Domestication (Image: Jody Hewgill)

Working group chases wild ideas on domestication

We humans love cats and dogs. We raise chickens and collect their eggs. We drink milk from cows, eat bread from wheat, and wear sweaters of wool from alpacas and sheep. What would life on Earth be like were it not for the domestication of plants and animals?

For more than 10,000 years, domestication has shaped human evolution and the world as we know it. Yet researchers still have a lot to learn about this remarkable phenomenon. “Domestication is not just something that happens to other species; it’s also happening to us — it’s a relationship,” says SFI External Professor Amy Bogaard, professor of Neolithic and Bronze Age Archaeology at the University of Oxford. It’s a complex, long-term, multi-generational process in which “we’re all affecting each other’s evolution.” That marks a dramatic shift in thinking about domestication, which was long mischaracterized as “human mastery of the environment or the wild,” she says.

Bogaard is working with University of Oxford evolutionary biologist Greger Larson, director of the Palaeogenomics & Bio-Archaeology Research Network, to bring 16 researchers to SFI March 9–11 to debate the most cutting-edge research and questions about domestication. “The conversation is necessarily cross-disciplinary,” Bogaard says, with participants in zoogenomics, archaeobotany, genetics, anthropology, and more. But a precise definition of domestication is not on Larson’s agenda. “We are instead querying the nature of relationships between human groups and lots of different plants and animals, and then how all of those things get complicated because they all start integrating with each other,” says Larson.

As an icebreaker, Larson will ask each researcher to share “the most radical, crazy idea about the origins of domestication.” It’s intended to be a fun but productive conversation that transcends traditional silos of thought.

Understanding our origins is key to understanding who we are, Larson says. “The entire planet and everything that we’re surrounded by — including our electricity and our clothes and our houses and everything that we take for granted about the way in which we interact with the planet — is predicated upon a relationship that is a domestic one between us and a bunch of plants and animals. And we still really don’t have the foggiest clue of how this all came about.”

Bill Miller inaugurates namesake campus

Posed with a pair of golden shears, SFI Board Chair Emeritus Bill Miller addressed a crowd gathered at SFI’s newly renovated Miller Campus in Tesuque, NM during the annual Applied Complexity Network & Board of Trustees Symposium.

At the surprise ceremonial debut, Miller thought of Ludwig Wittgenstein — the genius philosopher who spent the latter part of his career chasing “snippets” of insight across a range of topics. “The early Wittgenstein was all about solving problems,” Miller said. “He wanted to ground language in logic, so he wrote the Tractatus.” Following a meeting with critic Frank Ramsey, Wittgenstein “completely changed his way of thinking, and spent the rest of his career on philosophical investigations which were just forays, snippets into this or that.”

Why we should bother with snippets of isolated insights is a recurring question for Miller, and for SFI. A legendary investor, Miller is often asked how he chooses his investments, and whether his time at SFI has had any practical effects for SFI. Miller is one of Amazon’s early investors. “Once infrastructure and technology develop, it can be hard to put on the brakes. If we move toward a renewables-heavy system, for example, we’ll need ways to address extended shortages even if they pop up only once or twice every twenty years,” she says. It’s important to plan now for future challenges.

Decarbonizing the energy supply

Shifting from carbon-emitting energy sources to renewable ones will be an essential part of addressing climate change, but the path to a renewable power grid is uncharted. A few states have already set specific renewable energy goals; last March, New Mexico passed legislation mandating that, by 2045, the state’s public electric utilities will be 100 percent carbon-free. This February 26–28, an SFI working group will explore how New Mexico might best approach the transition to renewable energy sources, and what lessons could be useful for other regions.

The working group will include SFI faculty and other researchers, as well as experts who work in advocacy, government, and New Mexico’s public utilities.

“If SFI has held lots of workshops on the theory of power grids, but to really work toward decarbonization, we need to dive into the details — hence the mix of local and global expertise,” says SFI Professor Cris Moore, who is organizing the workshop with External Professors Jessika Trancik (MIT), Seth Blumsack (Penn State), and Paul Hines (University of Vermont). Moore expects the meeting will result in “strategies specific enough to New Mexico to be useful, but at the same time provide insights that we can export to the rest of the world.”

Planning for a low-carbon energy future is inherently uncertain. We don’t know how demand, prices, or regulations will shift, and renewable energy sources themselves are variable over different timescales. Planning for daily fluctuations in wind speed or sunlight will require different technological and financial strategies than for rare, severe events that might, say, envelop an entire region in cloud cover for a week.

A primary question in planning a net-zero energy system is how to avoid highly suboptimal lock-in, says Trancik. “Once infrastructure and technology develop, it can be hard to put on the brakes. If we move toward a renewables-heavy system, for example, we’ll need ways to address extended shortages even if they pop up only once or twice every twenty years,” she says. It’s important to plan now for future challenges.

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Parallax

THE NEWSLETTER OF THE SANTA FE INSTITUTE

Winter 2019–20

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INSIDE...Unraveling time...Questions that matter...Alien transmissions...MORE
The mysteries of the universe that complexity science seeks to explain are widespread, adaptive regularities emerge at different levels and how exactly something is governed by its own effective theory — from the theory of molecular interactions to the theory of ecological stability. And furthermore, the way many of these theories share striking family resemblances by virtue of constraints of energy, time, and information. This is the fundamentally dual nature of complexity theory — recognizing the need for the autonomy of theories at different levels while at the same time exploring the common features of these theories.

Consider two profound representational frameworks — mathematics and natural language — that share their own specific goals to explore and explain the worlds that they each represent. Aparajita published in natural language or mathematics is an explanation of what or how mathematics or language. Not in terms of psychology or the conscious bond. At the same time both math and natural language share the properties of syntax and semantics and conform to limitations of length, clarity, and comprehensibility. Thereby each theory is required by their contingent domain of application while possessing deep meta-theoretical affinities by virtue of sharing universals, analogies, and shared users (that is, human beings).

At a recent meeting hosted in Washington by the National Science Foundation and reported by the authors of the book, "Mathematics: The Science of Patterns," and Kastorn Blagovev from the division of physics, SFI convened a group of complexity researchers to summarize our current understanding of universality in complex systems.

Forming pattern formation, neuroscience, ecology, evolution, and collective computation, researchers report for deeper understanding that the insights of logic and mythology be presented to the researchers have learned through a cellular unit of time. "One can now ask questions that apply across species and across niches and that can be understood by shaded principles of scaling, evolution, information, and computation. While area was presented without recourse to reducibility (that is, explanations dominated by interactions among microscopically constituent) common principles of entropy production, robust information encoding, and scaling through microscopic and macroscopic interactions, the control of networked components, and the efficient use of energy to store and transport information. This February, a diverse international working group will meet at SFI to find a fresh take on the problem. This February, a diverse international working group will meet at SFI to find a fresh take on the problem. There were noftime and ecological interactions, the control of networked components, and the efficient use of energy to store and transport information. This February, a diverse international working group will meet at SFI to find a fresh take on the problem. This February, a diverse international working group will meet at SFI to find a fresh takeon the problem.

One goal is to identify fruitful questions for a laboratory setting. Grilli notes the project has recruited members with "the experimental expertise to actually test these ideas in the real world!" Sri Venkatraman of the University of California, San Diego researchers with their innovative labs can track individual bacteria through out their life cycles. "A key challenge in aging studies has been to identify clean experimental systems in which extrinsic (e.g., environmental) and intrinsic (e.g., genetic) factors contribute towards the aging of an organism can be precisely controlled," says Iyer-Biswas. Consequently, even basic questions such as how aging is mediated by the nuclear accumbens or dopamine receptors — both of which may provide analogies for human beings, and colonies are in some ways like organs. "Looking at things in this way," says Grilli, "allows us to see multiple levels at the same time."

Working group to study aging in single-celled organisms

For something as ubiquitous in modern life as electrical power, few of us know much about the rules that govern power production, fees, or transmission. Most people, including academics and lawmakers, know even less about the Regional Transmission Organizations, or DTOs, that develop those rules. But last September, committees from both the U.S. House and Senate invited SFI External Professor Seth M. Blandin, with colleagues from Boise State University and Duke University, to fill them in on what the researchers have learned through a recently funded project called RTOGov (short for RTO Governance). DTOs were first formed in the late 1990s as part of a federal initiative to restructure the electric utility industry and break up the electrical monopoles that then provided power to the country. DTOs are charged with helping ensure a reliable electrical grid at the lowest possible cost, but the rules for how they achieve these goals are determined not by federal regulators but by a group of regional stakeholders that may include power companies, utilities, and financial players like hedge funds and banks. Who is actually at the table making these rules, and how much each vote counts, varies by region, says Blandin. The goal of the RTOGov project, which has been supported by the American Energy Research and Safety Foundation and the Hearing Committee on Legislation, is to understand how DTOs make rules and how these rules-making processes affect the operation of regional grids. The rules that DTOs set govern things like fee structures, cybersecurity, and how much energy on the grid can come from which sources — the ratio of renewable energy to fossil-fuel-based power, for instance. DTOs can also develop incentives for certain types of power generation. "They basically determine the economic environment for new technologies, and the tools that people operate the power grid have available to keep it going reliably," says Blandin. The details can look wildly different from one region to the next. Now, House and Senate committees are trying to figure out how things have changed so much since the mid-1990s that we need to rethink the mission, goals, and oversight of these organizations, he says.

As new technologies are developed, and as states set goals toward decarbonization, DTOs play a critical role. If you care about electricity costs or reliability or sustainability, these DTOs are incredibly important," says Blandin. "The most important sustainability organizations you’ve never heard of, I say. A lot of our aging grid is driven by the power grid technology transition. It’s quite possible that technology while keeping it reliable is not just technology, but the environment in which rules and regulations are made."

Why Congress cares about Regional Transmission Organizations (and you should too)
Workshop to explore diversity, inequality through “science of science”

In his 2008 Einstein Lecture to the American Physical Society, Richard A. O. Dyson noted, “When I look at the history of mathematics, I see a succession of illogical jumps, improbable coincidences, jokes of nature.” As an example, Dyson cited Erwin Schrödinger’s discovery that his wave optics equation happens to describe the behavior of atoms. The revelation that nature functions with complex numbers and not real numbers shocked both Schrödinger and the greater scientific community.

The “science of science” is a growing interdisciplinary field with a broad goal of understanding the structure and dynamics of science itself. The discipline evaluates the relationship between scientists and their scholarly products to try to determine the drivers of scientific discovery.

In March, SFI will host a workshop, “A New Synthesis for the Science of Science.” The workshop is being organized by SFI External Professor Aaron Clauset (University of Colorado Boulder), SFI Professor and Cowan Chair in the Social Sciences, Dan Ariely, and former Omidyar Fellow Daniel B. Larremore (University of Colorado Boulder). The meeting will bring together a diverse collection of researchers to formulate a synthesis of concepts, models, methods, and data to craft a new vision for the field.

The workshop will also focus on the individual and structural inequalities within science that slow the pace and limit the diversity of discovery. Specifically, participants will explore the mechanisms that produce epistemic and social inequality. For example, why do a handful of graduate programs produce 50 percent of all tenure-track faculty across different fields? Or why do women produce fewer papers throughout their careers than their male peers?

“Scientific investigations of complex problems benefit from diverse perspectives,” says Gaëtan. “This research can help us to see how some deeper changes in the system can alleviate structural barriers and inequalities.”

By using the scientific method to study the scientific ecosystem, the organizers hope to set an agenda for the future growth of the science of science.

“The past 20 years have been really exciting because now we have the data and computational tools to understand the creation of new knowledge,” says Clauset. “This workshop aims to articulate the organizing questions that should guide the next five to ten years of work and help us address the underlying causes of pervasive inequalities in science.”

Wealth inequality and social network structure

The historic wealth of Istanbul and Singapore owed much to their positions on the Bosporus and the Malacca Strait, respectively. Situated on an essential link in the flow of wealth, the elites of these cities profited from their hold-up power.

An ongoing project of the Behavioral Sciences Program at SFI is exploring this basic idea, but applied to wealth differences within societies. Social networks with bottlenecks like the Bosporus or the Malacca Strait may support high levels of wealth disparity. Similarly, the company store stands between the miner and the supplier of the necessities of life on which his family depends. The elevated prices that people pay result from the hold-up power that stems from what network theorists call the ‘centrality’ of the company store.

An NSF-funded research project is exploring the effects of network structure on wealth inequality. In February over 40 anthropologists, economists, and others will review their research so far and chart new directions.

“The amazing thing about this project,” says Eleanor Power, former SFI Omidyar Fellow and now at the London School of Economics and co-Principal Investigator on the project, “is that we have the data collected in over 50 communities around the world and for two different periods of time, all using the same measurement protocols.” Of the scope of the data will allow systematic comparisons across vast differences in technology, culture, and institutions.

“Key research objective,” says SFI External Professor Matthew Jackson, a project leader from Stanford University, “is to determine which types of networks, inequality, and other institutions can exist together — are consistent with each other — and which are not.”

SFI Professor Samuel Bowles, another project leader, explains, “Based on our theoretical work with former SFI Omidyar Fellow Williemon Kets and SFI External Professor Rajiv Sethi, there are good grounds to think that economies with star-like networks will be more unequal than those with more densely connected networks. But we’ll see what we learn from the data.”

Jeremy Koster of the University of Cincinnati is among the project organizers. “Coordinating a quantitative project in collaborative cross-cultural research of this magnitude requires a lot of interdisciplinary brainstorming, trust-building, and skill sharing, this is why we are coming back to SFI in February.”

History’s arc bends toward quantification

This January, SFI researchers will take a quantitative look at an age-old question: to what extent is human history shaped by impersonal trends, big ideas, and great leaders?

“Historians have qualitatively debated the relative roles of these phenomena, and it’s clear all three have had some effect throughout history,” says SFI Professor David Wolpert, who is co-organizing the working group with External Professor Manfred Laubichler (Arizona State University), Applied Complexity Fellow Michael Price, and Program Postdoctoral Fellow Hayme Shimao.

“We’re now at a point in time where we can begin to explore, quantitatively, which of these has been most important, and when,” Laubichler says.

Take the fall of Rome, for example — a complex coalition of new ideas, such as Christianity; the cult of personality around Roman emperors; and imperial plagues and population movements. Scholars have long argued about which of these many factors might have broken the empire’s back. Now, thanks to a bloom of new archaeological datasets, it may be possible to actually quantify how much each of these factors impacted the Mediterranean and Europe.

As an example of the type of research the group is pursuing, Price cites a recent paper on the Justinian Plague published in PNAS. By mapping and analyzing archaeological evidence drawn from papyri, coins, inscriptions, and pollen, the paper’s authors were able to test popular claims that the pandemic, estimated to have spread between 546 and 570 CE, played a key role in the decline of the Byzantine Empire and the subsequent transition from antiquity to the middle ages. (Spoiler alert: it did not.)

The working group builds on previous SFI research into “Computational History,” “Big History,” and “Clyodynamics,” which seek to uncover mathematical patterns in human history to better understand its underlying dynamics. To that end, the group will be honing analytical tools from complexity science, such as time-series analysis, to crack the “current” of historical and archaeological data that has been growing over the past two decades.

A regular map of the United States showing results of the 2016 presidential election by county, with red, blue, and purple to indicate voting percentages (right). A cartogram (left) illustrates the same data, but skewed to represent population. (Images: SFI External Professor Mark Newman)

RESEARCH NEWS BRIEFS

RESEARCH FOR AN ELECTION YEAR

Media in the U.S. have already been covering the lead-up to the 2020 U.S. presidential election for months, and in the years since the 2016 election, researchers at SFI have been taking a complex systems approach to understanding the political landscapes in the U.S. and around the world. As we enter this election season in earnest, here are some of the highlights of our election-related science, from new ways to illustrate political maps to different polling questions for better predictions.

WHAT MATTERS IN AN ELECTION?

In 2016, SFI External Professor Mark Newman (University of Michigan) developed a variety of election cartograms that play with scale, representing counties and states proportionally based on their populations or representation in the electoral college. These graphical representations offer a fresh perspective on the political landscape in the U.S. by combating the “apparent parity” of the traditional, geographically proportional red and blue map. This parade, Newman notes on his website, “fails to allow for the fact that the population of the red states is on average significantly lower than that of the blue ones. The blue may be small in area, but they represent a large number of voters, which is what matters in an election.”

IT’S WHO YOU KNOW, NOT WHAT YOU KNOW

We usually rely on polls to predict election outcomes, but those polls are not always reliable. In the 2016 U.S. presidential election, Hillary Clinton lost in five states where polls had anticipated her victory. In a February 2018 paper published in Nature Human Behaviour, SFI Professor Mirra Gaëtan and co-authors examined an alternative approach. Whereas most election polls ask people about their own voting habits, Gaëtan and her colleagues found that questions about the views of a voter’s social circle actually provide more insight, improving the accuracy of voting predictions. The researchers studied the usefulness of social-circle questions in both the 2016 U.S. presidential election and the 2017 French presidential election by means of national pre-election surveys and aggregate polls. The results indicate the efficacy of social-circle questions in tapping into ‘local’ wisdom rather than asking potential voters to make assumptions about the behavior of the general population.

REALISTIC IF NOT (YET) REAL

In the 2019 UK general election, the Computed Physics Physicist, SFI Professor Sidney Redner offered a mini-review of the voter model that had played a central role in both probability theory and statistical physics. The classic voter model, which randomly selects a voter who then adopts the state (voting habits) of a neighbor, lacks nuance, resulting in consensus that is not always achieved in reality. In his review, Redner presented a variety of extensions to this model that endeavor to incorporate socially motivated aspects of decision making. A lack of corresponding empirical data means we should avoid mistaking these extensions for social reality, but they provide useful theoretical insights on how opinions can change over time in large-scale populations.

FORENSIC ANALYSIS FOR VOTER FRAUD

The U.S. isn’t the only country concerned with voter fraud. The results of Turkey’s 2017 constitutional referendum indicated majority support of the country’s shift to autocracy, but allegations of electoral irregularities and misconduct suggest otherwise. In a 2018 PLOS One paper, SFI External Professor Stefan Thurner (Complexity Hub Vienna) and his collaborators used statistical forensics to identify and verify cases of masscheating. They utilized

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In November of 2019, 14 SFI postdocs withdrew to an isolated research location to accomplish, in just 72 hours, a monumental task — decoding the first complex communication from an alien civilization.

For the benefit of humanity, the aliens managed to divert their spacecraft for enough time to transmit a signal that would reveal a fundamental difference between their complex biology and ours. They were responding to images on the Golden Record, which launched aboard the Voyager spacecraft in 1977, engraving with a cosmic introduction to Earth and its inhabitants.

Among the record’s 15 encoded images were multiple depictions of the two parent system of reproductive biology. “The aliens were totally shocked by these images, because in their world children are conceived and raised by three parents instead of two,” says Albert Rao, an Omidyar Fellow and Baird Scholar. “For scientists who study complex, living systems, it brings up all kinds of interesting questions about why three parent systems would arise and what that might imply for the evolution of everything from molecular mechanisms to social institutions.”

With combined expertise in biology, evolution, information theory, mathematics, physics, philosophy, archaeology, cognitive science, and economics, the postdocs were uniquely qualified to receive and interpret the wide-ranging difference between their complex biology and ours. They were responding to images on the Golden Record, which launched aboard the Voyager spacecraft in 1977, engraving with a cosmic introduction to Earth and its inhabitants.

According to the postdocs, the aliens’ three-parent system confers a distinct evolutionary advantage. “It’s also as the sexual reproduction protects ourselves from the harmful mutations that proliferate in asexual species, like dandelions, the three-par-ent reproductive system adds another layer of protection and genetic diversity, especially on planets bombarded with high radiation, which can cause a high mutation rate.”

Exactly why the aliens’ three-parent system came to dominate, as opposed to a four-, five-, or n-parent system, might be explained by the coordination costs and social ramifications of searching for multiple mates at once. In their treatise, the authors describe the exponential difficulty of finding a “soul triplet”—a perfect romantic combination in a sea of possibilities.

Other social considerations of the three-parent system include a heightened risk of disease transmission and a societal trend towards a uniform culture. According to Omidyar Fellow David Kinney, such a uniform culture is needed to avoid the cognitive overload caused by trying to juggle the cultures and languages of three parents, nine grandparents, and potentially dozens of partial siblings.

There are so many social angles to explore in this system,” says sociologist Tamara van der Does, a Program Postdoctoral Fellow. “The number of biological sexes would have been three, but it points the way towards profound questions about the way time operates in the body and beyond.

It’s not just a matter of scale. That came human body also observes a circadian rhythm, a rhythm dictating sleep and waking. Invading pathogens might break havoc within, following their own timescales of life, reproduction, and death. The brain and body age and break down. In the world outside, ecosystems grow and change on myriads simul-aneous schedules. So do civ-ilizations, economies, philosophies, species. Meanwhile, human bodies participate in all the trappings of economic and political time, from 9-5 to days to months to the years and full of entire sys-
tems of government, all the while perceiving psychological-time romances that are over in a flash, comedies that seem to last forever.

Given the seemingly endless layers of time in complex systems, it makes sense that, until now, working groups in SFI’s research theme on Adaptation, Aging, and the Arrow of Time have studied them separately. For instance, one group has focused on the nature of sleep, while others have explored ecological evolution, infectious diseases, or cognitive regime shift. However, an upcoming meeting, held April 2–4, 2020, will mark an exciting development.

“We have all these topical areas that have been meeting in isolation, and it’s time to bring them together,” says Amy P. Chen, Program Manager for Adaptation, Aging, and the Arrow of Time. The upcoming gathering combines the program’s annual General Meeting with its Core Theory meeting, as well as inviting contribu-
tions from the advisory board. The aim is to begin working towards a unified theoretical approach to time.

To that end, rather than being presentation-focused, “there will be a lot of time for group discussions, so participants have a chance to hear from each other,” says Chen. “There will be a lot of time to ask questions.”

“The big picture is what is core” says Krakauer. “In each of the application areas, we want to know how time organizes phenomena; but “the deeper set of issues has to do with how things unravel in time . . . that’s the common theme in all of these. The time to make something, and the time to break something.”

Also integral to the meeting will be new participants, including Simon Grondin (Université Laval, Québec), who can offer insight from areas not currently in the Complex Time portfolio, such as psychology and philosophy.

These are subjects well-equipped to tackle what may be complex time’s most mind-bending hurdle: the fact that, as Krakauer notes, “we build the clock.” Does absolute time exist, and if so, how could we theorize it? Only time will tell.

Omidyar Fellow Tyler Marghets says imagining a three-parent system “is actually a really great way to gain insight into the origins and implications of our more familiar two-parent system . . . in the future, it might spark new ideas that might help travelers better understand themselves.”

“Our thoughts are interesting questions that can be pursued in this model,” says archaeologist Stefani Cracraft, an SFI-ATT Center Postdoc-
toral Fellow. “One of the great things about being a postdoc at SFI is that you have exper-
tence in one area, but you also get exposure to other fields that connect to it.”

After 72 hours of intense transcription, the post-
docs steered themselves to record the final transmission in the treatise — the core innova-
tions of alien culture, including “hyperdrive tech-
nology, the unified theory of physics, and the meaning of ‘universality’ that portion of the transmission did not arrive intact. The full treatise on three-parent reproduction, replete with figures and references to terrestrial scientific literature, will be published in the summer of 2020 in conjunction with the Inter-
planetary Planetary Meeting.

*The alien transmission is a fictional premise. Any resemblance to actual species, civilizations, or planets is purely coincidental.

To make rigor accessible to everyone’ SFI welcomes Director for Education

In the few short months since Carrie Cowan arrived at SFI, she’s been immersed in the complex culture and in uncovering new ways to advance the Institute’s educational mission. But the moments that most stood out as exciting for the new Director for Education are all about the people.

“Some of the most remarkable experiences have been lunchtimes and teasetimes, when you just sit down with random people,” Cowan explains. “You end up having these amazing conversa-
tions about science and about life — always with a lot of intellectual curiosity.”

Cowan joined SFI in September from Jackson Laboratory, a biomedical research institution in Maine, where she oversaw Ph.D. and post-
doctoral training. She led similar efforts at Jackson Laboratory, a biomedical research institution in Maine, where she oversaw Ph.D. and post-
doctoral training. She led similar efforts at the University of California San Diego, where she co-founded and directed the Center for Systems Biology.

Cowan’s perspective on education aligns with SFI’s mission, especially when it comes to expanding the reach of complexity science. “The big picture is: what is time?” says Krakauer. “In each of the application areas, we want to know how time organizes phenomena, but “the deeper set of issues has to do with how things unravel in time . . . that’s the common theme in all of these. The time to make something, and the time to break something.”

Also integral to the meeting will be new participants, including Simon Grondin (Université Laval, Québec), who can offer insight from areas not currently in the Complex Time portfolio, such as psychology and philosophy.

These are subjects well-equipped to tackle what may be complex time’s most mind-bending hurdle: the fact that, as Krakauer notes, “we build the clock.” Does absolute time exist, and if so, how could we theorize it? Only time will tell.
Leading scientists and legal scholars are weighing in on a national debate about fair housing laws. On October 18, a group of ten computer scientists, social scientists, and legal scholars from the Santa Fe Institute and the University of New Mexico submitted a formal response to the U.S. Department of Housing and Urban Development’s (HUD) proposal to dramatically revamp the Fair Housing Act.

Key amendments in HUD’s new legislation would absolve landlords and lenders from any legal responsibility for discrimination that results from a third-party computer algorithm. Such algorithms are already widespread in our society and are used to automate decisions about who gets a card credit, a lease, or a mortgage. As the proposal is written, landlords and lenders would be protected from charges of “disparate impact” (unintentional discrimination that nonetheless leads to wide disparities) so long as their algorithms don’t overtly factor in protected characteristics like race, gender, religion, or disability status, or rely on proxy variables for those characteristics.

According to the experts, the HUD amendments related to algorithms are based on a fundamental “failure to recognize how modern algorithms can result in disparate impact—and how subtle the process for auditing algorithms can be.” Modern machine-learning algorithms are based on a fundamental “failure to recognize how modern algorithms can result in disparate impact and how subtle the process for auditing algorithms can be.”

If you could answer any question you put your mind to, what would you ask?

For Ramanan Laxminarayan this is not a hypothetical, three-wishes kind of question—it’s a real dilemma that early career researchers need to confront head-on. By December of 2018, during the seventh Postdocs in Complexity conference, he’ll be coming to Santa Fe to hash out some answers with the Santa Fe Institute and James S. McDonnell Foundation fellows.

Generally I find there are a lot of bright people out there who can answer any question they want to.

For more information on the seventh SFI-NSF Postdocs in Complexity Conference, and an agenda, visit https://www.santafe.edu/events/jmri-sf-philosophy.

As an added bonus, he says once a researcher has found their question, they’ll have a much easier time communicating their research to outsiders.

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election data made available on the election commission’s website, removing potential outliers and examining election fingerprints. The researchers found “systematic and highly significant statistical support for the presence of both ballot stuffing and voter rigging.” These statistical irregularities persisted in the 2018 presidential and parliamentary elections, indicating systematic biases that need to be combated.

WHY DO SO MANY ELECTIONS VERGE ON STALEMATE?

History offers up numerous examples of near 50-50 election results. In the past decade alone, we’ve witnessed the 2014 Swiss referendum on mass immigration, the 2016 U.S. presidential election, and the British Brexit vote (also in 2016). All three were characterized by controversial issues and hostile attacks on both sides, and all three ended in a near stalemate, with a narrow margin of defeat or victory for the losing and winning parties.

In a 2019 paper in *Physical Review E*, SFI collaborator Stefan Bornholdt (Institute Rudjer Boskovic) and his colleagues present a voter model that explains what drives public opinion toward stalemate. In a word, it is repulsion. As voters are either convinced or repelled by statements, they can change sides or switch to an undecided state if they come to doubt their former opinion. In a contentious debate, when a voter is repelled by at least one out of four statements, a phase transition occurs where neither party can win in the long run and no clear winner emerges. To shift these dynamics from stalemate to majority, the study offers several recommendations for moving away from hostile statements and toward rational discourse. Their most radical proposal? “To declare results as invalid where the difference between yes and no is less than ten percent.”

SFI COMMUNITY LECTURE SERIES: SPRING 2020 LINEUP

The Santa Fe Institute Community Lectures bring leading thinkers to Santa Fe to explore the most alluring questions in science, and to address the complex issues that face our species and our planet.

Tuesday, February 25
RAJIV SETHI
“Stereotypes, Crime, and the Pursuit of Justice”
7:30 p.m., The Lensic Performing Arts Center

Tuesday, March 24
SARA WALKER
“The Information Origins of Life”
7:30 p.m., The Lensic Performing Arts Center

UPCOMING COMMUNITY EVENTS

SFI’s 2020 InterPlanetary Festival is expanding this summer, launching from the success of three-day events in 2018 and 2019 to eight weeks of lectures, working groups, musical performances, interviews, and immersive art, each focusing on one of eight topics crucial to the future of our interplanetary civilization.

EIGHT COMPLEX TOPICS SPANNING EIGHT WEEKS

July 2–4  Emergent Engineering
July 9–11  Astrobiology & Life Detection
July 16–18  Motion & Energy Technology
July 23–25  Architecture, Cities, & Scale
July 30–Aug 1  Autonomous Ecosystems
Aug 6–8  Time Design
Aug 13–15  Intelligent Systems
Aug 20–22  Planetary Policy, Law, & Regulation

EXPLORE THE DEPTHS EACH WEEKEND

THURSDAYS
• Curated film screenings, introduced by luminaries from science, media, technology, and beyond

FRIDAYS
• InterPlanetary panel discussions • Live outdoor concerts • Cosmic ales & cocktails

SATURDAYS
• Live podcast recordings • Keynote presentations • Multimedia art performances

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GET THE LATEST DEVELOPMENTS, PRE-REGISTER, AND MARK YOUR CALENDARS FOR SUMMER 2020!