



# Update

November/December 2009



## RESEARCH NEWS

### Modeling ways to beat the next flu outbreak



Three SFI External Professors are modeling patterns of flu outbreak and response to help health officials manage the next pandemic.

Soon after H1N1's initial emergence last year, mathematical epidemiologist Lauren Ancel Meyers at UT Austin and colleagues used Facebook to gauge initial perceptions about and behaviors toward the flu, then conducted a national poll. As news media attention tapered, they noted that "people's perception of the risk of flu increased, but their willingness to adopt prevention measures declined," she says. Now they are surveying New York City and Milwaukee, which had large summer outbreaks, and L.A. and D.C., which did not, to

see how local infection levels affect residents' behaviors.

Regardless of perceptions, optimizing the public health response to the pandemic could affect millions of lives. The U.S. stockpile has 50 million anti-viral drug treatments for national distribution. (Though not vaccines, anti-virals can treat symptoms and reduce transmission.)

In modeling millions of scenarios, according to Lauren, the politically tractable option of distributing five million anti-virals a month distributed proportionally to states' populations consistently emerged among the better choices. She is currently looking at how best

to distribute vaccines to reduce hospitalizations and deaths.

Carlos Castillo-Chavez, a theoretical epidemiologist at Arizona State University, weaves practical and theoretical elements into what he calls "the big question: How do you weigh interests with risk?"

Mexico, for example, implemented social measures at tremendous economic cost, whereas the U.S. and Canada adopted less stringent measures. Now, people's cross-immunity may protect sub-populations from later rounds by changing the entire immunological landscape. [> more on page 3](#)

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## BUSINESS NETWORK NEWS

### Understanding systemic risk in markets

Can financial market phenomena such as bubbles, runs, and crashes be understood through the lens of complexity science?

An SFI Business Network meeting in New York on October 15 explored the role of systemic risk in financial markets. The gathering drew a dozen experts from the financial sector and another dozen scientists.

Systemic risk occurs when a system – a market, an ecosystem, or society as whole, for example – bears underlying interdependencies whose disturbances might, in certain situations, cause the entire system to collapse, says SFI Professor Fabrizio Lillo (University of Palermo), one of the Institute's organizers of the event.

[> more on page 3](#)

## INSIDE SFI

### Evening event combines science, music, and drama

A public event in Santa Fe on November 14 weaved science and music into a unique SFI evening program, says SFI Special Projects Coordinator Valerie Plame Wilson.

"Voyages of Discovery: A Celebration of the 25th Anniversaries of SFI and the Santa Fe Symphony Orchestra, and the Bicentenary Births of Charles Darwin and Felix Mendelssohn," included Mendelssohn symphonies performed by the orchestra.

The music was interspersed with commentary from SFI Faculty Chair David Krakauer on Darwin's historic significance in biology, evolution, and scientific discovery in general. Actors in period costumes performed dramatic readings from the correspondences of Darwin and Mendelssohn.

The concert was underwritten by Andrew and Sydney Davis. ■

## RESEARCH NEWS

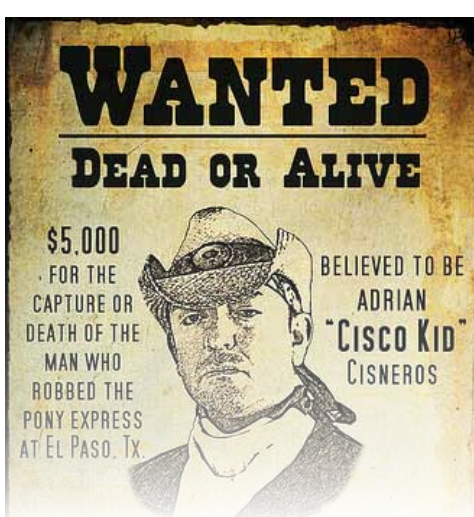
### Can rewards backfire? Behavioral research says yes

As a homegrown economic experiment, SFI Professor Sam Bowles once offered, in lieu of an allowance and clothing money, to pay his teenage children to do household tasks, complete with a price list.

"The prices were pretty good, but not a stitch of work was done," he recalls.

Sam, Director of SFI's Behavioral Sciences Program, has been focusing much of his research on people's responses to economic incentives.

"We looked at a vast number of cases in which people were given incentives to do simple things," he says. "All but a few of these experiments backfired to one degree or another."



For example, children who were told they'd be given a reward for drawing pictures all but stopped drawing. Paying potential blood donors in the hopes of increasing donations made people less likely to do so. Daycare centers that began fining parents for picking up their children after hours did not see an increase in parental punctuality; in fact, their tardiness increased.

Sam believes rewards may diminish intrinsic motivations; in other words, being paid for an altruistic act may seem to cheapen the deed in the mind of the deed doer.

This notion extends to the workplace. The employer who adopts what economists would term an "optimal" incentive system may simply appear [> more on page 2](#)



## LIT BITS

Field research during war: Ethical dilemmas; **Libby Wood [SFI Professor]**; *New Perspectives in Political Ethnography*, 2007, pp. 205-223

The nature and timing of the Neolithic demographic transition in the North American Southwest; **Tim Kohler [SFI External Professor]**; Glaude, M.; *Neolithic Demographic Transition and Its Consequences*, 2008, pp. 81-105

The first-mover advantage in scientific publication; **Mark Newman [SFI External Professor]**; *EPL* 86 (6), June 2009, pp. 196-201

The rationalization of charity: The influences of professionalism in the nonprofit sector; Hwang, H.; **Walter (Woody) Powell [SFI**

**External Professor]**; *Administrative Science Quarterly* 54 (2), June 2009, pp. 268-298

Climate as a driver of evolutionary change; **Douglas Erwin [SFI Professor]**; *Current Biology* 19 (14 SP ISS), July 28, 2009, pp. 575-583

Random graphs with clustering; **Mark Newman [SFI External Professor]**; *Physical Review Letters* 103 (5), July 31, 2009, pp. 303-306

Market reaction to a bid-ask spread change: A power-law relaxation dynamic; Ponzi, A.; **Fabrizio Lillo [SFI Professor]**; Mantegna, R.N.; *Physical Review E* 80 (1 PT 2), July 2009, pp. 210-221

Effect of citrus hosts on the generation, maintenance, and evolutionary fate of genetic variability of citrus exocortis viroid; Bernad, L.; Duran-Vila, N.; **Santiago Elena [SFI External Professor]**; *Journal of General Virology* 90 (Pt 8), August 2009, pp. 2040-2049

The economy needs agent-based modeling; **J. Doyne Farmer [SFI Professor]**; **Duncan Foley [SFI External Professor]**; *Nature* 460 (7256), August 6, 2009, pp. 685-686

FRANZ: Reconstruction of wild multi-generation pedigrees; Riester, M.; **Peter Stadler [SFI External Professor]**; Klemm, K.; *Bioinformatics* 25 (16), August 15, 2009, pp. 2134-2139

Evolutionary dynamics of the LTR retrotransposons roo and rooA inferred from twelve complete *Drosophila* genomes; de la Chaux, N.; **Andreas Wagner [SFI External Professor]**; *BMC Evolutionary Biology* 9, August 18, 2009, pp. 17-33

Where Darwin doesn't fit...; **W. Brian Arthur [SFI External Professor]**; MacKenzie, D.; *New Scientist* 203 (2722), August 22, 2009, pp. 26-28, 30-31

Fragmentation within matrilineal pedigrees is associated with fragmentation in grooming networks of captive rhesus macaques (*MACACA MULATTA*); Beisner, B.A.; **Matthew Jackson [SFI External Professor]**; Cameron, A.; **Jessica Flack [SFI Research Professor]**; **David Krakauer [SFI Professor and Faculty Chair]**; *McCowan*,

## PEOPLE

### Dan Schrag on President's S&T council



Dan Schrag, an SFI External Professor and Science Board member, was named recently to President Barack Obama's 18-member council on science and technology.

Dan is professor of Earth and Planetary Sciences at Harvard University, as well as director of Harvard's Center for the Environment. His research has focused on climate and climate change over the broadest range of Earth history.

Dan was at SFI in September to deliver one of the Ulam lectures in honor of SFI Distinguished Professor Murray Gell-Mann. ■

#### > Can rewards backfire? continued from page 1

greedy, leading not to employee compliance but angry retaliation.

As part of Sam's ongoing working group on the co-evolution of institutions and behaviors, he examined the results of group cooperation games in which the rewards were greatest for all if its players cooperated. More often than not, the subjects worked together. In fact, from American students to Zimbabwean villagers, cooperators would band together to punish players who behaved selfishly, even if it was at the punishers' own expense.

"Fines imposed by peers who do not stand to benefit personally invariably induce shirkers to shape up," he says, "most likely because they induce shame rather than anger."

Sam will deliver a series of lectures on related topics at Yale University in January as its Castle Lecturer in Ethics, Politics, and Economics. The lectures will be published as a book by Yale University Press. He also will hold the next meeting of his co-evolution working group in January. ■

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The *SFI Update* is published bi-monthly by the Institute to keep our community informed about current work and activities. Please send comments to Ginger Richardson at [grr@santafe.edu](mailto:grr@santafe.edu).

## RESEARCH NEWS

### Looking to technology to win the race against climate change



Jessika Trancik

Researchers working to transform sunlight and other resources into inexpensive, near-zero-carbon energy find themselves in a race against a formidable opponent: rapidly advancing climate change.

"There's limited time to find an answer," says SFI Omidyar Fellow Jessika Trancik, whose research focuses on the evolution of technologies related to low-carbon energy conversion.

"To prevent the most damaging effects of climate change, our global energy infrastructure will need to reach very close to zero carbon dioxide emissions in the second half of this century," she says.

Jessika is working on the problem from three angles designed to develop a fundamental understanding of how technologies change over time. One focuses on developing a data-driven framework for comparing energy technologies.

She and her colleagues collect information to better understand how technologies evolve and how to compare them based on a variety of attributes, such as cost, carbon emissions, and resource size.

She also explores how the design features of a technology can lead to faster rates of improvement – for example, unit scale, how the components of a technology are interconnected, and how these may affect the rate of change. She believes the work may reveal design features that can be incorporated into a technology to allow for rapid improvement. This, in turn, could help policymakers decide which technologies to support and invest in.

In a third area of research, she looks at a subset of candidates for low-carbon energy conversion. She says nanostructured energy technologies are perfect examples of the

difficulty of achieving an optimal combination of components at the outset, but where there is great potential for high performance in the future – in this case in reaching very low cost and low carbon intensity. She is exploring ways to simultaneously realize practical solutions more quickly and tailor the design of technologies to allow for future improvement.

"These and other technologies don't just show up in optimal form," Jessika says. "The challenge is to balance curiosity-driven research with the time constraints imposed by climate change. Ideally, we would like to be able to do both: determine the general paths that are more promising, and explore the complete space of possibilities along these general paths."

Jessika leaves SFI in January to continue her research as an assistant professor in the Engineering Systems Division at MIT. ■

## PEOPLE

### Caroline Buckee accepts Harvard appointment

Caroline Buckee has accepted an appointment as an assistant professor in the Department of Epidemiology at Harvard School of Public Health. Her Harvard appointment begins July 1, 2010.

Caroline is an SFI Omidyar Fellow and a Sir Henry Wellcome Research Fellow in Zoology at the University of Oxford. Her SFI research has focused on combining experimental and theoretical techniques to understand the evolution of genetically diverse pathogen species. ■

## PEOPLE

### APS recognizes David Campbell



SFI Science Board Co-Chair David Campbell has been recognized by the American Physical Society for his outstanding contributions to physics. He will be awarded the 2010 Julius Edgar Lilienfeld Prize during the annual APS meeting in March in Portland, Oregon.

David is being honored "for pioneering new approaches to the study of complex systems,

using the complementary approaches of nonlinear dynamics and statistical physics, and for communicating the excitement of this new field to diverse audiences," according to the APS citation.

He shares a \$10,000 prize with Shlomo Havlin, a professor of physics at Israel's Bar-Ilan University. The prize was established in 1988 by Beatrice Lilienfeld in memory of her husband, Austro-Hungarian physicist Julius Edgar Lilienfeld.

David is Provost of Boston University and the former director of the Center for Nonlinear Studies at Los Alamos National Laboratory. ■



## LIT BITS (cont.)

B.; *American Journal of Primatology* 71 (SUPPL), August 2009, p. 54

Going to extremes: How like minds unite and divide; Sunstein, C.R.; **Herbert Gintis [SFI External Professor]**; *Nature* 461 (7260), September 3, 2009, pp. 40-41

Response to comments on "Energy uptake and allocation during ontogeny"; Zuo, W.Y.; Moses, M.E.; Hou, C.; **William (Woody) Woodruff [SFI External Professor]**; **Geoffrey West [SFI Distinguished Professor]**; **Jim Brown [SFI External Professor]**; *Science* 325 (5945), September 4, 2009, pp. 32-33

Inferring friendship network structure by using mobile phone data; **Nathan Eagle [SFI Omidyar Fellow]**; Pentland, A.; Lazer, D.;

*Proceedings of the National Academy of Sciences* 106 (36), September 8, 2009, p. 15274

Information accessibility and cryptic processes; Mahoney, J.R.; Ellison, C.J.; **Jim Crutchfield [SFI External Professor]**; *Journal of Physics A-Mathematical and Theoretical* 42 (36), September 11, 2009, pp. 9-25

Evidence for human microRNA-offset RNAs in small RNA sequencing data; Langenberger, D.; Bermudez-Santana, C.; Hertel, J.; Hoffmann, S.; Khaitovich, P.; **Peter Stadler [SFI External Professor]**; *Bioinformatics* 25 (18), September 15, 2009, pp. 2298-2301

Above-ground forest biomass is not consistently related to wood density in tropical forests; Stegen, J.C.; Swenson, N.G.;

Valencia, R.; **Brian Enquist [SFI External Professor]**; Thompson, J.; *Global Ecology and Biogeography* 18 (5), September 2009, pp. 617-625

Evolution of vault RNAs; **Peter Stadler [SFI External Professor]**; Chen, J.J.L.; Hackermuller, J.; Hoffmann, S.; Horn, F.; Khaitovich, P.; Kretschmar, A.K.; Mosig, A.; Prohaska, S.J.; Qi, X.D.; Schutt, K.; Ullmann, K.; *Molecular Biology and Evolution* 26 (9), September 2009, pp. 1975-1991

Reciprocal specialization in ecological networks; Joppa, L.N.; Bascompte, J.; Montoya, J.M.; **Ricard Solé [SFI External Professor]**; Sanderson, J.; Pimm, S.L.; *Ecology Letters* 12 (9), September 2009, pp. 961-969

T-cell vaccine strategies for human immunodeficiency virus, the virus with a thousand faces; **Bette Korber [SFI External Professor]**; Letvin, N.L.; Haynes, B.F.; *Journal of Virology* 83 (17), September 2009, pp. 8300-8314

Trading networks with price-setting agents; **Lawrence Blume [SFI External Professor]**; Easley, D.; Kleinberg, J.; Tardos, E.; *Games and Economic Behavior* 67 (1), September 2009, pp. 36-50

The topology of drug-target interaction networks: Implicit dependence on drug properties and target families; Mestres, J.; Gregori-Puigjane, E.; Valverde, S.; **Ricard Solé [SFI External Professor]**; *Molecular Biosystems* 5 (9), 2009, pp. 1051-1057

## INSIDE SFI

### Adapting food production to a changing world climate

A recent meeting in Washington, D.C., on climate change and agriculture raised questions that were both sobering for planet Earth and interesting for SFI, says Institute President Jerry Sabloff.

The conference explored ways to counter the effects of climate change on food production worldwide. It brought together experts from many disciplines to begin to define the public policies and investments needed to ensure that useful scientific advances reach farmers in both the developed and developing regions.

John Holdren, White House science advisor and director of the Office of Science and Technology Policy, gave the keynote address.

Jerry attended the September 14 meeting via an invitation from conference organizer Nina Fedoroff, Science & Technology Advisor to the Secretary of State. Nina is an SFI External Professor and Science Steering Committee member.

"It was clear from this conference that many changes will occur no matter what actions we take," Jerry says. "The challenges of climate change are daunting right now."

Temperature increases already are altering crop yields, for example, which may require changes in the way crops are grown.

"As the discussion indicated, in many cases it is not so much a matter of mitigating the effects of climate change as it is adapting to its effects," he notes.

Jerry says the topic is a good one for SFI, and he is discussing the issues raised at the conference with resident faculty members. "There may be some real opportunities for SFI to contribute down the road," he says. ■

## PEOPLE

### Nancy Deutsch joins SFI as VP for Development



Being passionate about the mission of an organization is requisite to being its representative, says Nancy Deutsch, who joined the Institute's staff on September 8 as Vice President for Development & Corporate Relations.

"SFI for me is about the interesting and challenging and important questions about our world being looked at by this collection of great thinkers who are part of this community," she says.

Nancy comes to SFI with three decades of fundraising, foundation relations, and corporate development experience, beginning with a major gifts role in public broadcasting in Washington, D.C., in the late 1970s. She has spent much of her career supporting research universities and foundations in southern California. Most recently she was executive director of development for cancer programs at UC Irvine.

She says she is spending her first few months on the job seeking a better understanding of SFI and the roles development can play. Meanwhile she and her staff are working on several critical campaigns already under way.

"This is an amazing place," she says. "It is interesting to me that SFI's donors are incredibly passionate about the research and what the Institute was founded to represent. It makes my job easier. I become a facilitator, helping others support SFI."

Nancy and her husband Ron have maintained a vacation home in Santa Fe since the early 1980s. They have an adult daughter and three grandchildren and enjoy travel and golf. ■

### > Systemic risk continued from page 1

Meeting participants explored the extent to which tools and principles of complexity science might allow for a richer understanding of systemic risk in financial markets and the economy. Network science, for example, might help identify unknown relationships in the marketplace. Feedback loops might explain, and amplify, certain market contagion effects. Interdependencies might contribute to varying degrees of susceptibility of a system to perturbations.

One problem the group encountered is that no common definition of systemic risk exists, nor has a scientific approach to measuring risk in a system been accepted.

"What are the proper measures for describing the state of the system?" asks Fabrizio. "This is a difficult question. The market system is not very transparent. There is a great deal of local knowledge about market effects, but not much is understood at the global level."

The meeting was a chance for economists and other scholars to begin a discussion of market characteristics that might be appropriate indicators for measuring systemic risk. Among those



they discussed were connectivity, adaptation, and homogeneity.

The day after the meeting a smaller group met to discuss plans for future study of systemic risk, to include a meeting at SFI next year with a broader range of disciplines represented.

Organizers of the October 15 event included Nobel laureate Kenneth Arrow (Stanford, economics), SFI Professor Dooyne Farmer (complex

systems, econophysics), SFI External Professor and Science Steering Committee Chair John Geanakoplos (Yale, economics), SFI Science Board Co-Chair Simon Levin (Princeton, ecology), Legg Mason Capital Management's Chief Investment Strategist Michael Mauboussin, Legg Mason Chief Investment Officer and SFI Board of Trustees Chair Bill Miller, Risk Economics Ltd. Founder David Mordecai, SFI External Professor John Rundle (UC Davis, physics), and Fabrizio. ■

### > Flu modeling continued from page 1

Carlos's study of Japanese youths' high susceptibility to H1N1 raised another dilemma: The flu's severity among youth indicates they should be vaccinated, he explains, but the high transmission rate among them means many likely already have had it, so immunizing them *en masse* wastes the vaccines.

Another vulnerable – and controversial – cohort is undocumented groups, Carlos says. Transient workers live in higher population densities and use public transport, but often have less access to medical resources.

"Those are the people you want to give access to," he points out. Add corruption in stressed medical systems and inadequate access to supplies in poor countries, and an increasingly complex landscape emerges.

Behavioral epidemiologist Joshua Epstein at the Brookings Institution has developed the world's first planetary-scale agent-based model to help address such questions. In his simulated societies, individuals (or agents) exhibit varying levels of susceptibility, stages of disease, and changes in behavior. Josh has modeled coupled contagion dynamics of fear and disease, the effectiveness of global travel restrictions, and the cost of social measures.

"Health care workers are the most important cadre in containing the flu and treating the sick, but they're a big component of the absentee pool," he explains. "Almost 20 percent could miss work, which would degrade the flu containment strategy in a nonlinear way."

In a recent PLOS *Currents* study, he and colleagues showed that closing U.S. schools for a month could run \$47 billion in GDP – and trigger other effects.



Depending on the next wave's virulence, and the availability and public use of vaccine and anti-viral treatments, the benefits of delaying

the peak of the epidemic by closing schools may outweigh the cost. But now we have a sense of the cost. ■

## INSIDE SFI

# Institute science blog accessible at [www.santafe.edu](http://www.santafe.edu)

Discussion of just about any subject in the SFI research portfolio can be found on the Institute's science blog "Simplicity & Complexity."

The blog includes contributions from SFI faculty as well as follow-up discussion. A recent entry, for example, asks "Did Krugman Get It Wrong?," a reference to economics Nobel

laureate Paul Krugman's article in the *New York Times Magazine* on September 6, 2009. Suggested readings from SFI's "Foundations of Complexity" reading group are posted as well.

"Simplicity & Complexity" is accessible from the upper right corner of the Institute's home page at [www.santafe.edu](http://www.santafe.edu). ■

## PEOPLE

# Bette Korber recognized by SAGE magazine



SFI External Professor Bette Korber is among 20 New Mexicans being recognized with 2009 Women Making a Difference awards by SAGE magazine, the *Albuquerque Journal's* monthly magazine about women.

Bette's award, one of two in the Science category, recognizes her work on a global HIV database and an AIDS vaccine.

In addition to her SFI appointment, Bette is an immunologist in the Theoretical Division at Los Alamos National Laboratory. ■

## PEOPLE

# Former Institute International Fellow wins prestigious Colombian award



Former SFI International Fellow Juan-Camilo Cárdenas Campo has received a 2009 Science Award from the Fundación Alejandro Ángel Escobar, recognized by many as the most prestigious scientific award in Colombia.

The award in the Environment and Sustainable Development category recognizes research that contributes to the conservation and sustainable use of natural resources and the environment.

Juan-Camilo's award commends his work on institutions, poverty, and cooperation in the local handling of common resources.

Juan-Camilo is Professor in the Department of Economics at the Universidad de los Andes, Bogota. ■

## SFI IN THE NEWS

A September 12 *Wall Street Journal* article, "Wall Street's Math Wizards Forgot a Few Variables," says some finance experts and economists blame the failure of too-simple financial risk models for the 2008 market meltdown. SFI Professor Doyne Farmer is quoted: "You don't need a model of human psychology to see that there was a danger of impending disaster...But economists have failed to make models that accurately address such phenomena and adequately address their couplings." His work to model complex financial interactions is mentioned. [http://www.nytimes.com/2009/09/13/business/13unboxed.html?\\_r=2&emc=eta1](http://www.nytimes.com/2009/09/13/business/13unboxed.html?_r=2&emc=eta1)

Excerpts from an address by SFI Distinguished Professor and Nobel laureate Murray Gell-Mann were reprinted in *Science News* online on September 12. In his address to 150 15- to 18-year-olds gathered for an Adventures of the Mind summit, he described the origins of and philosophy behind SFI's approach to science: "The way we operate is to be completely transdisciplinary. Prob-

lems are worked on without any regard for what field they originally come from...That's quite different from what happens at most universities, where you have departments and textbooks and professional societies and sections of granting agencies all dividing people up into special compartments...It's so exciting to watch these ideas bubbling up from the bottom, not being imposed from the top."

[http://www.sciencenews.org/view/generic/id/46769/title/A\\_place\\_removed\\_from\\_the\\_pressure\\_of\\_received\\_ideas](http://www.sciencenews.org/view/generic/id/46769/title/A_place_removed_from_the_pressure_of_received_ideas)

An October 14 book review in *The Globe and Mail* gives high marks to SFI Professor W. Brian Arthur's new book, *The Nature of Technology: What It Is and How It Evolves* (Free Press, 2009). The book explores the ways innovation occurs and posits that technological innovation is never new but rather results from creative combinations of existing ideas. "His book is an accessible meditation on technology, somewhat academic and far more complex than this snapshot. We live in

a world of technology, however, and this is worth reading if you want to understand how that world evolves."

<http://www.theglobeandmail.com/report-on-business/nothing-new-under-the-technological-sun/article1322660/>

An October 14 *New Scientist* article mentions SFI Omidyar Fellow Nathan Eagle's txteagle project that soon will allow Kenyans to sign up to earn income by completing translation and image tasks distributed by cell phone. A September 27 *New York Times* article also mentions the project.

<http://www.newscientist.com/article/mg20427305.700-virtual-workforce-found-in-kenyan-refugee-camp.html>

<http://www.nytimes.com/2009/09/28/technology/internet/28village.html>



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