Regulation: How parameters define what’s possible

“Regulation” occasions thought of government prescriptions and legal limits. But explicit formal rules are narrowly defined - giving rise to the optimized outcomes of a living organism or product distribution. Each describes constraints — at the parameter level self-interested impulses, 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
> more on page 4

SFI economic modeling gains support of ‘rethinkers’

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

RESEARCH NEWS

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> more on page 4

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.

> more on page 3

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
defining complexity is no simple matter

In preparation for the day quantum computer happens, most of today’s encrypted data will be at risk of being decoded by future quantum codebreakers. SFI Professor John Preskill at the University of California, Santa Barbara, says that a complex system is one whose key features can’t be easily simulated, and one from computational complexity, which says that a computer 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 Professor Jon Machta believe that a deepening of our understanding of complexity is more to be simulated, like circuit—composing the future 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 experimental results and the fundamental principles of the theoretics to come together and enrich one another.”


Schumpeterian economic dynamics as a quantifi-

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 (SEND) models: A new tool for modeling ecological net-
work across spatial scales; LaFla, H.D.; Jennifer Dunne; Theoretical Ecology 3 (3), August 2010


Visual characterization of targeted effect of holo-
transferrin-tagged dihydroartemisinin on human breast cancer cells; Sun, J.D.; Xu, Z.; Ballin Hess; Chinese Science Bulletin 56 (23), August 2010.

major east-west divide underlies Y chromosome stratiﬁcation across Indonesia; Karah, T.M.; Half-
man, T.; Dar'mazine, D.; Steve Lasing; Hammer, M.F.; Molecular Biology and Evolution 27 (8), August 2010.


This milligravimeter wave spectrometer of methacryla-
toric; Rogier Braakman; Blakes, G.A.; Journal of Molecular Spectroscopy 283 (2), August 2010.

Social norms as choreography; Herb Gintis, Politi-
ical, Philosophy, & Economics 9 (1), August 2010.

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 less-known cryptosystem, the McEliece system, is immune to attack by Shor-like factoring algorithms. The paper — by graduate student Hang Dinh and Alex Russell, both of Stony Brook University of Connecticut, and Cris, a computer science professor at the University of New Mexico — was online at 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 comments area 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 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 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.

VIDE O & 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.
Punish, but not too hard: How costly punishment spreads in the spatial public goods game; Dirk Helbing; Stefani, A.; Pons, M.; Tabak, G.; New Journal of Physics 12, August 3, 2010

Multirationalization of large-scale social networks in an online world; Saeli 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; Domengez J.; Georges, E.; Michel Morvan; Nuñez, M.; Sene, S.; PLOS One 6 (8), August 5, 2010

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

Some lessons from sixty years of planning; Murray Gell-Mann; International Journal of Modern Physics A 25 (60), August 10, 2010

People

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

“We’re curious about these sea changes and so did the rules of the economic game. People changed, agriculture, property rights were suddenly necessities of life. But with the onset of disasters,” he says. “A critical part of humanitarian aid has been working on – and living – since his stint at SFI nine years ago when he studied queasiequips in dynamic environments.

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

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 doesn’t. “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 interfaces 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’s Richard Weller. See here, SFI explores 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 lampost?” he asked. “Because that’s where the light is.”

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 postdoc fellow Berta Naya as an example. Berta 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.”
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. The researchers – SFI External Professor Harold Morowitz of George Mason University, Vijayashanti 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.

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 “unveiled 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 Yoshua Bengio questions the centuries-old practice of managing people through rewards and punishment and reviews successful institutions that succeeded 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.

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 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
Betts 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 SFI 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.

Some options for year-end charitable giving
SFI appreciates those who have chosen to support the Institute in these difficult times. Here are some options as you consider year-end charitable giving plans for the remainder of the year. Consult your tax advisor, financial advisor, or attorney for details.

- Gifts made before December 31 can generate tax deductions for this year.
- Proposed changes in federal tax law could actually reduce the tax benefits of charitable giving beginning next year.
- Cash gifts can eliminate federal income tax on up to half of adjusted gross income.
- Gifts of securities worth more than they cost are often deductible at current value and can offset tax on up to 30 percent of adjusted gross income.
- Sale of investments worth less than they cost and gifting the cash proceeds can create an investment loss as well as a deduction in the amount of the gift.
- Giving portions of certain retirement plan assets, such as mandatory withdrawals, can offer tax benefits.
- Other giving options include gifts through a living will or trust or through a life insurance policy.

For information about giving to SFI, call 505-946-3678 or email Nancy Deutsch at nancy@santafe.edu.