A Message from SFI Vice President for Science

Hello from the intellectual monastery on the mountain! It feels a bit like that these days since we are open with indoor masking, so our researchers are back together (and our staff), we are hosting a handful of visitors at any given time, and we are having in-person seminars again. But it is generally more quiet and contemplative than in pre-pandemic times. We had hoped to host several in-person or hybrid meetings this fall, but only one squeaked by in August before we had to call off those meetings through the end of the year, except for very small micro working groups, due to the rise of the variant. The rest have been rescheduled for 2022. Our new improved IT equipment in the large Noyce conference room has dramatically improved the online experience of talks, and will be deployed in other meeting rooms as hybrid talks and meetings and conferences are the future of academia everywhere.

Since they weren’t mentioned in the last Matrix, there were a couple of other events in September to recount here. The annual Science Board Symposium and Business meeting occurred virtually on Sept. 10-11, delayed by a few months from its usual April or May dates. The focus was on “Intelligence: From the Individual to the Collective.” It started with a celebration of “The Intelligence of Murray Gell-Mann,” and continued with excellent talks by Linda Smith (Indiana U), Radhika Nagpal (Harvard), and Tom Mitchell (CMU, SFI), accompanied by lots of lively discussion. Sept. 15-17, there was a Complex Time hybrid working group hosted by David Krakauer on “Toward a Multiscale Theory of Birth and Death Pattern II.” Caitlin McShea is the new program manager for the JSMF funded Complex Time program and is who you should contact about any Time-related meetings.

The rest of the year is pretty quiet, as people had to move planned in-person meetings to 2022. Stefani Crabtree (Utah State U, ASU-SFI) and I are hosting a micro working group next week, Oct. 18-20, on “Resilience of French Polynesia Islands over a Millennium of Human Interactions with Biodiversity.” Our little 5-person meeting has the distinction of being the first meeting in March 2020 to get postponed due to pandemic. On Nov. 8-10, David Wolpert is hosting an NSF-funded virtual workshop on “The Future of Thermodynamics of Computation.” The annual ACtioN Symposium will occur, virtually, Nov. 5-6. Its topic is “Emergent Engineering.” If you are interested in attending that, please contact Casey Cox, the Director of the Applied Complexity Network.

Our External Faculty profile this edition is of Dan Stein, Professor of Physics and Mathematics, New York University, who has been involved with SFI from its pre-beginning. He was the first director of the Complex Systems Summer School in 1988 and co-directed it for most of its first decade. Thank you Dan! He’s played many other roles at SFI and continues to be very actively involved. Dan is here for the month of October collaborating with Mirtha Galesic and others on work at the intersections of physics and social sciences. He has also recently been in the news as a commentator on the award of half of the 2022 Physics Nobel Prize to Giorgio Parisi for his work on spin glasses, and applications to various problems beyond physics. Dan will be giving an informal seminar on Weds. Oct. 20 about this titled “Complexity Science and the 2021 Nobel Prize in Physics.”

Cheers,
Jennifer Dunne
Vice President for Science

Updates and trends

Reminder: New NSF Proposal and Grant Guidelines:
The National Science Foundation has released NSF 22-1, a new version of the Proposal & Award Policies & Procedures Guide (PAPPG) for proposals submitted on or
after October 4, 2021. Significant changes and additions to the Guidelines include:

I. The NSF has added a new category of proposal mechanism for Planning Grants. In the past, Planning Grants have been funded primarily as components of specific programs. This new mechanism permits planning grants for any new research area. Planning proposals may be used to support initial conceptualization, planning and collaboration activities that aim to formulate new and sound plans for large-scale projects in emerging research areas. PIs must contact the NSF program officer(s) whose expertise is most germane to the proposal topic prior to submission of a planning proposal. Project Descriptions for planning grants must be no more than eight pages. Only internal merit review is required for planning proposals; in some instances, Program Officers may elect to obtain external reviews to inform their decision. Requests may be for up to $100,000 per year (including indirect costs) and for up to two years in duration. The award size, however, will be consistent with the scope of the proposed planning activities and of a size comparable to planning grants in similar areas. Interested PIs at the Santa Fe Institute are strongly encouraged to contact the SFI Sponsored Research Office for more information about this new mechanism.

II. A table entitled, NSF Pre-award and Post-award Disclosures Relating to the Biographical Sketch and Current and Pending Support. This new required table identifies where pre- and post-award current and pending support disclosure information must be provided.

III. An increase in the page limit for the biographical sketch from two to three pages. Note that the basic format for the biosketch has not changed, nor will NSF be allowing more listed publications or synergistic activities than permitted in the past; rather, the increase in page length is apparently a recognition that more space may be needed to include all appointments and complete publication citations.

IV. Updates to the current and pending support section of NSF proposals to require that information on objectives and overlap with other projects be provided to help NSF and reviewers assess overlap/duplication.

V. For any NSF proposal including travel or workshops, the applicant organization’s Authorized Organizational Representatives (AORs; Susan Carter and Lori Kam at SFI) will be required to certify that prior to the proposer’s participation in the meeting for which travel support is being requested, the proposer will assure that the meeting organizer has a written policy or code-of-conduct addressing harassment.

Please check with the Sponsored Research office for assistance or if you have questions about these new provisions applicable to NSF proposals and awards. We recommend that you seek assistance early in the proposal process (at least one month prior to submission) to assure compliance with the revised Guidelines.

**Funding and people**

**Recent Proposals**

Melanie Mitchell, NSF, EAGER: Developing data and evaluation methods to assess the generality and robustness of AI systems for abstraction and analogy-making. $199,661 over 18 months.

David Wolpert, NSF, The future of thermodynamics of computation. $49,991 for one year.

Jennifer Dunne, NERC/NSF, Community and structural collapse during Mass Extinctions (CASCaDE). $41,917 over three years.


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Chris Kempes, Vicky Yang, Sidney Redner, and Geoffrey West, NSF, URoL:EN Emergence of regulatory network. $1,429,798 over four years.

Vicky Yang, NSF, Understanding the effect of individual decision-making strategies on collective decision outcomes. $476,231 over three years.

**EXTERNAL FACULTY PROFILE**

Daniel Stein, Professor of Physics and Mathematics, New York University.

1) How did you first get involved with SFI?

I was intrigued with the idea of
a complex systems institute since 1984, when SFI was still more of an idea and a hope than an institution with a physical home. In October of that year Phil Anderson, under whom I had recently obtained my Ph.D., attended what became a sort of founding conference that brought together physicists, biologists, economists, psychologists, and leading scholars from a variety of other disciplines. The proceedings were published in a volume called *Emerging Syntheses in Science*, edited by David Pines, which provided something of an intellectual charter for a new kind of institute doing a new kind of science. Phil’s enthusiasm was contagious and given my research inclinations at the time, I knew it was only a matter of time before I got involved myself.

That happened sooner than I anticipated. Something like a year and a half later, Mike Simmons, who was soon to become Vice-President of SFI, and Pete Carruthers, also heavily involved, asked me to direct a new kind of summer school focusing on complex systems science. At the time no one knew exactly what that meant, what topics should be included, who would (or should) come, where it would be housed (SFI was then located in a small former convent on Canyon Rd., so that was out), and (biggest headache of all), how it would be paid for. Those were exciting times (especially as measured by the number of sleepless nights).

But somehow it all came together, and the first Santa Fe Summer School on Complex Systems was held in May-June 1988 at St. John’s College in Santa Fe. Over a hundred student, postdoc, and faculty participants attended, and its success convinced us of the existence of a large unmet demand. Erica Jen directed it the following year, and after that I co-directed the Summer School with Lynn Nadel through 1998. I’m happy that the Summer School is still going strong to this day, but what brings me the most pleasure is seeing how many people who later became heavily involved with SFI had their first contact with it through attending the Summer School.

2) What does SFI mean to you?

The nonstop intellectual excitement and stimulation is a given. But most of all it means being part of a worldwide community of scholars in multiple disciplines, many of which have led to lasting friendships. It’s a great privilege to have the opportunity to exchange ideas and learn firsthand about the research of people working in areas far from my own. (And it doesn’t hurt that it’s located in Santa Fe.)

3) How have you been involved with SFI recently? What are you working on now?

During the past decade I’ve co-chaired the Science Board (2013-2016) with Mimi Koehl; joined the External Faculty in 2018; spent two months of a sabbatical in 2015 at SFI and will again be at SFI in October 2021 as part of another sabbatical; and have attended more workshops, conferences, and working groups at SFI than I can recall.

4) What are you working on now?

Much of my current research is in disciplinary areas that I would not consider complex systems research. But a substantial part still focuses on topics of interest to SFI, including mathematical work on predictability and “nature vs. nurture” in discrete spin systems far from equilibrium; universality in protein copy number in unicellular organisms, and mechanisms of size control in E. coli; and especially work on belief spread in social systems, in collaboration with Mirta Galesic and others at SFI.

Opportunities

Please contact Susan Carter, SFI Research Development Director, at scarter@santafe.edu or Lori Kam at ljkam@santafe.edu, Sponsored Research Administrator for more information or assistance with these opportunities.

FEDERAL AGENCIES

National Science Foundation

**Human Networks and Data Science (HNDS); NSF 22-505**

The Human Networks and Data Science program (HNDS) supports research that enhances understanding of human behavior by leveraging data and network science research across a broad range of topics. HNDS research will identify ways in which dynamic, distributed, and heterogeneous data can provide novel answers to fundamental questions about individual and group behavior. HNDS is especially interested in proposals that provide data-rich insights about human networks to support improved health, prosperity, and security. HNDS has two tracks: Human Networks and Data Science – Infrastructure (HNDS-I), and Human Networks and Data Science – Core Research (HNDS-R). The new Solicitation permits direct applications to the Core Research program.

**Deadlines:** January 13, 2022 for direct submissions to HNDS-R; February 3, 2022 for HNDS-I proposals.

**Macrosystems Biology and NEON-Enabled Science (MSB-NES); Research on Biological Systems at Regional to Continental Scales; NSF 22-504**

The Macrosystems Biology and NEON-Enabled Science (MSB-NES) program will support quantitative, interdisciplinary, systems-oriented research on biosphere processes and their complex interactions with climate.
land use, and changes in species distribution at regional to continental scales as well as training activities to broaden participation of researchers in Macrosystems Biology and NEON-Enabled Science. MSB-NESS projects that use data and/or resources from the National Ecological Observatory Network (NEON) are encouraged. Substantive NEON-enabled projects rely on data and/or samples collected by NEON and/or co-locate research activities at NEON sites. Projects may develop tools that will explicitly enhance the processing, use, and/or analysis of NEON data or collections, in the context of addressing a specific research question or hypothesis. This Solicitation will fund two types of projects: Macrosystems Research Awards (MRA) to advance Macrosystems Biology research broadly, including substantively NEON-enabled research, and innovative training to conduct this research, as well as Macrosystems Small Awards (MSA) employing targeted approaches to advance understanding of regional to continental-scale processes, addressing a theoretical challenge such as scaling or teleconnections, or for the development or advancement of novel approaches to processing, use and/or analysis of NEON data or collections within the context of Macrosystems Biology research questions.

**Deadlines:** January 10, 2022 and November 14, 2022.

**Dear Colleague Letter: Enabling Secure and Trustworthy Cyberspace (SaTC) CISE-SBE Interdisciplinary Collaborations; NSF 21-122**

NSF is encouraging the submission of collaborative Early-Concept Grants for Exploratory Research (EAGER) proposals that will foster novel interdisciplinary research on the fundamentals of security, privacy, and trustworthy cyberspace that will lead to new knowledge and approaches to design, build, and operate cyber systems, protect persons, organizations, and existing infrastructure, and motivate and educate individuals about cybersecurity and privacy. The research would include one or more Computer and Information Science and Engineering (CISE) researchers and one or more Social, Behavioral, and Economic Sciences (SBE) researchers. NSF anticipates funding up to 10 EAGER awards pursuant to this DCL.

**Submissions are by invitation only.** Prior to submitting a proposal, teams are required to send an email to the email listed at the end of the DCL with a description of the project concept, following the instructions in the letter. The team will be notified as to whether the proposal is invited to submit.

**Deadline: December 10, 2021 (For invited proposals).**

**Research on the Science and Technology Enterprise: Indicators, Statistics, and Methods (NCSES S&T); NSF 21-627**

The NSF National Center for Science and Engineering Statistics (NCSES) is encouraging the research community to conduct research on the S&T enterprise, develop improved survey methodologies that could benefit NCSES surveys, explore alternate data sources that could supplement NCSES data, create and improve indicators of S&T activities and resources, strengthen methodologies to analyze S&T statistical data, and explore innovative ways to communicate S&T statistics. To that end, NCSES invites proposals for individual or multi-investigator research projects, doctoral dissertation improvement awards, conferences, experimental research, survey research and data collection, and dissemination projects.

Areas of interest include but are not limited to: (A.) Improving analytical techniques to produce better indicators of issues related to: education and retention of scientists and engineers; the demand, supply, career pathways, and/or characteristics of science and engineering personnel; outcomes and impacts R&D expenditures in various sectors, countries, and fields; estimates of current and near-term future S&T resources, and measures of U.S. competitiveness in S&T. (B.) Developing new and/or improved methods of measuring the inputs, outputs, interactions, and social or economic impacts of S&T activities. (C.) Developing new data, analyses, and/or indicators of the globalization of science, engineering, and technology, as well as analyses leading to a better understanding of the changing global economy. (D.) Improving data collection methodologies for S&T surveys and censuses. (E.) Improving analysis and data processing methodologies for NCSES data by researching topics such as imputation techniques, privacy protections, or data consistency. (F.) Pursuing innovations in the dissemination of S&T statistics to encourage communication of information in a timely and user-friendly fashion. |

**Deadline: January 18, 2022.**

**Integrative Research in Biology (IntBIO); NSF 21-622**

The Integrative Research in Biology program replaces the Rules of Life track in the Directorate for Biological Sciences. The solicitation invites collaborative proposals that tackle bold questions in biology and require an integrated approach to make substantive progress. The research should be synergistic and produce novel, holistic understanding of how biological systems function and interact across different scales of organization, e.g., from molecules to cells, tissues to organisms, species to ecosystems and the entire Earth.

Research teams should be fully engaged in the training and education of the next generation of scientists who will be future leaders in integrative research and who can navigate across subdisciplines and engage in integrative thinking.

**Deadline: January 25, 2022.**

**Computer and Information Science and Engineering (CISE): Core Programs; NSF 21-616**

The NSF CISE Directorate supports research and education projects that develop new knowledge in all aspects of computing, communications, and information science and engineering, as well as advanced cyberinfrastructure, through its core programs. Proposals are invited in several project classes, as follows: Small Projects—up to $600,000
operate over long return intervals. Researchers who are external forcing functions such as climatic cycles that turn over at intermediate to longer time scales; and processes; pools of materials such as nutrients in soils times; feedbacks between ecological and evolutionary organisms that have extended life spans and long turnover time and space; population or community dynamics for the effects of interspecific interactions that vary over processes on populations, communities, or ecosystems; the effects of natural selection or other evolutionary science. Research areas include, but are not limited to, questions in evolutionary biology, ecology, and ecosystem of extended time series of data to address important Deadline: January 20, 2022.

**Broadening Participation in Computing (BPC); NSF 21-571**
The Broadening Participation in Computing program (BPC) aims to significantly increase the number of U.S. citizens and permanent residents receiving post-secondary degrees in the computing disciplines, and to encourage participation of other underrepresented groups in the discipline. With this solicitation, the BPC program seeks to engage the computing community to develop and implement innovative methods, frameworks, and strategies to improve recruitment and retention of these students through undergraduate and graduate degrees. Projects that target stages of the academic pipeline through faculty ranks are encouraged. All BPC projects must have the potential for widespread, national impact; they should either develop an effective practice that could be widely deployed or deploy existing effective practices to reach larger audiences. The BPC program will support three categories of awards: Alliances, Demonstration Projects, and Supplements. **Deadline: January 20, 2022.**

**Long Term Research in Environmental Biology (LTREB); NSF 21-544**
The Long Term Research in Environmental Biology (LTREB) Program supports the generation of extended time series of data to address important questions in evolutionary biology, ecology, and ecosystem science. Research areas include, but are not limited to, the effects of natural selection or other evolutionary processes on populations, communities, or ecosystems; the effects of interspecific interactions that vary over time and space; population or community dynamics for organisms that have extended life spans and long turnover times; feedbacks between ecological and evolutionary processes; pools of materials such as nutrients in soils that turn over at intermediate to longer time scales; and external forcing functions such as climatic cycles that operate over long return intervals. Researchers who are uncertain about the suitability of their project for the LTREB Program are encouraged to contact the cognizant Program Officer. The Program intends to support decadal projects. Funding for an initial, 5-year period requires submission of a proposal that includes a 15-page project description containing two essential components: a decadal research plan and a description of core data. **Deadline: Proposals accepted anytime.**

**National Institutes of Health/National Science Foundation**

**Smart Health and Biomedical Research in the Era of Artificial Intelligence and Advanced Data Science; NSF 21-530**
The purpose of this interagency program solicitation is to support the development of transformative high-risk, high-reward advances in computer and information science, engineering, mathematics, statistics, behavioral and/or cognitive research to address pressing questions in the biomedical and public health communities. Transformations hinge on scientific and engineering innovations by interdisciplinary teams that develop novel methods to intuitively and intelligently collect, sense, connect, analyze and interpret data from individuals, devices and systems to enable discovery and optimize health. Solutions to these complex biomedical or public health problems demand the formation of interdisciplinary teams that are ready to address these issues, while advancing fundamental science and engineering. **Deadlines: November 10, 2021 and November 10, 2022.**

**NATIONAL SCIENCE FOUNDATION AND INTEL CORPORATION**

**Principles and Practice of Scalable Systems (PPoSS); NSF 22-507**
The aim of the Principles and Practice of Scalable Systems (PPoSS) program is to support a community of researchers who will work symbiotically across the multiple disciplines of computer architecture, high-performance computing (HPC), machine programming, programming languages and compilers, security and privacy, systems, and theory and algorithms to perform basic research on scalability and correctness and accuracy of modern applications, systems, and toolchains built on heterogeneous architectures. The intent is that these efforts will foster the development of principles that lead to rigorous and reproducible artifacts for the design and implementation of large-scale systems and applications spanning the full hardware/software stack. PPoSS seeks to fund projects that lay the foundations for sustainable approaches for implementing performant, scalable, and correct and accurate computing applications that run on heterogeneous platforms. Both planning grants of up to $250,000 each and large grants of up to $1,000,000 per year for five years will be considered. **Deadline: January 24, 2022 and January 23, 2023.**
FOUNDATIONS

Alfred P. Sloan Foundation Program on Economic Institutions, Behavior, & Performance
This program supports rigorous and objective research projects on U.S. economic structure, behavior, and performance whose findings inform and strengthen decision-making by regulators, policymakers, and the public. The program includes sub-programs on Behavioral Economics Applications and Foundations; Economic Analysis of Science and Technology; Empirical Economic Research Enablers; and Administrative Data Research Facilities.
Deadline: A Letter of Inquiry may be submitted anytime; full proposals by invitation only.

Templeton World Charity Foundation: The Science of Religious and Spiritual Exercises
The Templeton World Charity Foundation has launched a new five-year strategic framework that emphasizes both interdisciplinary scientific research on fundamental aspects of human nature, and the development of practical tools and innovations for human flourishing. As part of this framework, the Foundations invites proposals that will expand understanding of the science of religious and spiritual exercises. Research grants of up to $500,000 will be awarded to support teams composed of interdisciplinary teams of empirical researchers, scholars, and practitioners.
Deadlines: Expressions of interest must be submitted via the Foundation website by November 5, 2021. Invited full proposals will be due February 9, 2022.

Looking Ahead

EVENTS

Science Talks
10/5/2021 Hybrid Slice of Science Seminar - “Metanumerical Mathematics I” by Andrés Ortiz-Muñoz (SFI).
10/14/2021 Hybrid Seminar - “Mathematical and Computational Foundations for Enabling Predictive Digital Twins at Scale” by Karen Willcox (University of Texas, Austin; SFI).
10/20/2021 Informal Seminar - “Complexity Science and the 2021 Nobel Prize in Physics” by Dan Stein (New York University; SFI),
10/27/2021 Hybrid Seminar by Kelle Dhein (University of Kentucky),
11/1/2021 Hybrid Seminar by Peter Dodds (University of Vermont).
11/2/2021 Hybrid Slice of Science Seminar - “Metanumerical Mathematics II” by Andrés Ortiz-Muñoz (SFI).
11/3/2021 Hybrid Colloquium by Kathleen Araújo (Boise State University).
12/7/2021 Hybrid Slice of Science Seminar by Mingzhen Lu (Stoichiometric limitation of nature-based carbon solutions, response timescales of systems (geosphere, biosphere, noosphere)).
12/14/2021 Hybrid Seminar by Amos Golan (American University; SFI).

Science Meetings
10/18-19/2021 Hybrid Workshop “The Future of Thermodynamics of Computation” organized by David Wolpert (SFI), Christopher Lynn (Princeton), Joshua Grochow (U.C. Boulder), and Jan Korbel (Medical University & Complexity Science Hub, Vienna)
10/18-20/2021 Micro Working Group “Resilience of French Polynesia Islands over a Millennium of Human Interactions with Biodiversity” organized by Jennifer Dunne (SFI) and Stefani Crabtree (Utah State University; SFI)
11/8-11/2021 Hybrid Workshop “Dynamics of Interacting Contagions” organized by David Wolpert (SFI)

Visitors
Mark Ritchie (Syracuse University), 1/1/2021—12/31/2021. SFI host: Jennifer Dunne [Virtual]
Kelsey Reese (University of Notre Dame), 4/26/2021—12/31/2021. SFI host: Stefanie Crabtree
Jack Shaw (Yale University), 6/13/2021 — 8/5/2021. SFI host: Jennifer Dunne
Tasnim Farita (Massachusetts Institute of Technology), 9/7/2021 — 5/31/2022. SFI host: David Wolpert
Fred Cooper (SFI), 9/20/2021 — 12/31/2021. SFI host: Jennifer Dunne
Victor Odouard (Cornell University), 9/23/2021 — 8/31/2022. SFI host: Melanie Mitchell
Paula Sabloff (SFI), 9/27/2021 — 12/31/2021. SFI host: Jennifer Dunne
Daniel Stein (New York University; SFI), 10/2-29/2021. SFI host: Jennifer Dunne
William Poole (California Institute of Technology), 9/30/2021 – 10/2/2021. SFI host: Andréa Ortiz-Muñoz

Andrea Graham (Princeton University), 10/3-30/2021. SFI host: Jennifer Dunne

Eric Libby (Umeå University), 10/11-25/2021. SFI host: Jennifer Dunne

Anjali Bhatt (Harvard University; SFI), 10/12/2021 – 12/31/2021. SFI host: Jennifer Dunne

Karen Willcox (University of Texas, Austin; SFI), 10/12-14/2021. SFI host: David Wolpert

Mark Ritchie (Syracuse University), 10/14-20/2021. SFI host: Jennifer Dunne

Abigail Buffington (College of William and Mary), 10/15-20/2021. SFI host: Jennifer Dunne

Jennifer Kahn (College of William and Mary), 10/15-20/2021. SFI host: Jennifer Dunne

Stefani Crabtree (Utah State University; SFI), 10/15-20/2021. SFI host: Jennifer Dunne

Spencer Wood (Washington State University), 10/18/2021 – 1/22/2022. SFI host: Jennifer Dunne

Kelle Dhein (University of Kentucky), 10/27/2021. SFI host: Melanie Mitchell

Peter Dodds (University of Vermont), 11/1-5/2021. SFI host: Jennifer Dunne

Juniper Lovato (University of Vermont), 11/1-5/2021. SFI host: Jennifer Dunne

Laurent Hébert-Dufresne (University of Vermont), 11/1-5/2021. SFI host: Jennifer Dunne

Steen Rasmussen (University of Southern Denmark; SFI), 11/1-8/2021. SFI host: Jennifer Dunne

Ricard Solé (University of Pompeu Fabra; SFI), 11/8-24/2021. SFI host: Jennifer Dunne

Victor Maull (University of Pompeu Fabra), 11/8-24/2021. SFI host: Ricard Solé

Daniel Amor (Massachusetts Institute of Technology), 11/8-24/2021. SFI host: Ricard Solé

Cosma Shalizi (Carnegie Mellon University; SFI), 12/3-10/2021. SFI host: Cris Moore

Karen Adolph (New York University), 12/5-21/2021. SFI host: Susan Fitzpatrick

Amos Golan (American University; SFI), 12/12-17/2021. SFI host: Jennifer Dunne