Transmission: SFI insights into COVID-19

Complexity science offers a wealth of tools for understanding pandemics. At the applied level, epidemiologists use network-science techniques developed at SFI in the early 2000s to track outbreaks, epidemics, and pandemics like Ebola, SARS, influenza, and the novel coronavirus. Beyond the crucial work of tracking and preventing the spread of biological contagions, complexity science can also shed light on “coupled” problems — the social consequences of pandemic-related misinformation, for example, or the long-term economic repercussions of shutting down global economies.

To present expert perspectives on the complexities of the COVID-19 pandemic, SFI has launched an online series called “Transmission.” President David Krakauer, who initiated the series, envisioned a collection of short, accessible media created by SFI faculty, on topics related to their scientific expertise.

“Very important work is being done by SFI scientists of direct relevance to the pandemic,” Krakauer says, “and the SFI community also has novel insights that might help people deal with the situation more broadly.”

He cites SFI researchers who are working to monitor and model the COVID-19 pandemic, to develop vaccines and tests, and to project the socio-economic impact of the pandemic and plot paths to recovery.

The series launched Monday, March 30, with five SFI-authored insights. Krakauer himself penned T-001 (see p.2), which makes the case for eliminating coronavirus through “citizen-based medicine.” T-002 by Omidyar Fellow David Kimsey takes up the issue of scientists needing to sacrifice a level of certainty in order to provide clear recommendations to policymakers, while External Professor John Harro stakes out against conflicting recommendations on allowable group size in T-003. The third transmission, by External Professor Jürgen Jost and his collaborator Luis Hoang Duc, presents techniques for analyzing inconsistent data on COVID-19 case counts and deaths. T-004, by External Professor Simon DeDeo, asks how we can win “the quarantine end-game,” by creating and communicating new guidelines for social interaction.

The series will continue for the foreseeable future, with new insights published every Monday at santafe.edu/transmission.

Carrying on with collaborative research

SFI has always prided itself on its ability to bring together top scientists from around the world. Traditionally, they’ve met in the same room, with catered meals and coffee on tap. Now, in an effort to help slow the spread of the COVID-19 pandemic, SFI faculty, postdocs, and staff are making the most of remote work.

Researchers are holding a weekly teleconference to catch up on each others’ science. Called “remotely together” in the initial email invitation from Professor Cris Moore, the Wednesday meetings consist of seminar presentations, informal science talks, and, in Moore’s words, “the usual — luncheon conversations.”

Davis Professor Melanie Mitchell delivered the first seminar on March 18, presenting her current research into how we can evaluate an AI’s ability to form abstract concepts. For example, an artificial neural network can accurately identify a picture of a cable bridge, but cannot extend this understanding to the “bridge” of a nose, or a “bridge” between scholarly disciplines. Mitchell presented some classic and state-of-the-art problem sets that have been proposed to test this type of abstraction, including one designed by her mentor, Douglas Hofstadter. In classic SFI style, she invited participants to interrupt with questions.

SFI’s IT department set up the video conference, and despite a few audio and visual glitches, participants could speak up throughout the presentation. Interlocutors quickly learned to state their names before speaking, so others could identify them.

“The online format took a little getting used to,” Mitchell says, “but the essential experience of dialogue and camaraderie went amazingly smoothly.”

Toward the end of the presentation, Mitchell returned to the bridge example with a prescient challenge from the field of AI. One explanation for how humans are able to abstract a concept like “bridge” has to do with the way we experience the world as physical, embodied beings. If an AI has never used a plank to cross a stream, or driven the Golden Gate, can it really abstract the ultimate purpose of the object?

Participants unmuted their microphones to applaud, then rallied for an overtime Q&A, approximating the “embodied” experience of lingering in the conference room to continue a lively conversation on a complex problem.

The Institute responds to the pandemic

In-person gatherings canceled through end of August

With the rapid global spread of the novel coronavirus, SARS-CoV-2, the Santa Fe Institute suspended all public events and scientific meetings and directed all faculty and staff to work remotely beginning Friday, March 1. The State of New Mexico reported its first cases of COVID-19 earlier that week, and the City of Santa Fe reported its first case on Wednesday, March 11.

All SFI gatherings, including community lectures, workshops, symposia, working groups, seminars, meetings of the Applied Complexity Network, summer schools, and the InterPlanetary Festival have also been canceled or rescheduled until after the end of August.

“This is all terrible news and we all desire that the pandemic be controlled more quickly than current projections,” wrote President David Krakauer, who made the decision to cancel summer events in consultation with SFI leadership and colleagues at research universities. “However SFI of all places needs to come to terms with the complexity of the situation. And we will adapt quickly if the situation improves.”

Answering the call to adapt, some groups and programs have re-organized to convene online (see “Sustainable investing” and “Language,” p.2, and “Meaningful work,” p.3).

SFI researchers are also using online platforms to stay abreast of each others’ research (see “Carrying on,” p.9) and to forge new collaborations aimed at fighting the novel coronavirus (see “After the first wave,” p.5).
TRANSMISSION

In a research setting, it is often necessary to develop a method that every one of us without any special training, might be justly awarded to all the citizens of the world. For SFI Trustee Katherine Collins, Head of Sustainable Investing at Putnam, the ESG framework is a good start. But it fails to address a number of causes that reestablish a kind of simplicity.

In a video for TIME, argued that misinformation is important public health data, and that by preventing the disease to touch the complex web, the role of misinformation, and the importance of social distancing, in top media outlets like The New York Times, CBS and The New York Times. Omidyar Fellow Daniel Kimmy was featured in Bloomberg, Wired, and other outlets for using mobile phone data to help understand and monitor the pandemic (see p. 4).

In a column about the “Transmis -sion” series (see p. 4) and the “After the first wave” workshop (see p. 4), The Santa Fe Reporter invited readers to join scientists in using “knowledge and reason to fight the pandemic”.

SFI IN THE NEWS

A new toolkit for sustainable investing

Most of us share our thoughts, ideas, and beliefs online, and the sheer volume of words now flowing in the public sphere presents an unprecedented opportunity for psychologists who study language. What we say and write can reveal more about us than our words alone convey. Within the vast repertoire of communicators cyberspace lie patterns that can provide rich insights into how our minds work. But psychologists who study language and social cognition have struggled to make sense of such huge amounts of data using traditional methodologies. In the field of computer science, recent advances in machine learning have begun to produce tools that could be useful to mine these datasets. A two-day SFI working group, now scheduled to convene online in April, will bring together psychologists and computer scientists to explore how the two fields can collaborate.

Working group views language as a window into human minds

You could have all the content in the world, but if you don’t have methods (to analyze it), you’re stuck,” said working group organizer and external Professor Marzbani Banaj, a psychologist at Harvard. “But we do now.” The collaboration will focus on “the coming together of these large sets of data that contain human expressions of language and methods that are being designed by computer scientists — algorithms — that plow through these massive amounts of words to be able to tell us something about these hidden patterns,” she added. At the same time, psychologists will share their own methods, for analyzing text, which could help computer scientists refine their algorithms. “We’re trying to jump-start a collaborative, interdisciplinary approach, to be able to speak to each other.”

In addition to Banaji, the 11-member working group will include researchers with backgrounds in computer science, psychology, brain science, and social dynamics. Among them, Aylín Caliskan, a computer scientist at George Washington University who studies machine learning, SFI Professor Laurent Hébert-Dufresne, and computer scientist Jamie Pennebaker of the University of Texas at Austin.

The idea for the working group came to Banaji, who is known for her research on implicit bias, when she read a paper about machine learning. The study got her thinking about what psychologists might be able to learn from computer scientists, especially when it comes to unearthing the layers of meaning from large datasets.

Diagram from Alesha Swarbrick’s Book of Life, circa 1658 (Image: Public Domain)

CITIZEN-BASED MEDICINE

Imagine a world where one had the opportu- nity to prevent cancer. And that this involved no special training, but rather, the ability to effectively deploy it across the global population. I suspect that we would all stay at home, strive as best we could to remain productive, and thereby become an active part in one of the greatest public-health achievements in the his- tory of public health. The Nobel Prize for medi-cine would be justly awarded to all the citizens of the world.

This is an impossible scenario for cancer. It is an impossible scenario for effectively all of the top 20 causes of deadly disease in the world. For heart disease, cancer, stroke, and Alzhei-mer’s disease, we have at best a rather patchy understand- ing of their origins, how they cause illness, and how we might treat them.

Each of these diseases is correlated, to different extents, with our genetics, behavioral habits, social systems, economies, and eco-systems. For example, heart disease has a smaller genetic component and is far more depend-ent on our diets and addictions and our behavior — particularly how active we are. The same factors have an impact on cancer but the largest influence comes from genetics and environmental factors and conditions. And these factors feed back on one another to make isolation a single optimum point of intervention nearly impossible. This is what we describe as Complex Complexity. And it makes prevention and early intervention far more difficult.

But the world that we can only dream of for cancer, and for most of the top 20 causes of mor-tality, is a reality for COVID-19 — we will have a treatment window of a couple of years, or less and it will work. So why the huge system shock with COVID-19? It has to do with a rather unique convergence of causes that reestablishes a kind of simplicity.

We have this golden moment where there’s urgency to act in a more complete and thoughtful way, and an openness to take in new inputs and protocols. The goal of this meeting is to make sure we are doing something wise and not something merely clever.

The past three years have seen a surge in sus-tainable investing. Motivated by the intensifying climate crisis, investment firms and their clients increasingly opt for funds that demonstr-ate Environmental, Social, and Governmental practices known in the industry as “ESG.” There’s even a framework for evaluating ESG-funds, which often outperform tradi-tional counterparts.

For SFI Trustee Katherine Collins, Head of Sustain-able Investing at Putnam, the ESG framework is a good start. But it fails to address a fundamental question: What happens when you take a system that is highly mechanized and focused on very short-term feedback and collage it with a system that’s long-duration in nature, has a rather differ-ent system of feedback, and supports all life as we know it?”

Collins believes the “machine” of finance is just beginning to tune itself to the importance of sustaining the environment on which it depends, but lacks the right tools to do so.

To that end, Katherine and ACtIoN member Putnam Investments will co-host a Virtual Topi-cal Meeting beginning in late May to explore how complexity science can inform sustainable investing. The meeting will bring investors together with leading climate and complexity scientists to discuss “The Complexity of Sus-tainability and Investing.”

In addition to Collins, who is Vice Chair of SFI Board of Trustees, other speakers will include External Professor Jessika Trancik and Science Board co-chairs Simon Levin and Dan Schrag. Schrag, a climate scientist who served on Presi-dent Obama’s advisory council for science and technology, noted how rare it is for investors to seek out scientists for advice on sustainability. “We’re not investing anything every day to ask about the climate?” he remarked.

One of the group’s objectives is to explore what mathematics might look like for sustainable enterprises. “Most of the math of finance is inherently extractive and zero-sum in its calcu-lating,” Collins explains. And current frame-works sometimes “miss the forest for the trees.” For example, there are ways for a well-run com-pany to score highly on the ESG framework, even if its product is inherently wasteful and unnecessary — like a sustainably harvested version of the “Thowest” from the 1970s. Some companies, by contrast, produce great prod-ucts but are not well managed.

External Professor Carl Bergstrom, an epidemiologist, has also spoken widely about the role of misinformation, and the importance of social distancing, in top media outlets like STAT. Working group views language as a window into human minds

Most of us share our thoughts, ideas, and beliefs online, and the sheer volume of words now flowing in the public sphere presents an unprecedented opportunity for psychologists who study language. What we say and write can reveal more about us than our words alone convey. Within the vast repertoire of communicators cyberspace lie patterns that can provide rich insights into how our minds work. But psychologists who study language and social cognition have struggled to make sense of such huge amounts of data using traditional methodologies. In the field of computer science, recent advances in machine learning have begun to produce tools that could be used to mine these datasets. A two-day SFI working group, now scheduled to convene online in April, will bring together psychologists and computer scientists to explore how the two fields can collaborate.

“Finally, more on page 4”

CREDITS

EDITOR: Jennie Marshall
CONTRIBUTORS: Sienna Latham, Caitlin McShea, Katherine Mast, April Rave, Paul Stapleton, Deb Timmo
DESIGN & PRODUCTION: Laura Egley Taylor VP FOR SCIENCE: Jennifer Dunne Parallel is published quarterly by the Santa Fe Institute, 1399 Bassett St., Santa Fe, NM 87508 (Email: jennie.marshall@marshall@santafe.edu) www.santafe.edu

Working group views language as a window into human minds

Most of us share our thoughts, ideas, and beliefs online, and the sheer volume of words now flowing in the public sphere presents an unprecedented opportunity for psychologists who study language. What we say and write can reveal more about us than our words alone convey. Within the vast repertoire of communicators cyberspace lie patterns that can provide rich insights into how our minds work. But psychologists who study language and social cognition have struggled to make sense of such huge amounts of data using traditional methodologies. In the field of computer science, recent advances in machine learning have begun to produce tools that could be used to mine these datasets. A two-day SFI working group, now scheduled to convene online in April, will bring together psychologists and computer scientists to explore how the two fields can collaborate.

“You could have all the content in the world, but if you don’t have methods (to analyze it), you’re stuck,” said working group organizer and external Professor Marzbani Banaj, a psychologist at Harvard. “But we do now.” The collaboration will focus on “the coming together of these large sets of data that contain human expressions of language and methods that are being designed by computer scientists — algorithms — that plow through these massive amounts of words to be able to tell us something about these hidden patterns,” she added. At the same time, psychologists will share their own methods, for analyzing text, which could help computer scientists refine their algorithms. “We’re trying to jump-start a collaborative, interdisciplinary approach, to be able to speak to each other.”

In addition to Banaji, the 11-member working group will include researchers with backgrounds in computer science, psychology, brain science, and social dynamics. Among them, Aylín Caliskan, a computer scientist at George Washington University who studies machine learning, SFI Professor Laurent Hébert-Dufresne, and computer scientist Jamie Pennebaker of the University of Texas at Austin.

The idea for the working group came to Banaji, who is known for her research on implicit bias, when she read a paper about machine learning. The study got her thinking about what psychologists might be able to learn from computer scientists, especially when it comes to unearthing the layers of meaning from large datasets.
The study of network dynamics, or how we can understand the num-
ner of individuals in a given social system, involves knowledge of network
theory and models. Individuals in a group have various types of networks —
which can change and diversity — when individuals cross the boundaries of one
organization to another. Bhatt, who holds an PhD in physics from Har-
vard University and is completing a PhD in organizational behavior at Stanford Graduate
School of Business, blends organizational and cultural theories, which are
grounded in some extent in the mathematical models of evolutionary biology and the quantitative
tools of computational linguistics. Developing a systematic approach for cultural diversity in
organizations could help managers who are increasingly being asked to consider cultural
change and diversity, and also offer broader social relevance as well. “If we want to under-
stand cultural shifts in society, we might want to understand more about what’s happening
in organizations,” says Bhatt.

George Cantwell, who is completing his PhD in
physics from the University of Texas at El Paso and is completing
a PhD in psychology as well
in organizations, concern human sociology and psy-
Here are a few recent questions raised in this context,” he says. At
SFI, Cantwell will be working with Professor
Cris Moore on an NSF-funded project aimed at
identifying when it is mathematically possible to
predict patterns for complex, non-high-
dimensional real-world datasets.

Jonas Dalege
One of the central
fundamental challenges in the study of complex
systems is that they are agnostic to the
algorithms one can use to try to understand them. “People are often
interested in finding patterns in the data, but it’s important to remember
that what we observe in the data is not necessarily what’s
really occurring in the system,” Dalege says. “It’s possible that the patterns we
see are the result of some underlying structure that we haven’t
fully understood.”

Natalie Grefenstette
Grefenstette was
still in elementary
class when she
started thinking about
how life began on Earth,
where it might be
and the potential for
life in other places.

Mingzhen Lu
Beneath our feet,
out of our sight, is
a world — a world
of molecular interac-
tions. Plants, fungi,
and microbes work
together symbiotically
with each other,
using the resources they
interact with
— carbon, nitrogen, and
other nutrients
available to one another. “This cooperation
has propelled the evolution of all land
organisms on Earth,” Lu says. “The
inland terrestrial ecosystems evidence
this — plants and animals have
evolved as a unitary system.”

All SFI fellows participate in a unique training program designed to
develop their scientific, communication, and leadership skills. Most
SD go on to hold faculty positions at major universities and research
institutions, where they serve as lifelong ambassadors for the
philosophies and methodologies of complexity science.

ANJALI BHATT
Human organ-
cization, from
to schools to
to understand
their own
structural
patterns over time. We
know that a society
is more than just a
that changes over time. We
know that a society
is more than just a
school system. We also know that
strategies and models to understand the dynamics of organ-
cultural diversity. She is particularly interested in how network dynamics changes
when individuals cross the boundaries of one
organization to another. Bhatt, who holds an PhD in physics from Har-
vard University and is completing a PhD in organizational behavior at Stanford Graduate
School of Business, blends organizational and cultural theories, which are
grounded in some extent in the mathematical models of evolutionary biology and the quantitative
tools of computational linguistics. Developing a systematic approach for cultural diversity in
organizations could help managers who are increasingly being asked to consider cultural
change and diversity, and also offer broader social relevance as well. “If we want to under-
stand cultural shifts in society, we might want to understand more about what’s happening
in organizations,” says Bhatt.

George Cantwell, who is completing his PhD in
physics from the University of Texas at El Paso and is completing
a PhD in psychology as well
in organizations, concern human sociology and psy-
Here are a few recent questions raised in this context,” he says. At
SFI, Cantwell will be working with Professor
Cris Moore on an NSF-funded project aimed at
identifying when it is mathematically possible to
predict patterns for complex, non-high-
dimensional real-world datasets.

Jonas Dalege
One of the central
fundamental challenges in the study of complex
systems is that they are agnostic to the
algorithms one can use to try to understand them. “People are often
interested in finding patterns in the data, but it’s important to remember
that what we observe in the data is not necessarily what’s
really occurring in the system,” Dalege says. “It’s possible that the patterns we
see are the result of some underlying structure that we haven’t
fully understood.”

Natalie Grefenstette
Grefenstette was
still in elementary
class when she
started thinking about
how life began on Earth,
where it might be
and the potential for
life in other places.

Mingzhen Lu
Beneath our feet,
out of our sight, is
a world — a world
of molecular interac-
tions. Plants, fungi,
and microbes work
together symbiotically
with each other,
using the resources they
interact with
— carbon, nitrogen, and
other nutrients
available to one another. “This cooperation
has propelled the evolution of all land
organisms on Earth,” Lu says. “The
inland terrestrial ecosystems evidence
this — plants and animals have
evolved as a unitary system.”

All SFI fellows participate in a unique training program designed to
develop their scientific, communication, and leadership skills. Most
SD go on to hold faculty positions at major universities and research
institutions, where they serve as lifelong ambassadors for the
philosophies and methodologies of complexity science.

ANJALI BHATT
Human organ-
cization, from
to schools to
to understand
their own
structural
patterns over time. We
know that a society
is more than just a
that changes over time. We
know that a society
is more than just a
school system. We also know that
strategies and models to understand the dynamics of organ-
cultural diversity. She is particularly interested in how network dynamics changes
when individuals cross the boundaries of one
organization to another. Bhatt, who holds an PhD in physics from Har-
vard University and is completing a PhD in organizational behavior at Stanford Graduate
School of Business, blends organizational and cultural theories, which are
grounded in some extent in the mathematical models of evolutionary biology and the quantitative
tools of computational linguistics. Developing a systematic approach for cultural diversity in
organizations could help managers who are increasingly being asked to consider cultural
change and diversity, and also offer broader social relevance as well. “If we want to under-
stand cultural shifts in society, we might want to understand more about what’s happening
in organizations,” says Bhatt.

George Cantwell, who is completing his PhD in
physics from the University of Texas at El Paso and is completing
a PhD in psychology as well
in organizations, concern human sociology and psy-
Here are a few recent questions raised in this context,” he says. At
SFI, Cantwell will be working with Professor
Cris Moore on an NSF-funded project aimed at
identifying when it is mathematically possible to
predict patterns for complex, non-high-
dimensional real-world datasets.

Jonas Dalege
One of the central
fundamental challenges in the study of complex
systems is that they are agnostic to the
algorithms one can use to try to understand them. “People are often
interested in finding patterns in the data, but it’s important to remember
that what we observe in the data is not necessarily what’s
really occurring in the system,” Dalege says. “It’s possible that the patterns we
see are the result of some underlying structure that we haven’t
fully understood.”

Natalie Grefenstette
Grefenstette was
still in elementary
class when she
started thinking about
how life began on Earth,
where it might be
and the potential for
life in other places.

Mingzhen Lu
Beneath our feet,
out of our sight, is
a world — a world
of molecular interac-
tions. Plants, fungi,
and microbes work
together symbiotically
with each other,
using the resources they
interact with
— carbon, nitrogen, and
other nutrients
available to one another. “This cooperation
has propelled the evolution of all land
organisms on Earth,” Lu says. “The
inland terrestrial ecosystems evidence
this — plants and animals have
evolved as a unitary system.”

All SFI fellows participate in a unique training program designed to
develop their scientific, communication, and leadership skills. Most
SD go on to hold faculty positions at major universities and research
institutions, where they serve as lifelong ambassadors for the
philosophies and methodologies of complexity science.
Transmission (cont. from page 2)  
quarantine, maintaining social distance in public, practicing appropriate hygiene, and developing new habits for home-work during quarantine, maintaining social distance in public.
Interacting contagions call for complex models

When disease modelers map the spread of viruses like the novel coronavirus, Ebola, or the flu, they traditionally treat them as isolated pathogens. Under these so-called “simple” dynamics, it’s generally accepted that the forecasted size of the affected population will be proportional to the rate of transmission.

But according to former SFI postdoc Laurent Hébert-Dufresne at the University of Vermont and his co-authors Samuel Scarpino at Northeastern University, a former Omidyar Fellow, and Jean Gabriel Young at the University of Michigan, the presence of even one more contagion in the population can dramatically shift the dynamics from simple to complex. Once this shift occurs, microscopic changes in the transmission rate trigger macroscopic jumps in the expected epidemic size—a spreading pattern that social scientists have observed in the adoption of innovative technologies, slang, and other contagious social behaviors.

Interacting contagious diseases like influenza and pneumonia follow the same complex spreading patterns as social trends. The findings, published in Nature Physics, could lead to better tracking and intervention when multiple diseases spread through a population at the same time.

“The interplay of diseases is the norm rather than the exception,” say Hébert-Dufresne. “And yet when we modeled it, it’s almost always one disease in isolation.”

The researchers first began to compare biological and social contagions in 2015 at SFI, when Hébert-Dufresne was asked to study how social trends propagate through reinforcement. The classic example of social reinforcement, according to Hébert-Dufresne, is “the phenomenon through which 10 friends telling you to see the new ‘Star Wars’ movie is different from one friend telling you the same thing 10 times.”

Like multiple friends reinforcing a social behavior, the presence of multiple diseases makes an infectious disease contagious that would be its own. Biological diseases can reinforce each other through symptoms, as in the case of a sneezing virus that helps to spread a second infection like pneumonia. Or, one disease can weaken the host’s immune system, making the population more susceptible to a second, third, or nth contagion.

When diseases reinforce each other, they rapidly accelerate through the population, then fizzle out as they run out of new hosts. According to the researchers’ model, the same super-exponential pattern characterizes the spread of social trends, like viral videos, which are widely shared and then cease to be relevant after a critical mass of people have viewed them.

The same complex patterns that arise for interacting diseases also arise when a biological contagion interacts with a social contagion, as in the example of a virus spreading in conjunction with an anti-vaccination campaign. The paper details a 2005 Dengue outbreak in Puerto Rico, where failure to accurately account for the interplay of Dengue strains reduced the effectiveness of a Dengue vaccine. This in turn sparked an anti-vaccination movement—a social epidemic—that ultimately led to the resurgence of measles—a second biological epidemic. It’s a classic example of real-world complexity, where unintended consequences emerge from many interacting phenomena.

Although it is fascinating to observe a universal spreading pattern across complex social and biological systems, Hébert-Dufresne notes that it also presents a unique challenge. “Looking at the data alone, we could observe this complex pattern and not know where it would lead,” he says. “A deadly epidemic was being reinforced by a virus, or by a social phenomenon, or some combination.”

“We hope this will open the door for more complex models for interacting phenomena. It’s a platform to move beyond looking at contagions individually.”

A follow-up workshop on interacting contagions has been tentatively scheduled for November 2020, at SFI.

Language (cont. from page 2)
meaning embedded in theorrent of words flowing across the Internet.

“Although I don’t study language, I’ve always been interested in how language reflects our beliefs and values and on the other hand how we use language to shift the way we think,” Banaji said.

Originally scheduled to meet in Santa Fe, the working group, “Language as a Window into Human Minds: Explorations with Computer-readable and Reflective Languages and Natural Conversation” will be held online, April 23.

ACHIEVEMENTS

“The ergodocity problem in econometrics,” a perspective piece written by External Professor Ole Peters (London Mathematical Laboratory) received one of the highest Altmetric attention scores for 2019. The scores are calculated based on the number of mentions a paper receives in news outlets, social media, and blog posts.

As of April 2020, the paper’s Altmetric score is over 2000, making it the highest-scoring paper in the journal Nature Physics.

The contact network used in the authors’ simulations (left), alongside number of infected neighbors for simple biological contagions, complex social contagions, and interacting contagions (right). For full figure and caption, find us here.

DID ANIMALS RISE WITH OXYGEN?

Oxygen is essential for life—all animals need it for at least some part of their life cycle. But Earth was not always the oxygen-rich planet it is today. Determining how and when the world became oxygenated enough to support animal life has been a challenge in the field of geobiology. A study, which grew out of an SFI working group, published in the journal Geobiology by SFI External Professor Doug Erwin and colleagues, critiques six prominent arguments in the debate over the timing and role of oxygenation in the rise of animals and identifies key research questions that need to be answered.

THE SCIENCE OF STORIES

From ancient myths to modern novels, good stories capture our attention. Aristotle famously observed that a plot has a beginning, middle, and end—and what other patterns might be at play? In a new issue of PLOS One, one dedicated to the “science of stories,” SFI Professor Mirta Galesic and her fellow guest-editors, Peter Dodds (University of Vermont), Mohit lyer (UMass Amherst), and Matthew Jockers (Washington State University), collect examples of emerging computational approaches that could add a new dimension to narrative analysis. When compared to computational techniques, computational approaches can render “detailed, moment-by-moment analysis of semantic and emotional narratives, their internal dynamics, and their similarities and differences when compared to stories of other authors, cultures, and times.”

SYNTHETIC BIOLOGY FOR TERRAFORMATION

Saving endangered ecosystems like tropical forests and drylands—and the ecological services they provide—is one of the biggest challenges of modern times. As the loss of these systems accelerates, some scientists have proposed an unusual remedy: using synthetic biology to change ecological communities in ways that prevent their demise. But as SFI External Professor Ricardo Solé and six colleagues detail in the journal Nature, “ecological engineering” is rife with risks and presents a host of scientific and ethical challenges that need to be carefully considered. What would it take to successfully alter an environment—from the gut microbiome to the biosphere—to make it more hospitable to certain life forms?

THE THERMODYNAMICS OF COMPUTING WITH CIRCUITS

The circuits that make up the brain of a computer require a lot of energy to operate—so much so that running computers accounts for ~5 percent of U.S. energy consumption. And with demand for high-powered information technology and computing power increasing with the rapid technological advances that bring us ever-smarter cell phones, laptops, and other devices, there’s tremendous interest among manufacturers and scientists in developing more energy-efficient computer systems. A new paper by SFI Professor David Wolpert and Program Postdoctoral Fellow Artemy Kolchinsky in the New Journal of Physics describes one of the major problems that computer scientists will need to overcome to achieve that goal: how the topology of a circuit limits which parts of it can interact—with how those limitations affect the thermodynamic costs of operating the system.

IF CANCER WERE EASY, EVERY CELL WOULD DO IT

Instead of asking why we get cancer, Leonardo Oliva of Ohio State University and SFI Professor Michael Lachmann use signaling theory to explore how our bodies have evolved to keep us from getting more cancer. Their evolutionary model, published in Scientific Reports, reveals two factors in our cellular architecture that thwart cancer: the expense of manufacturing growth factors and the range of benefits delivered to cells nearby. Individual cancer cells are kept in check, when there’s a high energetic cost for creating growth factors that signal cell growth. To understand the evolutionary dynamics in the model, the authors emphasize the importance of thinking about the competition between a mutant cancerous cell and surrounding cells.

Two evolutionary spaces illustrate how a small change in environmental conditions with few immediate effects opens up a gradual path toward escape change (Figure: André de Roos).
What does a meteor sound like when it hits the atmosphere? Ask Thomas Ashcraft, who is SFI’s artist and citizen scientist in residence.

Ashcraft has been profiled in The New York Times for detecting and photographing “sprites,” fleeting, almost subliminal, luminous events that occur above super-strong lightning strikes.

At SFI, he has converted a tiny building into a mysteriously atmospheric wunderkammer (wonder room) called “Heliotown II.” The building, formerly a pool house, is now home to a series of tiny dioramas that attempt to expand space and time.

Ashcraft was a farmer in the Ozarks in the 1980s, but something called him to Santa Fe. Now he has a laboratory set up on his property near Santa Fe, where his radio observatory monitors the complex sounds that space dust makes colliding with the atmosphere, and a Jupiter observatory that operates in cooperation with NASA. A video camera runs 24/7, capturing meteor strikes and fireballs through an automated system that also records their sounds. A few years ago he became interested in what was going on at night around his house, so he started recording the nocturnal scene and was “surprised at how dynamic the night time was.” He put a couple of trail cameras up at the SFI Cowan Campus with a jackalope decoy within Heliotown II (Photo: Laura Egley Taylor); Diorama showing miniature Heliotown II (Photo: Laura Egley Taylor); Triple moon Jupiter observatory (Photo: Ashcraft); Wondrous display of the Theater’s Gum Ark within Heliotown II (Photo: Laura Egley Taylor); Juvenile coyote impresario jackalope decay (Photo: Ashcraft).