



Update

March / April 2010



RESEARCH NEWS

Can physics ideas apply to paleontology?



Contrasting the 1,300 butterfly species in a Peruvian park with the barren expanses of Antarctica shows that climate influences biodiversity, but determining how is more difficult.

When the editor of *Current Biology* asked SFI Professor Doug Erwin, a paleontologist at the Smithsonian, to write something for a special issue on climate and biodiversity, he groaned. After all, he doesn't even study climate.



Doug Erwin

"I said yes in a moment of weakness," he says, "mostly because I was interested in learning about what other people had been doing."

Out of that moment of weakness has sprung a unique, transdisciplinary, SFI-style research project, one

that aims to use ideas from physics to understand paleontology.

Paleontologists tend to approach things like historians do, says Doug. They look for evidence of past events – past climates and past biodiversity, for example – and try to fit the patterns they see into a story.

The broad outlines of this story are clear, and obvious: Climate influences biodiversity. Just compare the 1,300 species of butterflies in a single Peruvian park with the bio-barren expanses at the poles.

But discerning how climate influences biodiversity gets more difficult. Different paleontologists prefer different explanations, and the records on their own can't resolve the matter.

Doug suggests paleontologists try thinking more like physicists. Physicists and other scientists create hypotheses, generate predictions,

and test them against the evidence. Similarly, paleontologists could create simple models encapsulating the different explanations for climate's impact on diversity, see how they make different predictions, and then return to the fossil record to test them.

Remarkably, no one has ever done that.

Doug is collaborating with SFI Faculty Chair David Krakauer to begin to create such models, though he acknowledges their notions are highly conceptual at this point.

"It's not that physicists think better, or that paleontologists think better," Doug says. "They just think differently. SFI has taught me that applying one way of thinking to a different kind of problem can be very productive." ■

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RESEARCH NEWS

New Omidyar Fellow asks why monogamy has evolved

In about 83 percent of all human societies, polygyny – in which men can be married to more than one wife – is considered the norm. Scores of anthropological and biological theories account for the evolution of this arrangement. What is less clear, says new SFI Omidyar Fellow Laura Fortunato, is the other 17 percent. Specifically, why has monogamous marriage evolved?

While Laura is not the first to explore the origins and evolution of social monogamy, she is among the first to develop a theoretical framework for its study.

"Evolutionary explanations conflicted with historical and ethnographic evidence," she says.

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INSIDE SFI

SFI course offers complexity tour

SFI is offering a new three-day primer on complexity for professionals, university faculty and students, and others interested in how the methods and results of this interdisciplinary field can be applied in their own work or studies.

The May 19-21 course, "Exploring Complexity in Science and Engineering from a Santa Fe Institute Perspective," will provide an intensive tour of the major topics of complex systems science, including dynamics and chaos, networks, biological and technological evolution, scaling, and agent-based computer modeling. Taking the course requires no specific background in mathematics, science, or computation.

"Exploring Complexity" will be taught in Portland, Oregon, by a group of SFI faculty and associates. Lectures, > more on page 2

RESEARCH NEWS

New view: Rare events add up to evolution

A new model testing a longstanding evolutionary hypothesis offers a mind-bendingly simple explanation: Life just happens.

Species are forever racing their environments. Rather than marching toward perfection, a lineage simply adapts to demands of the age, according to the Red Queen hypothesis (named for her line "It takes all the running you can do to keep in the same place" in *Through the Looking-Glass, and What Alice Found There*).

It further posits that species expire, and speciate, at a constant rate. Just as radioactive atoms each have an equal chance of decay, a species' longevity offers no guarantee of its continued existence.

Despite its popularity, the hypothesis has never been tested.

"You can wave your hands around and say the environment is constantly degrading," says

Mark Pagel, SFI External Professor and Professor of Biological Sciences at Reading University. "But why would that mean species produce new species at > more on page 2



Alice meets the Red Queen

LIT BITS

Diffusive behavior and the modeling of characteristic times in limit order executions; Eisler, Z.; Kertesz, J.; **Fabrizio Lillo**; Mantegna, R.N.; *Quantitative Finance* 9 (5), 2009

Beyond Darwin: On the role of niche construction and self-organization in evolution; **Pablo Marquet**; *Revista Chilena de Historia Natural* 82 (4), December 2009

Evolutionary plasticity and innovations in complex metabolic reaction networks; Rodrigues, J.F.M.; **Andreas Wagner**; *PLOS Computational Biology* 5 (12), December 2009

Biologistics and the struggle for efficiency: Concepts and perspectives; **Dirk Helbing**; Deutsch, A.; Diez, S.; Peters, K.; Kalaidzidis, Y.; Padberg-Gehle, K.; Lammer, S.; Johans-

son, A.; Breier, G.; Schulze, F.; Zerial, M.; *Advances in Complex Systems* 12 (6), December 2009

Model for non-Gaussian intraday stock returns; Gerig, A.; Vicente, J.; **Miguel Fuentes**; *Physical Review E* 80 (6 pt 2), December 2009

Market impact and trading profile of hidden orders in stock markets; Moro, E.; Vicente, J.; Moyano, L.G.; Gerig, A.; **J. Doyme Farmer**; Vaglica, G.; **Fabrizio Lillo**; Mantegna, R.N.; *Physical Review E* 80 (6 pt 2), December 2009

Quantum-algorithms for Simon's problem over non-abelian groups; Alagic, G.; **Cris Moore**; Russell, A.; *ACM Transactions on Algorithms* 6 (1), December 2009

Exploring biological network structure with clustered random networks; Bansal, S.; Khandelwal, S.; **Lauren Ancel Meyers**; *Bioinformatics* 10, December 9, 2009

Human synthetic lethal inference as potential anti-cancer target gene detection; Conde-Pueyo, N.; Munteanu, A.; **Ricard Solé**; Rodriguez-Caso, C.; *BMC Systems Biology* 3, December 16, 2009

On the origin of species by natural and sexual selection; **Sander van Doorn**; Edelaar, P.; Weissing, F.J.; *Science* 326 (5960), December 18, 2009

Universal behavior of extreme price movements in stock markets; **Miguel Fuentes**; Gerig, A.; Vicente, J.; *PLOS One* 4 (12), December 23, 2009

Emergence of scale-free syntax networks; Corominas-Murtra, B.; Valverde, S.; **Ricard Solé**; *Evolution of Communication and Language in Embodied Agents*, 2010

Revisiting counterinsurgency; Branch, D.; **Libby Wood**; *Politics Society* 38, 2010

Living technology: Exploiting life's principles in technology; Bedau, M.A.; McCaskill, J.S.; Packard, N.H.; **Steen Rasmussen**; *Artificial Life* 16 (1), 2010

The computational structure of spike trains; Haslinger, R.; Klinkner, K.L.; **Cosma Shalizi**; *Neural Computation* 22 (1), January 2010

Advancing the metabolic theory of biodiversity 12; Stegen, J.C.; **Brian Enquist**; Ferriere, R.; *Ecology Letters* 13 (1), January 2010

PEOPLE

AMS recognizes Castillo-Chavez



External Professor Carlos Castillo-Chavez has been awarded the 2010 AMS Award for Distinguished Public Service by the American Mathematical Society. Carlos is a

Regents Professor and the Joaquin Bustoz Jr. Professor of Mathematical Biology at Arizona State University.

The award, presented on January 14 at the Joint Mathematics Meetings in San Francisco, recognizes his leadership of numerous programs designed to spark interest in math and science among traditionally underrepresented and economically disadvantaged students.

Carlos directs several institutes at ASU that provide sequential intense summer experiences to students from high school to the postdoctoral level. Many of his students have participated in SFI summer education programs, as well.

"The importance of providing opportunities and multiple successful pathways to all U.S. aspiring mathematicians must be continuously carried out," he says, "not only to preserve the intellectual capacity that we have but also to broaden and enrich the mathematical community through the systematic inclusion in the wonderful and empowering world of mathematics of Americans who have been traditionally underrepresented." ■

In memoriam: Eli Sercarz

Eli Sercarz, SFI Science Board member and renowned immunologist and UCLA professor emeritus of microbiology and molecular genetics, died November 3 in Topanga, California. He was 75. His research helped advance the understanding of autoimmune diseases, cancer, and other disorders. ■

CREDITS

Editorial staff

John German
Ginger Richardson
Della Ulibarri

Contributors

Rachel Feldman
Krista Zala
Julie Rehmeier

Design and production

Michael Vittitow

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> Rare events continued from page 1



Mark Pagel

a constant rate?" To investigate, he and colleagues analyzed speciation rates in 101 phylogenetic trees across the spectrum of life and tested explanations for each rate.

They found that species within a genus, be it dogs or orchids, diversify evenly over time.

And – to their surprise – single rare events rather than compounded events account for most of it.

"Any single change is rare, from an accident in the genome to a change in female mating preferences," says Mark. "But the list is long,

and any one of them could happen at any time and cause speciation to occur."

Their new interpretation of the Red Queen: Speciation happens mostly from rare random events that cause reproductive isolation.

A description of their work appears in the January 21, 2010, issue of *Nature*. ■



Wolves, coyotes, jackals, and dogs all have speciated at about the same rate over their 12-million-year history, while hawks and buzzards have speciated at their own rate for 28 million years. (Photos courtesy Mark Pagel)

PEOPLE

Joseph Traub joins National Academies committee



SFI External Professor Joseph Traub has been appointed to the Division Committee on Engineering and Physical Sciences of the National Academies.

The committee provides advice and strategic insights to boards and standing committees within its purview, including disciplinary boards for mathematics, physics, computer science, and astronomy as well as boards and standing committees serving each of the major military services, the intelligence community, and the Department of Homeland Security.

Joe is the Edwin Howard Armstrong Professor of Computer Science at Columbia University. ■

> Complexity course continued from page 1

demonstrations, and projects will show how complex systems research and thinking can apply to the participants' work. It is being organized and led by SFI External Professor Melanie Mitchell, in collaboration with the Institute's education program.

"The Institute has long offered courses on complexity to advanced graduate and postdoctoral students, but this is the first time an SFI course has been made available to the general public," who might not have extensive backgrounds in math and science, Melanie says.

She recommends the course for business and government managers, industrial research and development staff, medical and social work professionals, and university faculty and students in any area of science or social science.

For more information, see <http://www.santafe.edu/education/schools/focus>. ■

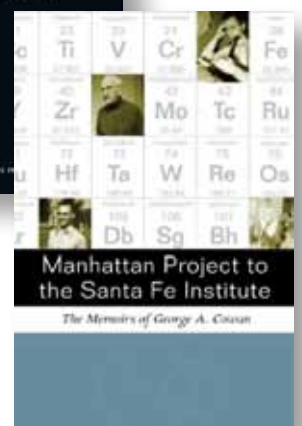
PEOPLE

Institute book news

Two new books by members of SFI's community are available to the public.

In "Think Twice: Harnessing the Power of Counterintuition" (Harvard Business School Press) SFI Trustee Michael Mauboussin, Chief Investment Strategist for Legg Mason Capital Management, shows decision makers how to make sound business decisions by recognizing and avoiding common mental missteps, spotting erroneous thinking patterns, and more fully appreciating the complexities presented by many decisions.

"Manhattan Project to the Santa Fe Institute: The Memoirs of George A. Cowan" (University of New Mexico Press) is a firsthand account of how science works through the eyes of a career physical chemist who witnessed the birth of nuclear weapons at Los Alamos National Laboratory, the birth of the new field of complexity science as the Santa Fe Institute's founding president, and numerous and significant science



policy debates along the way. George, an SFI Distinguished Professor and Trustee Emeritus, weaves into his memoirs intriguing anecdotes about a large cast of notable scientists. ■

LIT BITS (cont.)

Field theory for biogeography: A spatially explicit model for predicting patterns of biodiversity; O'Dwyer, J.P.; **Jessica Green**; *Ecology Letters* 13 (1), January 2010

Towards a renaissance of economic theory; **Herbert Gintis**; *Journal of Economic Behavior & Organization* 73 (1 SP ISS), January 2010

Towards a non-abelian electric-magnetic symmetry: The skeleton group; Kampmeijer, L.; **Sander (F.A.) Bais**; Schroers, B.J.; Slingerland, J.K.; *Journal of High Energy Physics* (1), January 2010

Discrete epidemic models; Brauer, F.; Feng, Z.L.; **Carlos Castillo-Chavez**; *Mathematical Biosciences & Engineering* 7 (1), January 2010

Blaming the messenger: Notes on the current state of experimental economics; Eckel, C.; **Herbert Gintis**; *Journal of Economic Behavior & Organization* 73 (1 SP ISS), January 2010

Speciation as an active force in promoting genetic evolution; Venditti, C.; **Mark Pagel**; *Trends in Ecology & Evolution* 25 (1), January 2010

Evolutionary dynamics of populations with conflicting interactions: Classification and analytical treatment considering asymmetry and power; **Dirk Helbing**; Johansson, A.; *Physical Review E* 81 (1 pt 2), January 2010

Antagonistic coevolution of two imprinted loci with pleiotropic effects; **Jon Wilkins**; *Evolution* 64 (1), January 2010

Density-dependence of functional development in spiking cortical networks grown in vitro; Ham, M.I.; Gintautas, V.; Rodriguez, M.A.; Bennett, R.A.; Maria, C.L.S.; **Luis Bettencourt**; *Biological Cybernetics* 102 (1), January 2010

Network games; Galeotti, A.; Goyal, S.; **Matthew Jackson**; Vega-Redondo, F.; Yarovitz, L.; *Review of Economic Studies* 77 (1), January 2010

Pros and cons of estimating the reproduction number from early epidemic growth rate of influenza A (H1N1); Nishiura, H.; Chowell, G.; Safan, M.; **Carlos Castillo-Chavez**; *Theoretical Biology & Medical Modeling* 7, January 7, 2010

Dynamic networks from hierarchical Bayesian

graph clustering; Park, Y.; **Cris Moore**; Badger, J.S.; *PLOS One* 5 (1), January 11, 2010

Target prediction and a statistical sampling algorithm for RNA-RNA interaction; Huang, F.W.D.; Qin, J.; Reidys, C.M.; **Peter Stadler**; *Bioinformatics* 26 (2), January 15, 2010

Phylogenies reveal new interpretation of speciation and the Red Queen; Venditti, C.; Meade, A.; **Mark Pagel**; *Nature* 463 (7279), January 21, 2010

Quantification of artistic style through sparse coding analysis in the drawings of Pieter Bruegel the Elder; Hughes, J.M.; Graham, D.J.; **Dan Rockmore**; *Proceedings of the National Academy of Sciences* 107 (4), January 26, 2010

INSIDE SFI

Chris Wood offers outlook for SFI's Business Network for 2010 and beyond

The *Update* sat down recently with SFI Vice President for Administration Chris Wood for his thoughts about his new role leading the Institute's Business Network.

Update: *What is the status of the assessment of the Business Network as you and the SFI leadership map plans for 2010 and beyond?*



Chris: We are still very much in the planning stage, attempting to identify those aspects of the program that are most compelling for our members and evaluating possible new directions. It's important that the Business Network continue those aspects of the program that have been valuable in the past, while at the same time exploring interesting new ideas and programs.

In addition, SFI Trustee Leighton Read is leading a Trustee group that will work with SFI

senior management, faculty and postdocs, and Business Network staff to review our goals for the size, composition, and program foci of the Business Network in the coming years.

Update: *What are some of the issues you are looking at?*

Chris: One important question is optimal size for the Network, which currently has 36 members. Having a Business Network, say, one quarter to one third larger would be useful from the perspective of the diversity of the corporate sectors and firms represented, the increased opportunity for beneficial interactions among members, and increased revenue for the Institute.

Another interesting challenge is to encourage diversity in the size and longevity of members. We would like to find ways to encourage small businesses and startups to be part of the Network while not compromising its value to the larger more established corporate members.

Update: *Do you expect major changes?*

Chris: In my view changes to the Network are likely to be more evolutionary than revolutionary in character. We hope to engage the Network members to a greater extent in both developing and executing Network events. I will feel that we've had a big success if we can maintain and grow the number of Business Network members and increase the value of the Network to both members and to SFI researchers.

Update: *How did the Network weather the 2008-2009 economic storm?*

Chris: We lost some members, we gained some members, and the net is down only a small bit. We're looking to regain some of the members who had to drop out for purely economic reasons as soon as possible. I've been in touch with many of them already.

Update: *What are you learning from your discussions with Network members?*

Chris: That's an ongoing process and there is still much to learn. But one thing I am learning already is that there are both common interests



“Creating an environment in which academic scientists can interact effectively with members of the corporate and business community is one of the things SFI does best...”

shared by most members, as well as specific interests that are as varied and as numerous as the number of members. That variety will be an ongoing challenge.

Update: *As you look back on the history of the Business Network, which was formed in 1992, what do you think is its legacy to this point?*

Chris: It is tangible evidence that SFI, which is relentlessly focused on basic research and does not take on consulting or project work for businesses or government, is nevertheless compelling to the corporate world. You might imagine that as focused on the bottom line as the corporate world is, Network members might have difficulty raising internal support for membership. But year after year, the members say they get value out of engaging the Institute, its researchers, and its scientific ideas. That is very gratifying.

Update: *What does the Business Network do for the research here at the Institute?*

Chris: I continue to be gratified at the number of really compelling questions that get asked by our Network members and others in the corporate and business worlds. Creating an environment in which academic scientists can interact effectively with members of the corporate and business community is one of the things SFI does best, namely, bringing disparate groups together over a common set of questions or problems. Just stand back and watch the intellectual sparks fly!

Update: *How has this new challenge been personally for you?*

Chris: The Business Network is a very, very important activity for the Institute and I am grateful for the opportunity. I will consider it an important accomplishment if we can make Business Network activities “must attend” events for the entire SFI community. ■

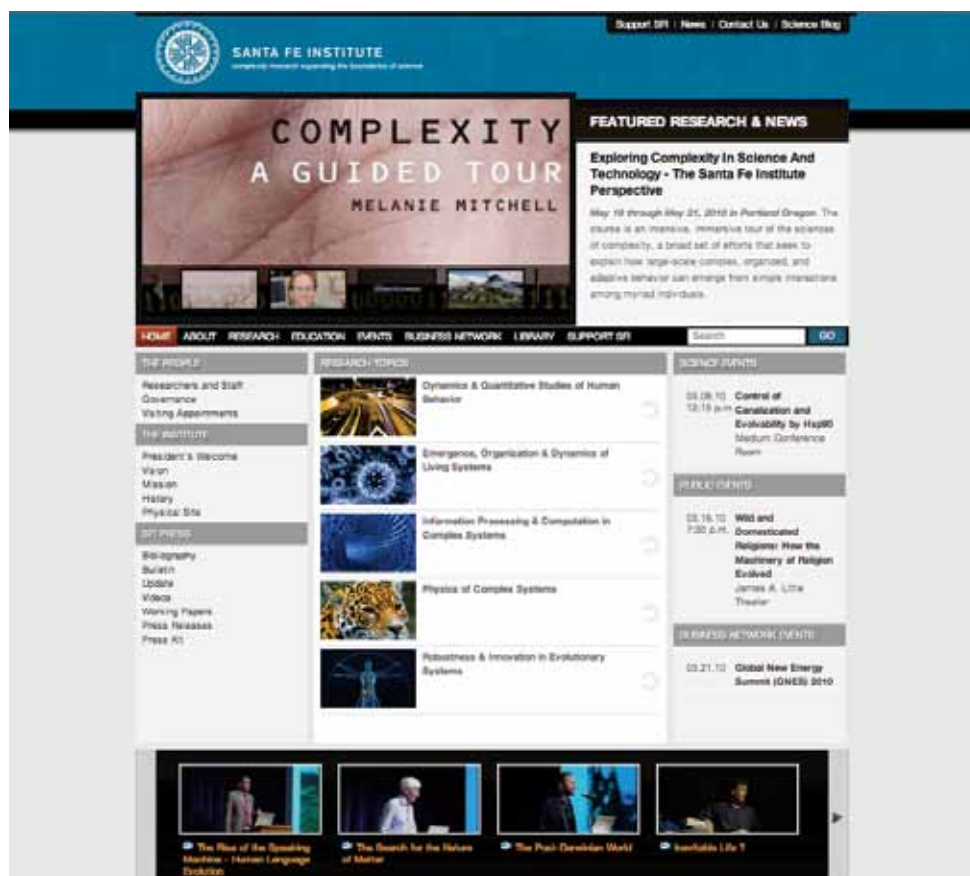
INSIDE SFI

SFI launches new web site

The Institute's web site (www.santafe.edu) has a new look for 2010.

Faculty Chair David Krakauer, who led the redesign, says the goal was a dynamic, information rich, and navigable site that personalizes the browsing experience for several of the Institute's key return audiences. Customized pages for researchers, Business Network members, reporters, trustees, and students/teachers are each a click away from the home page. Video and audio downloads of Institute events are readily accessible.

“We wanted the user to not have to go very far to get something out of the site,” he says. David worked with IT Director Nate Metheny, Information Architect Atty Mullins, Web Support Specialist Elizabeth Martinez, Administrative Coordinator Casey Cox, and Special Project Coordinator Vesna Currie to review the online approaches of a number of institutions and emulate some of their sites' best features. ■



Nina Fedoroff named AAAS president-elect



SFI External Professor Nina Fedoroff, science and technology adviser to the U.S. Secretary of State and the U.S. Agency for International Development, has been elected to serve a one-year term as 2011 president of the American Association for the Advancement of Science (AAAS). ■

Museum recognizes Murray Gell-Mann



Institute Distinguished Fellow and Trustee Murray Gell-Mann will be presented the National Award of Nuclear Science and History at the National Museum of Nuclear Science & History's Einstein Society Gala at the Sheraton Uptown Hotel in Albuquerque March 20. ■

How and why Mayan culture waned



Why some Mayan cities thrived while others were abandoned relatively rapidly in the 9th century was the topic of a February 24 SFI Public Lecture in Santa Fe given by Institute President Jerry Sabloff, who has spent 45 years studying Mayan civilization as an archaeologist.

Archaeologists for years had sought a single cause of the decline. But now they believe several factors – political, environmental, and

economic – combined to drive the Mayan culture shift. Jerry and several colleagues at the School for Advanced Research led the investigation of systemic factors that contributed to the change.

“As a result of more scholarly research, both in quantity and quality, and a host of new scientific studies that look at climate and ecology, we have a much better picture of what happened at that time,” Jerry said to a standing-room only crowd.

For more information about SFI Public Lectures, see www.santafe.edu. ■



Upcoming Public Lectures



March 16 - Institute Miller Scholar Daniel Dennett will discuss “Wild and Domesticated Religions: How the Machinery of Religion Evolved.” He examines how and why their parts work together and explores how we

can respond thoughtfully to the challenges they currently suggest. Dan, whose research centers on philosophy of mind, philosophy of science, and philosophy of biology, is in residence as SFI’s inaugural Miller Scholar at Cowan Campus through May 2010. **(7:30 p.m., James A. Little Theater, 1060 Cerrillos Road, Santa Fe)**



May 5 - SFI Omidyar Fellow Nathan Eagle will discuss “Big Data, Global Development, and Complex Systems.” In collaboration with the mobile phone, internet, and credit card industries, Nathan and colleagues are

aggregating and analyzing behavioral data from over 250 million people from North and South America, Europe, Asia, and Africa and developing large-scale network analysis and machine learning algorithms that will provide deeper insight into human behavior. **(7:30 p.m., James A. Little Theater, 1060 Cerrillos Road, Santa Fe)**

> Human monogamy continued from page 1

In a recent paper she co-authored with Marco Archetti (University of Oxford), titled “Evolution of Monogamous Marriage by Maximization of Inclusive Fitness,” Laura developed a game-theoretic model to conceptualize variation in marriage strategies across societies.

She then used the model’s results to generate specific predictions about the history and cross-cultural distribution of monogamous marriage. Currently she is working to extend this framework to other features of human social organization.

She believes that by applying her conceptual and methodological approaches, others may formulate more effective cases.

“My work won’t necessarily provide answers to the origins of monogamy,” Laura says, “but it may focus future investigations of the archaeological, historical, and ethnographic evidence relating to human social organization.”

Laura is no stranger to the Institute. In 2006, she attended the Complex Systems Summer School in Beijing. Her work there helped form the basis of her current research. ■

SFI IN THE NEWS

The Christian Science Monitor on January 20 reviewed the work of several SFI researchers who are studying the economy as a living system. Quoted in the article are SFI Professors John Miller and Doyne Farmer and SFI External Professors Brian Arthur and Duncan Foley. www.csmonitor.com/Innovation/Responsible-Tech/2010/0120/The-living-breathing-economy

A February 3 *Santa Fe Reporter* cover story, “Born Poor?,” features SFI Professor Sam Bowles and highlights his work on the intergenerational transmission of wealth. http://sfreporter.com/stories/born_poor/5339/all/

A February 4 *Santa Fe New Mexican* feature article profiles archaeologist and new Institute President Jerry Sabloff. “We underestimate the skills and intelligence of ancient cultures,” he said. “I’m a strong believer in the lessons of history.” www.santafenewmexican.com/HealthandScience/Action-archaeology

A February 7 *New York Times* article, “The Art of Being Santa Fe,” reviews Santa Fe’s modern art and intellectual culture and mentions SFI. <http://travel.nytimes.com/2010/02/07/travel/07santafe.html>

A February 8 *National Public Radio* story reviews SFI External Professor Dan Rockmore’s

work to use statistical techniques to spot art forgeries.

www.npr.org/templates/story/story.php?storyId=123405424

A February 8 blog post on CNNMoney.com by senior editor Adam Lashinsky reviews the discussions at the recent World Economic Forum in Davos and mentions “smartypants big thinkers like the Santa Fe Institute’s Geoffrey West” and his remarks about smart-grid technology. http://brainstormtech.blogs.fortune.cnn.com/2010/02/08/the-davos-wrap/?section=magazines_fortune

A February 12 *Santa Fe New Mexican* article, “Unlocking Mysteries of the Maya,” reviews Institute President Jerry Sabloff’s work to understand the decline of Mayan cities around AD 800. www.santafenewmexican.com/HealthandScience/Unlocking-mysteries-of-the-Maya

A February 19 National Public Radio Morning Edition story quotes SFI Omidyar Fellow Nathan Eagle in a story about the ease of tracking individuals’ behaviors and movements via cell phone. “It’s insane. I mean, the vast majority of our species are carrying around a little device that’s continually logging their behavior,” Nathan said. www.npr.org/templates/story/story.php?storyId=123879603

Meeting: Whence the complexity textbook?

Numerous popular books about complexity science have been published. Researchers associated with the Institute have proposed, or are overseeing, complexity courses and curricula at a handful of American universities.

But still no textbook. A March 15 meeting at SFI will, if Faculty Chair David Krakauer and President Jerry Sabloff have their way, correct this oversight.

David believes the Institute is the perfect venue for the writing of such a book. “We have the experts

needed to write it, but we don’t have departments [or departmental barriers] like the universities do,” he says.

He envisions members of SFI’s scientific community writing the book’s chapters.

Who would publish it? Who would fund it? Would it be a rudimentary undergraduate textbook or one more suited for graduate students? Those are some of the questions the meeting will begin to address, he says. ■



SANTA FE INSTITUTE

1399 Hyde Park Road
Santa Fe, New Mexico 87501
T 505.984.8800
F 505.982.0565
www.santafe.edu