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

siam news

Volume 58/ Issue 1
January/February 2025

Stressing Microbes to Create Macroscopic Patterns

By Matthew R. Francis

Microbes in Petri dishes often grow in distinctive circular or wavelike patterns that are visible even without a microscope (see Figure 1). These growth formations develop without any long-range communication between individual cells, which means that they arise from microscopic mechanical and biochemical interactions rather than environmental factors. External forces—e.g., the borders of the Petri dish, added chemicals, or fluid properties of the growth medium—affect the macroscopic patterns in unique ways.

To understand the emergence of collective growth patterns, one must draw connections between several factors across a range of length scales. Computational biologists, mathematicians, and biomedical engineers use numerical simulation techniques to model the way in which idealized bacteria form macroscopic patterns simply from the stresses that they exert on each other as they grow and multiply [2]. "You have a cell that grows and divides, grows and divides," Scott Weady of the Flatiron Institute's Center for Computational Biology said. "How does a bacterium that slows its growth in response to pressure influence the global mechanics of the colony?"

It is difficult to dynamically measure individual cell size and growth in a lab, and functionally impossible to measure the mechanical stresses that each microbe imposes on its neighbors. To further complicate the situation, microbes in these environments are tightly packed, with effectively no empty space between them. This arrangement results in a nonlinear problem wherein the growth of each simulated "bacterium" is inhibited by its neighbors, while the bacteria's own existence simultaneously exerts stress on those same neighbors. Solving this problem necessitates the use of mathematical methods that were developed for grain packing and computer graphics, as well as techniques from the branch of applied math known as *active matter*. Weady and his collaborators constructed a macroscopic fluid model that is controlled by parameters from the microscopic simulations, and ultimately reproduced the familiar circular growth patterns of microbe cultures.

Packing 'Em In

Modeling efforts in ordinary granular matter research frequently seek to identify the arrangement of grains with fixed shapes and sizes under gravity or other constraints. Scientists often approximate microbes like *E. coli* bacteria or certain types of yeast as sphero-cylinders: capsule-like shapes consisting of spheres that are sliced in half, with a cylinder of the same diameter inserted between the halves.

The growth of these "grains" introduces a new type of stipulation, in addition to simple restrictions that the particles cannot overlap; now, models must also include the stress that each microbe places on its neighbors (and vice versa). This stress inhibits the allowable growth of individual cells within the boundaries of the microbial colony, eventually producing the aforementioned concentric macroscopic growth patterns.

The simplified model involves a set of N sphero-cylinders with constant diameter b

See **Macroscopic Patterns** *on page 4*

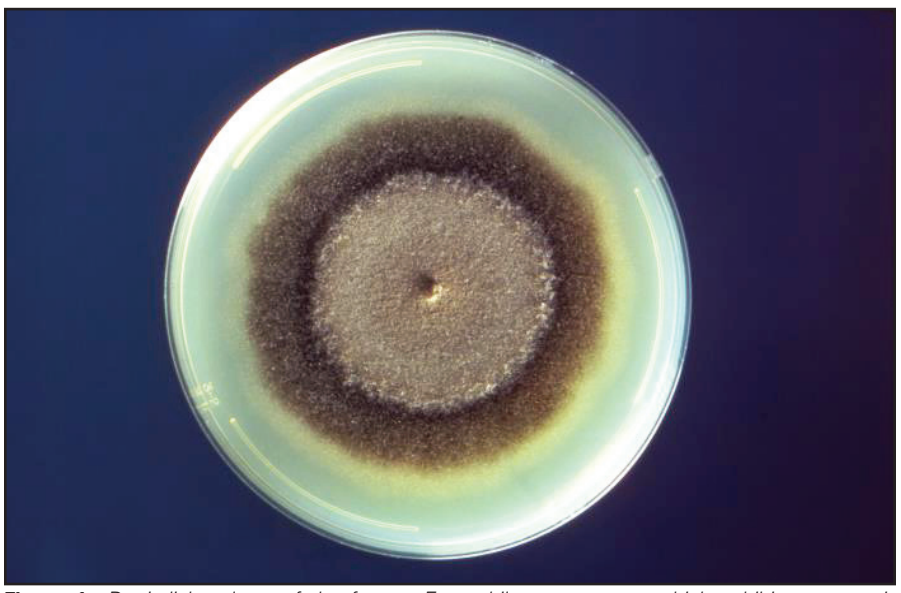

Figure 1. *Petri dish culture of the fungus Exserohilum rostratum, which exhibits concentric growth patterns that are particularly noticeable because of how the cells change color as they age. Public domain image courtesy of the Centers for Disease Control and Prevention/Libero Ajello.*

Tradeoffs in Differential Privacy and Learning From Smartphone Data

By Manuchehr Aminian

When providing services like next word prediction, autocorrect, autocomplete, and spellcheck, the developers of mobile devices must balance tradeoffs of utility and privacy while addressing traditional concerns with algorithm runtime and communication efficiency. During the 2024 SIAM Conference on Mathematics of Data Science[1] (MDS24), which took place last October in Atlanta, Ga., Jelani Nelson of the University of California, Berkeley, delivered an invited presentation[2] that introduced the theoretical underpinnings of differential privacy. He discussed this technique's ability to inform and analyze protocols that allow a server to learn statistics (like word frequency) while still retaining tunable control of user privacy.

Nelson's talk covered a striking breadth of ideas, including statistics, combinatorics, projective geometry, algorithm design, and asymptotic analysis. These disparate approaches all come together nicely to establish state-of-the-art methods with provable bounds.

What Does "Privacy" Mean, Exactly?

Certain conveniences in modern smartphones that we take for granted—such as spellcheck or next word prediction when texting—are actually nuanced mathematical problems due to the complex structure of human languages. As with most machine learning tasks, the successful solution of these problems requires huge volumes of training data — in this case, text messages.

When trying to protect user privacy, adding *noise* to the data might seem like a logical first step. However, the use of noise may not be as foolproof as it initially seems; in fact, the very definition of "noise" depends on the context of the situation, and too much of it can spoil the data's usability. Nelson utilized sample images to demonstrate that "adding noise" is surprisingly subtle, which means that approaches to anonymization, privacy, or reconstruction might not necessarily be straightforward. For example, averaging many noisy images of the same scene or performing *wavelet denoising* on a single noisy image can still recover some aspects of the information (see Figure 1).

While the study of database privacy spans multiple decades, the introduction and uptake of differential privacy as a framework has only commenced in the past 20 years [2]. One common variant of this framework is *local differential privacy*:

$$\frac{P(M_i = M : x_i = x)}{P(M_i = M : x_i = x')} \leq e^{\varepsilon},$$

where x_i is the data held by the ith device. For all devices i and possible messages M, this definition states that the ratio of probabilities of finding a given message when replacing the underlying data should be bounded by a number that is ideally close to 1. More broadly, the likelihood of seeing an output to a query should not change significantly based on its inclusion or exclusion (relating to the factor ε). An algebraic manipulation can make this definition look more like an "analysis-style" bound between log-likelihood functions. When a procedure satisfies this inequality with $\varepsilon = 0$, all of the probabilities that it expresses are the same; as a result, the message does not depend on the user's data

See **Smartphone Data** *on page 2*

[1] https://www.siam.org/conferences-events/siam-conferences/mds24

[2] https://meetings.siam.org/sess/dsp_programsess.cfm?SESSIONCODE=80305

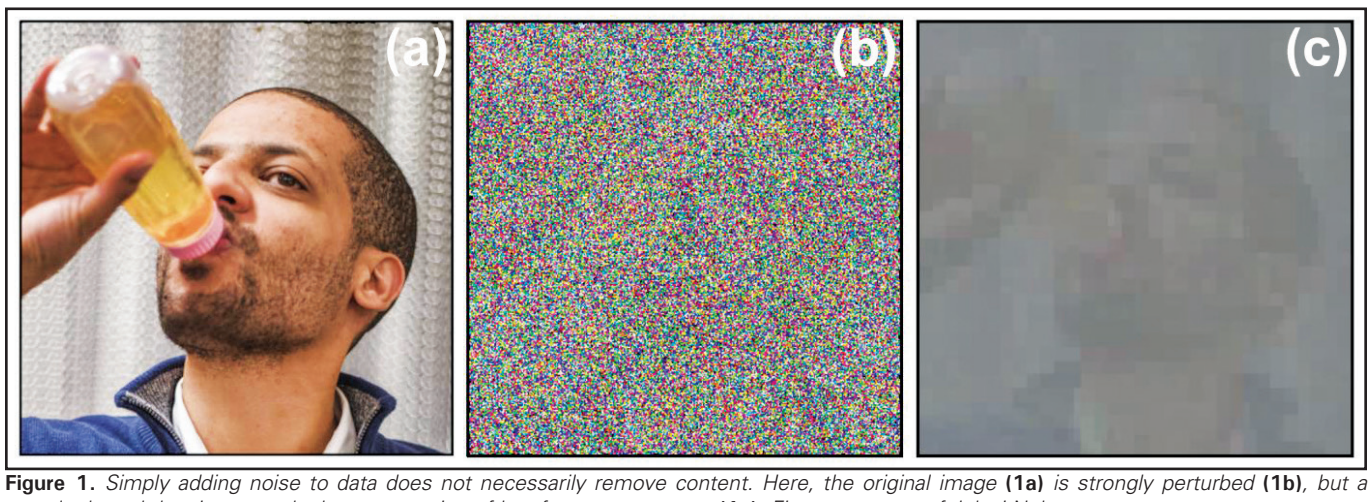

Figure 1. *Simply adding noise to data does not necessarily remove content. Here, the original image* **(1a)** *is strongly perturbed* **(1b)***, but a wavelet-based denoiser reveals the preservation of low-frequency content* **(1c)***. Figure courtesy of Jelani Nelson.*

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Smartphone Data

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whatsoever and the protocol is perfectly private. Similarly, small positive values represent minute changes in probability.

This framework is powerful for several reasons. For instance, a given system can be provably ε-differentially private for some ε, protocols may allow for tunable parameters that affect ε, or practical algorithms can be benchmarked for an estimated ε. While $\varepsilon \ll 1$ is desirable, Nelson explained that tech companies often have systems with an ε on the order of 2 to 8 (or more!) to maintain good utility.

Protocols and Tradeoffs

To prelude his discussion of protocols at MDS24, Nelson outlined five interrelated priorities that protocols should ideally address: (i) privacy; (ii) utility, which is some measure of how much the analyst is able to learn about the data; (iii) communication between the device and server; (iv) server compute time; and (v) device compute time. Protocols span a range of sophistication levels, with various tradeoffs. For example, naive protocols obtain lower bounds; a protocol for which devices send the server a uniform random selection of predetermined messages (or no messages at all) would optimize privacy and device compute time but yield no utility.

In 1965, Stanley Warner introduced a fundamental protocol called *randomized response* to address noncooperative survey participants [4]. Consider a set of words $\{1, \ldots, k\}$ (knowing that we can map words to integers) and suppose that a device's message contains $x = 1$. Given this protocol, the device sends the word to the server with probability $e^{\varepsilon} p$; any other word $2, \ldots, k$ is sent with probability p, where the exact p is calculated in terms of k and ε. The server then accumulates the distribution by adding $\alpha + \beta$ for the communicated $x = x_i$; it accumulates a *negative* value β for the estimated frequency of *all other* words. The specific choices of α and β ensure that the accumulation *in expectation* for this system is 1 for x_i and 0 otherwise, leading to a linear system that results in $\alpha = \dfrac{e^{\varepsilon+k-1}}{e^{\varepsilon}-1}$ and $\beta = \dfrac{-1}{e^{\varepsilon}-1}$. Figure 2 provides a sampling of parameters.

This system's simplicity and relatively low compute costs certainly make it appealing, though Nelson commented that the loss in utility for a given ε is provably "terrible." Rapid advances in this field are leading to more sophisticated protocols—such as subset-based methods [5] or the Hadamard Response privatization scheme [1]—that can be analyzed under the framework of so-called *combinatorial designs*. While these newer protocols implement more sophisticated strategies, the fundamental principles of protocol analysis remain the same.

ε	α	β (when $x \neq x_i$)	$\alpha + \beta$ (when $x = x_i$)
0.1	9.509×10^3	-9.508	0.95×10^3
1	0.583×10^3	-0.582	0.582×10^3
10	1.045	-4.54×10^{-5}	1.045

Figure 2. *Parameter values for updating word frequency via randomized response under a dictionary of $k = 10^3$ words and several choices for privacy parameter ε. The formulas for α and β are meant to accumulate 1 (when $x = x_i$) or 0 (when $x \neq x_i$) in expectation. Figure courtesy of Manuchehr Aminian.*

Scheme Name	Communication	Utility Loss	Server Time
Randomized Response	$\lceil \log_2 k \rceil$	$\left(2 + \frac{k}{e^{\varepsilon}}\right) \frac{n e^{\varepsilon}}{(e^{\varepsilon}-1)^2}$	$n + k$
Recursive Hadamard Response	$\lceil \log_2 k \rceil$	$8 \frac{n e^{\varepsilon}}{(e^{\varepsilon}-1)^2}$	$n + k \log k$
Hybrid ProjectiveGeometryResponse	$\lceil \log_2 k \rceil$	$4\left(1 + \frac{1}{q-1}\right) \frac{n e^{\varepsilon}}{(e^{\varepsilon}-1)^2}$	$n + kq \log k$

Figure 3. *A collection of schemes with proven communication costs in terms of user-server communication, utility loss (reconstruction of a word frequency distribution), and server runtime as a function of dictionary size k, number of users n, privacy parameter ε, and prime q that underlies the field $\mathbb{F}_q^t$. Figure adapted from [3].*

Projective Geometry and Preferred Messages

The work of Nelson and his colleagues utilizes ideas from finite projective geometry to implement a pair protocol called ProjectiveGeometryResponse (PGR), which also has a hybrid version (HPGR) [3]. In the context of differential privacy protocols for smartphones, finite fields enable parameter tuning and careful control over groups of words.

Motivated by a "meta approach" from the creators of the Hadamard Response [1], Nelson and his collaborators expand upon the original set of words $\{1, \ldots, k\}$ to introduce three new aspects. First, they construct a message space $\mathcal{Y}$; for each message x, they then construct a subset $S_x \subset \mathcal{Y}$ with exactly s entries that serve as "preferred messages" for x. Finally, a constraint over pairs of sets S_x and $S_{x'}$ ensures that the entries have exactly ℓ messages in common. If preferred sets allude to phrases with similar meanings, then the phrase "hi" might have a set of preferred messages $S_x = \{$"hello", "greetings", "salutations"$\}$, such that $s = 3$; however, the message space $\mathcal{Y}$ may be an abstraction and not actually a set of strings. While this adds complexity to the process, the flexible construction of $\mathcal{Y}$ and choice of s and ℓ allow for optimization and new protocols that finely control utility, privacy, communication, and compute time.

Within this framework, Nelson's group begins with a *finite field* $\mathbb{F}_q$ that contains the numbers 0 through $q-1$ (q prime), which are equipped with modular arithmetic [3]. Taking a tuple with t elements yields $\mathbb{F}_q^t$, to which one can introduce an inner product $\langle u, v \rangle$ that is the usual inner product modulo q. Two points in $\mathbb{F}_q^t$ belong to the same equivalence class if they lie on the same ray, and each equivalence has many points. One canonical way to select a representative, called a *projective point*, is with vectors whose first nonzero entry is 1. For example, the projective points in $\mathbb{F}_q^3$ include all tuples of the forms $(1, y_2, y_3)$, $(0, 1, y_3)$, or $(0, 0, 1)$. It is then possible to associate words and messages with projective points in a unique way that avoids the assignment of parallel elements in $\mathbb{F}_q^t$. Preferred sets S_x are constructed through the constraint of elements u that satisfy $\langle x, u \rangle \equiv 0 \pmod{q}$. S_x is thus an orthogonal subspace to x, which serves as a tidy computational approach.

The punchline is an algorithm that gives an explicit recipe for the choice of s, ℓ, and S_x and parameters q and t for the field $\mathbb{F}_q^t$, which results in provable values for communication, utility loss, and server runtime. The hybrid version of this algorithm also decouples the privacy parameter ε from utility loss and server time; the choice of q instead provides an explicit tradeoff between these two factors (see Figure 3). Although PGR and HPGR both take a small hit in server time, they offer improved prefactors for utility loss. Nelson noted that while computer science often fixates on big-O bounds, prefactors are important for practical computations, and a factor of two can indeed be a valuable improvement.

The breadth of topics in this field of study—and particularly in the application of projective geometry—was perhaps the most surprising aspect of Nelson's presentation at MDS24. Because the large-scale uptake of machine learning and artificial intelligence requires knowledge of topics such as linear algebra, optimization, statistics, algorithms, and ethics, the applied mathematics community is currently endeavoring to educate the next generation of professionals and academics with a multidisciplinary perspective. While there are no easy solutions, Nelson's success with tools from the realm of theoretical mathematics stands as a parallel to this challenge and emphasizes the many significant functionalities of applied math.

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ISSN 1557–9573. To be published 10 times in 2025: January/February, March, April, May, June, July/August, September, October, November, and December.
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Rebounding Together: SIAM's Membership Milestones in 2024

By Paula White

This time last year, I shared that 2023 was the first year since the onset of the COVID-19 pandemic to see an increase in SIAM membership numbers [1]. To keep this momentum going throughout 2024, our staff focused on growing and strengthening the SIAM member community this past year. Here, I would like to highlight some noteworthy membership accomplishments and explain their impacts.

SIAM activity group[1] (SIAG) memberships are rebounding after three challenging years. Conference attendees can join the corresponding SIAG for free as a perk of SIAM membership, and student members can join two SIAGs for free; SIAM staff and SIAG officers made great efforts to advertise these benefits in 2024. This work seems to have paid off, as SIAG involvement—especially among students—rose last year.

SIAG membership also grew thanks in part to SIAG officers' engagement with their members. For example, SIAM's newest SIAG on Equity, Diversity, and Inclusion[2] held its first virtual business meeting and organized several minisymposia at the 2024 SIAM Annual Meeting,[3] which took place in Spokane, Wash., last July. Additionally, five SIAGs held webinar series in 2024, and more than 10 in-person SIAM conferences (some of which were co-located) offered opportunities for members to connect with a wide variety of SIAGs.

SIAM currently has 16 sections[4] in different geographic regions—11 within North America and five across other continents—with a 17th section approved for New England. The Northern and Central California Section of SIAM,[5] which was founded in 2023, held its inaugural conference in October 2024,[6] and many sections reported record or near-record attendance at their annual meetings last year. Section memberships are both free and automatic for any current SIAM members who live or work in the geographic 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.

In 2024, all 16 sections launched new communities on SIAM Engage:[7] SIAM's online platform where members can network and share information about future meetings and career opportunities. Many members utilize the platform to promote upcoming events, webinars, job openings, postdoctoral positions, and more throughout the year, so be sure to join Engage if you have not yet done so.

SIAM also created an Engage community for student chapter officers in 2024, providing a space to brainstorm and share success stories. We added 13 new student chapters in 2024 and saw overall student membership grow for the second year in a row, which is a positive sign that SIAM membership is actively recovering from the drop during the pandemic. SIAM student chapters[8] provide participants with invaluable opportunities to develop relationships with other students and faculty members outside of the classroom, communicate ideas and research, learn about career prospects, and hone their leadership skills.

As a reminder, most students can join SIAM[9] for free! Full-time students are eligible for free membership if they are graduate students at a SIAM Academic Member institution,[10] involved with a SIAM student chapter, or nominated by *any* regular SIAM member. Free student membership offers all of the same benefits as regular student membership (which only costs $25.00 per year), except that free student members cannot vote in SIAM elections and only

See **Membership Milestones** *on page 5*

Attendees of the 2024 SIAM Annual Meeting, which took place in Spokane, Wash., last July, visit the registration desk. All SIAM conference attendees now have the option to bundle the purchase of SIAM membership with conference registration. SIAM photo.

[1] https://www.siam.org/get-involved/connect-with-a-community/activity-groups

[2] https://www.siam.org/get-involved/connect-with-a-community/activity-groups/equity-diversity-and-inclusion

[3] https://www.siam.org/conferences-events/siam-conferences/an24

[4] https://www.siam.org/get-involved/connect-with-a-community/sections

[5] https://www.siam.org/get-involved/connect-with-a-community/sections/northern-and-central-california-section-of-siam

[6] See page 12 for an article about this inaugural meeting.

[7] https://engage.siam.org/home

[8] https://www.siam.org/get-involved/connect-with-a-community/student-chapters

[9] https://www.siam.org/membership/individual-membership/student-membership

[10] https://epubs.siam.org/academic-members

Newest Members of the SIAM Board of Trustees and Council Take Office

By Lina Sorg

Last fall, eligible SIAM members cast their votes in the annual election to select the Society's newest members of the Board of Trustees and Council. The seven elected and re-elected[1] individuals began their three-year terms on January 1, 2025.

The Board manages and oversees SIAM, including its professional and scientific policies and objectives; maintains fiduciary responsibility of the organization by overseeing budgets, funds, investments, and so forth; and retains complete legal control of its assets. The Council—which is chaired by the SIAM president—formulates and reviews SIAM's scientific polices, monitors its technical activities, puts forth new initiatives, and provides recommendations to the Board as appropriate.

Here, the three newly-elected members of the Board and four newly-elected members of the Council share their reactions and outline their visions for their time in office. Their complete candidate statements are available online.[2]

SIAM Board of Trustees

Alina Chertock (North Carolina State University): "I'm thrilled and honored to have been elected to the SIAM Board of Trustees; thank you to everyone for your trust and support. I'm especially excited to encourage collaborations across fields, support early-career researchers, and make it easier for mathematicians to connect and grow. Together, we'll advance applied mathematics and positively impact our field."

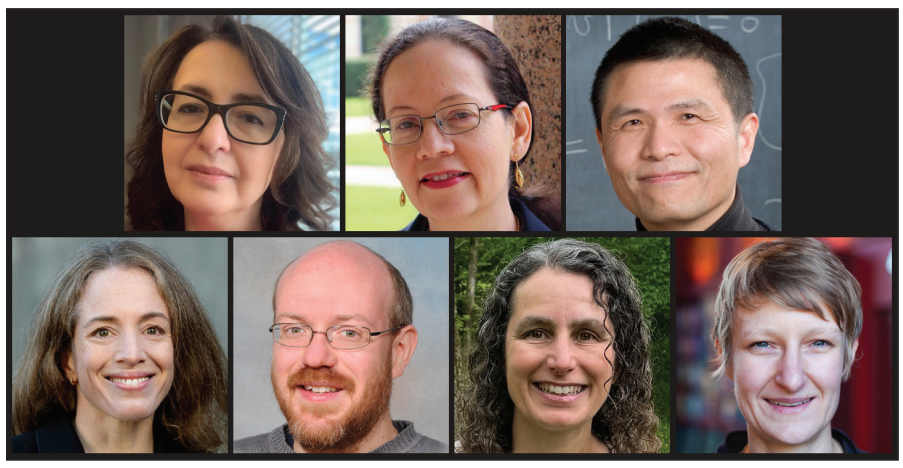
Beatrice Riviere* (Rice University): "It is a true privilege and honor to serve SIAM as a member of the Board of Trustees. I look forward to working with the Board and SIAM leadership to promote applied mathematics and interdisciplinary research for tackling societal problems."

Chi-Wang Shu* (Brown University): "I am honored to be reelected to serve on the SIAM Board of Trustees. SIAM is unique in its position as a vehicle that facilitates the exchange of ideas and promotion of major research directions in mathematics, which can be used in application fields. I look forward to continuing to contribute to the further advancement of SIAM as a platform that encourages collaboration between applied mathematicians and scientists in other disciplines."

SIAM Council

Inga Berre* (University of Bergen): "SIAM unites diverse scientific communities within applied mathematics and computational science. Considering SIAM's broad international and intersectoral reach and its pivotal role in shaping the careers of many researchers, I am honored to have been elected for a second term on the SIAM Council. To me, SIAM's backbone is its platform for research dissemination and communication, which is facilitated by its high-quality journals and conferences. I am eager to further advance these efforts."

Henry Cohn (Microsoft Research): "I am delighted and grateful to have been elected to the SIAM Council. SIAM has played a key role in applied mathematics since its founding, and its publications, conferences, and other activities are invaluable resources for both its members and the broader scientific community. I look forward to contributing to this important work."



The newly elected members of the SIAM Board of Trustees and SIAM Council. Top row, left to right: Board members Alina Chertock (North Carolina State University), Beatrice Riviere (Rice University), and Chi-Wang Shu* (Brown University). Bottom row, left to right: Council members Inga Berre* (University of Bergen), Henry Cohn (Microsoft Research), Evelyn Sander* (George Mason University), and Carola-Bibiane Schönlieb* (University of Cambridge). Photos courtesy of the elected individuals.*

Evelyn Sander* (George Mason University): "I am excited to serve a second term on the SIAM Council and extremely honored by the trust that members have placed in me. My primary focus for the Council is to make changes within SIAM to help increase representation and inclusion in applied mathematics. Careful work within SIAM can have a large impact for groups that are traditionally underrepresented in the field. Another key item is to make SIAM more attractive to applied mathematicians in industry, thus better representing the entire workforce of applied mathematicians and providing all SIAM members with a great opportunity to learn about exciting industrial breakthroughs."

Carola-Bibiane Schönlieb* (University of Cambridge): "I am honored and delighted to have been elected to the SIAM Council for a second term. I am passionate about mathematics and its applications and will ensure that the field continues to flourish. Also, encouraging early-career researchers through mentoring, improving diversity within mathematics, and fostering dialogue and exchange within our mathematical community are all topics that are close to my heart and that I will continue to support."

The continued dedication of SIAM's leadership and membership contribute to the ongoing success of the Society, and SIAM is deeply grateful to the entire slate of candidates and the members who cast their votes in the recent election. We extend our thanks to all of the candidates for their willingness to serve our community.

Lina Sorg is the managing editor of SIAM News.

[1] * indicates an incumbent member

[2] https://www.siam.org/publications/siam-news/articles/siam-presents-newest-leadership

10 Years of Growth and Inspiration With the Broader Engagement Program

By Vladana Hrivnakova-Gonzalez and Mary Ann Leung

In 2015, Mary Ann Leung—president and founder of the Sustainable Horizons Institute[1] (SHI)—organized the first Broader Engagement[2] (BE) program to take place at a SIAM conference. BE seeks to bring students from all walks of life, especially those from underprivileged backgrounds who might not otherwise have the opportunity to attend a conference, into the SIAM community. The program provides financial assistance for students to participate in professional conferences, where they can network with experienced researchers in the fields of applied mathematics, computational science, and data science. Now, a decade and more than 300 students later, we reflect on the BE program's continued impact; anticipate additional BE activities at the upcoming 2025 SIAM Conference on Computational Science and Engineering[3] (CSE25), which will take place in Fort Worth, Texas, this March; and invite the entire SIAM community to join the celebration.

Turning Conferences Into Classrooms: A Brief History

Tony Baylis of Lawrence Livermore National Laboratory and Roscoe Giles and Jennifer Teig von Hoffman of Boston University founded BE in 2007 for the Supercomputing Conference,[4] where it ran each year through 2014. In 2015, Lois Curfman McInnes of Argonne National Laboratory (co-chair of the Organizing Committee for CSE15) invited Leung to join the committee. When asked to bolster student attendance at the conference, Leung—who had previously served as co-chair, deputy chair, and chair of the BE program—decided to bring BE to CSE15.[5] By doing so, she hoped to draw more students from underprivileged backgrounds to both CSE15 and the field of computational science and engineering as a whole [1].

During the weeklong meeting, BE participants attended invited talks, minisymposium presentations, interdisciplinary technical sessions, workshops, and discussion groups that advanced their knowledge and skillsets. The program was well received, and Leung was again invited to orchestrate BE at CSE17,[6] CSE19,[7] CSE21,[8] and the upcoming CSE25[9] [3, 4]. In light of the program's continued success, SIAM's partnership with BE further expanded to the 2022 SIAM Conference on Mathematics of Data Science (MDS22) and MDS24 [2].

Creating Lasting Connections and Community

Since its inception, BE's main goal has been to help participants develop a sense of connection and belonging within their fields of study. The program also provides opportunities for professionals to volunteer and learn through activities that target community engagement, including skill-building workshops, mentoring sessions, and daily breakfast meetups called *Guided Affinity Groups* (GAGs): dynamic study and mentorship groups that feature guest speakers such as SIAM leadership, SIAM activity group[10] officers, conference plenary speakers, and researchers from scientific institutions and national laboratories. After their debut at

See **Broader Engagement** *on page 6*

[1] https://shinstitute.org

[2] https://shinstitute.org/the-broader-engagement-be-program

[3] https://www.siam.org/conferences-events/siam-conferences/cse25

[4] https://supercomputing.org

[5] https://shinstitute.org/siam-cse15-broader-engagement-program

[6] https://shinstitute.org/broader-engagement-cse17

[7] https://shinstitute.org/siam-cse19-be-program

[8] https://shinstitute.org/siam-cse21-broader-engagement-program

[9] https://shinstitute.org/be-cse-2025

[10] https://www.siam.org/get-involved/connect-with-a-community/activity-groups

Macroscopic Patterns

Continued from page 1

(see Figure 2). Each microbe n increases in length from $\ell_0 = 2b$ at an exponential rate τ that is moderated by the contact stress $\lambda\sigma_n$ exerted by its neighbors:

$$\frac{d\ell_n}{dt} = \frac{\ell_n}{\tau}\exp(-\lambda\sigma_n).$$

Once a microbe reaches a length of $2\ell_0$, it divides into identical sphero-cylinders and the process repeats. The microbes only move and rotate under the influence of contact forces $\mathbf{F}_n$ and torques T_n from their neighbors:

$$\frac{d\mathbf{x}_n}{dt} = \frac{\mathbf{F}_n}{\xi\ell_n} \quad \text{and} \quad \frac{d\theta_n}{dt} = \frac{12}{\xi\ell_n^3}T_n.$$

Here, ξ is a friction constant due to the substrate beneath the microbes, $\mathbf{x}_n$ is the position of the center of mass, and θ_n is the orientation.

The result is a nonlinear optimization problem that requires an effective solution for the entire colony. Even when disregarding food supply and other external factors, this non-Newtonian problem does not have ordinary action-reaction forces. "From a modeling perspective, you no longer have conservation laws," Weady said. "So you have to think about non-conservation."

The simulation—which begins with one microbe—is governed by a single free parameter $\lambda' = (\tau/\xi\ell_0^2)\lambda$ (scaled to be dimensionless) that characterizes sensitivity to stress from neighboring microbes. Running the simulation until the colony reaches a maximum size of $R = 150\ell_0$ reveals emergent concentric growth patterns that qualitatively correspond to those in Petri dishes.

Waves Without Waves

While these particle simulation results certainly look compelling, it is hard to check the microscopic picture against reality. Measuring the growth and division rates for microbial colonies is difficult, and tracking movement, rotation, and stress for huge numbers of organisms is impractical at best. To connect the microscopic view with measurable macroscopic quantities, Weady and his colleagues formulated a set of continuum fluid equations based on an existing model that researchers often use to describe microbe growth. "Our insight was to bridge two different modeling strategies that have existed for a long time in a new, satisfying way," Weady said. Philosophically, this approach is much like how condensed matter physicists utilize computationally challenging multi-particle quantum calculations to find equations that describe bulk material properties.

The relevant collective properties for this scenario are ambient fluid pressure p and flow velocity $\mathbf{u}$ (as opposed to internal forces, stresses, and torques on individual cells). To model microbe growth and division, the researchers employ a growth flux field that is parameterized by the same stress sensitivity λ as in the particle simulations. Since the microbes do not orient themselves preferentially along any axis in the absence of external forces, the macroscopic model assumes rotational isotropy and treats pressure simply as a function of position and time.

The fluid model equations—analogous to the microscopic force equations—are

$$\xi\mathbf{u} + \nabla p = 0 \quad \text{and} \quad \nabla\cdot\mathbf{u} = (1/\tau)e^{-\lambda p},$$

where pressure vanishes at the colony's boundary. For equivalent stress sensitivity values λ', the solutions to these fluid equations produce very similar patterns to the microscopic simulations (see Figure 3). Although these patterns might closely resemble waves, the fluid model indicates a clear distinction.

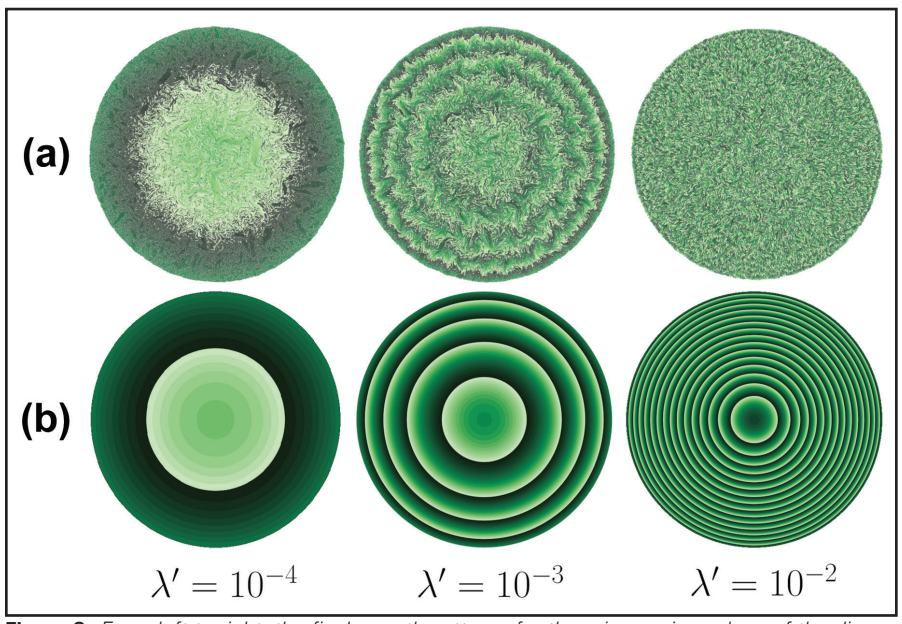


Figure 3. *From left to right: the final growth patterns for three increasing values of the dimensionless growth sensitivity λ' for particle simulations* **(3a)** *and the fluid model* **(3b)**. *Microbes that are more sensitive to stress exhibit tighter wave-like patterns. The "fuzziness" in 3a stems from nonlinear microscopic interactions, while the fluid model in 3b produces artificially smooth rings that still have the same qualitative characteristics. Figure adapted from [2].*

"They look a lot like waves and move a lot like waves, but based on the [mathematical] solution, they're not really waves," Weady said. "Some cells [experience] more stress over their lifetime, and some experience less. The cumulative process of resistance to growth happens all the time — there's no wave pattern to that. The cells feel more or less stress depending on where they are, and that persists, accumulates, and gets passed on from generation to generation."

New Ways to Stress Microbes

Despite the obvious applications to laboratory biology, Weady admitted that his group's primary motivation was curiosity. "We did simulations and saw this [thing] that was kind of cool," he said. "Let's try and understand it. That's what we do as theoretical applied mathematicians, but it's a concrete prediction that can be tested."

For precisely this reason, an important next step will be some simple laboratory experiments on *E. coli* — though Weady and his collaborators are interested in extending the math to additional scenarios as well. Weady specified that the simulations and models are already three dimensional; they were only restricted to flat surfaces for the investigation's first iteration in order to match laboratory settings.

Immediate extensions to this mathematical work will involve examinations of the interactions between two microbe populations, the effect of surface properties—such as a liquid substrate—on a single population's growth, and overall growth over a curved surface[1] [1]. "Microbes often colonize ships, or something like that," Weady said. "I'm interested in putting [microbes] in different environments with different curvatures and [seeing] how stress sensing might relate to curvature sensing, and how it affects spread over a surface."

While this research might be driven by curiosity, its applications could inspire a deeper knowledge of real-world systems — potentially even those that do not concern microbes. As such, the connection between simple stresses on colony growth and macroscopic patterns has profound implications for our mathematical understanding of the propagation of structures across relatively wide distances in the absence of communication.

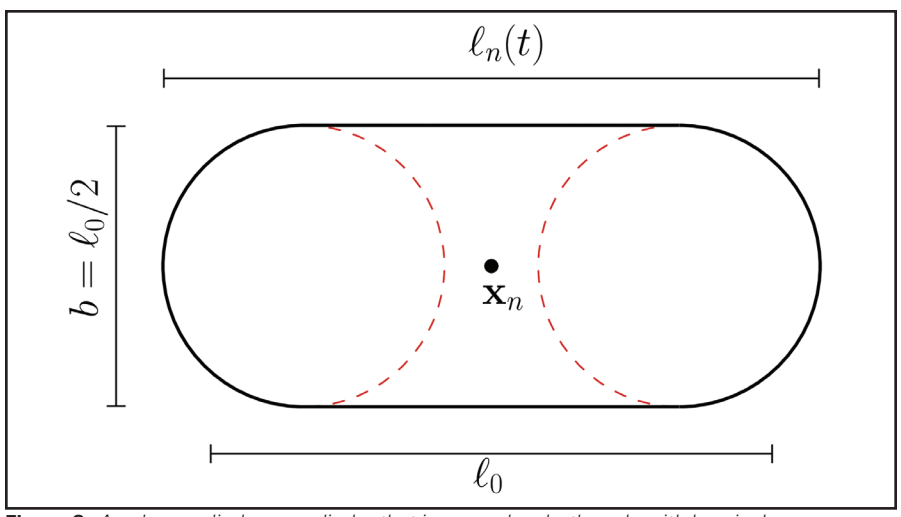


Figure 2. *A sphero-cylinder—a cylinder that is capped on both ends with hemispheres—serves as a simple mathematical model for a bacterium. Here, the diameter b of bacterium n is fixed while the length ℓ_n varies from ℓ_0 to $2\ell_0$ at a rate that is determined by a characteristic growth scale and interactions with neighboring microbes. Figure courtesy of the author.*

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[1] Francis, M. (2023, November 1). Wildebeest self-organization via active matter theory. *SIAM News*, *56*(9), p. 12.

[2] Weady, S., Palmer, B., Lamson, A., Kim, T., Farhadifar, R., & Shelley, M.J. (2024). Mechanics and morphology of proliferating cell collectives with self-inhibiting growth. *Phys. Rev. Lett.*, *133*(15), 158402.

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

[1] https://www.siam.org/publications/siam-news/articles/wildebeest-self-organization-via-active-matter-theory

SIAM Publications: Safeguarding Quality in a Changing Landscape

By Kivmars Bowling

As a nonprofit and independent society publisher, SIAM has always maintained an unremitting focus on quality above all else. This core principle is increasingly at risk across the scholarly publishing landscape.

Three unfortunate incentives are collectively compromising the quality and integrity of scientific publishing: (i) the "publish or perish" culture of academia; (ii) the gold open access/transformative agreements model, which financially motivates publishers to accept more papers; and (iii) the use of generative artificial intelligence (AI) to turbocharge commercial paper mills, i.e., fraudulent organizations that produce fake manuscripts, data, and authorship. Some publishers are now finding that their emphasis on quantity over quality has allowed the publication of content that should never have survived a robust editorial review process. Open access without quality is pointless and erodes trust among all stakeholders — including the public.

In this broader context, SIAM's longstanding focus on quality—through the publication of first-rate, cutting-edge, *vetted* research for a global audience—has never been more important. The many strong testimonials from authors and readers attest to the high standards of SIAM publications. However, we cannot be complacent in the face of growing threats to research integrity, including plagiarism; citation and reviewer cartels [2]; citation coercion by peer reviewers [5]; paper mills; paid guest/ghost authorship; data fabrication; image manipulation; and the hijacking of identities, special issues, journals, and publishers [1].

Generative AI large language models remain prone to mistakes or "hallucinations," such as the appearance of nonexistent references in bibliographies. But these errors will likely be eradicated in the near future, and publishers may soon receive AI-generated papers with entirely plausible abstracts, body text, figures, data, and bibliographies. While most researchers behave honestly, a small minority of bad actors will likely use AI tools to quickly produce questionable publications. To minimize fraudulent activity, the publishing industry is considering the use of identity checks for authors and reviewers. Academic institutions must also proactively address alleged research misconduct issues and affirm research integrity; one possible idea is that "[e]very research article submitted to a journal should come with a digital certificate validating that the authors' institution(s) has completed a series of checks to ensure research integrity" [3].

SIAM is actively assessing new tools to identify submissions that may potentially come from paper mills or are duplicated across publishers. We have long used an industry-wide plagiarism checker called Similarity Check[1] to assess all submissions; staff also review the results manually. In addition, authors who publish in the *SIAM Journal on Scientific Computing* and *SIAM Journal on Matrix Analysis and Applications* can request a reproducibility badge if their code and data are available in supplementary materials or a permanent public repository.

SIAM published its Editorial Policy on Artificial Intelligence[2] in October 2023, but policy is not prevention. While attempts are underway to watermark AI-generated content [4], it is unlikely that any detection tool will be able to robustly identify AI-generated text in the long term. As such, the system will always involve an element of trust that determined bad actors can exploit to their advantage. This is where the *human* element of SIAM's editorial process will continue to be absolutely vital, so let me take this opportunity to thank SIAM editors, reviewers, and staff for their tireless and vigilant work.

Join Our Accessibility Advisory Group

Are you a person with a visual impairment who reads SIAM publications online, or have you helped colleagues or students navigate accessibility challenges? Please fill out the online form[3] to join our new Accessibility Advisory Group! SIAM is looking to improve the accessibility of its online publications and would highly appreciate your input and feedback on issues such as effective alternative text for figures and user-friendly file formats.

We have been actively working with our platform and production vendors to design a roadmap for compliance with the Web Content Accessibility Guidelines 2.2,[4] which form the standard for digital accessibility. These efforts will broadly ensure that the SIAM Publications Library is compliant with the upcoming European Accessibility Act[5] as well as U.S. mandates under Title II of the Americans with Disabilities Act[6] and Section 508 of the Rehabilitation Act.[7]

Students in EducationUSA Nepal's Opportunity Funds Program peruse a selection of donated SIAM textbooks. Photo courtesy of Daniel Smartt.

New *SIAM Journal on Life Sciences*

Following a successful proposal by Jonathan Rubin of the University of Pittsburgh and Simone Bianco of Altos Labs, SIAM is delighted to announce that the new *SIAM Journal on Life Sciences (SIALS)* was approved by the SIAM Board of Trustees and SIAM Council and will begin accepting submissions in spring 2025.[8] Rubin will serve as editor-in-chief (EIC) and Bianco will serve as one of three section editors. *SIALS* will publish research about the substantive use of quantitative methods—including modeling, computing, and mathematical analysis—in the study of biological systems and their applications. Submissions should involve new mathematical models of biological systems, the development and application of novel quantitative methodologies, and/or the use of existing mathematical methodologies for the analysis of biological models. All articles must include a clear connection to life sciences topics with biological, medical, or industrial relevance.

We thank everyone in the SIAM life sciences community who has supported this journal's launch. To receive updates and announcements about *SIALS*, please fill out the online contact form.[9]

Book Series on Mathematical Neuroscience

SIAM has launched a new book series on *Mathematical Neuroscience*[10] that is led by three EICs: Daniele Avitabile of Vrije Universiteit Amsterdam, Mathieu Desroches of the Inria Branch of the University of Montpellier, and Serafim Rodrigues of the Basque Center for Applied Mathematics. The series will comprise tutorials, monographs, and textbooks that address mathematically grounded work on neural models at all scales.

See **SIAM Publications** *on page 7*

Publication	Outgoing Editor-in-chief	Incoming Editor-in-chief
JUQ	Peter Challenor (University of Exeter)	Bani Mallick (Texas A&M University), co-editor-in-chief with Sebastian Reich (University of Potsdam)
SICOMP	Robert Krauthgamer (Weizmann Institute of Science)	Chandra Chekuri (University of Illinois Urbana-Champaign)
SIMA	Robert Lipton (Louisiana State University)	Pierre-Emmanuel Jabin (Pennsylvania State University)

Figure 1. *The outgoing and incoming editors-in-chief for the SIAM/ASA Journal on Uncertainty Quantification (JUQ), SIAM Journal on Computing (SICOMP), and SIAM Journal on Mathematical Analysis (SIMA). Figure courtesy of the author.*

[1] https://www.crossref.org/services/similarity-check
[2] https://epubs.siam.org/artificial-intelligence
[3] https://go.siam.org/0gk083
[4] https://www.w3.org/TR/WCAG22
[5] https://shorturl.at/txYVv
[6] https://www.ada.gov
[7] https://www.fcc.gov/general/section-508-rehabilitation-act
[8] See the announcement on page 6 for more information about *SIALS*.
[9] https://go.siam.org/3innf8
[10] https://epubs.siam.org/book-series/ne

Membership Milestones

Continued from page 3

receive *SIAM Review*[11] in its electronic format. Moreover, nonmember students who take part in SIAM programs will also find that membership is now included with their participation in most cases.

To make it easier for all new members—both students and nonstudents—to join SIAM, we have begun to bundle membership with conference registration. SIAM staff continue to simplify other processes by which individuals can become members as well. Furthermore, SIAM offers discounts to certain populations to make SIAM membership more accessible.[12] For instance, early-career researchers benefit from a 50 percent discount off the price of regular membership for the first three years after graduation, and a 25 percent discount for the fourth and fifth years. People who reside in developing countries can join SIAM for $15.00 annually with an *outreach membership*.[13] Finally, members of other industrial and applied mathematics societies with which SIAM has signed agreements qualify for *reciprocal membership*,[14] which comes with a 30 percent discount.

Would you like to help ensure the continued growth of the SIAM community in 2025? All members can support both SIAM and our profession in the following ways:

- Nominate two students for free membership in 2025. All regular SIAM members can nominate two students each year!
- Encourage recent graduates in your circles to join SIAM and take advantage of the early-career membership discount.
- 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 ensures continued access to important benefits like discounts on journals, books, and conferences; participation in SIAGs and Engage; and more. Simply check the "auto-renew" box when you renew online, and your membership will automatically renew at the end of the year.

Returning to pre-pandemic membership levels is an ongoing priority at SIAM, which means that membership growth will continue to remain a focus of the Society in 2025. I encourage you to help us strengthen the SIAM community in the new year by nominating one or more student members; volunteering; joining a SIAG; conversing on Engage; attending a webinar, conference, or section meeting; and subscribing to SIAM newsletters and journals. If you have questions about how to get involved or make the most of your membership, please don't hesitate to reach out to our membership team at **membership@siam.org**.

[11] https://www.siam.org/publications/siam-journals/siam-review
[12] https://www.siam.org/membership/individual-membership
[13] https://www.siam.org/membership/individual-membership/outreach-membership
[14] https://www.siam.org/about-us/collaborations/guidelines-for-establishing-reciprocity

References

[1] White, P. (2024, January 22). A year of growth and learning at SIAM. *SIAM News*, *57*(1), p. 11.

Paula White is the Membership Manager at SIAM.

Broader Engagement

Continued from page 4

CSE17 with focus topics like quantum computing and machine learning, GAGs quickly gained popularity and became a core component of the BE program.

Although GAGs commence at the early hour of 7:30 a.m., they offer participants an invaluable chance to interact with their peers, meet researchers with similar backgrounds, and gain mentorship and support from established scientists and academics in their fields. These sessions embody BE's ongoing mission to *connect people and create opportunities*. To that end, SHI understands that the program would not exist without direct support from the BE Organizing Committee,[11] tutorial leaders, and GAG leaders who donate their time and hard work to the mission.

For many participants, BE marks their first time attending a professional conference — and sometimes their very first opportunity to network and learn outside of an academic setting. "The most impactful aspects of the BE program were the connections I made and the conversations I had with my peers, mentor, program leaders, and other participants of the conference," Nya Feinstein[12] of West Virginia University said of MDS24. "Though I learned an incredible amount about my field and was exposed to a wealth of new ideas and inspiration, one of the most impactful takeaways was the importance of community."

SHI takes great pride in inspiring BE participants to become mentors and teachers, and perhaps return to present their own tutorials in the future. Wiktoria Zielinska[13] of the University of Illinois Urbana-Champaign, who took part in BE at MDS24 and is a former SHI Sustainable Research Pathways[14] summer intern, feels that motivation towards leadership. "Being on the other side of that and helping others really instilled a lot of confidence in me and my abilities in tech," she said. "I want to finish my own tutorial so that I can reach more people who were once in my shoes and didn't know what they were doing at first."

[11] https://shinstitute.org/category/organizing-committee

[12] https://shinstitute.org/nya-feinstein-2

[13] https://shinstitute.org/wiktoria-zielinska-4

[14] https://shinstitute.org/sustainable-research-pathways

At SHI, sustainability is about more than maintaining its programs; it's about people. By collaborating, mentoring, and returning year after year, BE alumni have created a self-sustaining network that uplifts new voices in science and continues to strengthen the community. In honor of this generous and empowering spirit, SHI will host a special alumni minisymposium at CSE25 called *Empowering Each Other: Building a Supportive Scientific Community — Alumni Reflections*. This celebratory minisymposium will honor those who have been with us throughout BE's 10-year journey with SIAM, many of whom started as summer interns or BE participants and are now leaders and teachers for the next generation.

Technical Tutorials and Skill-building Workshops at CSE25

Along with the aforementioned alumni session, BE programming at CSE25 will include five technically diverse GAGs[15] — each led by a distinguished professional from the computational science world. In addition, a skill-building "Lightning Talks" workshop presented by Aimee Maurais of the Massachusetts Institute of Technology will help attendees prepare for their poster presentations. Another key highlight will be a series of technical tutorials: beginner-friendly workshops that intend to explore various tools and technologies for computational science and engineering. Each tutorial seeks to make its information accessible to students and anyone who is interested in enhancing their career. The sessions are open to all conference attendees in accordance with BE's goal to share knowledge and create a community of passionate, connected individuals.

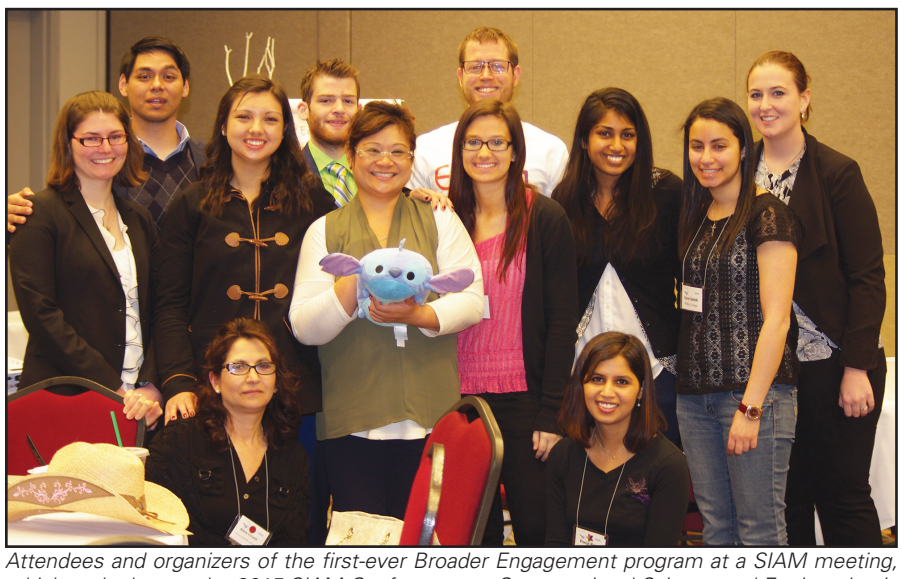
The five technical tutorials at CSE25 will be as follows:

- "Best Practices and Tools for Secure Scientific Software Development," led by Nitin Sukhija of Slippery Rock University
- "Accessible High-performance Computing Using the Julia Language," led by Johannes Blaschke of Lawrence Berkeley National Laboratory
- "Understanding Generative AI: The Core Concepts," led by Xi "Bill" Chen of the University of California, Santa Cruz
- "Hands-on HPC Crash Course on High Performance Computing," led by Suzanne Parete-Koon of Oak Ridge National Laboratory
- "Intro to GPU Programming and Optimizing GPU Performance," led by Giacomo Capodaglio and Gina Sitaraman of AMD.

These tutorials would not be possible without the incredible support of the SHI community, BE supporters, and alumni.

For 10 years, SHI has worked to create a welcoming space for newcomers at SIAM conferences. We look forward to our continued partnership with SIAM and future opportunities to build community.

[15] https://shinstitute.org/guided-affinity-groups-for-becse25



Attendees and organizers of the first-ever Broader Engagement program at a SIAM meeting, which took place at the 2015 SIAM Conference on Computational Science and Engineering in Salt Lake City, Utah. Photo courtesy of the Sustainable Horizons Institute.

Broader Engagement (BE) participants and Guided Affinity Group (GAG) leaders converse during a GAG breakfast as part of the BE program at the 2024 SIAM Conference on Mathematics of Data Science, which took place in Atlanta, Ga., last October. Photo courtesy of David Brown.

References

[1] Crivelli, S., & Leung, M.A. (2015, October 1). Life is a tensor…pilot program aims at expanding SIAM impact. *SIAM News*, *48*(8), p. 10.

[2] Español, M., Horth, S., Leung, M.A., & Uribe, V. (2022, December 1). Broader Engagement program expands to the 2022 SIAM Conference on Mathematics of Data Science. *SIAM News*, *55*(10), p. 3.

[3] Leung, M.A., & Pineda, J. (2021, July 6). Growing, inspiring, and diversifying computational science and engineering through Broader Engagement. *SIAM News*, *54*(6), p. 12.

[4] McCoy, D., & Leung, M.A. (2017, May 1). Broader Engagement program returns to CSE17 with a focus on community engagement. *SIAM News*, *50*(4), p. 8.

Vladana Hrivnakova-Gonzalez, who has a background in nonprofit communications and program organization, is dedicated to creating supportive science, technology, engineering, and mathematics (STEM) environments through her work at the Sustainable Horizons Institute (SHI). Mary Ann Leung is founder and president of SHI. She is dedicated to workforce development and increasing opportunities for underprivileged students in STEM.

New SIAM Journal Comes to Life

We are excited to announce the launch of the new ***SIAM Journal on Life Sciences (SIALS)***. *SIALS* will publish research that features the substantive use of *quantitative methods*—including modeling, computing, and mathematical analysis—in the study of *biological systems and their applications*.

SIALS seeks to attract readership and submissions from a broad community of researchers across many fields and industries who are interested in bringing an advanced mathematical lens to the study of life sciences. The journal will include several features to promote accessibility to this diverse audience while maintaining the mathematical standards and top-notch editorial handling that characterize the SIAM journals family.

We plan to start accepting submissions and have a SIALS website up and running in spring 2025. Look out for upcoming announcements of new developments, sign up to receive email alerts[1] with the most up-to-date *SIALS* information, and be ready to prepare your results in the quantitative life sciences for a *SIALS* submission!

[1] https://go.siam.org/3innf8

SIAM Publications

Continued from page 5

If you have an idea for a book in this series—or any other SIAM book series, for that matter—please contact Elizabeth Greenspan (Executive Editor of SIAM Books) at **greenspan@siam.org**. SIAM publishes high-quality monographs and textbooks and is also seeking proposals for more general interest books.

Editor-in-chief Transitions

2025 will see EIC transitions for three SIAM journals: the *SIAM/ASA Journal on Uncertainty Quantification*, *SIAM Journal on Computing*, and *SIAM Journal on Mathematical Analysis* (see Figure 1, on page 5). We extend our sincere gratitude to the outgoing EICs for their excellent leadership and welcome their successors.

Record Readership and New Enhancements

The continued evolution of the SIAM Publications Library[11] has again led to record readership and engagement with SIAM publications. Journal article downloads are up by 50 percent since 2020, and 2024 saw a 23 percent increase from 2023. A SIAM journal article is now downloaded once every 21 seconds.

Librarians look at full-text article downloads as a key metric when deciding whether to renew your SIAM resources. *With that in mind, please access SIAM journals on the SIAM Publications Library from within your campus IP range or institutional VPN whenever possible.* Every download of the SIAM version of an article (rather than a preprint from arXiv) is a vote for your library to maintain a subscription to SIAM journals.

Following the success of the SIAM Epidemiology Collection,[12] we launched the SIAM High Impact Article Collection:[13] a selection of frequently downloaded and highly cited articles. In 2024, the collection featured 75 articles that rotated periodically and were freely available for a limited time.

The new SIAM Bookstore,[14] which is fully integrated with the SIAM Publications Library, officially launched in January 2024. SIAM can now sell e-books directly to individuals, and the implementation of single sign-on allows members to use the same login to secure their member book discount. Early data indicates that the new bookstore is also reaching nonmembers more successfully, thereby broadening the scope and sale of SIAM books.

Thanks to developments last year, it is now possible for journal and book authors to directly embed playable video content within the body of a journal article or book chapter. SIAM also published its first two books with full-text XML versions—*Mathematical Foundations of Finite Elements and Iterative Solvers*[15] by Paolo Gatto and *Fundamentals of Numerical Computation: Julia Edition*[16] by Tobin Driscoll and Richard Braun—which provide a much-improved alternate reading experience, particularly on mobile devices.

Continued Expansion of SIAM Proceedings

We strengthened the SIAM Proceedings collection[17] last year by expanding the number of proceedings that SIAM publishes and further investing in the production process. In 2024, SIAM secured three new proceedings agreements:

- SIAM has been selected as the proceedings publisher for the International Congress of Mathematicians 2026,[18] which will take place in July 2026 in Philadelphia, Pa. (where SIAM's headquarters is located)
- SIAM published the Proceedings of the 2024 International Meshing Roundtable[19]
- SIAM will publish the Proceedings of the 8th International Conference on Automatic Differentiation,[20] which took place in September 2024.

If you know of any other high-quality proceedings that SIAM should consider publishing, please reach out to me at **bowling@siam.org**.

SIAM Book Donations in Nepal

In 2024, SIAM donated slightly worn undergraduate and lower-level graduate textbooks to students in EducationUSA Nepal's Opportunity Funds Program,[21] an initiative of the U.S. Department of State's Bureau of Education and Cultural Affairs. This program aims to improve the accessibility of U.S. higher education for international students from disadvantaged backgrounds.

Please Recommend SIAM Journals and E-books to Your Libraries

As always, I will close with a very important request: *Please contact your librarian and recommend that your institution subscribe to the full collection of SIAM journals and e-books for your research and teaching needs*. Given static or declining library budgets, large commercial publishers increasingly dominate library subscription spending. These publishers focus on delivering profits to shareholders, whereas SIAM—a nonprofit society publisher—invests its revenue surplus back into the global scientific community through its programs, policy advocacy, and outreach projects. A subscription with SIAM means that your institution is actively supporting the people in your field, rather than just numbers on a balance sheet. And if your librarian hears strong faculty support from you and your department, they are far more likely to renew or expand their SIAM publication holdings.

Finally, let me say thank you to our readers, authors, editors, and reviewers. It is a privilege to work with you all, and we excitedly anticipate our continued collaboration to publish the best research globally and serve the SIAM community. I look forward to chatting with many of you at a SIAM conference later this year, and please feel free to reach out to me at any time at **bowling@siam.org** with any ideas, questions, or comments.

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[5] Wren, J.D., Valencia, A., & Kelso, J. (2019). Reviewer-coerced citation: Case report, update on journal policy and suggestions for future prevention. *Bioinform.*, *35*(18), 3217-3218.

Kivmars Bowling is the Director of Publications at SIAM.

[11] https://epubs.siam.org

[12] https://epubs.siam.org/topic/topics/topic-epidemiology

[13] https://epubs.siam.org/topic/topics/topic-highimpact

[14] https://epubs.siam.org/bookstore

[15] https://epubs.siam.org/doi/book/10.1137/1.9781611977097

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[17] https://www.siam.org/publications/proceedings

[18] https://www.mathunion.org/icm/icm-2026

[19] https://epubs.siam.org/doi/book/10.1137/1.9781611978001

[20] https://www.autodiff.org/ad24

[21] https://opportunity.usefnepal.org/info.php

Artificial Intelligence Tools Facilitate MDS24 Conference Scheduling

By Eric C. Chi, David F. Gleich, and Rachel Ward

The 2024 SIAM Conference on Mathematics of Data Science[1] (MDS24), which took place last October in Atlanta, Ga., was organized a bit differently than most SIAM conferences. As co-chairs of the Organizing Committee, we chose to heavily emphasize posters to increase participation while avoiding multi-session parallelism. In addition to roughly 100 minisymposia, MDS24 hence featured approximately 600 posters across five different poster sessions — the most of any SIAM conference to date. We connected the minisymposia and poster sessions by requiring that each minisymposium also have a set of four associated posters. This condition added a new level of complexity to the configuration.

While we initially thought about relying on artificial intelligence (AI) to organize much of the conference, we ultimately determined that modern AI tools are not yet capable of such a task. Nevertheless, they can certainly contribute to multiple aspects of the planning process. Here, we detail the ways in which AI tools saved us time and otherwise improved MDS24.

Key Efforts When Organizing a Conference

We received minisymposium and poster abstracts several months before the event. Members of the MDS24 Organizing Committee helped us review these submitted abstracts and assess their relevance to data science and any established themes. Next, we had to produce a schedule of sessions for each of the meeting's five days. Although organizers often do so by moving sticky notes around a board, planners of recent conferences—including the 2023 SIAM Conference on Computational Science and Engineering[2] (CSE23)—have begun to experiment with automated tools [1]. We implemented AI techniques to address the time-consuming parts of conference organization and enhance the meeting.

Verifying Abstract Compliance

As mentioned earlier, one significant change for MDS24 was the mandatory associated posters for each minisymposium. Given the design of SIAM's conference system, the most pragmatic way to collect this information was to ask minisymposium organizers to list their associated posters in the minisymposium abstract. Because this requirement was different from previous SIAM conferences, we wanted to check the submissions earlier than usual to ensure compliance. This screening process marked our first employment of AI tools. Rather than rely on AI directly, we utilized ChatGPT to write a graphical user interface that read minisymposia proposals from a file and allowed us to easily flag them as compliant or not compliant[3] (see Figure 1). We used the output of this program to generate a list of individuals with incomplete abstracts, then followed up with them.

Extracting Data to Match Posters and Minisymposia

Next, we had to match records of minisymposium submissions with associated posters. With roughly 400 items to match, this task would be exceedingly tedious by hand; however, writing a script to automate matching would also be time consuming. Although we asked submitters to adopt a common format to expedite our efforts, there was a high level of variance in everyone's interpretation of the instructions.

A good mental model for some modern AI tools—e.g., large language models such as GPT-4, which is used in ChatGPT—is that they can serve as "fancy regular expressions" that allow users to restructure information. We thus anticipated that these tools might successfully extract poster information data from the irregular raw minisymposia text. Using the OpenAI application programming interface (API), we created a custom GPT-4 prompt to take in a minisymposium proposal and return a JavaScript Object Notation (JSON) file with a list of posters (see Figure 2 and Figure 3, on page 9). *This method worked like a charm and was much easier than manually crafting rules to handle all of the different ways in which this information was encoded.* With poster titles in hand, we employed standard text matching tools to associate these posters with a minisymposium record and SIAM poster record.

Scheduling

We built upon the CSE23 scheduling tools that were designed by Alicia Klinvex of the Naval Nuclear Laboratory [1] to generate the MDS24 schedule. Her toolset includes a number of helpful programs that obtain submission data and identify authors with flipped first and last names — a necessary audit to avoid double scheduling. Based on conversations with Klinvex, we replaced the genetic program with an integer optimization problem for MDS24.

SOFTWARE AND PROGRAMMING

```
system_message = {
    "role": "system",
    "content": "You are a helpful assistant that extracts poster information from text and
        formats it into a JSON array with objects containing 'title', 'people' (optional),
        and 'email' (optional). The poster information is usually before the organizers
        section of the associated text. Only report email if it's a valid email address.
        There will be multiple posters to find. Give raw JSON output"
  }
user_message = {
    "role": "user",
    "content": <raw minisymposium text>
}
```

Figure 2. *The GPT-4o prompt that extracted information about posters from the associated minisymposium abstract. Figure courtesy of the authors.*

AI was perhaps most useful in avoiding topical overlap among minisymposia in the same time slots. For this task, we computed an *embedding* of each minisymposium abstract — i.e., a high-dimensional vector that represents the abstract in a vector space where a Euclidean distance between minisymposia makes sense. We easily acquired embeddings with an OpenAI API call for the `text-embedding-3-large` model, which simply needs the piece of text. The embeddings allowed us to evaluate a distance between minisymposia that we then used to construct a graph of potential topic overlaps. We thought of these overlaps as *hard conflicts*: minisymposia that *should not* occur at the same time. Figure 4 (on page 9) depicts the resulting graph of hard conflicts, each of which was encoded as a constraint in the integer program that required the two events to be scheduled at different times.

To dive a bit deeper, *conflicting* is actually a transitive property. For example, if we don't want to schedule A and B at the same time and we don't want to schedule B and C at the same time, then we *also* don't want to schedule A and C at the same time. Therefore, we would ideally include an entire connected component as a conflict group. MDS24 had 10 distinct minisymposium sessions in each time slot, which meant that no more than 10 sessions could conflict with each other. The transitive expansion was hence infeasible, as some connected components of conflicts had more than 10 nodes.

To mitigate this issue, we created a soft penalty that enumerated all paths in the network and weighted them based on distance. The integer optimization problem then sought to minimize the number of soft conflicts from this path-weighted graph, along with a few small terms from the topics that the minisymposium organizers selected. Cindy Phillips of Sandia National Laboratories, who used integer optimization to schedule a previous iteration of the SIAM Conference on Parallel Processing for Scientific Computing, helped us realize that we needed to round the values to only a few distinct weights to encourage the solver to perceive "big" moves in objective space.

The integer program saved us an enormous amount of time and made it easy to add constraints, such as "ensure that people

See **Conference Scheduling** *on page 9*

[1] https://www.siam.org/conferences-events/siam-conferences/mds24

[2] https://www.siam.org/conferences-events/past-event-archive/cse23

[3] https://chatgpt.com/share/67449e07-a69c-8006-a141-8492d50bad10

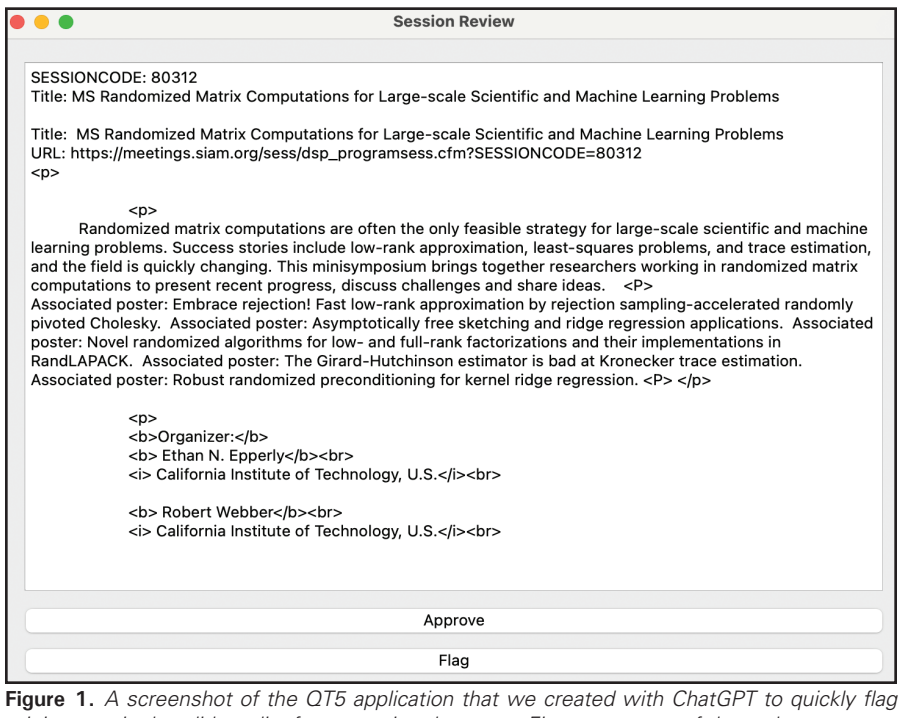

Figure 1. *A screenshot of the QT5 application that we created with ChatGPT to quickly flag minisymposia that did not list four associated posters. Figure courtesy of the authors.*

Countering the Risks of Computer Technology to Preserve Democracy

The Tech Coup: How to Save Democracy from Silicon Valley. *By Marietje Schaake. Princeton University Press, Princeton, NJ, September 2024. 336 pages, $27.95.*

BOOK REVIEW
By Ernest Davis

In a 2022 article for *MIT Technology Review*, journalist Melissa Heikkilä asked BlenderBot 3—an artificial intelligence (AI) chatbot produced by Meta—the question, "Who is a terrorist?" [2]. It answered, "Well, that depends on who you ask. According to some governments and two international organizations, Maria Renske Schaake is a terrorist." As it so happens, Maria Renske "Marietje" Schaake is not a terrorist; she is a politician from the Netherlands. Schaake was previously a member of the European Parliament from 2009 to 2019 and is currently a fellow at the Stanford Institute for Human-Centered Artificial Intelligence. She has been a leading figure in the development of European Union (EU) policy to regulate computer-related technology, having held various roles in a number of relevant organizations and projects. And now she has written a book titled *The Tech Coup: How to Save Democracy from Silicon Valley*, which identifies the threats of computer technology and poses several potential defenses.

As with most strange AI behaviors, no one has explained why BlenderBot 3 accused Schaake of terrorism; in fact, there is very likely no meaningful explanation. Schaake largely shrugs off this incident in her book, and it seems that no real harm came of it. But in other cases, given the casual transmission of information from one automated system to another and the impenetrability of computerized decision-making, such mistakes can have—and may have already had—serious consequences. Computerized decision support systems might take a similarly ridiculous claim seriously and decide to put someone on a no-fly list, withhold a visa, triple their insurance premiums or deny insurance claims, refuse to hire or rent to them, take away their children, or deny bail upon arrest. Even if they were so inclined, the human officials who execute these decisions might have no way of tracing and identifying the original error. Reported cases may only be the tip of the iceberg.

The Tech Coup: How to Save Democracy from Silicon Valley. By Marietje Schaake. Courtesy of Princeton University Press.

The Tech Coup discusses a wide range of dangers that the computer industry poses to both individuals and society. As suggested in the subtitle, *How to Save Democracy from Silicon Valley*, the core focal points are the threat of huge behemoths in the computer industry—especially Alphabet/Google, Meta/Facebook, Apple, Amazon, and Microsoft—to democratic institutions and standards, and the role of governments—particularly the U.S. and EU—in addressing those threats. Schaake clearly and convincingly describes the inherently antidemocratic aspects of these corporations; they are richer and more powerful than many sovereign states, and they use their great wealth and power primarily to amass even more wealth and power. These computer companies are notorious for exhibiting monopolistic tendencies and bad labor practices, obscuring important aspects of their businesses, and using shadow companies to hide some of their sleazier endeavors. Such organizations also control vast quantities of private information, and—as the 2016 Cambridge Analytica scandal revealed—can be culpably careless about the use of that data.

In perfect secrecy, with no need to consult anyone and no incentive to consider the public good or anything beyond the bottom line, major tech corporations can unilaterally make decisions that affect hundreds of millions of people. They can and often do carry out their own foreign policy, making arrangements with foreign countries that may contradict the interests of the U.S. and EU. When faced with regulation accountability or efforts to shed light on deceitful matters, these businesses can deploy armies of lobbyists to ensure that nothing happens that would inconvenience them.

The Tech Coup also includes a lengthy commentary about the dangers that are associated with computer technology beyond large corporations. Even if the dozen largest computer companies decided to devote their efforts purely to the "public good" (as Schaake defines it), many threats would still remain. Dangers stem from cryptocurrency, cyberattacks by both foreign powers and criminals, biased or flawed outputs of computer programs (as mentioned previously), electronic voting machines with no paper trail, autocratic governments' use of sophisticated computer technology to

See **Computer Technology** *on page 11*

Conference Scheduling

Continued from page 8

with multiple events don't get scheduled on the first and last day." We were able to generate a feasible schedule within about 20 minutes. The solver still hadn't found an optimal solution after 16-18 hours (though it was still making headway), so we chose to stop the solver at that time and use the best solution it had found up to that point. With the benefit of hindsight, we now wish that we had tried a greedy improvement/swapping strategy on the final solution.

Organizing Poster Sessions

We also employed AI to organize the five poster sessions at MDS24. Again using the OpenAI API call with `text-embedding-3-large`, we computed embeddings for each poster abstract and then calculated a one-dimensional spectral embedding of the weighted graph of affinities between posters. Spectral embeddings attempt to minimize the energy of a spring system based on the edges at which each vertex (i.e., poster) is associated with a point on a line. Since poster sessions often follow a linear organizational setup in long rows or columns, this approach yielded a reasonable topic order to ensure that attendees who were interested in one particular poster might also be interested in nearby displays.

Reproducibility, Costs, and Ethical Implications

Following Randall LeVeque's 2013 advice to the SIAM community [2], our rough, unedited code for these tasks is available on GitHub.[4] These files include embeddings for the minisymposia and posters at the time they were scheduled.

We maintained a ChatGPT Plus subscription[5] for $20.00 a month and spent between $1.00 and $2.00 in API fees for custom prompts and embeddings. Although we could have completed every MDS24 scheduling duty without the use of AI, the AI tools probably saved us 40 to 80 hours of work versus the alternative of conducting all tasks manually.

Some of the AI outputs were programs that were likely based on examples from Stack Overflow[6] and/or GitHub.[7] These examples may have included codes without appropriate copyright permissions.

Where AI Wasn't Helpful

The organization of any conference necessitates a vast amount of human interaction. Contacting invited speakers (many of whom we knew personally), following up on minisymposia submissions that were missing posters, and interacting with SIAM conference staff all required timely, individualized emails, and we didn't find AI tools to be particularly helpful with aspects that involved this type of human element.

AI to Augment Human Ability

Many AI proponents expect the technology to *replace* human work by automating simple tasks. An example in the context of MDS24 is our extraction of poster information from minisymposium abstracts, which worked well. However, we believe that AI tools should *augment* (rather than replace) human work. They enabled us to realistically pursue ambitious ideas for MDS24 by lowering the barriers to entry and execution; our use of embeddings for minisymposium topic overlap and poster organization is one such example. The complete manual optimization of poster layout is neither a practical nor resourceful use of time when organizing a SIAM conference, but AI tools allowed us to efficiently try. AI technology augmented and enhanced our efforts to improve MDS24, and we encourage future conference organizers to experiment with similar methods.

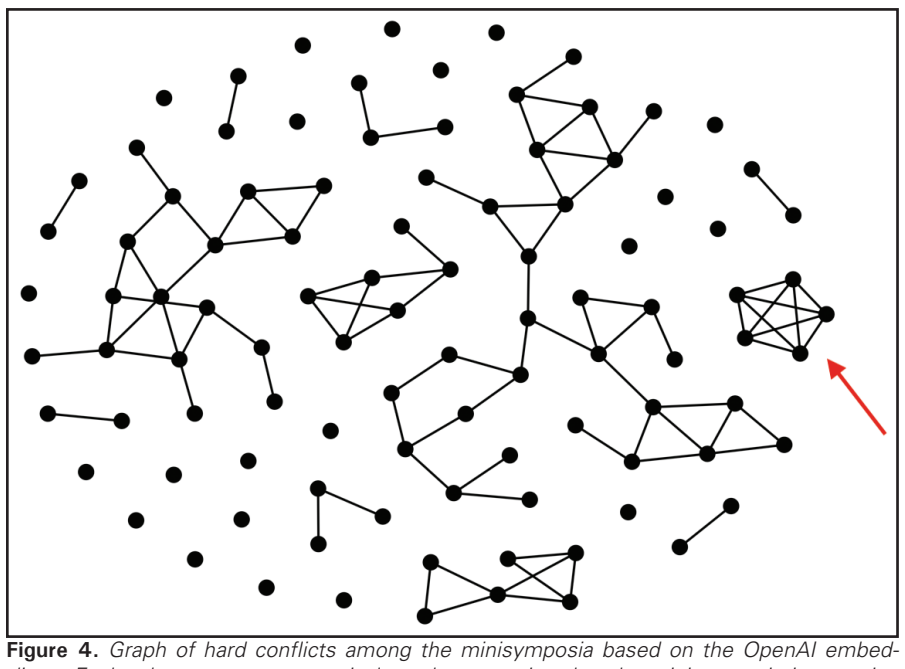
Figure 4. *Graph of hard conflicts among the minisymposia based on the OpenAI embeddings. Each edge represents a topical overlap, meaning that the minisymposia in question should not occur at the same time. These minisymposia were often thematically consistent; for instance, the fully connected group of nodes on the right (marked by the red arrow) represents sessions about topology and data. Figure courtesy of the authors.*

Acknowledgments: We are extremely grateful to Alicia Klinvex, who helped us set up the initial integer optimization model and provided tools to manage minisymposium data from SIAM. We also thank Cindy Phillips for answering our questions about IP formulations and Tammy Kolda for providing initial feedback to this article. Finally, we acknowledge the SIAM conference staff for all of their help throughout the MDS24 planning process.

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[2] LeVeque, R.J. (2013, April 1). Top ten reasons to not share your code (and why you should anyway). *SIAM News*, *46*(3), p. 8.

Eric C. Chi is an associate professor of statistics at Rice University who contributes to statistical learning and optimization techniques. His research spans high-dimensional data analysis, machine learning, and applied mathematics. David F. Gleich is a professor of computer science at Purdue University who specializes in matrix and graph algorithms with applications in network science and data analysis. His work focuses on scalable computational methods for complex systems. Rachel Ward is a professor of mathematics at the University of Texas at Austin with expertise in optimization, machine learning, and computational mathematics. Her research addresses foundational challenges in data science and signal processing.[8]

[4] https://github.com/dgleich/mds2024-tools

[5] https://openai.com/index/chatgpt-plus

[6] https://stackoverflow.com

[7] https://github.com

[8] In keeping with the theme of the article, these biographies were generated by ChatGPT (with light edits by *SIAM News* staff).


```
{ "url": "https://meetings.siam.org/sess/dsp_programsess.cfm?SESSIONCODE=80312",
  "posters": { "posters": [
    { "title": "Embrace rejection! Fast low-rank approximation by rejection sampling-
         accelerated randomly pivoted Cholesky"
    }, { "title": "Asymptotically free sketching and ridge regression applications"
    }, { "title": "Novel randomized algorithms for low- and full-rank factorizations and
         their implementations in RandLAPACK"
    }, { "title": "The Girard-Hutchinson estimator is bad at Kronecker trace estimation"
    }, { "title": "Robust randomized preconditioning for kernel ridge regression"
} ] } }
```


Figure 3. *Result of the OpenAI prompt from Figure 2 (on page 8) on the text in Figure 1 (on page 8). Figure courtesy of the authors.*

Numerics for Stochastics

By Desmond J. Higham and Peter E. Kloeden

The following is a brief contribution from the authors of An Introduction to the Numerical Simulation of Stochastic Differential Equations,[1] which was published by SIAM in 2021. This book describes the numerical solution of stochastic differential equations and is suitable for a broad audience that ranges from undergraduate students to established researchers. Computational examples illustrate key ideas, computer code supplements each chapter, and 150 exercises and 40 programming projects provide further opportunities for readers to explore the material.

The authors also share a short excerpt about the Fokker-Planck equation from chapter 14, titled "Steady States." It has been abridged and edited for clarity.

An Introduction to the Numerical Simulation of Stochastic Differential Equations is a lively, accessible presentation of the numerical solution of stochastic differential equations (SDEs). We kept the prerequisites to a minimum to ensure that the topic is accessible to the widest conceivable readership, and only assumed a competence in algebra and first-year undergraduate calculus. A major motivation for this book was the sustained citation level of a 2001 article on the subject that appeared in the "Education" section of *SIAM Review* [3]. Based on that impactful publication and ensuing discussions with colleagues, we identified a definite need for a self-contained, elementary text that conveys the fundamentals as succinctly as possible. Our book follows the style of the original article [3] and offers a myriad of computational examples and illustrative figures to support the concepts.

Because the field of numerical SDEs is relatively new but rapidly expanding, we were able to include novel material on modern topics that did not appear outside of research articles and monographs at the time of publication, including the following areas:

- Failure of the standard Euler-Maruyama method to converge for a simple nonlinear SDE
- Asymptotic and mean-square stability for numerical SDEs
- Mean exit times
- Exotic options in mathematical finance
- Steady state behavior
- Multilevel Monte Carlo methods
- SDEs with jumps
- SDE models in the social sciences
- Modeling with colored noise
- Pitfalls in the approximation of double stochastic integrals
- Stochastic modeling and simulation regimes in chemical kinetics.

Many aspects of numerical SDEs can be confusing and sometimes raise questions that are as philosophical as they are mathematical. Within the limitations of accessibility, we aimed to clearly explain the issues that surround strong versus weak solutions and convergence, Itô versus Stratonovich calculus, mean-square versus asymptotic stability, and the thermodynamic limit.

In our experience, the best way to understand an algorithm is to experiment with a suitable computer program. For this reason, each chapter of *An Introduction to the Numerical Simulation of Stochastic Differential Equations* concludes with a full walkthrough of a "Program of the Chapter" that explores a key topic.

[1] https://epubs.siam.org/doi/book/10.1137/1.9781611976434

The following excerpt about the computation of long-time trajectories combines selected parts of chapter 14 on "Steady States." This topic continues to be an important research area, not least because of its connections to modern algorithms in statistical sampling and machine learning.

Meet the Fokker-Planck Equation

For a deterministic ordinary differential equation (ODE) $\mathrm{d}x(t)/\mathrm{d}t = f(x(t))$, any point $x^\star$ such that $f(x^\star)=0$ is a steady state. A solution that begins at a steady state will remain there because the derivative will always be 0. And if $x^\star$ is a locally attractive steady state, then initial conditions that are sufficiently close to $x^\star$ will produce solutions for which $x(t) \to x^\star$ as $t \to \infty$. If all solutions approach the fixed point, it is said to be *globally attractive*.

These concepts extend to SDEs. In particular, any point $x^\star$ such that $f(x^\star)= g(x^\star)=0$ is a fixed point of the SDE

$$\mathrm{d}X(t) = f(X(t))\mathrm{d}t + g(X(t))\mathrm{d}\,W(t).$$

However, a more general scenario is also possible. Because $X(t)$ is a random variable at each time t, we can think of it as being characterized by a density function $p(x,t)$; for each time t, the integral $\int_a^b p(x,t)\mathrm{d}x$ gives the probability that $a \le X(t) \le b$. Since $p(x,t)$ is a function of two variables, it is reasonable to imagine that it satisfies a partial differential equation (PDE). This is indeed the case under appropriate conditions, and the relevant PDE takes the form of the *Fokker-Planck* or *Kolmogorov forward PDE*:

$$\frac{\partial}{\partial t}p(x,t) + \frac{\partial}{\partial x}(f(x)p(x,t)) - \frac{1}{2}\frac{\partial^2}{\partial x^2}(g(x)^2 p(x,t)) = 0. \quad (1)$$

If the solution approaches a time-invariant limit as $t \to \infty$, we can logically consider a *steady state density function* $p(x)$ that stems from setting the time derivative in (1) to 0. Doing so leads to the ODE

$$\frac{\mathrm{d}}{\mathrm{d}x}(f(x)p(x)) - \frac{1}{2}\frac{\mathrm{d}^2}{\mathrm{d}x^2}(g(x)^2 p(x)) = 0. \quad (2)$$

As an example, consider the Ornstein-Uhlenbeck process wherein $f(x)=-\lambda x$, $g(x)=\sigma$, and $\lambda > 0$. The steady Fokker-Planck equation in (2) becomes

$$-\lambda\frac{\mathrm{d}}{\mathrm{d}x}(xp(x)) - \tfrac{1}{2}\sigma^2\frac{\mathrm{d}^2}{\mathrm{d}x^2}p(x) = 0. \quad (3)$$

We find that the only solution to this ODE that corresponds to a density function over $-\infty < x < \infty$ is

$$p(x) = \frac{1}{\sqrt{2\pi\sigma^2/(2\lambda)}}\mathrm{e}^{-x^2/(2\sigma^2/(2\lambda))}, \quad (4)$$

i.e., the density of a $N(0, \sigma^2/(2\lambda))$ random variable. All solutions approach this steady state. This finding is consistent with the properties

$$\mathbb{E}[X(t)] \to 0 \quad \text{as} \quad t \to \infty$$

and

$$\mathbb{E}[X(t)^2] \to \frac{\sigma^2}{2\lambda} \quad \text{as} \quad t \to \infty; \quad (5)$$

the latter of these follows from Itô's formula.

Computing to a Steady State

In Figure 1, we take $\lambda = 0.75$, $\sigma = 1$, and $X(0)$ uniformly over $(1,3)$ in the Ornstein-Uhlenbeck process. We then apply the Euler-Maruyama method with step size $\Delta t = 1$ and generate histograms for the time T solutions that arise from 10^6 independent paths. We deliberately chose a large Δt to emphasize the fact that the exact and Euler-Maruyama steady states are not equal. Figure 1 depicts the initial data X_0 and provides computations for times $T=2$, $T=4$, and $T=6$. The solid and dashed curves respectively represent analytical expressions for the exact and Euler-Maruyama steady state densities of this simple SDE.

FROM THE SIAM BOOKSHELF

Additional Notes

Algorithms that time-step toward the steady state of a differential equation are intimately connected to algorithms that iterate toward the solution of an optimization problem. In particular, we can utilize an SDE viewpoint [7] to interpret the *stochastic gradient method*, which is widely used in the field of deep learning to train artificial neural networks [2].

Time-stepping to a steady state is also a useful way to generate samples from a given distribution. Suppose that we wish to sample from a random variable with density $p(x) = C\rho(x)$, where we do not need to explicitly specify the normalizing constant C that makes $\int_{-\infty}^{\infty} p(x) = 1$. First, we write $\rho(x) = \mathrm{e}^{-V(x)}$ for some function $V(\cdot)$. We see that the SDE with $f(x) = -V'(x)$ and $g(x) = \sqrt{2}$ has the appropriate invariant measure. We may hence compute an approximate sample by following the SDE's path for a sufficiently long time.

In the Markov chain Monte Carlo setting, researchers have combined this idea with a Metropolis-Hastings-style acceptance/rejection step [6] to produce a method that is now called the *Metropolis-adjusted Langevin algorithm* [1, 4, 5]. This algorithm is particularly effective for multidimensional distributions. When the SDE is *ergodic*, averaging over a long time period is equivalent to averaging over all paths. Therefore, to compute $\mathbb{E}[\phi(X^\star)]$—where the random variable $X^\star$ represents the stationary distribution—it is reasonable to truncate T at a suitably large value and compute an approximation to $\lim_{T\to\infty} T^{-1}\int_0^T \phi(X(t))\mathrm{d}t$ for a single path.

Enjoy this passage? Visit the SIAM Bookstore[2] to learn more about An Introduction to the Numerical Simulation of Stochastic Differential Equations[3] and browse other SIAM titles. Additionally, two book reviews of this text have published in SIAM Review; Guenther Leobacher of the University of Graz offered his impressions in the December 2023 issue[4] (Vol. 65, Issue 4), and Minh-Binh Tran of Texas A&M University shared his thoughts in the March 2024 issue[5] (Vol. 66, Issue 1).

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Desmond J. Higham is a professor of numerical analysis at the University of Edinburgh. He is a SIAM Fellow. Peter E. Kloeden is a retired Chair of Applied and Instrumental Mathematics at Goethe University Frankfurt. He is now a visiting researcher at the University of Tübingen. Kloeden's research interests include the analysis and numerics of random and nonautonomous systems and their applications. He is a SIAM Fellow.

[2] https://epubs.siam.org/bookstore

[3] https://epubs.siam.org/doi/book/10.1137/1.9781611976434

[4] https://epubs.siam.org/doi/10.1137/23N975818

[5] https://epubs.siam.org/doi/10.1137/24N975864

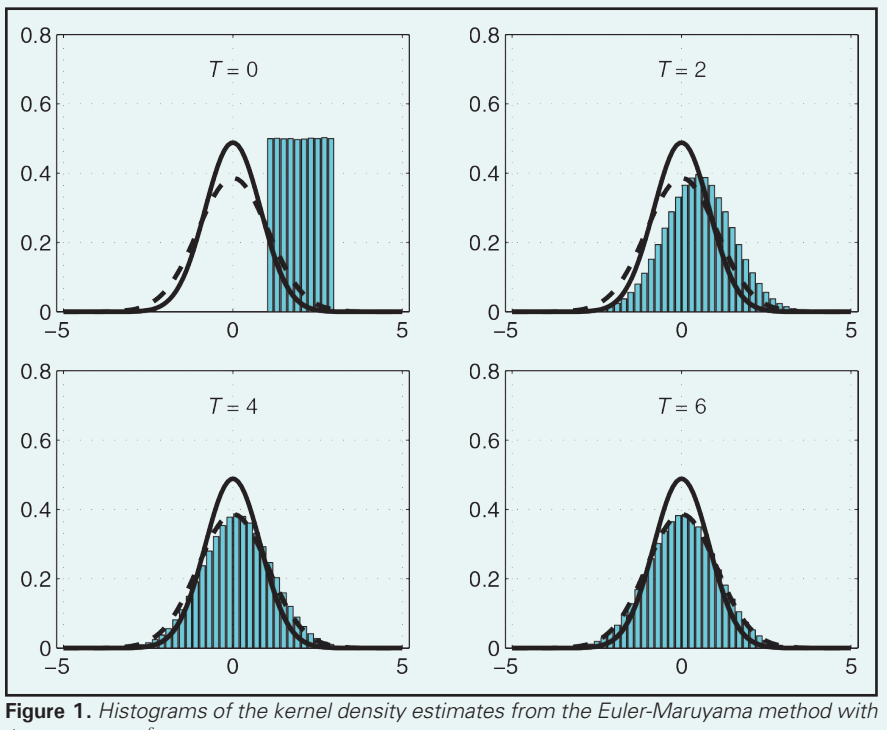

Figure 1. *Histograms of the kernel density estimates from the Euler-Maruyama method with $\Delta t = 1$ over 10^6 independent paths for an Ornstein-Uhlenbeck process at times $T = 0$, 2, 4, and 6, where X_0 is uniform over $(1,3)$. The solid curves depict the steady state density for the stochastic differential equation (normal with a mean of 0 and variance of $\sigma^2/(2\lambda)$), while the dashed curves represent the steady state density for the numerical method (normal with a mean of 0 and variance of $\sigma^2/(2\lambda(1-\lambda\Delta t/2))$). Figure courtesy of Introduction to the Numerical Simulation of Stochastic Differential Equations.*

SIAM Names Two Project NExT Fellows for 2024-2025

By Lea Jenkins, Marissa Gee, and Trevor Leslie

SIAM is pleased to announce that Marissa Gee of Kenyon College and Trevor Leslie of the Illinois Institute of Technology have been selected as the 2024-2025 SIAM Project NExT (New Experiences in Teaching) Fellows. Congratulations to these outstanding early-career mathematicians!

The Mathematical Association of America[1] (MAA) organizes Project NExT[2]—a professional development program for new or recent Ph.D.s in the mathematical sciences—to bolster numerous aspects of participants' careers in academia, including the teaching and learning of mathematics, research and scholarship, service to the community, and other professional activities. Project NExT supports faculty at the start of their careers by offering workshops, a peer network, and mentorship as they navigate their academic paths.

Marissa Gee of Kenyon College.

Since 2020, SIAM has sponsored two Project NExT Fellows on a yearly basis. This annual sponsorship is one of many ways in which SIAM supports the professional development of junior faculty, especially in the area of applied mathematics education. Early-career faculty in postsecondary environments help to ensure that students from all types of backgrounds obtain the necessary skills to tackle the complex, real-world applied mathematics problems of the future. Over the course of their first year, each cohort of Project NExT Fellows participates in a range of programs to prepare them for this instructional role. Workshops and information sessions strengthen instructors' abilities to engage students in specific types of math courses, support mentees from historically underserved groups, involve undergraduate students in mathematics research, ready future K-12 mathematics teachers for the workforce, write grant proposals, and balance teaching and research.

SIAM aids in this important faculty development by encouraging Fellows to participate in activities with the SIAM Education Committee.[3] For example, Fellows help to arrange SIAM-sponsored events at the Joint Mathematics Meetings[4] and MAA Mathfest,[5] organize minisymposia at SIAM conferences, and volunteer for Student Days activities at the SIAM Annual Meeting.[6] Fellows also contribute to the planning and execution of SIAM outreach events and enhance engagement with undergraduate and graduate SIAM student chapters.[7]

SIAM Project NExT Fellow Marissa Gee is an assistant professor in the Department of Mathematics and Statistics at Kenyon College. Her research focuses on optimal control problems with applications in robotics and ecology. Gee earned a B.S. in mathematics from Harvey Mudd College in 2018 and an M.S. and Ph.D. in applied mathematics from Cornell University in 2021 and 2024, respectively. In graduate school, she joined the Cornell University SIAM Student Chapter and attended SIAM conferences with generous support from the SIAM Student Travel Award;[8] both experiences benefited her greatly. She is excited to continue engaging with the community as a Project NExT Fellow.

Trevor Leslie of the Illinois Institute of Technology.

Gee is also passionate about effective and inclusive mathematics education. As a Ph.D. candidate, she helped to lead workshops on effective grading, inclusive assessment, and universal design at Cornell's Center for Teaching Innovation[9] and the Center for the Integration of Research, Teaching and Learning.[10] Gee incorporates real-world applications and projects into her classes, often drawing inspiration from her interactions with other applied mathematicians. She hopes to instill her students with an appreciation for mathematics as a tool to better understand the world and looks forward to further growth as an educator at Kenyon.

Trevor Leslie, the other 2024-2025 SIAM Project NExT Fellow, is an assistant professor of applied mathematics at Illinois Tech. His research interests include partial differential equations, mathematical fluid dynamics, and collective behavior. Leslie's latest work uses a "sticky particle" discretization scheme to predict clustering features of solutions to the Euler alignment system; this framework has already been implemented by other researchers in the field and was the primary basis for a recent grant from the U.S. National Science Foundation.

Leslie is an active speaker and contributor to conferences and symposia. He is currently co-organizing a weeklong interdisciplinary workshop on collective behavior in complex systems[11] that will take place at the Institute for Mathematical and Statistical Innovation[12] in March 2025; he is also slated to co-organize the next conference of the Great Lakes Section of SIAM,[13] which will be held at Illinois Tech in September 2025. As a dedicated instructor and mentor, Leslie currently supervises one Ph.D. student and one master's student. He regularly teaches a wide range of courses in analysis, differential equations, and related topics.

Before arriving at Illinois Tech, Leslie held postdoctoral positions at the University of Wisconsin-Madison, Simons Laufer Mathematical Sciences Institute, and University of Southern California. He received a B.S. in mathematics from Indiana University Bloomington, an M.S. in mathematics from the University of Illinois Chicago (UIC), and a Ph.D. in pure mathematics from UIC. Leslie has been an active member of the SIAM community since his time as a graduate student, when

See **Project NExT** *on page 12*

[1] https://maa.org
[2] https://maa.org/maa-project-next
[3] https://www.siam.org/get-involved/connect-with-a-community/committees/education-committee
[4] https://jointmathematicsmeetings.org
[5] https://maa.org/event/mathfest
[6] https://www.siam.org/conferences-events/siam-conferences/an25
[7] https://www.siam.org/get-involved/connect-with-a-community/student-chapters
[8] https://www.siam.org/conferences-events/conference-support/travel-and-registration-support
[9] https://teaching.cornell.edu
[10] https://cirtl.net
[11] https://www.imsi.institute/activities/emergent-behavior-in-complex-systems-of-interacting-agents
[12] https://www.imsi.institute
[13] https://www.siam.org/get-involved/connect-with-a-community/sections/great-lakes-section-of-siam

Computer Technology

Continued from page 9

repress their own citizens, and weaponry that incorporates increasingly powerful computational technology.

Moreover, many of the computer products that constitute the most direct attacks on democracy are made by small companies. For instance, the facial recognition software Clearview AI—which was secretly sold to more than 600 police departments before the public learned of its existence—was mostly built by software engineer Hoan Ton-That, who worked out of his apartment with only occasional collaborators and, by Silicon Valley standards, minuscule funding [1].

While Schaake discusses AI at length, it is not the primary focus of her book. She concentrates on present and imminent risks rather than long-term dangers. All in all, I find her discussion about threats to be well-informed, clear, and sensible.

In the final chapter of *The Tech Coup*, Schaake proposes regulatory measures to counter the antidemocratic consequences of computer technology. These straightforward, rational recommendations include prohibiting government use of commercial spyware, controlling the sale and transfer of private information like health records and location history, regulating facial recognition systems, limiting or prohibiting cryptocurrencies, requiring large measures of public transparency in all aspects of the computer industry, and mandating that software meet reliability and safety standards against hacking.

The quality of Schaake's writing is very uneven. Her account of the 2017 presidential election in Kenya—which was undermined by unreliable digital voting equipment to the point that the High Court of Kenya demanded a complete redo of the whole election—is clear, passionate, readable, and infuriating. However, her retellings of frustrating interactions with computer industry bigwigs at fancy conferences are generally less interesting. At times, Schaake descends into political speak that combines nebulous, jargony statements about high-minded principles with lists of acronyms for resolutions and agencies, trusting that the reader is familiar with organizations like the U.S. Cybersecurity and Infrastructure Security Agency and U.S. National Telecommunications and Information Administration. Overall, however, *The Tech Coup* is a very worthwhile read.

As I write this review in mid-December 2024, OpenAI is currently halfway through a 12-day fest[1] with the jejune name of "Shipmas" that features daily announcements and releases of new products and capabilities. This "celebration" makes it abundantly clear that addressing concerns about their products' safety is a very low priority for OpenAI, and that any consideration of accountability is nowhere on their radar. As the Trump administration takes office in the U.S., I anticipate that it will not be sympathetic to Schaake or receptive to her views. The threats grow rapidly, and the political will to face them is quickly vanishing.

The existence of immensely powerful, rapacious, unscrupulous, secretive corporations who are a law unto themselves has remained a persistent feature of American society since at least the 1860s. How much greater are the threats that democracy now faces than those it has faced in the past? Has the computer industry caused harm—or is it likely to cause harm—on a scale that is comparable to the fossil fuel or tobacco industries? I do not argue for complacency, but rather for perspective in light of these long-standing historical trends.

[1] https://openai.com/12-days

References

[1] Davis, E. (2024, March 1). The perils of automated facial recognition. *SIAM News*, *57*(2), p. 6.

[2] Heikkilä, M. (2022, August 31). What does GPT-3 "know" about me? *MIT Technology Review*. Retrieved from https://www.technologyreview.com/2022/08/31/1058800/what-does-gpt-3-know-about-me.

Ernest Davis is a professor of computer science at New York University's Courant Institute of Mathematical Sciences.

Call for Proposals to Host the 2030 U.S. National Congress on Theoretical and Applied Mechanics

The U.S. National Committee for Theoretical and Applied Mechanics[1] (USNC/TAM) is currently soliciting proposals from institutions that are interested in hosting the 2030 U.S. National Congress on Theoretical and Applied Mechanics. Since 1950, a National Congress on Theoretical and Applied Mechanics has taken place every four years to foster and promote the exchange of ideas and information among the various disciplines within the mechanics community and chart future priorities in mechanics-related research, applications, and education.

If your institution is interested in hosting the Congress, please contact Thomas Pence, secretary of USNC/TAM and chair of the site selection subcommittee, at **pence@egr.msu.edu** for information on developing your proposal. USNC/TAM is eager to work with interested parties during proposal development. Proposals should then be submitted electronically to Thomas Pence at **pence@egr.msu.edu** and Horacio Espinosa, chair of USNC/TAM, at **espinosa@northwestern.edu**.

The proposal timeline is as follows:

- Final proposal submission: **March 20, 2025** (submitted electronically)
- Finalist presentations: First weekend in May 2025 at USNC/TAM meeting in Washington, D.C. (with a Zoom option)
- Decision announcement: June 2025.

Learn more on the *SIAM News* website.[2]

[1] https://www.nationalacademies.org/our-work/us-national-committee-for-theoretical-and-applied-mechanics-usnc-tam
[2] https://www.siam.org/publications/siam-news/articles/call-for-proposals-to-host-the-2030-us-national-congress-on-theoretical-applied-mechanics

Northern and Central California Section of SIAM Holds Inaugural Conference

By Noémi Petra and Roummel Marcia

The first annual meeting[1] of the Northern and Central California (NCC) Section of SIAM[2] took place in October 2024 at the University of California, (UC) Merced. Nearly 200 students and researchers from academic institutions, industry, and the national laboratories participated in this three-day event. Although most attendees came from Northern California and the Central Valley, students from as far as Colorado and Texas traveled to present their research at the meeting.

The 1st SIAM Northern and Central California Sectional Conference[3] (NCC24) commenced with a plenary talk by Michael Mahoney of UC Berkeley and Lawrence Berkeley National Laboratory (LBNL), who discussed paradigms for scientific machine learning foundation models. On the second day, Rob Schreiber of Cerebras Systems[4] spoke about wafer-scale computing and its corresponding impact on scientific computing at the hardware, architecture, and algorithmic levels. The final day featured a plenary address by Mariel Vazquez of UC Davis, who described the role of knot theory in geometrical and topological models of nucleic acids.

NCC24 boasted 10 minisymposia that explored a variety of topics, such as fluid dynamics, numerical analysis, optimization, inverse problems, scientific and high-performance computing, uncertainty quantification, and scientific machine learning. Presenters included graduate students and faculty members from a variety of universities across the country, the national laboratories, research centers like Ames Research Center and the Air Force Office of Scientific Research, and companies such as Amazon[5] and Volcano Platforms.[6]

The conference program incorporated two evening poster sessions with a total of 66 posters from 10 undergraduate students, 44 graduate students, and 12 nonstudent researchers; after the sessions, judges conferred outstanding poster awards in each category. The NCC24 poster prize recipients were undergraduate students Rodrigo Flores of UC Merced and Oscar Thompson of California State University (CSU), East Bay; graduate students Nicholas Rondoni of UC Santa Cruz and Scott West and Jacqueline Alvarez of UC Merced; and Prabhat Kumar of LBNL. The judges also awarded honorable mentions to undergraduate students He (Amber) Wei of UC Berkeley, Elijah Valverde of San Francisco State University, and Adrian Kisieu of UC Merced; graduate students Michael Kielstra of UC Berkeley and Elsie Cortes of UC Merced; and nonstudent researchers Joy Bahr-Mueller of Sandia National Laboratories (SNL) and Elizabeth Glista of Lawrence Livermore National Laboratory (LLNL).

Additionally, four panel discussions connected undergraduate students, graduate students, and early-career researchers with the greater scientific community. Each session addressed a different topic: career opportunities for undergraduates, the transition from student to researcher (e.g., preparing for internships and postdoctoral positions), industry and laboratory careers, and the role of artificial intelligence and machine learning in science. "It was fantastic to meet so many students, researchers, and faculty from across the state," Stefan Wild, a panelist from LBNL, said. "Our panel was especially interactive — there was a clear appetite for the topic and awesome questions from everyone." Panelists spanned academia, industry, and the national laboratories and included Shima Alizadeh of Amazon Web Services,[7] Kenny Chowdhary of NVIDIA,[8] Marta D'Elia of Atomic Machines,[9] Jessica De Silva of CSU Stanislaus, Habib Najm and Cosmin Safta of SNL, Andy Nonaka and Stefan Wild of LBNL, Noémi Petra and Joshua Viers of UC Merced, Jon Wilkening of UC Berkeley, and SIAM President Carol Woodward of LLNL.

The NCC Section of SIAM was established and recognized by SIAM in 2024. Its primary goal is to provide ongoing opportunities for mathematicians in academia, industry, the national laboratories, and government to come together and form strong social and professional networks. This section also strives to provide undergraduate and graduate students, early-career researchers, and regular SIAM members with the chance to connect and take part in the many offerings of both the SIAM community and the regional academic, laboratory, and industry communities. "NCC24 brought world-class, high-quality research presentations and discussions to the region," Anh Thai Nhan of Santa Clara University said. "This is particularly meaningful for faculty members who are from primarily undergraduate institutions and don't have major research funding."

Attendees of the 1st SIAM Northern and Central California Sectional Conference, which was held at the University of California, Merced, in October 2024, pose for a group photo on campus. Photo courtesy of Veronica Adrover.

The importance of establishing local research communities cannot be overstated. "The meeting filled a critical need for applied mathematicians in our region from numerous institutions and companies to share current work and challenges," Woodward said. "It was fantastic to meet so many people working on related topics, all within an easy drive from each other."

The officers of the NCC Section of SIAM—Petra (chair), D'Elia (vice chair), Safta (secretary), and Esmond Ng of LBNL (treasurer)—served as NCC24 Organizing Committee co-chairs. The Technical Program Committee included Alizadeh, Najm, Wild, Wilkening, Woodward, Javier Arsuaga of UC Davis, Mario Bencomo of CSU Fresno, Robert Bassett of the Naval Postgraduate School, Marcella Gomez of UC Santa Cruz, Gianluca Iaccarino of Stanford University, and Franziska Weber of UC Berkeley. Onsite arrangements and logistics were coordinated by the Local Organizing Committee—UC Merced faculty members Roummel Marcia, Boaz Ilan, Changho Kim, Erica Rutter, and Shilpa Khatri—with help from the UC Merced SIAM Student Chapter.[10]

Information about upcoming activities and opportunities for involvement with the NCC Section of SIAM is available on the section's website.[11]

Acknowledgments: NCC24 was made possible by funding support from SIAM; the U.S. National Science Foundation's Division of Mathematical Sciences grant 2433859; the Lopker family; and UC Merced's Department of Applied Mathematics, School of Natural Sciences, and Graduate Division.

Noémi Petra is an associate professor of applied mathematics at the University of California (UC) Merced. Prior to joining UC Merced, she was a postdoctoral fellow at the Oden Institute at The University of Texas at Austin. Petra's research interests include large-scale Bayesian inverse problems governed by differential equations, uncertainty quantification in inference and prediction, and optimal experimental design. She is a recipient of the U.S. National Science Foundation's Faculty Early Career Development Program award. Roummel Marcia is a professor and chair of the Department of Applied Mathematics at UC Merced. He holds a Ph.D. in applied mathematics from UC San Diego. Prior to joining UC Merced, Marcia was a postdoctoral researcher at the University of Wisconsin-Madison and a research scientist at Duke University. His research interests include large-scale optimization, numerical linear algebra, signal processing, machine learning, and computational biology.

[1] https://www.siam.org/conferences-events/section-meetings/northern-and-central-california-section-of-siam-annual-meeting-2024
[2] https://www.siam.org/get-involved/connect-with-a-community/sections/northern-and-central-california-section-of-siam
[3] https://sites.google.com/view/siam-ncc/siam-ncc-conference-2024
[4] https://cerebras.ai
[5] https://www.amazon.jobs
[6] https://www.volcanoplatforms.com
[7] https://aws.amazon.com
[8] https://www.nvidia.com
[9] https://www.atomicmachines.com
[10] https://appliedmath.ucmerced.edu/siam_chapter
[11] https://sites.google.com/view/siam-ncc

Several of the outstanding poster award and honorable mention recipients at the 1st SIAM Northern and Central California Sectional Conference—which took place in October 2024 at the University of California, Merced—gather for a celebratory photo. From left to right: Poster session lead and Local Organizing Committee member Changho Kim of the University of California (UC) Merced; Joy Bahr-Mueller of Sandia National Laboratories; Michael Kielstra of UC Berkeley; Jacqueline Alvarez of UC Merced; Nicholas Rondoni of UC Santa Cruz; and He (Amber) Wei of UC Berkeley. Photo courtesy of Veronica Adrover.

Project NExT

Continued from page 11

he twice co-organized the Chicago Area SIAM Student Conference: a joint meeting between the students of Illinois Tech, UIC, and Northwestern University. He now aspires to foster the same mathematical enthusiasm in his students that he enjoyed during his own studies.

Applicants for Project NExT must submit a personal statement, research statement, one-page curriculum vitae, and letter of support from their department chair. Eligibility requirements include a recent Ph.D. in mathematics, statistics, mathematics education, or another math-intensive field; a current teaching position; and experiences, attitudes, ideas, and leadership abilities that would contribute to the cohort. To be considered for SIAM sponsorship, applicants must note their SIAM membership on their application. An MAA committee selects all Fellows. Visit the Project NExT website[14] for further details and consider applying before the next deadline of **April 15, 2025**!

A single faculty member can have an immeasurable impact on their students' careers in mathematics, positively influencing both SIAM and the broader scientific community as a whole. We encourage junior SIAM members who are pursuing careers in academia to consider the Project NExT program as a way to improve applied mathematics education for the next generation of interdisciplinary problem-solvers.

Lea Jenkins is a professor in the School of Mathematical and Statistical Sciences at Clemson University, where she works on modeling and simulation problems with industrial applications. She holds a Ph.D. in mathematics from North Carolina State University and is the Vice President for Education at SIAM. Marissa Gee is an assistant professor of mathematics at Kenyon College, where she studies application-driven problems in optimal control. She holds a Ph.D. in applied mathematics from Cornell University. Trevor Leslie is an assistant professor in the Department of Applied Mathematics at the Illinois Institute of Technology. His research is in the field of partial differential equations, with a focus on models from fluid dynamics and collective behavior.

[14] https://maa.org/maa-project-next

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 Computational Science and Engineering (CSE25)

March 3–7, 2025 | Fort Worth, Texas, U.S.
go.siam.org/cse25 | #SIAMCSE25

ORGANIZING COMMITTEE CO-CHAIRS
David Bindel, *Cornell University, U.S.*
Elizabeth Cherry, *Georgia Institute of Technology, U.S.*
Judith Hill, *Lawrence Livermore National Laboratory, U.S.*

EARLY REGISTRATION RATE DEADLINE
February 6, 2025

HOTEL REGISTRATION DEADLINE
February 6, 2025

SIAM International Conference on Data Mining (SDM25)

May 1–3, 2025 | Alexandria, Virginia, U.S.
go.siam.org/sdm25 | #SIAMSDM25

GENERAL CO-CHAIRS
Vagelis Papalexakis, *University of California, Riverside, U.S.*
Matteo Riondato, *Amherst College, U.S.*

EARLY REGISTRATION RATE DEADLINE
April 3, 2025

HOTEL REGISTRATION DEADLINE
April 3, 2025

SIAM Conference on Applications of Dynamical Systems (DS25)

May 11–15, 2025 | Denver, Colorado, U.S.
go.siam.org/ds25 | #SIAMDS25

ORGANIZING COMMITTEE CO-CHAIRS
Ryan Goh, *Boston University, U.S.*
Alexandria Volkening, *Purdue University, U.S.*

EARLY REGISTRATION RATE DEADLINE
April 14, 2025

HOTEL REGISTRATION DEADLINE
April 14, 2025

SIAM Conference on Applied and Computational Discrete Algorithms (ACDA25)

July 30–August 1, 2025 | Montréal, Québec, Canada
go.siam.org/acda25 | #SIAMACDA25

ORGANIZING COMMITTEE CO-CHAIRS
Martin Farach-Colton, *New York University, U.S.*
Bora Ucar, *ENS-Lyon, France*

SUBMISSION AND TRAVEL AWARD DEADLINES
January 27, 2025: Short Abstract and Submission Registration
February 3, 2025: Archival Proceedings Papers and Non-archival Extended Abstracts
March 31, 2025: Posters
April 28, 2025: Travel Fund Applications

SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS25)

October 14–17, 2025 | Baton Rouge, Louisiana, U.S.
go.siam.org/gs25 | #SIAMGS25

ORGANIZING COMMITTEE CO-CHAIRS
Luca Formaggia, *Politecnico di Milano, Italy*
Chris Kees, *Louisiana State University, U.S.*

SUBMISSION AND TRAVEL AWARD DEADLINES
March 18, 2025: Minisymposium Proposal Submissions
April 15, 2025: Contributed Lecture, Poster, and Minisymposium Presentation Abstract Submissions
July 14, 2025: Travel Fund Applications

Information is current as of January 2, 2025. Visit *siam.org/conferences* for the most up-to-date information.

Upcoming SIAM Events

SIAM Conference on Computational Science and Engineering
March 3–7, 2025
Fort Worth, Texas, U.S.
Sponsored by the SIAM Activity Group on Computational Science and Engineering

SIAM International Conference on Data Mining
May 1–3, 2025
Alexandria, Virginia, U.S.
Sponsored by the SIAM Activity Group on Data Science

SIAM Conference on Applications of Dynamical Systems
May 11–15, 2025
Denver, Colorado, U.S.
Sponsored by the SIAM Activity Group on Dynamical Systems

SIAM Conference on Applied Algebraic Geometry
July 7–11, 2025
Madison, Wisconsin, U.S.
Sponsored by the SIAM Activity Group on Algebraic Geometry

SIAM Conference on Financial Mathematics and Engineering
July 15–18, 2025
Miami, Florida, U.S.
Sponsored by the SIAM Activity Group on Financial Mathematics and Engineering

The Third Joint SIAM/CAIMS Annual Meetings
July 28–August 1, 2025
Montréal, Québec, Canada

SIAM Conference on Control and Its Applications
July 28–30, 2025
Montréal, Québec, Canada
Sponsored by the SIAM Activity Group on Control and Systems Theory

SIAM Conference on Computational Geometric Design
July 28–30, 2025
Montréal, Québec, Canada
Sponsored by the SIAM Activity Group on Geometric Design

SIAM Conference on Applied and Computational Discrete Algorithms
July 30–August 1, 2025
Montréal, Québec, Canada
Sponsored by the SIAM Activity Group on Applied & Computational Discrete Algorithms

SIAM Conference on Mathematical & Computational Issues in the Geosciences
October 14–17, 2025
Baton Rouge, Louisiana, U.S.
Sponsored by the SIAM Activity Group on Geosciences

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SIAM Members: Renew Your SIAM Membership for 2025 at *my.siam.org*

What's new at SIAM?

- SIAM held a course, "From Machine Learning to Large Language Models – An Introduction," just prior to the SIAM Conference on Mathematics of Data Science (MDS24), for individuals wanting to transition their career in AI and learn how AI can benefit companies and pioneer advancements in the field.
- Thirteen new student chapters were established in 2024. This program continues to grow and helps keep students connected to SIAM and the applied math community throughout the world.
- SIAM sections expanded their coverage with the newly approved New England 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 Northern and Central California Section of SIAM held its inaugural meeting and the SIAM Activity Group on Equity, Diversity, and Inclusion held its first virtual business meeting in 2024.

Free student members: Don't forget that you need to renew your membership to continue receiving benefits in 2025. Join two activity groups for free!

If you're a member of a student chapter but you're not a member of SIAM, you can join for free at ***my.siam.org*** to start receiving all the benefits that come with SIAM student membership. Be sure to add your chapter to your profile to ensure that your membership is free. All chapter officers are required to be SIAM members.

"I gained so many great things from participating in the SIAM-Simons Undergraduate Summer Research Program. 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."

— America Jarillo-Montero, undergraduate student, Simpson College

SIAM Offers Free Student Memberships

Professors, did you know your students are eligible for free membership if:

- Your college or university is an Academic Member of SIAM
- You have a student chapter at your school
- They are referred by a member of SIAM (like you!)

Student and early career members consistently say they joined SIAM because their advisers recommended that they do so. Go to ***siam.org/membership/student*** to check your students' eligibility or contact *membership@siam.org*. SIAM Student membership includes: free membership in two SIAM Activity Groups; subscription to *SIAM News;* subscription to *SIAM Review* (electronic access only for free student members); 30% discount on all SIAM books; eligibility to hold office and serve on SIAM committees; free membership in your local section of SIAM; opportunities to benefit and grow both personally and professionally; plus lots more!

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.

Join an activity group when renewing or creating your SIAM membership. If your membership is current, join activity groups at *siam.org/membership/activity-groups*.

Analysis of Partial Differential Equations (SIAG/APDE)
Chair: Alexis Vasseur
Vice Chair: Dehua Wang
Program Director: Helena Nussenzveig Lopes
Secretary: Anna Ghazaryan

Applied and Computational Discrete Algorithms (SIAG/ACDA)
Chair: Jonathan Berry
Vice Chair: Kathrin Hanauer
Program Director: Henning Meyerhenke
Secretary: Nate Veldt

Applied Mathematics Education (SIAG/ED)
Chair: Allison Lewis
Vice Chair: Maeve McCarthy
Program Director: Ariel Cintron-Arias
Secretary: Michaela Kubacki

Computational Science and Engineering (SIAG/CSE)
Chair: Julianne Chung
Vice Chair: Edmond Chow
Program Director: Sarah Knepper
Secretary: Benjamin Peherstorfer

Discrete Mathematics (SIAG/DM)
Chair: Maya Stein
Vice Chair: Paul Wollan
Program Director: Chun-Hung Liu
Secretary: Ryan Martin

Geometric Design (SIAG/GD)
Chair: Yongjie Jessica Zhang
Vice Chair: Carolina Beccari
Program Director: Emil Zagar
Secretary: Jeff Poskin

Geosciences (SIAG/GS)
Chair: Sara Gasda
Vice Chair: Luca Formaggia
Program Director: Jeffrey Hyman
Secretary: Jed Brown

Life Sciences (SIAG/LS)
Chair: Ruth Baker
Vice Chair: Cecilia Diniz Behn
Program Director: Karin Leiderman
Secretary: Cole Zmurchok

Linear Algebra (SIAG/LA)
Chair: Laura Grigori
Vice Chair: Agnieszka Miedlar
Program Director: Kirk Soodhalter
Secretary: Kathryn Lund

Mathematical Aspects of Materials Science (SIAG/MS)
Chair: Lia Bronsard
Vice Chair: Dejan Slepchev
Program Director: Carlos Garcia Cervera
Secretary: Silva Jimenez Bolanos

Elections of officers for the following activity groups will be held in 2025 for terms beginning January 1, 2026. Please nominate a colleague or yourself for election at *siam.org/Forms/SIAM-Activity-Group-Leadership-Suggestions*.

- Algebraic Geometry
- Control and Systems Theory
- Data Science
- Dynamical Systems
- Equity, Diversity, and Inclusion
- Financial Mathematics and Engineering
- Imaging Science
- Optimization
- Supercomputing

Mathematics of Planet Earth (SIAG/MPE)
Chair: Pedram Hassanzadeh
Vice Chair: Elaine Spiller
Program Director: Kara Peterson
Secretary: Nan Chen

Nonlinear Waves and Coherent Structures (SIAG/NWCS)
Chair: Paul Milewski
Vice Chair: Andre Nachbin
Program Director: Manuela Girotti
Secretary: Deniz Bilman

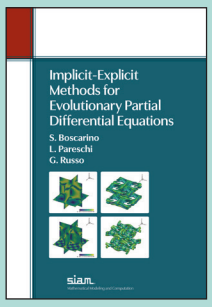
Orthogonal Polynomials and Special Functions (SIAG/OPSF)
Chair: Howard Cohl
Program Director: Kerstin Jordaan
Secretary: Tom Trogdon

Uncertainty Quantification (SIAG/UQ)
Chair: Karen Veroy Grepl
Vice Chair: Georg Stadler
Program Director: Robert Scheichl
Secretary: Teresa Portone

siam | BOOKS

Quality and Value in Mathematical Science Literature

New From SIAM

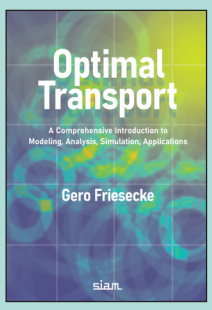


Implicit-Explicit Methods for Evolutionary Partial Differential Equations

Sebastiano Boscarino, Lorenzo Pareschi, and Giovanni Russo

Implicit-explicit (IMEX) time discretization methods have proven to be highly effective for the numerical solution of a wide class of evolutionary partial differential equations (PDEs) across various contexts. These methods have become mainstream for solving evolutionary PDEs, particularly in the fields of hyperbolic and kinetic equations. This first book on the subject provides an in-depth yet accessible approach. The authors summarize and illustrate the construction, analysis, and application of IMEX methods using examples, test cases, and implementation details; guide readers through the various methods and teach them how to select and use the one most appropriate for their needs; and demonstrate how to identify stiff terms and effectively implement high-order methods in time for a variety of systems of PDEs.

2024 / x + 323 pages / Softcover / 978-1-61197-819-3 / List $89.00 / SIAM Member $62.30 / MM24

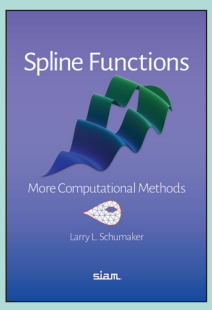


Optimal Transport
A Comprehensive Introduction to Modeling, Analysis, Simulation, Applications

Gero Friesecke

Optimal transport problems have been found to arise in many different fields of mathematics, science, and engineering and interest in the subject has exploded. This accessible book begins with an elementary and self-contained chapter on optimal transport on finite state spaces that does not require measure theory or functional analysis. It builds up mathematical theory rigorously and from scratch, aided by intuitive arguments, informal discussion, and carefully selected applications. It is the first book to cover modern topics such as Wasserstein GANs and multimarginal problems and includes a discussion of numerical methods and basic MATLAB code for simulating optimal transport problems directly via linear programming or more efficiently via the Sinkhorn algorithm. Additionally, it provides classroom-tested exercises in every chapter.

2024 / xii + 333 pages / Softcover / 978-1-61197-808-7 / List $79.00 / SIAM Member $55.30 / OT199



Spline Functions
More Computational Methods

Larry L. Schumaker

This new book is a continuation of the author's earlier book *Spline Functions: Computational Methods*, published in 2015 by SIAM. It focuses on computational methods developed in the last ten years that make use of splines to approximate functions and data and to solve boundary-value problems. The first half of the book works with bivariate spaces of splines defined on H-triangulations, T-meshes, and curved triangulations. The second half makes use of these spaces to solve boundary-value problems, with a special emphasis on elliptic PDEs defined on curved domains. The book contains numerous examples and figures to illustrate the methods and their performance.

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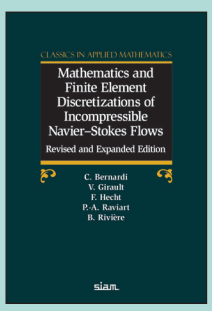

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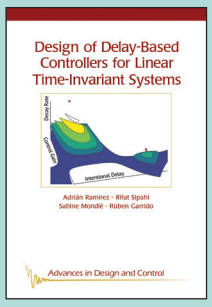

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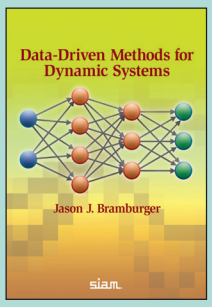

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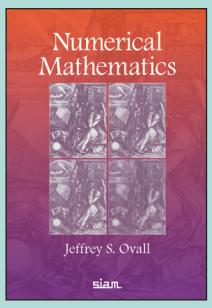

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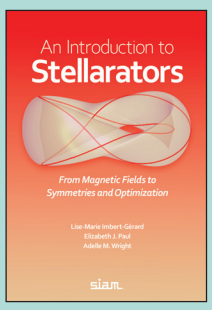

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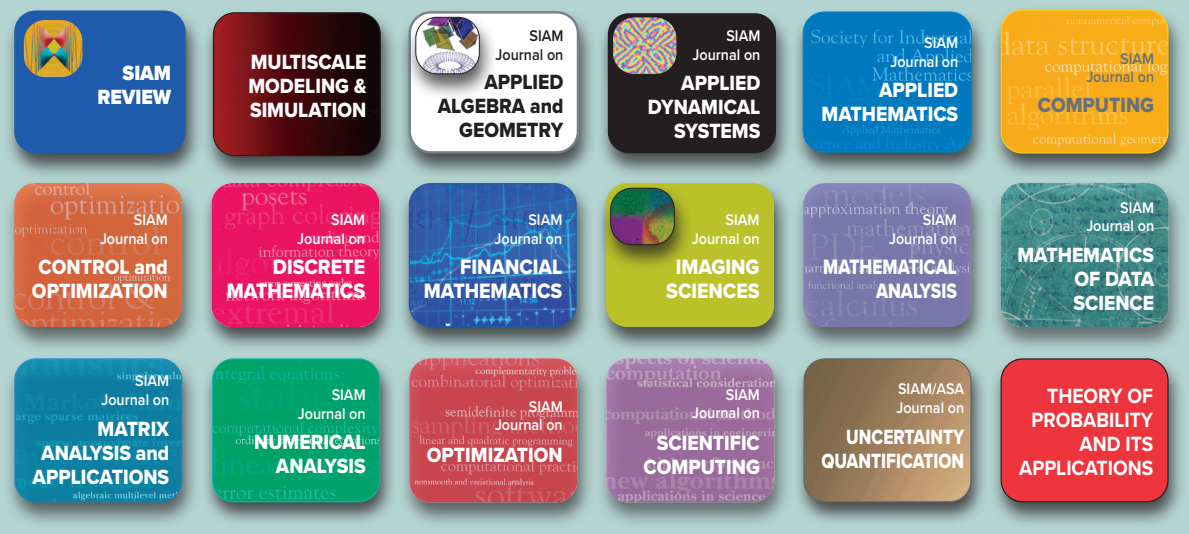

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