

DECADES OF INVESTIGATION

by several SFI researchers, including Professor **Sam Bowles** and External Professor **Herbert Gintis**, culminated in their conclusion that cooperation within groups and a willingness to collaborate in conflict against outsiders co-evolved in the human species. Much of their research is compiled in a new book, *A Cooperative Species: Human Reciprocity and Its Evolution* (Princeton University Press, May 2011).

USING TECHNIQUES borrowed from astrophysics, SFI Omidyar Fellow **Simon DeDeo** and External Professors **David Krakauer** and **Jessica Flack** sifted through 150 hours of observations Flack had collected on patterns of conflict in a monkey society. The researchers discovered evidence for a “conflict clock”—a social version of biological clocks like circadian rhythms—that predicts when animals will fight.

SFI HAS WELCOMED three eminent scholars as the first George A. and Helen Dunham Cowan Chairs in Human Social Dynamics, to be referred to as the Cowan Professors: anthropologist and SFI External Professor **Robert Boyd** of UCLA, economist **Ricardo Hausmann** of Harvard, and experimental psychologist **Mahzarin R. Banaji** of Harvard.

AS PART OF A GRANT from the Institute for New Economic Thinking, SFI Professor **J. Doyne Farmer** and External Professors **Rob Axtell** and **John Geanakoplos** are working to create an agent-based model of the economy that will help scientists, economists, and policy makers better understand past financial crises and possibly predict future crises.

SCIENCE BOARD CO-CHAIR **Stephanie**

Forrest and her collaborators are working under a DARPA grant to develop a biologically inspired approach to software debugging—a kind of natural selection for software. In effect, during each generation of a program’s development, a group of slight variations are created and the best mutations are preserved. This process is repeated until the program functions.

FOR THE THIRD TIME in as many years, SFI and the Santa Fe Symphony collaborated to produce a unique concert exploring the interface between music and science. “Voyages of Discovery III: Bach On the Brain,” featured selected works of Johann Sebastian Bach interspersed with commentary by SFI Vice President and neuroscientist **Chris Wood** about the brain’s response to sound and music. The event included two special concerts for New Mexico fourth graders.



TWO INSTITUTE SCIENTISTS gave talks at the 2011 TED Global

event in Edinburgh, Scotland. SFI Distinguished Professor **Geoffrey West** explained how the world’s cities are scaled versions of one another. SFI External Professor **Mark Pagel** described how language evolved in humans as a response to the evolutionary dilemma presented by social learning. Their talks are available at www.ted.com.



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IN A *Journal of Theoretical Biology* paper, a group of scientists explores the prospects for general, predictive theories in biology akin to those in the physical sciences. The paper suggests that such theories take inspiration not only from physics, but also from the information sciences. SFI co-authors included External Professor **David Krakauer**, Faculty Chair **Doug Erwin**, External Professor **Jessica Flack**, Science Board member and External Professor **Walter Fontana**, Distinguished Professor **Geoffrey West**, and External Professor **Peter Stadler**.

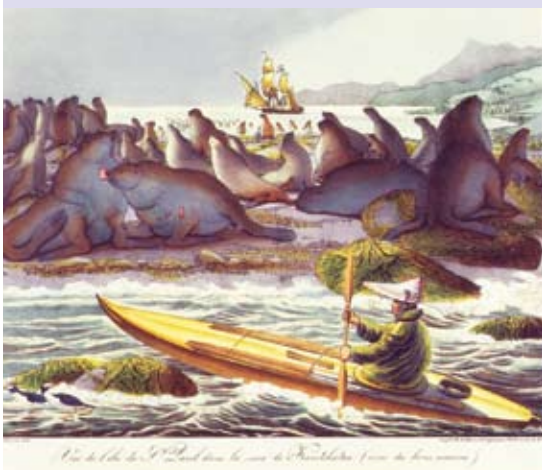
SFI WAS SELECTED to lead a three-year, NSF-sponsored model program called **GUTS y Girls**, designed to attract New Mexico girls to careers in science, technology, engineering, math, and information and communications technology—fields in which women are historically underrepresented.

SFI DISTINGUISHED PROFESSOR **Geoffrey West** and collaborators at MIT proposed a fractal geometry-inspired model that takes in basic meteorological data—such as annual temperature, precipitation, humidity, and solar radiation—and computes how tall a tree is likely to grow under those conditions. The team’s research results, published in *PLOS One*, are consistent with local meteorological data and tree measurements obtained from the US Forest Service.



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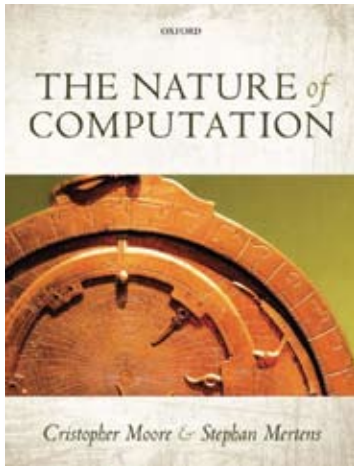
A STUDY BY former SFI Omidyar Fellow **Jessika Trancik**, former Graduate Fellow **James McNerney**, Professor **J. Doyne Farmer**, and External Professor **Sidney Redner** demonstrated a way to measure the interconnectedness of a technology’s components and predict which technologies are likeliest to advance rapidly and which, due to their complexity, are likely to improve more slowly. The technique could serve as an aid for policy makers weighing technology investment decisions.



SFI PROFESSOR **Jennifer Dunne** and colleagues from Idaho State University are using interviews, ecological observations, and archaeological studies to quantify how humans fit in their food webs on Sanak Island, Alaska, for the last 5,000 years. Such a “whole system” study of the human roles in a food web has never been done.

MODERN HUMANS likely originated in southern Africa rather than eastern Africa as was generally assumed, according to the results of a Stanford University study that involved statistical analysis of the largest dataset to date of genetic diversity among African hunter-gatherer groups. SFI Science Board Co-Chair **Marcus Feldman** was the corresponding author.

IN THREE Stanislaw Ulam Memorial Lectures in three nights, SFI External Professor **David Krakauer** explored the extraordinarily convergent theories from math, physics, computation, and biology as they relate to the emergence of intelligence on Earth, and speculated about the future for biological intelligence in a world of distributed thinking machines.



A NEW BOOK by SFI Professor **Cris Moore** and External Professor **Stephan Mertens**, *The Nature of Computation* (Oxford University Press, July 2011), provides an overview of computational complexity and the state of the field of mathematics today.

BY ANALYZING A TENTATIVE FAMILY TREE for 2,135 past and present languages, SFI Distinguished Fellow **Murray Gell-Mann** and collaborator **Merritt Ruhlen** concluded in *PNAS* that the proto-language from which most modern languages descended likely featured a verb-last sentence structure.

A SPECIAL OCTOBER 2011 ISSUE of the journal *Chaos* includes several papers co-authored by researchers affiliated with SFI and chronicles the progress made since 1989 in developing quantifiable measures of complexity. The papers arose from a January 2011 SFI workshop organized by SFI External Professors **Jim Crutchfield** and **John Machta**.

IS SUSTAINABLE DEVELOPMENT

a science? In a study published in *PNAS*, SFI Professor **Luis Bettencourt** and **Jasleen Kaur** (Indiana University) assembled some 20,000 academic papers by 37,000 authors published between 1974 and 2010 and concluded that around the year 2000, worldwide research in sustainable development had coalesced to the point where most contributors were part of a single, global collaboration network, and the field was producing and drawing from unified sets of concepts and theories—evidence that “bodes well for the continued impact and longevity of sustainability science,” wrote Bettencourt.

SFI OMIDYAR FELLOW **Simon DeDeo**, with External Professor **David Krakauer** (University of Wisconsin-Madison), has been awarded a \$339,000 Advancing Theory in Biology grant from the National Science Foundation to investigate biological processes using the tools of computer science. The study applies classical computational theory to understand



the unusual and counterintuitive ways living organisms (as opposed to engineered systems) collect information from their environments and use it to adapt, in processes DeDeo terms “natural computation.”

IMPRINTING, the conditional expression of a gene in an individual, accounts for much of the evolutionary change not adequately described in classical genetic theory.

In a study published in 2011 in the *American Naturalist*, SFI Omidyar Fellow **Jeremy Van Cleve**, Science Board Co-Chair **Marcus Feldman** (Stanford), and **Laurent Lehmann** (University of Neuchatel) modeled notional populations over many generations and found that even minor population-wide demographic variables—such as small differences in male-to-female ratios and frequency of individuals’ movement among groups—seem to play important roles in which alleles are imprinted in individual offspring.

