SANTA FE INSTITUTE

Update

November / December 2010

Form arises from parameters and constraints at a crowded train station in Liverpool, England. (Keith Gentry, istockphoto.com)

RESEARCH NEWS

Regulation: How parameters define what's possible

"Regulation" occasions thought of government proscriptions and legal limits. But explicit formal rules are narrowly defined examples of a broader phenomenon: parameters that define, within any complex system, what's possible – from the interactions of individual units like genes, computers, or consumers to system-scale behaviors. At its essence, the study of regulation is the study of how constraints influence form and function.

Classical examples include the selection mechanisms of neo-Darwinian evolutionary theory or Adam Smith's market-guiding "invisible hand." Each describes constraints – at the parameter level self-interested impulse, and mechanistically, buyer behavior or adaptation and natural selection – giving rise to the optimized outcomes of a living organism or product distribution.

These examples have been updated from their 18th and 19th century forms. The gestures of Smith's hand, for example, depend in great part on the contemporary infrastructure of a market, including the formal and informal rules regulating the behaviors of its participants.

"What norms ensure coordination in one place, and in another place chaos?" asks SFI Faculty Chair David Krakauer.

David and SFI VP for Administration Chris

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RESEARCH NEWS

SFI economic modeling gains support of 'rethinkers'

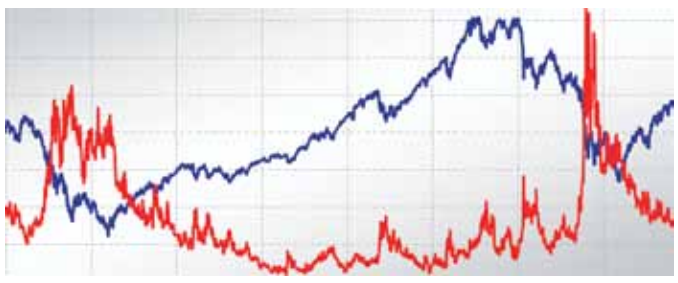
More than three years after the global financial crisis, economists are still wondering why some of their forecasting models failed to alert them. A growing number of them is asking whether new kinds of models are needed.

One rethinking effort led by SFI Professor Doyne Farmer is among 27 projects to receive initial funding from the Institute for New Economic Thinking, which seeks to promote changes in economic theory and practice through conferences, grants, and education initiatives. INET was founded in 2009 with a $50 million pledge by George Soros.

Doyne and External Professors Rob Axtell and John Geanakoplos want to build an agent-based model of the U.S. economy. Unlike traditional economic models, agent-based models don't make top-down assumptions about how the whole economy behaves.

An agent-based model instead builds behaviors from the bottom up, assigning particular behavioral rules to each decision-making agent in the economy. This enables the emergence of more complex, life-like market behaviors, such as the copycat behavior that leads to "herding" among investors, or investors learning from experience or switching their strategies.

Agent-based models also can incorporate the interactions among different sectors of the economy – such as housing and finance – at different scales, something the traditional models don't do very well.



Doyne spoke at INET's April 2010 inaugural meeting about the need for new kinds of models that depict truly rational behavior: that of agents making decisions based on incomplete information in complex, changing environments. ■

RESEARCH NEWS

Workshop explores how institutions & people co-evolve

What changes first: the society or the individual? Finding the answer is far more complicated than picking either the chicken or the egg.

SFI Professor Sam Bowles' January workshop, "The Co-evolution of Human Behaviors and Social Institutions," is being organized with several SFI faculty members, a group that has been investigating the interplay and evolution of individuals and social structures since about 1998.

"We're looking at why individuals change what they do, why a whole society changes how it does things, and how the two are related," says Sam.

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BUSINESS NETWORK NEWS

Interests converge in first SFI meeting with Google

It takes only four characters to state Newton's first law: F=ma. But are such simply expressed theories possible – or even desirable – in an age of large data sets and complicated biological and social systems?

SFI Faculty Chair David Krakauer and Google Engineering Director Graham Spencer, an SFI Trustee, debated the question to begin a day-long joint meeting at Google headquarters in Mountain View, Calif., in late September.

David argued that simpler theory is important because it facilitates communication between scientists and "interoperability" between fields, and large data sets and powerful computers might stand in the

> more on page 3

LIT BITS

Higher coordination with less control: A result of information maximization in the sensorimotor loop; Zahedi, K.; **Nihat Ay**; Der, R.; *Adaptive Behavior* 18 (3-4), June 2010

Improved IBD detection using incomplete haplotype information; Genovese, G.; Leibon, G.; Pollak, M.R.; **Dan Rockmore**; *BMC Genetics* 11, June 30, 2010

A generalization of the cumulant expansion: Application to a scale-invariant probabilistic model; Rodriguez, A.; **Constantino Tsallis**; *Journal of Mathematical Physics* 51 (7), July 2010

The rate and spectrum of spontaneous mutations in a plant RNA virus; Tromas, N.; **Santiago Elena**; *Genetics* 185 (3), July 2010

Evolutionary dynamics from a variational principle; Klimek, P.; **Stefan Thurner**; Hanel, R.; *Physical Review E* 82, July 6, 2010

Bcheck: A wrapper tool for detecting RNase P RNA genes; Yusuf, D.; Marz, M.; **Peter Stadler**; Hofacker, I.L.; *BMC Genomics* 11, July 13, 2010

Optimal control for pandemic influenza: The role of limited antiviral treatment and isolation; Lee, S.; Chowell, G.; **Carlos Castillo-Chavez**; *Journal of Theoretical Biology* 265 (2), July 21, 2010

Schumpeterian economic dynamics as a quantifiable model of evolution; **Stefan Thurner**; Klimek, P.; Hanel, R.; *New Journal of Physics* 12, July 30, 2010

Statistical identification with hidden Markov models of large order splitting strategies in an equity market; Vaglica, G.; **Fabrizio Lillo**; Mantegna, R.N.; *New Journal of Physics* 12, July 30, 2010

Language networks: Their structure, function, and evolution; **Ricard Solé**; Corominas-Murtra, B.; Valverde, S.; Steels, L.; *Complexity* 15 (6), July-August 2010

Stochastic ecological network occupancy (SENO) models: A new tool for modeling ecological networks across spatial scales; Lafferty, K.D.; **Jennifer Dunne**; *Theoretical Ecology* 3 (3), August 2010

Interactions among patch area, forest structure, and water fluxes in a fog-inundated forest ecosystem in semi-arid Chile; Barbosa, O.; **Pablo Marquet**; Bacigalupe, L.D.; Christie, D.A.; del-Val, E.; Gutierrez, A.G.; Jones, C.G.; Weathers, K.C.; Armesto, J.J.; *Functional Ecology* 24 (4), August 2010

What's wrong with the fundamental existence and welfare theorems? **Duncan Foley**; *Journal of Economic Behavior & Organization* 75 (2), August 2010

Visual characterization of targeted effect of holotransferrin-tagged dihydroartemisinin on human breast cancer cells; Sun, J.D.; Xu, Z.; **Bailin Hao**; *Chinese Science Bulletin* 55 (22), August 2010

Major east-west division underlies Y chromosome stratification across Indonesia; Karafet, T.M.; Hallmark, B.; Cox, M.P.; Sudoyo, H.; Downey, S.; **Steve Lansing**; Hammer, M.F.; *Molecular Biology and Evolution* 27 (8), August 2010

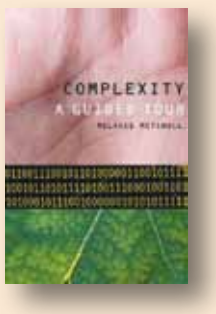
Ligand field theory and the origin of life as an emergent feature of the periodic table of elements; **Harold Morowitz**; Srinivasan, V.; **D. Eric Smith**; *Biological Bulletin* 219 (1), August 2010

The millimeter-wave spectrum of methoxyacetonitrile; **Rogier Braakman**; Blake, G.A.; *Journal of Molecular Spectroscopy* 262 (2), August 2010

The millimeter-wave spectrum of 2-cyanoethanol; **Rogier Braakman**; Blake, G.A.; *Journal of Molecular Spectroscopy* 262 (2), August 2010

Social norms as choreography; **Herb Gintis**; *Politics, Philosophy, & Economics* 9 (3), August 2010

Book news



SFI External Professor and Science Board member Melanie Mitchell's book *Complexity: A Guided Tour* (Oxford University Press, 2009) has received the Phi Beta Kappa Book Award in Science, for outstanding contributions by scientists to the literature of science. Melanie is author or editor of five books and more than 70 scholarly papers in the fields of artificial intelligence, cognitive science, and complex systems. ■

Achievements

SFI President Jerry Sabloff will present the American Anthropological Association's 2010 Distinguished Lecture at the Association's annual meeting November 17-21 in New Orleans. His lecture, "The Circulation of Ideas: Anthropology and Public Outreach," will examine communication between anthropologists and their publics.

President Obama has asked External Professor Carlos Castillo-Chavez to serve on the President's Committee on the National Medal of Science.

SFI External Professor Jessica Green will direct the new Center for the Biological Ecology of Built Environments, funded by a $1.8 million grant to the University of Oregon from the Sloan Foundation. ■

Corrections

In the September/October *Update*, SFI External Professor Alfred Hübler's name appeared incorrectly as Arthur Hübler. External Professor Wojciech Zurek's name was incorrectly inverted as Zurek Wojciech. ■

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The *SFI Update* is published bi-monthly by the Institute to keep its community informed. Please send comments or questions to John German at *jdg@santafe.edu*.

The Institute is on the web at **www.santafe.edu.**

RESEARCH NEWS

Defining complexity is no simple matter

What is complexity? Way back in 1989, SFI hosted a workshop that framed how scientists have thought about this question ever since – but it didn't come to a definitive answer, according to SFI External Professor Jim Crutchfield.

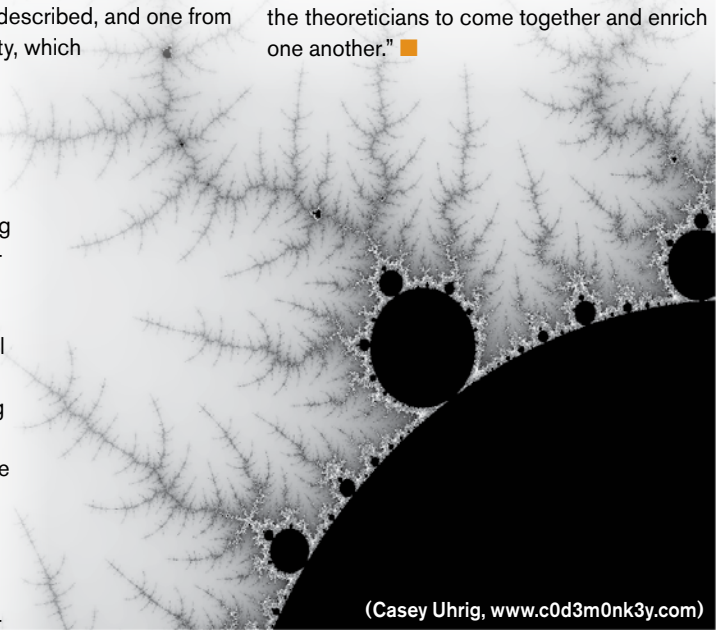
"One keeps hearing that there are so many measures of complexity," Jim says. "People seem to have the idea that it's just all such a mess, but it's not!"

In fact, he says, there are now only a couple of key definitions of complexity, and they're closely related: one from information theory, which says that a complex system is one whose key features can't be easily described, and one from computational complexity, which says that a complex system is one that can't be easily simulated.

Although progress *has* been made in developing theories relating to complexity, their application hasn't been as convincing. Jim and SFI External Professor Jon Machta believe that a deepening of our understanding of complexity is key to more applications, like circumventing the coming failure of Moore's laws for the development of technology, understanding the biological basis of computation in the brain, and understanding how patterns spontaneously emerge.

So the two are sponsoring a workshop, "Randomness, Structure, and Causality," in January, both to take stock of the current understanding of complexity and to develop it in new domains for the future.

"A new level of rigor has emerged over the last two decades in the science of complex systems," Jim says. "The time is right for the practically motivated measures of the experimentalists and the fundamental principles of the theoreticians to come together and enrich one another." ■

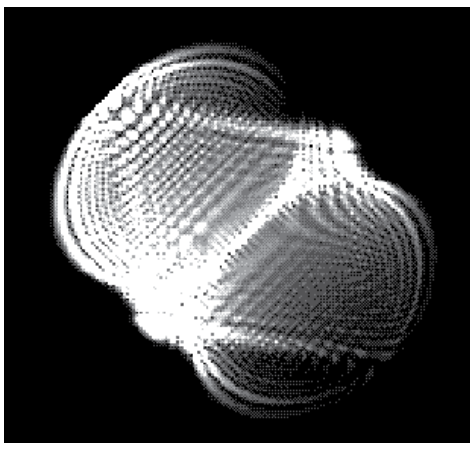

(Casey Uhrig, www.c0d3m0nk3y.com)

RESEARCH NEWS

1978 cryptosystem would withstand future quantum codebreakers

A future quantum computer running Peter Shor's 1994 factoring algorithm could break most public-key cryptosystems, including those currently used for online banking and other secure digital transactions. If and when that happens, most of today's encrypted data will no longer be secure.

In preparation for the day quantum computer codebreakers are switched on, SFI Professor Cris Moore and collaborators have demonstrated mathematically that a lesser-known cryptosystem, the McEliece system developed in 1978 by Caltech mathematician Robert McEliece, is immune to attack by all Shor-like factoring algorithms.


Particle doing a quantum walk, with constructive and destructive interference creating Moire patterns of high and low probability. (Courtesy Cris Moore)

The paper – by graduate student Hang Dinh and Professor Alex Russell, both of the University of Connecticut, and Cris, a computer science professor at the University of New Mexico – is available online at http://arxiv.org/abs/1008.2390.

McEliece's system uses a mathematical approach based not on factorization but on error-correcting codes. The new research has shown this problem cannot be solved using the quantum Fourier analysis that Shor's algorithm uses, says Cris.

While not proving the McEliece cryptosystem is unbreakable (the researchers say the approach could be vulnerable to other types of quantum attacks), their results provide strong evidence that breaking it would require radically new ideas, making it a candidate for a post-quantum cryptosystem – implementable with classical computers today, but destined to remain secure even if quantum computers are built. ■

INSIDE SFI

SFI's presence on Facebook, Twitter draws following and comment

The number of people who follow SFI on Facebook has surpassed 1,000 for the first time, with about 600 people now receiving SFI news flashes via Twitter.

SFI has been communicating on Facebook and Twitter regularly since July. Facebook's comment feature has added an interactive dimension to SFI news, as well.

"We want to make it easy for people who are interested in the Institute's work to stay in touch," says SFI Communications Director John German. "People are offering their thoughts, and that makes for a richer set of perspectives and ideas."

Here are some options for subscribing to, receiving, and sharing SFI news:

- **Facebook:** Receive, comment on, like, or share SFI news on Facebook. If you click the "Like" (thumbs up) button at the top of our Facebook page, you will receive regular SFI research news via your own Facebook News Feed. Find SFI's official Facebook page in the "Follow Us" section at the bottom of the home page.
- **Twitter:** Opt for short, timely news flashes via Twitter by subscribing to @sfi_news. Navigate to the "Follow Us" section at the bottom of the SFI home page.
- **RSS:** Get headlines and links to the latest SFI news via email by subscribing to Santa Fe Institute News via RSS. Select the RSS button at the top right of SFI's home page to make your category selections.
- **Subscribe:** Subscribe to the emailed *Update* or SFI Activity Announcements (public events in Santa Fe) by clicking the "Subscribe" button at the bottom left of the SFI home page.
- **Share:** You can now share the SFI news articles you like via Facebook, Twitter, Linked In, and about 250 other sharing networks by selecting an icon from the sharing menu near the headline of each online article.
- **Video & audio downloads:** The Institute's web site now offers lectures, colloquia, and other educational content via SFI's YouTube channel, iTunes U, and SFI's Video Library. ■

LIT BITS (cont.)

Punish, but not too hard: How costly punishment spreads in the spatial public goods game; **Dirk Helbing**; Szolnoki, A.; Perc, M.; Szabo, G.; *New Journal of Physics* **12**, August 3, 2010

Multirelational organization of large-scale social networks in an online world; Szell, M.; Lambiotte, R.; **Stefan Thurner**; *Proceedings of the National Academy of Sciences* **107** (31), August 3, 2010

Attraction basins as gauges of robustness against boundary conditions in biological complex systems; Demongeot, J.; Goles, E.; **Michel Morvan**; Noual, M.; Sene, S.; *PLOS One* **5** (8), August 5, 2010

Error threshold in RNA quasispecies models with complementation; Sardanyes, J.; **Santiago Elena**; *Journal of Theoretical Biology* **265** (3), August 7, 2010

Some lessons from sixty years of theorizing; **Murray Gell-Mann**; *International Journal of Modern Physics A* **25** (20); August 10, 2010

Population annealing with weighted averages: A Monte Carlo method for rough free-energy landscapes; **Jon Machta**; *Physical Review E* **82** (2 pt 2), August 18, 2010

Transmission of single HIV-1 genomes and dynamics of early immune escape revealed by ultra-deep sequencing; Fischer, W.; Ganusov, V.V.; Giorgi, E.E.; Hraber, P.T.; Keele, B.F.; Leitner, T.; Han, C.S.; Gleasner, C.D.; Green, L.; Lo, C.C.; Nag, A.; Wallstrom, T.C.; Wang, S.Y.; McMichael, A.J.; Haynes, B.F.; Hahn, B.H.; **Alan Perelson**; Borrow, P.; Shaw, G.M.; **Tanmoy Bhattacharya; Bette Korber**; *PLOS One* **5** (8), August 20, 2010

Microbial secretor-cheater dynamics; **Steven Frank**; *Philosophical Transactions of the Royal Society B-Biological Sciences* **365** (1552), August 27, 2010

Archaeological support for the three-stage expansion of modern humans across northeastern Eurasia and into the Americas; **Marcus Hamilton**; Buchanan, B.; *PLOS One* **5** (8), August 30, 2010

Language acquisition meets language evolution; Chater, N.; **Morten Christiansen**; *Cognitive Science* **34** (7 SP ISS), September 2010

Theory for the evolution of diffusible external goods; Driscoll, W.W.; **John Pepper**; *Evolution* **64** (9), September 2010

Big Macs and Eigenfactor scores: Don't let correlation coefficients fool you; West, J.; Bergstrom, T.; **Carl Bergstrom**; *Journal for the American Society for Information Science and Technology* **61** (9), September 2010

How to monitor ecological communities cost-efficiently: The example of plant-pollinator networks; Hegland, S.J.; **Jennifer Dunne**; Nielsen, A.; Memmott, J.; *Biological Conservation* **143** (9), September 2010

Reconstruction of pedigrees in clonal plant populations; Riester, M.; **Peter Stadler**; Klemm, K.; *Theoretical Population Biology* **78** (2), September 2010

Composition vector approach to whole-genome-based prokaryotic phylogeny: Success and foundations; Li, Q.A.; Xu, Z.; **Bailin Hao**; *Journal of Biotechnology* **149** (3 SP ISS), September 1, 2010

A general basis for quarter-power scaling in animals; Banavar, J.R.; Moses, M.E.; **Jim Brown**; Damuth, J.; Rinaldo, A.; Sibly, R.M.; Maritan, A.; *Proceedings of the National Academy of Sciences* **107** (36), September 7, 2010

STDP-driven networks and the C. elegans neuronal network; Ren, Q.S.; Kolwankar, K.M.; Samal, A.; **Jürgen Jost**; *Physica A-Statistical Mechanics and Its Applications* **389** (18), September 15, 2010

Not wanted, not needed; **J. Doyne Farmer**; Makhijani, A.; *Nature* **467** (7314), September 23, 2010

Neutron stars in f(R) gravity with perturbative constraints; Cooney, A.; **Simon DeDeo**; Psaltis, D.; *Physical Review D* **82** (6), September 28, 2010

PEOPLE

Nigel Snoad: Unraveling the complexities of humanitarian crises and responses

More than 200 relief organizations assisted in post-earthquake Haiti. How can so many organizations work together to provide humanitarian aid in the most efficient way – securing as many lives as possible without any one group or individual taking control?

This is a conundrum Nigel Snoad, a former SFI graduate fellow and past participant in SFI's Complex Systems Summer School, has been working on – and living – since his stint at SFI nine years ago when he studied quasispecies in dynamic environments.

"The humanitarian aid community is finally realizing they're dealing with a complex system," he says. "A critical part of humanitarian preparedness will come down to building and understanding models."

Nigel in Kabul, Afghanistan on behalf of the U.N.

Nigel has seen such systems from the inside. He has advised the United Nations on using technology to streamline the delivery of aid and provided pandemic contingency planning. He took part in on-the-ground response after Haiti's earthquake. Immediately after the 2004 tsunami, he set up field operations in Indonesia and led the coordination of logistics for the international response. Currently, he develops information-sharing technology at Microsoft for use in large-scale disasters.

He refers to some of the analytical tools and simulations being done at SFI and elsewhere as a means of learning about what works and what does not. "I think modeling will be acknowledged as an important way to prepare for crises," he says. "People can't prepare for everything. But understanding cause and effect will allow them to act with greater insight and adapt more quickly to changing circumstances."

Based on his experiences and studies, Nigel predicts that the crises that necessitate such responses will become increasingly intense. "We'll need to develop more complex responses."

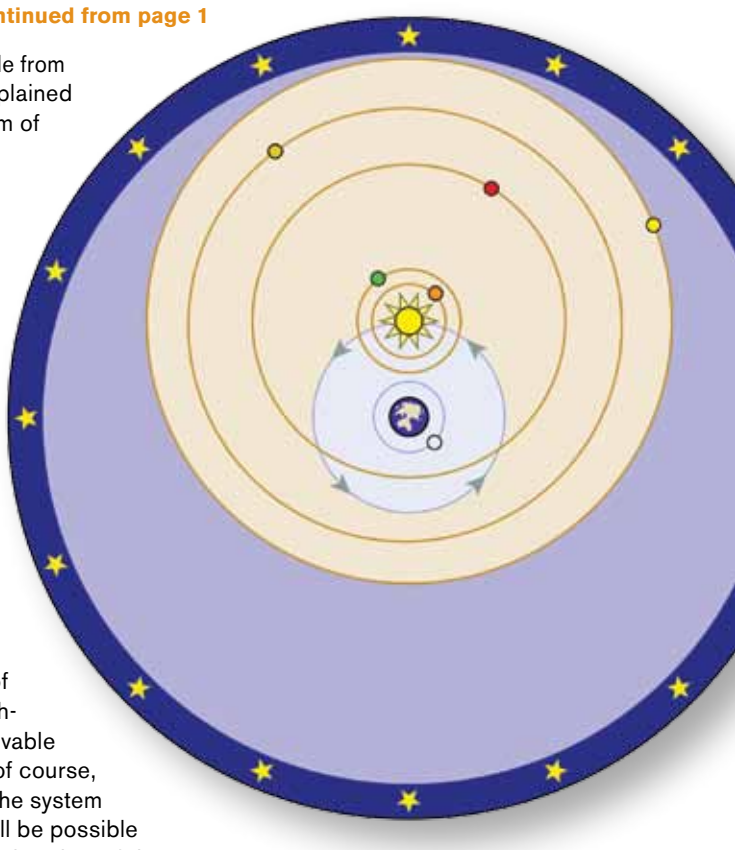
He is enlisting collaborators of many disciplines from places like SFI to help rethink how the humanitarian aid community approaches crises. "So far, it's been about building better Band-Aids," he says. "But Band-Aids will only work for so long." ■

For the second year, SFI and the Santa Fe Symphony Orchestra collaborated to produce a unique event exploring the interface between science and music. The October 31 "Voyages of Discovery: The Planets" at the Lensic in Santa Fe featured the works of Claude Debussy (Nocturnes) and Gustav Holst (The Planets), projection images of the solar system and commentary by Dr. José Francisco Salgado of Chicago's Adler Planetarium, and commentary by SFI Omidyar Fellow Simon DeDeo, seen here. Simon spoke about the connections between music, mathematics, and the structure of solar systems – both ours and those around other stars.

> *Google meeting* continued from page 1

way of that. He cited an example from early physics: Tycho Brahe explained planetary orbits using a system of interconnected circles, but Johannes Kepler used the same data to develop a simpler explanation: ellipses. The problem, David said, is that the descriptions are mathematically equivalent, and computational methods might not find the simpler answer.

Graham countered that simpler theory is OK, provided it offers a means of quantifying complex phenomena. He adopted cybernetics researcher Norbert Weiner's convention of measuring the complexity of a system based on the algorithmic complexity of some observable property of the system. This, of course, captures only a small part of the system under observation. It might still be possible to find simple models, he said, but that might mean stumbling on something that happens to be simple."Why are you looking for your keys under the lamppost?" he asked. "Because that's where the light is."



Depiction of Tycho Brahe's solar system, in which the Moon and the Sun orbit the Earth, and Mercury, Venus, Mars, Jupiter, and Saturn orbit the Sun. All is surrounded by a sphere of fixed stars.

SFI External Professors David Ackley and Walter Fontana continued with a discussion of novel forms of computation, including Ackley's "infinite" computers and Fontana's concept of a programming language to describe biochemical reactions. SFI External Professor Jim Crutchfield and Google's Joseph Smarr spoke about network fragility and the changing nature of social and economic networks.

Informal side discussions were an equally important feature of the meeting, says SFI VP for Administration Chris Wood, who manages the Business Network. "There will be lots of individual follow-up, and that's where much of the value of the meeting will play out," he says, pointing to SFI postdoctoral fellow Bela Nagy as an example. Bela spent several days talking with members of Google's Public Data Explorer Team and spoke about the need for data preservation on the web.

"The kind of people interested in Santa Fe Institute science – there's a big overlap between those people and the kind of people who work at Google," Graham said, and he wanted to get the two groups together and talking. "If other stuff falls out of that, that's all the better." ■

> *Co-evolution* continued from page 1

As an example, he says, 12,000 years ago humans had no conception of private property when they hunted and gathered for the necessities of life. But with the onset of agriculture, property rights were suddenly common across societies. People changed, and so did the rules of the economic game.

"We're curious about these sea changes in social organization and how individual values are at once a cause and a consequence of them," he says. "We're looking at this across many scales."

The workshop involves a cast of collaborators from a number of disciplines including neuroscience, economics, psychology, anthropology, and ecology. ■

(Pgiam, istockphoto.com)

SFI IN THE NEWS

The October 22 *Montreal Gazette* quotes SFI Professor Sam Bowles in an article about the evolutionary implications of cooperation and conflict.

SFI External Professor Kenneth Weiss is quoted in an October 9 *New York Times* article titled "The failed promise of genomics."

An October 5 *Albuquerque Journal* article features SFI, calling it an "eclectic collection of intellectual firepower gathered on a hillside above Santa Fe."

Miller-McCune magazine on September 27 features Omidyar Fellow Laura Fortunato's work on the evolutionary benefits of monogamy.

The *New York Times* on September 24 profiles SFI's Valerie Plame Wilson and "Fair Game," a just-released movie portraying her experiences as a CIA agent.

In a September 16 *Newsweek* article, SFI Professor Doyne Farmer says mainstream economists aren't receptive to new, more scientific approaches.

Physics World on September 9 covered the work of External Professor Stefan Thurner and collaborator Rudolph Hanel, whose modeling found that a small number of bad reviewers can undermine the scholarly peer-review process.

The September *Green Fire Times* offers an insider's account of SFI's 2010 Global Sustainability Summer School.

The June issue of *Administrative Science Quarterly* reviews a book edited by SFI visiting scholar Brooke Harrington that examines the science and practice of deception. The book arose from an SFI workshop she organized on deception in 2007.

Read these articles and sign up to receive SFI news via RSS, Twitter, and Facebook at www.santafe.edu.

RESEARCH NEWS

Did metal catalysts jumpstart life on Earth?

A research team including two SFI scientists has proposed a type of catalyst that could have jumpstarted metabolism and life itself, deep in hydrothermal ocean vents.

According to their model, molecular structures involving transition metal elements (iron, copper, nickel, etc.) and ligands (small organic molecules) could have catalyzed the synthesis of basic biochemicals (monomers) that acted as building blocks for more complex molecules, leading ultimately to the origin of life.

The researchers – SFI External Professor Harold Morowitz of George Mason University, Vijayasarathy Srinivasan also of George Mason, and SFI Professor D. Eric Smith – did the work as part of a Frontiers in Integrative Biological Research (FIBR) grant from the National Science Foundation.

"You can start out with these small metal-ligand catalysts, and they'll build up the monomers that can be used to make the (large protein catalysts)," Harold said in a *Scientific Computing* article about their work.

The researchers plan to recreate in the laboratory the conditions and ingredients that led to these structures.

Their paper on the topic appeared in the August 2010 issue of *The Biological Bulletin*. ■

> *Regulation* continued from page 1

Wood are co-organizers of this year's Business Network & Trustees Symposium, November 11-13, which will focus on regulation in a variety of complex systems.

Several of the talks will address the dynamics of digital information and the digitally-mediated marketplace, for which rules and norms of sharing and property are still being set. Regulation in biological systems will be discussed as well, an area of study that has undergone an overhaul in the last decade as research has revealed regulation's central role in turning widely shared genetic components – humans and sponges famously share 70 percent of their DNA – into fantastically different creatures.

Speakers from economics, national security, health care, international relations, and other fields will add a societal dimension to the meeting.

"The overarching theme is to use regulation in all its forms as models for thinking about how to incorporate the most effective regulation in systems we build or influence," says Chris. "We're hoping the symposium will encourage creative thinking and cross-disciplinary insights across the physical, biological, social, and information sciences." ■

SFI Online

Multimedia and supplementary content available at *www.santafe.edu/news*

Letter: Physics might help explain the evolution of altruism
SFI Faculty Chair David Krakauer and Professor Jessica Flack write in *Nature* that the longstanding debate in social evolution about whether individual-level selection or kin selection accounts for the evolution of altruism in many ways parallels the statistical physics-thermodynamics debate among physicists in the late 19th and early 20th centuries. Read the unabridged version of their letter at www.santafe.edu/news.

Special issue of *Nature*: Science of cities needed
SFI External Professor Luis Bettencourt and Distinguished Professor Geoffrey West write in the October 21 issue of *Nature* – a special issue on cities – that a grand unified theory of sustainability, with cities and urbanization at its core, must be created to help guide development and combat the multiple threats facing humanity today.

Video: How and why cooperation works
In an October 13 SFI public lecture, Harvard's Yochai Benkler questions the centuries-old practice of managing people through rewards and punishment and reviews successful institutions that succeed through cooperation.

Audio: Merging of disciplines part of a trend
In an online interview for the American Anthropological Association, SFI President Jerry Sabloff discusses archaeology and anthropology, transdisciplinary science, and ways the Institute is changing.

Audio: Complexity science, foreign policy, and Afghanistan
In a public radio interview, SFI Diplomat in Residence Bill Frej, former United States Agency for International Development mission director for Afghanistan, outlines his plans to apply SFI-style thinking to the complex adaptive system of Afghanistan.

Video: How networks of people & information shape our world
Network science is illuminating never-before-seen relationships and patterns all around us. In three lectures over three nights, part of SFI's Ulam Lecture series, SFI External Professor Mark Newman describes some of the insights network science offers.

Video: What secrets does the ECG still hold?
In an August 18 SFI public lecture, External Professor Tim Buchman turns to complex systems science for hidden structure within the electrocardiogram's signals and ways the ECG might point towards better health.

Working paper: Self-organizing signals would reduce traffic jams
External Professor Dirk Helbing and collaborators modeled traffic flow and found that self-organizing traffic lights that communicate and make decisions in coordination with other intersections could significantly reduce city traffic congestion.

News release: Researchers prepare for first human trial of mosaic HIV vaccine
Bette Korber, a senior researcher at Los Alamos National Lab and an SFI External Professor, is part of an international team preparing for the first human trial of a mosaic HIV vaccine candidate.

Audio: Size tells us most of what we need to know about a city
In an October 8 radio interview, Distinguished Professor Geoffrey West and External Professor Luis Bettencourt explain what they are learning about cities, in particular how a given city's population correlates to hundreds of variables.

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