Newsjournal of the Society for Industrial and Applied Mathematics

sinews.siam.org

siam news

Volume 56/ Issue 2
March 2023

Characterizing Musical Sounds with Topological Data Analysis

By Guo-Wei Wei

"Can one hear the shape of a drum?" Mathematician Mark Kac posed this famous question in 1966, and it has intrigued researchers ever since [4]. If you hear the sound of a drum—i.e., the set of overtones that it produces—can you infer its shape? Mathematically, the essence of this spectral geometry question wonders whether one can uniquely determine a shape based on the eigenvalues of the Laplacian operator that is defined on the shape. Many examples of isospectral manifolds are not isometric in settings with two or more dimensions [3]. But the problem is not yet closed, as listeners can indeed discern the shapes of certain geometric types according to their sounds. Kac's thought-provoking query also impacts a myriad of fields beyond mathematics, including architectural acoustics, audio forensics, pattern recognition, radiology, imaging science, and musical science.

Composers commonly use drum sets with multiple pieces of varying sizes (rather than a single drum) to facilitate a tonic harmonic progression: the foundation of harmony in modern music. Drum sets can train the human brain to distinguish the overtones of individual drums via a comparative training/learning process that teaches listeners to hear the shape of a particular drum from the set.

To create tonal harmony, artisans in ancient China built a set of 65 chime bells—known as the Zenghouyi Bells—that date back to between 475 and 433 B.C.E., in the Warring States Period (see Figure 1a). They designed the shape of each chime bell to produce a distinct sound. The 65 bells gradually vary in size and weight, ranging from 153.4 centimeters (60.4 inches) to 20.4 centimeters (8.0 inches) in height and

See **Musical Sounds** *on page 3*

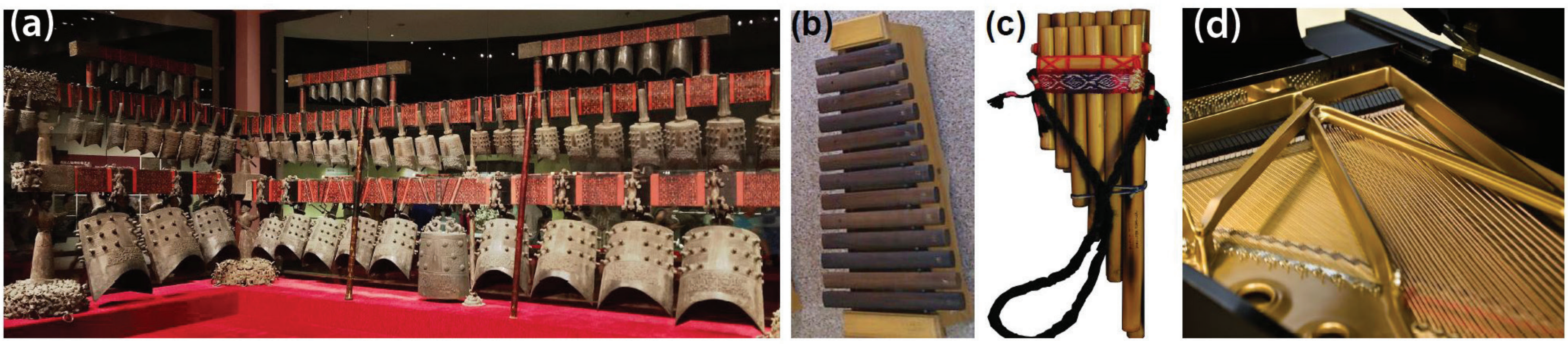


Figure 1. *Progression patterns in musical instruments.* **1a.** *The Bianzhong of Marquis Yi of Zeng (Zenghouyi Bells): ancient chime bells that hang on several sets of wooden racks.* **1b.** *A xylophone.* **1c.** *A pan flute from South America.* **1d.** *The strings of a grand piano. Figures courtesy of Wikimedia Commons via Creative Commons Attribution-Share Alike licenses. Figure 1a by Wikimedia user YouTable and reproduced under the 4.0 International license, 1b by Wikimedia user Ferbr1 and reproduced under the 3.0 Unported license, 1c by Andrew Dunn and reproduced under the 1.0 Generic license, and 1d by David Maiolo and reproduced under the 3.0 Unported license.*

SIAM Session Connects Education and Research at the 2023 Joint Mathematics Meetings

By Adewale Adeolu, Ben Galluzzo, and Kathleen Kavanagh

Applied mathematicians regularly use mathematical modeling to situate mathematics in real-life contexts. The popularity of math modeling is growing rapidly in educational settings; in fact, it now appears in many secondary—and even primary—mathematics curricula because of its connection to real-world problem-solving. However, educators often struggle to find the time, inspiration, and means to craft relevant questions and modeling scenarios for their students.

At the 2023 Joint Mathematics Meetings[1] (JMM23), which took place in Boston, Mass., in early January, the SIAM Education Committee[2] organized a "Session on Education as Research and Research as Education."[3] During this session, four speakers discussed different strategies to broaden the impact of scientific research across a variety of communities and formats. Their talks described the transformation of research into student experiences and, in turn, the transformation of student experiences into research. At the end of the event, a panel of mathematicians from industry and academia commented on real-world research problems that are accessible to students. Additionally, all of the speakers shared a collection of resources—including funding pathways for education-focused projects as well as opportunities for pedagogical research—that can help the mathematical community better communicate modeling research to educational audiences.

Karen Yokley (Elon University) and Nicholas Luke (North Carolina Agricultural and Technical State University) began offering a yearly collaborative National Science Foundation (NSF)-funded Research Experiences for Undergraduates (REU) program[4] in the summer of 2020. Faculty from Elon and North Carolina A&T have since mentored 10 undergraduates in mathematical biology research projects each summer. This REU is unique because it explicitly provides opportunities for students with little to no research experience. At the JMM23 session, Yokley and Luke addressed both the challenges and benefits of running this program during the COVID-19 pandemic. Although recruiting students for remote participation required significant effort, participants were able to complete successful projects, learn about a wide range of biomathematics programming, and build essential career skills. Yokley and Luke also noted that the students wrote a great deal, developed their communication abilities, and interacted with peers from other institutions and backgrounds to broaden their own perspectives.

Many external funding opportunities for young faculty members—including the NSF Computer and Information Science and Engineering Research Initiation

See **Education and Research** *on page 4*

During the SIAM-sponsored "Session on Education as Research and Research as Education" at the 2023 Joint Mathematics Meetings (JMM23), which took place in Boston, Mass., in January, a panel discussion explored the different aspects of integrating research with teaching. From left to right: panelists Wesley Hamilton (MathWorks), Rebecca Hardenbrook (University of Utah), and Tosin Babasola (University of Bath). Photo courtesy of Kathleen Kavanagh.

[1] https://www.jointmathematicsmeetings.org//jmm

[2] https://www.siam.org/about-siam/committees/education-committee

[3] https://meetings.ams.org/math/jmm2023/meetingapp.cgi/Session/5641

[4] https://www.elon.edu/u/academics/arts-and-sciences/mathematics-statistics/reu-ncatsu-and-elon

Nonprofit Org
U.S. Postage
PAID
Permit No 360
Bellmawr, NJ

siam.
SOCIETY for INDUSTRIAL and APPLIED MATHEMATICS
3600 Market Street, 6th Floor
Philadelphia, PA 19104-2688 USA

siam news
Volume 56/ Issue 2/ March 2023

Recapping the 9th Annual Irish SIAM Student Chapter Conference

By Victoria Sánchez Muñoz

Participants of the 9th Annual Irish SIAM Student Chapter Conference, which was held at the University of Galway in December 2022, pose for a group photo. Photo courtesy of Tatiana Lapina.

The University of Galway (UoG) SIAM Student Chapter recently organized the 9th Annual Irish SIAM Student Chapter Conference,[1] which took place at UoG on December 9, 2022. This one-day conference united young researchers in industrial and applied mathematics throughout Ireland and beyond.

The SIAM student chapters in Ireland take turns hosting the event each year; the very first iteration was held at UoG (formerly called the National University of Ireland, Galway) in 2014. Last year's conference, which returned to Galway for the fifth time, was also the first meeting to commence after Ireland fully lifted its COVID-19 restrictions. 43 registered attendees from multiple universities in Ireland partook in the day's festivities. The agenda included two keynote lectures, seven contributed talks, and five poster presentations.

The first keynote speaker was Stephen Russell, a computer vision research engineer at Valeo Vision Systems (one of the meeting's sponsors). Russell, who graduated from UoG and was even a founding member and the first president of the UoG SIAM Student Chapter, spoke about the role of computer vision and applied mathematics in the development of driver assistance systems.

Romina Gaburro of the University of Limerick was the second keynote speaker. She presently serves as Ireland's country coordinator for European Women in Mathematics[2] and the Irish ambassador for the International Mathematical Union's Committee for Women in Mathematics.[3] Gaburro's research explores inverse problems and related topics in analysis and partial differential equations, and her talk introduced the concept of the inverse problem: the mathematical technique behind imaging science and material characterization.

The morning session consisted of Russell's keynote lecture and contributed talks from Robert Garvey of the University of Limerick and Pouyan Nejadi of UoG. The subsequent coffee break, which gave attendees an initial opportunity to peruse the posters, also revealed a hidden icebreaker task. Each person's name badge included a mathematical expression (e.g., a function, matrix, definition, etc.), and participants had to find the individual with their "inverse" and engage in conversation during future breaks. The overall response to this activity was very positive because it encouraged people to interact outside of their own circles.

After two more contributed talks by Leah Keating of the University of Limerick and Khang Ee Pang of University College Dublin, attendees played several rounds of a popular game show called *Countdown* during a brief "Mystery Session." The contest involves two types of 30-second rounds: a number round and a letter round. During the number round, participants had to use a few given numbers—along with basic math operations—to get as close as possible to another number. During the letter round, players were tasked with creating the longest possible word with a set of predetermined letters. Everyone seemed to enjoy this relaxing yet competitive game before lunch.

During the 9th Annual Irish SIAM Student Chapter Conference, which took place at the University of Galway in December 2022, attendees engaged in a "Mystery Session" that was based on a game show called Countdown. Examples of name badges with mathematical expressions are shown below; participants had to find their "inverses" during the coffee breaks. Photo courtesy of Tatiana Lapina.

The afternoon session began with another contributed talk by Sarah Murphy of the University of Limerick and Gaburro's keynote address. After one last coffee break, Caroline Pena and Niall Donlon—both of the University of Limerick—delivered the final contributed talks. Once the organizers awarded prizes for the best presentation and poster, participants had a chance to network during the poster session. The evening concluded with a fully funded dinner at a local restaurant thanks to support from conference sponsors.

One of the conference's underlying objectives was sustainability. UoG maintains a sustainability event checklist that implements certain measures. For example, participants were highly encouraged to bring their own mugs and water bottles, return badges for reuse, take public transportation if possible, and book any necessary accommodations via a webpage with sustainable choices. The coffee and tea for breaks had a green certification as well. To save paper, the conference booklet was only available on the meeting's webpage and via a QR code (printed on recycled paper) during the event.

The UoG SIAM Student Chapter would like to thank all participants for a wonderful conference. We also sincerely appreciate the financial support from SIAM, Valeo Vision Systems,[4] and the Stokes Applied Mathematics Cluster[5] at UoG.

If you are interested in learning more about the UoG SIAM Student Chapter, please contact us at ***siam.univofgalway@gmail.com*** *or follow us on Twitter at* ***@SIAMUniOfGalway****.*

Victoria Sánchez Muñoz is a Ph.D. student in quantum games in the School of Mathematical and Statistical Sciences at the University of Galway in Ireland. She is currently the president of the University of Galway SIAM Student Chapter.

[1] https://www.universityofgalway.ie/science-engineering/school-of-maths/society-forindustrialandappliedmathematicssiam/9thannualirishsiamstudentchapterconference
[2] https://www.europeanwomeninmaths.org
[3] https://www.mathunion.org/activities/committee-women-mathematics-cwm
[4] https://www.valeo.com/en/ireland
[5] https://www.universityofgalway.ie/researchcentres/collegeofscience/stokes-cluster

siam news

ISSN 1557–9573. Copyright 2023, all rights reserved, by the Society for Industrial and Applied Mathematics, SIAM, 3600 Market Street, 6th Floor, Philadelphia, PA 19104-2688; (215) 382-9800; siam@siam.org. To be published 10 times in 2023: January/February, March, April, May, June, July/August, September, October, November, and December. The material published herein is not endorsed by SIAM, nor is it intended to reflect SIAM's opinion. The editors reserve the right to select and edit all material submitted for publication.

Advertisers: For display advertising rates and information, contact Kristin O'Neill at marketing@siam.org.

One-year subscription (nonmembers): Electronic-only subscription is free. $73.00 subscription rate worldwide for print copies. SIAM members and subscribers should allow eight weeks for an address change to be effected. Change of address notice should include old and new addresses with zip codes. Please request address change only if it will last six months or more.

Printed in the USA.
siam *is a registered trademark.*

Navigating the World of Journal Publication as an Early-career Researcher

AN22 Panel Offers Tips for Nascent Journal Authors and Reviewers

By Lina Sorg

Students and postdoctoral/early-career researchers must juggle multiple responsibilities while also taking the appropriate steps to strategically advance their budding careers. One important component of this process is consistent publication in reputable scientific journals. SIAM's 18 peer-reviewed journals[1] collectively serve as the leading source of knowledge for the world's applied mathematics, computational science, and data science communities. During an inaugural session[2] at the 2022 SIAM Annual Meeting,[3] which took place in Pittsburgh, Pa., last year, four experienced SIAM publication experts offered advice to attendees who were interested in contributing to journals as authors and/or reviewers.

The panel comprised Howard Elman (University of Maryland), SIAM Vice President for Publications; Mark Ainsworth (Brown University), editor-in-chief of the *SIAM Journal on Numerical Analysis* (*SINUM*); Hans De Sterck (University of Waterloo), editor-in-chief of the *SIAM Journal on Scientific Computing* (*SISC*); and Evelyn Sander (George Mason University), editor-in-chief of the *SIAM Journal on Applied Dynamical Systems* (*SIADS*). The panelists spoke about effective writing and submission strategies for prospective authors, specified requirements for publication in SIAM journals, and commented on the review process.

"SIAM is the premier publisher of applied math across the board," Elman said at the session's onset. "If you think you have an interesting, good result, you should think of SIAM." He encouraged early-career researchers to write with careful intention and consult their advisors throughout the process. "It's hugely important to write well and state your ideas clearly," Elman continued. "Not everyone will understand what's in your head." Authors must consider their draft's readability from the perspective of potential readers and present proofs, analyses, results, and visuals—such as graphs, tables, and diagrams—in a way that is easily understandable to the intended audience.

De Sterck echoed Elman's comments and added that a paper's abstract and introduction should reflect the results' novelty and prove that the work is worthy of consideration. Writers can even use selections from a well-written abstract to develop their "novelty statement:" a brief paragraph that highlights the contribution's significance

See **Journal Publication** *on page 5*

[1] https://www.siam.org/publications/journals

[2] https://meetings.siam.org/sess/dsp_programsess.cfm?SESSIONCODE=75160

[3] https://www.siam.org/conferences/cm/conference/an22

During the 2022 SIAM Annual Meeting, which took place in Pittsburgh, Pa., last year, a panel of four SIAM publication experts fielded questions from attendees who were interested in learning more about the process of writing and reviewing journal papers. SIAM photo.

Musical Sounds

Continued from page 1

from 203.6 kilograms (448.9 pounds) to 2.4 kilograms (5.3 pounds) in weight. The Zenghouyi Bells comprise a tonal range from C2 to D7 and can play all 12 semitones in the middle area of the range, thus enabling different melodies, intervals, and temperaments. The same design principle appears in many other musical instruments, such as xylophones (see Figure 1b, on page 1), pan flutes (see Figure 1c), and pianos (see Figure 1d). Due to the close physical proximity of the chime bells, resonance may occur when they are struck, giving rise to prolonged harmony. Chime bells were traditionally made of bronze—one of the most precious metals of the time—and used in various rituals, ceremonies, and entertainment events.

A fascinating connection exists between the progression patterns of musical instruments and mathematical filtration (see Figure 2a) — a popular technique in modern algebra and topological data analysis (TDA). TDA is a recent branch of applied mathematics that utilizes topological and geometric concepts to understand and extract topological patterns and structures in data. The main workhorse of TDA is persistent homology [2, 6], an extension of algebraic topology that employs filtration to create a mathematical microscopy of a point cloud. Persistent homology delineates the shape of data through comparative analysis of the topological invariant changes that are induced by filtration [6]. When paired with advanced machine learning and deep learning algorithms, it finds tremendous success in the field of data science. Persistent homology has become one of the most powerful tools for simplifying the geometric complexity and reducing the high dimensionality of biomolecular interactions [5], ultimately revolutionizing drug discovery[1] and effectively forecasting emerging viral variants.[2]

However, persistent homology is not directly applicable to the tonal analysis of chime bells. First, one may regard the collection of chime bells as the result of a set of evolving chime bell manifolds, rather than the result of point cloud filtration. Additionally, no change in topological invariants is associated with the homotopic shape evolution of chime bells. And finally, persistent homology cannot present a frequency or tonal analysis of chime bells or many other musical instruments.

Recently, researchers proposed an evolutionary de Rham-Hodge method [1] as a multiscale generalization of the classical de Rham-Hodge theory: a landmark of 20th-century mathematics. This novel technique provides a multiscale geometric and topological analysis of filtration-induced manifolds; using these manifolds, one can define a family of evolutionary Hodge Laplacians on the set of chime bells to characterize their tonal evolution. In association with a family of de Rham complexes, evolutionary Hodge Laplacians reveal the full set of topological invariants—such as Betti numbers—in their kernel or null space dimensions.

The point cloud counterpart of the evolutionary de Rham-Hodge method on manifolds is called persistent spectral graph (also known as persistent Laplacians) on simplicial complexes [7, 8]. Like the evolutionary de Rham-Hodge method, persistent Laplacians both return the full set of topological invariants in their harmonic spectra (as does persistent homology) and capture the homotopic shape evolution of data during filtration in their first non-harmonic spectra (see Figures 2b and 2c); persistent homology cannot handle this latter task.

Sheaf theory created a generalization of persistent Laplacians, and the resulting persistent sheaf Laplacians enable the embedding of heterogeneous characters in topological invariants (e.g., encoding non-geometric information in a geometry-based simplicial complex) [10]. Persistent path Laplacians—another generalization that is built from the path complex—are designed for directed graphs and directed networks [9]. These new persistent topological Laplacians lay a mathematical foundation for tonal analysis in musical science and significantly extend the applicable domain and power of TDA.

[1] https://sinews.siam.org/Details-Page/persistent-homology-analysis-of-biomolecular-data

[2] https://sinews.siam.org/Details-Page/topological-artificial-intelligence-forecasting-of-future-dominant-viral-variants

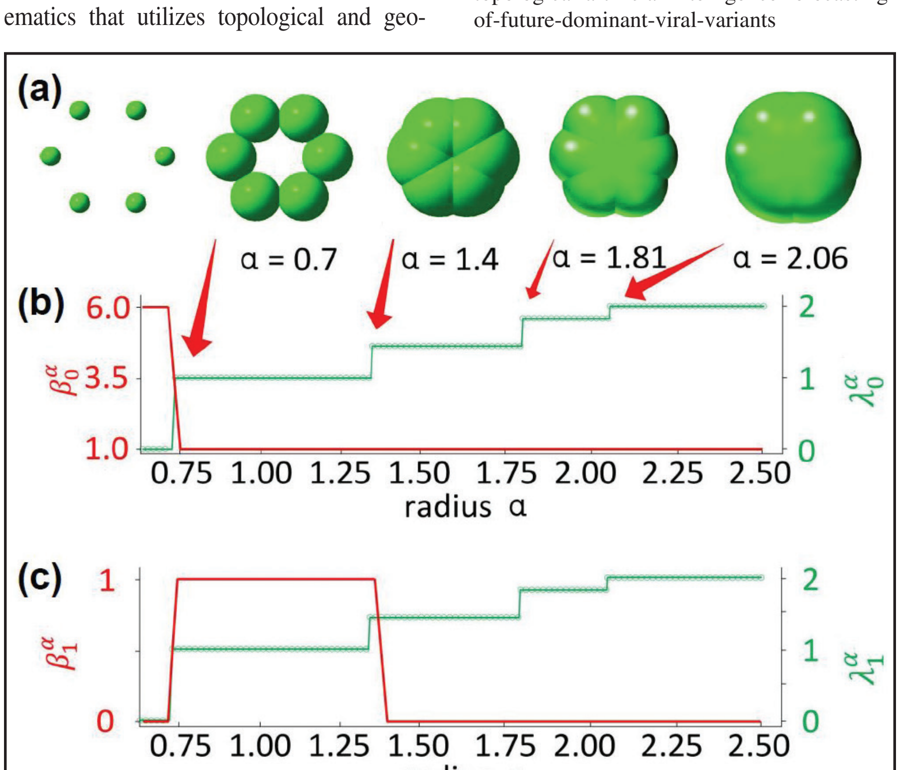


Figure 2. *Illustration of filtration and persistent Laplacian spectra.* **2a.** *Filtration of a point cloud.* **2b–2c.** *Persistent Laplacian analysis of the point cloud. Here,* β_j^α *and* $\lambda_j^\alpha\,(j=0,1)$ *are respectively persistent Betti-j numbers and the first nonzero eigenvalues of the jth persistent Laplacian. Note that* λ_j^α *captures the homotopic shape evolution of data (see the frequency changes after* $\alpha=1.5$*), which is not reflected in* β_j^α*. Figure courtesy of Jian Jiang.*

References

[1] Chen, J., Zhao, R., Tong, Y., & Wei, G.-W. (2021). Evolutionary de Rham-Hodge method. *Discrete Contin. Dyn. Syst. Ser. B*, *26*(7), 3785-3821.

[2] Edelsbrunner, H., & Harer, J. (2008). Persistent homology — a survey. *Contemp. Math.*, *453*, 257-282.

[3] Gordon, C., Webb, D., & Wolpert, S. (1992). Isospectral plane domains and surfaces via Riemannian orbifolds. *Inventiones Math.*, *110*(1), 1-22.

[4] Kac, M. (1966). Can one hear the shape of a drum? *Am. Math. Mon.*, *73*(4P2), 1-23.

[5] Liu, J., Xia, K.-L., Wu, J., Yau, S.S.-T., & Wei, G.-W. (2022). Biomolecular topology: Modelling and analysis. *Acta Math. Sin. Engl.*, *38*(10), 1901-1938.

[6] Lum, P.Y., Singh, G., Lehman, A., Ishkanov, T., Vejdemo-Johansson, M., Alagappan, M., … Carlsson, G. (2013). Extracting insights from the shape of complex data using topology. *Sci. Rep.*, *3*(1), 1-8.

[7] Mémoli, F., Wan, Z., & Wang, Y. (2022). Persistent Laplacians: Properties, algorithms and implications. *SIAM J. Math. Data Sci.*, *4*(2), 858-884.

[8] Wang, R., Nguyen, D.D., & Wei, G.-W. (2020). Persistent spectral graph. *Int. J. Numer. Methods in Biomed. Eng.*, *36*(9), e3376.

[9] Wang, R., & Wei, G.-W. (2023). Persistent path Laplacian. *Found. Data Sci.*, *5*, 26-55.

[10] Wei, X., & Wei, G.-W. (2021). Persistent sheaf Laplacians. Preprint, *arXiv:2112.10906*.

Guo-Wei Wei is an MSU Foundation Professor at Michigan State University. His research explores the mathematical foundations of biological science and data science.

A Pressure Puzzle: More is Less

MATHEMATICAL CURIOSITIES

By Mark Levi

Water—treated here as an ideal fluid—flows steadily through a pipe with a narrowing, driven by excess pressure p in the wider portion. Wishing to increase the flow rate, I widen the wider portion even more (see Figure 1) while maintaining the same excess pressure p as before. Will this widening achieve the desired result and increase the flow rate? Readers may wish to pause here before reading on.

The answer is the opposite of what one might expect: the flow rate will actually *decrease*. But how can widening any part of the pipe decrease the flow rate? The resolution of this paradox is that I "forgot" that the driving pressure remains fixed. In an extreme case where the pipe barely narrows, one must push water very quickly to sustain the pressure differential. Therefore, narrowing the wide part increases the flow. In other words, a disparity in thickness increases the resistance because a greater disparity in thickness means a greater change of speed when the water enters a narrower section — and this requires more effort.

Here is a formal proof. By Bernoulli's law,

$$\frac{\rho v^2}{2} + p + \cancel{p_{\text{atm}}} = \frac{\rho V^2}{2} + \cancel{p_{\text{atm}}}, \qquad (1)$$

where p is the driving pressure and v, V are the velocities, as marked in Figure 1. Since the water is incompressible, the volumes that enter and leave per second are equal:

$$Av = aV,$$

where A, a are the cross-sectional areas (larger quantities are denoted by capitals). Substituting $v = \frac{a}{A}V$ into (1) and solving for V gives

$$V^2 = \frac{2p/\rho}{1-\left(\frac{a}{A}\right)^2}. \qquad (2)$$

Fixing the exit cross-section a and letting $A \downarrow a$ yields $V \to \infty$, and so the flux $aV \to \infty$; this confirms the aforementioned intuitive conclusion. Maintaining a fixed p when $A \approx a$ requires huge flux.

At the other extreme, widening the supply pipe ($A \to \infty$) while still fixing the exit a leads to a saturation limit for the flux aV, since a is fixed and

$$V^2 \to 2p/\rho, \qquad (3)$$

according to (2).

What does all of this have to do with the well-known fact that water shoots out of a hole in the side of a barrel with velocity V depending only on the depth of the hole: $V = \sqrt{2gh}$, where h is the depth? One can think of a hole in the barrel as a narrowing in a pipe where the driving pressure is hydrostatic, generated by the water column above the level of the hole and given by $p = \rho gh$.

According to (3), $V = \sqrt{2p/\rho}$; substituting $p = \rho gh$ indeed yields $V = \sqrt{2gh}$. Incidentally, this is precisely the velocity that a free-falling drop (released from rest) would gain after distance h. The idea of the previous sentence provides an alternative and immediate derivation of $V = \sqrt{2gh}$ for the velocity of the water that is shooting out of the hole in the barrel.

Mark Levi (levi@math.psu.edu) is a professor of mathematics at the Pennsylvania State University.

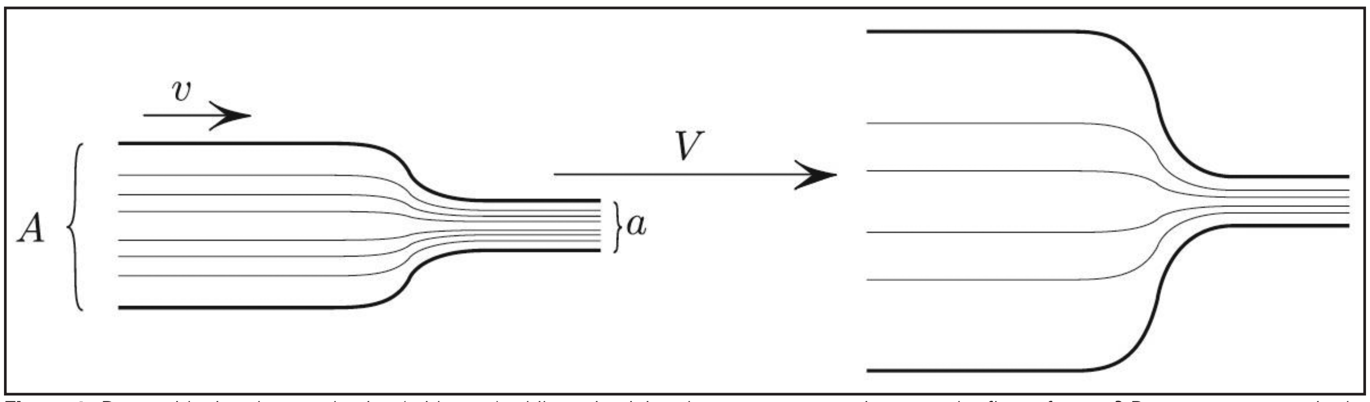


Figure 1. *Does widening the supply pipe (wide part) while maintaining the same pressure increase the flow of water? Pressure excess p in the wider part over that in the lower part is the same in both cases. Figure courtesy of Mark Levi.*

Education and Research

Continued from page 1

Initiative[5] and the Faculty Early Career Development Program[6] (CAREER)—require proposals that integrate research and education. This stipulation is often difficult for applicants, who may be tempted to fall back on standard boilerplate content. During JMM23, Christopher Musco (New York University) described his experience with creating an education plan for a CAREER proposal that combined his personal research in theoretical computer science with his teaching responsibilities. This information was particularly pertinent for early-career researchers and highlighted the importance of innovative statements in both scholarship and education. Musco—who is actively involved with MathWorks Math Modeling Challenge,[7] a program of SIAM—also emphasized the urgent need for collaborative grant writing between postdoctoral scholars and faculty members, as such projects will directly benefit scholars when they eventually become faculty members themselves.

Next, Mihhail Berezovski (Embry-Riddle Aeronautical University) detailed his success in growing a course called "Research Project in Industrial Mathematics"—initiated by Preparation for Industrial Careers in Mathematical Sciences[8] (PIC Math)—into an annual program that effectively matches students with industrial partners. Berezovski acknowledged the challenge of identifying willing partners in industry; in fact, he found many of them through cold calls or conversations in unusual settings, such as the grocery store. He also reflected on the program's numerous benefits. For example, involved companies receive "free" analysis of a pertinent real-world problem, and students gain invaluable skills and hands-on experience in industrial settings — many even receive job offers from the organizations with which they collaborate. Most impressive was the diversity of the course's participants; over half of the students identify as female and more than 80 percent come from historically underrepresented groups.

Adewale Adeolu and Ben Galluzzo (both of Clarkson University) focus their research on mathematics education and its connections to real-world problem-solving. During their presentation, they overviewed their current efforts to develop a novel technology called M2Studio[9] that helps secondary students learn mathematical modeling. M2Studio provides affordances that support users' understanding of math modeling, such as dynamically linked representations. Adeolu and Galluzzo shared findings from a qualitative study with three high school students who engaged in mathematical modeling activities with M2Studio. The study revealed that students used feedback from dynamically linked representations to adjust their models. M2Studio also serves as a cognitive tool that encourages students to perform unit analysis, name and relate variables, and identify connections between variables with mathematical operations.

The final component of SIAM's education-based JMM23 session was a panel that focused on the challenges and benefits of integrating research and teaching. Kathleen Kavanagh (Clarkson University) moderated the panel, which consisted of three mathematicians: Wesley Hamilton (MathWorks), Rebecca Hardenbrook (University of Utah), and Tosin Babasola (University of Bath). All of the panelists share a passion for blending research with teaching and engaging students with the relevance of mathematics in critical environmental issues. As the speakers recounted stories of student achievement, it was apparent that they found these activities just as rewarding as their students. For instance, Babasola motivated classroom interest in climate change by asking "What is chocolate, and where does it come from?", which helped students personally connect to the problems at hand. The panelists endorsed a wide range of software tools that engage students with mathematics, including MATLAB,[10] GeoGebra,[11] and the Common Online Data Analysis Platform[12] (CODAP).

Ultimately, the JMM23 session demonstrated that the applied mathematics and computational science communities need more opportunities to exchange resources, case studies, and relevant findings to better combine research and classroom experiences and subsequently broaden the impact of this integration.

Adewale Adeolu is a National Science Foundation-funded postdoctoral researcher in the Institute for STEM Education at Clarkson University. Ben Galluzzo is an associate professor of mathematics at Clarkson University. Kathleen Kavanagh is a professor of mathematics at Clarkson University and the Vice President for Education at SIAM.

[5] https://beta.nsf.gov/funding/opportunities/computer-information-science-engineering-research
[6] https://beta.nsf.gov/funding/opportunities/faculty-early-career-development-program-career
[7] https://m3challenge.siam.org
[8] https://www.maa.org/programs-and-communities/professional-development/pic-math
[9] https://concord.org/our-work/research-projects/m2studio
[10] https://www.mathworks.com/products/matlab.html
[11] https://www.geogebra.org
[12] https://codap.concord.org

Journal Publication

Continued from page 3

and value in the context of the existing literature. Because journal submissions are on the rise and acceptance is competitive, all journal editors—SIAM and otherwise—pay particular attention to novelty statements. "It's important to express why you think an idea is meaningful and how it compares to what is already available in the literature," De Sterck said.

When crafting the abstract and introduction, researchers should also think about their topic's relevance to the journal in question in order to convince editors that the paper is a good fit. "If you decide to submit to a SIAM journal, make sure that you're submitting to the *right* journal," Sander said. For example, a dynamical systems article that does not emphasize applications is not appropriate for *SIADS* and might instead be better suited for a non-SIAM journal.

Ainsworth disclosed that most of the papers he rejects for *SINUM* are denied because authors neglected to follow the necessary editorial guidelines. "Pay attention to the basics," he said. "Make sure that you're fulfilling the criteria and your paper is formatted with the right typesetting package. This applies to experienced researchers as well."

To make a submission even more compelling, authors can suggest referees, associate editors, and reviewers who are well equipped to handle the article. "This shows that you've investigated the journal, gives the editor an idea of how to view the paper, and demonstrates that you see where the paper might fit within the editorial board," Sander said. De Sterck urged writers to recommend at least one associate editor for their papers, noting that the suggested individual(s) should ideally be well-established in their careers and experts with the material at hand.

When attendees asked the editors how they typically distribute papers to their editorial boards, De Sterck revealed that he keeps a file on hand with keywords that pertain to all of the associate editors at *SISC*, which helps him determine the ideal candidates for the job. Meanwhile, Ainsworth simply sends papers to associate editors who are familiar with the topic. "I make sure it goes to someone who really knows the field and can choose the right reviewers," he said, commenting that he disliked receiving papers in unfamiliar areas when he was an associate editor because he had difficulty evaluating them.

Next, conversation turned to the nuances of the review process. "Reviewing a paper is a weighty responsibility," Elman said. "You want to make the right judgment and be critical but fair." Reviewers must assess the content's accuracy and determine whether the paper is suitable for and fits the standards of the journal to which it was submitted. Peer-reviewed articles carry a certain level of prestige, and Elman encouraged reviewers to take their duties seriously. "It's free labor on your part, but it's part of being in the community," he said. "Read papers that you think are interesting; give your best shot at a review; and if you think something is wrong, say so."

Ainsworth echoed Elman's remarks about reviewing as a community duty.

A panel at the 2022 SIAM Annual Meeting, which took place in Pittsburgh, Pa., last year, addressed various aspects of the writing and review process for journal papers. From left to right: Hans De Sterck (University of Waterloo), Howard Elman (University of Maryland), Evelyn Sander (George Mason University), and Mark Ainsworth (Brown University) offer advice to students and early-career researchers in the audience. SIAM photo.

"You want people to review your papers, so if someone asks you to review a paper, you should do it unless you have a very good reason not to," he said. "It's part of being a good citizen. If someone sends me a paper and I know I'm the right person to do it, I'll agree even if I'm busy." Ainsworth added that if a solicited individual must turn down a review request, they should suggest other possible reviewers rather than simply rejecting the invitation.

Sander pointed out that reviewing another researcher's paper can even benefit one's own career advancement. "If it's the right paper for you, you should be reading it to that level anyway and helping to shape it," she said. But she also cautioned against agreeing to serve as a reviewer and failing to follow through, as doing so only delays the publication process and hurts the author. "Being responsible for when you say 'yes' is a very important part of the process," Sander said.

While the average time to a first decision for SIAM journals is four months, individual journals may vary widely. If one has not received a decision six to eight months after initial submission, it is perfectly acceptable to follow up with a request for information. Additionally, all four panelists agreed that publishing preprints to arXiv[4] is worthwhile in terms of both the citations and the exposure.

Ultimately, the panelists encouraged all audience members to submit their research to SIAM journals, regardless of career stage or experience level. "SIAM publishes very high-level journals, but don't feel that you're not good enough," Ainsworth said. "Talk to people, get advice, but don't rule it out without trying."

Lina Sorg is the managing editor of SIAM News.

[4] https://arxiv.org

Announcing the SIAM-Simons Undergraduate Summer Research Program

SIAM is delighted to announce the establishment of the SIAM-Simons Undergraduate Summer Research Program. Through support from the Simons Foundation,[1] this new applied mathematics and computational science program will provide research, networking, and mentorship opportunities to U.S. students from underrepresented groups — thus allowing the SIAM community to play a strong role in developing, expanding, and diversifying the next generation of researchers and practitioners.

"We are proud to partner with the Simons Foundation over the next five years in our shared efforts to broaden participation and engagement in the mathematical and computational sciences," Suzanne Weekes, Executive Director of SIAM, said. "We continue to work towards the reality of a more robust, diverse, and inclusive STEM community. At SIAM, we are deeply committed to this work, and we are thankful for the Simons Foundation's investment in our efforts."

Each year, the SIAM-Simons Undergraduate Summer Research Program will establish five sites across the U.S. for a six-week program of research and learning in applied mathematics and computational science. One faculty mentor and two students will work together at each site for these six weeks. Students will learn how to conduct scientific research, effectively communicate mathematics and computational science principles, and gain an improved understanding of careers in applied mathematics and computational science. The students and mentors from each site will also come together via video conference to present their work, participate in professional development activities, and engage in community-building initiatives.

Applications for the SIAM-Simons Undergraduate Summer Research Program will be reviewed on a rolling basis beginning on March 6 until all spots are filled.

To apply,[2] students must submit a written statement regarding their interest in the program, their college transcripts, and two letters of recommendation. Expenses for lodging, meals, and travel will be covered by the program, and accepted applicants will receive a weekly stipend. They will also visit the Flatiron Institute in New York City and attend the SIAM Annual Meeting the year after their summer research experience to present their work. Faculty mentors—selected from SIAM's highly qualified member base—will work closely with student participants and SIAM and receive a stipend for their involvement.

"It is deeply important that the identities of scientists and mathematicians reflect the diverse world we inhabit," David Spergel, president of the Simons Foundation, said. "The Simons Foundation is proud to partner with SIAM to diversify the next generation of researchers and practitioners in applied mathematics and computational science."

Read more about the program in the full online announcement.[3] Applications will be reviewed on a rolling basis beginning on March 6 until all spots are filled. SIAM is incredibly grateful to the Simons Foundation for funding this important new program; for more information, please visit the website.[4]

[1] https://www.simonsfoundation.org
[2] https://www.surveymonkey.com/r/SSUSRP_2023
[3] https://sinews.siam.org/Details-Page/siam-establishes-the-siam-simons-undergraduate-summer-research-program
[4] https://www.siam.org/simons

Self-Promotion and Advocacy Provide Industry With the Mathematicians That It Needs

By Derek Kane

CAREERS IN MATHEMATICAL SCIENCES

I have spent 22 years at DEKA Research and Development,[1] a company that uses science and engineering to measurably improve people's lives. The corporation has worked on projects that relate to dialysis, clean water, mobility for individuals who rely on wheelchairs, prosthetics, and regenerative medicine. During my time with DEKA, I have hired four mathematicians — all of whom have been exceptional. The first was an undergraduate student at Brown University who employed random forests to solve a particularly knotty problem that utilized diagnostic test data to improve predictions of pulmonary embolisms. His solution allowed us to create a test for which physicians previously had to rely on conflicting and non-specific data.

The second mathematician was a summer intern from Worcester Polytechnic Institute who developed the signal processing algorithm for a tabletop magnetic resonance imaging (MRI) demonstrator. He later secured a permanent position at DEKA and spent his time investigating closed-loop physiological control, image processing, and medical safety systems. With no experience writing embedded code, this individual succeeded admirably on each task.

After completing his undergraduate degree at Southern New Hampshire University, my third mathematician joined our delivery robot program's path planning team[2] and investigated optimal robot routing. Although he had never before written embedded code in `C`, his grasp of path planning's fundamental elements, ability to clearly explain ideas, and unique set of solutions were all invaluable. This employee quickly mastered the necessary programming skills and now leads the path planning team.

The most recent mathematician that I hired holds a Ph.D. from the University of Michigan. She has made fundamental improvements to our analysis of test data—despite having no prior experience in this realm—and delivered a talk earlier this year to describe her methods to the test group. She also reexamined and improved DEKA's application of Kalman filters to a medical sensing system, considered alternate optimal predictive filters, and investigated model predictive control for a physiological device. Most recently, she thoroughly explored the physics of diffusion and how to best align experimental results with the governing equations, again explaining her results in a company-wide talk.

These mathematicians possess remarkable flexibility when approaching and understanding complex problems. Their solutions are unique, and they are not afraid to seek answers in disciplines that are not traditionally associated with the problem in question. Furthermore, the level of rigor that they apply to their work is vital for success — certainly in medical products but also in any industry where resources are limited, customers are demanding, or failure is disastrous. Another valuable quality among mathematicians is their absolute fearlessness when facing new challenges. Graduate study certainly equips mathematicians with the confidence that they can eventually solve a problem by studying it and examining previous work. I believe that these traits are not exclusive to the mathematicians with whom I have been fortunate to work, but are instead fundamental elements of how mathematicians are taught to think.

Given these sterling qualities, why don't companies hire more mathematicians? In my opinion, mathematicians' fatal flaw is underselling themselves to industry. DEKA is one of the rare businesses that does not depend on the automated scanning of resumes; instead, our recruiters send me the resumes of mathematicians and other applicants with odd but interesting backgrounds. Because I am a mathematician myself, I can appreciate the value of these individuals. But their resumes are typically sparse, often providing only a thesis title and maybe a list of classes that they've taught.

Among other projects, DEKA Research and Development works to improve mobility for individuals who use wheelchairs. DEKA and other industry-based companies around the world need mathematicians to help solve society's most important and difficult problems. Photo courtesy of DEKA Research and Development.

Most businesses scan resumes for keywords that indicate an applicant's compatibility with some elements of the job description. It is thus essential that candidates carefully read the job description and echo its wording. Early-career mathematicians should also learn how to appreciate and articulate the way in which their academic background allows them to contribute to the target areas.

As a discipline, we must ensure that new mathematicians understand the questions that drive other fields and recognize their own capability to answer those questions. Mathematicians are trained in the fundamental models of every discipline; they have either explicitly studied these models or possess the necessary tools to comprehend them upon further examination. If a student is interested in water desalination, for example, they will be able to contribute to this subject if they have worked on differential equations, dynamical systems, manifolds, measure theory, Banach spaces, and so forth. These same areas of study will also serve them well in finance, network analysis, remote sensing, computing, and robotics. Any industry that relies on technology (they all do) or analysis (all of the interesting ones do) will ultimately want a mathematical model of its particular problem.

In addition to establishing a solid grounding in mathematics, we should insist that students learn to code. Simulation and programming translate one's expertise into company value. Programming on a resume also provides easy justification for hiring, since organizations always need people who write code. If an applicant's background is actually in numerical methods or another clearly software-oriented discipline, they should mention all of their relevant skills: system administration, low-level hardware programming, code optimization, etc. Combinatorists should note all of the applications with which they have worked (i.e., optimization, linear programming, and graph theory) and understand their discipline's relevance to machine learning, logistics, planning, and the like.

Because all programming is fundamentally the same, the particular tools are largely unimportant. If a mathematician knows how to program in Python or `R`, that knowledge—plus their understanding of algorithms and the structure of problem solutions—will allow them to quickly master

See **Industry** *on page 8*

[1] http://www.dekaresearch.com
[2] http://www.dekaresearch.com/autonomous-mobility

Members of the SIAM Community Elected as 2022 AAAS Fellows

In October 2022, the American Association for the Advancement of Science (AAAS) elected more than 500 of its members as AAAS Fellows. These individuals were selected based on their outstanding efforts to better serve society through the advancement of science and its applications. They collectively represent the 24 distinct sections of AAAS—including categories like Mathematics; Physics; Engineering; and Information, Computing, and Communication—and are honored for their successes in research, technology, teaching and academic administration, industry and government, and/or science communication. Eligible nominees must be AAAS members for at least four continuous years prior to nomination.

The 2022 AAAS Fellows include the following members of the SIAM community:

- Linda M. Abriola, *Brown University*
- Tryphon T. Georgiou, *University of California, Irvine*
- Lise Getoor, *University of California, Santa Cruz*
- Abba B. Gumel, *University of Maryland, College Park*
- Brendan Hassett, *Brown University*
- Hans G. Kaper, *Georgetown University* (editor-in-chief of *SIAM News*)
- Irena Lasiecka, *University of Memphis*
- Lorenzo M. Polvani, *Columbia University*
- Padma Raghavan, *Vanderbilt University*
- Pengyu Ren, *The University of Texas at Austin*
- Robert Rosner, *University of Chicago*
- Talitha M. Washington, *Clark Atlanta University / Atlanta University Center*
- Mohammed J. Zaki, *Rensselaer Polytechnic Institute*

Congratulations to these individuals on their extraordinary achievement. The class of 2022 Fellows will be acknowledged during the Fellows Forum at the 2023 AAAS Annual Meeting,[1] which will take place in Washington, D.C., in early March.

A full list of all new AAAS Fellows is available online.[2] Visit the webpage[3] for more information about the AAAS Fellows program.

[1] https://meetings.aaas.org
[2] https://www.aaas.org/page/2022-fellows-0
[3] https://www.aaas.org/fellows

Introducing the SIAM Transformation Society

Over the years, SIAM has benefitted from the generous support of its members — both through gifts that they make during their lifetimes and via their estate plans. Estate gifts are especially important to SIAM because they help the Society look to the future, plan ahead, and prepare to address any unexpected challenges that may arise. Estate gifts allow many of our members to leave a lasting legacy of which they can be proud.

Because estate gifts are so important, we want to specially thank, recognize, and highlight SIAM members who have already graciously included SIAM in their estate plans. To this end, we have created the *SIAM Transformation Society*: a recognition society for SIAM's estate gift donors. Transformation Society members will receive periodic updates on the impact of planned giving at SIAM, opportunities to connect with their peers who have similarly dedicated a portion of their estate to SIAM, and special recognition through a variety of channels. Members will also receive a special welcome gift when they join.

Individuals are eligible to become members of the SIAM Transformation Society if they have included SIAM in their estates in any of the following ways:

- Through a bequest
- With a gift of real estate or other personal property
- By making SIAM the beneficiary of a life insurance policy or retirement account
- By making a gift that utilizes the Required Minimum Distribution (RMD) from their IRA or similar retirement account.

Please contact Abby Addy, SIAM's Director of Development and Corporate Relations, at **aaddy@siam.org** or **(267) 648-3529** if you have done any of the above, or if you have questions about the Transformation Society.

We look forward to recognizing your philanthropy and thank you for your continued membership and support.

Musings on Mathematics in Mid-20th-century America

Axiomatics: Mathematical Thought and High Modernism. *By Alma Steingart. The University of Chicago Press, Chicago, IL, January 2023. 300 pages, $35.00.*

BOOK REVIEW
By Ernest Davis

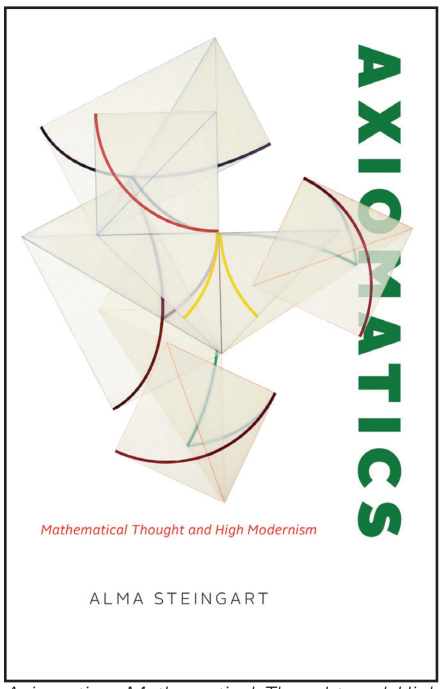
As author Alma Steingart writes in the book's introduction, *Axiomatics: Mathematical Thought and High Modernism* is not a history of mathematics. The book contains practically no theorems, proofs, calculations, or conjectures; and despite the title, there are very few axioms. It does include capsule biographies of many mathematicians—which describe how they studied, got hired, taught, wrote textbooks and reports, gave keynote talks on methodology, and raised funds—but there are no accounts of them actually doing mathematics (or any details about their personal lives). Rather, *Axiomatics* is a history of "mathematical thought"—that is, thoughts *about* mathematics—primarily by American mathematicians but also by social scientists, physicists, historians, and others.

The text's six chapters and epilogue comprise seven loosely connected essays, each of which addresses a different aspect of mathematical thought. Though the titular subject of axiomatics is a recurrent theme, it is only central in two or three of the essays; meanwhile, the subject of high modernism merely makes an occasional appearance.

Chapter 1 offers a history of frameworks for algebraic topology between 1930 and 1960 and documents its progression through different levels and forms of abstraction, illustrated largely by the career of Norman Steenrod. Steenrod first studied point-set topology with Raymond Louis Wilder, a student of Robert Lee Moore; his notes and letters from that period are full of carefully drawn geometric diagrams. He then went to Princeton University to work with Solomon Lefschetz, the leading figure in the development of algebraic topology. Lefschetz penned *Algebraic Topology*, which does not contain a single diagram, in 1942. George David Birkhoff described the text as "a culmination of the abstract phase" of algebraic topology. In 1945, Samuel Eilenberg and Saunders Mac Lane introduced category theory as a unifying framework for a wide range of algebraic and geometric theories. Seven years later, Eilenberg and Steenrod published *Foundations of Algebraic Topology*, which begins with a purely algebraic axiomatization and only later comments on the geometric interpretation. At each stage of topology's development, some members of the older generations found themselves somewhat resentful of the new approaches. Steingart identifies "high modernism" in mathematics as this unending process of constant revising, restructuring, and recasting.

Chapters 2 and 3 discuss how researchers came to view mathematical abstraction generally and axiomatization specifically as powerful analytic tools across a wide range of fields — including the increasingly abstract mathematics in 20th-century physics, Kenneth Arrow's axiomatization of social choice theory, and Oskar Morgenstern and John von Neumann's development of game theory. Some of these topics are more axiomatic in style than in actual content. For instance, Steingart quotes the following description from a chapter entitled "Choosing an Appropriate Axiomatics" in Yona Friedman's 1975 book, *Toward a Scientific Architecture*:

> The work of architects and planners produces enclosures — separations in space.
>
> A separation in space (an enclosure) cannot be the work of architects and planners if it does not have at least one access.
>
> In a system of spatial separations, there must be at least one enclosure that differs from the others in some respect, whether as a result of physical qualities or of others.



Axiomatics: Mathematical Thought and High Modernism. By Alma Steingart. Courtesy of the University of Chicago Press.

These are certainly not axioms in the sense that Euclid or David Hilbert used the term.

Chapter 4 describes a vogue among pure mathematicians in the 1940s and 1950s for describing pure mathematics as akin to abstract art; at the time, abstract expressionism in painting—as practiced by artists like Jackson Pollock and heralded by critics like Clement Greenberg—was the last word in the *avant-garde*. Steingart notes that math's association with art served a number of purposes. It was an easy (if not particularly accurate) way of explaining pure math research to lay people, it justified pure math research outside of applications, it allowed pure math to separate itself from its association with the military-industrial complex, and it promoted a Cold War vision of American intellectuals as individualists who carved their own paths. Many mathematicians discussed the comparison, although some—like von Neumann—were opposed to it. The discourse reached an apex in a 1951 speech entitled "Mathematics and the Arts" by topologist Marston Morse, which included this impassioned *cri de cœur*:

> Often, as I listen to students as they discuss art and science, I am startled to see that the 'science' they speak of and the world of science in which I live are different things. The science that they speak of is the science of cold newsprint, the crater-marked logical core, the page that dares not be wrong, the monstrosity of machines, grotesque deifications of men who have dropped God, the small pieces of temples whose plans have been lost and are not desired, bids for power by the bribe of power secretly held and not understood. It is science without its penumbra or its radiance, science after birth, without intimation of immortality.
>
> The creative scientist lives in 'the wildness of logic' where reason is the handmaiden and not the master. I shun all monuments that are coldly legible. I prefer the world where the images turn their faces in every direction, like the masks of Picasso. It is the hour before the break of day when science turns in the womb, and waiting, I am sorry that there is between us no sign and no language except by mirrors of necessity. I am grateful for the poets who suspect the twilight zone.

Chapter 5 of *Axiomatics* addresses the struggle between pure mathematicians like Marshall Stone and applied mathematicians like Richard Courant in the 1950s and 1960s. At that time, applied math received more government funding while pure math attracted more doctoral students and led to faculty positions. Eugene Wigner's famous 1959 speech, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences," was a pivotal event; both sides of the debate tried to use the lecture to support their points of view.

In chapter 6, Steingart reflects on her own discipline and recounts mathematicians and intellectual historians' growing interest in the history of mathematics during the 1960s and 1970s. She describes the profound, disturbing effects of Thomas Kuhn's *The Structure of Scientific Revolutions* and Quentin Skinner's essay on "Meaning and Understanding in the History of Ideas." Kuhn argued that the history of science was marked by large conceptual revolutions, while Skinner argued that the notion of an eternal conceptual framework was a myth. How could one reconcile either of these perspectives with the stability of mathematics over the millennia? Whereas the earlier chapters of *Axiomatics* are almost purely descriptive, Steingart explicitly shares her own opinions in this section; the phrase "I think" appears more than once. She contends that the issue—which is still not resolved—is not primarily a historical problem, but rather a problem with the conceptualization of mathematics itself. Though the Platonic view of mathematics is intellectually unsustainable and historically naive, there is not yet a coherent alternative.

The book concludes with a short epilogue that describes mathematicians' retreat from abstraction and re-engagement with the concrete through activities like Thomas Banchoff and Charles Strauss' work with computer graphics.

To a marked degree, *Axiomatics* is a history of institutions: universities, committees, professional organizations, and government agencies. Chapter 1 opens with the 1950 decision by Harvard University's Department of Mathematics to give a faculty appointment to Claude Chevalley, an algebraist with an abstract approach, rather than Arne Beurling, an analyst who used classical techniques for classical problems. Steingart provides long, detailed accounts of reports, white papers, keynote addresses, and efforts to lobby government funding agencies.

The scope of *Axiomatics* is limited in a number of dimensions. The focus is strictly American; Steingart acknowledges some French members of Bourbaki but ignores almost all British, Russian, or other European mathematicians later than Hilbert. In fact, Harvard, Princeton, and the Institute for Advanced Study are much more present than the rest of U.S. academia combined. G.H. Hardy's *A Mathematician's Apology*, the best-known defense of pure mathematics, is omitted. In terms of mathematical fields, Steingart barely discusses mathematical logic — the area that deals most directly with axiomatics. She mentions analysis, number theory, and probability theory even less, and most of the pure mathematicians that appear are algebraists or topologists. The fraught issue of grade-school math education is ignored; the omission of the "New Math" of the 1960s, a famous overreach by the mathematical establishment, is particularly striking.

Yet within its scope, *Axiomatics* is a groundbreaking accomplishment and a major contribution to the history of mathematics in the 20th century. The extent and care of its research and the depth of its analysis are truly impressive.

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

SIAM Texas-Louisiana Section Successfully Hosts 5th Annual Meeting

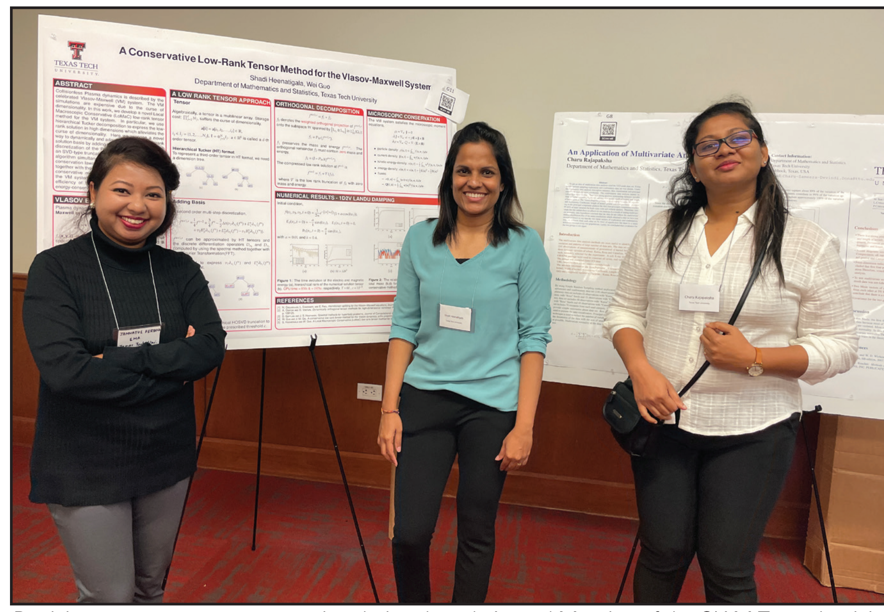
By Yifei Lou

The SIAM Texas-Louisiana (TX-LA) Section[1] held its 5th Annual Meeting[2] (TXLA22) in Houston, Texas, from November 4-6, 2022. The Department of Mathematics at the University of Houston (UH) hosted the conference,[3] which attracted 348 attendees; this record-breaking turnout demonstrates the tremendous growth of the SIAM TX-LA Section. SIAM provided travel support for the plenary speakers, 29 travel awards for undergraduate and graduate students, and cash prizes for two outstanding posters.

The three-day conference agenda included a career panel, a hands-on tutorial on data-driven full waveform inversion, four plenary lectures, two poster sessions, and more than 60 minisymposia blocks (each with up to four talks). Presenters reported on cutting-edge methodologies and computational algorithms—such as model order reduction, algebraic geometry, and scientific machine learning—for a wide spectrum of applications that ranged from the geosciences and biomedicine to hydrodynamics, optics, and fluids.

The first special event was a career panel that featured Detlef Hohl (Shell), Youzuo Lin (Los Alamos National Laboratory), Rami Nammour (TotalEnergies), Annalisa Quaini (University of Houston), and Carol Woodward (Lawrence Livermore National Laboratory). The panel drew over 50 attendees and stimulated a series of interesting questions and answers between the panelists and the audience.

Two of the career panelists also delivered plenary lectures; Hohl spoke about deep learning approaches for content-based image retrieval of industrial materials, and Woodward provided an overview of time integration methods and software for scientific simulations. The other two plenary lecturers were Karen Willcox (University of Texas at Austin) and Minh-Binh Tran (Texas A&M University). Willcox's talk pertained to digital twins with applications in aircraft and cancer treatment, while Tran reported on recent advances in wave turbulence theory. All of the plenary lectures were well attended.



Participants pose at a poster session during the 5th Annual Meeting of the SIAM Texas-Louisiana Section, which was held in Houston, Texas, in November 2022. Photo courtesy of Yifei Lou.

The career panel at the 5th Annual Meeting of the SIAM Texas-Louisiana Section, which took place in Houston, Texas, in November 2022, featured five individuals from academia, industry, and the national laboratories. From left to right: Youzuo Lin (Los Alamos National Laboratory), Carol Woodward (Lawrence Livermore National Laboratory), Detlef Hohl (Shell), Annalisa Quaini (University of Houston), and Rami Nammour (TotalEnergies). Photo courtesy of Yifei Lou.

TXLA22 boasted two poster sessions to accommodate nearly 80 submissions. The contributed posters covered a wide variety of topics, including convolutional neural networks, nematic liquid crystals, eviction, and even Sudoku puzzles. Mohammad Shah Alam (University of Houston) presented the winning poster in the graduate category, while Gavin McIntosh (Tarleton State University) won the undergraduate award. Both students received cash prizes for their excellent posters.

For the first time at a TX-LA annual meeting, the SIAM TX-LA Section organized a mentoring lunch to complement the career panel. While the panel offered useful career advice on a more general scale, the one-on-one meetings between senior researchers and students explored more personal and individualistic topics. The 34 registered graduate students and postdoctoral researchers (the protégés) were matched with 39 participating mentors based on factors like research area, career stage, and general interests. A post-event survey found that roughly 90 percent of participants would recommend this program to colleagues and friends, while more than 93 percent would participate again in the future.

The TXLA22 Organizing Committee[4] comprised a local UH group, the SIAM TX-LA Section officers, and the section's district liaisons. The UH Organizing Committee was chaired by William Ott and included Loïc Cappanera, Gabriela Jaramillo, Alexander Mamonov, Andreas Mang, Maxim Olshanskii, and Annalisa Quaini. Attendees praised the conference's vibrant scientific programming and strong student presence in the poster sessions, career panel audience, and mentorship lunch. Its success has inspired the section officers and liaisons to begin planning the 6th Annual Meeting, which will take place at the University of Louisiana at Lafayette sometime this year!

Yifei Lou is an associate professor in the Department of Mathematical Sciences at the University of Texas at Dallas. She currently serves as secretary of the SIAM Texas-Louisiana Section.

1 https://www.siam.org/membership/sections/detail/siam-texas-louisiana-section-siam-txla

2 https://www.siam.org/conferences/cm/conference/txla22

3 https://www.math.uh.edu/siamtxla22

4 https://www.math.uh.edu/siamtxla22/committee.shtml

Industry

Continued from page 6

any tool that an employer wants to use. But if one is going to pick up a language, I would recommend Python; its libraries allow the use of `R` tools, functions already exist for almost any problem of interest, and it's free.

However, resumes and skillsets comprise only a small fraction of the job-hunting process. Hiring managers want to know that prospective employees will do useful work, and do this work quickly. As such, successful industry experience is the most convincing evidence of one's utility.

The simplest way to obtain a permanent position at DEKA is via an internship. Interns are relatively easy to hire because they don't entail the same commitment as full-time employees. Once someone demonstrates strong capability as an intern, hiring after graduation is straightforward. Even if an intern ultimately chooses to seek employment elsewhere, their internship experience offers proof of practical skills and constitutes a ready-made conversation topic during interviews.

SIAM and other mathematical societies encourage student collaboration with industry through a variety of programs that afford many of the same benefits as internships. I have had the opportunity to participate in SIAM and the Mathematical Association of America's Preparation for Industrial Careers in Mathematical Sciences (PIC Math) program,[3] as well as SIAM's Mathematical Problems in Industry (MPI) Workshop.[4] I was greatly impressed by MPI, as participants were actually able to render an answer of real value in a very short time.

There is plenty of room for professional mathematics societies to work with other institutions and ease early-career mathematicians into industry. For instance, a number of industrial organizations—including IEEE, the International Society for Optics and Photonics, and SAE International—could help promote the value of mathematicians to their member companies; every company looks for creative people who can respond to novel problems and capitalize on new opportunities. Similarly, human resources associations might have ideas about how to best prepare mathematicians for a variety of positions.

SIAM's industrial outreach and collaboration is invaluable. Nevertheless, strengthening the capacity of mathematicians in industry also requires considerable effort on the industrial side, with support from strong math advocates and participation in recruitment programs. Companies in such programs likely hope for two things: answers to real problems that provide company value, and access to high-quality candidates for employment. We must find ways to advocate the benefits of mathematics to companies that have never worked directly with mathematicians.

I have profited tremendously from my own mathematics education, as well as the knowledge and skill of the mathematicians with whom I have been privileged to collaborate. Companies and agencies need mathematical talent to solve society's biggest challenges. We must work to ensure that mathematicians have the chance to contribute their capable expertise to critical real-world scenarios.

Derek Kane is a mathematician who has worked at DEKA Research and Development since 2000. He received a B.S. in mechanical engineering from the Massachusetts Institute of Technology in 1985 and a Ph.D. in mathematics from the University of Michigan in 1996, for which he studied cohomology of division algebras over p-adic fields.

3 https://www.maa.org/programs-and-communities/professional-development/pic-math

4 https://www.siam.org/students-education/programs-initiatives/mathematical-problems-in-industry-workshop

During the 38th Annual Mathematical Problems in Industry (MPI) Workshop, which took place at Worcester Polytechnic Institute in June 2022, graduate student Katherine Johnston of the University of Washington (left) worked with Derek Kane to address real-world research and design problems that were posed by industrial representatives. Participation in industry/academic collaborations like MPI significantly improve one's chances of being noticed by a prospective employer. Photo courtesy of David Edwards.