Mice live on the order of years; humans, a century; and mysticetes longer still. Somehow, very similar chunks of tissue – near copies of each other, whether they find themselves in a shrew or a horse – age and degenerate at rates based on their organismic containers. Why?

Two dozen specialists in genomics, molecular dynamics, and the evolutionary aspects of aging met at SFI July 27-29 to explore these and other mysteries of growing old. The workshop, “Systems biology and the physical foundations of aging,” brought together researchers with contrasting areas of expertise and common interests.

“It’s easier to predict that societal surprises will occur than it is to predict what those surprises will be and when they will occur. What if, for example, life expectancy becomes significantly longer than expected in the not-too-distant future?”

“That’s one of the potential surprises that may occur when you least expect it,” says SFI Postdoctoral Fellow Béla Nagy. He and SFI Professor Doyne Farmer are co-organizers of a September 14-17 Business Network theme week held at SFI called “The future is not what it used to be.” During the week, nearly 20 participants will hear SFI researchers and veteran futurists review past attempts to predict the future, assess lessons learned, and, of course, consider what the future holds. > more on page 2

Just how accurate are today’s predictions of the future? (Images iStockphoto.com/Mlenny Photography [left]/Clint Spencer [right])
Metabolic-network-driven analysis of bacterial ecological strategies; Freilich, S.; Kreimer, A.; Borenstein, E.H. (SFI Postdoctoral Fellow); Youel, N.; Sharer, R.; Grapha, U.; Rapkin, E.; Genome Biology 10 (8), 2009, pp. 63-70
Hierarchical models, marginal polytopes, and linear codes; Kahle, T.; Wenzel, V.; Ay, Nihat (SFI External Professor); Kyedembak, 45 (2), 2009, pp. 189-207
Comment on “Ergodicity and central-limit theorem in systems with long-range interactions” by A. Figueroedo et al.; Pacheco, A.; Rapisarda, A.; Tsallis, Constantino (SFI External Professor); Physica A 385 (6), March 2009, pp. 30-33
Escort mean values and the characterization of power-law-decaying probability densities; Tsallis, Constantino (SFI External Professor); Physica A, 2009, 388 (24), pp. 5056-5062
Discovering cis-regulatory modules by optimizing barbequces; Moeen, A.; Bykgolug, T. Prokatha, S.J.; Studies, Peter (SFI External Professor); Discrete Applied Mathematics 157 (10 SP ISS), May 28, 2009, pp. 2458-2468
A refinement of the common cause principle; Ay, Nihat (SFI External Professor); Discrete Applied Mathematics 157 (10 SP ISS), May 28, 2009, pp. 2439-2457

industry, to develop a long-term research program of quantitative analysis, modeling, and prediction of terrorist activities.

Co-organizers Aaron Clauset (SFI Omidyar Fellow) and Constantino Tsallis (TIMTEC Corporation) believe such a program ultimately could shed new light on how to forecast and interdict terrorism.

“Our goals were to identify the big questions for this new field, and identify the common ground among the different teams,” Aaron says.

Neil F. Johnson’s (University of Miami) team has focused on conflicts like those in Iraq and Afghanistan, arguing for instance that the survey methods used to estimate the civilian casualty counts are highly biased. Johnson and his team have thus far received. With better models, he says, arguing that the possible relationships deserve greater scientific attention than they have thus far received. With better models, he contends, science may be able to explain and predict attack severity to a greater extent than is now possible.

The working group for the first time convened researchers who are working on just that – applying techniques from the natural and mathematical sciences to tease apart the dynamics of political violence. Future work will apply these new techniques to many other conflicts and will attempt to distill common causes and effects across conflicts.

Ultimately, Aaron says, the collaborations that grew out of the meeting could result in a much deeper understanding of the dynamics of terrorism. “Progress here offers the very real possibility of both understanding and helping to limit terrorism,” he says. 
Multiple ecological pathways to extinction in mam- mals; Davidson, A.D.; Hamilton, M.J.; Boyer, A.G.; Brown, Jim (SFI External Professor and Science Steering Committee Member); Cialdell, G.; Proceedings of the National Academy of Sci- ences 108 (26), June 30, 2009, pp. 10702-10705
Scientific discovery and topological transitions in collaboration networks; Bellencourt, Luis (SFI External Professor); Kaiser, D.I.; Kear, J.; Journal of Informetrics 3 (3), July 2009, pp. 210-221
The ontology of scale-free syntax networks: Phase transitions in language acquisition; Comiex-Murtra, B.; Valverde, S.; Solé, Ricard (SFI External Professor); Advances in Complex Systems 12 (3), June, 2009, pp. 371-392
On the bias of traceroute sampling: Or, power-law degree distributions in regular graphs; Achliop- lass, D.; Clauset, Aaron (SFI Omidyar Fellow);
Kempe, D., Moons, Christophor (SFI Professor); Journal of the ACM 56 (4), June 2009, pp. 53-80
Population stability, cooperation, and the invisibility of the human species; Hamilton, M.J.; Burger, O.; DeLong, J.P.; Walker, R.S.; Mosse, M.E.; Brown, Jim (SFI External Professor); Proceedings of the National Academy of Sciences 106 (30), July 28, 2009, pp. 12551-12560
An economic model of friendship: Homophily, minorities, and segregation; Currasen, S.; Jackson, Matthew (SFI External Professor); PLoS, Econometrics 7 (7), July 2009, pp. 1003-1046
Resolution in organic chemistry and its implication in biogenesis; Morowitz, Harold (SFI Science Board Chair Emeritus); Ennasvain, V.; Smith, Eric (SFI Professor); Complexity 14 (6), July-August 2009, pp. 7-8

It could become a scientist’s best friend: software that incorporates everything you read, write, speculate, and infer, along with the whole body of literature and data relevant to your field, and comes up with helpful suggestions, un- seen connections, and even resource budgets to help guide your research.

The same kind of software could aid in non- science areas, too, from crop rotation planning for agriculture to decision support for logistics. SFI Visiting Scientist Stephen Racunas is a lead- ing body work under a two-year U.S. Office of Naval Research grant, “Contradiction-based logic for information fusion,” to develop the required theory and algorithms.

“Contradiction-based logic is a direct formaliza- tion of the scientific method,” explains Stephen, who is also a senior research engineer at Stanford University’s Medical School, where he is working toward biomedical applications of the technology. “[It] aims to find the rela- tionships between new ideas, old ideas, and unexplained or unfounded data.”

CBL is not a statistical model of scientific infer- ence, nor is it an artificial intelligence scheme. “In a way it’s the opposite of AI,” he says. “In no way does it attempt to replace, model, or supplant human thought. At most it’s Artificial Anti-Stupidity...it’s more like a spell-checker for the realm of ideas.”

Rather than attempt the Quixotic task of captur- ing the entire structure of scientific knowledge in an authoritative interdisciplinary database or expert system, Stephen’s approach is to glean that structure from the bottom up, using the ques- tions scientists ask, the conjectures they pour the data they collect, and the conclusions they favor as raw material.

RESEARCH NEWS

Logic language: Constructing knowledge the way scientists do

By translating these myriad thoughts and observations into the formal language of model theory, CBL creates a mathematical mapping of the ever-evolving state of scientific knowledge. This mapping can then be plumbed using well-established mathematical optimization techniques.

“Because of the way this new logic is set up,” Stephen says, “each optimal hypothesis is a boundary point” in an abstract space in which theories, data, and other constraints— including time and budgetary concerns, if the scientist wishes—are connected along high-dimensional surfaces.

“The best hypotheses are the ones on the border—where constraints meet possibilities,” he says.

Nathan Collins: Giving the social sciences a good dose of math

What political science needs is a good dose of mathematics, according to SFI Omidyar Fellow Nathan Collins.

How do people choose whether to vote? Why do they prefer one candidate over another? How do they form their beliefs about political candidates? Mathematical models, Nathan says, can help answer all these questions.

Take voting behavior, for example. Like a bowl- ing ball, voters are subject to inertia: They tend to vote if they voted last time, and they tend not to vote if they didn’t. Unless, that is, they’re dissatisfied – then they switch strate- gies. When expressed mathematically, this principle alone can explain long-term trends in voter turnout remarkably well, Nathan found.

He created a super-simple model in which all voters are dedicated Republicans or dedicat- ed Democrats, and they decide only whether or not to vote. Voters whose party consistently wins may decide voting based on the better. Conversely, non-voters whose party losses may get prodded into voting.

Of course big external events like a war or an economic collapse can impact voter satisfac- tion too, and Nathan’s model can predict those. During stable periods, though, he argues, that his model captures much of the doisamam (SFI 2009).

To test the model he examined voting data from six countries during the relatively stable period between the end of World War II and the end of the 1960s. “Our model was a closer fit than any other reasonable model,” Nathan says.

The spike in voter turnout in the U.S. in the last election, he says, may indicate that recent events have changed basic satisfaction rates, leading to a longer-term change in voter turnout.

Nathan earned a master’s degree in physics at MIT before lacking political science for his PhD at Stanford.

SFI Omidyar Fellow Nathan Eagle has been named by MIT’s Technology Review magazine as one of the world’s top innovators under the age of 35 for his pioneering work on mining mobile phone data for the public good.

Selected from more than 800 nominees by a panel of expert judges and the magazine’s editor- in-chief, the TR35 is an elite group of young innovators. Their work spans the fields of medi- cine, computing, communications, nanotechnol- ogy, and more.

Petabytes of data about human movements, transactions, and communication patterns are continuously and inadvertently being generated by modern technology, from mobile phones to credit cards. Nathan analyzes cell phone data sets that represent the social network topology and dynamics of entire countries within both the developed and developing worlds.

By coupling anonymized communication events from hundreds of millions of people with other re- gional sociopolitical and socioeconomic informa- tion, Nathan and his collaborators are developing machine learning and network analysis tools that will provide deeper insight into human societies. Ultimately his research agenda is to determine how to use these insights to improve the lives of the billions of people who generate this data.

Nathan and the other 2009 TR35 winners are being featured in the September/October issue of Technology Review and will be honored at the EnTech@MIT 2009 Conference September 22–24.

The workshop was sponsored by the National Institute of Aging of the National Institutes of Health, the American Federation for Aging Research, and the Glenn Foundation for Medical Research.
A series of opinion pieces in the August 6 issue of Nature written by several SFI-affiliated researchers makes the case for the expanded use of agent-based modeling for a number of important problems. A piece by SFI Professor Doyne Farmer and SFI External Professor Duncan Foley criticizes traditional models used by economists to predict the performance of the economy, and proposes the greater use of agent-based models. The article notes the work of several SFI-affiliated researchers, including SFI External Professors Rob Axtell and Stefan Thurner and SFI External Professor, Science Board Member, and Science Steering Committee Chair John Geanakoplos. Another piece by SFI External Professor Josh Epstein says agent-based computational models can capture irrational behavior, complex social networks, and global scale – all essential in confronting the H1N1 virus. Epstein describes his past work with Rob Axtel to model the spread of disease using an early epidemiological agent-based model. An editor’s piece in the same issue says “the field [of economics] could benefit from lessons learned in the large-scale modeling of other complex phenomena, such as climate change and epidemics. Those lessons, taken together with lessons from the downturn, suggest an ambitious research agenda – not just for economists, but for psychologists, political and social scientists, computer researchers, and more.” The editorial concludes that more development work is needed to bring computer simulations to a state of informing economic policy.

An August 6 post in the Chicago Tribune business blog “Bums on Business” by Greg Bums notes the trendiness of new technology companies to leave the Chicago area, typically for the West Coast, and take their innovations with them. It quotes SFI External Professor Brian Arthur: “Rather than springing from individual breakthroughs, new technologies increasingly arise by combining existing ones. The advantage goes to regions with the scale and know-how to fit together many small advances. ‘That principle applies anywhere,’ said W. Brian Arthur. Parlaying local knowledge into the next big thing becomes tougher given the increasing complexity of today’s scientific ventures, said Arthur, who explores the subject in a new book, “The Nature of Technology.”


A July 24 Science Careers article in Science online mentions SFI in a discussion of the growing need for researchers working in network science. “Some researchers have jump-started network research careers by taking summer courses at the Santa Fe Institute. As network science has gained momentum, a number of interdisciplinary centers dedicated to network science have emerged — for example, at North-eastern University, the University of Michigan, Indiana University, the University of Notre Dame, and in non-university settings such as the Santa Fe Institute and Los Alamos National Laboratory.” The article quotes SFI External Professor and Science Board Member Mark Newman. http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2009_07_24/caredit.a0900091

An August 4 article in the Chicago Tribune business blog “Bums on Business” by Greg Bums notes the trendiness of new technology companies to leave the Chicago area, typically for the West Coast, and take their innovations with them. It quotes SFI External Professor Brian Arthur: “Rather than springing from individual breakthroughs, new technologies increasingly arise by combining existing ones. The advantage goes to regions with the scale and know-how to fit together many small advances. ‘That principle applies anywhere,’ said W. Brian Arthur. Parlaying local knowledge into the next big thing becomes tougher given the increasing complexity of today’s scientific ventures, said Arthur, who explores the subject in a new book, “The Nature of Technology.”


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New York Times science blogger Andrew Revkin, in a two-part “Dat Earth” blog entry on July 17 and 20, discusses several issues raised at the first Summer School on Global Sustain ability at SFI, attended by several dozen graduate students and researchers and co-sponsored by SFI and the National Renewable Energy Labora-