Newsjournal of the Society for Industrial and Applied Mathematics sinews.siam.org

siam news

Volume 57/ Issue 1
January/February 2024

Designing the Smart Grid of the Future

By Bert Zwart

The power grid is one of the most significant engineering achievements in the history of humankind, having kept the lights on for more than a century. Traditionally, the supply of electricity has depended on large, controllable generators that transform fossil fuels into power. These generators employ several methods to balance the supply and demand of electricity while accounting for physical constraints on the network. In the past, electricity demand was relatively easy to predict (even several days in advance) and transport was unidirectional; electricity traveled from large suppliers via high-voltage *transmission networks* to low-voltage *distribution networks*, and finally to consumers.

This standard setup has already begun to change and will continue to radically do so over the next several decades. In response to global warming, renewable energy sources—such as wind and solar—are gradually phasing out fossil fuels. This ongoing shift will make the supply of electricity less centralized, less predictable, and more difficult to control; for instance, the addition of rooftop solar panels to the power grid means that a significant portion of energy production will take place locally. The system's inertia is also decreasing as traditional generators become less common, meaning that authorities must handle unforeseen events (like failures) at a much faster rate.

Researchers have proposed numerous technological innovations to address these emerging issues. Storage devices may take over the customary role of balancing supply and demand, and smart devices—such as refrigerators and air conditioners—can respond to fluctuations in electricity supply. Electric vehicles might charge at a variable rate or even deliver electricity back to the grid. In addition, the evolution of new energy markets that enable peer-to-peer trading is an exciting novelty [10]. All of these advancements come with additional privacy and security challenges as well as associated communication requirements, though developments like 5G and cloud-based services will help to address the latter.

The Need for Mathematics

Incremental changes to the current set of mechanisms that balance supply and demand will not sufficiently or effectively incorporate these developments. Existing algorithms mainly consist of (i) automated control mechanisms that handle imbalances on short time scales of up to several minutes to ensure that frequencies remain at a nominal value; (ii) offline optimization techniques that provide readjustments on the time scale of 15 minutes to several hours; and (iii) energy markets that manage challenges on time scales that range from hours to days. These mechanisms collectively balance the *transmission grid*—which comprises high-voltage networks that span regions or even countries—wherein the demand by local *distribution grids* (networks that span neighborhoods

See **Smart Grid** on page 4

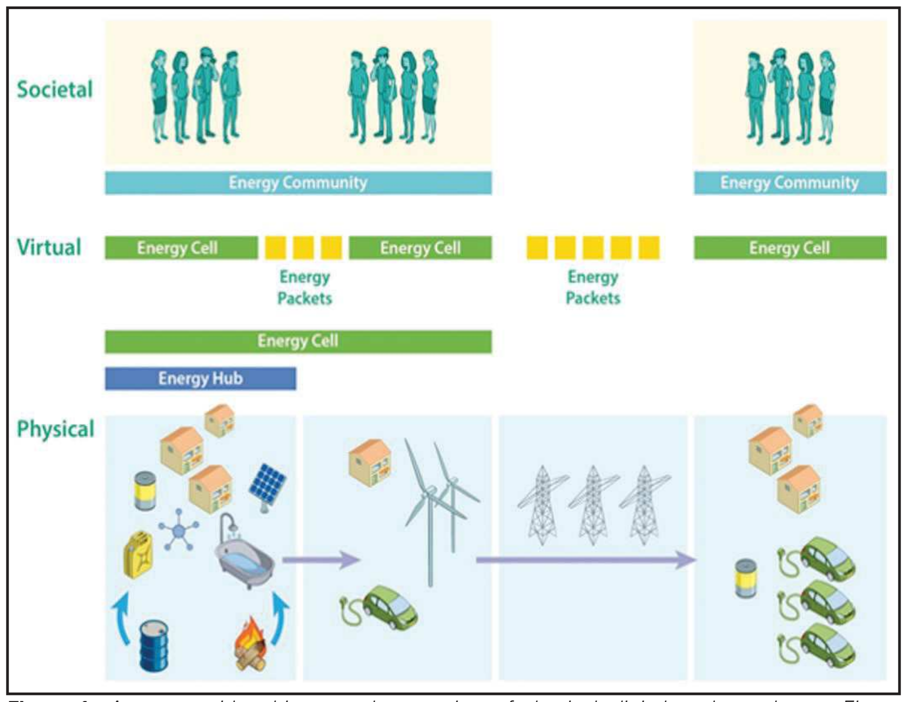

Figure 1. *A power grid architecture that consists of physical, digital, and user layers. Figure courtesy of Pavol Bauer of Delft University of Technology.*

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Off-diagonal Ramsey Numbers From Pseudorandom Graphs

By Jacques Verstraete and Sam Mattheus

Ramsey theory is a branch of mathematics that attempts to find uniformity in sufficiently large structures. It is arguably one of the most important branches of combinatorics and has deep connections to a variety of other fields, including number theory, geometry, ergodic theory, logic, and computer science. It also finds practical applications in areas such as coding and information theory, zero-error channel capacity for noisy communication channels, computational complexity of information retrieval, and very-large-scale integration design and network visualization. Here, we discuss a recent breakthrough on a decades-old Ramsey theory problem from renowned mathematician Paul Erdős.

The quintessential introductory example is sometimes called the *party problem*; given any group of six individuals at a party, Ramsey theory guarantees that one can either find at least three people who all know each other, or at least three people who all do not know each other. This problem is best phrased in the mathematical language of graph theory. If we designate the party attendees as vertices, we can place a red edge between two people who know each other and a blue edge between two people who do not. Regardless of the resulting configuration of red or blue edges, we are guaranteed to find a red triangle or blue triangle: in other words, three people who all know each other or three people who do not know each other. This scenario is the first and perhaps most famous example of a quantity known as a *Ramsey number*.

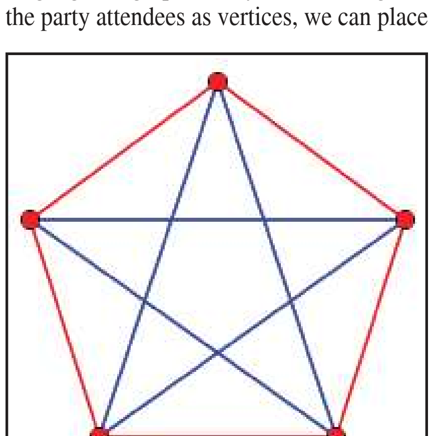

Figure 1. *Ramsey graph $r(3,3)$ with five vertices. Figure courtesy of Jacques Verstraete.*

Ramsey Number	Value	Ramsey Number	Value	Ramsey Number	Value
$r(3,3)$	6	$r(3,4)$	9	$r(3,5)$	14
$r(3,6)$	18	$r(3,7)$	23	$r(3,8)$	36
$r(3,9)$	39	$r(4,4)$	18	$r(4,5)$	25

Figure 2. *A list of all Ramsey numbers whose exact values are known.*

Frank Ramsey first showed the existence of Ramsey numbers in 1930 [10]. The definition is as follows: Given any integers $s,t \geq 2$, the Ramsey number $r(s,t)$ is the minimum number N such that no matter how we color the pairs (red or blue) in a set of N vertices, we are guaranteed a set of s vertices between which all edges are red, or a set of t vertices between which all edges are blue. We already alluded to these uniform substructures—called monochromatic subsets—in the party example. Now, the question at hand is to determine the value of $N=r(s,t)$. The solution to the party problem is the statement that $r(3,3)=6$, combined with the observation that amongst only five people, it is possible that there may not be three who all know or do not know each other (see Figure 1).

The graph in Figure 1 fails to form a red or blue triangle and therefore shows that $r(3,3)>5$. Unfortunately, Ramsey numbers are exceedingly difficult to determine; in fact, only a few Ramsey numbers $r(s,t)$ for $t \geq s \geq 3$ have been verified over the course of nearly a century (see Figure 2).

Given this difficulty, mathematicians are more concerned with *estimates* of Ramsey number values — especially for large values of s and t. In the 1930s, Erdős and George Szekeres proved one of the first general theorems along these lines, establishing in particular that $r(s,t) \leq t^{s-1}$ [4]. Another success in Ramsey theory was Jeong Han Kim's determination that

$$r(3,t) \geq a\frac{t^2}{\log t} \qquad (1)$$

for some constant $a>0$ [5]. Together with a theorem of James B. Shearer [12], Kim's findings demonstrate that $r(3,t)$ is not too far from $t^2/\log t$ when t is large. This result arose from martingale analysis of the random triangle-free process, whereby red edges—which are uniformly selected from all edges that do not complete a triangle—are individually and randomly added to a graph with no edges. The process concludes with a red graph that has no triangles; all of the missing edges are blue.

According to Figure 2, only two Ramsey numbers $r(4,t)$ are known. As such, the next major challenge is to study the growth of $r(4,t)$ for large values of t. The first upper bound comes from the Erdős-Szekeres theorem, which implies that $r(4,t) \leq t^3$ for $t \geq 2$ [4]. Erdős repeatedly conjectured that $r(4,t)$ should not be too far from t^3 [3]. Decades later, Tom Bohman and Peter Keevash used the so-called random K_4-free process to show that $r(4,t)$ is at least roughly $t^{5/2}/\log^2 t$ [2]. If one starts with an empty graph on $t^{5/2}/\log^2 t$ vertices and repeatedly adds red edges uniformly at random—conditioned on not creating a K_4—the process ends with a random K_4-free graph in which all of the missing edges are blue. The key is to prove with positive

See **Ramsey Numbers** on page 2

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siam news
Volume 57/ Issue 1/ January/February 2024

5 **Introducing the Most Recent SIAM Project NExT Fellows**
SIAM annually sponsors two Fellows of Project NExT (New Experiences in Teaching), a professional development program for new or recent Ph.D.s in the mathematical sciences. David Elzinga and Erin Ellefsen—the latest SIAM Project NExT Fellows—join Kathleen Kavanagh to overview the program.

6 **Musings on the Statistical Physics of Complex Systems**
David Aldous reviews *In a Flight of Starlings: The Wonders of Complex Systems,* which recounts the life's work of author Giorgio Parisi and reflects on the scientific lessons that he learned along the way. Parisi, who received the 2021 Nobel Prize in Physics, uses personal accounts to convey the beauty and value of modern science.

8 **Reflections From a Student in the SIAM-Simons Undergraduate Summer Research Program**
2023 was the inaugural year of the SIAM-Simons Undergraduate Summer Research Program, which provides support for 10 undergraduate students from underrepresented groups to conduct scientific research with faculty mentors across the U.S. Rachel Ahumada describes her experiences with the program and extolls its benefits.

9 **A Mentor Perspective on the SIAM-Simons Undergraduate Summer Research Program**
Malena Español, Alicia Prieto-Langarica, and Padmanabhan Seshaiyer—three mentors in the 2023 cohort of the SIAM-Simons Undergraduate Summer Research Program—collaborate with SIAM's Karen Bliss to encapsulate the mentor experience, discuss their respective projects, and advocate for the importance of student research.

10 **Another Robust Year for SIAM Publications**
In 2023, SIAM Publications implemented key initiatives that pertain to new technologies, research integrity, and global outreach. Kivmars Bowling, the Director of Publications at SIAM, recaps updates to the online bookstore, ongoing efforts to develop resources for early-career researchers, and more.

Ramsey Numbers

Continued from page 1

probability that no complete blue subgraph of size more than t arises. Yusheng Li, Cecil Rousseau, and Wenan Zang established that

$$r(4,t) \leq b\,\frac{t^3}{\log^2 t}, \qquad (2)$$

where $b>1$ is close to 1 when t is large [6]. Unfortunately, the K_4-free process seems to hit a barrier if one starts with more than $t^{5/2}/\log^2 t$ vertices, which is far from Erdős' conjecture that $r(4,t)$ is not far from t^3.

To find a lower bound for Ramsey numbers $r(s,t)$, one must create a red-blue coloring of the edges between N vertices such that no subset of size s has all red edges and no subset of size t has all blue edges; one can then conclude that $r(s,t)>N$. For instance, $r(4,4)>17$ since the graph in Figure 3a has no monochromatic subsets of size four. This example, which is known as a Paley graph, was discovered in 1955 and has many remarkable properties. Furthermore, Figure 3b depicts one of the more than 30,000 examples that show $r(4,5)>24$. It is difficult to conduct a computer search to identify examples that give lower bounds on $r(4,t)$ for large t, as there are generally too many colorings to examine. For this reason, $r(4,6)$ and $r(5,5)$ are currently unknown.

However, we recently achieved a breakthrough for $r(4,t)$ by blending a broad variety of mathematical techniques [7]. More precisely, we employed a combination of finite geometry, linear algebra, probabilistic methods, and combinatorial structural arguments to prove Erdős' conjecture. For some constant $c>0$ and all $t \geq 4$,

$$r(4,t) \geq c\,\frac{t^3}{\log^4 t}. \qquad (3)$$

This result is close to the upper bound (2) and was inspired in part by the recent discovery that good constructions tend to hide inside so-called *pseudorandom graphs*, which deterministically exhibit many of the likely properties of a truly random graph with the same expected edge density [8]. If the red edges in our coloring form a pseudorandom graph with no monochromatic set of size s, then random sampling of the vertices with appropriate probability will likely yield a graph with no monochromatic blue set of size t. This fact relies upon the modern method of *containers*, which essentially demonstrates that extraordinarily few monochromatic blue sets of size t exist in such colorings [1, 11]. When applied to a carefully constructed graph that arises from finite geometry, it yields (3). Specifically, one can appeal to so-called *Hermitian unitals* in projective planes. Let $\mathbb{F}_q$ denote the finite field of order q and V denote the three-dimensional vector space of triples (x,y,z), where $x,y,z \in \mathbb{F}_{q^2}$. The points of the Hermitian unital are thus all one-dimensional subspaces of V whose generators (x,y,z) satisfy

$$x^{q+1}+y^{q+1}+z^{q+1}=0. \qquad (4)$$

Arithmetic in this equation occurs over the finite field $\mathbb{F}_{q^2}$. The lines of the Hermitian unital are the sets of collinear points that satisfy the equation and combinatorially form the blocks of a design or Steiner $(q+1)$-tuple system. Our graph for $r(4,t)$ has vertices that represent the lines in the Hermitian unital; here, two vertices are adjacent via a red edge if their corresponding lines intersect on the unital. Remarkably, choosing these subsets of points and lines gives rise to an incidence structure that does not contain a configuration of four pairwise nonparallel lines, with no three concurrent at a single point. Figure 4 depicts this geometry—sometimes called the O'Nan or Pasch configuration—and labels the six points where the lines intersect as a through f.

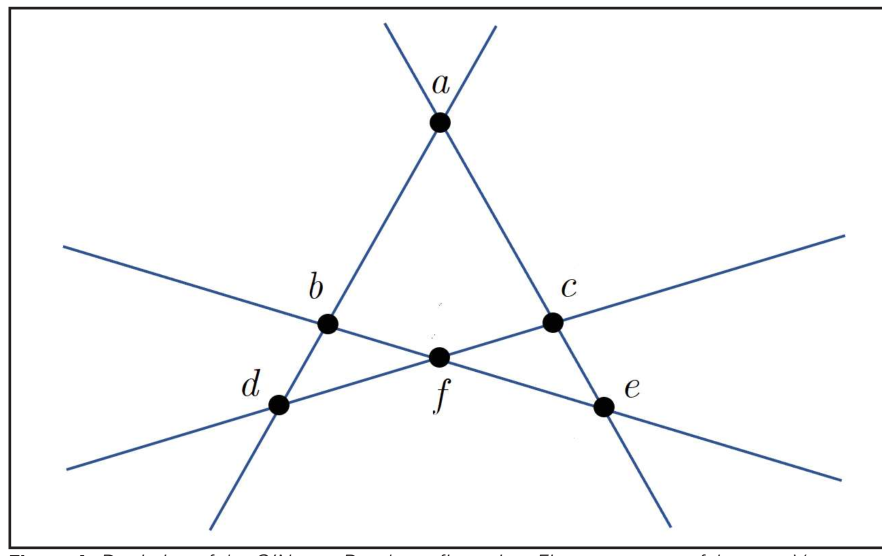

Figure 4. *Depiction of the O'Nan or Pasch configuration. Figure courtesy of Jacques Verstraete.*

Michael O'Nan was the first researcher to verify that this configuration does not occur in the Hermitian unital [9]. This implies that all monochromatic subsets with four vertices in the aforementioned graph are somewhat atypical, as they comprise at least three concurrent lines and can be easily disposed of. Furthermore, this graph enjoys good pseudorandomness properties; when combined with substantial use of the probabilistic method, such pseudorandomness allows the final graph to prove that $r(4,t)$ is not far from t^3.

Although the pseudorandom graph approach to Ramsey theory is rather recent, it provides a new and exciting point of view for classical problems in the field [8]. Specifically, it laid the foundation for the solution of a decades-old conjecture on the growth rate of $r(4,t)$—which purely random processes were unable to achieve—and will likely produce more results across Ramsey theory and related areas in the future. The approach also facilities the study of many additional problems that pertain to Ramsey theory, such as Erdős-Rogers functions and more general Ramsey numbers for graphs. To attack the central problem of the growth rate of $r(s,t)$ for each $s \geq 5$, interested researchers might wish to find higher-order geometric analogues of the aforementioned Hermitian unital.

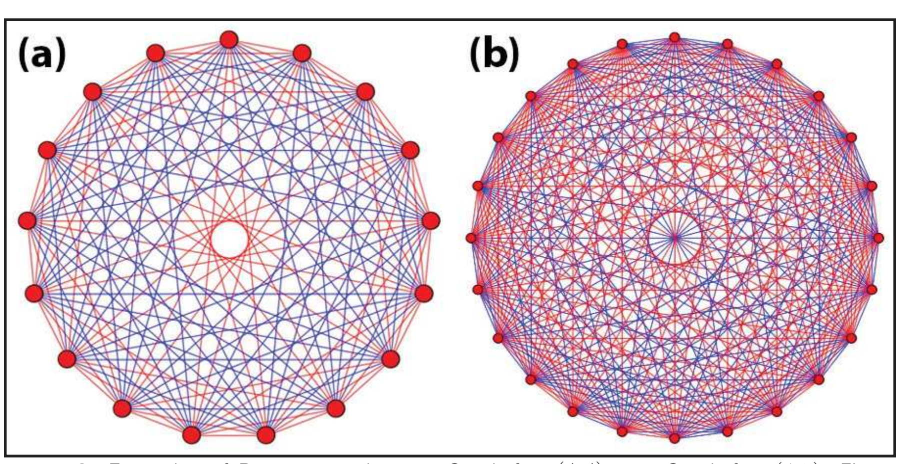

Figure 3. *Examples of Ramsey graphs.* **3a.** *Graph for $r(4,4)$.* **3b.** *Graph for $r(4,5)$. Figure courtesy of Jacques Verstraete.*

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SIAM Introduces Its Newly Elected Leadership

By Lina Sorg

At the end of 2023, the SIAM community voted in the annual election to select the Society's new and returning leadership:[1] the incoming President-Elect, Vice President-at-Large, Secretary, three members of the SIAM Board of Trustees, and four members of the SIAM Council.

The President-Elect will shadow current President Sven Leyffer (Argonne National Laboratory) for the entirety of 2024 and serve as President from January 1, 2025, until December 31, 2026. The newly elected Vice President-at-Large and Secretary began their terms on January 1 and will retain their positions until December 31, 2025. New and returning members of the SIAM Board of Trustees and SIAM Council will remain in office until December 31, 2026.

Here, SIAM's newest leadership—all of whom have been dedicated, involved members throughout the years—react to their recent appointments and share their goals for their time of service. Their full candidate statements are available online.[2]

President-Elect

Carol Woodward (Lawrence Livermore National Laboratory): "I am delighted and grateful to have been selected as President-Elect of SIAM. The opportunity to serve SIAM as President-Elect—and later as President—is both a tremendous honor and responsibility. SIAM has long been a bedrock for applied mathematicians, providing crucial support, recognition, and connections. As we confront new challenges—explosive growth in data science, shifts in computational science, and financial complexities—I am committed to helping SIAM meet these challenges while maintaining its extremely high-quality and successful activities. I plan to support our journals and programs, expand global connections, and champion diversity. With collective support, we'll navigate these changes and ensure that SIAM remains the go-to hub for applied mathematics by embracing excellence and fostering a welcoming community."

[1] * indicates an incumbent member
[2] https://sinews.siam.org/Details-Page/siam-announces-newest-leadership

Vice President-at-Large

Xiaoye Sherry Li (Lawrence Berkeley National Laboratory): "I am deeply honored to have been elected by my colleagues to serve as the Vice President-at-Large for SIAM. SIAM is a vibrant community that fosters the rapid growth of interdisciplinary fields in computational science and engineering. I am committed to working with the community to establish closer collaborations among theoreticians and practitioners; expand nontraditional areas that require cross-cutting technologies, such as the analysis of experimental data from scientific instruments and robust artificial intelligence/machine learning; and provide more opportunities for undergraduate students, graduate students, and other junior scholars."

Secretary

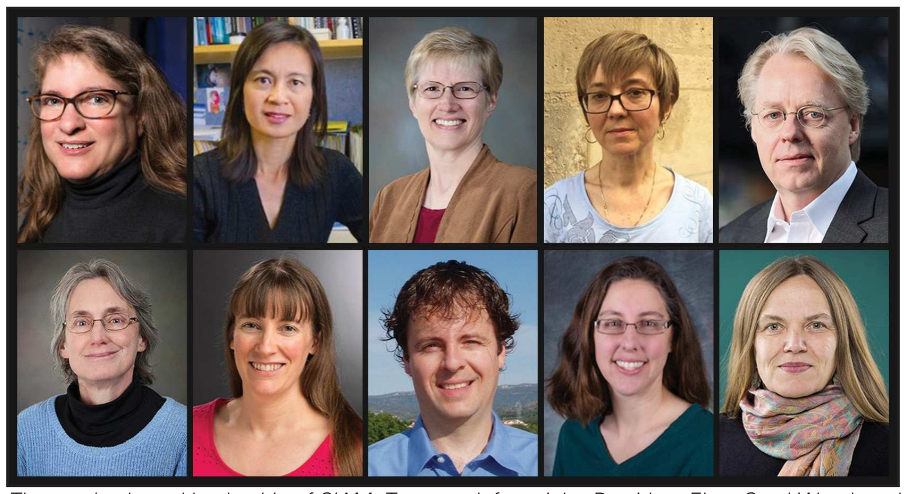
Karen Devine (Sandia National Laboratories, retired): "I am honored to be elected as SIAM Secretary. Thank you to all of the SIAM election candidates for their willingness to serve. My goal is to increase member participation in SIAM activities, and I invite all members—especially early-career individuals—to enhance their careers by getting more deeply involved with SIAM. SIAM's website offers a list of opportunities for involvement;[3] please feel free to contact me for more information. I'd love to hear from you!"

[3] https://www.siam.org/get-involved

SIAM Board of Trustees

Liliana Borcea* (University of Michigan): "I am honored to be re-elected and serve alongside the distinguished scientists on the SIAM Board of Trustees. My focus will remain on increasing the impact and visibility of SIAM and applied mathematics as key players when addressing the ever-growing scope and complexity of

See **Elected Leadership** *on page 5*



The newly elected leadership of SIAM. Top row, left to right: President-Elect Carol Woodward (Lawrence Livermore National Laboratory), Vice President-at-Large Xiaoye Sherry Li (Lawrence Berkeley National Laboratory), Secretary Karen Devine (Sandia National Laboratories, retired), and SIAM Board of Trustees members Liliana Borcea (University of Michigan) and Jan S. Hesthaven (École Polytechnique Fédérale de Lausanne). Bottom row, left to right: SIAM Board of Trustees member Cynthia Phillips (Sandia National Laboratories) and SIAM Council members Elizabeth Cherry (Georgia Institute of Technology), Hans De Sterck (University of Waterloo), Judith Hill (Lawrence Livermore National Laboratory), and Andrea Walther (Humboldt-Universität zu Berlin). Photos courtesy of the elected individuals.

Collective Organization in Cyanobacteria: How Earth's Oldest Organisms Form "Active Spaghetti"

By Matthew R. Francis

Cyanobacteria are a diverse group of single-celled organisms whose lineage dates back to the earliest days of life on Earth. Sometimes known as *blue-green algae*, these bacteria predate true algae (which are classified as plants) by billions of years and are the earliest known organisms to harvest sunlight for energy via photosynthesis. While some cyanobacteria produce toxins that are harmful to animal life, they are also responsible for a significant amount of nitrogen fixation within food webs.

Modern cyanobacteria subsist in a wide range of environments, from soil, streams, and freshwater lakes to extreme locales like hot springs, Antarctic lakes, and rocky bacterial reefs called stromatolites. Although cyanobacteria are prokaryotes—single-celled organisms without nuclei or other distinct internal structures—that form seemingly undifferentiated green slimes called *microbial mats* on a macroscopic scale, some species can self-organize into microscopic networks (see Figure 1). And they have *always* done so.

"You get the same patterns, same structure, and same kind of activity in billion-year-old fossils and nowadays," physicist Lucas Goehring of Nottingham Trent University said. "Basically, there's something very important [about] how these structures provide some sort of fitness for the cyanobacteria to the landscape."

In other words, understanding how and why self-organization arose in this ancient lineage can provide clues about the history of evolution as a whole. Goehring and Mixon Faluweki of the Malawi University of Science and Technology recently collaborated with Jan Cammann and Marco Mazza of Loughborough University to construct a big-picture view of these organisms' behavior. The model organisms in the resulting study—published in *Physical Review Letters* [1]—were *Oscillatoria lutea* and *Kamptonema animale*: cyanobacteria that form long filaments of many individual cells. These strands organize themselves into the distinctive web-like networks that appear in both fossils and modern environments.

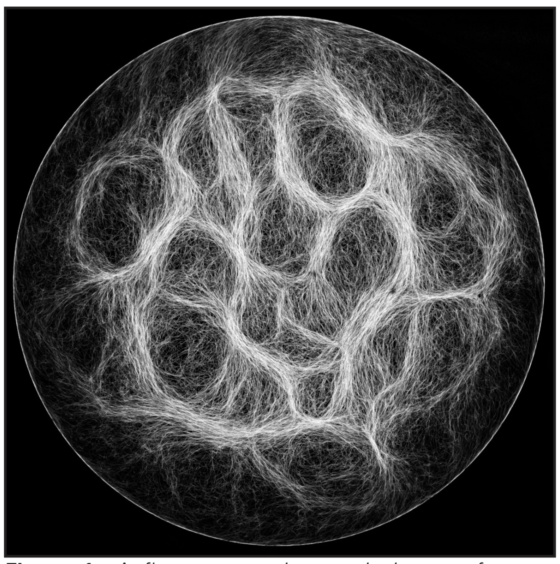


Figure 1. *A fluorescent microscopic image of cyanobacteria that form a distinct web-like pattern, where individual bacterial fibers align with each other rather than randomly distribute. Figure courtesy of [1].*

"We didn't really have an idea [as to] how these patterns emerge, so we set out to model their motion," Cammann said. "After some attempts, we finally arrived at [a model] that we were happy with, which reproduces these patterns exactly."

Chain-Chain-Chain, Chain of Cells

Like all bacteria, filamentous cyanobacteria reproduce by cell division. However, the daughter cells remain stuck together and divide exclusively along a single axis — yielding long, nonbranching chains that are only one bacterium wide. So from a self-organization standpoint, the primary unit is not a cell but a filament, which can be nearly a thousand times longer ($L \approx 1.5$ mm) than it is wide ($\sigma \approx 4$ μm). The researchers thus refer to cyanobacterial tangles as "active spaghetti." "This [chaining] represents an early transition from single-celled to multicellular life," Goehring said, though the cells do not perform specialized functions in the way that many other organisms would later evolve to do.

Mathematically, the process of filamentation means that we cannot treat these organisms as point particles. Though they do not have heads or tails, the strands move preferentially in one direction in an almost worm-like way. A single filament can interact with several others at different points along its length, and these other filaments may link up with separate chains. "The filamentous nature turns out to be the key in the pattern formation that we observe," Mazza said. "The [microbial mat] is not just an amorphous green slime. [It] can react to external perturbation, be it a rapid change in temperature, light intensity, and so on."

The collaborators focused their attention on one particular property: density. At low bacterial concentrations, the filaments lack any measurable order and can be treated as a fluid; at higher densities, however, they spontaneously organize into distinctive web patterns. Therefore, the challenge was to build a mathematical model that describes this behavior and test it against experimental data.

From Liquid Crystals to Bacterial Webs

Cammann led the theoretical portion of this study as part of his doctoral research, drawing inspiration from well-established models of nematic liquid crystals. These filamentous yet nonbiological materials also self-organize under certain conditions and undergo clear phase transitions, which enable myriad technological applications. "The filamentous nature is the minimal extension of point particle models that is required to quantitatively reproduce what we see in nature," Cammann said.

He treated the bacteria as links in a flexible chain that is confined to a two-dimensional surface, such as a stromatolite or rock face. The model describes the orientation angle θ_i of each filament head relative to the lab coordinate system, as well as its angular speed ω_i—i.e., how quickly the filaments twist—via coupled differential equations that are modified from condensed matter physics:

$$\frac{d\theta_i}{dt} = \omega_i - J\mathcal{F}(\theta_i)$$

$$\frac{d\omega_i}{dt} = -\frac{1}{\tau}[\omega_i - J\mathcal{F}(\theta_i)] + \sqrt{2D_\omega}\,\xi_i(t).$$

Here, J is the interaction strength, τ is the time scale for curvature fluctuations (measured experimentally), D_ω is a diffusion coefficient, and $\xi_i(t)$ is a Gaussian random noise term with zero mean and unit variance. The force term

$$\mathcal{F}(\theta_i) = -(N_i)^{-1}\sum_{j\sim i}\frac{\partial}{\partial\theta_i}\cos[2(\theta_i-\phi_j)]$$

connects the head of chain angle θ_i to the orientation angle ϕ_j of the nearest link in each chain, which goes to zero when the filaments are aligned. The summation is only over the N_i bacteria that are in physical contact with each other, so the force term is set to zero outside of a distance d that is equal to the mean bacterial diameter. The simulations also account for experimentally determined filament velocities and curvatures, thereby allowing the researchers to obtain the diffusion and interaction parameters.

"Everything in the model is designed around what we see observationally,"

See **Cyanobacteria** *on page 6*

SIAM New York – New Jersey – Pennsylvania Section Holds Inaugural Conference

By Kathleen Kavanagh and Roy Goodman

In July 2022, SIAM approved the creation of a new Section[1] to serve industrial and applied mathematicians in the region of New York, New Jersey, and Pennsylvania. The resulting SIAM New York – New Jersey – Pennsylvania (SIAM-NNP) Section[2] seeks to promote collaboration for basic research and mathematical applications in industry and science, facilitate continued communication among its members, and generally support the SIAM mission. As such, SIAM-NNP held its first annual meeting[3] at New Jersey Institute of Technology (NJIT) in October 2023. Roughly 375 attendees convened over the course of several days to enjoy and participate in 26 unique minisymposia, nine contributed sessions, and 47 poster presentations. Four plenary speakers discussed their research and introduced the audience to a broad range of topics, as follows:

- Yuejie Chi (Carnegie Mellon University): "A Tale of Preconditioning and Overparameterization in Ill-conditioned Low-rank Estimation"
- Qiang Du (Columbia University): "Nonlocal Models on Bounded Domains: Formulation, Analysis, and Computation"
- Susan Bailey (Clarkson University): "Using Models and Experiments to Explore the Drivers of Microbial Evolution"
- Fengyan Li (Rensselaer Polytechnic Institute): "Efficiency Improvements in Wave and Kinetic Transport Simulations."

The meeting featured a strong student and early-career presence; 30 undergraduate students, 133 graduate students, and 54 postdoctoral researchers were in attendance. Two junior researchers also presented a pair of engaging 50-minute tutorials on the following emerging research topics, which was certainly a conference highlight:

- Roni Barak Ventura (New York University): "Causal Inference with Transfer Entropy: An Introduction for Beginners"
- Annan Yu (Cornell University): "Theory and Practices of Linear Systems in Machine Learning."

The evening before the invited talks and minisymposia began, student attendees were invited to a special mixer that included a pizza dinner, networking opportunities, and a digital SIAM scavenger hunt (with SIAM merchandise prizes for the winning teams). The night concluded with a question-and-answer panel with industry experts that allowed participants to ask candid questions about industrial career opportunities for applied and computational mathematicians. The panel comprised Michael Henderson (IBM Research), Ross Ingram (Naval Nuclear Laboratory), Jeffrey Sachs (Merck), Erin Tripp (Air Force Research Laboratory), and Biao Yin (Bank of America).

SIAM and the NJIT Department of Mathematical Sciences, College of Science and Liberal Arts, and Office of the Provost all offered support for SIAM-NNP's 2023 Annual Meeting. SIAM-NPP Section leadership—president Roy Goodman (NJIT), vice president Yue Yu (Lehigh University), secretary Rongjie Lai (Purdue University), and treasurer Eric Forgoston (Montclair State University)—orchestrated the event, with help from Anthony Harkin (Rochester Institute of Technology), Ross Ingram (Naval Nuclear Laboratory), Silvia Jiménez Bolaños (Colgate University), Kathleen Kavanagh (Clarkson University), and Kyle Mandli (Flatiron Institute). A scientific committee of 20 SIAM members from academia and industry—including companies such as Corning Inc., IBM, and Merck—also supported the conference.

Beginning with the first announcement of our intention to form this Section, the response from the community has been overwhelmingly positive. We hope that this meeting helps to establish SIAM-NNP as a strong hub for our region's industrial and applied mathematics community. All of the region's SIAM members are automatically members of this Section. We encourage them to get involved and continue to build upon what we have started.

Kathleen Kavanagh is a professor of mathematics at Clarkson University and the former Vice President for Education at SIAM. Roy Goodman is an associate professor in the Department of Mathematical Sciences at New Jersey Institute of Technology and founding president of the SIAM New York – New Jersey – Pennsylvania Section.

[1] https://www.siam.org/membership/sections
[2] https://www.siam.org/membership/sections/detail/siam-new-york-new-jersey-pennsylvania-section
[3] https://sites.google.com/view/siam-nynjpa/annual-meeting

Students attend the industry question-and-answer panel with experts in the field during the introductory mixer event at the first annual meeting of the SIAM New York – New Jersey – Pennsylvania Section (SIAM-NNP), which took place at New Jersey Institute of Technology in October 2023. Photo courtesy of Roy Goodman.

Smart Grid

Continued from page 1

of consumers) is fixed. The mechanisms (e.g., online frequency control and offline optimization of energy production) also take place separately and depend on a *time scale separation assumption*. Such simplifying assumptions, which decompose the balancing problem across space and time, are no longer realistic and waste billions of dollars each year. Finally, many algorithms ignore or linearize the network's physical constraints — an assumption that becomes more problematic when power grids operate closer to their physical capacities, resulting in similar losses [7].

Future coordination mechanisms—such as online control mechanisms, offline optimization, markets, and combinations thereof—must be able to account for the presence of numerous small suppliers, smart devices, low levels of inertia, and high levels of uncertainty while simultaneously meeting high privacy and security standards. This problem yields formidable scientific challenges in the mathematical areas of distributed and real-time optimization, control, game theory, market design, privacy, security, stochastics, and complex systems.

Many individuals and institutions have recognized the need for a focused effort on these areas in recent years. For example, a 2016 report from the U.S. National Academies of Sciences, Engineering, and Medicine[1] identified relevant challenges in dynamical systems and optimization (particularly the AC optimal power flow problem) [7]. And in 2019, the Isaac Newton Institute for Mathematical Sciences[2] organized a semester-long program on the mathematics of energy systems[3] that addressed corresponding issues in stochastics, machine learning, reliability, and market design.

Designing a New Architecture

If we set out to redesign the entire power grid from scratch, how would we do so? From a mathematical perspective, this is a vast decentralized stochastic dynamic optimization problem in which the behavior of physics, networks, and agents must be jointly modeled, analyzed, and optimized. Two frameworks that partially address this challenge have already arisen in the context of the internet: *network utility maximization* and *layered network architectures* [3, 5]. These frameworks explain the successful performance of the Transmission Control Protocol (TCP)—a key distributed algorithm that determines the number of packets that may be submitted for a particular connection—and have helped to develop refined versions of the TCP. Essentially, the frameworks seek to design algorithms that decouple a network's user layer from its physical layer by constructing an intermediate digital layer; the act of packetizing information enables this decomposition.

Logistics networks exhibit a similar phenomenon in the operation of the *ocean container*: a large vessel that can store a wide variety of products; is movable via sea, road, or rail; and effectively optimizes transport [6]. Certain ideas about the analogous design of a control architecture for a quantum internet are currently materializing [3-5]. Typically, the resulting architectures consist of a "thin" digital layer—known as a bowtie or hourglass architecture—that connects the user to physical layers. Such architectures already persist in many other areas of science [9]. Figure 1 (on page 1) utilizes concepts like energy cells, packets, communities, and hubs to envision this type of layering in the power grid.

What stops us from developing these ideas for the grid? First of all, digitizing energy is much harder than digitizing information. Because energy storage is not easy, it is difficult to establish a separation of time scales — which in turn makes it tougher to decompose the resulting optimization problem into several subproblems. And while the internet has grown organically over time, we would have to redesign the new power grid on top of legacy systems. Finally, evaluating an architecture's efficiency is not a simple task, namely because no Shannon's theorem exists for power grids.

These and other questions are all part of active research efforts. For example, current studies are exploring and even deploying the idea of packetizing energy [1]. Furthermore, scaling laws from probability theory and statistical physics—which provide mathematically rigorous ways to perform model reduction techniques—suggest that it might be possible to demonstrate the optimality of certain designs in a suitable asymptotic regime [2]. Concepts from the theory of complex networks and extreme value theory [8] have also successfully contributed to the rigorous study of reliability in the context of renewable energy systems. These developments promise great results for this line of research, and I remain optimistic that we will live to see a future in which the power grid is as efficient as the internet.

Bert Zwart delivered a public lecture[4] about this research at the 2023 SIAM Conference on Computational Science and Engineering,[5] which took place last year in Amsterdam, the Netherlands.

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Bert Zwart is a group leader at Centrum Wiskunde & Informatica and a professor at Eindhoven University of Technology in the Netherlands. His mathematical expertise is in probability and operations research. Zwart is a former recipient of INFORMS' Erlang Prize; in 2019, he co-organized a semester program on the mathematics of energy networks at the Isaac Newton Institute for Mathematical Sciences.

[1] https://www.nationalacademies.org
[2] https://www.newton.ac.uk
[3] https://www.newton.ac.uk/event/mes

[4] https://meetings.siam.org/sess/dsp_talk.cfm?p=130244
[5] https://www.siam.org/conferences/cm/conference/cse23

Introducing the Most Recent SIAM Project NExT Fellows

By Kathleen Kavanagh, David Elzinga, and Erin Ellefsen

SIAM recognizes the importance of promoting the professional development of junior faculty members, especially in the areas of teaching and education. The SIAM Activity Group on Applied Mathematics Education[1] (SIAG/ED) aims to support early-career educators by advancing the development and practice of educational programs, courses, and resources in the field of applied math. Over the last five years, SIAM has also sponsored two Project NExT (New Experiences in Teaching) Fellows on an annual basis. Project NExT[2] is a professional development program for new or recent Ph.D.s in the mathematical sciences. The Mathematical Association of America[3] (MAA) facilitates the program, which "addresses all aspects of an academic career: improving the teaching and learning of mathematics, engaging in research and scholarship, finding exciting and interesting service opportunities, and participating in professional activities."


David Elzinga of the University of Wisconsin-La Crosse.

Applied mathematics educators must prepare their students for the workforce and introduce them to employment prospects in a variety of sectors, including business, industry, and government. Junior faculty in particular play a key role in inspiring and empowering their students—especially those from underrepresented backgrounds—to solve a wide range of complex, real-world problems while simultaneously nurturing a deep-rooted appreciation for mathematics. But upon graduating with a Ph.D. in mathematics (or a related field) and accepting an academic teaching position, not all new faculty are fully equipped with the right resources or training to effectively support their students. Project NExT acknowledges this potential disconnect and aims to provide its Fellows with a network of peers and mentors as they navigate their careers and mentor students of their own.

Over the course of their first year as Project NExT Fellows, each cohort participates in a variety of workshops during MAA MathFest[4] and the Joint Mathematics Meetings[5] (JMM). Previous workshop topics have included effective time management, vibrant and inclusive communities, the incorporation of modeling in differential equations, classroom orientation around inquiry, and student preparation for careers in industry. SIAM Project NExT Fellows are also strongly encouraged to maintain regular correspondence with the SIAM Education Committee[6] and take part in its activities, such as helping to organize SIAM-sponsored events at JMM and MathFest and attending SIAG/ED meetings.

SIAM is pleased to announce David Elzinga (University of Wisconsin-La Crosse) and Erin Ellefsen (Earlham College) as the newest SIAM Project NExT Fellows. Both recipients greatly appreciate SIAM's sponsorship of their Fellowships and are eager to continue their growth as educators.

David Elzinga is an assistant professor in the Department of Mathematics and Statistics at the University of Wisconsin-La Crosse. He earned a B.S. in mathematics from Wichita State University in 2018 and graduated from the University of Tennessee in 2023 with an M.S. in statistics and a Ph.D. in mathematics, with a concentration in mathematical biology.

As a graduate student, Elzinga served as co-president of the University of Tennessee SIAM Student Chapter[7] and organized events that promoted community building around applied mathematics scholarship. His research couples mathematical and statistical modeling to combat the spread of infectious diseases in animals and provide practical recommendations to natural resource managers.


Erin Ellefsen of Earlham College.

At the University of Wisconsin-La Crosse, Elzinga teaches undergraduate and graduate statistics courses and looks forward to starting his own research lab and recruiting interested students. He is grateful for all that SIAM has done to support him in his career and is excited to continue his involvement with the Society in the future.

Erin Ellefsen is an assistant professor in the Department of Mathematics at Earlham College. She received a B.A. in mathematics from Luther College in 2017 and a Ph.D. in applied mathematics from the University of Colorado Boulder in 2022. While in graduate school, Ellefsen became a SIAM member and was involved with her university's chapter of the Association for Women in Mathematics.[8] During that time, her research focused on nonlocal mathematical models with ecological applications.

Ellefsen now teaches and conducts research at Earlham, where she and her students use ordinary differential equations to model invasive species management. She is also passionate about supporting underrepresented groups in the mathematical sciences. Project NExT has already served as an invaluable foundation for Ellefsen's career by helping her implement best teaching practices in the classroom, jumpstarting her scholarship, and connecting her with a network of like-minded mathematicians. She is grateful for SIAM's sponsorship and looks forward to remaining involved with SIAM in the future and engaging with more applied mathematicians as she advances her career.

Applications for Project NExT require a personal statement, research statement, one-page curriculum vitae, and letter of support from the candidate's department chair. Eligibility requirements include a recent Ph.D. in mathematics, statistics, math education, or a similarly math-intensive field; a current teaching position; and experiences, attitudes, ideas, and leadership abilities that would benefit the cohort. To be considered for SIAM sponsorship, candidates must indicate their SIAM membership on their application. An MAA committee makes all Fellow selections, and the next application deadline is **April 15, 2024**. Visit the Project NExT website[9] for more information.

Exceptional faculty members are invaluable assets to both SIAM and the larger scientific community as a whole. SIAM is excited to continue its sponsorship of Project NExT Fellows and contribute to excellence in applied math education for future generations of interdisciplinary thinkers.

Kathleen Kavanagh is a professor of mathematics at Clarkson University and the former Vice President for Education at SIAM. David Elzinga is an assistant professor in the Department of Mathematics and Statistics at the University of Wisconsin-La Crosse. His research focuses on infectious disease spread in animals. Erin Ellefsen is an assistant professor in the Department of Mathematics at Earlham College, where she researches invasive species management.

[1] https://www.siam.org/membership/activity-groups/detail/applied-mathematics-education
[2] https://maa.org/programs-and-communities/professional-development/project-next
[3] https://maa.org
[4] https://maa.org/meetings/maa-mathfest
[5] https://www.jointmathematicsmeetings.org
[6] https://www.siam.org/about-siam/committees/education-committee
[7] https://math.utk.edu/siam
[8] https://awm-math.org
[9] https://maa.org/programs-and-communities/professional-development/project-next

Elected Leadership

Continued from page 3

problems that are driven by rapidly developing technological discoveries and an explosion of data. I would also like SIAM to play an even stronger role in recruiting and training a versatile generation of scientists who can move easily between disciplines and have impactful careers in academia, research labs, and industry."

Jan S. Hesthaven* (École Polytechnique Fédérale de Lausanne): "It is always a special honor to be elected by the SIAM membership as their voice on the SIAM Board of Trustees. The solutions to many major challenges of the day—e.g., climate change, the energy transition, or the continued development of artificial intelligence to drive innovation in science and technology—are all deeply anchored in computational and applied mathematics. These rapid and extensive changes will require us to rethink education and promote an increased societal understanding of emerging advanced technologies, some of which will be truly transformative. I look forward to helping to position SIAM as a key stakeholder in this transformation."

Cynthia Phillips (Sandia National Laboratories): "It was such a happy surprise to be elected to the SIAM Board of Trustees. With so many strong candidates, I am grateful for and humbled by the support from SIAM membership. During my term, SIAM will likely need to update its policy on the use of artificial intelligence (AI) tools like ChatGPT in publications. I hope to contribute to discussions about allowable use, such as for automatic grammar correction, which is a service to authors who are not native English speakers and to editors and reviewers. However, I believe SIAM should be cautious about allowing AI tools to write other aspects of technical papers."

SIAM Council

Elizabeth Cherry* (Georgia Institute of Technology): "I am honored to have been re-elected for a second term on the SIAM Council. I have been proud to call SIAM my professional home since I was a graduate student, and I want SIAM to play that same role in the lives of both new and established practitioners in applied and industrial mathematics and adjacent fields. It is a privilege to continue to serve SIAM in this role, help maintain the Society's prominence as a global leader, and address new challenges and opportunities."

Hans De Sterck* (University of Waterloo): "I am thrilled to continue my engagement as a member of the SIAM Council for another three-year term. There is no shortage of topics that will require the Council's specific attention: SIAM's positioning with respect to open-access publishing and reproducibility, the goal of making real improvements to equity and diversity in our field, and effective conference formats in a post-pandemic world. With its leading journals and conferences, SIAM is a great asset to our scientific community. I look forward to helping increase the reach and effectiveness of the Society as a member of the SIAM Council."

Judith Hill (Lawrence Livermore National Laboratory): "I am very honored and humbled to have been elected to the SIAM Council. I hope to champion ways for SIAM to enhance its engagement with current and future student members through increased conference participation, mentorship opportunities, and professional involvement in student chapters. To ensure that we have diverse viewpoints that represent the many experiences in our Society and profession, we must support our future members in order to retain as many perspectives as possible. I look forward to serving our community."

Andrea Walther (Humboldt-Universität zu Berlin): "I am very grateful and honored to have been elected by my colleagues to serve on the SIAM Council. We have many challenges to address in order to maintain SIAM's success: incorporating and addressing machine learning in mathematical research, providing networking opportunities and face-to-face meetings with as small a carbon footprint as possible, increasing the accessibility of publications for researchers all over the world, and supporting the professional development of young scientists in increasingly demanding environments."

The dedication of SIAM's elected leadership contributes to the Society's continued growth and sustained relevance in continuously changing times. SIAM is thankful to the entire slate of candidates, as well as the members who voted in the most recent election. We appreciate all that you do to advance the community.

Lina Sorg is the managing editor of SIAM News.

Take Advantage of SIAM's Visiting Lecturer Program

Hearing directly from working professionals about research, career opportunities, and general professional development can help students gain a better understanding of the workforce. SIAM facilitates such interactions through its Visiting Lecturer Program (VLP), which provides the SIAM community with a roster of experienced applied mathematicians and computational scientists in industry, government, and academia. Mathematical sciences students and faculty—including SIAM student chapters—can invite VLP speakers to their institutions to present about topics that are of interest to developing professional mathematicians. Talks can be given in person or virtually.

Points to consider when hosting a visiting lecturer include the choice of dates, speakers, topics, and any additional or related activities. It is important to familiarize lecturers with their audience so they can refine the scope of their talks, but just as crucial to accommodate speakers' suggestions so listeners can capitalize on their experiences and expertise. Read more about the program and view the current list of participants online.[1]

[1] https://www.siam.org/students-education/programs-initiatives/siam-visiting-lecturer-program

Musings on the Statistical Physics of Complex Systems

In a Flight of Starlings: The Wonders of Complex Systems. *By Giorgio Parisi. Penguin Press, New York, NY, July 2023. 144 pages, $24.00.*

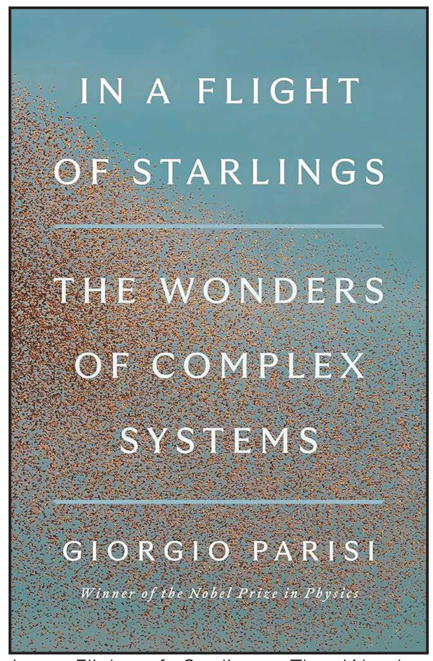
BOOK REVIEW
By David Aldous

In this slim volume with only eight short chapters, theoretical physicist Giorgio Parisi recounts his life's work and reflects on the scientific lessons he learned along the way. Parisi—who received the 2021 Nobel Prize in Physics[1] "for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales"—writes that "this book is my attempt to convey to a wide readership something of the beauty, importance, and cultural value of modern science."

Chapter 1 describes Parisi's study of the flocking behavior of starlings, which he undertook in the mid-2000s. Specifically, he recounts the difficulties of obtaining and analyzing three-dimensional photographs and videos. Parisi concludes this section by noting that local interactions determine the overall dynamics of a flock; in short, how and when a bird turns depends on its relative distance from neighboring birds. This "locality" is of course reminiscent of statistical physics models, so the chapter provides a nice example of statistical physics methods that answer a question about biological population behavior. It is also an exemplar of an effective popular-science-style exposition written by a scientist.

In chapter 2, Parisi describes the state of physics research in Rome around 1970. Here, he comments on the individuals and the work on elementary particles that he witnessed as a junior researcher. Younger readers may be particularly intrigued by some of the practical issues, such as mail communications that were routinely subject to the vagaries of the Italian postal system.

Chapter 3 provides an amiable account of Parisi's self-perceived missed opportunity for a Nobel Prize in the early 1970s, when he failed to identify the Yang-Mills fields and thus did not create quantum chromodynamics. This sentiment may resonate with some senior readers' experiences at a less rarified height. The account begins with a verbal description of a problem: Do "bounce" collisions between specific particles occur frequently or infrequently at high energies? Mathematically, the answer to this question depends on knowing whether a certain beta function is positive or negative. This chapter offers a detailed explanation of Parisi's thoughts, personal explorations, and interactions with other researchers.



In a Flight of Starlings: The Wonders of Complex Systems. By Giorgio Parisi. Courtesy of Penguin Press.

Parisi devotes chapter 4 to a dialogue about phase transitions, illustrated by both water (first-order transition) and ferromagnetism (second-order transition). This segment includes sketches of the Ising model and renormalization group methodology; it also addresses the notion that the many different occurrences of phase transitions should fall into only a few universality classes.

In chapter 5, Parisi discusses the parts of his research with which mathematicians are likely most familiar: spin glasses and the replica method. In fact, many people consider these topics to be the achievements that earned him the Nobel Prize. To quote Wikipedia,[2] "Spin glass, when contrasted with a ferromagnet, is defined as [a] 'disordered' magnetic state in which spins are aligned randomly or without a regular pattern, and the couplings too are random." To understand this concept mathematically, consider a model with two metaphoric levels of randomness: deep and surface. One can construct copies with the same realization of the deep randomness but independent realizations of the surface randomness; this construction with n copies enables the calculation of certain formulas. Parisi's "Eureka" moment arose when he considered these results as a function of n and took the continuous limit as n decreases to zero, which amazingly yielded meaningful answers. This paradoxical formulation and the overtly nonrigorous methodology naturally attracted the attention of theorem proof mathematicians. Subsequent deep work in rigorous theory is evident in the literature [3].

Parisi utilizes chapters 6 and 7 to contemplate the use of metaphors, intuition, and the birth of ideas in science. He illustrates his musings with various stories and remarks that published works in mathematics and the hard sciences "have been completely purified, reduced to formal language in which there is seldom any allusion to non-technical reasoning." In my own field of mathematical probability, however, this assessment is not true; indeed, the introduction to a research paper should—and often does—provide some intuition as to why readers would expect the main result to be correct. And regarding allusions, I am happy to use an analogy whenever the opportunity arises — such as the comparison between random walks on graphs and electrical networks, for example. In the aforementioned quotation, Parisi is presumably referring to the traditional expectation that scientific papers should contain concise exposition (likely due to the lack of physical journal space). On the contrary, this requirement is surely archaic in the digital era.

Parisi also writes about how the observation "that completely different systems could have the same mathematical

See **Complex Systems** *on page 7*

[1] https://www.nobelprize.org/prizes/physics/2021/summary

[2] https://en.wikipedia.org/wiki/Spin_glass

Cyanobacteria

Continued from page 3

Goehring said. The key quantity of interest for both the model and laboratory work was the critical density of bacteria, which was on the order of 50 strands per square millimeter (see Figure 2). "You go from gas-like behavior at low density to a collective response phase at higher density, which we can predict from back-of-the-envelope calculations, more detailed modeling, and experiments." Goehring continued. "They all agree with each other quantitatively."

The Four Fs of Mathematical Biology

This quantitative match is essential because humans frequently spot patterns that do not actually exist. Although bacterial webs may look strikingly like neuron structures in the brain or galaxy clusters on cosmic scales, the physical interactions are radically different. "Similarity of form can be incredibly deceptive," Goehring said. "You have to compare numbers; otherwise you can easily fool yourself."

"Biologists talk about three Fs: form, function, and force," Mazza said. "This trinity of Fs plays a role here because there is the filaments and the fluctuations in their shapes. If you were to condense our paper to one statement, it would be that 'the fluctuations in shape lead to this pattern, which gives rise to important biological function.'"

Mazza then acknowledged the importance of another F: the *feedback loop* between theoretical modeling and experimental evidence. Cammann agreed. "The parameters that we put in our model are all based on [laboratory] measurements of individual filaments or pairwise interactions of filaments," he said. "With all of these measured parameters on individual behavior, we get an emergent pattern that matches the emergent pattern that also appears in experiments with many filaments."

Fossil stromatolites are some of the oldest traces of life on Earth, and the filamentary webs of long-dead cyanobacteria indicate that this type of self-organization significantly predates multicellular plant or animal life. In other words, organisms were organizing since the very beginning. Understanding this organization validates the importance of collective action as an evolutionary strategy since the dawn of life. And despite the mathematical model's complexity, the present-day ubiquity of cyanobacteria also helps to explain the relevance of this work.

"We have a very pretty fountain at Loughborough," Cammann said. "Whenever someone asked me, 'What do you do for your Ph.D.?' I pointed to the fountain and said, 'The green stuff in there, this is what I do.'"

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Matthew R. Francis is a physicist, science writer, public speaker, educator, and frequent wearer of jaunty hats. His website is BowlerHatScience.org.

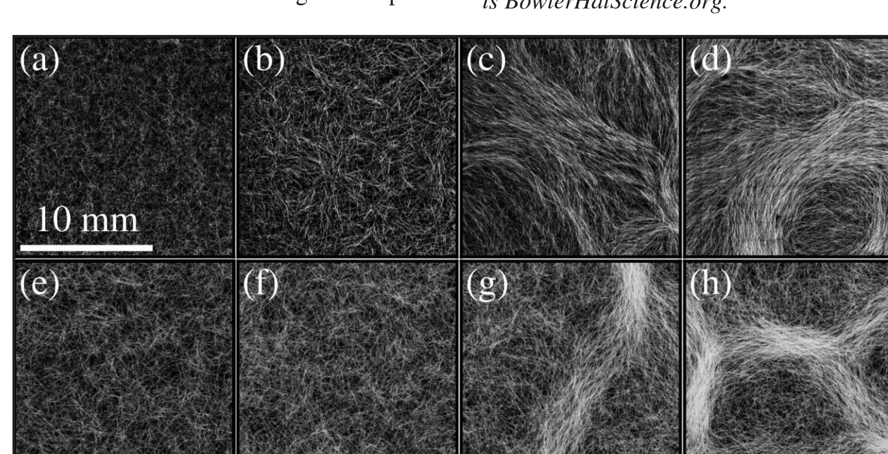

Figure 2. *Snapshots of cyanobacteria with increasing density.* **2a–2d.** *Microscopic images of the bacteria.* **2e–2h.** *Images generated by a mathematical model. The transition to self-organization occurs at the same density in both instances. Figure courtesy of [1].*

What is Entropy?

MATHEMATICAL CURIOSITIES

By Mark Levi

A short and clear answer to the question in the title of this article may be difficult to find (at least, it was for me). I would therefore like to illustrate the entropy of gas on the simple parody of ideal gas: a single particle—a "molecule"—that bounces elastically between two stationary walls. To strip away the remaining technicalities, let's take the molecule's mass as $m=1$. Our system has one degree of freedom $n=1$ (as opposed to $n=3$ in a monatomic gas).

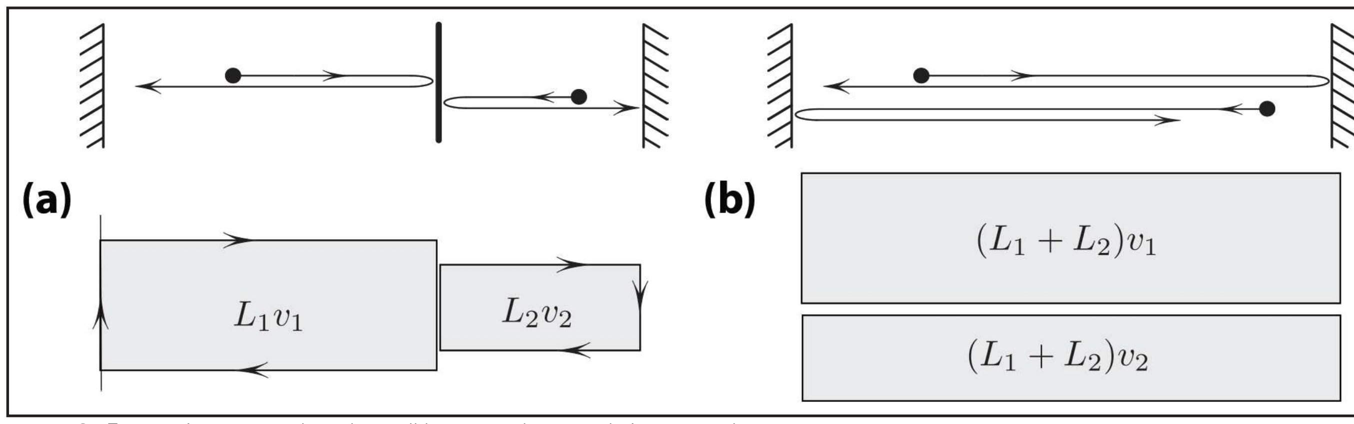

Figure 2. *Entropy increases when the wall between the vessels is removed.*

Entropy in One Sentence

The phase plane trajectory of the particle in Figure 1 is a rectangle with area $2vL$. *The entropy S of the "gas" in Figure 1 is the logarithm of the area inside the phase plane trajectory:*[1]

$$S=\ln(\text{area})=\ln(2vL). \qquad (1)$$

Taking the log in (1) is a natural (apologies for the pun) choice. For one, it makes the entropy additive. Indeed, consider a system that consists of two "vessels" with lengths L_1, L_2 and speeds v_1, v_2 (see Figure 2a). The phase space is now the Cartesian product $\{(x_1,v_1;x_2,v_2)\}$. The four-dimensional volume of the Cartesian product of two rectangles is $2v_1L_12v_2L_2=\text{Area}_1\text{Area}_2$; the logarithm of the product is thus $S=S_1+S_2$.

Another motivation for taking the logarithm is that it makes the entropy in (1) analogous to Shannon's entropy. Roughly speaking and in the simplest setting, this latter form of entropy counts the number of letters in a word; this number is then the logarithm of the number of possible words.[2] The area in Figure 1 is the most natural measure of the number of possible states, thus making S a continuous analog of Shannon's entropy.

If we add a small amount dQ of heat to the gas at temperature T, why does the entropy change according to

$$dS=\frac{dQ}{T}, \qquad (2)$$

the standard formula in most physics textbooks? Feynman's beautiful lectures explain (2) in a more realistic setting but take several pages, so here is a quick explanation of (2) in our simple case.

Explanation of (2)

Let's add heat dQ by increasing the kinetic energy of the molecule in Figure 1, which amounts to increasing v:

$$dQ=d(v^2/2)=v\,dv. \qquad (3)$$

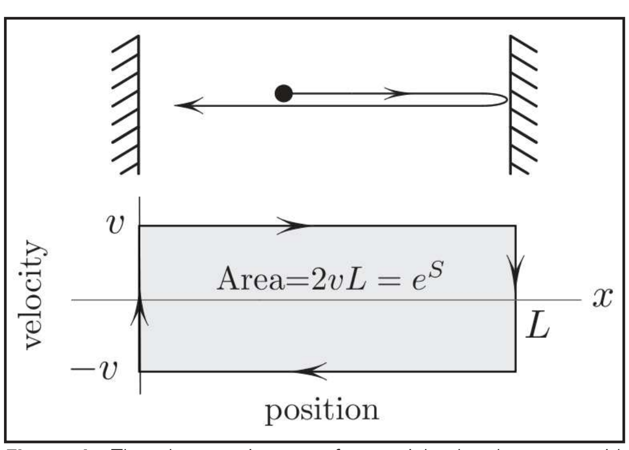

Figure 1. *The phase trajectory of a particle that bounces with speed v encloses area $2Lv$.*

The change dv in turn causes $S=\ln(2vL)$ to change:

$$dS\overset{(1)}{=}\frac{dv}{v}=\frac{v\,dv}{v^2}\overset{(3)}{=}\frac{dQ}{v^2}=\frac{dQ}{T},$$

where the "temperature"

$$T=v^2 \qquad (4)$$

is twice the kinetic energy of the molecule. I put "temperature" in quotes because it is measured in units of energy rather than degrees. The coefficient that relates the two units is called the Boltzmann constant.

Boltzmann Constant

We can measure the temperature of a gas in units of average kinetic energy of a molecule[3] per degree of freedom, or in Kelvin degrees. The coefficient between these two measures is called the Boltzmann constant k_B:

$$\frac{1}{n}mv^2=k_B\,T,$$

where n is the number of degrees of freedom and T is in Kelvin units. To put it differently, k_B is the kinetic energy per molecule per degree of freedom that is required to raise the temperature by 2°K. Not surprisingly, it is a tiny number: $k_B\approx1.4\times10^{-23}$ J/K (joules per Kelvin). The units of temperature in (4) are the same as those of kinetic energy, so "k_B" $=1$ (and also $n=1$) in that case.

Entropy Increase

When two substances are mixed, the entropy of the mixture is greater than the sum of the original entropies:

$$S_{\text{mixture}}>S_1+S_2.$$

For our one-dimensional gas, this statement borders on triviality. Indeed, consider two side-by-side vessels (see Figure 2). Removing the wall does not affect the speeds but does increase the "volume," which becomes $L=L_1+L_2$ so that

$$S_{\text{before}}=\ln(L_1v_1)+\ln(L_2v_2)<\ln(Lv_1)+\ln(Lv_2)=S_{\text{after}}.$$

Adiabatic Processes

All thermodynamics textbooks mention that entropy does not change during adiabatic processes.[4] For our "gas," this amounts to the following rigorously proved statement: *If the length $L=L(\varepsilon t)$ changes smoothly over the time interval $0\le t\le1/\varepsilon$, then the product Lv changes by the amount $O(\varepsilon)$ if ε is sufficiently small.*

This basic example captures the essential mechanism and the reason for adiabatic invariance of entropy in ideal gases. However, no rigorous proof of adiabatic invariance exists — even for the simplest system of two "molecules" that are modeled by hard disks bouncing inside of a square with slowly moving walls. The gap between what we believe and what we can actually prove is enormous.

In conclusion, it seems that discussions of entropy—at least on simple phase plane examples like the one here—belong in dynamical systems textbooks (and in physics texts when entropy is mentioned).

The figures in this article were provided by the author.

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[1] The same definition applies to the actual gas; in that case, the area is replaced by the volume that is enclosed by the energy surface in the phase space. The dimension of this space is enormous, and the volume must be measured in appropriate units.

[2] As long as we allow all possible combinations of letters, and each letter is equally probable.

[3] Twice the kinetic energy as in (4).

[4] I.e., a slow change of vessel with no heat or mass exchange with the outside.

Complex Systems

Continued from page 6

description was a very important discovery for physicists." This statement puzzles me; isn't the idea that one exponential function arises in many contexts a main practical point of mathematics? As for intuition, I found the content sadly unhelpful because it focused on rather familiar thoughts about the use of intuition in *solving* a problem. But solving a problem is the easy case; in theoretical mathematics (though perhaps less so in applied mathematics and general science), the ultimate intuition desideratum involves *formulating* a problem and choosing to work on it based on an intuitive feeling that a solution—or even an attempt at a solution—might open the door to a novel avenue of research.

Finally, chapter 8 briefly examines the relationship between science and society. For instance, Parisi notes that "it is fundamental that scientists find seeking to solve a puzzle *fun*," and continues by writing that "science and its institutions need to be funded by society, and society hardly gives a damn about whether the scientists are enjoying their work or not." He also states that "science needs to be defended not just for its practical aspects but for its cultural value," but fails to develop this theme throughout the book.

One overall comment about the text is that aside from the initial chapter on starlings, the subject material is not easy to visualize. As such, general readers may be disappointed by not really *seeing* the advertised "wonders." The overall tone is likewise a bit too cerebral to entice anyone who is not already interested in physics, and such readers may find the topics and style—which vary between chapters—rather disjointed. As reviewer Sam Kean noted in *The American Scholar*, "the book ends up stranded between different genres — not quite a beach read, not quite a memoir, not quite a pop-science primer on modern physics" [2].

My own attempts at popular exposition affirm the difficulty of choosing and adhering to a style, so—to put a positive spin on my previous remark—*In a Flight of Starlings* may serve as a testbed for one's specific taste in style. In my opinion, chapter 3 successfully provides an entertaining account of progress by different individuals that eventually solves a problem — all while using only superficial descriptions of the actual scientific issues at hand. In contrast, chapter 5 attempts a more informative verbal and pictorial description of replica symmetry (and replica symmetry breaking) that does not effectively convey the message to a reader who is unfamiliar with the physics worldview.

Regarding Parisi's memoir style, many readers are presumably familiar with G.H. Hardy's *A Mathematician's Apology*, which is replete with delightfully provocative assertions [1]. The opinions and descriptions of cultural backgrounds in Parisi's tome seem rather bland in comparison.

The SIAM audience might wonder about the connection between theoretical physics and applied mathematics. Many people likely assume that Steven Hawking was part of the Department of Physics at the University of Cambridge, when he was actually a member of the Department of Applied Mathematics and Theoretical Physics within the Faculty of Mathematics. Relativity, quantum theory, and so forth are clearly special to the properties of the physical universe, but I've always viewed statistical physics—in the context of biological or human activities—as simply a different kind of applied mathematics. And while the study of quantitative aspects of networks surely ought to be classified as applied math, it has largely been overtaken by statistical physicists and computer scientists.

To conclude on a more uplifting note, it is always worth looking at any exceptional scientist's account of science topics. Most of Parisi's chapters have something to say that does not exist elsewhere at this level, and his enthusiasm is clearly evident. Therefore, readers who already have an interest in non-mathematical descriptions of physics are sure to enjoy *In a Flight of Starlings*. The book will also prove useful for physics or applied mathematics students who wish to view the profession with a sense of breadth that is typically not evident in textbooks or university lectures.

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[1] Hardy, G.H. (1940). *A mathematician's apology*. London, UK: Cambridge University Press.

[2] Kean, S. (2023). Don't forget intuition. *The American Scholar*. Retrieved from https://theamericanscholar.org/dont-forget-intuition.

[3] Talagrand, M. (2011). *Mean field models for spin glasses: Volume II: Advanced replica-symmetry and low temperature*. In *A series of modern surveys in mathematics* (Vol. 55). Berlin, Germany: Springer-Verlag.

David Aldous is a professor emeritus at the University of California, Berkeley. His research in mathematical probability explores weak convergence, exchangeability, Markov chain mixing times, continuum random trees, stochastic coalescence, and spatial random networks. He also routinely engages in critical communication about mathematical probability's connection to the real world.

Reflections From a Student in the SIAM-Simons Undergraduate Summer Research Program

By Rachel Ahumada

2023 introduced the SIAM community to the newly established SIAM-Simons Undergraduate Summer Research Program,[1] and I was privileged to participate in the first cohort last summer. The program provides monetary support for 10 undergraduate students to work with faculty mentors, conduct and communicate scientific research, and learn about careers in applied mathematics and computational science. Here, I wish to introduce this opportunity to the broader SIAM community and extoll its benefits to students from underrepresented groups, such as people of color like myself.

Before participants begin their research, they are assigned to one of five sites across the U.S. and paired with another undergraduate student who has similar interests. Then, both students are matched with a mentor who offers suggestions for prospective research topics. For example, Drake Lewis of Kenyon College and I studied simultaneous localization and mapping (SLAM) at Rice University in Houston, Texas, under the direction of Dr. Illya Hicks, the Department Chair of Computational Applied Mathematics and Operations Research.

Throughout the program—which lasts for a total of either six or eight weeks, depending on site assignment—all students take part in weekly Zoom meetings with each other. The entire cohort also visits the Simons Foundation's Flatiron Institute[2] in New York City. During our in-person visit, we presented our work, engaged in a question-and-answer session with a panel of researchers, and toured the Institute — all of which inspired gratitude for the generosity of the Simons Foundation. Spending time with the other students also fostered a sense of connection between us. Ultimately, we concluded our summer placements by writing research papers and preparing presentations for upcoming conferences. This remarkable academic opportunity was meticulously orchestrated, with each component contributing uniquely to the experience as a whole.

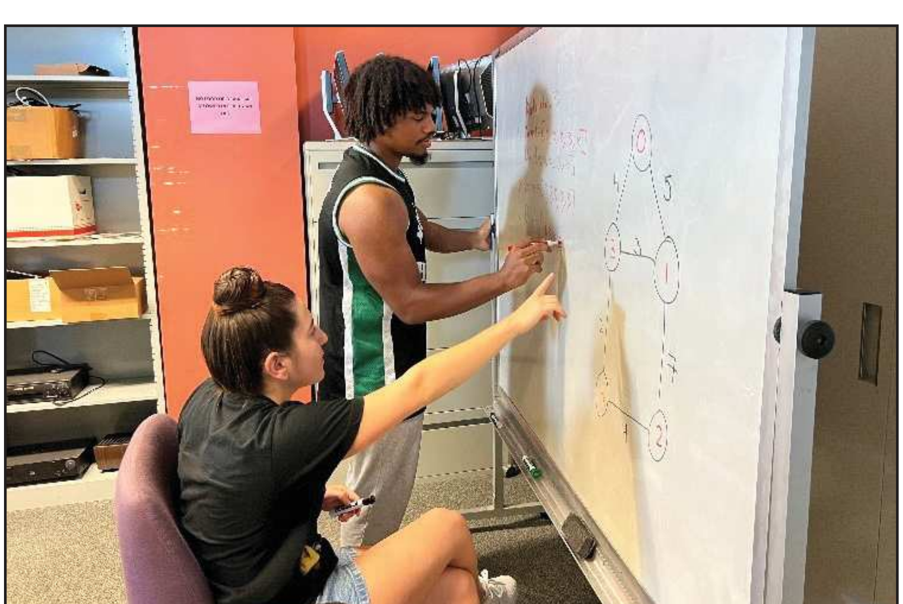
As I mentioned, my research project focused on SLAM: a technique that autonomous devices—such as rovers and self-driving cars—employ to map their surroundings and pinpoint their location within an environment. Drake and I delved into a variety of graph theory problems in order to better understand SLAM, with specific emphasis on a method called pose graph optimization (PGO) that involves a minimum cycle basis (MCB) computation. Similar to a basis of a vector space, a cycle basis of a graph is a maximal linearly independent set of cycles that can generate all other cycles in the graph. Suppose that a graph's edges have nonnegative weights; the weight of a cycle basis is then the sum of the weights of the basis elements.

PGO uses diverse robotics features to minimize the accuracy gap between a robot's estimated and actual positions—which enhances SLAM's effectiveness—while MCB forms the graph's bases with minimum weight in the calculation. Furthermore, the all-pairs shortest path (APSP) represents the shortest path from a root to all nodes in a graph and is vital in the search for the MCB. In brief, we rely on APSP to find the MCB, which is essential for PGO, which optimizes SLAM. Even though we did not have enough time for a full robotics implementation, we successfully computed all other necessary components of the problem.

Throughout my eight weeks with the SIAM-Simons program, Dr. Hicks imparted valuable strategies that significantly heightened my learning experience. He emphasized the importance of seeking guidance, encouraged us to ask questions, and reassured us that it's okay to not immediately comprehend new material and concepts. Many participants were conducting research for the first time, and it is important to recognize that perfection is not the expectation; in fact, refraining from asking questions due to potential embarrassment can be far more detrimental. Because I knew nothing about SLAM before arriving at Rice, Dr. Hicks helped me select appropriate reading materials. He advised me to assess a book's first chapter and switch to a more comprehensible text if necessary, which enhanced my understanding of research techniques and proved especially beneficial as I navigated the complexities of graph theory.

The research process reflects the distinctive approaches and challenges of each problem and is therefore unique for everyone. Drake and I committed 35-40 hours to our research project each week and established a routine of meeting twice a week with our mentor; these gatherings served as concrete opportunities to share progress, ask for guidance, and receive literature recommendations. As part of our research process, we created a collaborative project outline with Dr. Hicks that provided us with checkpoints to improve time management. Every week, we read and annotated relevant articles before transitioning to the coding task at hand. Yet despite these distinct steps, the process was far from linear. For example, sometimes Drake and I had to explore additional articles or books from the library because our initial resources were insufficient. Some days were marked by programming challenges with limited progress, while others brought significant strides that allowed us to complete our weekly tasks ahead of schedule. I learned that these ebbs and flows are a normal part of the research process. Thankfully, SIAM-Simons participants can brave the highs and lows with their partners and collaborate to solve unexpected problems, which makes the entire process less daunting.

Student participants of the 2023 SIAM-Simons Undergraduate Summer Research Program visited the Simons Foundation's Flatiron Institute in New York City to meet one another, present their projects, tour the facility, and interact with a panel of researchers. Drake Lewis of Kenyon College is on the far left and author Rachel Ahumada of Azusa Pacific University is second from left. Photo courtesy of Karen Bliss.



During the 2023 SIAM-Simons Undergraduate Summer Research Program, Rachel Ahumada (left) of Azusa Pacific University and Drake Lewis of Kenyon College studied simultaneous localization and mapping (SLAM) at Rice University under the direction of Illya Hicks. Here, the duo solves the minimum cycle basis of a graph. Photo courtesy of Ilya Hicks.

I'd like to particularly highlight the importance of sustained communication, as insights from weekly Zoom meetings with the other eight SIAM-Simons students and their mentors—as well as Dr. Karen Bliss (Senior Manager of Education and Outreach at SIAM) and occasional guests—certainly contributed to my overall academic growth. Each meeting offered a unique element of value. For example, the first get-together covered important reminders, discussed SIAM membership and other relevant information, and prepared us for our visit to the Flatiron Institute. During the following week's check-in, a panel of applied mathematicians of color shared insightful experiences, encouragement, and advice that resonated with my own journey. The third week acquainted us with graduate students who spoke about funding strategies and introduced a wealth of resources for fellowships and paid internships. And during the last meeting, we presented our research and practiced effective communication techniques.

My participation in the SIAM-Simons Undergraduate Summer Research Program provided firsthand insight into the research process, played a pivotal role in my professional development, and cemented my sense of community within the field of applied mathematics. The program offered me a unique opportunity to collaborate with a diverse group of students, which yielded new insights and expanded my perspective. I learned so much from Drake and had a lot of fun working with him; some of my fondest memories from this experience are our conversations during breaks from reading and coding. The SIAM-Simons program also sets participants apart academically, and engaging in undergraduate research helps students stand out when applying for internships, graduate school, and jobs.

I would encourage future participants to embrace any initial discomfort or uncertainties because these feelings signal personal growth. Learning occurs when you step outside of your comfort zone, and I promise that it gets easier as time goes on. Believe in yourself, trust your research partner, and remember to ask your mentor for help. And while the research aspect of this program is of course important, don't forget to have fun! Make the most of living in a new city and meeting new friends. Exploring Houston with Drake and my roommates was one of my favorite parts of this whole experience — I still keep in touch with all of them!

The SIAM-Simons Undergraduate Summer Research Program was an incredible learning experience that allowed me to grow both personally and professionally. Collaborating with such a diverse group of researchers was truly inspiring, and navigating the research process firsthand led me to seriously consider attending graduate school. Finally, I wish to thank my research partner, Drake Lewis, for his hard work and assistance throughout our project. I am also grateful to Dr. Hicks and Dr. Bo Jones of Rice University, as well as Dr. Bliss of SIAM, for their support and guidance during the entire experience. This program has created a supportive community that promotes equity, diversity, and inclusion, and I'm so excited to see the work of future participants. Ultimately, the SIAM-Simons Undergraduate Summer Research Program introduces the possibilities of graduate school and career research to people of color like me, who have the aptitude and eagerness for applied mathematics but may never have dreamed that such possibilities were attainable. Finally, I extend my sincere gratitude to the Simons Foundation for allowing me this amazing opportunity.

*Are you a student who is interested in participating in the SIAM-Simons Undergraduate Summer Research Program,[3] or do you know a student who would benefit from this opportunity? The deadline for student applications for the 2024 program is **February 7th**, and letters of recommendation are due by **February 14th**. Visit the online portal[4] to submit your application today.*

Rachel Ahumada is a senior at Azusa Pacific University, where she is pursuing a major in applied mathematics with a computer science focus. Her research interests include data analysis and data mining. Ahumada was a member of the inaugural 2023 cohort of the SIAM-Simons Undergraduate Summer Research Program.

1 https://www.siam.org/simons
2 https://www.simonsfoundation.org/flatiron
3 https://www.siam.org/simons
4 https://siam.smapply.org/prog/siam_programs

A Mentor Perspective on the SIAM-Simons Undergraduate Summer Research Program

By Karen Bliss, Malena Español, Alicia Prieto-Langarica, and Padmanabhan Seshaiyer

2023 was the inaugural year of the SIAM-Simons Undergraduate Summer Research Program,[1] which provides annual support for ten undergraduate students to embark on a focused summer curriculum of mentorship, scholarship, and research in applied mathematics and computational science. The program establishes mentors at five research sites across the U.S. and assigns two students to each location; participants receive a weekly stipend and funding for lodging, meals, and travel. Over the course of either six or eight weeks, the students work with their mentors and learn how to conduct scientific research, effectively communicate mathematical and computational science principles, and prepare for a scientific career.

The SIAM-Simons program targets U.S. students from groups that are typically underrepresented and historically marginalized in science, technology, engineering, and mathematics (STEM) — specifically ethnic minorities. Although many individuals from these groups are interested in applied math and computational science, it can be difficult for them to find role models and experiential opportunities that allow them to envision themselves forging successful careers in these disciplines. The SIAM-Simons program therefore seeks to foster a strong sense of community and belonging among participating students and instill confidence as they continue on their academic paths.

In addition to the program's immersive research component, recurring virtual meetings provide a forum for students to share their work, build their networks, and learn from others in the field via question-and-answer panel discussions about career development and graduate school. Participants also visit the Simons Foundation's Flatiron Institute[2] in New York City to meet each other in person, tour the Institute, and learn about the work of its employees. Students who took part in the inaugural cohort reported feeling more confident, connected, and capable as a result of the program.

The 2023 mentors, sites, and research projects were as follows:

- Heiko Enderling and Renee Brady-Nicholls of Moffitt Cancer Center: "Identifying Novel Biomarkers for Cancer Treatment Personalization"
- Malena Español of Arizona State University (ASU): "Computational Methods for Inverse Problems in Imaging"
- Illya Hicks of Rice University: "Minimum Cycle Basis for Pose Graph Optimization"
- Alicia Prieto-Langarica of Youngstown State University (YSU): "Cost/Benefit Analysis of Yearly Mammograms: A Social Justice Approach to Individualized Medicine"
- Padmanabhan Seshaiyer of George Mason University (GMU): "Program MASTER: Modeling, Analysis, and Simulation for the Grand Challenges Through Innovative Training, Education, and Research."

Here, three of the mentors from the 2023 cohort discuss their respective projects, reflect on their experiences, and advocate for the importance of research and professional development opportunities for undergraduate students.

Malena Español of ASU: "Computational Methods for Inverse Problems in Imaging"

At the ASU site, students Ashley Ramsay-Allison of Florida State University and Kelsi Anderson of St. Mary's College of Maryland worked to determine parameters for curve fitting in nonlinear models. The students' invaluable contributions throughout the summer included calculating Jacobian matrices for various nonlinear functionals and implementing them via MATLAB. They also utilized both synthetic and real data to produce a comparative analysis of the Gauss-Newton method, alternating least squares, and variable projection methods. Throughout the eight-week program, Ashley and Kelsi developed and honed their proficiency in MATLAB, LaTeX, and Overleaf, and enhanced their communication and teamwork skills.

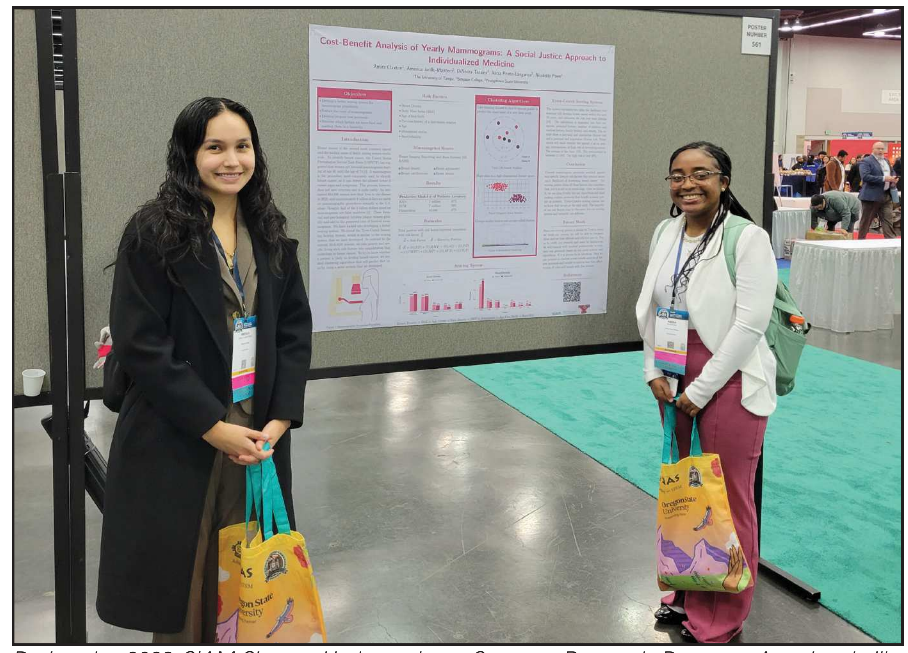
SIAM provided everyone with mentor-participant guidelines but encouraged mentors and student pairs to modify them to suit their unique personalities and needs. Agreeing on expectations and communication strategies from the project's onset was especially helpful, and the whole experience was very rewarding. The students were motivated, independent, and otherwise outstanding in their mathematical and programming capabilities.

Alicia Prieto-Langarica of YSU: "Cost/Benefit Analysis of Yearly Mammograms"

The U.S. Preventative Services Task Force[3] recommends that women who are 40 years of age and older receive biennial breast cancer screenings via mammography. In light of this guideline, participants of the six-week YSU project examined breast cancer risk factors, screening techniques, inequities in screening access and healthcare in the U.S., and different types of screening protocols in other countries. The SIAM-Simons program ran concurrently with a National Science Foundation Research Experience for Undergraduates[4] (REU) at YSU; as such, SIAM-Simons students Amira Claxton of the University of Tampa and America Jarillo-Montero of Simpson College collaborated with REU student DiDi Tensley of YSU. Using a public database of risk factors and cancer diagnoses, the trio employed clustering algorithms and classification methods to group women into three categories based on their level of breast cancer risk.

Amira, America, and DiDi joined other REU students every weekday morning for a "working breakfast" that included various community-building activities (led by myself or a YSU student assistant). Next, the SIAM-Simons participants met with me to discuss the previous day's progress; together, we would make a plan for the remainder of the morning. After a break for lunch, most afternoons began with a professional development session. These sessions covered a variety of topics, such as professionalism in STEM, careers in mathematics, graduate school, CVs and branding, and effective research presentations. After a mid-afternoon progress update and goal-setting session, the student researchers continued with their daily tasks. We hosted a group trip for them every weekend and organized other outings as well. After the summer activities concluded, Amira and America attended the SACNAS National Diversity in STEM Conference[5]—which took place in Portland, Ore., last October—and presented a poster about their work.

As a YSU professor, I seldom see students of color in my mathematics classrooms; working with math majors or research students of color is even more uncommon. I love engaging with all of my students, but collaborating with Amira, America, and DiDi—three women of color—was the most rewarding professional experience of my career thus far. Due to our shared backgrounds and experiences, it was easy to build connections; understand their concerns, fears, and hesitations; and address them effectively and promptly. I highly recommend this program to interested students and professors. There is nothing like being able to be your full self and do math.



During the 2023 SIAM-Simons Undergraduate Summer Research Program, America Jarillo-Montero of Simpson College (left) and Amira Claxton of the University of Tampa utilized clustering algorithms and classification methods to study breast cancer risk factors and screening techniques. They conducted their research under the direction of mentor Alicia Prieto-Langarica of Youngstown State University. Here, Jarillo-Montero and Claxton present a poster of their results at the SACNAS National Diversity in STEM Conference, which took place in October in Portland, Ore. Photo courtesy of Alicia Prieto-Langarica.

Padmanabhan Seshaiyer of GMU: "Program MASTER"

As mentors and educators, it is important to expose students to work that expands beyond mere discovery and addresses real-world problems with tangible impacts on society. This mentoring philosophy helps me better connect with my students, so I was pleased to learn that I was selected to serve as a mentor in the inaugural 2023 SIAM-Simons program. In addition to coaching two motivated undergraduates on advanced topics in mathematics, problem solving, data-driven modeling, computing, visualization, and multidisciplinary applications, I sought to enhance their awareness of the ever-increasing utility of mathematical approaches in biological, engineering, and bio-inspired systems.

I was excited to meet the students that were assigned to my site at GMU: Adan Baca of the University of Arizona and Diego Gonzalez of the University of La Verne. As a research mentor in this new program, I aimed to nurture their curiosity; encourage them to explore real-world, global challenges; guide and support them as they navigated the complexities of mathematical modeling; create interdisciplinary connections beyond mathematics; and provide opportunities for scientific and professional growth. During the program, GMU graduate student Alonso Ogueda also served as a co-mentor. He met individually with the students to discuss the merits of graduate school and otherwise serve as a sounding board for their professional development.

For their project, Adan and Diego modeled, simulated, and analyzed a patient detox journey. They utilized a modified susceptible-infected-recovered (SIR) epidemiological framework to generate a mathematical model that treats addiction as an infectious disease, accounts for its unique factors, and depicts its perpetuation throughout communities and populations. This novel model examines the impact of different types of treatment interventions, demonstrates the efficacy of recovery and treatment programs in lowering addiction rates, and holds promise for public health decision-making and resource allocation.

Although Program MASTER was hosted within GMU's Department of Mathematical Sciences, the SIAM-Simons participants also engaged with Holly Matto from the College of Public Health, who specializes in social work and is an expert in addiction research. She helped us identify missing compartments in our SIR model and incorporate important

See **Mentor Perspective** *on page 11*

Adan Baca (left) of the University of Arizona and Diego Gonzalez of the University of La Verne worked with mentor Padmanabhan Seshaiyer of George Mason University (GMU) during the inaugural SIAM-Simons Undergraduate Summer Research Program in 2023. While at GMU, Baca and Gonzalez modeled, simulated, and analyzed a patient detox journey by treating addiction as an infectious disease. Photo courtesy of Evan Cantwell.

[1] https://www.siam.org/simons
[2] https://www.simonsfoundation.org/flatiron
[3] https://www.uspreventiveservicestaskforce.org/uspstf/draft-recommendation/breast-cancer-screening-adults
[4] https://www.nsf.gov/crssprgm/reu
[5] https://www.sacnas.org/conference

Another Robust Year for SIAM Publications

By Kivmars Bowling

2023 was a vibrant year for SIAM Publications, with the realization of key initiatives around new technologies, research integrity, and global outreach. It was also heartening to witness the lively return of in-person interactions at conferences, where our book acquisition editors and journal editorial board members engaged in fruitful discussions with the community.

Submissions to SIAM's renowned journals were consistently strong, and surging journal article downloads once again reflected the content's high quality. Following similarly robust growth in 2021 and 2022, 2023 saw a 15 percent increase in downloads; a SIAM journal article is now downloaded once every 24 seconds. This growth was driven in part by ongoing upgrades to the SIAM Publications Library.[1] In addition to the existing PDF format, we introduced Extensible Markup Language (XML) versions of nearly all new SIAM journal articles last year, which offers readers an additional onscreen viewing option that is responsive to different digital devices.

New Online SIAM Bookstore

In December 2023, we reached another major milestone with the launch of our new online SIAM Bookstore[2] within the SIAM Publications Library (see Figure 1). This integration provides far greater reach and exposure for SIAM books, especially given the extensive global audience that visits the platform each year. The bookstore includes several exciting new features:

- **Single Sign-on:** SIAM members can now secure their year-round 30 percent member discount on SIAM books by signing in with their existing *my.siam.org* credentials (members should use the same email address that is associated with their account). Indeed, any registered user on the SIAM Publications Library will use SIAM login credentials; two sets of login details are no longer needed.
- **E-books for Individuals:** For the first time, you can now purchase online access to SIAM's e-book titles right from the bookstore. This feature makes the books continuously and easily accessible, though PDF download is not available.
- **Print and E-book Bundles:** Users can buy both the print and e-book versions of certain titles in one transaction. Members receive a 35 percent discount and nonmembers receive a 20 percent discount on bundled list prices.
- **Predictive Search:** Finding your next read has never been easier. Our predictive search feature anticipates your queries and provides instant suggestions as you type.
- **Textbook Browse:** You can now easily browse all SIAM textbooks in one place.[3]
- **Personalized Recommendations:** Our advanced recommendation system learns your reading preferences and suggests books and other content that is tailored just for you.
- **Guest Checkout:** Nonmembers and new customers can now use a guest checkout for added speed and convenience.

SIAM's outstanding book collection encompasses more than 600 titles on applied mathematics, computational science, and data science that are written by renowned authors. The funds from SIAM book sales go towards supporting our community of researchers, educators, and students through conferences,[4] individual member benefits, SIAM Career Fairs,[5] the SIAM Job Board,[6] and more. So be sure to explore the new bookstore today! It is easier than ever to find books that will be indispensable to your research, teaching, or learning endeavors.

If you have an idea for a new book project, please contact Elizabeth Greenspan (executive editor of SIAM Books) at **greenspan@siam.org**. SIAM publishes high-quality monographs and textbooks and is always seeking proposals for more general interest books.

Finally, SIAM sincerely thanks those book authors[7] who have graciously donated all or part of their royalties this year to support the SIAM Student Travel Fund.[8] Your generosity ensures that the next generation of applied mathematicians and computational scientists can attend and present their work at future SIAM conferences.

Research Integrity, Artificial Intelligence, and Reproducibility

The topic of research integrity has become increasingly prevalent across scholarly publishing in light of growing challenges that are associated with large language models, paper mills (fraudulent organizations that produce fake manuscripts and data and sell authorship), image manipulation, and reproducibility. SIAM is actively engaged in discussions and pilot projects across the industry, and SIAM Publications took two specific steps in this arena last year.

First, after extensive consultation among various publications committees, we published the SIAM Editorial Policy on Artificial Intelligence[9] (AI) in October 2023. SIAM extends its sincere thanks to all of the volunteers who contributed valuable feedback throughout this process. The policy states that SIAM authors are permitted to use AI for tasks like language polishing or editing, but any use must be fully documented and acknowledged. Authors assume full responsibility for the integrity, accuracy, originality, and copyright of any submitted content. SIAM recognizes that the existing policy will undoubtedly require subsequent revision over time with the continued development of technology and conversations on acceptable use.

Second, the *SIAM Journal on Scientific Computing* (*SISC*) started to offer reproducibility badges in early 2023. Authors who make their code and data available in a permanent public repository or via *SISC* supplementary materials may request a "*SISC* Reproducibility Badge: Code and Data Available" at the time of manuscript submission (see Figure 2). More than 10 published articles already display the badge; this paper[10] serves as an example.

Figure 2. *Authors who write for the SIAM Journal on Scientific Computing (SISC) and make their code and data available in a permanent public repository or via SISC supplementary materials can request a "SISC Reproducibility Badge: Code and Data Available" when submitting their papers.*

SIAM is currently assessing additional tools and procedures to preserve research integrity and help make science more reproducible and impactful. However, the greatest defense against integrity issues is the *people* who are involved in the SIAM editorial process: the many SIAM editors and reviewers who perform outstanding work and vigilantly apply their expertise, as well as the SIAM staff who deliver industry-leading levels of copyediting and production quality control. So let me thank everyone who participates in this process and contributes to its discerning robustness.

Editor-in-chief Transitions

2024 brings editor-in-chief (EIC) transitions for three of SIAM's journals: the *SIAM Journal on Applied Dynamical Systems* (*SIADS*), *SIAM Journal on Control and Optimization* (*SICON*), and *SIAM Journal on Mathematics of Data Science* (*SIMODS*). We extend our utmost appreciation to the outgoing EICs for their outstanding leadership over the past six years and welcome their successors (see Figure 3, on page 12). Particular thanks go to Tamara Kolda of MathSci.ai as the founding editor-in-chief of *SIMODS*, which has already developed into an outstanding, highly regarded journal under her capable guidance.

Request for Input: Developing Skills for Early-career Researchers

As research quality around the world continues to grow, SIAM must engage young scientists and position itself as the global voice for applied mathematics, computational science, and data science. To that end, the Society hosted two webinars in June 2023—one in English and one in Mandarin—for early-career journal authors and reviewers in Asia. Both webinars addressed a variety of relevant questions: "How do you submit to SIAM journals?" "What makes a good SIAM article?" "How do you write a strong review?" and "What should you think about as a new reviewer?" These trainings followed in the footsteps of a popular in-person event[11] on the same topic at the 2022 SIAM Annual Meeting.[12]

Howard Elman of the University of Maryland (SIAM's Vice President for

See **SIAM Publications** *on page 12*

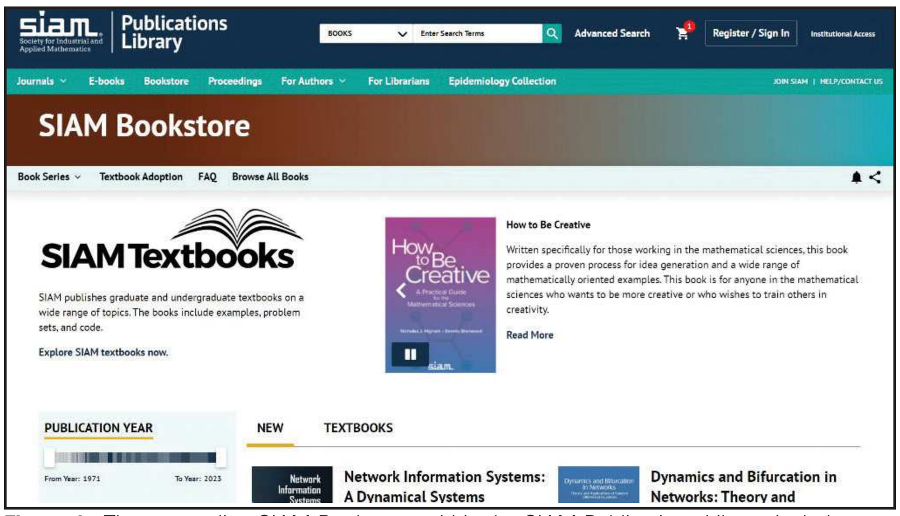


Figure 1. *The new online SIAM Bookstore within the SIAM Publications Library includes several exciting features and offers greater reach and exposure for SIAM books.*

[1] https://epubs.siam.org
[2] https://epubs.siam.org/bookstore
[3] https://go.siam.org/VhKngA
[4] https://www.siam.org/conferences/calendar
[5] https://www.siam.org/careers/resources/siam-career-fairs
[6] https://www.siam.org/careers/job-board
[7] https://www.siam.org/publications/books/about-siam-books/for-authors/detail/student-travel-fund-supporters
[8] https://www.siam.org/conferences/conference-support/siam-student-travel-awards
[9] https://epubs.siam.org/artificial-intelligence
[10] https://epubs.siam.org/doi/full/10.1137/22M1536510
[11] https://sinews.siam.org/Details-Page/navigating-the-world-of-journal-publication-as-an-early-career-researcher
[12] https://www.siam.org/conferences/cm/conference/an22

A Year of Growth and Learning at SIAM

By Paula White

Now that the new year is upon us, I have begun to reflect on everything that I have learned since joining SIAM as the Membership Manager in July 2023. These last six months have flown by, and while I acknowledge that I still have much to learn about SIAM, I have already met many staff and community members who have taught me an enormous amount in a short span of time. I would thus like to share a little of my newfound knowledge, highlight some of the Membership team's 2023 accomplishments, and explain their corresponding impacts.

SIAM membership is growing once again. Like many member-based organizations, SIAM membership numbers declined during the COVID-19 pandemic (presumably due to the lack of in-person conferences and events). Encouragingly, however, 2023 was the first year to show an increase in membership since the pandemic's onset — a promising sign that the community is beginning to re-engage with the Society and take advantage of its many benefits.

Student membership in particular has experienced an auspicious increase. And why wouldn't it? Most students can join for free![1] Full-time students are eligible for free membership if they are graduate students at a SIAM Academic Member Institution,[2] involved with a SIAM Student Chapter,[3] or nominated by any regular SIAM member. The benefits of free student membership are identical to regular student membership (regular student members only pay $25 per year), except that free student members only receive *SIAM Review*[4] in electronic format and are not eligible to vote in SIAM elections.

The formation of new SIAM Student Chapters[5] is partially responsible for the recent increase in student membership. 2023 saw the establishment of 14 additional chapters and the reactivation of four formerly lapsed chapters; in addition, five more applications for new chapters are currently pending. SIAM Student Chapters provide participants with invaluable opportunities to develop networks with faculty members and colleagues outside of the classroom, share ideas and research with like-minded people, learn about career prospects, and hone their leadership skills.

Regular membership numbers are also beginning to rebound. Recruitment and retention of this group have both risen in the last year, which is a great sign because regular members are among SIAM's most engaged individuals. They routinely attend and speak at SIAM conferences,[6] purchase SIAM journals and books and/or regularly contribute content, and join SIAM Activity Groups[7] (SIAGs).

Unfortunately, early-career memberships have not sustained such growth, despite the plethora of benefits and discounted membership rate: a 50 percent discount on the price of regular membership for the first three years after graduation, and a 25 percent discount for the fourth and fifth years. Both students and early-career members can take advantage of SIAM travel awards[8] for conferences, utilize the SIAM Job Board,[9] attend SIAM Career Fairs,[10] and access information about internships,[11] fellowships,[12] and other resources[13] that help identify career opportunities.

All types of SIAM membership offer plenty of ways to engage with the organization. SIAM currently has 15 Sections[14] in different geographical regions—10 within North America and five beyond it—with a 16th soon to appear in Northern-Central California. The SIAM New York – New Jersey – Pennsylvania Section[15] launched in 2023 and held its inaugural conference in October,[16] and many Sections reported record or near-record attendance at their annual meetings last year. Most Section membership is free and automatic for any current SIAM member who lives or works in the geographical area of the Section in question. To become involved with a SIAM Section, simply attend a Section activity or contact the Section officers in your locality.

All 23 SIAGs utilize SIAM Engage,[17] SIAM's online community platform where members can network with each other and share information about upcoming meetings and career prospects. Six SIAGs currently host active webinar series throughout the year, with a collective total of 34 webinars in 2023. All of these events are promoted on Engage, so be sure to join the platform if you have not yet done so. SIAM Sections will also migrate their listservs to Engage in 2024. Members can look forward to more exciting webinars and chances to connect during the year.

How can you help us ensure continued growth in 2024? Existing members can support the SIAM community and strengthen our profession in a variety of ways:

- Nominate two students for free membership. All regular SIAM members can nominate two students each year!
- Encourage recent graduates in your circles to join SIAM. As I mentioned earlier, early-career members receive a 50 percent discount on the price of regular membership for their first three years after graduation.
- Select the auto-renew option at *my.siam.org* so you don't forget to renew your membership at the end of the year. Doing so eliminates renewal reminders and guarantees that you retain access to important benefits like discounts on journals, books, and conferences; access to SIAGs and Engage; and more. Just check the "auto-renew" box when you renew online and your membership will automatically renew at the end of the year.

As I have learned and hopefully made evident, SIAM has much to offer its members. I encourage you to make a New Year's resolution to take advantage of the many opportunities to learn and grow through SIAM in 2024.

Paula White is the current Membership Manager at SIAM.

1 https://www.siam.org/membership/join-siam/individual-members/student
2 https://go.siam.org/RO0OaH
3 https://www.siam.org/students-education/student-chapters
4 https://www.siam.org/publications/journals/siam-review-sirev
5 https://www.siam.org/students-education/student-chapters/start-a-chapter
6 https://www.siam.org/conferences/calendar
7 https://www.siam.org/membership/activity-groups
8 https://www.siam.org/conferences/conference-support
9 https://jobs.siam.org
10 https://www.siam.org/careers/resources/siam-career-fairs
11 https://www.siam.org/careers/internships
12 https://www.siam.org/careers/fellowships
13 https://www.siam.org/careers/resources
14 https://www.siam.org/membership/sections
15 https://www.siam.org/membership/sections/detail/siam-new-york-new-jersey-pennsylvania-section
16 Read more about the inaugural meeting of the SIAM New York – New Jersey – Pennsylvania Section on page 4 of this issue.
17 https://engage.siam.org/home

Every type of SIAM membership—from free student membership to regular membership—offers plenty of opportunities to engage with the Society and take advantage of its many benefits and offerings. Stop by the SIAM booth at an upcoming conference for more information or to chat with a staff member. Photo courtesy of Paula White.

Mentor Perspective

Continued from page 9

state transitions; I encourage future mentors to employ a similarly multilayered approach.

Adan and Diego presented this work as both a poster and full talk at the 16th Annual International Symposium on Biomathematics and Ecology Education and Research[6] at Virginia Commonwealth University in November 2023. Both students also delivered two different presentations on this topic at the 2024 Joint Mathematics Meetings,[7] which took place in San Francisco, Calif., in early January. We are currently preparing to submit our results to a peer-reviewed journal for consideration.

Undergraduate research provides students with a valuable experience that goes beyond academic learning to shape their skills, knowledge, and attitudes; prepare them for future careers; and contribute to the advancement of knowledge in STEM. I commend both SIAM and the Simons Foundation for creating a partnership that promotes such impactful undergraduate research in applied mathematics.

Conclusions

The inaugural 2023 cycle of the SIAM-Simons Undergraduate Summer Research Program was a tremendous success, and participating students offered overwhelmingly positive feedback. 97 percent of students reported either good or great gains in research skills, and 90 percent reported good or great gains in attitudes (i.e., enthusiasm and interest in applied math, confidence, and so forth). "I gained so many great things from this [program]," America Jarillo-Montero of Simpson College, who worked with Alicia Prieto-Langarica of YSU, said. "I met fantastic people, made great memories, got one step ahead in my career, and gained resources and information about things I always considered out of my reach." Kelsi Anderson of St. Mary's College of Maryland spoke about her positive experience with Malena Español at ASU, increased sense of self-assurance, and newfound appreciation for mathematics. "I felt more connected to applied math when working with people who look like me and share similar interests," she said. "Realizing my capability throughout this program also helped me feel more in touch with the field."

All 2023 participants are encouraged—and will receive funding—to present their research at the in-person component of the 2024 SIAM Annual Meeting,[8] which will take place from July 8-12 in Spokane, Wash. In the meantime, SIAM is already gearing up for the program's 2024 cycle. The 2024 mentors, sites, and research projects are as follows:

- Henry Boateng of San Francisco State University: "Fun at the Intersection of Linear Algebra and Probability"
- John Jungck of the University of Delaware: "Biomimetic Design Criteria for Self-assembly and Self-folding Viral Capsid Models"
- Sooie-Hoe Loke of Central Washington University: "Interest Rate Modeling and Asset Pricing in Incomplete Markets"
- Marilyn Vazquez Landrove of Simpson College: "Data Augmentation Applied to Tabular Data"
- Alexandria Volkening of Purdue University: "Characterizing Biological Patterns Using Optimal Transport and Topological Data Analysis."

Details about each of these projects is available online.[9] Student applications for the 2024 cohort must be submitted by **February 7th**, and letters of recommendation are due by **February 14th**. If you are an interested student, visit the online portal[10] to submit your application today.

The application window for SIAM members who wish to serve as mentors for the 2025 cycle of the SIAM-Simons Undergraduate Summer Research Program will open in July, with a deadline of September. The importance of undergraduate research and mentorship cannot be overstated, so please consider hosting a research project at your institution next year.

Karen Bliss is the Senior Manager of Education and Outreach at SIAM. Malena Español is an assistant professor in the School of Mathematical and Statistical Sciences at Arizona State University. Her research interests include inverse problems, image processing, and materials science. Alicia Prieto-Langarica is a distinguished professor in the Department of Mathematics and Statistics at Youngstown State University. Her research focuses on applied mathematics in fields like biology, sociology, and public policy. Padmanabhan Seshaiyer is a professor of mathematical sciences at George Mason University who previously served as chair of the SIAM Diversity Advisory Committee. He works in the broad area of computational mathematics, mathematical biology, data science, biomechanics, design thinking, and STEM education.

6 https://math.vcu.edu/events/past-events/16th-annual-international-symposium-on-biomathematics-and-ecology-education-and-research.html
7 https://jointmathematicsmeetings.org
8 https://www.siam.org/conferences/cm/conference/an24
9 https://www.siam.org/simons
10 https://siam.smapply.org/prog/siam_programs

SIAM Texas-Louisiana Section Holds Sixth Annual Meeting

By Bruce Wade

The SIAM Texas-Louisiana (TX-LA) Section[1] held its 6th Annual Meeting[2] (TXLA23) in Lafayette, La., from November 3-5, 2023. The Department of Mathematics at the University of Louisiana at Lafayette (UL Lafayette) hosted the three-day conference, which attracted more than 350 attendees — including 249 speakers and 165 undergraduate and graduate students. This record-breaking number of participants demonstrates the tremendous growth of the SIAM TX-LA Section and the continued success of UL Lafayette's Department of Mathematics.

The TXLA23 program[3] consisted of a career panel, a mentoring workshop, a poster session, 34 unique minisymposia, and four plenary lectures; SIAM provided travel support for the plenary speakers and 20 travel awards for students. Presenters reported on cutting-edge methodologies and computational algorithms in research areas such as applied algebra, algebraic geometry, biomathematics, computational mathematics, data science, and various application areas in science and engineering.

The four plenary lecturers shared novel research in a variety of fields. Susanne Brenner (Louisiana State University) and Maxim Olshanskii (University of Houston) addressed finite element methods in two different contexts: for problems with rough coefficients and for the solution of partial differential equations (PDEs) on surfaces. Marta D'Elia (Pasteur Labs) discussed scientific machine learning in industrial pipelines, and Robert Kirby (Baylor University) spoke about high-level software for numerical PDEs.

The 45-minute career panel, which took place on the first day of the conference, featured panelists Henry Schenck (Auburn University), Matthias Maier (Texas A&M University), and Phillip Whitman (UL Lafayette). The speakers outlined their respective employment trajectories, offered nuanced advice based on their own experiences, answered questions from the audience, and stimulated interesting discussions with attendees.

Attendees of the 6th Annual Meeting of the SIAM Texas-Louisiana Section, which was held in November 2023 at the University of Louisiana at Lafayette, enjoy a banquet at the end of the conference's second day. Photo courtesy of Kimberly Gardner.

53 presenters participated in the poster session at TXLA23, including the following six Outstanding Student Poster winners:

- 1st place: Jaryd Domine (Southern Methodist University) for "Waves in Black Hole Geometries: An Energy-based Discontinuous Galerkin Method"
- 2nd place: Kendall Gibson (Tulane University) for "Modeling the Elastohydrodynamics of Swimming Choanoflagellates"
- 3rd place: Daniela Florez Pineda (Tulane University) for "Assessing the Risk of Dengue Outbreaks Across Continental Biomes in Brazil"
- Tie for 4th place: Kyle Earp (Tarleton State University) for "Bayesian Methods to Infer Parameters for ODE Models of Disease Spread"
- Tie for 4th place: Sang-Eun Lee (Tulane University) for "Collective Dynamics of Self-avoidant, Secreting Particles"
- Tie for 4th place: David Pecoraro (Texas A&M University) for "Approximation of the Compressible Euler Equations in the Low Mach Limit."

The TXLA23 Organizing Committee consisted of Azmy Ackleh, Hayriye Gulbudak, Amy Veprauskas, Bruce Wade (chair), Xiang-Sheng Wang, and Yangwen Zhang (all from UL Lafayette), as well as the SIAM TX-LA Section officers: President Andrea Bonito (Texas A&M University), vice president Shawn Walker (Louisiana State University), secretary Jesse Chan (Rice University), and treasurer Natasha Sharma (University of Texas at El Paso).

TXLA23 received positive feedback from attendees for its vibrant scientific program and strong student presence. We hope that its success will carry over to next year's event, which will take place at Baylor University in late 2024.

Attendees and speakers at the 6th Annual Meeting of the SIAM Texas-Louisiana Section—which took place at the University of Louisiana at Lafayette (UL Lafayette) in November 2023—gather for a group photo. From left to right: Jude Kong (York University), Saburi Rasheed (UL Lafayette), Olaniyi Iyiola (Morgan State University), Bruce Wade (UL Lafayette), Ayodele Ashefon (UL Lafayette), and Nchedo Nwankwor (UL Lafayette). Photo courtesy of Bruce Wade.

Bruce Wade is the C.B.I.T. TC/LEQSF Regents Professor of Mathematics and head of the Department of Mathematics at the University of Louisiana at Lafayette. He holds a Ph.D. in mathematics from the University of Wisconsin-Madison with a specialization in computational math. Wade completed a postdoctoral appointment at Cornell University and is an emeritus professor at the University of Wisconsin-Milwaukee.

[1] https://www.siam.org/membership/sections/detail/siam-texas-louisiana-section-siam-txla
[2] https://www.siam.org/conferences/cm/conference/txla23
[3] https://userweb.ucs.louisiana.edu/~C00424602/SIAMTXLA2023

SIAM Publications

Continued from page 10

Publications) and Susanne Brenner of Louisiana State University (associate editor of the *SIAM Journal on Numerical Analysis* and a SIAM Past President) led the English webinar, while Qiang Du of Columbia University (editor-in-chief of the *SIAM Journal on Applied Mathematics*) and George Yin of the University of Connecticut (then-editor-in-chief of *SICON*) hosted the Mandarin event. SIAM is grateful to these individuals for taking the time to share their expertise and advice.

In light of the clear demand for this type of training, SIAM is currently assessing the prospect of creating a bank of online resources to guide researchers on key professional skills. But what topics should such resources cover? If you are a student or early-career researcher, what would you find most useful? If you mentor students and early-career researchers, what would help them develop the necessary skills to build a successful career in academia or industry?

Students and SIAM members have already suggested the following topics to me: How to craft a good article abstract, how to write a solid peer review, how to create a compelling conference poster, how to deliver a successful conference presentation, and how to avoid plagiarism and comply with publication ethics. If you have ideas for possible topics, please record your thoughts on this Google Form[13] and indicate whether you are willing to collaborate with SIAM to create or test such resources; this will help gauge interest among the SIAM community.

Equity, Diversity, and Inclusion

In May 2023, SIAM began to ask journal authors, editors, and referees for gender and diversity information on a voluntary, opt-in basis. The peer review system[14] prompts users to share this data when they create or update their profiles, and authors and referees receive email links that encourage them to do so. Only SIAM staff can see the data, and only in the aggregate on an anonymous basis (not for individual users). SIAM does not utilize this information to make publication decisions, nor do we share it with third parties.

To date, SIAM has received 1,536 responses about gender, 1,351 responses about ethnicity, and 1,397 responses about race. We encourage authors, editors, and referees to complete their profiles so that we can establish a baseline picture of the diversity within SIAM journals. SIAM will then use these records to identify trends and measure the progress of activities that are designed to strengthen equity, diversity, and inclusion within the organization.

[13] https://go.siam.org/NW1ef8
[14] https://peerreview.siam.org

SIAM Journals and Open Access Funder Mandates

All SIAM journals are already fully compliant with the European Plan S and U.K. Research and Innovation funder mandates via *green open access routes*. More information is available online.[15]

In 2022, the U.S. Office of Science and Technology Policy released a new public access policy called the Nelson Memo.[16] A key change from the 2013 Holdren Memo[17] was the elimination of the 12-month embargo for federally funded work. In 2023, several U.S. federal agencies released drafts and sought public consultation for their respective updated public access policies, which will go into effect by the end of December 2025. At this point in time, the drafts indicate that SIAM authors will be able to comply with the policies by depositing a copy of their accepted manuscript in the relevant federal agency repository (also known as the green open access route). We will provide confirmation once the federal policies are finalized.

[15] https://epubs.siam.org/journal-authors#openaccess
[16] https://www.whitehouse.gov/wp-content/uploads/2022/08/08-2022-OSTP-Public-Access-Memo.pdf
[17] https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf

Please Recommend SIAM Journals and E-books to Your Libraries

The continued health of SIAM's high-quality publishing program—and the health of many SIAM programs for the global research community—relies heavily on institutional support in the form of journal subscriptions and library e-book purchases. Large commercial publishers dominate library budgets, so it is very important for librarians to hear from you if you support and appreciate the rigor and quality of SIAM publications. *Please reach out to your librarian and recommend that they subscribe to SIAM journals and e-books for your research and teaching needs.* Your voice as a faculty member or student makes a tremendous difference.

It is also important to note that librarians always look at full-text downloads as a key metric when deciding which resources to renew. *Remember to access SIAM journals from within your campus IP range or institutional VPN whenever possible*; every downloaded SIAM article shows your librarian the value of and demand for SIAM resources.

Thank you to everyone in the SIAM community who devotes their time and energy to ensure the outstanding quality of SIAM publications. And thank you to those who read and engage with our content. I look forward to talking with more of you at one of the upcoming SIAM conferences this year. And of course, feel free to reach out to me at **bowling@siam.org** with any ideas, questions, or comments.

Kivmars Bowling is the Director of Publications at SIAM.

Publication	Outgoing Editor-in-Chief	Incoming Editor-in-Chief
SIADS	Evelyn Sander (George Mason University)	Lora Billings (Montclair State University
SICON	George Yin (University of Connecticut)	Huyên Pham (Université Paris Cité)
SIMODS	Tamara G. Kolda (MathSci.ai)	Mikhail Belkin (University of California San Diego)

Figure 3. *The outgoing and incoming editors-in-chief for the SIAM Journal on Applied Dynamical Systems (SIADS), SIAM Journal on Control and Optimization (SICON), and SIAM Journal on Mathematics of Data Science (SIMODS).*

InsideSIAM

Conferences, books, journals, and activities of Society for Industrial and Applied Mathematics

SIAM | CONFERENCES

A Place to Network and Exchange Ideas

Upcoming Deadlines

SIAM Conference on
Uncertainty Quantification (UQ24)
February 27–March 1, 2024 | Trieste, Italy
go.siam.org/uq24 | #SIAMUQ24

ORGANIZING COMMITTEE CO-CHAIRS
Amy Braverman, *NASA Jet Propulsion Laboratory, U.S.*
Gianluigi Rozza, *SISSA, Italy*
Claudia Schillings, *Freie Universität Berlin, Germany*

EARLY BIRD RATE DEADLINE
January 30, 2024: Disconnect time is 11:59 p.m. CET

HOTEL INFORMATION
Hotel information can be found at *siam.org/conferences/cm/lodging-and-support/hotel-transportation-information/uq24-hotel-transportation-information*.

SIAM Conference on
Parallel Processing for Scientific Computing (PP24)
March 5–8, 2024 | Baltimore, Maryland, U.S.
go.siam.org/pp24 | #SIAMPP24

ORGANIZING COMMITTEE CO-CHAIRS
Michael Bader, *Technische Universität München, Germany*
Anshu Dubey, *Argonne National Laboratory, U.S.*

SIAM International
Meshing Roundtable Workshop 2024 (SIAM IMR24)
March 5–8, 2024 | Baltimore, Maryland, U.S.
go.siam.org/imr24 | #SIAMIMR24

WORKSHOP CHAIR
Scott Mitchell, *Sandia National Laboratories, U.S.*

PP24 and IMR24 PRE-REGISTRATION DEADLINE
February 5, 2024: Disconnect time is 11:59 p.m. Eastern Time

PP24 and IMR24 HOTEL RESERVATION DEADLINE
February 5, 2024: Deadline is 5:00 p.m. local time

Minisymposium proposal deadline for AN24, DM24, and ED24 extended to February 15

THE FOLLOWING THREE CONFERENCES ARE CO-LOCATED:

SIAM Annual Meeting (AN24)
July 8–12, 2024 | Spokane, Washington, U.S.
Online Component July 18–20, 2024
go.siam.org/an24 | #SIAMAN24

ORGANIZING COMMITTEE CO-CHAIRS
Michael P. Friedlander, *University of British Columbia, Canada*
Anna Mazzucato, *Pennsylvania State University, U.S.*

SIAM Conference on
Applied Mathematics Education (ED24)
July 8–9, 2024 | Spokane, Washington, U.S.
go.siam.org/ed24 | #SIAMED24

ORGANIZING COMMITTEE CO-CHAIRS
Mario Banuelos, *California State University, Fresno, U.S.*
Roummel Marcia, *University of California, Merced, U.S.*

SIAM Conference on
Discrete Mathematics (DM24)
July 8–11, 2024 | Spokane, Washington, U.S.
go.siam.org/dm24 | #SIAMDM24

ORGANIZING COMMITTEE CO-CHAIRS
Peter Keevash, *University of Oxford, United Kingdom*
Blair D. Sullivan, *University of Utah, U.S*

AN24, ED24, and DM24 SUBMISSION AND TRAVEL AWARD DEADLINES
February 15, 2024: Minisymposium Proposals and Abstracts; Contributed Lecture, Poster, and Miniposterium (AN24 only) Abstracts
April 8, 2024: Travel Fund Application Deadline

Information is current as of January 4, 2024. Visit *siam.org/conferences* for the most up-to-date information.

Upcoming SIAM Events

SIAM Conference on Uncertainty Quantification
February 27–March 1, 2024
Trieste, Italy
Sponsored by the SIAM Activity Group on Uncertainty Quantification

SIAM Conference on Parallel Processing for Scientific Computing
March 5–8, 2024
Baltimore, Maryland, U.S.
Sponsored by the SIAM Activity Group on Supercomputing

SIAM International Meshing Roundtable Workshop
March 5–8, 2024
Baltimore, Maryland, U.S.

SIAM International Conference on Data Mining
April 18–20, 2024
Houston, Texas, U.S.
Sponsored by the SIAM Activity Group on Data Science

SIAM Conference on Applied Linear Algebra
May 13–17, 2024
Paris, France
Sponsored by the SIAM Activity Group on Linear Algebra

SIAM Conference on Mathematical Aspects of Materials Science
May 19–23, 2024
Pittsburgh, Pennsylvania, U.S.
Sponsored by the SIAM Activity Group on Mathematical Aspects of Materials Science

SIAM Conference on Imaging Science
May 28–31, 2024
Atlanta, Georgia, U.S.
Sponsored by the SIAM Activity Group on Imaging Science

SIAM Conference on the Life Sciences
June 10–13, 2024
Portland, Oregon, U.S.
Sponsored by the SIAM Activity Group on Life Sciences

SIAM Conference on Mathematics of Planet Earth
June 10–12, 2024
Portland, Oregon, U.S.
Sponsored by the SIAM Activity Group on Mathematics of Planet Earth

SIAM Conference on Nonlinear Waves and Coherent Structures
June 24–27, 2024
Baltimore, Maryland, U.S.
Sponsored by the SIAM Activity Group on Nonlinear Waves and Coherent Structures

2024 SIAM Annual Meeting
July 8–12, 2024
Online Component July 18–20, 2024
Spokane, Washington, U.S.

SIAM Conference on Applied Mathematics Education
July 8–9, 2024
Spokane, Washington, U.S.
Sponsored by the SIAM Activity Group on Applied Mathematics Education

SIAM Conference on Discrete Mathematics
July 8–11, 2024
Spokane, Washington, U.S.
Sponsored by the SIAM Activity Group on Discrete Mathematics

FOR MORE INFORMATION ON SIAM CONFERENCES: *siam.org/conferences* siam | MEMBERSHIP

Network | Access | Outreach | Lead

SIAM Members: Renew Your SIAM Membership for 2024 at *my.siam.org*

What's new at SIAM?

- The SIAM-Simons Undergraduate Summer Research Program and SIAM Postdoctoral Support Program were established to provide students and postdocs with exciting new mentoring and collaboration opportunities.
- Twelve new student chapters were established in 2023, including the first chapter in Central America. SIAM is excited that this program has continued to grow and helps keep our students connected to SIAM and the applied math community throughout the world.
- SIAM Sections expanded their coverage with the newly formed Northern and Central California Section of SIAM. Membership in these geographic subgroups is automatic with SIAM membership and provides an opportunity for local connections with fellow SIAM members.
- The SIAM New York-New Jersey-Pennsylvania Section held its inaugural meeting, and the new SIAM Activity Group on Equity, Diversity, and Inclusion began accepting members in 2023.
- Nine SIAM Activity Groups started or continued hosting recurring webinar series. New series from Supercomputing and Mathematics of Planet Earth were added this year.

"SIAM is the premier professional society for applied and industrial mathematicians. SIAM engages members at all levels through its student chapters, conferences, journals, prizes and awards programs, and member-driven activities. We welcome new members, ideas, and volunteers and are excited to continue growing our service to the community."

— Sven Leyffer, SIAM President, Argonne National Laboratory

Congratulations Newly Elected SIAM Activity Group Officers

New officers have been elected for the following SIAM Activity Groups (SIAGs). Thanks to all candidates for participating in this election, members who voted, and all outgoing officers for volunteering their time and knowledge serving these past few years. SIAM Activity Groups enhance and strengthen the objectives of SIAM as a whole and provide an intellectual space for peers to exchange ideas centered around a subject in applied mathematics, computational science, or cross-disciplinary application.

You can join an activity group when renewing or creating a membership, and if your membership is current, you can join activity groups by going to *siam.org/Membership/Activity-Groups*.

Algebraic Geometry (SIAG/AG)
Chair: Giorgio Ottaviani
Vice Chair: Heather Harrington
Program Director: Sonja Petrovic
Secretary: Luke Oeding

Control and Systems Theory (SIAG/CST)
Chair: Lorena Bociu
Vice Chair: Tobias Breiten
Program Director: Birgit Jacob
Secretary: Johan Karlsson

Data Science (SIAG/DATA)
Chair: Lars Ruthotto
Vice Chair: Dirk Lorenz
Program Director: Rebecca Morrison
Secretary: Jamie Haddock

Dynamical Systems (SIAG/DS)
Chair: Jonathan Rubin
Vice Chair: Mason Porter
Program Director: Alexandria Volkening
Secretary: Casey Diekman
Advisory Board:
Christian Bick
Victoria Booth
Louis Pecora
Priya Subramanian
Lennaert Van Veen

Financial Mathematics and Engineering (SIAG/FME)
Chair: Samuel Cohen
Vice Chair: Christa Cuchiero
Program Director: Luitgard A. M. Veraart
Secretary: Ibrahim Ekren

Imaging Science (SIAG/IS)
Chair: Gabriel Steidl
Vice Chair: Kui Ren
Program Director: Yifei Lou
Secretary: Fatma Terzioglu

Supercomputing (SIAG/SC)
Chair: Ulrike Yang
Vice Chair: Rio Yokota
Program Director: Hartwig Anzt
Secretary: Erin Carson

Elections of officers for the following activity groups will be held in 2024 for terms beginning January 1, 2025. Please suggest potential members for election by going to *siam.org/Forms/SIAM-Activity-Group-Leadership-Suggestions* and nominating a colleague or running yourself.

Analysis of Partial Differential Equations (APDE)
Applied and Computational Discrete Algorithms (ACDA)
Applied Mathematics Education (ED)
Computational Science and Engineering (CSE)
Discrete Mathematics (DM)
Geometric Design (GD)
Geosciences (GS)
Imaging Science (IS)
Life Sciences (LS)
Linear Algebra (LA)
Mathematical Aspects of Materials Science (MS)
Mathematics of Planet Earth (MPE)
Nonlinear Waves and Coherent Structures (NWCS)
Uncertainty Quantification (UQ)

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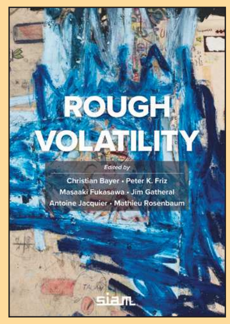

Rough Volatility

Christian Bayer, Peter K. Friz, Masaaki Fukasawa, Jim Gatheral, Antoine Jacquier, and Mathieu Rosenbaum, Editors

Volatility has traditionally been modeled as a semimartingale, with consequent scaling properties, but a new paradigm has emerged, whereby paths of volatility are rougher than those of semimartingales. According to this perspective, volatility behaves as a fractional Brownian motion with a small Hurst parameter.

Rough Volatility is the first book to offer a comprehensive exploration of the subject, organizing the material to reflect the subject's development and progression. It contributes to the understanding and application of rough volatility models by equipping readers with the tools and insights needed to delve into the topic and explores the motivation for rough volatility modeling and provides a toolbox for its computation and practical implementation.

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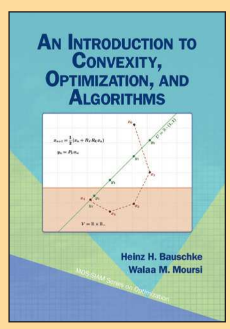

An Introduction to Convexity, Optimization, and Algorithms

Heinz H. Bauschke and Walaa M. Moursi

This concise, self-contained volume introduces convex analysis and optimization algorithms, with an emphasis on bridging the two areas. It explores cutting-edge algorithms—such as the proximal gradient, Douglas–Rachford, Peaceman–Rachford, and FISTA—that have applications in machine learning, signal processing, image reconstruction, and other fields. It contains algorithms illustrated by Julia examples and more than 200 exercises that enhance the reader's understanding of the topic. Clear explanations and step-by-step algorithmic descriptions facilitate self-study for individuals looking to enhance their expertise in convex analysis and optimization.

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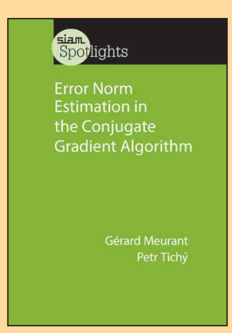

Error Norm Estimation in the Conjugate Gradient Algorithm

Gérard Meurant and Petr Tichý

The conjugate gradient (CG) algorithm is almost always the iterative method of choice for solving linear systems with symmetric positive definite matrices. This book describes and analyzes techniques based on Gauss quadrature rules to cheaply compute bounds on norms of the error. The techniques can be used to derive reliable stopping criteria. How to compute estimates of the smallest and largest eigenvalues during CG iterations is also shown. The algorithms are illustrated by many numerical experiments, and they can be easily incorporated into existing CG codes.

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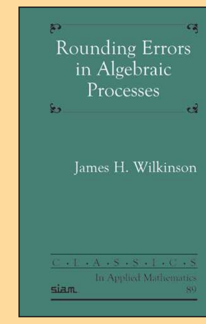

Rounding Errors in Algebraic Processes

James Hardy Wilkinson

Rounding Errors in Algebraic Processes was the first book to give systematic analyses of the effects of rounding errors on a variety of key computations involving polynomials and matrices.

A detailed analysis is given of the rounding errors made in the elementary arithmetic operations and inner products, for both floating-point arithmetic and fixed-point arithmetic. The results are then applied in the error analyses of a variety of computations involving polynomials and the solution of linear systems, matrix inversion, and eigenvalue computations. The conditioning of these problems is investigated. The aim was to provide a unified method of treatment, and emphasis is placed on the underlying concepts.

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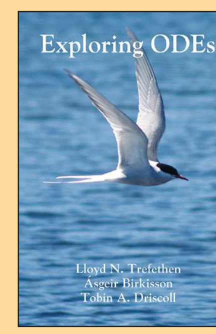

Exploring ODEs

Lloyd N.Trefethen, Ásgeir Birkisson, and Tobin A. Driscoll

Exploring ODEs is a textbook of ordinary differential equations for advanced undergraduates, graduate students, scientists, and engineers. It is unlike other books in this field in that each concept is illustrated numerically via a few lines of Chebfun code. There are about 400 computer-generated figures in all, and Appendix B presents 100 more examples as templates for further exploration.

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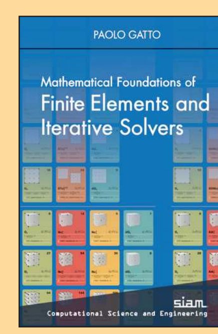

Mathematical Foundations of Finite Elements and Iterative Solvers

Paolo Gatto

This textbook describes the mathematical principles of the finite element method, a technique that turns a (linear) partial differential equation into a discrete linear system, often amenable to fast linear algebra. It examines the crucial interplay between analysis, discretization, and computations in modern numerical analysis; recounts historical developments leading to current state-of-the-art techniques; and, while self-contained, provides a clear and in-depth discussion of several topics, including elliptic problems, continuous Galerkin methods, iterative solvers, advection-diffusion problems, and saddle point problems.

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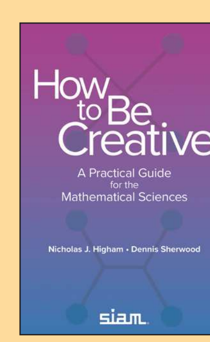

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by Nicholas J. Higham and Dennis Sherwood

Do you know precisely how your creativity happens? Can you coach other people to be more creative? This book is a how-to guide focused on helping people working in the mathematical sciences to generate great—or even greater—ideas by showing them "how to do it" and how to teach others how to do it, too. Building on the authors' many years of experience running creativity workshops, it provides a proven process for idea generation and a wide range of mathematically oriented examples.

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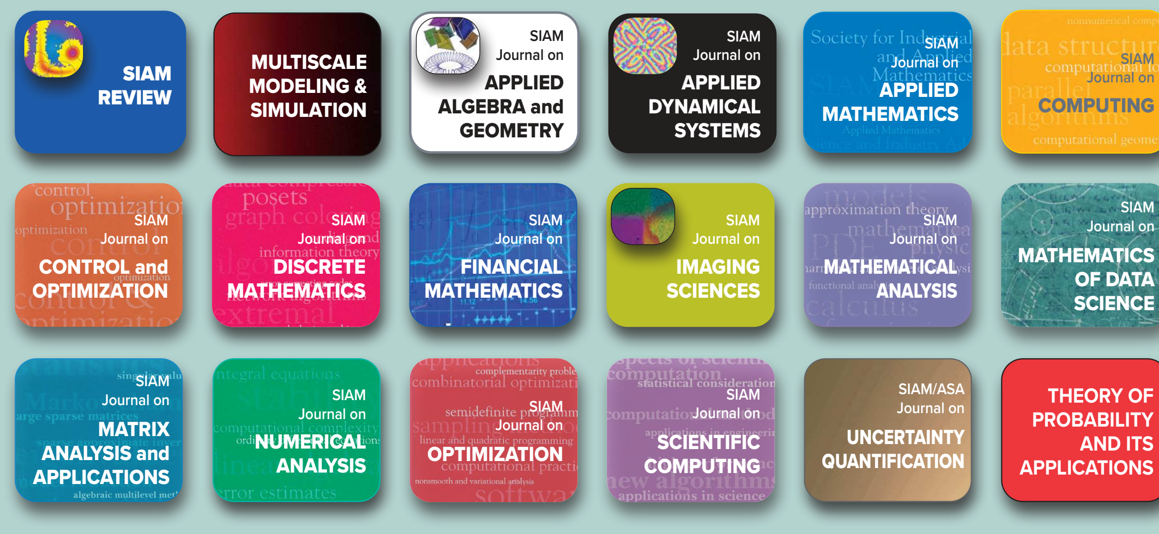

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