, differs from the rotational symmetry of a pinwheel spinning about its center.

Deciding whether two symmetries are alike is a longstanding problem in group theory, the mathematical study of symmetry. This challenge, called the Group Isomorphism Problem, dates back more than 100 years. And it’s not just a mathematical curiosity: The problem has implications in fields as diverse as geology, particle physics, and chemistry.

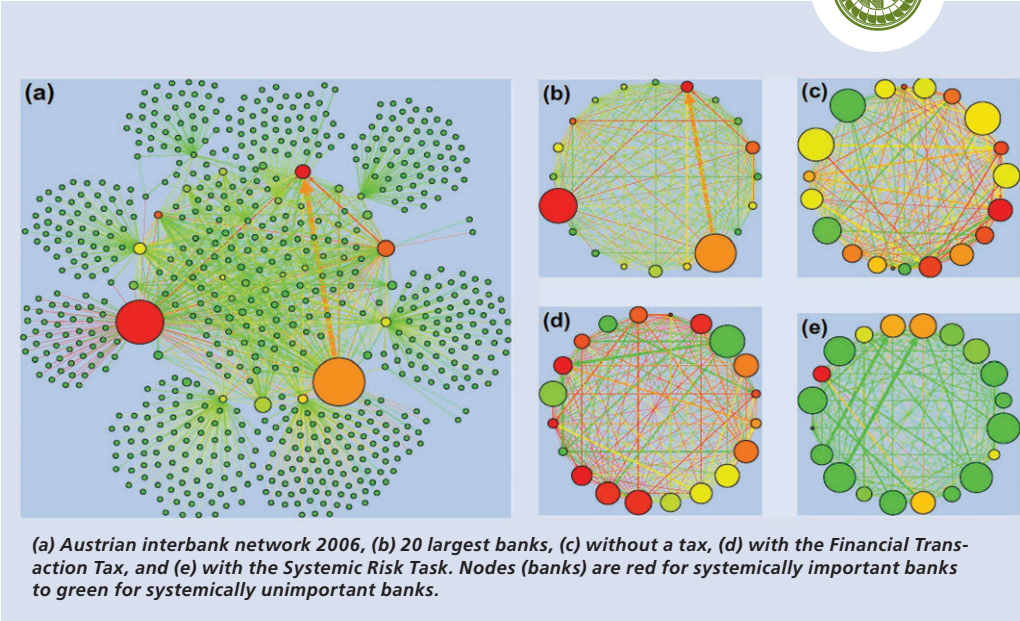
For simple cases like squares and pinwheels, differences are easily spotted. But for larger objects or in higher dimensions, researchers require computers and algorithms. Theoretical computer scientist Josh Grochow, an SFI Omidyar Fellow, organized a mid-May working group of two group theorists and two computer scientists, to better understand the structure of the Group Isomorphism Problem.

“It’s a pretty unique situation to have these two communities together, working on the same problem but with different goals, agendas, and techniques,” he says. “We think that each is benefiting from its interaction with the other.”

Grochow’s collaborators include mathematician Peter Brooksbank from Bucknell University, mathematician James Wilson from Colorado State University, and computer scientist Youming Qiao from the University of Technology, Sydney, in Australia.

Grochow and Qiao have collaborated for years on the problem; so have Brooksbank and Wilson. Recent research from each group “made it clear that our ideas might be fruitfully combined,” says Grochow. He notes that Wilson first suggested combining forces, and the working group at SFI was a natural early step.

Grochow says he sees this meeting as the first in a years-long effort. “Truly resolving the problem could take decades or longer,” he says. “We already see enough stepping stones that we think we could make progress for several years.” ■



(a) Austrian interbank network 2006, (b) 20 largest banks, (c) without a tax, (d) with the Financial Transaction Tax, and (e) with the Systemic Risk Task. Nodes (banks) are red for systemically important banks to green for systemically unimportant banks.

## Systemic risk tax could diminish cascading banking failures

In *Quantitative Finance*, SFI External Professor Stefan Thurner and colleagues conduct a network analyses of two multilayer interbank lending systems in Austria and Mexico to estimate the marginal systemic risk each transaction adds to the system, then suggest that a risk-proportional tax on individual loans between financial institutions could essentially eliminate the risk of future financial collapses and minimize systemic risk in interbank lending.

## Accounting for politics in green tech growth

Despite the significant effects of policy on technological progress, growth projections for renewable technologies rarely take into account political dynamics. A computational model developed by SFI Omidyar Fellow Marion Dumas and her collaborators forecasts 50-year carbon emission trajectories in the context of two competing political parties – a “green party” and a “brown party” with differing degrees of commitment to their constituents. Among other results, the model shows that winning an election early on has significantly greater impact on the 50-year trajectory than a later win, and a strong commitment from one party can force the less committed party to compromise. Their results were published in *Ecological Economics*. ■

# Evolutionary fork in the road: Migrate or cooperate

Life has evolved not just to survive, but to utilize limited resources in doing so. Migrating to avoid competition or staying close to home and cooperating is one notable, resource-related evolutionary fork in the road.

Amid growing interest in these two strategies, a small group of researchers is looking further ahead to understand how the strategies might have co-evolved and in what situations one strategy wins out over the other.

“We know migration and cooperation are linked, and we understand very well that general link,” says Jeremy Van Cleve, who with SFI Omidyar Fellow Eric Libby and SFI External Professor Michael Hochberg has organized a late-June SFI working group on the subject. “What [we] are attacking more specifically is the role of other factors shaping patterns of migration, which we know will then have an effect on patterns of costly helping” – that is, cooperation and altruism, he says.

One way for a species to deal with scarce resources is to migrate, says Van Cleve, a former SFI Omidyar Fellow now at the University of Kentucky. By spreading out over a wider area, families avoid fighting over food and other resources, raising the likelihood they’ll pass their genes on to the next generation.

Cooperation rarely evolves in that case – there’s no evolutionary gain. But when the rate of migration is low, individuals live near their relatives and cooperative strategies do evolve. Most ants in a colony, for example, are sterile daughters of a queen ant; the daughters help the queen by raising their sisters while the queen is responsible for reproduction.

Why do some species migrate and others cooperate? This is where the role of environmental heterogeneity might come in, says Van Cleve: “Does heterogeneity help us understand when migration might evolve to be low or high, and in turn how costly helping might evolve?” ■



(Image: istockphoto.com)



## Gonzales named an SFI Miller Scholar



Author Laurence Gonzales has been named a Miller Scholar of the Santa Fe Institute.

The Miller Distinguished Scholarship is the most prestigious visiting position at SFI, awarded to highly accomplished, creative thinkers who make profound contributions to our understandings of society, science, and culture.

While at *Playboy* magazine in the 1970s as a staff writer and articles editor, Gonzales began writing about airline crashes. This began his exploration of failure in complex mechanical and coupled mechanical-human systems.

He left *Playboy* in 1978 to become a freelance writer and has written for *Harper's*, *Men's Journal*, *National Geographic Adventure*, and other publications. Some of his essays, often portraying his own adventures in setting and thought, have been collected in three books, the latest of

which was *House of Pain* (2013).

He wrote the best-selling book *Deep Survival: Who Lives? Who Dies, and Why?* (2004) and its sequel *Surviving Survival: The Art and Science of Resilience* (2013), which explores why people make bad decisions and what leads some of them to survive while others perish.

His most recent non-fiction book is *Flight 232: A Story of Disaster and Survival* (2015). His most recent novel is *Lucy* (2011), a coming-of-age tale of a girl who is the result of a genetic experiment.

He has won many writing awards, including two prestigious National Magazine Awards and the Distinguished Service Award from the Society of Professional Journalists. He is on the adjunct faculty at Northwestern University's Medill School of Journalism.

He is the 7th SFI Miller Scholar since SFI Chair Emeritus Bill Miller conceived and underwrote the program in 2010.

More about Gonzales at [www.santafe.edu/news](http://www.santafe.edu/news). ■

## Two new topical short courses

Building on SFI's popular three-day Short Course in Complexity, two new courses are pulling together professionals interested in health care and innovation to explore insights and methods from complexity science applicable to those fields.

Exploring Complexity in Health and Medicine, October 12-14 in Santa Fe, will focus on how mathematical modeling, machine learning, computational diagnostics, and other tools from the study of complexity are transforming the health care system. The course is intended for medical practitioners, though academics and other professionals are encouraged to attend.

"Few industries are as complex as health care," says SFI Director of Education Juniper Lovato. "Health care practitioners are out there in the world making decisions every day, often with only local information. It's a problem that begs for a complexity approach. In addition, for SFI, health care is a great test of the value of complex systems tools and methods."

Exploring Complexity in Invention and Innovation, September 21-23 in Austin, Texas, provides a tour of the frontiers of innovation research. Designed to appeal to a variety of professionals, the course will explore the underlying forces and patterns that drive novelty in technology, biology, and social systems, and how innovation affects industry evolution and social behaviors, with an emphasis on prediction and social engineering.

Lovato says topic-specific short courses may expand into other fields. "We're putting our feelers out there and seeing who in society wants to interact with SFI and complex adaptive systems. We want to be surprised."

For course information, and to register, visit [www.santafe.edu/shortcourse](http://www.santafe.edu/shortcourse). ■

## Tracking animal migrations has become easier...now what?

Salmon navigate across vast swaths of open ocean and a maze of branching river networks to locate their natal waters. For years, scientists have described this as heroic feats of individuals.

More recently, though, researchers have observed that salmon migrating in large groups more accurately navigate home than salmon in smaller groups. Other species also migrate en masse over land and through air, and emerging hypotheses suggest some animals take advantage of collective navigation – a kind of group decision-making that helps get them where they're going. But testing these ideas in the wild can be technically and logistically difficult.

During a three-day working group at SFI, roughly a dozen ecologists and computer scientists will explore ways technologies might help researchers better understand why and how individuals in migrating groups make the choices they do.

In the past, GPS tracking has allowed researchers to study the location and movements of individuals. However, these individuals act only as trace particles (samples that indicate where the group has traveled); tracking them cannot reveal how social interactions inform group movement decisions.

Recent technological advances are beginning to lift this restriction. Tracking equipment such as new GPS units, passive integrated transponder (PIT) tags, and camera-laden drones has become better and less expensive, and imaging software that can identify individuals in video has grown more accurate. As a result, researchers now can capture fine-scale movements of many animals in parallel.

"We can now get the simultaneous trajectory of every individual in a group moving together in the wild. That's really an unprecedented data set," says SFI Omidyar Fellow Andrew Berdahl, who is hosting the late-June working group with Colin Torney of the University of Exeter. "Now the challenge is to determine how individuals are interacting with each other and with the environment, and how those interactions scale up to effective group-level migration strategies." ■

### > 72-hour collaboration continued from page 1

SFI President David Krakauer stopped by on Day 2 with chocolate and bourbon and to offer words of encouragement.

A few minutes before noon on Thursday, April 7, the team posted their paper, "Dynamics of Beneficial Epidemics," to the preprint server [arxiv.org](http://arxiv.org) ([arxiv.org/abs/1604.02096](http://arxiv.org/abs/1604.02096).) The work still needs to be reviewed by their scientific peers, but the research is attracting attention both from scientists and the news media.

The postdocs say they'd do it again. "It was great fun, and it was also rewarding to be so many minds thinking about the same thing in totally different ways," says Marion Dumas. "It brings a whole different perspective on what science is – not about any individual being right or wrong, but about disciplined collective inquiry." ■

May / June 2016  
UPDATE

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## Upcoming community events

**SFI Community Lecture, Tuesday, May 31, 7:30 p.m., The Lensic Performing Arts Center (211 W. San Francisco Street) – Biology and Creativity: Why Must We Write, Draw, Sing, and Dance.** Creative activities are too often thought of as childhood pastimes, and many of us gave them up early in life. But why do we long for them still? Are creativity and biology interconnected? Artist and author Lynda Barry thinks everything we call "art" has something in common, something that feels alive and is contained and transported by something that is not alive – a book, a tune, or a painting. She explores our innate ability to work with images and asks what the biological function of this thing we call "the arts" might be. Caution: This talk includes swear words, party tricks, and jokes about balls.

Barry is assistant professor of interdisciplinary creativity at the Wisconsin Institute of Discovery's Image Lab. Widely credited with expanding the literary, thematic, and emotional range of American comics through her groundbreaking weekly strip *Ernie Pook's Comeek*, she has written 17 books, worked as a commentator for NPR, and adapted her novel into a long-running off-Broadway play.

**SFI Community Lecture, Tuesday, June 7, 7:30 p.m., The Lensic Performing Arts Center (211 W. San Francisco Street) – The Language Hoax.** The language we speak shapes how we experience life, creating a world view based on its vocabulary and grammar...right? Not so, says John McWhorter. Drawing from the scientific literature, McWhorter explains how this widely-held belief is not only false, it leads to dangerous assumptions about cultures and races that differ from our own – and asserts that while cultures emphasize the ways human groups differ, languages suggest what we have in common.

McWhorter is an associate professor of English and comparative literature at Columbia University. He is a regular columnist for *Time*; a contributor to numerous newspapers, magazines, and television programs; and author of *The Language Hoax: Why the World Looks the Same In Any Language*.

SFI's 2016 Community Lectures are made possible through the generous underwriting of Thornburg Investment Management, with additional support from The Lensic Performing Arts Center. Tickets are free, but reservations are required; to reserve tickets, visit <http://tickets.ticketssantafe.org>. To watch a lecture as it happens, visit SFI's YouTube page; participate in the discussion live on Twitter at @SFIlive.