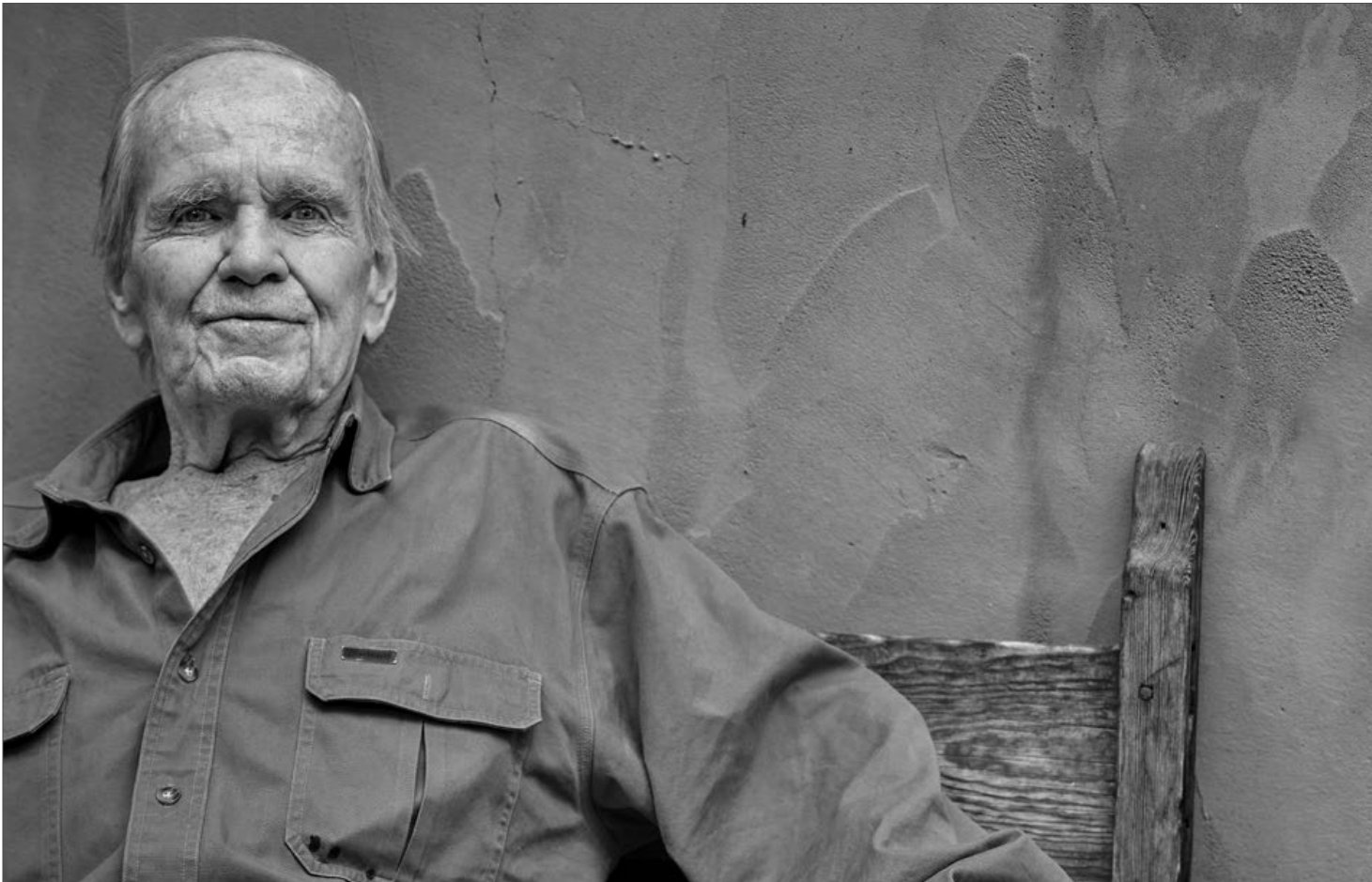




# Parallax

FALL 2022

THE NEWSLETTER OF THE SANTA FE INSTITUTE



Cormac McCarthy celebrating his 88th birthday at SFI's Miller Campus in July 2021 (Photo: Kate Joyce)

## Cormac and SFI: an abiding friendship

*In anticipation of Cormac McCarthy's newest books, "The Passenger" and "Stella Maris" (Knopf, 2022), former SFI Miller Scholar Laurence Gonzales recalls McCarthy's long and ongoing friendship with SFI.*

The novelist Cormac McCarthy has been a fixture around the Santa Fe Institute since its embryonic stages in the early 1980s. Cormac received a MacArthur Award in 1981 and met one of the members of the board of the MacArthur Foundation, Murray Gell-Mann, who had won the Nobel Prize in physics in 1969. Cormac and Murray discovered that they shared a keen interest in just about everything under the sun and became fast friends. When Murray helped to found the Santa Fe Institute in 1984, he brought Cormac along, knowing that everyone would benefit from this cross-disciplinary collaboration.

In Santa Fe, the pair would often visit at Murray's home and cook elaborate lunches and dinners, then share them with SFI researchers, including Geoffrey West, John H. Miller, and Eric Smith, and with filmmaker Celia Lowenstein. Together they would discuss everything from the pine tree shillings in Murray's coin collection to gravitational waves and the relative merits of fine wines. After Cormac moved from El Paso, Texas, to New Mexico, he became an SFI board trustee — a position he'll hold for life.

### **Early days of "The Passenger"**

In 2006, Cormac's novel "The Road" was published to great acclaim. The next year it won the Pulitzer Prize. Everyone in the literary world — not to mention at SFI — anticipated that the following year would bring the new novel that Cormac had talked about on

occasion. Cormac would happily regale you with stories for hours on end, but he was very tight-lipped about his own work; yet everyone at SFI knew that "The Passenger" was coming. In fact, they could often see him in his small office, working on the book with his pale blue Olivetti manual typewriter. The racket sometimes attracted visitors to his door, where they would peer in at this white-haired apparition hunched over the infernal machine, knocking out the words as if sparring in a boxing ring. But more years passed and no new novel appeared. Aware of his penchant for privacy, no one would ask. Cormac loved SFI because it was a cornucopia of fascinating ideas and intellectual stimulation, but it also offered quiet refuge and beloved anonymity.

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## Quantifying the risk of regime change

In 2008, as the world grappled with a financial crisis, SFI launched its first annual Risk meeting to examine how complexity science could illuminate the underpinnings of that global crisis. Fourteen years later, as we return to in-person meetings for the first time since the beginning of the COVID-19 pandemic, the world faces new and continuing upheavals, from climate change and biodiversity loss to exacerbated social polarization, from skyrocketing inflation to war in Ukraine. Our financial, supply, energy, belief, and political systems — to name a few — are undergoing regime shifts. None of these can be understood adequately in isolation; they are each part of complex coupled systems.

"It's undeniable that there has recently been a slate of changes to human society," says SFI VP for Applied Complexity Will Tracy. "Since our last in-person Risk meeting, we've gone from moderate-low interest rates to historically low rates, and now to experiencing skyrocketing inflation that we haven't seen since the '70s. Pathologies of discourse also exploded during the pandemic. More broadly, we've seen the spread of conspiracy theories and, perhaps most troublingly, a level of global destabilization not seen since the end of the Cold War."

On October 3, SFI researchers and members of ACTioN and SFI's Complexity Society met to explore these regime shifts from a complex-systems perspective. They focused on three large categories of change: trends, phase transitions, and cycles. Trends, the most intuitive type of system-level change, show consistent directionality over time and are relatively easy to predict. Phase transitions are fast, radical changes that happen on a global level. Cycles occur as regular fluctuations in a system.

The 2022 Risk Meeting was co-organized by Shannan Distinguished Professor and SFI Past President Geoffrey West and incoming Fractal Faculty member Niall Ferguson and co-hosted by Morgan Stanley. The planned schedule

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## Two micro-working groups build on collaborative research jams

Each spring and fall, the JSMF-SFI Postdocs in Complexity Conference brings early-career complexity researchers to Santa Fe for three days of collaboration, conversation, and professional development. Research jams — short meetings where fellows from a wide range of disciplines share their expertise to hash out interesting research questions — are among the highlights for many participants.

Sometimes, the research jams spark questions and collaborations that deserve further time and space. This October, in the week before the 9th JSMF-SFI Postdocs in Complexity Conference, two micro-working groups will meet to make progress on the

conversations they began last spring.

Rebekah Oomen, an evolutionary biologist at the University of Oslo, has been studying genetic information in a dataset on Atlantic cod in Norway. The research jams presented an opportunity for new questions about the data. In a population of fish, she says, "it's not often you could know who are the parents of which offspring. I realized this data had a lot of potential to address how the structure of sexual networks affects how populations grow and evolve." The research jams offered her the chance to collaborate with network scientists who could round out her own skill set to make meaningful progress on the question.

The research jam offered enough time to unearth interesting ideas, but not enough to make much progress. "Our time together was very short — only a few hours — and we just scratched the surface," says Oomen. "We had the question, we had the tools. If we could just sit down for a week together, we could make a lot of progress, and we'd have a lot of fun doing it." And so, October 11–18, the team will meet again for a micro working group titled "CodNet: How Do Individual Traits and Sexual Networks Shape Population Dynamics?"

Pedro Marquez-Zacarias, an incoming SFI Complexity Fellow, used the spring research jam to explore the space of possible genetics.

His group dove into questions about possible alternatives to the DNA- and RNA-based genetics we know on Earth. He says, "The topic seems simple on the surface — what are the possible genetics that could evolve?" But to really get at the question of whether evolution requires our kind of polymer-based genome, he needed perspectives from many disciplines. "It involves metabolism, which has a lot to do with bioenergetics, which is related directly to fitness and the growth of primitive cells. But that's not the whole story, of course. It's also very much about symbolics, and information theory," he says.

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# BEYOND BORDERS

## AGENTS AGAINST THE SYSTEM

Jean-Luc Godard 1930-2022  
Javier Marías 1951-2022

In the opening scene of Jean-Luc Godard’s absurd and irresistible science-fiction film “Alphaville,” the computer Alpha-60, an omniscient and omnipotent artificially intelligent overlord, declares, “Sometimes reality can be too complex to be conveyed by the spoken word. Legend remolds it into a form that can be spread across the world.” This so-called reality is human existence and the legend is technique and efficiency. Alphaville’s maxim is “Silence, Logic, Safety, Prudence” and Alpha-60 rules over it with intractable vacuum tubes.

“Alphaville” was made in 1965 in black and white. Travel between worlds is by dilapidated highway, if we are lucky, in a Citroën DS19. The most advanced prop in the film is a curvy jukebox. Everyone smokes. The hero, Lemmy Caution, is a squalid Philip Marlowe–type in a Peeping Tom trench coat. Caution is on a mission to abduct, or at least kill, Alpha-60’s architect, Professor von Braun — formerly known as Leonard Nosferatu. When Caution eventually meets Alpha-60, he is giving a lecture on what sounds like Gödel’s rotating universe: “Time is like a circle spinning innately.”

The Spanish writer Javier Marías was obsessed with espionage, spies, and secrecy. His characters are often misanthropic misfits, like Godard’s Lemmy Caution, who live vigorously in shadows. In a series of novels starting in 2002, Marías began a systematic analysis of those working within secret systems, those seeking assimilation, and the majority who are merely controlled. Marías’ father, the philosopher Julián Marías, sometimes described as the Spanish Bertrand Russell, was the author of numerous books, including the tantalizing “Metaphysical Anthropology: The Empirical Structure of Human Life.” In his book, Julián Marías described how a life is created in relation to networks of circumstances and experiences, a system of relations which through individuality achieves a “maximum condensation.” Javier Marías in his novels often seems to be exploring his father’s twin world, one where relationships are so concealed that individuals achieve a maximum of dispersal.

In one of Marías’ most recent books, “Berta Isla” (2017), a young spy in the making, Tomás Nevinson, is recruited by an inscrutable scholar, Sir Peter Wheeler. Wheeler describes spies as the ones who “are not exposed, who can’t be seen; unknown, opaque beings about whom almost no one knows anything . . . . Those who act swathed in mist . . . they are the ones who most disturb the universe.”

Godard and Marías were interested in systems and agents from both sides of the divide: citizen and instrument, and both sought to expose the risks of subjugating the individual will to the potentially obfuscating technologies of society. They were transmuting into art the concerns that Jacques Ellul surveyed in his 1954 book, “The Technological Society.” Ellul described technologies as all standardized means of obtaining results, or arriving at a perfect outcome, however questionable the result might be — in other words, our fascination with carelessly examined ends that bend values before efficiencies.

Ellul’s analysis of technology was building on Thorstein Veblen’s earlier interests in industry

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### CREDITS

EDITOR: Katherine Mast  
CONTRIBUTORS: Carrie Cowan, Anthony Eagan, Natalie Elliot, William Ferguson, Laurence Gonzales, Jenna Marshall, Stephen Ornes, Julie Rehmyer, Dinsa Sachan, and Aaron Sidder  
DESIGN & PRODUCTION: Laura Egley Taylor  
COPYEDITORS: Sienna Latham, Jenna Marshall  
VP FOR SCIENCE: Jennifer Dunne

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Parallax is published quarterly by the Santa Fe Institute. Please send comments or questions to Katherine Mast at [katie@santafe.edu](mailto:katie@santafe.edu).





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### SFI IN THE MEDIA

In mid-July, *The New York Times* cited a paper co-authored by **Eric Maskin** in a story about how software is stifling competition and slowing innovation.

**Jessika Trancik** spoke with *Marketplace* about Tesla’s plans to produce new fast chargers and adapters that expand their charging networks to other EV brands.

Also in *Marketplace*, **Melanie Mitchell** provided simple definitions of an algorithm and machine learning.

In an opinion for *Bloomberg*, **Niall Ferguson** made reference to several other SFI researchers as he explained why predicting the duration of a period of inflation is a complex-systems problem.

**Suresh Naidu** spoke with *Business Insider* about the real limits to the power that workers have, even

during the Great Resignation, unless they are accompanied by structural changes, too.

**David Krakauer** was interviewed by *Il Piccolo* on his workshop, “Quantitative Human Ecology,” held at the International Center for Theoretical Physics in Trieste.

**Matthew Jackson** spoke on Houston Public Media about the potential threat of a recession, and how we might prepare. *The New York Times*, the *Sydney Morning Herald*, CNBC, *Harvard Gazette*, and more featured research by Jackson, showing that friendships between the rich and the poor are key to reducing poverty. (See *Research Briefs*, page 6.)

Albuquerque’s KUNM spoke with **Kathy Powers** and **Sonia Gipson Rankin** about their new course at the University of New Mexico on algorithmic justice.

NPR highlighted **Orit Peleg’s** research on firefly synchronization.

**Josh Wolfe** spoke with *Fast Company* about small nuclear reactors as we move toward more green energy sources.

*Fast Company* says **SFI** exemplifies the kind of transdisciplinary work that is needed now more than ever before.

**Sam Scarpino** spoke with the *Boston Globe* about why wastewater testing could be useful for monitoring and responding to monekypox and other pathogens.

*Live Science* referenced work by **Andrew Dobson** in a feature exploring why the tropics have such impressive biodiversity.

Outlets including *AP News*, the *Santa Fe New Mexican*, *The Crime Report*, the *Albuquerque Journal*, and more featured **Cris Moore’s**

research suggesting that New Mexico’s proposed changes to pretrial detention won’t lead to reduced crime, as hoped.

**Jessika Trancik** spoke with WLRN on the complex realities and negative impacts of the mining requirements for electric vehicles.

In a Q&A with *Nautilus*, **Sean Carroll** discussed his latest book, “The Biggest Ideas in the Universe: Space, Time, and Motion,” and his approach to writing about physics.

In *Thompson Reuters Foundation News*, **W. Brian Arthur** discussed how positive tipping points could accelerate climate action.

*The New York Times* spoke with **Thalia Wheatley** about the importance of interaction and conversation when it comes to changing minds. 🌐

## Tom McCarthy named Miller Scholar

Novelist Tom McCarthy has been named a Miller Scholar at the Santa Fe Institute for 2022–2025. The Miller Scholarship is the most prestigious visiting position at SFI, awarded to highly accomplished, creative thinkers who make profound contributions to our understanding of society, science, and culture.

McCarthy is a globally acclaimed novelist and artist. His body of work has been recognized for its linguistic and artistic innovation. His books have been translated into more than twenty languages and adapted for cinema, theater, and radio. His 2015 novel, “Satin Island,” was short-listed for the Man Booker Prize and the Goldsmith Prize; his 2010 novel, “C,” was short-listed for the Man Booker Prize, the Walter Scott Prize, and the European Literature Prize. His 2005 debut novel, “Remainder,” received the 2007 Believer Book Award. In 2013 he was awarded the inaugural Windham-Campbell Literature Prize by Yale University.

His most recent novel is “The Making of Incarnation,” published in 2021. The title refers to the production of a new film called Incarnation, and the book’s protagonist, motion-capture technologist Mark Phocan, has been tasked with rendering our technologically infused lives in contexts medical, military, industrial, and cinematic — which is why he finds himself working on the eponymous movie’s production. Ultimately, Phocan’s work leads him to the legacy of time-and-motion pioneer Lillian Gilbreth, and delivers to readers a fascinating reflection on perpetual motion.

Miller Scholars are internally nominated and are free to devote their time at SFI to work of their choosing. They are encouraged to interact and collaborate with resident and visiting scientists,

Tom McCarthy (Photo: Kate Joyce)

with the goal of catalyzing and crystallizing ongoing research at SFI. SFI President David Krakauer writes, “Tom is one of those lyrically synthesizing minds that independently, and according to his own rule-system, discovers deep connections in the fabric of reality. As such he is an exemplary complexity thinker.”

In his novels, McCarthy takes up a striking number of themes that resonate deeply with SFI science, especially replication, gaming, and modeling. The interplay between art and science figure in McCarthy’s current thinking for a new novel, which may look at the ways that novelists and scientists model the world. It may be that the novel form is particularly well equipped to “model the modeler,” explains McCarthy, since

it has always been a “very hybrid form.”

SFI may also be an ideal place for artistic-scientific engagement of the sort that McCarthy celebrates. After his first visit to SFI this summer, McCarthy remarked that he was struck by the ways that SFI “operates as though C.P. Snow [that is, the cultural split between the arts and sciences] never happened.” At the same time, he notes, SFI simultaneously embraces the distinct kinds of work — and potential cross-fertilization — that can happen between novelists and scientists.

McCarthy will reside at the Institute part-time from 2022 to 2025, as the eleventh Miller Scholar since SFI Chair Emeritus Bill Miller conceived and underwrote the scholarship in 2010. 🌐

## Advancing science with machine learning

Computational scientists have long used math- and physics-based modeling and simulations to analyze big datasets and make predictions in a range of scientific areas. These models can work on large scales, such as to simulate the weather and climate, or to predict earthquake risk. They’re useful at small scales, too, to help identify potential new drugs that can do the most good with the fewest side effects, or predict how an infectious disease might affect an organism at the cellular level.

Machine learning has proven to be a powerful tool with a variety of applications. But complex areas like autonomous vehicle operation, rocket combustion, and monitoring the structural health of urban infrastructure increasingly demand predictions that go beyond the existing data, says External Professor Karen Willcox, a computational engineer at the University of Texas at Austin. These types of applications, says Willcox, need new methods that can make accurate and efficient predictions using sparse — or even changing — datasets.

“Computing power has increased, and we know that computing can play a major role in making critical societal decisions,” says Willcox. “So how do we think about moving beyond existing approaches to solve problems at scale in complex systems?”

Scientific machine learning offers a way forward.

Willcox and her colleagues will collect the insights from the workshop for a future issue of the journal *IEEE Computing in Science & Engineering*. She also hopes it will be the start of an ongoing conversation in a wider, interdisciplinary community that's focused on the future of computational models. 🍷

# Recap: Complexity-GAINs International Summer School

In human society, one of the great constants is change. Societies experience eras of innovation, integration, and cooperation, and others defined by polarization, fragmentation and collapse. How can we understand the dynamics of societies? And critically, how can we train the next generation of researchers to do so, with an eye toward preventing disintegration? This summer, 38 Ph.D. students from the U.S. and Europe gathered in Vienna, Austria, for SFI's first Complexity-GAINs international summer school to address these questions. Coming from a wide range of disciplinary backgrounds, students used the approaches of complexity science to consider how to better understand and prevent social

**Their work, and the final project reports, showed how working in diverse teams can lead to integration of theoretical ideas, formal modeling, and empirical investigations across traditional discipline boundaries.**

polarization and fragmentation. It's no small task; as SFI Professor and program co-director Mirta Galesic says, "We see the summer school as a small step towards a new way of doing social science, where core disciplines are still important, but where a new generation of scientists learn how to collaborate across boundaries to solve important issues facing societies today."

Reviving SFI's history of international schools, the two-week program\* was held in collaboration with the Complexity Science Hub Vienna. Faculty included researchers from SFI and four partner institutions in Germany, Austria, Italy, and the Netherlands (hence, GAINs) with expertise ranging from emotional dynamics to statistical physics.

SFI External Professor Henrik Olsson, another co-director, invited faculty and students to identify the most pressing issue in social science today, and identify what we need to understand in order to prevent disintegration. Answers ranged from addressing concerns about intelligent technologies and unintended consequences to spreading optimism and reaching disaffected members of society. Galesic emphasized the need for collective adaptation, and to uncover why society is stuck where it is and what we can do to nudge it toward a better state. "We need to understand the path dependencies that got us here and how we can get out," she says.

Discussions challenged the idea that polarization is necessarily bad. Several faculty cited evidence from collective decision-making that disagreement and dissent are beneficial in bringing to light a lack of information or confounding biases and arriving at good outcomes. SFI External Professor Han van der Maas



Students in this summer's Complexity-GAINs international summer school

(University of Amsterdam) pointed out that polarization around one topic is not necessarily bad, but that correlations across multiple issues can become dangerous.

Student projects echoed the theme of group decision-making and the value of diversity — both in the research questions they addressed as well as in the research process itself. "The students chose a wide range of topics for their projects, and the groups benefited greatly from their diverse experiences and skills," notes Olsson. "Their work, and the final project reports, showed how working in diverse teams can lead to integration of theoretical ideas, formal modeling, and empirical investigations across traditional disciplinary boundaries."

SFI Postdoctoral Fellow Tamara van der Does, who served as a teaching fellow for the program, observed, "Many students voiced that they felt isolated in their respective institutions — that no one there understood their cross-disciplinary work — and so they were especially happy to meet other like-minded researchers who would bounce off ideas without judgment." SFI External Professor Stefan Thurner (Medical University of Vienna; Complexity Science Hub Vienna), the program's third co-director, ended the summer school with an invitation to students: "We need to understand the collapse quicker than it is happening. Who can do this? It's us. It's great to know that you're all working on this and interested in these topics. Let's keep working together."

## Workshop to address long-standing debates in biological scaling

In 1932, biologist Max Kleiber observed that as organisms get bigger, their energy needs increase. But this relationship isn't linear: larger lifeforms use less than proportionally more energy. Known as Kleiber's law, this is one of the essential rules in biological scaling. Such relationships allow scientists to study how natural phenomena vary from small to large scales. In 2000, the Santa Fe Institute published "Scaling in Biology," a seminal book that crystallized the field's collective knowledge.

Since then, a lot has unfolded in this area of biology. "There have been some major theoretical advances that allow us to have more precise theories that predict a greater number of things in terms of scaling relationships," says SFI Professor Chris Kempes. "The field has expanded the scope from the original focus on mammals and vascular plants to everything from unicellular bacteria to viruses." In November, SFI External Professors Brian Enquist (University of Arizona), Mary O'Connor (University of British Columbia), and Kempes will organize a workshop called "Synthesizing Biological Scaling: Towards a Universal Theory" to take stock.

At the event, international experts on scaling will deliver talks and debate hot topics during breakout sessions. "The hope is that it will help resolve some long-standing conflicts in the field or help people understand how some of those conflicts were recently resolved," says Kempes.

For example, several presentations will address concerns around the network model, which states that evolution influences scaling relationships in the biological world. "Natural selection has maximized resource extraction and distribution within the body," Enquist

explains. Take the case of the vascular network. "There's a maximization of the network that it tries to supply the entire body, but at the same time, the network is also minimizing transportation times and the work involved in distributing the resources," says Enquist. However, he says, it's unclear if the hypothesis holds in unique organisms like bacteria that don't have well-defined transportation networks. The upcoming event is also crucial because SFI plans to publish a follow-up edition of "Scaling in Biology." "Everyone's coming to this meeting with an understanding that we are going to write a second book," says Kempes.

Speakers, who are all potential contributors, will summarize their chapters through the presentations. Enquist was one of the original book's contributors and a former Postdoctoral Fellow at SFI. "I never in my wildest dreams thought that I would be coming back to SFI a little over 20 years later to extend the scope — and assess the implications — of these same questions," he says. The field now includes questions about the role of temperature and climate in biological scaling, and researchers use scaling approaches to predict ecosystem functioning and the future of the biosphere in a changing climate. "These questions and challenges have brought whole new dimensions to the original scaling work developed at SFI," says Enquist.

The workshop and subsequent book will address how close the scientific community is to formulating a universal theory of biological scaling. "Universal theories are nice," says Kempes, "because they make the world simpler for us." For example, a universal theory of biological scaling would allow scientists to build simpler models of the biosphere, and that's important to address some of the pressing problems our planet faces. "Universal theories come with more predictive power, and we may need that for forecasting future ecology under climate change," says Kempes.



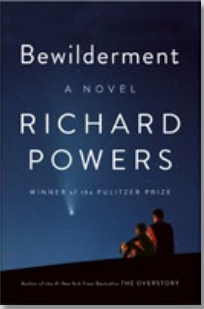
## What We're Reading

*Books chosen by SFI scholars on the theme of 'fidelity'*

When the Brothers Grimm were compiling their anthology of fairy tales, they fell into a theoretical dispute with their friend Achim von Arnim, who believed that transcribing oral folk stories was itself an act of poetry. He suggested that as intermediary writer-anthologists, the brothers necessarily distorted the originals. This was not a problem in von Arnim's eyes. To the contrary, he suggested that their efforts had produced a work of modern individual artistry bringing shape to, and necessarily transforming, the "natural poetry" of native folk communities. Jacob Grimm disagreed. As he wrote to von Arnim:

"In this case it is a matter of fidelity. A mathematical fidelity is completely impossible, nor is it to be found in even the most truthful and stringent history; but this does not matter, for we feel that fidelity is something real, not a sham, and this is why we can truly contrast it with infidelity. You cannot tell a story in an entirely adequate way, just as you cannot crack an egg without leaving some egg white sticking to the shell. This is how human life is, and also a matter of how the story is told, which is always changing . . . for me, true fidelity means not breaking the yolk."

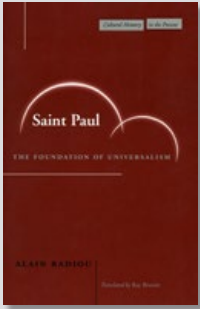
Our theme for this installment of What We're Reading is *fidelity*. Our recommenders have selected books that negotiate the difficulty at the heart of the dispute between the Grimms and von Arnim, the question of whether perfect fidelity is possible or even desirable.



**COLE MATHIS**  
SFI Visiting Program Postdoctoral Fellow  
***Bewilderment*, by Richard Powers**

*Bewilderment* is a story about how, and with whom, we empathize. Powers uses the relationship between an astrobiologist and his son to illustrate how our ability to understand others depends on

our ability to build models of others. But the fidelity of those models is never perfect, and much of the anxiety and beauty of life comes from the mismatch. This book left me wondering: if we cannot model the lives we share on Earth, how will we ever recognize life elsewhere?

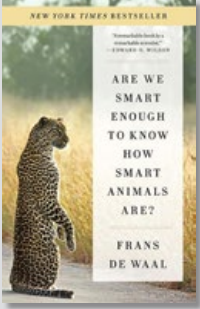


**TOM MCCARTHY**  
Novelist, SFI Miller Scholar  
***Saint Paul: The Foundation of Universalism*, by Alain Badiou**

For a leftist firebrand like Badiou to laud a Christian-institution builder may seem extremely counterintuitive — and it is. But Badiou, ever-fascinated by the revolutionary — and foundational — "event" that forms the bedrock of an intellectual, ethical, or (above all) political community, sees Paul as the ultimate expression of a mode of subjectivity that simply affirms, and proceeds on the basis not of logic but rather of fidelity — as he puts it elsewhere, "decides from the viewpoint of the undecidable."

**MELANIE MITCHELL**  
Davis Professor of Complexity, SFI Science Board Co-Chair

***Are We Smart Enough to Know How Smart Animals Are?*, by Frans de Waal**



This is an entertaining and eye-opening book about animal intelligence, with a profusion of examples from the ethological literature supporting de Waal's claims that primates, birds, fish, and other orders of animals possess complex cognitive abilities and a surprising degree of self-awareness and social intelligence.

The Night Shift

At the same 1981 MacArthur Foundation ceremony where Cormac had met Murray, he befriended another “genius grant” awardee, physicist George Zweig. George and Murray shared the distinction of having both discovered the subatomic particles that made up protons — Murray called them quarks; George called them aces; Murray’s name stuck. George and Cormac spent the following years discussing what George called the Night Shift — a sudden inspiration that solves a long-standing problem, often while one is falling asleep or waking up.

One day a few years ago, Cormac was sitting in the library at SFI with Laurence Gonzales, who was an SFI Miller Scholar from 2016 to 2020. Cormac said, commenting on the Night Shift, “Writing can be like taking dictation.” He’d been working on “The Passenger,” he said, since the 1970s. “I wrote four pages this morning,” he said. “I can still write.” He offered a wry smile. “But I haven’t been feeling well, and it’s hard to write when you’re not feeling well.”

Fierce Proclamations

He was in his mid-eighties then and seemed to be looking back on his entire career as he commented that he wrote “No Country for Old Men,” published in 2005, not so much as a novel but with the intention that it become a movie. It did become a movie, and it was successful both in profit and in praise. After premiering at Cannes, it won two Golden Globe Awards. It was then nominated for eight Academy Awards and won four, including Best Picture.

Cormac spoke of his 2001 novel “Blood Meridian,” saying that it was the only book for which he had done research. “And it was so hard, so hard,” he said, going from library to library, many at universities, and traveling through Mexico. “I’d rather dig ditches,” he said, than do all that research again.

Cormac has a penchant for fierce proclamations such as that. One beautiful day outside of SFI, he was heard to say, “I hate sunshine. Absolutely hate it. Perfect weather for me is fifty-five degrees and drizzling rain.”

On another day, SFI President David Krakauer’s assistant, Tim Taylor, came into the library to say that someone who was to have dinner



Cormac McCarthy and Murray Gell-Mann at SFI in August 2007 (Photo: SFI)

with Cormac had asked for his contact information. “I don’t have contact information,” Cormac said, as if Tim had suggested that he had fleas. To this day, he has no cell phone, no computer, and his phone number is not given out casually.

A Good Appetite for Great Feasts

Out of the blue in early 2022, his publisher, Alfred A. Knopf, made an announcement that made worldwide news and sent the publishing world in a dozen countries scrambling for the foreign rights: Cormac had not one but two new novels scheduled for release in the fall. One was “The Passenger,” which those at SFI had anticipated for so long. The other was called “Stella Maris,” which no one had ever heard of. The two were actually artistic approaches to the same story using different viewpoints and techniques, making two whole and complete — separate but related novels, like fraternal twins.

Cormac shared his writing with a few colleagues at SFI including his long-time friend, David Krakauer, who suggested that they might work on an experimental project together inspired by the books (this has been photographically documented in Laura Wilson’s new book of portraits, “The Writers”). In a 2015 event that SFI hosted at Santa Fe’s historic Lensic Performing Arts Center, people were granted a preview of parts of “The

Passenger” in an event directed by David Krakauer, with art by James Drake, music by Cormac’s son, John McCarthy, and performances by Caitlin McShea. The event made clear the Institute’s powerful influence on the novel. Throughout “The Passenger,” great themes of science and mathematics are played out with references to gravitons and S-matrix theory and the names of legendary physicists sprinkled around as if they were old pals. As indeed, a number of them were to Cormac and others at SFI. One of the main characters is a woman, a brilliant mathematician. Her brother is a physicist. One scene in “The Passenger” describes Murray delivering his paper on the Eightfold Way. George Zweig passes Richard Feynman in the hall, and Feynman is muttering to himself, “He’s right. The son of a bitch is right.”

In another scene, two friends are dining on fish in New Orleans. “They shared a bottle of Riesling,” Cormac wrote. “The German varieties tend to be a bit sweeter,” he said. “The French favor whites which can double as window cleaner.”

With this tantalizing preview, we can safely say that throughout the literary and scientific worlds, as within the Santa Fe Institute, people are awaiting the novels with what might be described as a good appetite for great feasts. Of which Murray and Cormac were very fond. 🍷

last spring. “Building bridges was the most interesting and exciting part of the meeting. Everyone was open to it, and open to thinking that we each have a small piece of the pie to understanding this complex world. We need to be comfortable with that, and with our own ignorance.”

Oomen, who recently completed her postdoctoral fellowship, has attended this conference six times. “These conferences have been a highlight of my postdoc. They are so fun and so inspiring. A lot of collaborations have come out of this, and more will come. A year, or many years later, I’ll remember I know someone with a particular skill set. I’ve got this awesome network to continue working with.”

And, these are lessons she’ll bring to her classroom as she opens her lab at the University of New Brunswick. “As a teacher, I’m looking forward to making sure whatever class it is, it gets a really interdisciplinary lens put on it so that students don’t feel like they’re stuck in a single field. I want students to have that open-mindedness.” 🍷

Fellow Katrin Schmelz (Konstanz University) discussing the importance of understanding how people respond to feeling controlled. The meeting also drew on expertise from beyond SFI researchers: Jessica Pisano (The New School for Social Research) weighing in on the politics of the Russian war in Ukraine, and

shrouded actors and threatening to converge on Godard’s algorithmic dictator.

Godard and Marías were two virtuosos who, in zany and subtle ways, increased awareness of the dangers of secrecy and the latent

“Coding the Past” workshop explores new database

A new online tool, the Database of Religious History (DRH), can help scholars of cultural evolution tackle tough questions in their field. It would particularly enable theorists to test their hypotheses against data, says Edward Slingerland, a professor of philosophy at the University of British Columbia and director of the DRH.

October 13–14, SFI External Professor Scott Ortman (University of Colorado Boulder) and Slingerland hosted a two-day workshop at the Santa Fe Institute to train a group of researchers to use the database.

As most of the research on religious traditions is niche and qualitative, “there’s no way to tell if the ideas of the scholars are wrong,” says Ortman. The database addresses this problem by implementing multiple vetting mechanisms. First, experts in the field create its entries — and their peers can disagree with the contributions through comments. All entries contain a poll — a set of questions and answers under various subheads, which allows users to delve deeper into a topic or investigate specific aspects of it. “You’re actually getting structured data about the historical record in a way that really doesn’t exist anywhere else,” says Slingerland.

The database, established in 2012 and recently funded by a major grant from the John Templeton Foundation, is still relatively new. “A lot of people don’t know about it,” says Slingerland. “We want to show people how it can be useful for them.” At “Coding the Past: The Challenges and Promise of Large-Scale Cultural Databases,” experts from disciplines such as anthropology, religious studies, history, and archaeology received first-hand experience using the database. They learned to craft entries, design polls, and perform advanced analyses. The organizers hoped the workshop’s stimulating atmosphere might kick-start a few collaborations. For example, archaeologists and anthropologists could join forces to gather data about places that the database doesn’t cover extensively.

The organizers also get feedback from the participants about the project. “A goal of the meeting was to have people pose questions they want to learn using a tool like this and see how well it currently captures the relevant data for those questions,” says Ortman. Slingerland is keen on finding how the polls are faring: “Are there questions missing that they would like to see there? Are some of the questions ambiguously worded in a way that makes it hard to understand?”

If adopted widely, the DRH could potentially revolutionize the field of religious history. “I hope people see how tools like the DRH allow you to zoom out and see big patterns across space and time, and how that can be a really useful tool,” says Slingerland. 🍷

Jonathan Haidt (New York University) speaking about the complex interplay of technology, social psychology, and belief.

“The meeting showcased the many ways complexity theory can help us understand and disentangle the different types of regime change we see in the world today,” says Tracy. 🍷

If adopted widely, the DRH could potentially revolutionize the field of religious history.

POSTDOCS (cont. from page 1)



The photos above are from the spring 2022 JSMF–SFI Postdocs in Complexity Conference at SFI’s Cowan campus. At left: Rebekah Oomen in discussion with her research jam group; at right: Pedro Marquez-Zacarias leads his research jam group. (photos: Katherine Mast)



His micro working group, “The Space of Possible Genetics: How does Life depend on the Architecture of Encoding Systems?” meets October 12–18. “There are many avenues we could pursue at this point,” says Marquez-Zacarias. “We’ll be honing it down into something we want to continue.”

Following the micro-working groups, the postdocs will gather again at SFI for training on public speaking, insights from former complexity

postdocs, advice on getting grants for transdisciplinary work, and, of course, more research jams.

At the Postdocs in Complexity Conference, “you know you’re going to be talking to people who have no idea about your field and vice versa. That sets the stage for really having to pay attention to people and understand the ideas they are bringing to the table,” says Marquez-Zacarias, who attended the conference for the first time

(Harvard University) speaking about climate change through a lens of multiple timescales, and Niall Ferguson (Stanford University) offering an international perspective of complexity and regime changes, Geoffrey West sharing lessons on the life cycles of cities, companies, and the planet, and incoming SFI Complexity

required, “a joint stock of knowledge and experience held in common by the peoples.” Neither Veblen nor Ellul could have anticipated the degree of system opacity threatened by modern computer software and machine learning. Today these systems are diverging from Wheeler’s

BEYOND BORDERS (cont. from page 2)

in his 1921 monograph, “The Engineers and the Price System.” Veblen foresaw an emerging mechanical world order with an inclusive organization of “interlocking processes and interchange of materials.” Veblen maintained that in such a world, entirely new forms of literacy would be

confidentialities of technologies — human and mechanical — and remind us of the role that art has always played in bringing complex, systemic ideas into aesthetic experience.

— David Krakauer  
President, Santa Fe Institute

# SFI welcomes 9 new and 1 returning External Faculty

**VIJAY BALASUBRAMANIAN**  
Cathy and Marc Lasry Professor, Department of Physics and Astronomy  
University of Pennsylvania

**FRANCE CÓRDOVA**  
President  
Science Philanthropy Alliance

**PETER DODDS**  
Professor, Department of Computer Science; Director, Vermont Complex Systems Center  
University of Vermont

**ALISON GOPNIK**  
Professor of the Graduate School – Psychology and Philosophy  
University of California, Berkeley

**ANDREA GRAHAM**  
Professor, Department of Ecology and Environmental Biology  
Co-Director, Program in Global Health  
Princeton University

**C. BRANDON OGBUNU**  
Assistant Professor, Department of Ecology and Evolutionary Biology  
Yale University

**ELEANOR POWER**  
Assistant Professor, Department of Methodology  
London School of Economics

**PAUL SMALDINO**  
Associate Professor, Cognitive and Information Sciences  
University of California, Merced

**HAN VAN DER MAAS**  
Professor & Head, Psychological Methods  
Distinguished Research Professor of Complex Systems in the Social and Behavioural Sciences  
University of Amsterdam

**WOODY POWELL, RETURNING**  
Jacks Family Professor, Graduate School of Education; Professor (by courtesy) of Sociology, Organizational Behavior, and Communication  
Stanford University



Vijay Balasubramanian



France Córdoba



Peter Dodds



Alison Gopnik



Andrea Graham



C. Brandon Ogbunu



Eleanor Power



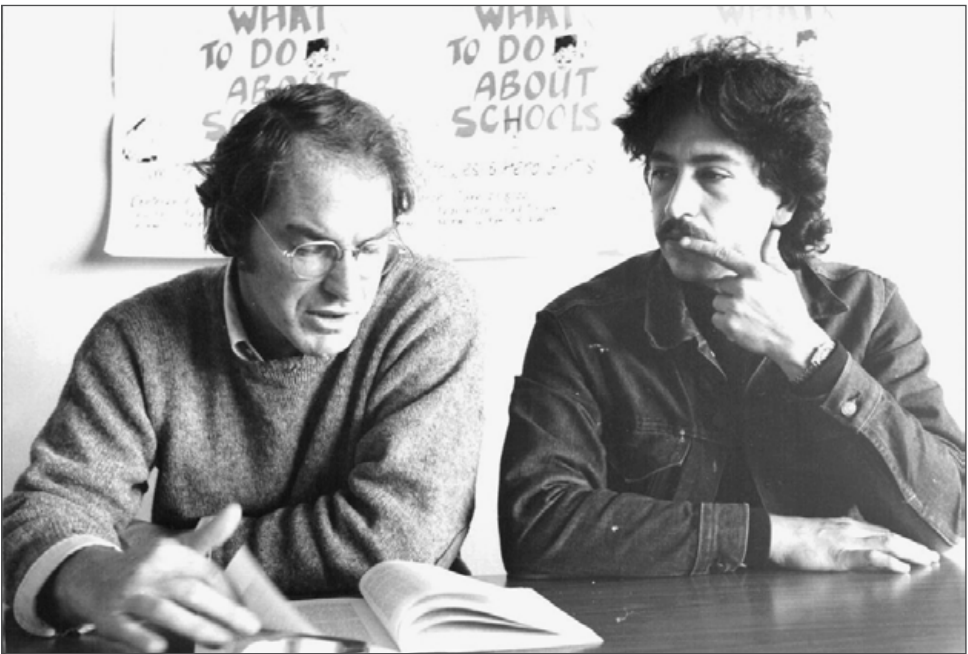
Paul Smaldino



Han van der Maas



Woody Powell



Sam Bowles and Herb Gintis, professors of economics at the University of Massachusetts, pictured during a press conference at the Teachers Federation Building in Sydney, Australia, during a two-day conference on the topic “what to do about schools in NSW,” June 21, 1976 (Photo: Peter John Moxham/Fairfax Media via Getty Images)

## Sam Bowles & Herb Gintis named Clarivate Citation Laureates

SFI Professor Sam Bowles and External Professor Herb Gintis have been selected as 2022 Citation Laureates by Clarivate “for providing evidence and models that broaden our understanding of economic behavior to include not only self-interest but also reciprocity, altruism, and other forms of social cooperation.”

Bowles and Gintis have collaborated since the late 1960s when they responded to a request from Dr. Martin Luther King, Jr., as he began to incorporate economic issues more deeply into his activism. They went on to publish not only in economics, but also in biology, psychology, anthropology, and archaeology. Most notably, their 1976 work “Schooling in Capitalist America: Educational Reform and the Contradictions of Economic Life” has been published in several languages and its English-language version cited more than 18,000 times.

Stepping outside the traditional bounds of economics, Bowles and Gintis have studied the ways that our environments and cultures, and especially how we make our living, have shaped our social values — questions that had typically

been left to psychologists and sociologists. In their 2012 book “A Cooperative Species: The Evolution of Human Reciprocity” they provide models and evidence from population genetics, archaeology, and anthropology, suggesting that our “better angels” — altruism and ethical motivations — may have a genetic basis.

“As far back as John Stuart Mill, economists have taken the amoral and self-interested *Homo economicus* as the model of an economic actor. But nobody – including Mill — believed that people are really like that,” says Bowles. “In recent years, behavioral experiments implemented across the world’s cultures and evolutionary game theory have added a new set of economic actors, exotically named *Homo altruisticus*, *Homo equalis*, and *Homo reciprocans*.”

Bowles and Gintis join 18 other 2022 Citation Laureates from four countries. According to Clarivate, the Laureate designation celebrates world-class researchers whose work is typically in the top 0.01% most-cited publications — demonstrating research influence comparable to Nobel Prize recipients.

## Archaeoecology: a fuller picture for past human–nature relationships

For decades now, archaeologists have wielded the tools of their trade to unearth clues about past peoples, while ecologists have sought to understand current ecosystems. But these well-established scientific disciplines tend to neglect the important question of how humans and nature have interacted and shaped each other across different places and through time. An emerging field called archaeoecology can fill that knowledge gap and offer insights into how to solve today’s sustainability challenges, but first it must be clearly defined. A new paper by SFI Complexity Fellow Stefani Crabtree and Jennifer Dunne, SFI’s Vice President for Science, lays out the first comprehensive definition of archaeoecology and calls for more research in this nascent but important field.

While an archaeology or palaeobiology study might examine a particular relationship, such as how humans in New Guinea raised cassowaries during the Late Pleistocene, archaeoecology takes a much broader view. “It’s about understanding the whole ecological context, rather than focusing on one or two species,” Dunne explains.

Crabtree hatched the idea for the paper in March 2020 after isolating in her father’s basement in Oregon as COVID spread across the U.S. She and Dunne, who had both worked on projects about the roles of humans in ancient food webs, realized



Hunting of a deer, wall painting, 6th millennium B.C. Museum of Anatolian Civilizations, Ankara. (Image: Wikimedia Commons)

### Archaeoecology examines the past ~60,000 years of interplay between humans and ecosystems.

that work didn’t fit readily in either archaeology or ecology. At the time, there was no notion in the scientific community of an area of research that deeply integrated those two disciplines. Crabtree, an archaeologist, and Dunne, an ecologist, saw an opportunity to define archaeoecology, including the role it can play

in addressing the myriad challenges of the Anthropocene.

Archaeoecology, they explain in the paper, examines the past ~60,000 years of interplay between humans and ecosystems. It aims to show not only how humans impact nature, but also how the ecosystems they live within shape human culture and dynamics. To achieve this, archaeoecology weaves together data, questions, strategies, and modeling tools from archaeology, ecology, and palaeoecology.

“What it’s doing is breaking down a traditional, but unnecessary, disciplinary separation between archaeology and ecology,” Dunne says.

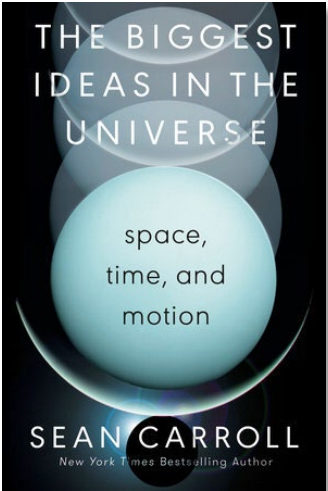
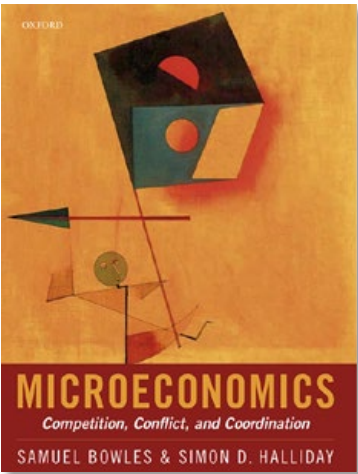
Crabtree hopes the paper will encourage more scientists to pursue research in the emerging field. And with humanity facing the twin crises of climate change and biodiversity loss, archaeoecology could yield crucial insights that help us navigate our present-day environmental challenges, she says. For instance, as climate change causes Utah’s Great Salt Lake to dry up, we don’t know exactly how this will impact the larger ecosystem. However, we can look to the past for warnings about what might be in store: Through an archaeoecological lens of the Aral Sea during the height of the Silk Road, we can see more clearly how the Soviet Union’s 1960s water diversion project and the subsequent desiccation of the sea impacted the surrounding ecosystems and human communities. Similarly, archaeologists have documented the stabilizing role that Martu Aboriginal People had on Australia’s Western Desert and the massive biodiversity loss that resulted when the people were removed from the land.

“Every ecosystem on the planet is impacted by humans in one way or another,” Crabtree says. “It’s naïve to look at just the last 100 years, because people have been impacting ecosystems everywhere for many thousands of years. We need to understand the past to understand our present and future. Archaeoecology helps with that. We can learn from these experiments with sustainability in the past.”

# New books by SFI Authors

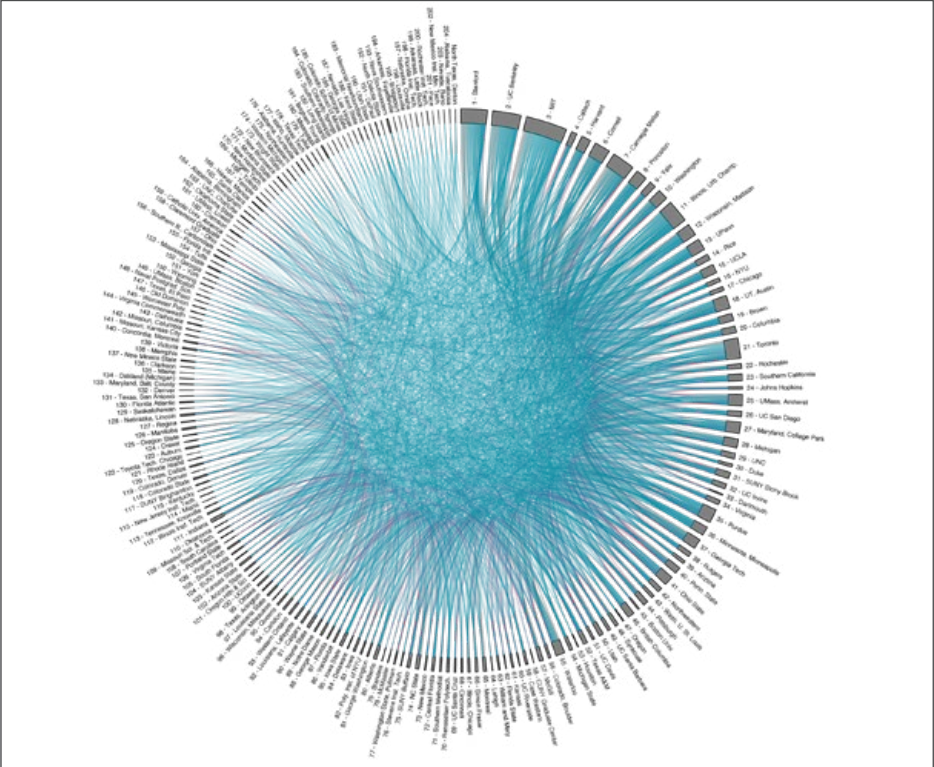
“**Microeconomics: Competition, Conflict, and Coordination**” (Oxford University Press, 2022), a new textbook by SFI Professor Samuel Bowles and Simon Halliday of the University of Bristol, upends the conventional content of economics texts and presents a new, more engaging way of teaching the subject.

According to a poll by the CORE Project, inequality, climate change, sustainability, and poverty are among the topics of greatest concern for today’s students of economics. Most economic textbooks, however, take up these topics only in their later chapters, if at all. This new book, available as an interactive ebook, free PDF, and traditional hardcover, provides an example of how economics might look if climate change and economic injustice appeared at the start of textbooks rather than at the end.



“**The Biggest Ideas in the Universe Vol. 1: Space, Time, and Motion**” (Dutton, 2022), by SFI Fractal Faculty member Sean Carroll (Johns Hopkins University) walks the difficult line between popular-science approaches to explaining physics and an expert-level deep dive into the subject. Rather than rely on metaphors and comparisons to paint verbal pictures of the discoveries about our universe, he invites readers with as little math training as high school algebra into the language and equations used by professional physicists. Carroll’s book explores the domains of classical physics, first establishing methods to strip away complications to reveal the essence of a system, then adding calculus to consider rates of change and the accumulation of matter, before culminating with a dive into black holes. 🌌

## RESEARCH NEWS BRIEFS



An interactive data visualization tool developed by Hunter Wapman and Dan Larremore, a supplement to “Quantifying hierarchy and dynamics in US faculty hiring and retention,” published in *Nature*, shows how faculty move from their doctoral university into faculty jobs.

### TWO STUDIES QUANTIFY BIAS IN US HIGHER ED

Two recent papers by CU Boulder and SFI co-authors explore the socioeconomic makeup and the educational backgrounds of tenure-track faculty across the U.S.

The first study, published in *Nature Human Behavior* in August, showed that academic faculty are 25 times more likely to have a parent with a doctorate degree. Moreover, researchers Allison Morgan (CU Boulder), Nicholas LaBerge (CU Boulder), former Complexity Postdoctoral Fellow Daniel Larremore (CU Boulder), SFI Professor Mirta Galesic, Jennie Brand (UCLA), and SFI External Professor Aaron Clauset (CU Boulder) found that the rate nearly doubles at prestigious universities, and has held more or less constant for the past 50 years.

A related study, published in *Nature* in September, is the most thorough analysis to date of the faculty structure in U.S. education. Co-authors Hunter Wapman (CU Boulder), Sam Zhang (CU Boulder), Clauset, and Larremore analyzed 300,000 tenure-track faculty employed in the years 2011–2020 at 368 Ph.D.-granting institutions. They found that just 20% of U.S. universities produced 80% of tenure-track faculty across the country. Among this 20% minority, the top five producing schools trained more tenured U.S. faculty than all universities outside the U.S. combined.

The researchers note that a biased system makes it much harder for good ideas to spread from less prominent institutions, and from socioeconomic and demographic groups that are under-represented amongst university faculty.

Read the study: “Socioeconomic roots of academic faculty,” at [doi.org/10.1038/s41562-022-01425-4](https://doi.org/10.1038/s41562-022-01425-4)  
Read the study, “Quantifying hierarchy and dynamics in US faculty hiring and retention,” at [doi.org/10.1038/s41586-022-05222-x](https://doi.org/10.1038/s41586-022-05222-x)

### A MASSIVE NEW DATASET FOR UNDERSTANDING ART

We’ve all seen art made from data, but what about data from art? In a feature paper in *Entropy*, Bhargav Srinivasa Desikan (École Polytechnique Fédérale de Lausanne), Hajime Shima (McGill University, former SFI Postdoctoral Fellow), and SFI Complexity Postdoctoral Fellow Helena Miton released a novel dataset for indexing, searching, retrieving, organizing, and analyzing 68,094 works of art by more than 1600 historically significant artists. Using state-of-the-art machine learning, the authors were able to extract both style representations and color distributions, which can be used to query stylistic periods for an artist or a movement (eg. Picasso’s “blue” phase). Their dataset, WikiArtVectors, aims to make computational data approaches available to art historians and cultural analysts, to help discover and understand patterns of cultural evolution.

Read the study at [doi.org/10.3390/e24091175](https://doi.org/10.3390/e24091175)

### WHEN CHILDHOOD FRIENDSHIPS SHAPE FUTURE EARNINGS

Friendships in childhood influence incomes in adulthood, and may play an important role in stimulating economic mobility. In new research published across two papers in *Nature*, SFI External Professor Matthew Jackson (Stanford), Raj Chetty (Harvard), Theresa Kuchler (NYU), Johannes Stroebel (NYU), and their collaborators analyzed a large sample of Facebook data on more than 70 million U.S. adults ranging from 25 to 44 years old. The researchers measured the strength of the individuals’ social networks and communities, and showed that a particular measure of how connected poorer people are to wealthier people predicts how likely they are to move up the economic ladder over time. Those with lower-income parents, who grew up in counties with a high level of connection between rich and poor, earned 20 percent more, on average, than those with fewer early relationships with wealthy friends.

In the second paper, the researchers delved into how these connections form. They found that institutions such as schools and churches play a major role in facilitating friendships across socioeconomic gaps.

Read the study, “Social capital I: measurement and associations with economic mobility,” at [doi.org/10.1038/s41586-022-04996-4](https://doi.org/10.1038/s41586-022-04996-4)  
Read the companion study, “Social capital II: determinants of economic connectedness,” at [doi.org/10.1038/s41586-022-04997-3](https://doi.org/10.1038/s41586-022-04997-3)

### THE FRUGAL CASE FOR ENERGY TRANSITION

If you think clean energy is expensive, try fossil fuels. A new report co-authored by Rupert Way, SFI External Professor Doyme Farmer, and their Oxford University colleagues shows that a rapid transition to renewable energy sources by 2050 could save the global economy trillions of dollars compared to both a gradual transition and to no transition at all. The report, published in *Joule*, models the probable future prices of both fossil fuels and renewables such as wind and solar based on empirical price data from the past. Crucially, the authors account for the falling costs of renewables that have been observed in recent decades, as these technologies have become more advanced and widespread. Even before considering the massive costs of climate change itself, they find that the sooner we transition to clean energy, the more we stand to save.

Read the study at [doi.org/10.1016/j.joule.2022.08.009](https://doi.org/10.1016/j.joule.2022.08.009)

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Parallax

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1399 Hyde Park Road

Santa Fe, New Mexico 87501

505.984.8800

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