

MAA FOCUS

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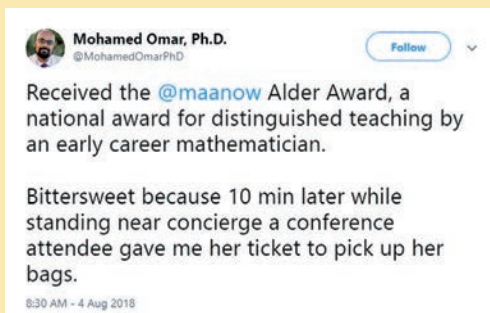
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From the Editor



This issue is always an interesting cross-over for me—it is the end of summer, coming right off of the conclusion of MAA MathFest, the start of the fall semester, and the beginning of preparation for the JMM. This year's MAA MathFest was an amazing celebration of MAA's community. There were great plenary talks by Talitha Washington, Eugenia Cheng, Laura Taalman, and Raegan Higgins, among others.

In the midst of this celebration of community and diversity, Dr. David Clark (Grand Valley State University), Dr. Chad Awtrey (Elon University), and Dr. Mohamed Omar (Harvey Mudd College) received the Alder Award for Distinguished Teaching by a Beginning College or University Faculty Member. Not long after these talks, Dr. Omar tweeted the following:



While we continue to celebrate the diversity of our membership, we also need to be conscious of the challenges that many of our colleagues are facing and continue to support them.

As you move through the fall semester, continue to support people in your community of students, colleagues at your university, and your MAA friends. Hope to see you all at the Joint Mathematics Meetings in Baltimore in January!

Jacqueline Jensen-Vallin

On the Cover



Photo of *Aurora Borealis* and *Wing* on the American Visionary Art Museum's exterior. Small museum in Baltimore with unusual rotating exhibits by self-taught artists, 2 sculpture plazas and a garden. avam.org

Photo by Beverly Ruedi.

Photo credits:

Page 4: Historic Lighthouse, credit: Albert Pego, iStock and Cincinnati Suspension Bridge, credit: kdow, iStock.

Page 13: Vote banner, credit: tostopphoto, iStock.

MAA FOCUS

Mathematical Association of America

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Visit maa.org/putnam to sign up for and learn more about the 79th William Lowell Putnam Mathematical Competition.

- October 15 Deadline for Putnam Competition Registration
- November 26 Deadline to submit an official Putnam team roster
- December 1 Putnam Mathematical Competition

MAA MathFest Deadlines

- October 31 Priority deadline for Themed Contributed Paper Session proposals
- October 31 Minicourse proposals due
- October 31 Invited Paper Session proposals due
- December 1 Regular deadline for Themed Contributed Paper Session proposals
- December 15 Workshop, Panel, Poster, and Town Hall Session proposals due
- December 31 Other Mathematical Session proposals due
- January 31 SIGMAA Session proposals due

National Research Experience for Undergraduates Program

Applications for MAA's National Research Experience for Undergraduates Program are being accepted through **December 15, 2018**. NREUP supports the participation of mathematics undergraduates from underrepresented groups in focused and challenging research experiences to increase their interest in advanced degrees and careers in mathematics. NREUP aims to reach students at the transition point between lower division and upper division studies, provide mentoring in a challenging summer program that will support students as they continue their undergraduate studies, and encourage students to pursue graduate studies and careers in mathematics.

Learn more and apply today: maa.org/nreup.

Fall MAA Section Meetings

EASTERN PA & DELAWARE

November 3, West Chester University

INDIANA

October 13, Hanover College

IOWA

October 5–6, Morningside College

MARYLAND/DC/VIRGINIA

November 2–3, Mary Washington University

NEW JERSEY

October 27, Montclair State University

NORTH CENTRAL

October 12–13, Southwest Minnesota State University

NORTHEASTERN

November 16–17, Southern New Hampshire University

OHIO

October 26–27, Malone University

SEAWAY

October 12–13, University of Toronto Mississauga

SOUTHERN CALIFORNIA-NEVADA

October 27, Scripps College

For the most up-to-date information on your section's activities go to maa.org/sections and click on the link for your section. ■



Important Deadlines

- October 30 Complimentary hotel room lottery
- November 20 To receive programs in the mail
- December 1 Hotel reservations with check deposit
- December 13 Hotel reservations thru JMM website
- December 27 Advance registration

50 year members honored at MathFest. Deanna Haunsperger (far right) with (from left to right): Gerald Edgar, Joel Cunningham, Roger Waggoner, Martha Siegel, Curtis Herink, Rich Mitchell, David Stone.



"You, too, can be a 50-year member – just pay your dues every year and live long enough."

— Roger Waggoner

Don't miss this exclusive offer for MAA members from Taylor & Francis!

MAA members receive 30% off all CRC Press titles with an exclusive member code. Login to your member profile page (maa.org) for additional details and the code.



MAA Project NExT is introducing new application cycle!

The first round of applications for the 2019 cohort of MAA Project NExT is due on October 15th. New(ish) faculty who are already in full-time teaching positions should use this deadline. Decisions will be made by December 1. Those accepting positions during this academic year (to start Fall 2019) will have a second application deadline of April 15th. For more information, see the MAA Project NExT website: projectnext.maa.org.

Found Math

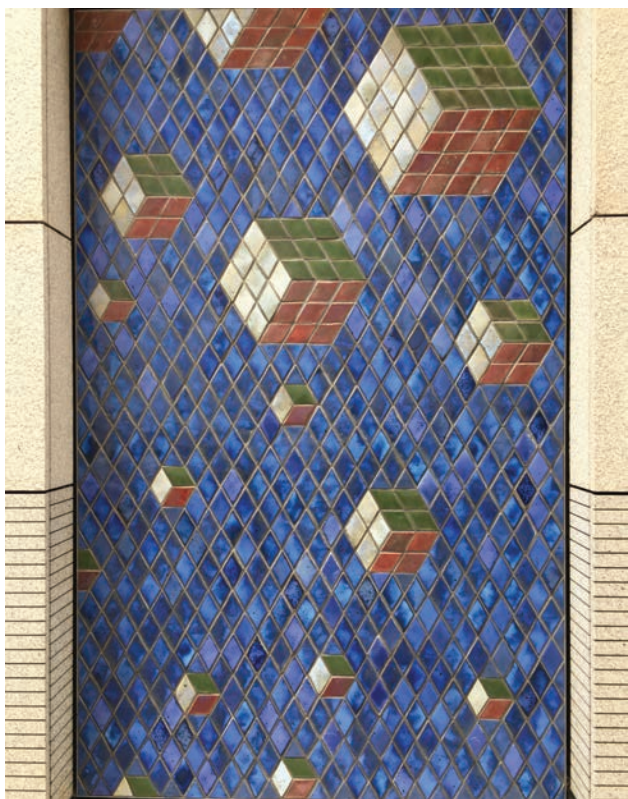


Photo was taken in an alley near Waithman Street, London.
— Submitted by Stephan Ramon Garcia, Pomona College



AMC Deadlines

AMC 8

Regular Registration	October 29
Final day to order additional bundles for the AMC 8	October 29
Late Registration	November 5

AMC 8 Contest will be held Tuesday, November 13, 2018.

AMC 10 and AMC 12

10/12 A	Early Bird Registration	January 8, 2019
	Regular Registration	January 9–22, 2019
10/12 B	Early Bird Registration	January 22, 2019
	Regular Registration	January 23–28, 2019

AMC 10/12A Contest will be held on February 7, 2019.

AMC 10/12B Contest will be held on February 13, 2019.

Kansas Section Teaching Award Winners

We apologize for missing the Kansas Section Teaching Award winners in the June-July *MAA FOCUS*.

2017 Kansas Section Teaching Award winner

Dr. Sarah Cook
Washburn University



2018 Kansas Section Teaching Award winner

Dr. Chad Wiley
Emporia State University



Membership Story

After reading Deanna Haunsperger's April/May 2018 *MAA FOCUS* column "How did you become a member of the MAA?", Henry Pollak (MAA President 1975–76) sent her his story.

The year is 1954. At this point I have been three years at Bell Laboratories, and have been a member of the AMS since my graduate student days. A coworker at Bell Labs is Gordon Raisbeck, a brilliant mathematician/engineer, Rhodes Scholar and son-in-law of Norbert Wiener. Raisbeck came to me and said I should join the MAA. Why? Because there was no New Jersey section of the MAA, New Jersey was divided between the Metropolitan New York section and the [EPaDel, which] included eastern Pennsylvania. New Jersey was negotiating to get its own section, and there were not enough members of the MAA in the state. Would I join?

Well, I did, and it was one of the best moves I ever made. In the 60s I became a governor of the NJ section, a member of CUPM, and then in the 70s a Hedrick Lecturer and a President of the MAA.

Lathisms Podcasts

New in 2018, the Lathisms website (funded by a Tensor-SUMMA grant) introduces their own podcast series with some of their honorees. Starting August 31, the Lathisms website will be featuring one podcast per week at lathisms.org/podcasts.html. Enjoy!

Journal of Humanistic Mathematics issue on Math Mamas

The *Journal of Humanistic Mathematics* (JHM) is pleased to announce its Special Issue on Mathematics and Motherhood, featuring articles from many MAA members. JHM is an open-access journal with no author charges. According to their website "The term humanistic mathematics could include a broad range of topics; for our purposes it means "the human face of mathematics." Thus our emphasis is on the aesthetic, cultural, historical, literary, pedagogical, philosophical, psychological, and sociological aspects as we look at mathematics as a human endeavor. More broadly, we aim to provide a forum for both academic and informal discussions about matters mathematical." The full issue on Mathematics and Motherhood can be found at scholarship.claremont.edu/jhm/vol8/iss2/.

Found Math



Photo was taken in the Sheraton at MAA MathFest.

— Photo by Audrey Malagon and Lisa Driskell

Williams College

Visiting Positions in Mathematics

The Williams College Department of Mathematics and Statistics invites applications for two two-year visiting positions in mathematics, to begin fall 2019. Candidates should have earned a Ph.D. in mathematics, applied mathematics, or a related field by summer, 2019. We will consider candidates with any area of mathematical expertise.

Visiting Assistant Professors are asked to teach four courses per year on our 12-week semester schedule, advise several undergraduate student colloquia (our capstone experience for seniors), and make small contributions to service activities in the department. This set of professional duties provides a window into the experience of being a mathematician in a liberal arts setting.

Our department offers a vibrant undergraduate program with majors in mathematics (including an applied mathematics emphasis) and in statistics. For more information, see math.williams.edu. The multidisciplinary environment is a rich and collegial setting for student education and faculty research. Williams College provides: the opportunity to apply for student research assistant support; a standard, annual allocation of funds to support travel and research; and a shared computer cluster for parallel computation. Visiting Assistant Professors are also eligible to participate in the college's comprehensive First Three professional development program (faculty-networks.williams.edu/networking-opportunities).

Approximately one hour from the Albany, NY airport, Williams College is located in Williamstown, a thriving destination proximate to: three major art museums; theater, music, and dance festivals; community supported agriculture farms; a highly-rated public school system; and many other resources.

The Williams undergraduate student body has 40% U.S. minority enrollment and nearly 10% international enrollment. Reflecting the institution's values, our department is diverse and inclusive, with 50% of our faculty being women, people of color, and/or members of the LGBTQ+ community. We encourage applications from members of underrepresented groups with respect to gender, race and ethnicity, religion, sexual orientation, disability status, socioeconomic background, and other axes of diversity.

Applications should be submitted via www.mathjobs.org. Your application should include the following components.

1) Please provide a cover letter. This letter might describe your interest in Williams and in the liberal arts, and

provide a brief summary of your professional experience and future goals. We ask you to address how your teaching, scholarship, mentorship and/or community service might support Williams's commitment to diversity and inclusion.

- 2) Please provide a current curriculum vitae.
- 3) Please provide a teaching statement. Ideally, this statement should be 2–3 pages long, and it might address your teaching philosophy, teaching experience, and any other reflections or relevant information you would like to share.
- 4) Please provide a brief research statement. Ideally, it should help our faculty, who come from a wide range of mathematical disciplines, understand the nature of your work and think about how to support you during your post-Ph.D. years.
- 5) Please have at least three recommenders submit letters of recommendation. If possible, at least one of these letters should comment on your experience as a teaching assistant or on any other instructional capacities in which you have served.

We also ask applicants to fill out this brief EEOC demographic survey: goo.gl/forms/xqT52JBGKXSonPU1. While completing this form is voluntary, we hope you will fill it out. Responses will be accessible only by administrators and EEO officers.

If you have questions about this position, contact search committee chair Chad Topaz (cmt6@williams.edu). Review of applications will begin on or after November 1 and will continue until the positions are filled. All offers of employment are contingent upon completion of a background check. Further information is available at faculty.williams.edu/prospective-faculty/background-check-policy.

Williams College is a coeducational liberal arts institution located in the Berkshire Hills of western Massachusetts. The college has built its reputation on outstanding teaching and scholarship and on the academic excellence of its approximately 2,000 students. Please visit the Williams College website (www.williams.edu). Beyond meeting fully its legal obligations for non-discrimination, Williams College is committed to building a diverse and inclusive community where members from all backgrounds can live, learn, and thrive.

MAA MathFest: Looking Forward

— JAMES SELLERS

Like some of you, I have been attending MAA MathFest meetings for many years. But I was really looking forward to the meeting in Denver as it was my first MAA MathFest as the secretary of the MAA. It turned out to be a wonderful meeting, and in this report I'd like to share with you some of my personal highlights—from the vantage point of the MAA Secretary.

For me, these meetings are all about “networking”—seeing old friends, making new ones, talking about MAA governance with some and about research in number theory and combinatorics with others. Networking is probably not the right term—it feels a bit too stuffy or business-like. What I really mean is building community, and it is that community that keeps me coming back to MAA MathFest! In fact, the MAA views this as one of the Association's core values which were finalized earlier this year—Community, Communication, Inclusivity, and Teaching & Learning. More information about the MAA Core Values can be found at www.maa.org/about-maa.

In my mind, there's no better way to build community than to enjoy food together. I shared meals with lots of friends, including some who were once former undergraduate students of mine and who have gone on to earn graduate degrees. And I made several new friends while in Denver, including Jean Bee Chan and Ken Ross, with whom I enjoyed a delightful breakfast. I am really looking forward to seeing them again when I visit the Golden Section's annual meeting in February!

I was also excited to see so much community building taking place at the MAA Pavilion in the Exhibitors

*James Sellers,
Ken Ross, and
Jean Bee Chan*



Hall! Caricatures were being drawn on Wednesday evening, groups gathered around the problem of the day activities, various “Meet the Important Person” opportunities took place, as well as lots of opportunities to interact with the MAA staff. The staff at the MAA deserve a great deal of credit for their vision and hard work in making the new MAA Pavilion such a success!

Of course, I also had to do “work” while at MAA MathFest. (After all, I am the MAA Secretary!) At the meeting of the MAA Board of Directors of July 31st, we discussed the ongoing work of creating a new vision statement for the MAA (now that the mission statement and the core values have been finalized). MAA President Deanna Haunsperger also announced the creation of two new presidential task forces—one to begin reviewing the MAA committee and council structure and another to consider ways in which the Association can support the work of the MAA sections.

The MAA Congress met on the following day. Highlights included a presentation by MAA Deputy Executive Director Doug Ensley, who shared about numerous programs and communities which are supported by the MAA. For those of you who love acronyms, these include CoMINDS (I think the

capitalization is correct!), StatPREP, and PIC Math. More information about MAA programs can be found at www.maa.org/programs-and-communities. The Congress members also elected several new officers:

- James Alvarez, MAA Officer-at-Large
- Jason Douma, Vice Chair of the Congress
- Clare Hemenway, Member of the Congress Elections Committee
- Krystina Leganza, Member of the Congress Elections Committee
- Ron Smith, Member of the Congress Elections Committee

And the Congress welcomed several new members earlier this year:

- Tim Chartier, Southeastern Section
- Thomas Hagedorn, New Jersey Section
- Chris Hallstrom, Pacific Northwest Section
- Diane Lussier, Southwestern Section
- Daniel Otero, Ohio Section
- Jeffrey L. Poet, Missouri Section
- Charles Ragozzine, Seaway Section
- Karen Stanish, Northeastern Section
- Eric West, Kansas Section

My attention then turned to the meeting itself. Several excellent talks

were given throughout the conference, and from a truly diverse series of invited speakers! For this I applaud Gerard Venema who recently completed nine years of outstanding service as MAA Associate Secretary.

Other highlights of the meeting included the President's Membership Jubilee where we celebrated the memberships of numerous colleagues, including some who have been members for more than 60 years! I was also really encouraged to see the attendance at the first-ever general contributed POSTER sessions. Several authors appeared to have lots of dialogue with those who were in attendance, arguably more dialogue than would have occurred in the traditional general contributed paper session talks of the past. I personally thought these sessions were a success. I was also very pleased by the great attendance at the MAA Prize Session on Friday morning. We celebrated the wonderful accomplishments of many in our Association at that time. A summarized listing of the prize recipients can be found at bit.ly/2N2TdQH. More details, including citations and brief biographies, can be found at each of the prize webpages at the MAA website (maa.org/awards).

At the close of the last day of the meeting, I had a chance to spend a few minutes chatting with Ken Ross and



Deanna Haunsperger (MAA President) and James Sellers

Martha Siegel, two past secretaries of the MAA. What an opportunity for me as the newest MAA secretary to hear stories from the past and to gain some wisdom about my role now and into the future. It's all about the community!

As I look forward to the future, let me highlight three invited speakers for the 2019 MAA MathFest which will be held in Cincinnati:

- Laura DeMarco, Northwestern University, will serve as the 2019 Hedrick Lecturer.
- Rochelle Gutierrez, University of Illinois at Urbana-Champaign, will be the 2019 Leitzel Lecturer.
- Erik Demaine, MIT, will deliver the inaugural Martin Gardner Lecture

on the closing day of the 2019 MAA MathFest.

I hope you will attend the 2019 MAA MathFest and look for ways to strengthen your community there! ■

James Sellers is a professor and Associate Head for Undergraduate Mathematics at Penn State University. He can be reached at Secretary@maa.org.

Left: Ken Ross, James Sellers, and Martha Siegel.

Right: Attendees enjoying the Contributed Poster Session.



Meeting the Future MAA and the Joint Mathematics Meetings

DEANNA HAUNSPERGER AND MICHAEL PEARSON

The MAA, now more than a century old, remains a vital part of the mathematical sciences community. And mathematics, in our technology-drenched era, has, if anything, become even more important as a key part of every citizen's intellectual toolbox.

Our society, and the mathematical sciences profession along with it, is changing so fast it's hard to keep up. The first iPhone was introduced in 2007, 11 years ago, with the first phone using the Android operating system released a year later. Yet smartphones are now ubiquitous, and most of us take their use for granted. And in 1998, when the AMS and MAA inked the current agreement for managing the Joint Mathematics Meetings, how many of us had Amazon (founded in 1994) accounts, much less Facebook (launched in 2004) or Twitter (launched in 2006)?!

Given the rapid pace of change across all areas of our professional lives, it's no surprise, then, that the MAA's practices and allocation of resources needs to change and adapt to the needs of our community.

As some readers have already learned, beginning in 2022, MAA national meeting activities will occur at MAA MathFest in the summer. The MAA will build on the continued growth of MAA MathFest and will also direct resources to better support MAA Sections and other programs that expand access and services to more members. The MAA believes that the strategic move from shared management of the Joint Mathematics Meetings under the 1998 agreement will allow us to better serve our members and the broader mathematical sciences community as we work to advance the understanding of mathematics and its impact on our world.

The AMS and the MAA have shared management, as well as contributed equally to the programming, of the Joint Mathematics Meetings under an agreement that has been in place since 1998. Through extensive discussions over the last five years, AMS and MAA have agreed that the 1998 agreement no longer meets the needs of either organization and will end following the Joint Mathematics Meetings in 2021.

A new model for the Joint Mathematics Meetings starting in 2022 will ensure a continued rich experience for the mathematical sciences community. The AMS and MAA agree that certain joint activities will continue, such as the Porter Public lecture, honoring the recipients of the AMS-MAA-SIAM Morgan Prize for Research by Undergraduates, and the JPBM Communications Award.

The AMS and the MAA have a long history of collaboration, and are both committed to working together to advance our shared interests. Many of us share affection for this long-standing annual gathering.

When the AMS decided to withdraw from the summer meetings in 1998, there was much discussion about whether that meeting would remain viable. Over the last 20 years, MAA MathFest has doubled in size, and we think it's safe to say that MAA has grown by leaps and bounds in our ability to develop a stellar program.

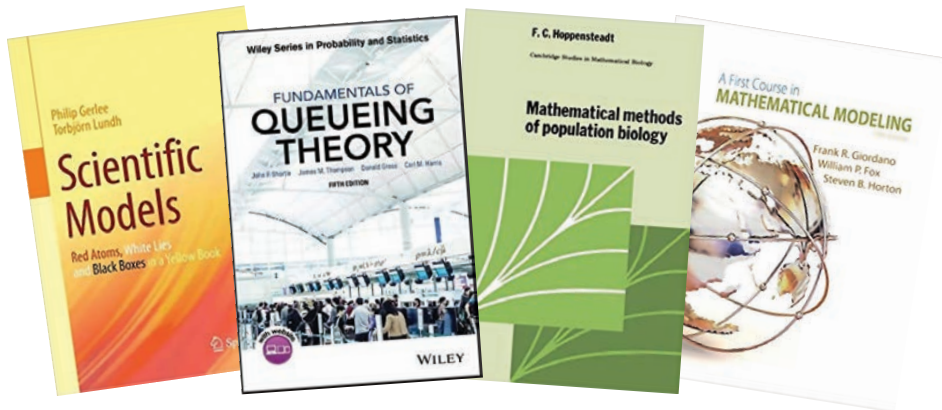
We also recognize that, in any given year, many of our members cannot attend either the Joint Mathematics Meetings or MAA MathFest, much less both. Given MAA's long-standing commitment to community, we ultimately decided that we need to reconsider the ways in which we engage members and direct resources in ways that open opportunities to broaden participation, for example through increased collaboration and support for MAA Section meetings, and through online platforms that allow MAA Sections, SIGMAAs, committees, and other groups to build community.

Of course, the major changes to the Joint Mathematics Meetings are still several years ahead of us. There is time to engage in thoughtful discussions and careful planning with the help and input of our community. ■



Dusting Off Your Bookshelf: Mathematical Modeling

—BRIAN BORCHERS



This month, the column will look at some recommended books on mathematical modeling from the Basic Library List. Mathematical modeling is an important part of applied mathematics that sometimes takes a back seat to methods for analyzing mathematical models. Two recent books that discuss how modeling fits into the broader context of applied mathematics are Alain Goriely's *Applied Mathematics, A Very Short Introduction*, and *Scientific Models: Red Atoms, White Lies, and Black Boxes in a Yellow Book* by Philip Gerlee and Torbjörn Lundh.

Courses in mathematical modeling are typically offered at the advanced undergraduate or beginning graduate level. Textbooks for these kinds of courses typically focus on the deterministic behavior of systems involving continuous quantities such as mass and concentration coming from areas such as mechanics, chemical reactions, and bacterial growth. With discrete time steps, the resulting models are systems of difference equations, while in continuous time we get systems of ordinary differential equations. We can also incorporate spatial variability to get models of diffusion that result in partial differential equations. Three notable textbooks on modeling from the BLL are *A First Course in Mathematical Modeling* by Frank R. Giordano, William P. Fox, and Steven B. Horton, *Mathematical Modeling Natural Systems* by Dietrich M. Imboden and Stefan Pfenniger, and *Concepts of Mathematical Modeling* by Walter J. Meyer. While not a traditional textbook, *Mathematical Modelling:*

Classroom Notes in Applied Mathematics edited by Murray S. Klamkin is a collection of case studies that can be adapted for use in modeling courses following the philosophy that modeling is best learned by doing.

Mathematical modeling is particularly important in mathematical biology, where a wide variety of mathematical models have been used, particularly when studying population biology and ecology. Three books from the BLL on modeling in mathematical biology are *Mathematical Models in Biology* by Leah Edelstein-Keshet, *Mathematical Methods of Population Biology* by F. Hoppensteadt, and *Mathematical Biology* by James D. Murray.

In many situations, it is necessary to model with discrete entities rather than continuous quantities. In this case, the actions of an individual entity are seldom deterministic and it is typically necessary to introduce a stochastic component to the modeling. Models with discrete entities and events occurring at random time intervals have long been used in modeling waiting lines, manufacturing processes, and inventory management. Here the discrete entities follow a predetermined path through a system that includes waiting lines (queues) and stations at which the entities are processed. Discrete event simulation modeling is a very general modeling approach for such systems that uses Monte Carlo simulation to generate statistical estimates of the average system behavior. This approach is described in *Stochastic Simulation* by Brian D. Ripley and *Discrete-Event*

System Simulation by Jerry Banks, John Caron, Barry L. Nelson and David Nicol. In a similar vein, analytical approaches to analyzing queueing models are discussed in *Fundamentals of Queueing Theory* by Donald Gross, John F. Shortle, James M. Thompson, and Carl M. Harris.

In recent years there has been interest in developing models for emergent behavior that occurs in systems where a large number of entities interact with each other and the environment according to rules that can be expressed as programs. This is known as agent-based modeling and has found particular application in mathematical biology. *Agent-Based and Individual-Based Modeling: A Practical Introduction* by Steven F. Railsback and Volker Grimm introduced this area of work. Emergent behavior is also found in systems in which a large number of entities are connected in a network—think of Facebook as a good example of this phenomenon. *Networks: An Introduction* by M. E. J. Newman is a good introduction to network models and their properties.

These are just a few of the books in the BLL dealing with modeling and applied mathematics. You can find the full list at www.maa.org/blf and full reviews of all of these books and many more at www.maa.org/maareviews. ■

Brian Borchers is a professor of mathematics at New Mexico Tech, where he teaches a variety of courses in modeling, optimization, and inverse problems.

Benefits of the MAA-T&F Partnership: Accessible Supplements to Articles

—BONNIE PONCE

The Mathematical Association of America has gone from self-publishing its journals to a publication partnership with Taylor & Francis Group printing and distributing *The American Mathematical Monthly*, *Mathematics Magazine*, *The College Mathematics Journal*, and *Math Horizons*. This partnership more broadly displays MAA's exceptional content to a global audience while also enhancing Taylor & Francis's mathematical portfolio. The partnership brings a wide variety of new benefits, many of which the MAA could not previously offer to authors and members.

One such benefit is the simplified navigation of our online content, which features a landing page with up-to-date covers of our publications. Clicking on a cover will take you to that journal or magazine's home page where volumes and issues are simple to scroll through and content is featured in large print.

Additionally, supplements to articles have increased publication visibility on Taylor & Francis's website. The website uses interactive tabs under the article's heading that highlight additional data such as supplements. MAA journal editors encourage supplements that enhance articles, such as *Mathematica* Notebooks, java scripts, classroom aids, and graphics. Through the partnership we can now host a wide variety of

media files including videos and gifs that enhance the content of the article.

Previously, the MAA hosted supplemental files on a journal specific supplemental website, with files sorted by year and volume. Linking supplements and corrections to the article itself will be much more efficient for members to read. Due to the increased accessibility and visibility of the supplemental material, even older articles will benefit from this change.

In addition to these changes, there will be more open access content to entice new readers. Many of *Mathematics Magazine's* puzzles, as well as special issues from *The American Mathematical Monthly* and *The College Mathematics Journal*, will be available through open access. There are a host of other new features that Taylor & Francis offers to MAA members who read the journals online. Read more about those benefits in future columns.

The partnership of MAA Press and Taylor & Francis Group allows MAA to share the high-quality mathematical exposition that MAA journals are known for with a worldwide audience, furthering our mission to advance the understanding of mathematics and its impact on our world. ■

Bonnie Ponce is Journals Managing Editor for the MAA.

The screenshot shows the MAA online publications platform website. The browser address bar displays 'https://maa.tandfonline.com'. The page features the MAA logo and navigation links for 'Log in', 'Register', and 'Cart'. A search bar is present with the placeholder text 'Enter keywords, authors, DOI etc.'. Below the search bar, there is a section titled 'More from MAA' with a list of links: 'MAA Career Resource Center', 'MAA Conferences', 'MAA Community', 'MAA Twitter', 'Become a Member', 'MAA Website', 'Your Colvitz Library', and 'MAA Magazines'. The main content area is titled 'Explore the Mathematical Association of America's portfolio of journals.' and displays four journal covers: 'The American Mathematical Monthly', 'Mathematics Magazine', 'The College Mathematics Journal', and 'Math Horizons'. The footer includes copyright information for Informa Group plc and Taylor & Francis Group, along with a registration number and contact details.



Math the Vote

— MICHAEL PEARSON, *Executive Director of MAA*

Readers of *MAA FOCUS* may have, at one time or another, seen Stirling's approximation for the factorial:

$$n! \sim \sqrt{2\pi n} \left(\frac{n}{e}\right)^n,$$

I suspect that it is less likely that you know much about the life of James Stirling (1692–1770), the Scottish mathematician for whom it is named. Aside from having his work recognized by both Isaac Newton and Leonhard Euler, Stirling was a supporter of the Catholic King James II of England, who had been deposed by his daughter and son-in-law (William and Mary) in 1688, and refused to swear an oath of allegiance to the rule of George I after matriculating to Oxford in 1711 at age 18. Stirling managed to piece together various mathematical positions for the next 20 years despite his Catholic faith, but by the mid-1730s, was back in Scotland and spent the rest of his working life managing coal mines.

While I fully believe that, broadly considered, humankind has made much progress in welcoming contributions from people with a variety of religious beliefs and other individual characteristics, data on participation of women and other historically marginalized groups suggest that we have much left to do. Such progress depends on action both within our discipline, and in the kinds of policies that our political leaders implement across areas as diverse as immigration, health care, housing, and public infrastructure such as roads, the electric grid, and water treatment.

A complete separation between mathematics and politics has, of course, never been observed. In these days when education and economic policies are highly politicized, those of us with careers in the mathematical sciences, whether teachers at any level or holders of careers in business, industry, and government, are likely acutely, if not painfully, aware that our livelihoods are far from independent from the decisions made by those elected to government positions at multiple levels.

I've heard from a number of MAA members concerned about the changing landscape in higher education, including consolidation of campuses, and the consolidation or even elimination of programs. Such decisions may be made with

limited input from the departments and faculty who are directly affected, and primarily driven by economic and political considerations perhaps based on faulty perceptions of public support of education.

The MAA does not take partisan positions in electoral politics, nor would I suggest that we begin doing so. However, I do think that it's incumbent on the MAA to support evidence-based decision making, and to encourage our community to engage policy-makers to do the same.

What we *do* take positions on is the structure and nature of the undergraduate program (see the CUPM Guide), appropriate pedagogical strategies (see the recent Instructional Practices Guide), and statements from the Committee on Faculty and Departments that reflect views on administrative structure and management. These are the kinds of resources that can provide lenses to gauge new structures by. Do the policies and practices at a given institution reflect the values articulated within these statements? Our goal is that they support departments to carry out their work in ways consistent with these guidelines.

By informing ourselves about the still evolving, but evidence-based effective practices our colleagues in mathematics and other relevant disciplines have implemented, I hope we can improve our ability to engage in productive conversations with policy-makers both within our organizations and in our communities. This exchange can help inform and improve decisions that ultimately shape our careers, the lives and careers of our students, and in fact the lives of our fellow citizens. As mathematicians, when we reach out and effectively engage our elected officials, we can help position mathematical ways of reasoning and knowing as critical to human health and progress.

I encourage all of us to consider how our work is situated within our departments, our institutions, and our community, and to think about how we can contribute to discussions to improve outcomes.

And by the way, do remember to vote in November! ■

GET MORE

See how the mathematical theory of communication takes on “fake news” and its effect on voting behavior: technologyreview.com/s/612004/a-mathematical-model-captures-the-political-impact-of-fake-news/.

An Engaged Congress: MAA MathFest

— MELISSA C. ERDMANN AND JENNIFER J. QUINN

MAA MathFest marked the third convening of MAA's Congress. Lead by Chair Su Dorée of Augsburg College, the event could be described as active classroom strategies applied to a meeting environment. There were times to listen and times to share; times to reflect, times to request, and times to resolve. Everything undertaken connected to one or more of MAA's recently approved core values: community, inclusivity, communications, and teaching and learning.

The meeting highlights presented below are preceded by their engagement method in italics.

Setting the Stage through Individual Introductions: As a new body that is constantly welcoming new members, it was important to learn about one another. In the process Representatives also learned about the MAA. Not only did each person introduce themselves, they shared something learned by reading an issue of MAA FOCUS from the past year. Snippets included events at the MAA MathFest Pavilion, microaffirmations to build positive environments, PIC Math's milestone of reaching over 2000 students on more than 130 campuses, outreach efforts of the Louisiana/Mississippi section inviting student and faculty participation from Historically Black Colleges and Universities, the profound impact of the life of Dr. Clarence Stephens, and so much more. Executive Director Michael Pearson praised Texas Section Representative and MAA FOCUS editor Jacqueline Jensen-Vallin for her fine work on this periodical including getting the October/November 2017 issue published on time despite the wrath of Hurricane Harvey. And as a harbinger of the work to



MAA MathFest attendees enjoy a talk.

come Rachel Levy, new Deputy Executive Director of MAA, charged the Congress to "Look around the room. Celebrate who is here and bring people into the room who are not here yet."

Polling Via Show of Hands: Continuing the theme of inclusivity started during Levy's introduction, Dorée posed a series of questions to reveal Congress's current composition. Not surprisingly, Congress is overwhelmingly tenured or tenure-track faculty from four-year colleges or comprehensive universities. Few members are employed by community colleges, high schools, research universities, or outside academia. Many Representatives indicated professional interest in educating future teachers. A very small number of Representatives are first generation college attendees, minorities, grew up in other countries, or speak at least two languages. There are currently no international or student representatives.

Mathematics and mathematics education are international endeavors and vibrant mathematics instruction can be found at every level of education. Indeed, the makeup of Congress is not as representative as one would like. How can the MAA welcome a more diverse group both into its membership

and into the Congress? A structural change to Congress proposed increasing the number of At-Large Representatives from six to eight and revising their constituencies to be more reflective of those missing from the room. Work on this initiative will occur throughout the year with a vote coming as early as summer 2019.

A second recurring theme emphasized how MAA and its members provide a wide-variety of activities and services to advance the understanding of mathematics and its impact on our



world. The breadth and complexity of these offerings is so great that it is unlikely the most conscientious Representative could know them all. Rather than ask for the impossible, Congress began the task of becoming a well-informed body using the following structures:

- **Presentation punctuated by moments of reflection and discussion.** Doug Ensley, in some of his final remarks as Deputy Executive Director, informed Congress about MAA Programs in his portfolio. He emphasized the many overlapping circles of MAA communities, from the American Math Competitions to professional development, from sections to SIGMAAs, from within the association to outside of it.
- **Question and Answer.** The Board of Directors provided an activity report in advance of the meeting and asked Representatives to respond to a short survey. President Deanna Haunsperger answered questions arising from the survey, responding both via email and at the Congress meeting.
- **Large group discussion.** Matt Boelkins, Grand Valley State University, lead Congress to develop and refine a shared understanding of the expectations for members of Congress.
- **Electronic Polling.** Starting with a task-force-generated list of topics that a well-informed MAA Congress needs to know, Jenny Quinn, University of Washington Tacoma, had members classify areas of knowledge as something that every Representative should know versus something a subset of Representatives should know.
- **Small Group, Self-Selected Learning Communities.** Dorée proposed seven themes for continued work, organized around MAA's core values. Representatives committed to a self-selected theme, agreed on leaders for their community,

and began brainstorming one to three key highlights or issues on which to focus. These "Congress Learning Communities" (called CLiCs) will share their knowledge with Congress and serve as resources as needed throughout the year.

Paper Ballots. The Congress held elections, according to the schedule given in the bylaws, for the positions of Officer-at-Large, Vice Chair of the Congress, and members of the Congress Elections Committee to begin service February 1, 2019.

- James Álvarez was elected Officer-at-Large to the MAA Board of Directors. Álvarez will continue in his role as Member-at-Large for minority interests. He is a Distinguished Teaching Professor and Professor of Mathematics at the University of Texas at Arlington where he has received multiple awards for his contributions to mathematics education and service to the profession.
- Jason Douma was elected Vice Chair of Congress. Douma represents the North Central Section. He is the Associate Vice President for Institutional Research and Professor of Mathematics at the University of Sioux Falls. Douma recently chaired a task force that produced an MAA values statement recommended to the Board of Directors.
- Clare Hemenway, Krystina Leganza, and Ronald Smith were elected to the Congress Elections Committee. They represent the Wisconsin, Indiana, and Oklahoma-Arkansas Sections, respectively.

Think-Pair-Square-Share. Congress has an important role as a conduit of information between members, sections, and MAA leadership. To ensure that communication flows in all directions, Dorée instituted an activity called "I wish the MAA...". Representatives individually completed the prompt, discussed their responses in pairs, discussed responses in pairs of pairs (hence "squares"), and shared the best idea from their square with Congress. Some ideas were already in the works like making plenary addresses available to members online, others confirmed ideas from earlier discussions like increasing support to sections, and still others raised issues in need of attention like advocating for non-tenure track and part-time faculty. Dorée expressed her appreciation for everyone's contributions and plans to repeat the activity at future meetings of Congress.

MAA is a member-driven association. The organization becomes stronger through your engagement. So please contact your Congressional representatives and share with them your questions, concerns, ideas, and wishes. ■

Melissa Erdmann is the Representative from MAA's Nebraska-SE South Dakota Section and Recorder for the Congress. Jenny Quinn is the Congress's Officer-at-Large to the Board of Directors and the Chair of the Council on Publications.

Having fun at the MAA Pavilion!





Using Makerspaces to Attract and Retain Women in STEM

Jenna Carpenter

Attracting and Retaining Women in STEM

Despite decades of effort to attract and retain women in STEM (Science, Technology, Engineering and Mathematics) majors at the collegiate level, we have made little progress, particularly in math, engineering and computing (AAUW, 2015). For example, 27% of computing and math jobs were held by women in 1960. In 2013, it was 26%. More recent data shows further erosion in computer science—just 16% of computer science majors were women in 2016. In 2015 the US Bureau of Labor Statistics reported the following statistics for engineering (ASCB, 2016):

- Women constitute 16% of chemical engineers, 12% of aerospace engineers, 12% of civil engineers, 7% of mechanical engineers
- Women have had no employment growth in STEM jobs since 2000

The latest data show that women now make up 49% of AP Calculus AB test takers in the U.S. Women are qualified and prepared to enter STEM majors in college, they just are electing to go elsewhere.

What does the research say works?

So, we haven't done particularly well. It matters, not only because it's the right thing to do, but also because women (at 56% in 2017) now outnumber men in college. But it's not like there haven't been myriad efforts to tackle this problem over the last two decades. Unfortunately, much of that effort has been directed at less-than effective strategies. But there is research that suggests approaches that do work. Things like connecting STEM to applications that make a difference in the world (NAE, 2008); using hands-on projects in STEM classes (Vaz, Quinn, Heinricher & Rissmiller, 2013); and developing a sense of belonging in STEM students (Stout, Dasgupta, Hunsinger & McManus, 2011) all hold promise for attracting more women to STEM majors in college.

Above: "Dean Jenna Carpenter showing us the Campbell University Camel Fab Lab & the Maker Space that's open & free to all students. #BeThatEngineerpic"

—Vicki Crowell (@MrsVcc07)



Objects made with the 3D printer.



Jenna with Campbell University engineering students.

Why Makerspaces?

At first glance, creating a makerspace might seem like an unusual way to approach the issue of attracting and retaining more women in STEM majors. But it turns out that you can incorporate all three of the research-based strategies, above, into a makerspace. How?

- Makerspaces provide students with the opportunity to connect STEM to real world applications that make a difference in the world because they provide a platform to support student projects, both on- and off-campus, for classes, K-12 outreach activities, service projects, support of non-profit groups, student competitions, not to mention that they allow students to realize their own ideas and just have plain fun.
- Makerspaces make it possible to realistically and inexpensively incorporate hands-on projects in STEM classes by facilitating efforts to build prototypes, more finished final projects and create models. Makerspaces also make it possible for faculty to build models and devices to demonstrate and teach concepts that are otherwise challenging for students to visualize and/or engage with tactically.
- Makerspaces can even help your students develop a sense of belonging IF you set up your makerspace to function as collaboration space that welcomes all, facilitates experimentation, and supports student mastery of both the equipment and software.

Other Advantages of Makerspaces

Aside from serving as a platform to incorporate research-based strategies to attract and retain women students, Makerspaces can serve as a springboard to introduce students to computer-aided design (CAD)

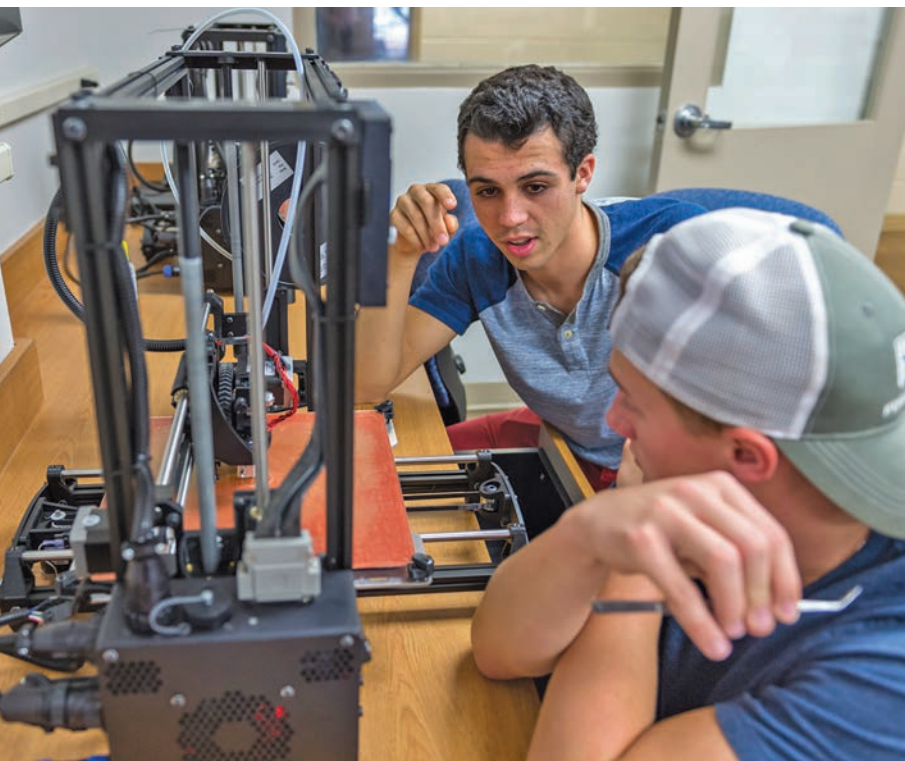
software; bolster student 3D visualization skills (which research shows helps them be more successful in the rest of their undergraduate career—Sorby, 2009); as well as invite and encourage student creativity and allow for expression of artistic talent in STEM-oriented courses. Lastly, a Makerspace can be designed in such a way as to allow women to acquire technical skills in a less-gendered environment, which can serve to increase both their sense of belonging and fit in the STEM world (Morocz, Levy, Forest & Nagel, Newstetter, Talley, Linsey, 2015; Roldan, Hui & Gerber, 2017).

What Can You Put in a Makerspace? Campbell University's Approach

You will likely find as many incarnations of “makerspaces” as there are 3D printers, so you need to have an understanding of your goals in creating a space, who is likely to use it and for what. Campbell University School of Engineering creat-

Embroidery machine in the Campbell University Makerspace.





Students working with the LulzBot TAZ 5 3D printers.

er/roller, drill press, mill, power tools, soldering equipment, heat gun, band saw, hand tools, and lathe, along with other equipment.

Our Makerspace is student run and managed, with training and oversight provided by our engineering lab manager. To encourage students to stop by the space frequently, it is open daily, Monday through Friday, for 3–5 hours per day for the entire campus. We are fortunate that the university has provided a sufficient budget that allows us to grant access to the Makerspace for free (including materials!) to anyone on campus. It is important to note that we are not a “shop.” By that, we mean that our student workers will gladly teach you how to use the equipment but we won’t make ten (or even one) of something for you. Sign-in is required of all users. Permission is required for 3D printing of large objects to discourage waste when CAD files contain design flaws. The Makerspace is used by

ed a Makerspace for use by not only our majors, but by any student, faculty or staff member at the university. Our goal was to facilitate student projects for our classes and build up students’ 3D visualization skills as a retention strategy for first-year students. We reached out to Makerspaces at other universities and solicited recommendations and advice, along with information on the pros and cons of different configurations. Some of the equipment that you will commonly find in a Makerspace include: a variety of 3D printers, vinyl cutter, embroidery machine, laser cutter, vacuum former/chamber, impulse sealer, metal press/breaker/roller, photo booth, drill press, mill, power tools, soldering equipment, heat gun, hot wire foam cutter, band saw, electronics kits, hand tools, engraver and lathe. At Campbell we created two lab spaces, a Makerspace and a Fab Lab. The Makerspace has ten 3D printers (four different brands with differing capabilities), a vinyl cutter and an embroidery machine. We intentionally wanted the Makerspace to be less “machine shop” and more “creative space with a welcoming, non-techy vibe.” The Fab Lab has the “machine-shop” type equipment, including a laser cutter, metal press/break-

multiple classes in engineering and elsewhere on campus to support student projects and 3D printer training is taught as part of our first-year projects-based engineering course, although we have lots of non-engineering students use the lab.

So is it working? In our first year of operation, we had approximately 1,000 visits in 9 months (on a campus with a total undergrad on-campus population of about 3,400). During year two, that number rose to 1,600–1,800 (all users are supposed to sign in, but when the lab gets busy, as it often does, student workers are not always able to make sure that everyone does; non-engineering classes and K–12 groups have started to use the space during year two but do not sign

Form 2 SLA (stereolithographic) 3D printers in the Makerspace.



in). We have seen heavy usage by women students (guys use it, too!). When asked, women students say that they come in and make things when they have a break between classes to “decompress” and that it is a “hang-out” for engineering majors. Moreover, although we allow our student workers to select the lab in which they work, 100% of student workers in the Makerspace are female. Women unfortunately don’t use the “machine-shop” equipment housed in the Fab Lab (which looks much more like a machine shop) very often, except for assigned course projects.

What’s next?

We are working to track student usage to determine who is using what equipment, how often and for what purpose. We are hoping to purchase a sewing machine and smaller vinyl cutter for the Makerspace (to do so, we need more space!). We are in the process of replacing some of the initial low-level 3D printers (they do wear out with tons of use), so we are experimenting with the ever-changing and ever-growing array of 3D printing capabilities on the market. And lastly, we are looking at ways to better utilize the space for additional K–12 outreach, summer camp, and related activities. Given a room capacity of about 20 people, these types of activities are challenging to run in our current lab.



Stickers made by SWE women students for E Week.

Questions? Please contact us at carpenter@campbell.edu If you plan to be in the Raleigh area, reach out and we’d be more than happy to give you a personal tour! ■

Jenna Carpenter is Dean, School of Engineering, Campbell University.



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3Blue1Brown

An Interview with Grant Sanderson

Jacqueline Jensen-Vallin

3 **Blue1Brown** (youtube.com/3blue1brown) is a YouTube channel featuring math relating to classroom topics as well as math for the interested amateur. I had the opportunity to speak with Grant Sanderson the day after his latest video, this one about quaternions (youtu.be/d4EgbgTm0Bg), became a social media sensation.

JJV: *Your videos are a great method for mathematical outreach at a variety of levels. Do you do outreach in person?*

Sanderson: Not as much. I do some teaching, which reaches a small number, but is of highest impact. Every now and then I give talks, and I used to do things for Khan Academy, but the videos are 95% of what I do.

JJV: *How do you want faculty to use your site?*

GS: There are two categories of videos: the first consists of those targeted at students (in particular, the series on linear algebra and the series on calculus), although hopefully those later in life interested in mathematics will learn something from them. One of the purposes of these is for grounding intuition into students minds before they enter a course, so that when the details come up in class, they have some intuition. It can be used before the hard work is done—before students are pushed up against misconceptions that classwork will bring.

The second category are the interesting applications that you have no reason to see in school, but give a sense of what problem-solving tactics mathematicians get giddy about. This is more just general... I don't want to use the phrase "inspire people about math," but to communicate what mathematicians really care about. This can make people think "I have more questions about this" which can make them identify with liking math in a way that they didn't before.

Use them whenever inspiration is at a low. or to show where the math your students are currently learning might lead. For example, if you are teaching analysis and you mention that analysis is the foun-

dation for topology, and students ask “What is topology?”... then here is a way to use the videos—not necessarily directly relevant to the course material, per se, but they can provide outside substance as an answer to the students’ questions.

JJV: *You mention in your Q&A (bit.ly/2Mj1uRW) that insinuating that there is “right” and “wrong” in mathematics and the challenge of mathematics can alienate people away from mathematics.*

GS: What some people like in math is this objective sense of right and wrong. But it can be problematic that you have a red X next to the homework that you did and that this one mark implies that all of the thoughts you put into this problem are invalid. It’s weird for that red X to somehow translate into feedback that you were wrong, instead of working with all of the valid ideas you may have had in forming the answer. We should instead acknowledge the right thinking that is behind that.

There is also a deeper thing going on here, where there are different phases of maturity in your relationship with math. At first, you believe in objective truth and falsehood in mathematics, but later you realize this truth and falsehood is with respect to a certain axiom system. Truth and falsehood are not objective in any way, as far as I can tell. It’s like a type of relativity. There is a vague connection here between this youthful look at math vs. how they see it in modern terms, and a transition for an individual from when they are a student to a graduate student. Our math lessons give an impression of God-given rules handed down and this can feel

alienating.

For instance, in the comments on the video *The Hardest Problem on the Hardest Test* (youtu.be/0kmNXy7er84, [about the William Lowell Putnam Mathematical Competition organized by the MAA]), several people claim that they got the answer very quickly. What they mean by “got the answer” was finding the probability was $1/8$ without an explanation. What we [mathematicians] mean by answer this question is “provide a full proof.” Why is that not our default? Why do people not say that understanding a question is the “right answer?” People think that the “right answer” should be that you filled in the right bubble, and less concerned with your thought process.

Contrast this with Ramanujan and the story of the book that he had. People wonder, “What book was it? It must have been written by a genius, too,” but it was a primer book for the calculus exams—a list of formulas that British professors thought that their students should know. Ramanujan thought of these as a list of personal challenges. That approach is much more likely to produce genius than the notion of bubbles or free response, even.

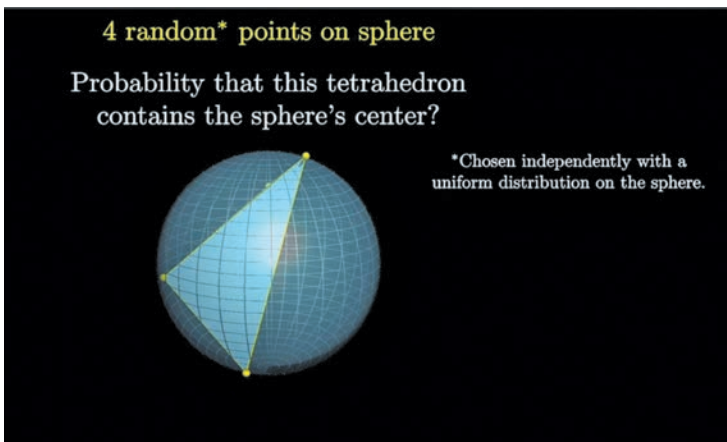
JJV: *Dweck and Boaler indicate that mathematical capability can be enhanced by a discussion of “working hard” and growth mindset—how does this motivate how you communicate math to others?*

GS: There’s probably a lot more I could do to convince people that only practice is something that leads to expertise. I try to say “you have to expose yourself to your own misconceptions

A1) ... Pretty hard ...	/10
A2) ... Hard ...	/10
A3) ... Harder ...	/10
A4) ... Very hard ...	/10
A5) ... Ughhh ...	/10
A6) ... Can I go home? ...	/10

A6) ... Potentially very elegant ...

some subtle shift in perspective that transforms it from very challenging to doable.



to really learn.” Adding these words is influenced by this work of Dweck and Boaler. I wish I had a meatier answer—that I could tell students that a particular set of practice would lead to an understanding of this topic that one of my videos showed in some way.

I try to, instead of saying “here is the truth” to give the path of discovery. The videos show an imagined path that would lead to the discovery of that thing that hopefully the viewer can empathize with in some way. The viewer should see, “It’s not always easy to see the trajectory, but going through that trajectory changes something from opaque to clearer.” And so when you yourself later see something opaque, you ask what path you could have walked down to discover that yourself.

The first video in the calculus series was trying to walk down a path of ideas: Instead of just saying “Here’s the definition... Here’s an example... But we can represent this as the area under a certain curve,” start with a non-calculus example that *motivates* the definition of a derivative, or the search for an area under a curve. The hope is that a viewer comes away thinking that if they were lucky enough to see the geometry in the right way, and ask the right questions, they could have invented calculus.

JJV: In a couple of videos you mention the MAA Putnam Exam and the MAA American Mathematics Competitions. What is your connection? Did you take these exams?

GS: In high school, a calculus teacher showed me that there is more to math than happens in class. He told me about the [MAA] AMC and I took them and liked them. I was sometimes good and sometimes bad. The state math contest was an ego-boosting thing when I got first place. There was a math portion of the academic decathlon that was ego-boosting. But then, on the AMC side of things, I didn’t do well on the AIME [American Invitational Mathematics Examination]. I missed the Olympiad stuff, which is more my speed—more time on one problem. It was good for me to be humbled and say, “You are not a hot shot, and geome-

try is something that you need to work on,” which was ironic because I thought my spatial relations were pretty good.

I took the [MAA] Putnam [Competition] in college. It was extremely fun. Even these days, to have a leisurely Saturday morning, I open up the released Putnam exams and work some problems. It’s like “research lite.” It isn’t going to take many months—it will take many hours. And you know these problems are well defined and solvable, which isn’t true about research mathematics.

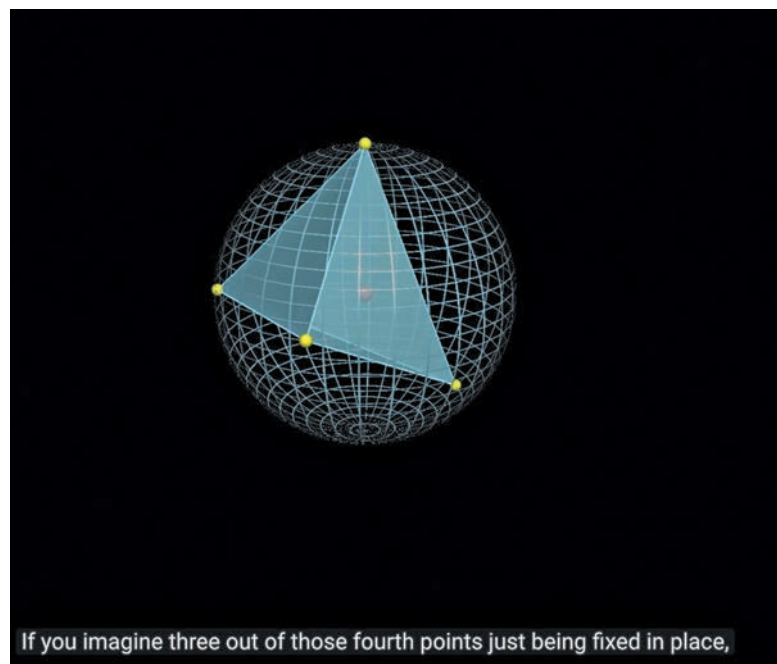
For every student who didn’t get first place, they are somehow being told that they are not good at math in some way. This can be healthy if they need to have their ego checked, or if they understand that scores on math-related things are not statements about your relationship with math as a whole. But it runs the risk of turning some people off from math.

Generally, math competitions are net positives. They foster a sense of not being alone and liking the same thing. Energy is put forward to solving hard problems. But I worry about the negative vector being added to this and wonder how large that effect actually is.

JJV: So, how could the MAA promote a contest?

GS: Like in the symphony, the conductor spends most of the time on the preparation and not the performance itself. The Putnam [Competition] is about the preparation, not in the six hours of the exam itself. When I was at Stanford, there was a seminar to prepare for the Putnam, and whether or not the Putnam is taken does not affect the impact of that seminar.

If I were at the MAA, I would definitely promote the net positives, but I don’t know how to reconcile these things that I have been talking about.



JJV: What is the timeframe from concept to publication of your videos?

GS: This is a hard question, since I have a list of all of the things that I'd like to make a video about. A topic might have been on that list for 1.5 years. But it might be that the only time I started to seriously engage with it was a month ago.

From the moment when I seriously engage with a topic, and work on writing a script, I can sometimes bang one out in a week. Like the “quaternions” one was something I've been thinking about for four months and sometimes when I was with friends, I would ask if I could teach a sample lesson. But it took two to three weeks when it became the main project. That was to write the script and put the visuals to it.

I love coding! Part of the reason that I put off the “quaternions” one was because the way I was coding 3-D stuff was like holding on to a slippery handle. But I found pleasure in rewriting the code and getting it to do what I want.

After the script, you know what needs to be done to put visuals to it, and you know there will be monotonic improvement and progress.

If I imagined writing a book, I would go a little crazy because all of it would be in the doubt phase—will this paragraph or chapter be in the final form? It's not about micro-problem solving and seeing progress.

And it's a really good test of how well you understand the mathematics to create a visual for an explanation—this leads to engaging with the material in a very different way by doing that.

JJV: How many scripts do you have that you weren't satisfied with and have discarded?

GS: Well, it's hard to know which of the things I've set aside are permanently discarded, or just waiting to be revisited. Things that were going to be part of a given project as interesting side notes have been thrown out permanently. Sometimes I get requests for these, but I can't listen to what the core fans want because it's not necessarily representative.

JJV: Which one is your biggest regret in terms of a topic that you want to approach and haven't gotten to yet?

GS: One about complex functions and fluid flow. There's a whole circle of ideas here. I might not have found the right subset of that circle of ideas yet. Also, conformal maps and why you would care about them; and there are two different videos that are intended to tee up the idea of complex analysis in some way—so what is the supporting cohort of topics that help motivate the particular visual that I want to throw in there. Maybe it will be fluid flow. But I probably will revisit that.

JJV: What's coming up next that we should be excited to see?

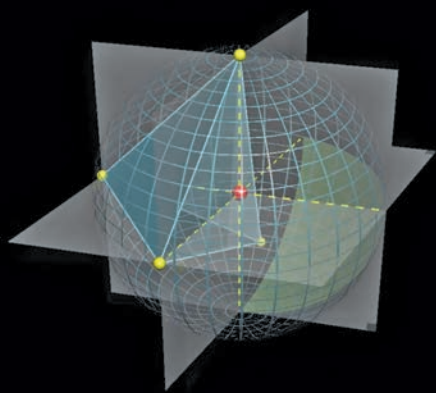
GS: As the completion of the quaternion project, there is a follow-up video about how quaternions describe position in space. This is why most people outside of math think this is most interesting. If you really understand what multiplication from the left and multiplication from the right look like, it becomes clear why you have to conjugate and why angle doubling happens. If that 30-minute video was a big inhale, this project will be a big exhale.

There will also be an interactive tool about this with sliders constrained so that the sum of squares of the sliders is one, and then you can see what the effect of multiplication will be on the stereographic projection. Whatever the project was, this will make it twice as good and allow people to play around and develop their own intuition, maybe with a set of challenges for viewers. This will be new and show a new interaction for the viewers.

JJV: What else do you want our readers to know?

GS: Putting lessons online is not that hard, and there are good reasons for their students. And your visuals don't need to be that in depth. There is good pedagogy in going at the speed of speech and not writing scripts ahead. It's definitely cheaper to make in terms of time.

And if you want to put visuals to things, it's not that hard to do—using Geogebra, Desmos and so on and you can probably whip it up in less time than you would have thought and there's great value! ■



if the fourth point is in the spherical triangle on the opposite side as the first three.

Departments

TOOLKIT

Preparing Students for the GRE Math Subject Test

— MOHAMED OMAR AND IVAN B. VENTURA

“How should I prepare for the GRE Math Subject Test?”

This is a common question asked by students embarking on the math graduate school application process. A common part of one’s graduate school application portfolio, the GRE Math Subject Test is a notorious standardized test that covers fundamentals from courses throughout undergraduate mathematics. Despite being an integral part of a student’s graduate school application, there aren’t many relevant resources for preparing for this exam. Only a handful of practice exams are available, many of them outdated and not representative of the recent steep increase in difficulty. GRE practice books help with mathematical content review, but do not develop strategies for tackling the seemingly esoteric style of problems that appear on the test. So, what can students do? In this article, we suggest strategies for helping students prepare that are specific to this test.

Creating Content Flow Charts

A typical strategy professors suggest for preparing for the subject test is reviewing specific subject areas and working on practice problems in those areas. One of the potential issues with this approach is that problems on the GRE Math Subject test tend to require recall of many different aspects of a subject instead of focusing on an isolated topic. An example of this phenomenon can be seen in the following sample problem we created for students at Harvey Mudd College and Cal Poly Pomona:

- 1) If $f: \mathbb{R} \rightarrow \mathbb{R}$ is defined by $f(x) = x \cdot |x|$ then which of the following must be true:
 - a) f is continuous on all of \mathbb{R}
 - b) f is differentiable at $x = 0$
 - c) f is odd

Approaching this problem requires quick recall of many different concepts in single variable calculus. One way to practice this is for students to make content flow charts. This involves placing definitions, theorems, and implications related to specific concepts from a particular subject area all on one large poster. For instance, if a student is studying for single variable calculus, she might create small bubble

boxes with the definitions for continuity, differentiability, and integrability. Then, she can draw arrows between bubble boxes to indicate conditions that imply others, and why these implications exist. For instance, an arrow can be placed from differentiability to continuity, with the key idea of the proof above the arrow. Furthermore, having counterexamples and general properties that illustrate the absence of an implication are beneficial as well. For instance, a student can give an example of a particular function such as $f(x) = |x|$ to illustrate continuity doesn’t imply differentiability, and can additionally list general properties of continuous functions that do not guarantee they are differentiable. Content flow charts allow students to see a general subject area from a bird’s eye view and connect related concepts.

Prepare for the Test Itself

As mathematicians and educators it is our natural tendency to want to teach the inner workings of a subject area, and spend time motivating the concepts at hand. However, the goal with the GRE Math Subject Test is to answer problems as quickly and accurately as possible, rather than lament over the depth of a certain topic. This is one of the biggest struggles we faced while helping students at our respective institutions prepare for the test, but one we had to quickly overcome. To see an example of how this comes about, consider the following problem:

- 2) Suppose x and y are integers, and $8x - 5y$ is divisible by 7. Which of the following must also be divisible by 7?
 - a) $-6x + 2y$
 - b) $-6x + 3y$
 - c) $-5x + 2y$
 - d) $-5x + 3y$
 - e) $-5x - 2y$

As mathematicians, our natural tendency is to explain phenomena captured by divisibility, find the correct answer, and give full justification as to why our answer choice is correct. However, it can be much quicker, as in this problem, to focus on strategies beneficial to completing the test quickly and accurately. In this problem for instance, it is quick to think of specifics instead of generality: pick a nontrivial pair (x, y) of integers, say for example $x = 3, y = 2$, for which $8x - 5y$ is divisible by 7. Then, check which of the given answers also satisfies these properties.

Another example of how our math teaching tendencies can be a detriment on this test is captured in the following problem:

- 3) If f is a twice differentiable real-valued function then

$$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x-h)}{h}$$

is

- a) $f'(x)$
- b) $2f'(x)$
- c) $\frac{1}{2}f'(x)$
- d) $f''(x)$
- e) $2f''(x)$

Experience might allow one to see this as the sum of a left derivative and right derivative, but this might be far from obvious for a student. Instead, a beneficial strategy for this problem which is particularly useful for many problems on the GRE subject test is to pick a good example. In this problem, it is strategic to pick a function $f(x)$ for which the five responses are all different, and apply the expression in question to that function. For instance, the value of the expressions in answer choices a) through e) are all different if applied to the function $f(x) = x^2$. The limit in question when applied to this function is $4x = 2f'(x)$, so answer choice b) must be the correct choice.

Emphasize Common Questions

There are certain classes of questions that appear quite often on the GRE math subject test. Emphasizing the mechanics of these problems will not only give students a few problems they can quickly answer, but will boost their confidence when taking the exam. Common problems include:

- Computing multiple partial derivatives of a multivariable function by switching the order in which the partials are taken. A prototypical such problem is to determine

$$\frac{\partial}{\partial y} \frac{\partial}{\partial x} \left(e^{x+y} + \sin(x) \sqrt{e^{2x} + 1} \right)$$

where it is much more advantageous to take the partial with respect to y first to completely eliminate the complicated summand dependent only on x .

- Applications of Green's Theorem to finding an integral over a closed curve. Such problems on the test typically test the basics of the theorem and can be performed quickly especially if one practices. A prototypical question of this type is:

$$\text{Determine } \oint_C 4y dx + 3x dy$$

where C is the circle of radius 2 centered at the origin, oriented counterclockwise. Students who practice this particular type of computation several times will quickly recognize to apply Green's Theorem and arrive at -4π by recognizing the integral as -1 times the area of a circle of radius 2.

- Using properties of the Normal distribution to estimate probabilities. More notably, using the normal distribution to approximate the binomial distribution in problems involving many coin flips. For instance, suppose a problem asks to approximate the probability of getting between 40 and 60 heads (inclusive) when flipping a fair coin 100 times. This problem is equivalent to determining the probability of a binomial random variable with parameters $n = 100$ and $p = 0.5$ having probability between 40 and 60. The standard deviation of this random variable is $\sqrt{np(1-p)}$ which in this case is 5. Approximating this random variable by a normal random variable, one can

recognize that the probability of getting between 40 and 60 heads (inclusive) when flipping 100 fair coins is roughly the same as the probability of a normal random variable lying within two standard deviations of its mean, which is approximately 0.95.

At first glance this might seem like an overly technical computation for one of 66 problems on a 3-hour multiple choice test, but many problems about this concept follow nearly identical computations.

- Computing a complex integral using residue calculus. Even if students have not taken a course in complex analysis, the overwhelming majority of problems on the GRE math subject test related to complex analysis follow the same mechanical processes, so students can learn how to perform such specialized computations.

Creating Study Opportunities

One of the common issues students run into when taking the GRE math subject test is an overwhelming feel of being underprepared. It is typical for students to think about this exam a few weeks before they need to take it, pick up a run-of-the-mill study guide, whimsically practice, and then take the test not realizing what just hit them! One way to help students avoid this is by creating a culture of studying for the test. In the past few years at both Harvey Mudd College and Cal Poly Pomona, we created a study group that met weekly for a few hours. During these meetings we shared a meal and discussed questions stemming from a practice exam. Creating this culture allowed students to feel accountable to each other, lean on each other for assistance, and (most importantly) got students actively studying for the exam well before the exam took place.

Study opportunities can also happen organically well before a student takes the exam. The GRE math subject test rewards students who have repeated exposure to material in the undergraduate curriculum. Along these lines, we have noticed that students who have had multiple experiences as graders or teaching assistants for courses are much more prepared for the exam than others. If a student expresses interest in graduate programs early in her college experience, or if you notice a student who seems particularly interested in pursuing mathematics, encourage her to grade or TA for a course.

We hope you (and your students) find these tips beneficial and help you create more opportunities for graduate work among your students. ■

Dr. Mohamed Omar is an associate professor of mathematics at Harvey Mudd College. See more of him at mohamedomar.org. Dr. Ivan Ventura is an assistant professor at Cal Poly Pomona.

GET MORE

Check out Dr. Omar's videos on various GRE topics at youtube.com/MohamedOmarMath.

Departments

MEET A MEMBER

Eileen Faulkenberry

What is your current job and how long have you been there?

I am a professor of mathematics at Tarleton State University, in Stephenville, TX. This is my sixth year at Tarleton, and my 16th year in the Texas A&M University System.

How long have you been an MAA member, and why did you initially join?

I feel like I grew up in the OK-AR section of the MAA, since my father has been a member for as long as I can remember. I went to my first MAA section meeting in 1997, just prior to beginning graduate school at Oklahoma State University. As a graduate student, I organized groups of graduate students to attend the section meeting every year, alternating between Oklahoma and Arkansas. In fact, I met my husband at an OK-AR section meeting! After graduation, we moved to Texas as I became an assistant professor and we transitioned to the Texas section in 2003.



What has kept you an MAA member since then?

MAA provides support through Project NExT, which is invaluable to new faculty. I was able to make connections through the section meetings that opened many doors to new experiences, research collaborations, and opportunities for transitions. I realized the value of these connections as a student so it is very important to me to provide the opportunity for my students to attend section meetings. Through support from our university, we are able to bring students to present their research and participate in the Calculus Bowl every year. These experiences provide a foundation for their futures as mathematicians.

Describe the MAA in four words.

Long-lasting
Impactful
Nurturing
Collaborative

What would you like to see from MAA in its second century?

As a mathematics educator, I would like to see MAA continue to collaborate with mathematics education organizations like NCTM to support high-quality research in mathematics education. MAA has a broad perspective that provides services and opportunities for those ranging from undergraduates through seasoned professors. ■

Found Math



twitter.com/BurnsideMath/status/1011041673424580615

— Submitted by Jeremy F. Alm

Invited Addresses



MAA Invited Address

**A Mathematical Journey of Culture,
Community, and Collaboration**

Pamela Harris, *Williams College*



MAA Invited Address

**The Past 50 Years of African Americans
in the Mathematical Sciences**

Edray Goins, *Pomona College*



MAA Invited Address

Symmetry, Almost

Amanda Folsom, *Amherst College*



MAA Invited Address

**Sailing Through Data:
Discoveries and Mirages**

Emmanuel Candes, *Stanford University*



AMS-MAA Invited Address

Miracles of Algebraic Graph Theory

Daniel Spielman, *Yale University*



AMS-MAA Invited Address

What is the Shape of a Rational Map?

Sarah Koch, *University of Michigan*

Departments

PRESIDENT'S MESSAGE

Take-aways from MathFest

—DEANNA HAUNSPERGER

MAA MathFest 2018 in Denver was a whirlwind of activity. The venue allowed for quick access between the invited lectures, the paper sessions, the contributed poster session, the exhibit hall—all the events at the conference. It was possible to slip out at the end of an invited lecture, drop by the MAA Pavilion to see mathematical busking (mathematical street performance) by Tim and Tanya Chartier, check out some MAA Press titles at the AMS booth, and scoot down the hallway to see some new ideas about creating a more inclusive mathematics major. MAA MathFest was a great opportunity to hear our Hedrick Lecturer Gigliola Staffilani talk about her research, exchange teaching ideas with colleagues from across the country, and grab lunch with old friends.

I did all of these things and so much more! What were my take-away lessons from the meeting? Let me tell you six of them.

- Laura Taalman reminded us all that it's okay to fail. With a photo of her wastebasket half-full of plastic creations gone badly



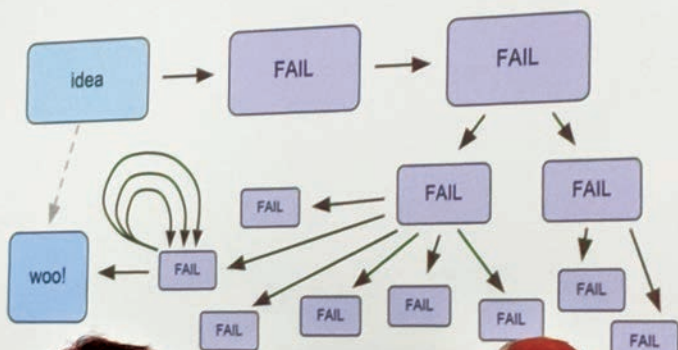
awry—failed attempts at creating a three-dimensional model on her 3-D printer—and a flow chart that showed us a realistic process of the many missteps involved in mathematical discovery, she pointed out to her audience, which was well-stocked with undergraduates, that failure is a natural part of investigation, and we should not get discouraged.

- Pam Gorkin showed us an old Martin Gardner trick: starting with a circle and any point P within that circle, it's easy to line a point on the edge of the circle up with P , and crease the paper there. The collection of these creases outlines an ellipse within the original circle! And I learned that the Blaschke ellipse of functional analysis is the same as the Poncelet ellipse of projective geometry, a result from her new Carus

monograph (with Daepf, Shaffer, and Voss), *Finding Ellipses*.

- Della Dumbaugh shared with us an idea she's using in her calculus classes. She identifies for her students which life lessons they are learning alongside the mathematical content in her courses. For instance, she explains that breaking a problem into simpler pieces (as we do in calculus) is a good approach to most large problems we are faced with in life. This has the potential to make mathematical ideas feel more relevant to the students, and has garnered her appreciative responses years later from students who remember those lessons.
- Eugenia Cheng taught us her new way to think about traits and be-

3D Design Process = Math Research Process



Above: Axel Brandt (a member of Tim Chartier's math busking team) performs with help from the audience.

Left: Taalman's process chart—failure is an option.

Right: Laura Taalman talks about failing.





Left: Gigliola Staffilani giving the Hedrick Lecture.

Right: Eugenia Cheng giving her talk.

Below: Jo Boaler presenting the results of her study.



haviors of mathematicians. Instead of using gender to discuss learning styles and research traits, she coined two new terms: “ingressive” and “congressive.” Ingressive people push forward to make progress, often in a solitary way, while concessive people build community and work with others to make advances. She used these two terms to talk about ways mathematicians can make our community more inclusive.

- Jo Boaler reported on a study she has performed regarding the Consortium for Mathematics and its Applications (COMAP)’s Mathematical Contest in Modeling. Her Stanford team tried to understand

the properties of the MCM that are related to its phenomenal success with female students: 43% of the participants are women, and 43% of the top-scoring team members are women. The MAA’s American Mathematics Competitions and Putnam Competition would do well to learn what they can from the success of the MCM to include women. Boaler’s results seem to show that having the competition be a true team competition, using the skills and talents of all members of the team, as well as decreasing the focus on speed and the dependence on terminology are all factors.

- On the final day of the conference, Steve Kennedy, Doug Ensley, and I ran a workshop for undergraduate women who were already attending MAA MathFest. This was a pilot program to catch these women at a critical time during their education and offer them the answers to some of the questions they may be asking: What’s graduate school like? What careers in industry are available to someone with a degree in mathematics? How can I combine being a mathematician and raising a family? The workshop, attended by 33 undergraduate women, was a success, and we are planning ways that we can expand it for future MAA

MathFests. Even these superstar undergraduate women have questions about their future in mathematics.

I’d like to thank retiring Associate Secretary Gerard Venema, Director of Meetings Anne Agniel and her team, and all the wonderful folks who serve on committees charged with planning the meeting. With 1629 mathematicians in attendance, MAA MathFest had spectacular programming, both mathematically and socially. My one specific favorite moment of MAA MathFest 2018 was definitely at the President’s Membership Jubilee when we were honoring the folks attending MAA MathFest who had been members of the MAA for 50 years. I was tickled when seven of them joined me up on stage to receive their 50-year pins. There, standing before me, was the embodiment of 350 years of loyalty and service to the MAA; they were happy (and a little sassy) and enjoying the moment as much as I was. They are a reminder to us all that the MAA is built on a strong foundation; it was an honor to share the stage with them. ■

Deanna Haunsperger is MAA president and professor of mathematics at Carleton College (email: dhaunspe@carleton.edu).





MAA Minicourses

You must be registered for JMM to attend a minicourse. Each course is \$100. The deadline for registering for a course is December 27. Abstracts for the minicourses can be found at bit.ly/20fKqym.

Minicourse #1

Mathematical Inquiry and Writing through Sports

Part A: Wednesday, 9:00–11:00 AM, Holiday Ballroom 1

Part B: Friday, 9:00–11:00 AM, Holiday Ballroom 1

Presenters:

Tricia Muldoon Brown, Georgia Southern University
Eric Kahn, Bloomsburg University

Minicourse #2:

Start Teaching Statistics using R and RStudio

Part A: Wednesday, 9:00–11:00 AM, Holiday Ballroom 2

Part B: Thursday, 9:00–11:00 AM, Holiday Ballroom 2

Presenters:

Randall Pruim, Calvin College
Shonda Kuiper, Grinnell College

Sponsor: SIGMAA Stat Ed

Minicourse #3:

Advanced Authoring in WeBWork: Turn good math problems into great ones & submit them to the OpenProblemLibrary

Part A: Wednesday, 2:15–4:15 PM, Holiday Ballroom 1

Part B: Friday, 1:00–3:00 PM, Holiday Ballroom 1

Presenters:

Michael E. Gage, University of Rochester
Marianna Bonanome, NYC College of Technology
Samar ElHitti, NYC College of Technology
K. Andrew Parker, NYC College of Technology

Sponsor: MAA Committee on Technology in Mathematics Education

Minicourse #4:

Teaching an Undergraduate Computational Science Course

Part A: Wednesday, 2:15–4:15 PM, Holiday Ballroom 2

Part B: Friday, 1:00–3:00 PM, Holiday Ballroom 2

Presenters:

Joseph Eichholz, Rose-Hulman Institute of Technology
Allen Holder, Rose-Hulman Institute of Technology

Minicourse #5:

Introduction to Inquiry-Based Learning

Part A: Thursday, 9:00–11:00 AM, Holiday Ballroom 1

Part B: Saturday, 9:00–11:00 AM, Holiday Ballroom 1

Presenters:

Victor Piercey, Ferris State University
Brian Katz, Augustana College
Susan Crook, Loras University
Candice Price, University of San Diego
Xiao Xiao, Utica College
Eric Kahn, Bloomsburg University

Sponsor: SIGMAA IBL

Minicourse #6:

Visualizing Multivariable Calculus & Differential Equations using CalcPlot3D

Part A: Friday, 9:00–11:00 AM, Holiday Ballroom 2

Part B: Saturday, 9:00–11:00 AM, Holiday Ballroom 2

Presenters:

Paul E. Seeburger, Monroe Community College
Monica VanDieren, Robert Morris University

Sponsor: WebSIGMAA

Minicourse #7:

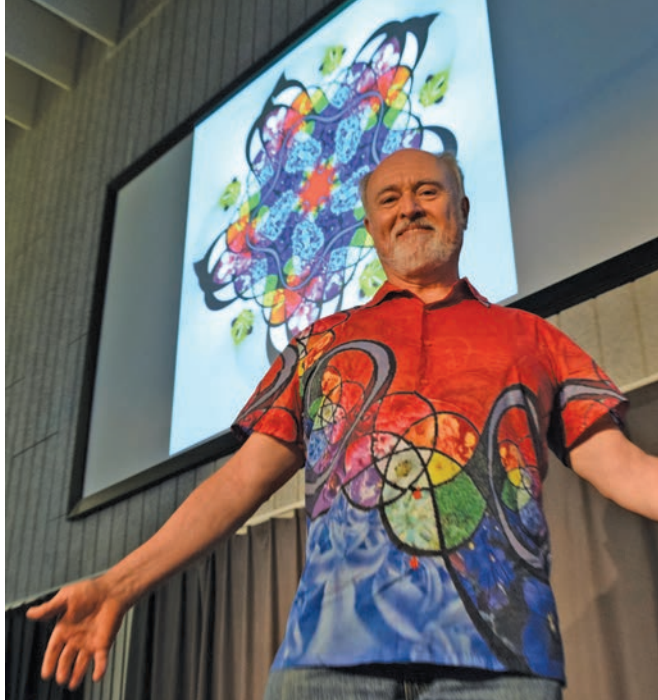
Using Data Applications to Inspire Linear Algebra Topics in the Classroom

Part A: Wednesday, 9:00–11:00 AM, Holiday Ballroom 3

Part B: Friday, 9:00–11:00 AM, Holiday Ballroom 3

An ellipsograph from the Smithsonian Learning Lab.





This photo was taken at the First Annual Fashion Show at Bridges in Stockholm. Frank Farris designed the shirt from a mandala like the one below. Photo by Sujan Shrestha.



Presenters:

Marie A. Snipes, Kenyon College
 Heather A. Moon, Lewis-Clark State College
 Tom Asaki, Washington State University
 Amanda Harsy, Lewis University

Minicourse #8:

Dance and Mathematics

Part A: Thursday, 9:00–11:00 AM, Holiday Ballroom 3
Part B: Saturday, 9:00–11:00 AM, Holiday Ballroom 3

Presenter:

Karl Schaffer, De Anza College

Minicourse #9:

Mathematical Art from Complex Analysis

Part A: Wednesday, 2:15–4:15 PM, Holiday Ballroom 3
Part B: Thursday, 1:00–3:00 PM, Holiday Ballroom 3

Presenters:

Frank Farris, Santa Clara University

Minicourse #10:

Object Based Learning and the Smithsonian Learning Lab

Part A: Thursday, 1:00–3:00 PM, Holiday Ballroom 1
Part B: Saturday, 1:00–3:00 PM, Holiday Ballroom 1

Presenters:

Amy Shell-Gellasch, Eastern Michigan University

Minicourse #11:

How to Run Successful Math Circles for Students and Teachers

Part A: Thursday, 1:00–3:00 PM, Holiday Ballroom 2
Part B: Saturday, 1:00–3:00 PM, Holiday Ballroom 2

Presenters:

Jane H. Long, Stephen F. Austin State University
 Gabriella Pinter, University of Wisconsin Milwaukee
 Diana White, University of Colorado Denver and National Association of Math Circles

Sponsor: SIGMAA on Math Circles for Students and Teachers (SIGMAA-MCST)

Minicourse #12:

Keep Teaching Statistics using R and RStudio

Part A: Friday, 1:00–3:00 PM, Holiday Ballroom 3
Part B: Saturday, 1:00–3:00 PM, Holiday Ballroom 3

Presenters:

Shonda Kuiper, Grinnell College
 Randall Pruim, Calvin College

Sponsor: SIGMAA Stat Ed

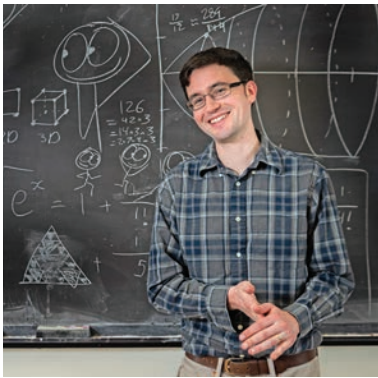
Karl Schaffer teaching dance and mathematics.



Lectures

MAA Project NEXt Lecture on Teaching and Learning Reflections on Teaching Calculus for the First Time

David Bressoud, *Macalester College*



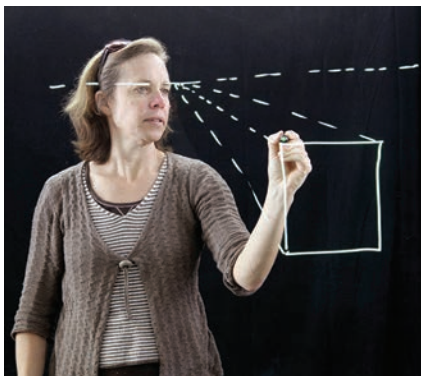
MAA Lecture for Students & Teachers Tic-Tac-Toe (or, What is Mathematics?)

Ben Orlin, *Math with Bad Drawings*

MAA Retiring Presidential Address

The Inclusion Principle: The Importance of Community in Mathematics

Deanna Haunsperger, *Carlton College*



MAA Lecture for Students Drawing Conclusions From Drawing A Square

Annalisa Crannell, *Franklin & Marshall College*

MAA-AMS-SIAM Gerald and Judith Porter Public Lecture

Big Data, Inequality, and Democracy

Cathy O'Neil, *CEO of ORCAA*



Departments

MAA BOOKS BEAT

Nuggets of Number Theory

—STEPHEN KENNEDY

Here, in quiz form, is a quick stroll through an elementary number theory course. What theorem does each Figure prove?

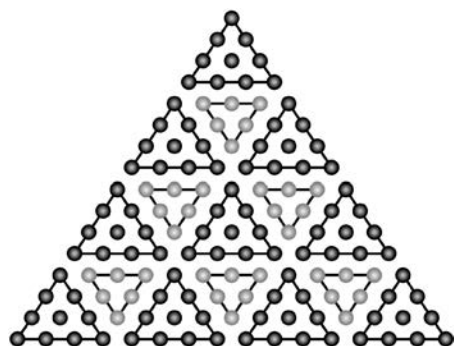
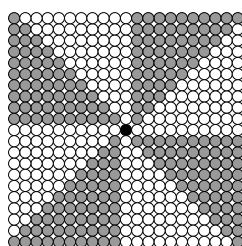


Figure A



$$(2n+1)^2 = 8T_n + 1$$

Figure B

		mod 5				
		0	1	2	3	4
mod 3	0	0	6		3	
	1		1	7		4
	2	5		2	8	

Figure C

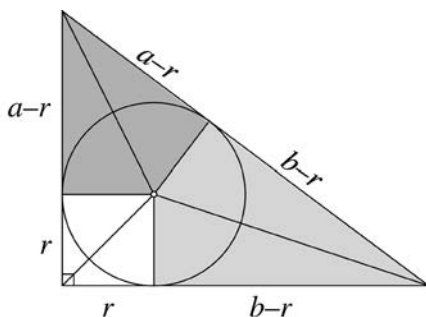


Figure D

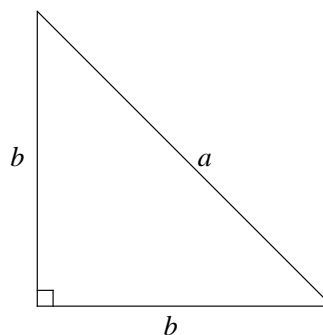
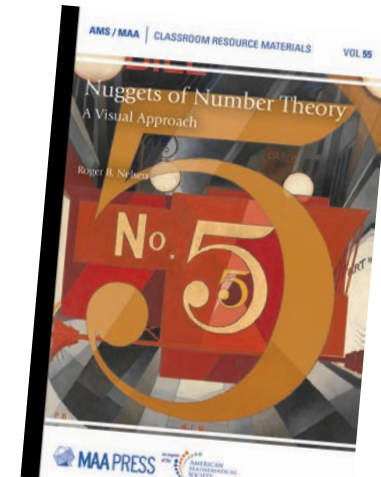
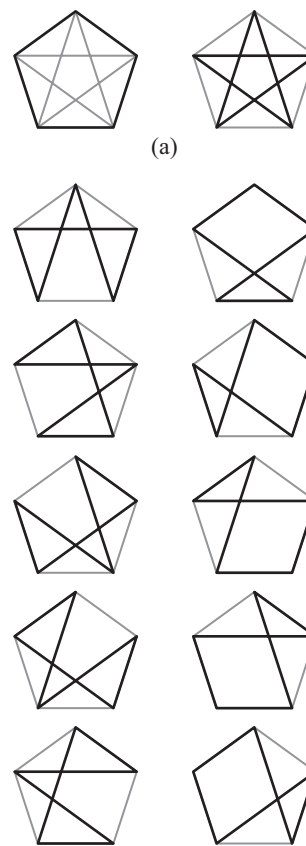


Figure E



Nuggets of Number Theory: A Visual Approach
Classroom Resource Materials
Roger B. Nelsen



(b)

Figure E

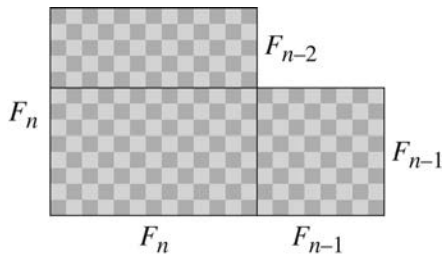


Figure G

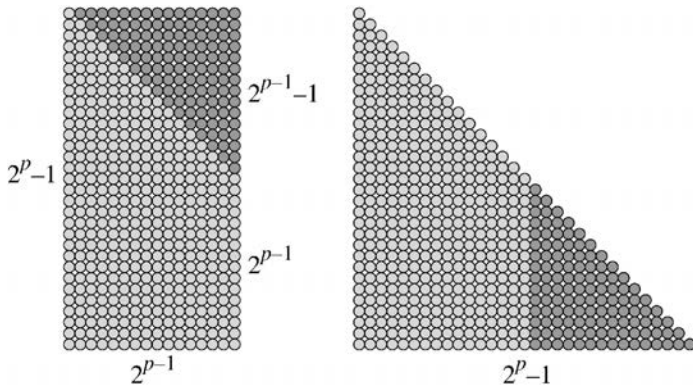


Figure H

Johann Bernoulli said of Newton's anonymous solution to the brachistochrone problem, "I recognize the lion by his claw." MAA members might say something similar about Roger Nelsen. If there exists a single, simple image that can capture the essence of the proof of a mathematical result, you can be sure that Nelsen will find it and show it to us. *Nuggets of Number Theory* collects hundreds of such leonine images that illustrate and illuminate essentially every topic in a first course in number theory. Well, OK, quadratic reciprocity is missing. I mean that remark as a public, Bernoulli-style challenge to Professor Nelsen and expect his response by Christmas.

If you're a visual thinker or if you're addicted to that beautiful Aha! feeling that a slick visual proof can deliver, you'll love this book. If you happen to be teaching number theory this semester (or sometime in the future), you'll want this book to enliven and enrich your arsenal of examples and problems. The quiz is a selection of some representative *Nuggets* from the book. The next paragraph contains the answers to the visual quiz—I encourage you not to read it!

Figure A: The sum of the squares of consecutive triangular numbers is the triangular number on the square of the first ($T_k^2 + T_{k+1}^2 = T_{k^2}$). Figure B: Every odd square is congruent to one modulo eight ($(2n+1)^2 = 8 * T_n + 1$). This fact immediately yields a proof of the existence of infinitely many square triangular numbers. As a hint, consider the triangular number T_{8T_n} , it is a square if T_n is square. Start with $T_n = 1$ (a square!) and iterate. Figure C: That's the Chinese Remainder Theorem for the case $x \equiv 2 \pmod{3}$, $x \equiv 3 \pmod{5}$. Figure D: The radius of the incircle of an integer-sided right triangle is

an integer. Figure E: This is the $p=5$ case of Wilson's Theorem. Can you reconstruct the proof from the picture? Hint: If you eliminate the symmetric ones (part (a) of the Figure), then the remaining pentagons (part (b)) fall into rotation classes. Hence their number must be divisible by five. Figure F: The $\sqrt{2}$ is irrational. Figure G: Cassini's identity for the Fibonacci follows from: $F_{n+1}F_{n-1} + F_nF_{n-2} = F_n^2 + F_{n-1}^2$. As an easy corollary, $\gcd(F_n, F_{n+1})=1$, for all n . Figure H: An even perfect number is triangular. ■

Stephen Kennedy (Carleton College) manages acquisitions for MAA Press. Contact him if you're interested in writing a book for MAA Press: kennedy@maa.org.

Mathematical Sciences Research Institute Berkeley, CA

MSRI invites applications for Research Members and Postdoctoral Fellows in the following programs: Holomorphic Differentials in Mathematics and Physics (August 12 – December 13, 2019), Microlocal Analysis (August 12 – December 13, 2019), Quantum Symmetries (January 21 – May 29, 2020) and Higher Categories and Categorification (January 21 – May 29, 2020). Research Memberships are intended for researchers who will be making contributions to a program and who will be in residence for one or more months. Postdoctoral Fellowships are intended for recent PhDs.

MSRI uses MathJobs to process applications. Interested candidates must apply online beginning August 1, 2018. To receive full consideration, applications must be complete, including all letters of support, by December 1, 2018. Application information can be found at www.msri.org/application.

It is the policy of MSRI actively to seek to achieve diversity in its programs and workshops. Thus, a strong effort is made to remove barriers that hinder equal opportunity, particularly for those groups that have been historically underrepresented in the mathematical sciences.

MSRI has been supported from its origins by the National Science Foundation, now joined by the National Security Agency, over 100 Academic Sponsor departments, by a range of private foundations, and by generous and farsighted individuals.

Departments

TOOLKIT

Faculty Writing Groups for Mathematicians

—Joseph Anderson, Jathan Austin, Yaping Jing, Lisa Schneider, Ryan Shifler, and Sarah Wesolowski

It's common for junior faculty members to struggle with balancing research and teaching. Particularly at a teaching-centric institution, finding enough research time to produce publishable work can be difficult. An idea that is strongly advocated in the humanities is forming a faculty writing group: a support group to help faculty stay motivated and support each other's continued research. We sought out ideas from others in designing our group (particularly the advice in *Write No Matter What* by Joli Jensen) and decided to investigate if it might work for the junior mathematics faculty at our university. Instead of rehashing ideas proposed by others, we'd like to share a few reflections on our group that may encourage junior faculty to begin their own.

What's the point of a writing group?

Our writing group has been a forum for discussing not only the writing process, but also for supporting each other's efforts in other scholarly activities. During our weekly meetings, we discuss writing research articles and grant proposals, and directing undergraduate research projects—any part of the professional development or research process is a valid topic of discussion. The group helps members stay accountable to themselves, but in a low-stress, informal atmosphere.

Why do I need to join/start a writing group?

All of our group members also collaborate with faculty at other institutions: through research groups, or via connections made at MAA section meetings or through Project NExT. However, we found that having a group at our home university helps us stay on track with our scholarship goals better than long-distance collaborations alone.

Moreover, the group has helped us get to know each other. Our department (mathematics and computer science) is one of the largest on our campus, with more than 30 faculty. One of the senior faculty often remarks that it feels as though we see more of each other at national conferences than we do during the semester. Our group fosters departmental camaraderie that might not happen otherwise and helps us stay up-to-date with our colleagues.



Left to right: Lisa Schneider, Joseph Anderson, Ryan Shifler, Sarah Wesolowski, Jathan Austin, and Yaping Jing

Can a writing group be interdisciplinary?

Research groups at R1 universities often have a common content focus, but at small institutions like ours, it is often difficult to find someone who has the same area of expertise. This could be a deterrent for junior faculty, particularly in the sciences, to seek out others to talk about their writing. Although our group members are in the same department, our research interests include algebra, computer science, physics, and mathematics education. In focusing on the writing process—rather than specific content—we have been able to support each other's research, hold each other accountable, and stay motivated.

What should be the focus of the group?

The writing process has been our main focus, but we found that our group discussions have also led to opportunities for cross-disciplinary collaborations. We try not to spend time on content discussions during our weekly meetings, but our discussions have nevertheless generated interest in collaboration that would not have otherwise occurred. If you have motivated and interested undergraduates, this can also be a great place to find approachable problems to combine different topics relevant to their interests.

How do I get started?

Our advice is to find some faculty who might appreciate a regularly-scheduled sounding board. Meet weekly. Record everyone's weekly goals and, at the next meeting, repeat. Be sure to include what you accomplished, what you didn't, and what you're going to do about it! ■

Joseph Anderson, Jathan Austin, Yaping Jing, Lisa Schneider, Ryan Shifler, and Sarah Wesolowski teach a wide range of mathematics and computer sciences courses at Salisbury University in Maryland. All of them are in the early stages of their academic careers.

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2019 Joint Mathematics Meetings Advance Registration/Housing Form



Name _____
(please print your name as you would like it to appear on your badge)

Mailing Address _____

Telephone _____ Fax: _____

In case you have an emergency at the meeting: Day #: _____ Evening #: _____

Email Address _____ Additional email address for receipt _____

Acknowledgment of this registration and any hotel reservations will be sent to the email address(es) given here. **Check this box to receive a copy in U.S. Mail:**

Affiliation for badge _____ (company/university) Nonmathematician guest badge name: _____ (Note fee of US\$ 22)

PLEASE NOTE THAT BADGES WILL NOT BE MAILED IN ADVANCE FOR THIS MEETING. YOU MAY OPT TO HAVE YOUR PROGRAM MAILED ON DEC. 12 (SEE BELOW)

Registration Fees

Membership please all that apply. First row is eligible to register as a member.
For undergraduate students, membership in PME and KME also applies.
 AMS & MAA AMS but not MAA MAA but not AMS ASL CMS SIAM
Undergraduate Students Only: PME KME
Other Societies: AWM NAM YMN AMATYC

Joint Meetings	by Dec 27	at mtg	Subtotal
<input type="checkbox"/> Member AMS, MAA, ASL, CMS, or SIAM	US\$ 345	US\$ 455	
<input type="checkbox"/> Nonmember	US\$ 548	US\$ 699	
<input type="checkbox"/> Graduate Student Member (AMS, MAA, ASL, CMS, or SIAM)	US\$ 78	US\$ 90	
<input type="checkbox"/> Graduate Student (Nonmember)	US\$ 124	US\$ 137	
<input type="checkbox"/> Undergraduate Student (Member AMS, ASL, CMS, MAA, PME, KME, or SIAM)	US\$ 78	US\$ 90	
<input type="checkbox"/> Undergraduate Student (Nonmember)	US\$ 124	US\$ 137	
<input type="checkbox"/> High School Student	US\$ 7	US\$ 15	
<input type="checkbox"/> Unemployed	US\$ 78	US\$ 90	
<input type="checkbox"/> Temporarily Employed	US\$ 281	US\$ 322	
<input type="checkbox"/> Developing Countries Special Rate	US\$ 78	US\$ 90	
<input type="checkbox"/> Emeritus Member of AMS or MAA	US\$ 78	US\$ 90	
<input type="checkbox"/> High School Teacher	US\$ 78	US\$ 90	
<input type="checkbox"/> Librarian	US\$ 78	US\$ 90	
<input type="checkbox"/> Press	US\$ 0	US\$ 0	
<input type="checkbox"/> Exhibitor (Commercial)	US\$ 0	US\$ 0	
<input type="checkbox"/> Artist Exhibitor (work in JMM Art Exhibit)	US\$ 0	US\$ 0	
<input type="checkbox"/> Nonmathematician Guest of registered mathematician	US\$ 22	US\$ 22	

AMS Short Course: *Sum of Squares (1/16-1/19)*

<input type="checkbox"/> Member of AMS	US\$ 124	US\$ 158
<input type="checkbox"/> Nonmember	US\$ 190	US\$ 225
<input type="checkbox"/> Student, Unemployed, Emeritus	US\$ 72	US\$ 93

MAA Minicourses (see listing in text)
I would like to attend: One Minicourse Two Minicourses
Please enroll me in MAA Minicourse(s) # _____ and # _____
Price: US\$ 100 for each minicourse.
(For more than 2 minicourses, call or email the MMSB.) \$ _____

Graduate School Fair Table

<input type="checkbox"/> Graduate Program Table	US\$ 125	US\$ 125
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(includes table, posterboard & electricity)
Dept. or Program to be represented (write below or email) _____ \$ _____

Receptions & Banquets

<input type="checkbox"/> Graduate Student/First-Time Attendee Reception (1/16) (no charge)	
<input type="checkbox"/> NAM Banquet (1/17)	
# _____ Chicken # _____ Salmon # _____ Vegetarian	US\$ 65
# _____ Kosher (Additional fees apply for Kosher Meals.)	US\$ 204
Total for NAM Banquet	\$ _____
<input type="checkbox"/> AMS Social (1/19) Regular Price # _____ US\$ 75	
Student Price # _____ US\$ 35	
Total for AMS Social	\$ _____

Printed Meeting Program (PLEASE CHOOSE)

<input type="checkbox"/> Meeting Program (pick up at mtg only)	US\$ 5
<input type="checkbox"/> Meeting Program mailed (U.S. residents only)	US\$ 10

Registration must be received by Nov. 20 to be eligible for shipping.
 I do not want a printed program.
Total for Meeting Program/Shipping \$ _____

Total for Registrations and Events \$ _____

Payment

Registration & Event Total (total from column on left) \$ _____

Hotel Deposit (only if paying by check) \$ _____
If you send a hotel deposit check, the deadline for this form is December 1.

Total Amount To Be Paid \$ _____

Method of Payment

Check. Make checks payable to the AMS. For all check payments, please keep a copy of this form for your records.

Credit Card. All major credit cards accepted. For your security, we do not accept credit card numbers by email, fax, or postal mail. If the MMSB receives your registration form by any of these methods, it will contact you at the phone number provided on this form.

Signature: _____

Purchase Order # _____ (please enclose copy)


Other Information

Mathematical Reviews primary field of interest # _____

I am willing to serve as a judge for the MAA Undergraduate Student Poster Session.

If you are an undergraduate, are you interested in participating in the Radical Dash, a multi-day scavenger hunt sponsored by the MAA?

For planning purposes for the MAA Two-year College Reception, please check if you are a faculty member at a two-year college.

Please this box if you have a disability requiring special services. 

To respect your privacy and to better serve you, please indicate your preferences for the following:

Please include my name and affiliation on the JMM Participant List.

Please include my name and postal address on promotional mailing lists.

Registration for the Joint Meetings is not required for the short course but it is required for the minicourses and the Employment Center. To register for the Employment Center, go to www.ams.org/profession/employment-services. For questions, email emp-info@ams.org.

Registration Deadlines

To be eligible for the complimentary hotel room lottery:	Oct. 30, 2018
In time to receive programs in the mail:	Nov. 20, 2018
Hotel reservations with check deposit:	Dec. 1, 2018
Hotel reservations, changes/cancellations through the JMM website:	Dec. 13, 2018
Advance registration for the Joint Meetings, short course, minicourses, and dinner tickets:	Dec. 27, 2018
Cancel in time to receive 50% refund on advance registration, banquets, minicourses, and short course	Jan. 8, 2019*

*no refunds issued after this date.

Mailing Address/Contact:

Mathematics Meetings Service Bureau (MMSB)
P. O. Box 6887
Providence, RI 02940-6887 Fax: 401-455-4004; Email: mmsb@ams.org
Telephone: 401-455-4144 or 1-800-321-4267 x4144 or x4137

2019 Joint Mathematics Meetings Hotel Reservations – Baltimore, MD

Please see the hotel information in the announcement or on the web for detailed information on each hotel. To ensure accurate assignments, please rank hotels in order of preference by writing 1, 2, 3, etc. in the column on the left and by circling the requested bed configuration. If your requested hotel and room type is no longer available, you will be assigned a room at the next available comparable rate. Please call the MMSB for details on suite configurations, sizes, availability, etc. All reservations, including suite reservations, must be made through the MMSB to receive the JMM rates. Reservations made directly with the hotels before **December 14, 2018** may be changed to a higher rate. All rates are subject to applicable local and state taxes in effect at the time of check-in; currently 15.5% state tax. **Guarantee requirements: First night deposit by check (add to payment on reverse of form) or a credit card guarantee. Please note that reservations with check deposits must be received by the MMSB by December 1, 2018.** People interested in suites should contact the MMSB directly at mmsb@ams.org or by calling 800-321-4267, ext. 4137; (401-455-4137).

Deposit enclosed (see front of form)
 Hold with my credit card. For your security, we do not accept credit card numbers by email, postal mail or fax. If the MMSB receives your registration form by any of these methods, it will contact you at the phone number provided on the reverse of this form.

Date and Time of Arrival _____ Date and Time of Departure _____ Number of adult guests in room _____ Number of children _____

Name of Other Adult Room Occupant (s) _____ Arrival: _____ Departure: _____

Housing Requests: (example: rollaway cot, crib, nonsmoking room, low floor) _____

- I have disabilities as defined by the ADA that require a sleeping room that is accessible to the physically challenged. My needs are: _____
- I am a member of a hotel frequent-travel club and would like to receive appropriate credit. The hotel chain and card number are: _____
- I am not reserving a room. I am sharing with _____, who is making the reservation.

Order of choice	Hotel	Single	Double 1 bed-2 people	Double 2 beds- 2 people	Triple 3 adults-2 beds	Quad 4 adults-2 beds	Rollaway/Cot Information (add to special requests if reserving online)
	Hilton Baltimore (co-headquarters)	US\$ 179	US\$ 179	US\$ 179	US\$ 199	US \$219	No charge for rollaway cots, available in king-bedded rooms only
	Student Rate	US\$ 149	US\$ 149	US\$ 149	US \$169	US \$189	
	Baltimore Marriott Inner Harbor (co-headquarters)	US\$ 169	US\$ 169	US\$ 169	US \$189	US\$ 209	No charge for rollaway cots, available in king-bedded rooms only
	Student Rate	US\$ 138	US\$ 138	US\$ 138	US \$158	US\$ 178	
	Sheraton Inner Harbor	US\$ 159	US\$ 159	US\$ 159	US\$ 179	US\$ 199	No charge for rollaway cots, available in king-bedded rooms only
	Student Rate	US\$ 145	US\$ 145	US\$ 145	US\$ 165	US\$ 185	
	Renaissance Harborplace Hotel	US\$ 155	US\$ 155	US\$ 155	US\$ 175	US\$ 195	No charge for rollaway cots, available in king-bedded rooms only
	Student Rate	US\$ 138	US\$ 138	US\$ 138	US\$ 158	US\$ 178	
	Hyatt Regency Baltimore	US\$ 150	US\$ 150	US\$ 150	US\$ 175	US\$ 200	Rollaway cots available for US\$ 25 per stay in king-bedded rooms only
	Student Rate	US\$ 140	US\$ 140	US\$ 140	US\$ 165	US\$ 190	
	Royal Sonesta	US\$ 149	US\$ 149	US\$ 149	US\$ 169	US\$ 189	Rollaway cots available for US\$ 30 per night in king-bedded rooms only.
	Student Rate	US\$ 134	US\$ 134	US\$ 134	US\$ 154	US\$ 174	
	Lord Baltimore Hotel	US\$ 139	US\$ 139	US\$ 139	US\$ 159	US\$ 179	Rollaway cots available for US\$ 20 per night in king-bedded rooms only
	Student Rate	US\$ 129	US\$ 129	US\$ 129	US\$ 149	US\$ 169	
	Hotel Monaco	US\$ 135	US\$ 135	US\$ 135	US\$ 155	US\$ 175	Rollaway cots available for US\$ 25 per stay in king-bedded rooms only.
	Student Rate	US\$ 125	US\$ 125	US\$ 125	US\$ 145	US\$ 165	
	Days Inn Baltimore Inner Harbor	US\$ 139	US\$ 139	US\$ 139	N/A	N/A	Rollaway cots available for US\$ 10 per night based on availability
	Student Rate	US\$ 129	US\$ 129	US\$ 129	N/A	N/A	
	Holiday Inn Inner Harbor	US\$ 139	US\$ 139	US\$ 139	US\$ 159	US\$ 179	No charge for rollaway cots, available in king-bedded rooms only
	Student Rate	US\$ 129	US\$ 129	US\$ 129	US\$ 149	US\$ 169	

$$\ell(\beta) = \sum_{i=1}^N y_i \sum_{k=0}^K x_{ik} \beta_k - \log(1 + e^{\sum_{k=0}^K x_{ik} \beta_k})$$

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