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Hispanic Heritage Month
September 15–October 15, 2018

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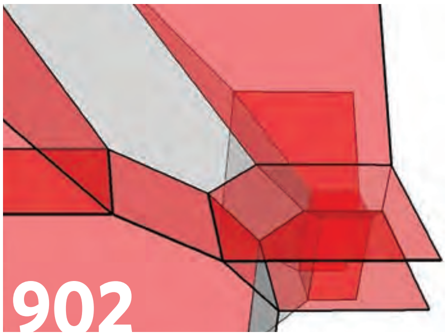

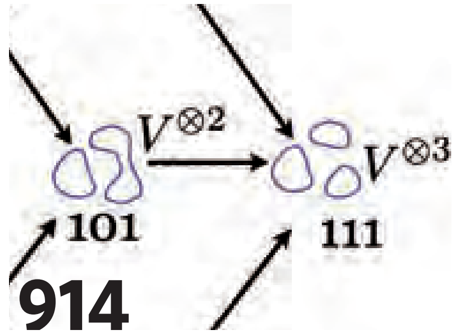

Ricardo Cortez presents our issue for Hispanic Heritage Month (page 901), which begins September 15. Federico Ardila shows how matroid theory has led to the solution of long-standing questions. Joseph Teran explains how movie animations model skin, clothing, and snow-covered ground. In a sampler of her address at the Eastern Sectional at Delaware this month, Elisenda Grigsby describes some invariants for knots and links, with possible application to the slice ribbon conjecture. A report on the difficult effects of hurricane María in Puerto Rico is followed by A Mathematical Moment and accompanying article on protecting against hurricane damage. John W. Dawson Jr. provides a book review, "The Vienna Circle and the Epic Quest for the Foundations of Science." This issue comes with best wishes to all for the coming academic year and your adventures in mathematics.

—***Frank Morgan, Editor-in-Chief***

FROM THE AMS SECRETARY

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ALSO IN THIS ISSUE

Notices
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ALSO IN THIS ISSUE, CONT'D.

GRADUATE STUDENT SECTION

IN EVERY ISSUE

AMERICAN MATHEMATICAL SOCIETY
Advancing research. Creating connections.

A Note from the Executive Director

I am writing to bring your attention to the *Global Survey of Scientists* (statisticalresearch-center.aip.org/cgi-bin/global18.pl) which will be available until October 31, 2018. The goal of this multicultural and multidisciplinary survey is to study social dynamics in the fields of physics, chemistry, astronomy, biology, computer science, mathematics, and the history and philosophy of science and technology by asking a large number of scientists and practitioners about their experiences, challenges, and interests, as well as collecting focused information about women in these fields.

Current data on the participation of women in the mathematical and natural sciences is scattered, outdated, and inconsistent across regions and research fields. The survey is aimed at rectifying this situation by producing sound, current, and consistent data from an expected pool of 45,000 respondents (regardless of gender) in more than 130 countries.

The survey is part of the project, "A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences: How to Measure It, How to Reduce It?" funded by the International Council for Science, with significant participation of the International Mathematical Union. The insights obtained from this survey will help inform interventions for member organizations to increase participation in STEM fields, especially for women.

For further information, please follow the link above and then choose one of the links to take the survey in the language of your choice; this will first bring you to a page with further details and contact information for questions.

Thank you.

Catherine A. Roberts
AMS Executive Director
July 2018

Notices
of the American Mathematical Society

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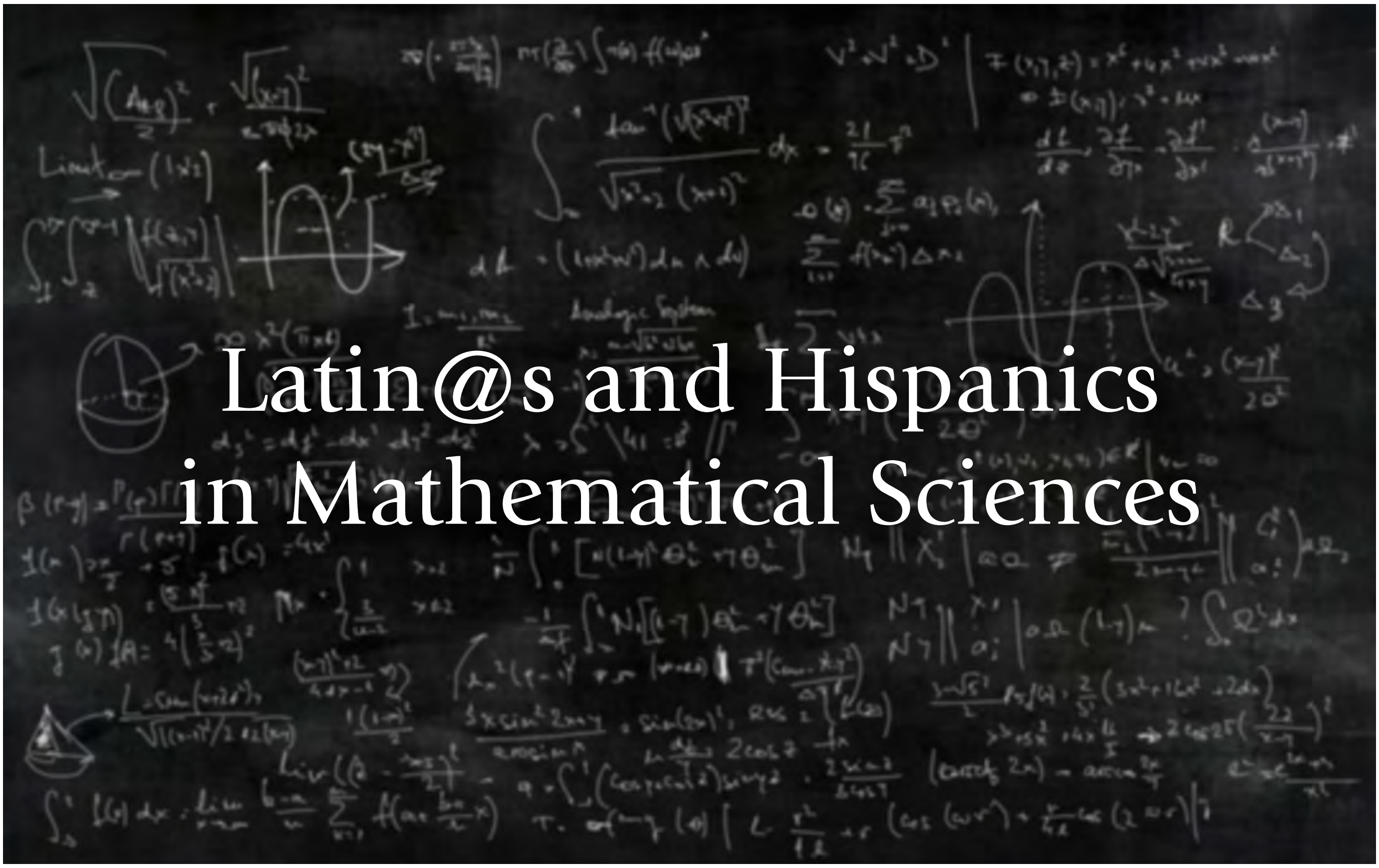

Latin@s and Hispanics in Mathematical Sciences

Ricardo Cortez

Hispanic Heritage Month[1] is a national observance that recognizes the contributions made by an estimated 57 million Latinos and Hispanics in the US and celebrates their heritage and culture. *Notices* has taken this opportunity to highlight selected new mathematical contributions by Latinos and Hispanics. The topics of the articles in this issue include an introduction to algebraic statistics, the geometry of matroids, the use of partial differential equations in movie animation, and collaborative mathematics education. Another article showcases six up-and-coming mathematicians to be featured in `lathisms.org`. While the focus is on mathematics, the issue also includes an article about an undocumented student's path to a successful mathematical career and an article about the challenges faced by Puerto Rican mathematicians in the aftermath of Hurricane Maria.

Readers will notice that there is no delineated section for Latinos in this issue. Instead the articles are interspersed throughout the issue, reflecting my view that work done by groups underrepresented in mathematics should be part of the mainstream. When we talk about underrepresentation in the mathematical sciences, we acknowledge that there is a troubling discrepancy between the 18 percent of the US population that is Latino and the 4 percent of the doctoral degrees in mathematics and statistics earned by Latinos.[2] The Hispanic Heritage Month issue of the *Notices* is a reminder that Latin@s make significant contributions in mathematics and that it takes the entire mathematics community to increase representation.

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[1]*September 15–October 15,* `https://www.hispanicheritagemonth.org`

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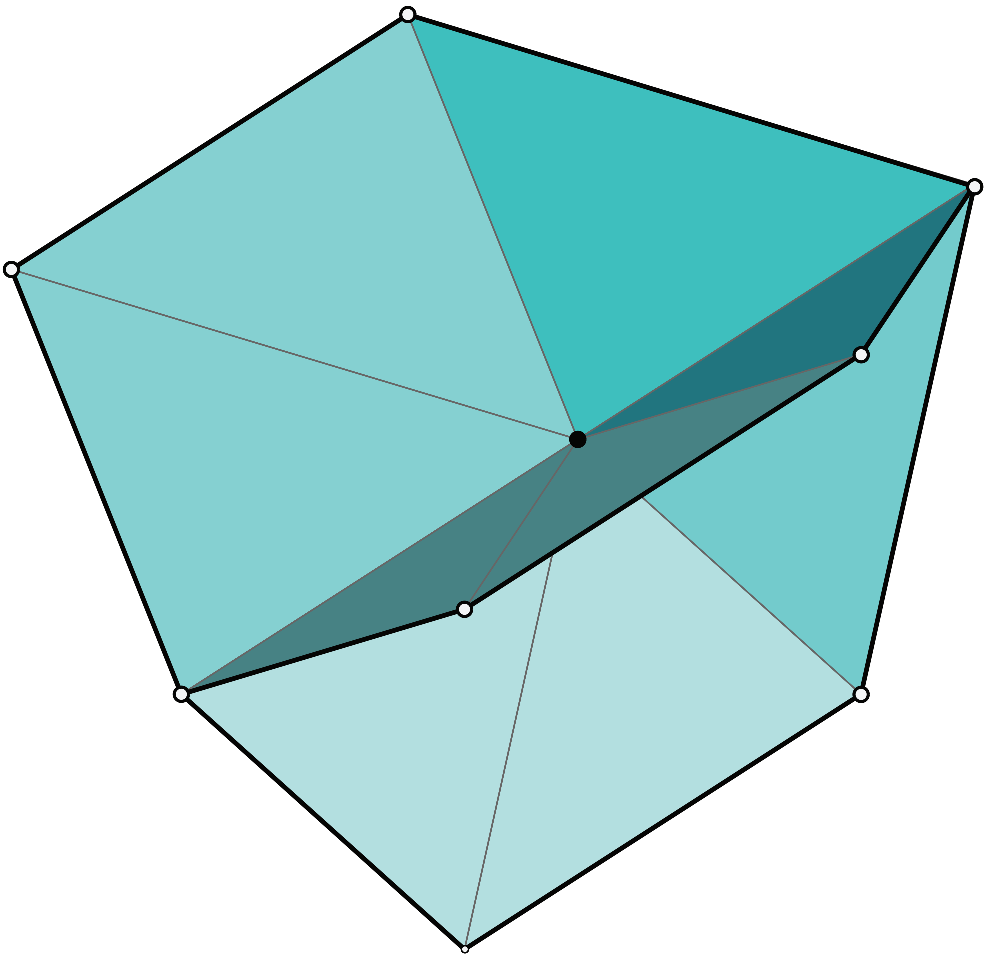
[2]*Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017.* Special Report NSF 17-310, *table 7-7.* `www.nsf.gov/statistics/wmpd`.

The Geometry of Matroids



Federico Ardila

Introduction

Matroid theory is a combinatorial theory of independence which has its origins in linear algebra and graph theory and turns out to have deep connections with many other fields. There are natural notions of independence in linear algebra, graph theory, matching theory, the theory of field extensions, and the theory of routings, among others. Matroids capture the combinatorial essence that those notions share.

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Gian-Carlo Rota, who helped lay the foundations of the field and was one of its most energetic ambassadors, rejected the "ineffably cacophonous" name of *matroids*. He proposed calling them *combinatorial geometries* instead.[1] This alternative name never really caught on, but the geometric roots of the field have since grown much deeper, bearing many new fruits.

The geometric approach to matroid theory has recently led to the solution of long-standing questions and to the development of fascinating mathematics at the intersection of combinatorics, algebra, and geometry. This article is a selection of some recent successes, stemming from three geometric models of matroids.

[1] *It was tempting to call this note "The geometry of geometries."*

Definitions

Matroids were defined independently in the 1930s by Nakasawa and Whitney. A *matroid* $M = (E, \mathcal{I})$ consists of a finite set E and a collection $\mathcal{I}$ of subsets of E, called the *independent sets*, such that

(I-1) $\emptyset \in \mathcal{I}$.
(I-2) If $J \in \mathcal{I}$ and $I \subseteq J$, then $I \in \mathcal{I}$.
(I-3) If $I, J \in \mathcal{I}$ and $|I| < |J|$, then there exists $j \in J - I$ such that $I \cup j \in \mathcal{I}$.

We will assume that every singleton $\{e\}$ is independent.

Thanks to (I-2), it is enough to list the collection $\mathcal{B}$ of maximal independent sets; these are called the *bases* of M. By (I-3), they have the same size $r = r(M)$, which we call the *rank* of the matroid. Our running example will be the matroid with

(1) $\quad E = abcde, \qquad \mathcal{B} = \{abc, abd, abe, acd, ace\},$

omitting brackets for easier readability. See Figure 1.

Let us now discuss the two most important motivating examples of matroids; there are many others.

Vector Configurations

Let $\mathbb{F}$ be a field, let E be a set of vectors in a vector space over $\mathbb{F}$, and let $\mathcal{I}$ be the collection of linearly independent subsets of E. Then $(E, \mathcal{I})$ is a *linear* matroid (over $\mathbb{F}$).

Graphs

Let E be the set of edges of a graph G and let $\mathcal{I}$ be the collection of forests of G, that is, the subsets of E containing no cycle. Then $(E, \mathcal{I})$ is a *graphical* matroid.

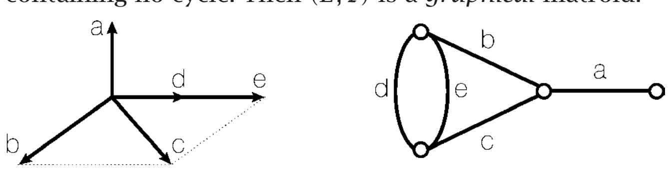

Figure 1. A linear and a graphical representation of the matroid of (1) with $\mathcal{B} = \{abc, abd, abe, acd, ace\}$.

There are several natural operations on matroids. For $S \subseteq E$, the *restriction* $M|S$ and the *contraction* M/S are matroids on the ground sets S and $E - S$, respectively, with independent sets

$$\begin{aligned} \mathcal{I}|S &= \{I \subseteq S : I \in \mathcal{I}\}, \\ \mathcal{I}/S &= \{I \subseteq E - S : I \cup I_S \in \mathcal{I}\} \end{aligned}$$

for any maximal independent subset I_S of S. When M is a linear matroid in a vector space V, $M|S$ and M/S are the linear matroids on S and $E - S$ that M determines on the vector spaces $\mathrm{span}(S)$ and $V/\mathrm{span}(S)$, respectively.

The *direct sum* $M_1 \oplus M_2$ of two matroids $M_1 = (E_1, \mathcal{I}_1)$ and $M_2 = (E_2, \mathcal{I}_2)$ on disjoint ground sets is the matroid on $E_1 \cup E_2$ with independent sets

$$\mathcal{I}_1 \oplus \mathcal{I}_2 = \{I_1 \cup I_2 : I_1 \in \mathcal{I}_1, I_2 \in \mathcal{I}_2\}.$$

Every matroid decomposes uniquely as a direct sum of its *connected components*.

Finally, the *orthogonal matroid* of M, denoted $M^\perp$, is the matroid on E with bases

$$\mathcal{B}^\perp = \{E - B : B \in \mathcal{B}\}.$$

Remarkably, this simple notion simultaneously generalizes orthogonal complements and dual graphs. If M is the matroid for the columns of a matrix whose rowspan is $U \subseteq V$, then $M^\perp$ is the matroid for the columns of any matrix whose rowspan is $U^\perp$. If M is the matroid for a planar graph G, drawn on the plane without edge intersections, then $M^\perp$ is the matroid for the dual graph $G^\perp$, whose vertices and edges correspond to the faces and edges of G, respectively, as shown in Figure 2.

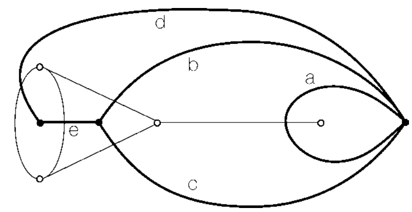

Figure 2. The planar graph of Figure 1 and its dual graph, whose set of bases is $\mathcal{B}^\perp = \{bd, be, cd, ce, de\}$.

Enumerative Invariants

Two matroids $M_1 = (E_1, \mathcal{I}_1)$ and $M_2 = (E_2, \mathcal{I}_2)$ are *isomorphic* if there is a *relabeling* bijection $\phi : E_1 \to E_2$ that maps $\mathcal{I}_1$ to $\mathcal{I}_2$. A *matroid invariant* is a function f on matroids such that $f(M_1) = f(M_2)$ whenever M_1 and M_2 are isomorphic. Let us introduce a few important examples.

The f-vector and the h-vector

The independent sets of M form a simplicial complex $\mathcal{I}$ by (I-2); its *f-vector* counts the number $f_k(M)$ of independent sets of M of size $k+1$ for each k. The *h-vector* of M, defined by

$$\sum_{k=0}^{r} f_{k-1}(q-1)^{r-k} = \sum_{k=0}^{r} h_k q^{r-k},$$

stores this information more compactly. For example, the matroid of (1) has

$$f(M) = (1, 5, 9, 5), \qquad h(M) = (1, 2, 2, 0).$$

The Characteristic Polynomial

We define the *rank function* $r : 2^E \to \mathbb{Z}$ of a matroid M by

$$r(A) = \text{ largest size of an independent subset of } A,$$

for $A \subseteq E$. Let $r = r(M) = r(E)$ be the rank of M. When M is a linear matroid, $r(A) = \dim \mathrm{span}(A)$. The *characteristic polynomial* of M is

$$\chi_M(q) = \sum_{A \subseteq E} (-1)^{|A|} q^{r(M) - r(A)}.$$

The sequence $w(M)$ of *Whitney numbers of the first kind* is defined by $\chi_M(q) = w_0 q^r - w_1 q^{r-1} + \cdots + (-1)^r w_r q^0$. For example, the matroid of (1) has

$$w(M) = (1, 4, 5, 2).$$

The characteristic polynomial of a matroid is one of its most fundamental invariants. For graphical and linear matroids, it has the following interpretations.

Graphs

If M is the matroid of a connected graph G, then $q\,\chi_M(q)$ is the *chromatic polynomial* of G; it counts the colorings of the vertices of G with q given colors such that no two neighbors have the same color.

Hyperplane Arrangements

Suppose M is the matroid of nonzero vectors $v_1, \dots, v_n \in \mathbb{F}^d$, and consider the arrangement $\mathcal{A}$ of hyperplanes

$$H_i : v_i \cdot x = 0, \qquad 1 \leq i \leq n,$$

and its complement $V(\mathcal{A}) = \mathbb{F}^d - (H_1 \cup \cdots \cup H_n)$. Depending on the underlying field, $\chi_M(q)$ stores different information about $V(\mathcal{A})$:

(a) ($\mathbb{F} = \mathbb{F}_q$) $V(\mathcal{A})$ consists of $\chi_M(q)$ points.
(b) ($\mathbb{F} = \mathbb{R}$) $V(\mathcal{A})$ consists of $|\chi_M(-1)|$ regions.
(c) ($\mathbb{F} = \mathbb{C}$) The Poincaré polynomial of $V(\mathcal{A})$

$$\sum_{k \geq 0} \text{rank } H^k(V(\mathcal{A}), \mathbb{Z}) q^k = (-1)^d \chi_M(-1/q).$$

Geometric Model 1. Matroid Polytopes

A crucial insight into the geometry of matroids came from two seemingly unrelated places: combinatorial optimization and algebraic geometry. From both points of view, it is natural to model a matroid in terms of the following polytope.

Definition 1 (Edmonds, 1970)**.** Let M be a matroid on the ground set E. The *matroid polytope*

$$P_M = \text{conv}\{e_B : B \text{ is a basis of } M\},$$

where $\{e_i : i \in E\}$ is the standard basis of $\mathbb{R}^E$, and we write $e_B = e_{b_1} + \cdots + e_{b_r}$ for $B = \{b_1, \dots, b_r\}$.

Figure 3 shows the matroid polytope for example (1).

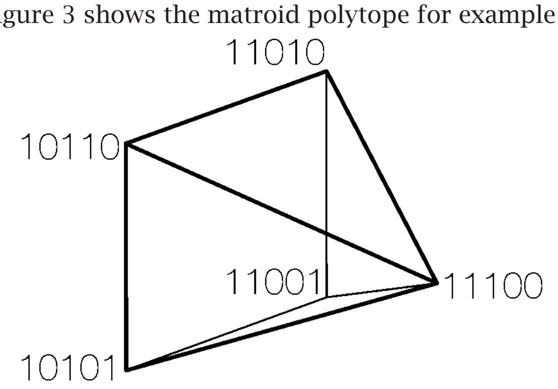

Figure 3. The matroid polytope for our sample matroid (1)**. The vertices exhibit which triplets form bases.**

Combinatorial Optimization

The central question of combinatorial optimization is the following: Given a family $\mathcal{B}$ of combinatorial objects and a *cost function* $c : \mathcal{B} \to \mathbb{R}$, find the object(s) B in $\mathcal{B}$ for which the cost $c(B)$ is minimized. To do this, one often looks for a polytope $P_{\mathcal{B}} \subset \mathbb{R}^d$ modeling the family $\mathcal{B}$ and a linear function f on $\mathbb{R}^d$ such that

- $P_{\mathcal{B}}$ has a vertex v_B for each object $B \in \mathcal{B}$, and
- $c(B) = f(v_B)$ for each $B \in \mathcal{B}$.

If one can do this, then the optimal object(s) B corresponds to the vertices of the face of the polytope $P_{\mathcal{B}}$ where the linear function f is minimized. This simple, beautiful idea is the foundation of *linear programming*. There are many techniques to optimize f, whose efficiency depends on the complexity of the polytope $P_{\mathcal{B}}$.

Edmonds observed that, given a matroid M and a cost function $c : E \to \mathbb{R}$ on its ground set, the bases $B = \{b_1, \dots, b_r\}$ of M of minimum cost $c(B) := c(b_1) + \cdots + c(b_r)$ can be found via linear programming on the matroid polytope P_M.

As a sample application, Edmonds used these ideas to solve the *matroid intersection problem* for matroids M and N on the same ground set. This problem asks us to find the size of the largest set which is independent in both M and N.

Algebraic Geometry

Instead of studying the r-dimensional subspaces of $\mathbb{C}^n$ one at a time, it is often useful to study them all at once. They can be conveniently organized into the space of r-subspaces of $\mathbb{C}^n$ called the *Grassmannian* $\text{Gr}(r, n)$; each point of $\text{Gr}(r, n)$ represents an r-subspace of $\mathbb{C}^n$.

A choice of a coordinate system on $\mathbb{C}^n$ gives rise to the *Plücker embedding* of

$$\text{Gr}(r, n) \overset{p}{\hookrightarrow} \mathbb{PC}^{\binom{n}{r}-1}$$

as follows. For an r-subspace $V \subset \mathbb{C}^n$, choose an $r \times n$ matrix A with $V = \text{rowspan}(A)$. Then for each of the $\binom{n}{r}$ r-subsets B of $[n]$ let

$$p_B(V) := \det(A_B)$$

be the determinant of the $r \times r$ submatrix A_B of A whose columns are given by the subset B. Although there are many different choices for the matrix A, they can be obtained from one another by elementary row operations, which only change the *Plücker vector* $p(V)$ by multiplication by a global constant. Therefore $p(V)$ is well defined as an element of projective space. The map p provides a realization of the Grassmannian as a smooth projective variety.

The torus $\mathbb{T} = (\mathbb{C} - \{0\})^n$ acts on $\mathbb{C}^n$ by stretching the n coordinate axes, thus inducing an action of $\mathbb{T}$ on $\text{Gr}(r, n)$. This action gives rise to a *moment map* $\mu : \text{Gr}(r, n) \to \mathbb{R}^n$ given by

$$\mu(V)_i = \frac{\sum_{B \ni i} |\det(A_B)|^2}{\sum_B |\det(A_B)|^2} \quad \text{for } 1 \leq i \leq n.$$

Now consider the trajectory $\mathbb{T} \cdot V$ of the r-subspace $V \in \text{Gr}(r, n)$ as the torus $\mathbb{T}$ acts on it, and take its closure. Where does the resulting toric variety $\overline{\mathbb{T} \cdot V} \subset \text{Gr}(r, n)$ go under the moment map? Precisely to the matroid polytope!

Define the *matroid $M(V)$ of the subspace $V \subset \mathbb{C}^n$* to be the matroid of the columns of A; its bases B correspond to the nonzero Plücker coordinates $p_B(V)$. Gelfand, Goresky, MacPherson, and Serganova showed that

$$\mu(\overline{\mathbb{T} \cdot V}) = P_{M(V)}.$$

Thus matroid polytopes arise naturally in this algebro-geometric setting as well.

As a sample application, the degree of $\overline{\mathbb{T} \cdot V} \subset \mathbb{PC}^{\binom{n}{r}-1}$ is then given by the volume of the matroid polytope $P_{M(V)}$. Ardila, Benedetti, and Doker used this to find a purely combinatorial formula for $\deg(\overline{\mathbb{T} \cdot V})$ in terms of the matroid $M(V)$.[2]

A Geometric Characterization of Matroids

In most contexts where polytopes arise, it is advantageous if they happen to have a nice structure. For example, in optimization, the edges of the polytope are crucial to various algorithms for linear programming. In geometry, they control the GKM presentation of the equivariant cohomology of the Grassmannian.

Matroid polytopes have the following beautiful combinatorial characterization, which was discovered in the context of toric geometry.

Theorem 2 (Gelfand–Goresky–MacPherson–Serganova, 1987)**.** *A collection $\mathcal{B}$ of subsets of $[n]$ is the set of bases of a matroid if and only if every edge of the polytope*

$$P_{\mathcal{B}} := conv\{e_B : B \in \mathcal{B}\} \subset \mathbb{R}^n$$

is a translate of $e_i - e_j$ for some i, j.

This makes matroid polytopes a very useful model for matroids. In fact, one could *define* a matroid to be a subpolytope of the cube $[0,1]^n$ that uses only these vectors as edges. Notice that from this polytopal point of view, even if one cares only about linear matroids, all matroids are equally natural. Matroid theory provides the correct level of generality.

The theorem above shows that in matroid theory, a central role is played by one of the most important vector configurations in mathematics, the *root system* for the special linear group SL_n:

$$A_{n-1} = \{e_i - e_j : 1 \le i, j \le n\},$$

as shown in Figure 4 for $n = 4$. From this point of view, it is natural to extend this construction to other Lie groups. The resulting theory of *Coxeter matroids*, introduced by Gelfand and Serganova, is ripe for further combinatorial exploration.

[2] *This was the subject of Carolina Benedetti and Jeff Doker's final project for the first course offered by the SFSU-Colombia Combinatorics Initiative in 2007, as described in* [2].

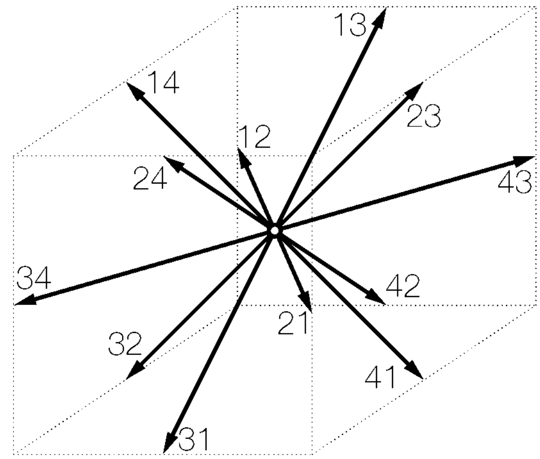

Figure 4. The root system $A_3 = \{e_i - e_j : 1 \le i, j \le 4\}$, where $e_i - e_j$ is denoted ij. Root systems play an essential role in matroid theory, as demonstrated by Theorem 2.

Hopf Algebra

Joni and Rota showed that many combinatorial families have natural *merging* and *breaking* operations that give them the structure of a Hopf algebra, with many useful consequences. In particular, in the 1970s and 1980s, Joni–Rota and Schmitt defined the *Hopf algebra of matroids* $\mathbb{M}$ as the span of the set of matroids modulo isomorphism, with the product $\cdot : \mathbb{M} \otimes \mathbb{M} \to \mathbb{M}$ and coproduct $\Delta : \mathbb{M} \to \mathbb{M} \otimes \mathbb{M}$ given by

$$M \cdot N := M \oplus N \qquad \text{for matroids } M \text{ and } N,$$
$$\Delta(M) := \sum_{S \subseteq E} (M|S) \otimes (M/S) \qquad \text{for a matroid } M \text{ on } E.$$

For $\mathbb{M}$ to be a Hopf algebra, we require an *antipode map* S, which is the Hopf-theoretic analogue of an inverse. General results of Schmitt and Takeuchi show that this map exists.

The antipode S is a fundamental ingredient of a Hopf algebra, so it is important to find an efficient formula for it. For the Hopf algebra of matroids $\mathbb{M}$, this was only resolved recently, thanks to the new insight that the matroid polytope plays an essential role. An important preliminary observation, which readily follows from Theorem 2, is that every face of a matroid polytope is itself a matroid polytope.

Theorem 3 (Aguiar–Ardila, 2017)**.** *The antipode of the Hopf algebra of matroids $\mathbb{M}$ is given by*

$$S(M) = \sum_{P_N \text{ face of } P_M} (-1)^{c(N)} N$$

for any matroid M, where $c(N)$ denotes the number of connected components of N.

This formula is the best possible: it involves no cancellation. It has the unexpected consequence that matroid polytopes are also algebraic in nature. In the Hopf algebraic structure of matroids, matroid polytopes are fundamental.

Geometric Model 2. Bergman Fans

We now introduce a second geometric model of matroids, coming from tropical geometry. The *flats* of M are an important ingredient; these are the subsets $F \subseteq E$ such that $r(F \cup e) > r(F)$ for all $e \notin F$. We say F is *proper* if it does not have rank 0 or r. The *lattice of flats* of M, denoted L_M, is the set of flats, partially ordered by inclusion, as shown in Figure 5.

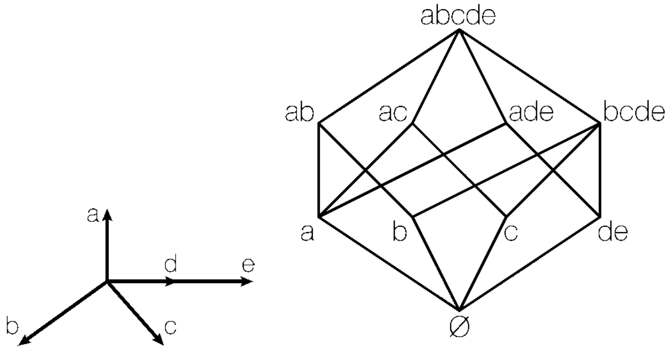

Figure 5. The lattice of flats of our sample matroid (1)**.**

When M is the matroid of a vector configuration E in a vector space V, the flats of M are the (subsets of E contained in the) subspaces spanned by E.

Tropical Geometry

Tropicalization is a powerful technique that turns an algebraic variety V into a simpler, piecewise linear space $\operatorname{Trop} V$ that still contains geometric information about V. Tropical geometry answers questions in algebraic geometry by translating them into polyhedral questions that can be approached combinatorially [4].

An important early success of the theory was Mikhalkin's 2005 tropical computation of the *Gromov-Witten invariants of* $\mathbb{CP}^2$, which count the plane curves of degree d and genus g passing through $3d + 1 - g$ general points. Since then, many new results in classical algebraic geometry have been obtained through tropical techniques.

Tropical varieties are simpler than algebraic varieties, but they are still very intricate. An important example to understand is that of linear spaces. What is the tropicalization of a linear subspace V of $\mathbb{C}^n$? Sturmfels realized that the answer depends only on the matroid of V. It can be described as follows.

Definition/Theorem 4 (Ardila–Klivans, 2006)**.**

(1) The *Bergman fan* Σ_M of a matroid M on E is the polyhedral complex in $\mathbb{R}^E / \langle e_E \rangle$ consisting of the cones

$$\sigma_{\mathcal{F}} = \operatorname{cone}\{e_F \,:\, F \in \mathcal{F}\}$$

for each flag $\mathcal{F} = \{F_1 \subsetneq \cdots \subsetneq F_l\}$ of proper flats of M. Here $e_F := e_{f_1} + \cdots + e_{f_k}$ for $F = \{f_1, \ldots, f_k\}$.

(2) The tropicalization of a linear subspace V of $\mathbb{C}^n$ is the Bergman fan of its matroid:

$$\operatorname{Trop} V = \Sigma_{M(V)}.$$

(3) The Bergman fan Σ_M is a cone over a wedge of w_r spheres of dimension $r - 2$, where w_r is the last Whitney number of the first kind.

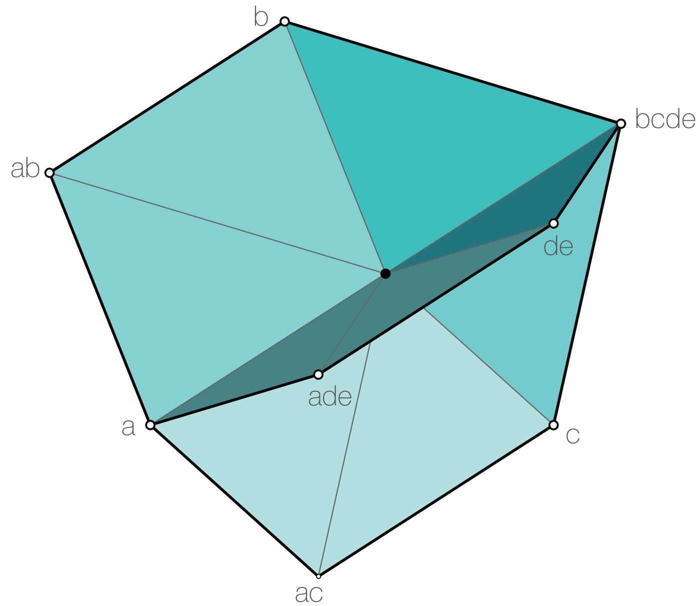

Figure 6. The Bergman fan of our sample matroid (1) **is modeled after the lattice of flats of Figure 5. It has 8 rays and 9 facets. It is a cone over a wedge of** $w_3 = 2$ **circles.**

A Geometric Characterization of Bergman Fans

Tropical varieties have a natural notion of *degree*, analogous to the notion of the degree of an algebraic variety. We have the following remarkable characterization.

Theorem 5 (Fink, 2013)**.** *A tropical variety has degree* 1 *if and only if it is the Bergman fan of a matroid.*

We conclude that Bergman fans are also excellent models for matroids. In fact, one could *define* a matroid to be a tropical variety of degree 1; this is the tropical analogue of a linear space. Notice that, although Σ_M only arises via tropicalization when M is a linear matroid, one should really consider the Bergman fans of all matroids; they are equally natural from the tropical point of view. Again, matroid theory really provides the correct level of generality.

The theorems above explain the important role that matroids play in tropical geometry. On the one hand, they provide a useful testing ground, providing hints for the kinds of general results that may be possible and the sorts of difficulties that one should expect. On the other hand, they are fundamental building blocks; for instance, in analogy with the classical definition of a manifold, a *tropical manifold* is a tropical variety that locally looks like a (Bergman fan of a) matroid, as in Figure 7.

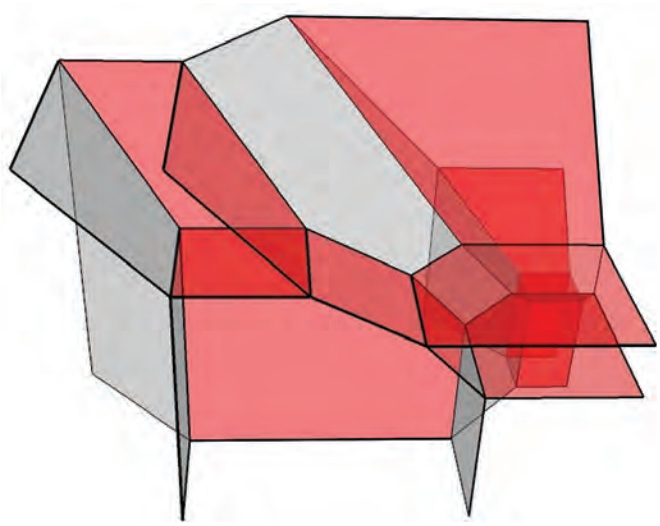

Figure 7. A tropical manifold is a tropical variety that locally looks like a (Bergman fan of a) matroid.

The Chow Ring and Hodge Theory

The *Chow ring* of the Bergman fan Σ_M is defined to be

$$A^*(\Sigma_M) := \mathbb{R}[x_F : F \text{ proper flat of } M]/(I_M + J_M),$$

where

$$I_M = \langle x_{F_1}x_{F_2} : F_1 \subsetneq F_2 \text{ and } F_1 \supsetneq F_2 \rangle,$$

$$J_M = \left\langle \sum_{F \ni i} x_F - \sum_{F \ni j} x_F : i, j \in E \right\rangle.$$

This ring has a natural geometric interpretation when M is linear over $\mathbb{C}$: Feichtner and Yuzvinsky proved that $A^*(\Sigma_M)$ is the Chow ring of De Concini and Procesi's *wonderful compactification* of the complement of a hyperplane arrangement.

Surprisingly, $A^*(\Sigma_M)$ behaves as nicely as the cohomology ring of a smooth projective variety. This is one of the most celebrated recent results in matroid theory, since it provided the tools to prove several long-standing conjectures, as we now briefly explain.

Theorem 6 (Adiprasito–Huh–Katz, 2015)**.** *The Chow ring $A^*(\Sigma_M)$ of the Bergman fan of a matroid M satisfies Poincaré duality, the hard Lefschetz theorem, and the Hodge–Riemann relations.*

The inspiration for this theorem is geometric, coming from the Grothendieck standard conjectures on algebraic cycles. The statement and proof are combinatorial. For further details and a precise statement, see [1], [3].

Let us focus on a comparatively small but very powerful consequence. The Chow ring $A^*(\Sigma_M)$ is graded of degree $r-1$, and there is an isomorphism $\deg : A^{r-1} \to \mathbb{R}$ characterized by the property that $\deg(F_1 \cdots F_{r-1}) = 1$ for any full flag $F_1 \subsetneq \cdots \subsetneq F_{r-1}$ of proper flats. Say a function $c : 2^E \to \mathbb{R}$ is *submodular* if $c_\varnothing = c_E = 0$ and $c_A + c_B \geq c_{A\cup B} + c_{A \cap B}$ for any $A, B \subseteq E$, and let

$$\overline{K}(M) = \left\{ \sum_{F \text{ flat}} c_F x_F : c \text{ submodular} \right\} \subset A^1(\Sigma_M).$$

The Hodge–Riemann relations imply that for any $L_1, \ldots, L_{r-3}, a, b \in \overline{K}(M)$, if we write $L = L_1 \cdots L_{r-3}$, we have

$$\deg(La^2)\deg(Lb^2) \leq \deg(Lab)^2. \quad (2)$$

Unimodality and Log-Concavity

We say a sequence $a_0, a_1, \ldots, a_r$ of nonnegative integers is *unimodal* if there is an index $0 \leq m \leq r$ such that

$$a_0 \leq a_1 \leq \cdots \leq a_{m-1} \leq a_m \geq a_{m+1} \geq \cdots \geq a_r,$$

and, more strongly, it is *log-concave* if for all $1 \leq i \leq r-1$,

$$a_{i-1}a_{i+1} \leq a_i^2.$$

It is *flawless* if we have

$$a_i \leq a_{s-i}$$

for all $1 \leq i \leq \frac{s}{2}$, where s is the largest index with $a_s \neq 0$.

Many sequences in mathematics have these properties, but proving it is often very difficult. Aside from their intrinsic interest, these kinds of questions have been a source of fresh mathematics, because their solutions have often required a fundamentally new construction or connection and have given rise to unforeseen structural results about the objects of interest.

For matroids, this Hodge theory provides such a connection. Consider the elements of the Chow ring $A^*(\Sigma_M)$,

$$\alpha = \alpha_i = \sum_{F \ni i} x_F, \qquad \beta = \beta_i = \sum_{F \not\ni i} x_F,$$

which are independent of i and lie in the cone $\overline{K}(M)$. A clever combinatorial computation in $A^*(\Sigma_M)$ shows that

$$\deg(\alpha^k \beta^{r-1-k}) = |\text{ coeff. of } q^k \text{ in } \chi_M(q)/(q-1)|.$$

As k varies, this sequence of degrees is log-concave by (2). In turn, by elementary arguments, this implies the following theorems, which were conjectured by Rota, Heron, Mason, and Welsh in the 1970s and 1980s.

Theorem 7 (Adiprasito–Huh–Katz, 2015)**.** *For any matroid M of rank r, the following sequences, defined in "Enumerative Invariants," are unimodal and log-concave:*

- *the Whitney numbers of the first kind $w(M)$, and*
- *the f-vector $f(M)$.*

Geometric Model 3. Conormal Fans

We now introduce another polyhedral model of M that leads to stronger inequalities for matroid invariants. We say that a flag $\mathcal{F} = \{F_1 \subseteq \cdots \subseteq F_l\}$ of nonempty flats of M and a flag $\mathcal{G} = \{G_1 \supseteq \cdots \supseteq G_l\}$ of nonempty flats of $M^\perp$ of the same length are *compatible* if

$$\bigcap_{i=1}^{l}(F_i \cup G_i) = E, \qquad \bigcup_{i=1}^{l}(F_i \cap G_i) \neq E.$$

All maximal compatible pairs have length $n-2$.

Definition 8 (Ardila–Denham–Huh, 2017)**.** The *conormal fan* $\Sigma_{M,M^\perp}$ of a matroid M is the polyhedral complex in $\mathbb{R}^E/\langle e_E\rangle \times \mathbb{R}^E/\langle e_E\rangle$ consisting of the cones

$$\sigma_{\mathcal{F},\mathcal{G}} = \text{cone}\{e_{F_i} + f_{G_i} : 1 \leq i \leq l\}$$

for each compatible pair of flags $(\mathcal{F}, \mathcal{G})$. Here $\{e_i : i \in E\}$ and $\{f_i : i \in E\}$ are the standard bases for two copies of $\mathbb{R}^E$.

It would be interesting to find an intrinsic characterization of conormal fans of matroids, in analogy with Theorems 2 and 5.

The Chow Ring and Hodge Theory

Consider the polynomial ring with variables $x_{F,G}$ where F and G are nonempty flats of M and $M^\perp$ respectively, not both E, such that $F \cup G = E$. When it is defined, we write $x_{\mathcal{F},\mathcal{G}} = x_{F_1,G_1} \cdots x_{F_l,G_l}$ for flags $\mathcal{F} = \{F_1 \subsetneq \cdots \subsetneq F_l\}$ and $\mathcal{G} = \{G_1 \supsetneq \cdots \supsetneq G_l\}$. We also need the special elements

$$a_i = \sum_{E \neq F \ni i} x_{F,G}, \quad a_i' = \sum_{E \neq G \ni i} x_{F,G}, \quad d_i = \sum_{F \cap G \ni i} x_{F,G}.$$

We define the *Chow ring of the conormal fan* of M to be

$$A^*(\Sigma_{M,M^\perp}) := \mathbb{R}[x_{F,G}]/(I_{M,M^\perp} + J_{M,M^\perp}),$$

where

$$I_{M,M^\perp} = \langle x_{\mathcal{F},\mathcal{G}} : \mathcal{F} \text{ and } \mathcal{G} \text{ are not compatible} \rangle,$$
$$J_{M,M^\perp} = \left\langle a_i - a_j, a_i' - a_j' : i,j \in E \right\rangle.$$

The Chow ring of the conormal fan behaves as nicely as the Chow ring of the Bergman fan, though proving it requires significant additional work.

Theorem 9 (Ardila–Denham–Huh, 2017)**.** *The Chow ring $A^*(\Sigma_{M,M^\perp})$ of the conormal fan of a matroid satisfies Poincaré duality, the hard Lefschetz theorem, and the Hodge–Riemann relations.*

This Chow ring $A^*(\Sigma_{M,M^\perp})$ has degree $n-2$, and there is an isomorphism $\deg : A^{n-2} \to \mathbb{R}$ characterized by the property that $\deg(x_{\mathcal{F},\mathcal{G}}) = 1$ for any maximal pair of compatible flags $\mathcal{F}$ and $\mathcal{G}$. The inequality (2) is still satisfied for elements of a suitable cone $\overline{K}(M, M^\perp)$.

Unimodality, Log-Concavity, and Flawlessness

We now apply (2) to the elements $a = a_i$ and $d = d_i$ of the Chow ring $A^*(\Sigma_{M,M^\perp})$, which are independent of i and lie in the relevant cone $\overline{K}(M, M^\perp)$. A subtle combinatorial argument shows that

$$\deg(a^k d^{n-2-k}) = |\text{ coeff. of } q^{k+1} \text{ in } \chi_M(q+1)|.$$

As k varies, this sequence of coefficients is the h-vector of the *broken circuit complex* $\overline{BC}_<(M)$. This is the collection of subsets of $E - \min E$ that do not contain a *broken circuit*; that is, a set of the form $C - \min C$ for a minimal dependent set C. The broken circuit complex depends on a choice of a linear order $<$ on E, but its h-vector is independent of $<$.

The inequalities (2) for the Chow ring $A_{M,M^\perp}$ then imply the following theorems, which were conjectured by Brylawski and Dawson in the 1980s.

Theorem 10 (Ardila–Denham–Huh, 2017)**.** *For any matroid M of rank r, the following sequences, defined in "Enumerative Invariants," are unimodal and log-concave:*

- *the h-vector of the broken circuit complex, and*
- *the h-vector $h(M)$.*

Theorem 10 is significantly stronger than Theorem 7. By work of Juhnke-Kubitzke and Le, it also implies a 2003 conjecture of Swartz: These h-vectors are flawless.

ACKNOWLEDGMENTS. I am very grateful to Gian-Carlo Rota, Richard Stanley, and Bernd Sturmfels for the beautiful mathematics and to my coauthors and students for the great fun we've had together trying to understand matroids a bit better every day.

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A version of this survey including a full list of references is at: math.sfsu.edu/federico/matroidsnotices.pdf.

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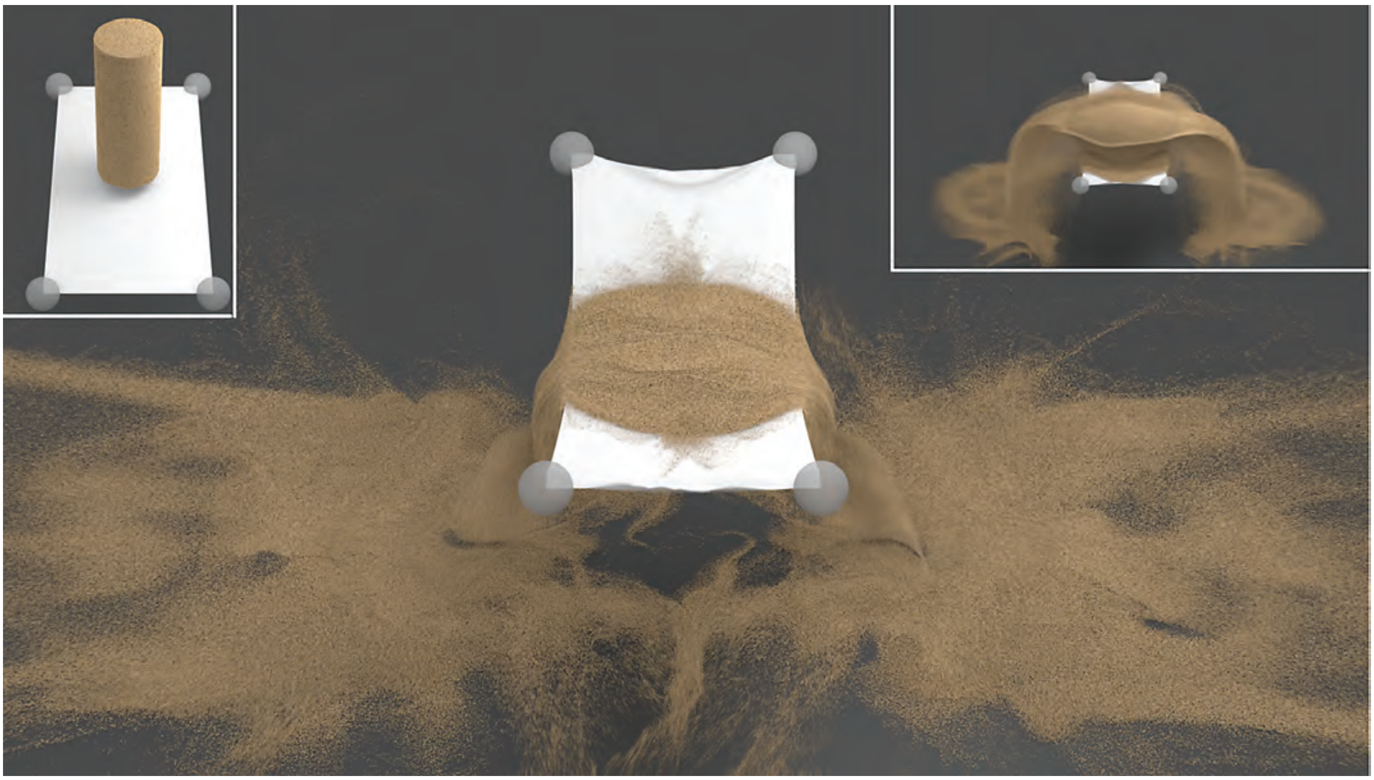
Figures 1–6 courtesy of Federico Ardila.
Figure 7 by Johannes Rau.
Author photo courtesy of May-Li Khoe.

Federico Ardila

ABOUT THE AUTHOR

Federico Ardila works in combinatorics and its connections to other areas of mathematics and applications. He also strives to build joyful, empowering, and equitable mathematical spaces. He has advised over forty thesis students in the US and Colombia; more than half of his US students are members of underrepresented groups and more than half are women. Outside of work, he is often playing fútbol or DJing with his wife May-Li, and Colectivo La Pelanga.

Movie Animation: A Continuum Approach for Frictional Contact



Joseph Teran

Introduction

Scientific computing and numerical methods have many new and exciting applications in modern movie visual effects. Studios such as Walt Disney Animation Studios, Industrial Light & Magic, and Pixar increasingly require expertise in the numerical solution of partial differential equations (PDEs). Such PDEs describe the dynamics of materials encountered in the world of the movie: water, dirt, sand, mud, air, clothing, hair, and skin. They also describe sensational phenomena such as fire and explosions. They are derived from classical continuum mechanics, such as the Navier-Stokes equation for incompressible fluid dynamics. Solving these PDEs is the key to creating visually compelling dynamic effects in the movie. Unfortunately the equations are highly nonlinear, and we cannot solve them exactly. But we can approximate solutions accurately using applied mathematics and scientific computing. While solving a PDE numerically is very computationally expensive and requires an expert user, it is often the only way to get satisfactory behavior at the level of quality demanded by today's motion pictures.

Many of the most challenging simulation problems in visual effects involve the frictional contact of many layers of thin and granular materials: clothing layers, granular materials like dirt, sand and snow. I will discuss the governing equations and the numerical methods used to approximate them.

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Balance Laws for Nonlinear Elastic Materials

Many materials such as character soft tissues and skin, clothing, hair, and even sand, and snow are governed by PDEs for the mechanics of nonlinear elastic solids undergoing finite strain. Conservation of mass and momentum implies that the mass density ρ and the material velocity $\mathbf{v}$ satisfy the equations

$$\frac{D\rho}{Dt} + \rho\nabla\cdot\mathbf{v} = 0, \quad (1)$$

$$\rho\frac{D\mathbf{v}}{Dt} = \nabla\cdot\boldsymbol{\sigma} + \mathbf{f}^b. \quad (2)$$

Here D/Dt is the material derivative that denotes differentiation along particle trajectories, and $\mathbf{f}^b$ is the body force density, e.g., gravitational force. For hyperelastic materials the Cauchy stress $\boldsymbol{\sigma}$ is defined in terms of the deformation gradient $\mathbf{F}$, which quantifies the change of shape in the material at each point in the continuum and its determinant $J = \det(\mathbf{F})$. For example, if $\mathbf{F}$ is a rotation tensor, then $J = 1$ and the material is undeformed locally. To express elastic behavior, the hyperelastic potential energy density $\Psi(\mathbf{F})$ increases as $\mathbf{F}$ is further from rotation. A model commonly used in computer graphics is

$$\Psi(\mathbf{F}) = \mu|\mathbf{F}-\mathbf{R}|_F^2 + \frac{\lambda}{2}(J-1)^2, \quad (3)$$

where $\mathbf{F} = \mathbf{RS}$ (rotation times stretch) is the polar decomposition of the deformation gradient. Here μ and λ are the Lame coefficients which measure the material's resistance to shear and volume change respectively.

Character Animation and Clothing

Character animation. The leftmost image shows the underlying skeleton used for animating the character Hook Hand Thug from Disney's *Tangled*. The other images were not part of the movie but a demonstration of our technique. The rightmost image shows the polyhedral skin mesh displaced from the animated skeleton. The center image shows the hexahedral mesh used for simulating quasi-static equilibrium.

In Disney's *Frozen* and *Tangled*, each character in the movie is represented geometrically as a polyhedral mesh as in Figure 1.[1] Animating the characters is done by specifying the trajectory of each one of the vertices in the mesh over time. This task can be very expensive, since a mesh will consist of hundreds of thousand to millions of vertices. To expedite the process, artists often control a simplified underlying skeleton with fewer degrees of freedom than the surface mesh (Figure 1, left). The skin vertex positions must then be extrapolated from the configuration of the underlying skeleton. Physically, the elastic properties of soft tissues like muscle, tendon, ligament, and fat determine this extrapolation. This can be described mathematically by a PDE that expresses elastic equilibrium with Dirichlet and free surface boundary conditions. This is equivalent to ignoring some "inertia" terms in equation (2) and writing the PDE in the Lagrangian rather than Eulerian view. The problem is equivalent to minimizing the total elastic potential energy subject to the Dirichlet boundary conditions. These problems can be approximated using a finite difference or finite element discretization over a structured hexahedral lattice (Figure 1, middle). The associated discrete system of equations is nonlinear, and Newton's method can be used with multigrid to solve the linearized systems. Fast computation is essential, since artists typically need many iterations to perfect a character animation for a given scene.

Once the motion of the character has been animated, the clothing must also be simulated in a post-process as in Figures 5 and 2. Each layer of clothing—shirt, pants, jacket, socks—is represented as a polyhedral mesh. This gives rise to a challenging contact problem between the layers of clothing, often expressed as a nonpenetration constraint for each pair of simple mesh facets like edge/edge and point/triangle. The most common means of satisfying these constraints are impulsive changes in momentum upon mesh facet collisions.

[1] *Others commonly use tetrahedral finite elements.*

Knit fabrics. Recently Jiang et al. [2] **showed that cloth and knit collisions can be resolved with MPM and elastoplasticity. Here each yarn in a knit sweater is simulated, and self and external contacts are naturally and efficiently resolved.**

Friction and Elastoplasticity

Many everyday materials such as metals, sand, snow, and mud behave elastically for a wide range of strains but plastically once nonphysical stresses are approached. Frictional contact can even be described as a plastic constraint on states of stresses that arise during contact. Recently, we have shown that even clothing can be simulated from a continuum view where Coulomb friction during contact places a constraint on the types of stress (see Figure 5).

In order to satisfy the constraints on the Cauchy stress, the deformation is decomposed into elastic and plastic components. Elastoplastic material behavior in the presence of large deformation is characterized by a multiplicative decomposition of the deformation gradient

$$\mathbf{F} = \mathbf{F}^E\mathbf{F}^P. \quad (4)$$

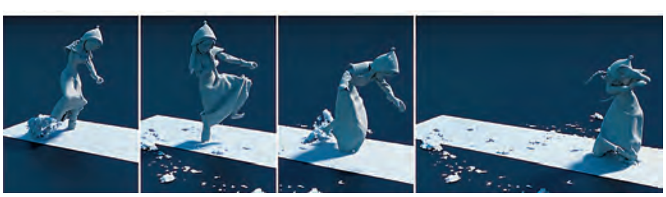
With this convention, the local elastic rest state varies with time, and its Jacobian is characterized by the $\mathbf{F}^E$ term. The $\mathbf{F}^P$ term is the Jacobian of the mapping from the initial rest state to the plastically modified rest state. For perfectly elastic materials like the skin, $\mathbf{F}^P = \mathbf{I}$. For plastic materials, the deformation in $\mathbf{F}^P$ is permanent and is forgotten elastically. Consider for example a snow-covered ground. It behaves elastically and retains its shape; however, as someone walks through it, impact with their feet causes deformation beyond the elastic limit, and their footprints are tracked in $\mathbf{F}^P$. To express this, the Cauchy stress is modified to vary only with potential energy increases from $\mathbf{F}^E$. This model was used in Disney's *Frozen* to model snow dynamics. Additionally, the material was designed to get stiffer or weaker as the plastic deformation loses or gains volume to allow for the stiffening effect of packing a snowball and to increase crumbling failure under expansion.

Material Point Methods (MPM)

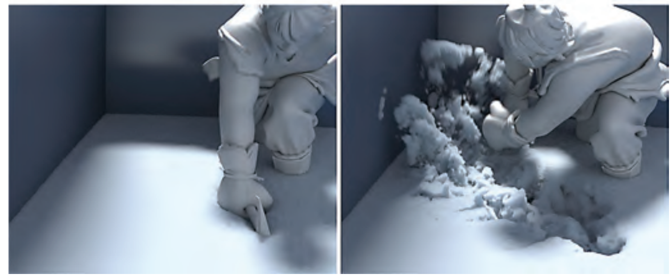
The key to translating these continuum descriptions of the plasticity physics into discretized approximations that can be used for visual effects is the Material Point Method (MPM) of Sulsky et al. [5]. This technique is a generalization of the Particle-In-Cell (PIC) approach of Harlow [1] to history-dependent materials. The production and practical art direction requirements of the snow simulation algorithm needed for Disney's *Frozen* were similar to those for water and incompressible fluids. Given the popularity of PIC for incompressible fluids in the effects industry, Stomakhin et al. [4] investigated the use of a PIC technique for snow simulation in *Frozen* (see Figures 3 and 4).

The MPM discretization of these equations can be viewed as an updated Lagrangian procedure, where the time t^n configuration is used as a reference configuration. The primary particle state includes positions $\mathbf{x}_p^n$ and velocities $\mathbf{v}_p^n$. Mass must also be stored per particle m_p, although it does not change with time in accordance with conservation of mass. Additionally, each particle must store the deformation gradient $\mathbf{F}_p^n$ as well as its plastic decomposition. Lastly, each particle must store a volume sample associated with the particle in the initial configuration V_p^0.

While the primary state is unstructured particles, MPM also makes use of a structured uniform grid. This representation is convenient for computing the divergence



Snow business. Anna from Disney's *Frozen* walks through deep snow. The dynamics are simulated with the MPM approach in [4].



More snow business. Kristoff from Disney's *Frozen* digs in deep snow. The dynamics are simulated with the MPM approach in [4].

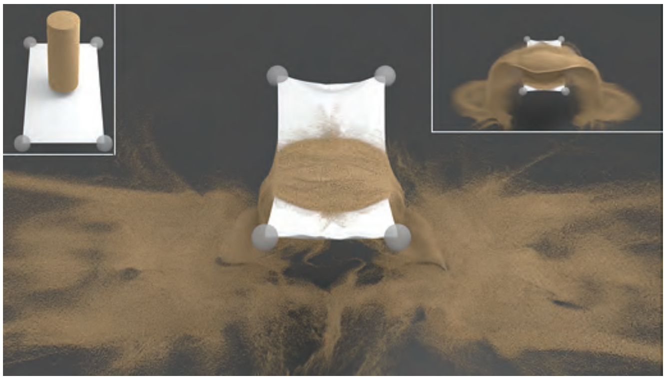
of stresses that appear in the momentum balance equations (2). MPM thus makes use of two representations of the material and requires interpolation/extrapolation to transfer information between the representations.

This relatively simple algorithm was used to simulate the interactions of the characters in *Frozen* with snow in their surroundings (see Figures 3 and 4). Although simplistic, the elastoplasticity model is capable of capturing a wide range of realistic snow behaviors. MPM simulation of more general elastoplastic materials has proven very useful for other applications in the field, including sand, mud, and dirt (see Figure 6). Even knit garments and clothing contact can be modeled as elastoplastic (see Figures 5 and 2).

Conclusion

These are just a few of the many PDEs and numerical methods that are used in modern movie special effects. It is truly an exciting and new application area for scientific computing researchers. The demands for realism

Cloth collisions. The dynamics of each garment that CG characters wear must be simulated to achieve sufficient realism. Physically they are modeled as elastic surfaces, but self and external collisions must also be resolved. Here it is done using MPM and elastoplasticity [2].



Beyond snow. More general elastoplastic models can be simulated with MPM. Klar et al. [3] investigate the use of the Drucker-Prager yield surface for dry sand.

and efficiency in movie production are always increasing. There is no shortage of algorithmic, mathematical, and programming challenges for tomorrow's scientific computing researchers.

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Author photo by Reed Hutchinson.

Joseph Teran

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Joseph Teran is an applied and computational mathematician whose research also includes virtual surgery, collision detection/contact modelling, and parallel computing. He received a 2011 Presidential Early Career Award for Scientists and Engineers (PECASE) and a 2010 Young Investigator award from the Office of Naval Research.

Below, Elisenda Grigsby describes some invariants for braids, knots, and links, and connects their study to Fox's slice-ribbon conjecture, as an introduction to her Invited Address for the AMS Fall Eastern Sectional Meeting being held at the University of Delaware, September 29–30.

J. Elisenda Grigsby

Braids, Surfaces, and Homological Invariants

I'm thrilled to be delivering an invited address at the fall eastern sectional meeting of the AMS. Rather than explaining the details of what I've worked on, I'll focus attention on why you should care.

For as long as mathematicians have studied knots and links—smooth embeddings of circles into S^3, considered up to isotopy—they have studied the smoothly embedded surfaces they bound. As with most of mathematics, one big reason they do it is that they can. Spend a few minutes doodling knot diagrams in your algebraic topology notebook (or watch Vi Hart's awesome "Snakes and Graphs" video on YouTube) and you'll see that every knot bounds a so-called checkerboard surface as in Figure 1. This surface is not guaranteed to be orientable, and typically isn't. Spend a bit more time doodling, though, and perhaps you'll rediscover Seifert's algorithm, which explicitly constructs an orientable surface in S^3 bounded by the knot.

Constructing surfaces bounded by a given knot is easy. It is much harder to determine whether any given surface one constructs has minimal possible complexity, as measured by its genus or, more generally, by the number of critical points of a Morse function inherited from an embedding.

Thanks to decades of (largely pre-YouTube) work, we know a lot more than we used to about questions of this type. But there are a number of basic points on which we remain ignorant. I'll highlight just one.

Consider the standard radial function on $\mathbb{R}^4$. The four-ball, B^4, is the set of points of radius at most 1, and its boundary is the three-sphere, S^3. Over 50 years ago, Fox asked the following question: *If a knot in S^3 bounds a smoothly embedded disk in B^4, does it bound a smoothly embedded disk in B^4 for which the radial function, when restricted to the embedding, has no local maxima?*

The expectation (hope? dream?) that the answer to Fox's question is yes is known as the *slice-ribbon conjecture*, since knots satisfying the first condition are called slice, and knots satisfying the second are called *ribbon*. The question may seem easy to resolve. It isn't. In fact, it is wide open in every sense. Even mathematicians who have thought seriously about it would feel uncomfortable betting money on one side or the other.

Old nails call for new hammers. Some of the best modern tools we have for studying smoothly embedded surfaces in B^4 are homological invariants coming from

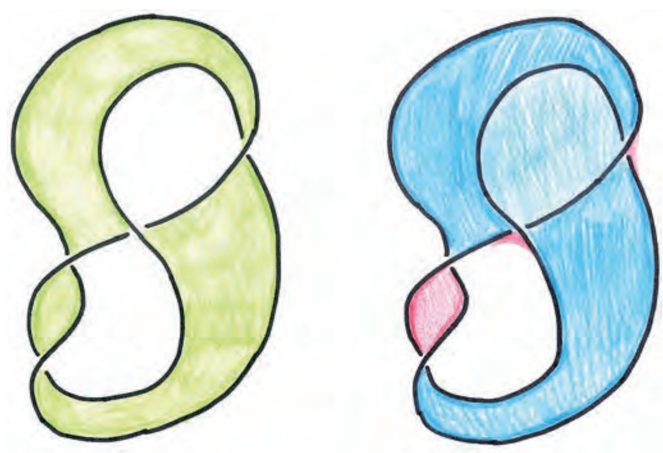

Figure 1. Every knot, such as the figure-eight knot pictured here, bounds a checkerboard surface and an orientable Seifert surface.

J. Elisenda Grigsby is professor of mathematics at Boston College and a deputy director at the Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown. Her email address is grigsbyj@bc.edu.

DOI: http://dx.doi.org/10.1090/noti1710

quantum topology, gauge theory, and symplectic geometry. In brief, one begins with data specifying a knot (for example, a knot diagram) and constructs from this data an abstract chain complex whose homology is independent of the choices made in its construction. An embedded surface in B^4 induces a map on the complex, and this map is well behaved with respect to internal gradings in the theory. In particular, the Euler characteristic of the surface bounds the map's degree, and one uses this fact to obtain a lowerbound on the genus.

Old nails call for new hammers.

To illustrate the power of this idea and connect it back to Fox's slice-ribbon question, let me describe a classical family of examples from complex geometry, made famous by John Milnor. Let p and q be a pair of relatively prime positive integers, and consider the vanishing set of the polynomial $f(z,w) = z^p + w^q$ in $\mathbf{C}^2$. Intersect this vanishing set with a three-sphere centered at the origin, and the resulting knot sits as a slope p/q curve on a standardly embedded torus. One natural way to construct a Seifert surface for this knot is by realizing it as the closure of a positive braid on q strands and forming a surface compatible with this presentation. A glance at Figure 2 tells us that the oriented surface constructed in this way has Euler characteristic $p - q(p-1)$. Noting that its boundary is connected, we compute that its genus is $(p-1)(q-1)/2$.

Milnor conjectured that one cannot find a lower genus surface bounded by the (p,q) torus knot, even when the surface is allowed to lie in the interior of B^4. Milnor's conjecture was eventually proved in the 1990s by Kronheimer and Mrowka using gauge theory. It has since been reproved using many of the more recently defined homological invariants. Indeed, the work of Kronheimer-Mrowka, combined with further work of Rudolph and Boileau-Orevkov, has the following consequence: *Any knot realizable as the transverse intersection of an affine complex plane curve with a round three-sphere satisfies a generalized version of the slice-ribbon conjecture.* That is, the minimal genus surface such a knot bounds in B^4 can be assumed to have no local maxima.

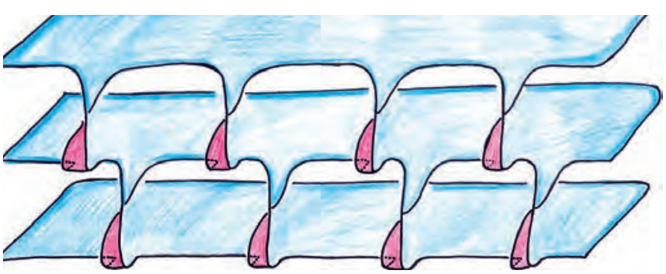

Figure 2. This braided surface bounded by a (3,4)-torus knot has genus (3-1)(4-1)/2 = 3.

Unfortunately, none of the homology theories can be applied off the shelf in any obvious way to give more widely applicable information about the slice-ribbon conjecture. The great hope is to define a computable ribbon obstruction one might apply to a slice knot (for example, one of those constructed in a 2010 paper of Gompf, Scharlemann, and Thompson) to produce a counterexample to the conjecture. But the internal gradings in the theories cannot distinguish between a local maximum and a minimum of the radial function, so it is not clear how to proceed. There are hints, however, that so-called *annular* versions of the theories well suited to studying braids and their closures in the complement of the braid axis may have more success.

In my talk, I will focus on a link homology theory due to Khovanov and extended by E. S. Lee and J. Rasmussen (see Figure 3).

The annular version of this theory was defined by Asaeda-Przytycki-Sikora in 2004 and re-interpreted by L. Roberts in 2007. More recently, my collaborators—J. Baldwin, T. Licata, Y. Ni, and S. Wehrli—and I have made further progress. While first attempts to find effective ribbon obstructions using this theory have been unsuccessful, we have uncovered a good deal of new information about braids, braid conjugacy classes, and braided surfaces. The annular version of the theory also carries additional algebraic structure, which has closely tracked the theory's topological and geometric applications. For example, it admits an action of the Lie algebra sl(2), and many key results and constructions can be phrased in terms of this action. With luck, this enhanced algebraic structure will point the way to other topological applications; or our failed attempts in this setting can be successfully carried out elsewhere; or both…

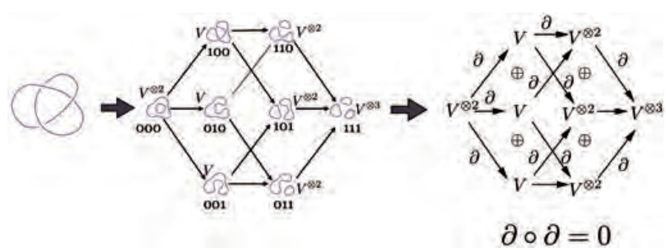

Figure 3. Khovanov discovered how to use the data of a link diagram to construct a multiply-graded chain complex whose homology is a link invariant. His construction was extended by Lee and Rasmussen to give strong information about surfaces in the four-ball.

Image Credits

Figure 1 by Siddhi Krishna, @knotofthepress. https://drive.google.com/file/d/1IGmGxTlpRkXxDxOg2boedUaRyYZMgEnQ/view.

Figure 2 by Siddhi Krishna, @knotoffthepress. https://drive.google.com/file/d/1xgQFmIoUlBCw7hnpu2EH54XTSR5LJEJY/view.

Figure 3 and author photo courtesy of Elisenda Grigsby.

Elisenda Grigsby

ABOUT THE AUTHOR

Elisenda Grigsby's background is in low-dimensional topology. She has developed a side interest in the mathematics behind neural networks, which she blogs about as often as she can (that is, as often as her kids—ages 4 and 7—allow) at `iamalearningcomputer.blogspot.com`.

Voting is open August 20–November 2

2018 American Mathematical Society Elections

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Ballots

AMS members will receive email with instructions for voting online by August 20, or a paper ballot by September 20. If you do not receive this information by that date, please contact the AMS (preferably before October 1) to request a ballot. Send email to ballot@ams.org or call the AMS at 800-321-4267 (within the US or Canada) or 401-455-4000 (worldwide). The deadline for receipt of ballots is November 2, 2018.

Write-in Votes

It is suggested that names for write-in votes be accompanied by the institution or web address of the individual for whom the vote is cast.

Replacement Ballots

A member who has not received a ballot by September 20, 2018, or who has received a ballot but has accidentally spoiled it, may write to ballot@ams.org or Secretary of the AMS, 201 Charles Street, Providence, RI 02904-2213, USA, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request a second ballot, indistinguishable from the original, will be sent by first class or airmail. However, the deadline for receipt of ballots will not be extended.

Biographies of Candidates

The next several pages contain biographical information about all candidates. All candidates were given the opportunity to provide a statement of not more than 200 words to appear at the end of their biographical information. Photos were supplied by the candidates.

Description of Offices

The **vice president** and the **members at large of the Council** serve for three years on the Council. That body determines all scientific policy of the Society, creates and oversees numerous committees, appoints the treasurers and members of the Secretariat, makes nominations of candidates for future elections, and determines the chief editors of several key editorial boards. Typically, each of these new members of the Council will also serve on one of the Society's five policy committees. Current and past members of the Council may be found here: www.ams.org/comm-all.html#COUNCIL.

The **Board of Trustees**, of whom you will be electing one member for a five-year term, has complete fiduciary responsibility for the Society. Among other activities, the trustees determine the annual budget of the Society, prices of journals, salaries of employees, dues (in cooperation with the Council), registration fees for meetings, and investment policy for the Society's reserves. The person you select will serve as chair of the Board of Trustees during the fourth year of the term. Current and past members of the Board of Trustees, as well as the full charge for a

Trustee, may be found here: www.ams.org/comm-all.html#BT.

The candidates for **vice president**, **members at large**, and **trustee** were suggested to the Council either by the Nominating Committee or by petition from members. While the Council has the final nominating responsibility, the groundwork is laid by the **Nominating Committee**. The candidates for election to the Nominating Committee were nominated by the current President, Kenneth A. Ribet. The three elected will serve three-year terms. The main work of the Nominating Committee takes place during the annual meeting of the Society, during which it has four sessions of face-to-face meetings, each lasting about three hours. The Committee then reports its suggestions to the spring Council, which makes the final nominations. Current and past members of the Nominating Committee, as well as the full charge, may be found here: www.ams.org/comm-all.html#NOMCOM.

The **Editorial Boards Committee** is responsible for the staffing of the editorial boards of the Society. Members are elected for three-year terms from a list of candidates named by the president. The Editorial Boards Committee makes recommendations for almost all editorial boards of the Society. Managing editors of *Journal of the AMS*, *Mathematics of Computation*, *Proceedings of the AMS*, and *Transactions of the AMS*; and Chairs of the *Colloquium*, *Mathematical Surveys and Monographs*, and *Mathematical Reviews* editorial committees are officially appointed by the Council upon recommendation by the Editorial Boards Committee. In virtually all other cases, the editors are appointed by the president, again upon recommendation by the Editorial Boards Committee. Current and past members of the Editorial Boards Committee, as well as the full charge, may be found here: www.ams.org/com-all.html#EBC.

Elections to the **Nominating Committee** and the **Editorial Boards Committee** are conducted by the method of approval voting. In the approval voting method, you can vote for as many or as few of the candidates as you wish. The candidates with the greatest number of the votes win the election.

A Note from AMS Secretary Carla D. Savage

The choices you make in these elections impact the direction the Society takes in its publications, conferences, programs, and policies. On behalf of the other officers and Council members, I urge you to take a few minutes to review the candidates' biographies, fill out your ballot, and submit it. The Society belongs to its members and by voting, you will influence its policies and priorities.

Also, I invite you to consider other ways of participating in Society activities. The Nominating Committee, the Editorial Boards Committee, and the Committee on Committees are always interested in learning of members who are willing to serve the Society in various capacities. Names are always welcome, particularly when accompanied by a few words detailing the person's background and interests. Self-nominations are probably the most useful. Recommendations can be transmitted through an online form (www.ams.org/committee-nominate) or sent directly to the secretary: secretary@ams.org or Office of the Secretary, American Mathematical Society, Department of Computer Science, Box 8206, North Carolina State University, Raleigh, NC 27695-8206 USA.

PLEASE VOTE.

Biographies of Candidates 2018

Biographical information about the candidates has been supplied and verified by the candidates.

Candidates have had the opportunity to make a statement of not more than 200 words on any subject matter without restriction and to list up to five of their research papers.

Candidates have had the opportunity to supply a photograph to accompany their biographical information. Acronyms: AAAS (American Association for the Advancement of Science); AMS (American Mathematical Society); ASA (American Statistical Association); AWM (Association for Women in Mathematics); CBMS (Conference Board of the Mathematical Sciences); CCR (Center for Communications Research); ECCO (Encuentro Colombiano de Combinatoria); IAS (Institute for Advanced Study), IBM (International Business Machines); ICERM (The Institute for Computational and Experimental Research in Mathematics; ICM (International Congress of Mathematicians); IMA (Institute for Mathematics and Its Applications); IMS (Institute of Mathematical Statistics); IMU (International Mathematical Union); IPAM (Institute for Pure and Applied Mathematics); JAMS (Journal of the AMS); LMS (London Mathematical Society); MAA (Mathematical Association of America); MCTP (Mentoring Through Critical Transition Points in the Mathematical Sciences); MSRI (Mathematical Sciences Research Institute); NAS (National Academy of Sciences); NRC (National Research Council); NSF (National Science Foundation); NZMS (New Zealand Mathematical Society); PIMS (Pacific Institute for the Mathematical Sciences); SIAM (Society for Industrial and Applied Mathematics); STEM (Science, Technology, Engineering and Mathematics).

courtesy of Sara Billey

Vice President

Sara Billey

Professor of Mathematics, University of Washington.

PhD: University of California, San Diego, 1994.

AMS Offices: Member at Large, AMS Council, 2005–2008.

AMS Committees: David P. Robbins Prize Selection Committee, 2015–2018; Western Section Program Committee, 2014–2016.

Selected Addresses: Plenary Speaker, Canadian Discrete and Algorithmic Mathematics Conference, Victoria, 2011; Plenary speaker, Nebraska Conference for Undergraduate Women, 2012; Four part invited lecture series, Mathematical Society of Japan Seasonal Institute, Osaka, 2012; AMS-MAA Invited Lecture, MathFest, Portland, 2014; Invited lecturer series, Encuentro Colombiano de Combinatoria (ECCO), Bogotá, 2014.

Additional Information: National Physical Science Consortium Fellowship supported by IBM and UCSD, 1990–1994; NSF Postdoctoral Fellowship, 1994–1998; UC Presidential Postdoctoral Fellowship, 1995–1997; NSF CAREER Award, 2000–2006; Presidential Early Career Award (awarded by Bill Clinton), 2000; Top Cited Author Award for Advances in Applied Math, 2005–2010, shared with A. Postnikov; Focus Board Member, Center for Communications Research (CCR), 2011–2014; Inaugural Fellow, American Mathematical Society, 2012; Editor for *Advances in Math*, 2004–2016, *Journal of Combinatorics*, 2010–present, and *Algebraic Combinatorics*, 2018; Program committee for the 2016 SIAM Meeting on Discrete Mathematics; Member, Policy, and Advocacy Committee for the Association of Women in Mathematics (AWM), 2016–2018; Faculty mentor, UW Student Chapter of the AWM, 2016–present; Member, scientific committee for ECCO, 2018; Program co-chair, FPSAC, Ljubljana, Slovenia, 2019; Member, AWM, MAA, SIAM, lifetime member of the AMS.

Selected Publications: 1. with M. Haiman, Schubert polynomials for the classical groups. *J. Amer. Math. Soc.*, **8** (1995), no. 2, 443–482. **MR1290232 (98e:05109)**; 2. Kostant polynomials and the cohomology ring for *G/B*, *Duke Math. J.*, **96** (1999), no. 1, 205–224. **MR1663931** (2000a:14060); 3. with V. Lakshmibai, Singular loci of Schubert varieties, *Progress in Mathematics*, **182**, Birkhäuser Boston, Inc., Boston, MA (2000). **MR1782635 (2001j:14065)**; 4. with F. Ardila, Flag arrangements and triangulations of products of simplices, *Adv. Math.*, **214** (2007), no. 2, 495–524. **MR2349710 (2008k:32080)**; 5. with M. Konvalinka and F. Matsen, On the enumeration of tanglegrams and tangled chains, *J. Combin. Theory Ser. A*, **146** (2017), 239–263. **MR3574231**.

Statement by Candidate: I am honored to run for Vice President of the American Mathematical Society. The AMS plays a key role in national and international advocacy for mathematicians in terms of funding, career opportunities, publishing, MathJobs.Org, research, and education. My professional goals align well with the mission of the AMS. I am devoted to mathematics research, teaching, and outreach. I am dedicated to mentoring a diverse group of mathematicians at all stages of their careers in partnership with AWM and ECCO. I have enjoyed collaborating with mathematicians in industry and government at IBM and CCR, and strive to open up opportunities for students to go into a wide variety of careers. If elected, I will work to achieve the mission of the AMS including promoting mathematics research, communication, and understanding. I will emphasize the importance of connecting professional mathematicians inside and outside of academia. I envision more common tools for the profession such as creating a common app for graduate school and increasing diversity in mathematical sciences by expanding opportunities through the AMS. I am committed to the success and advancement of the AMS as a professional society and look forward to having this opportunity to serve the members of the organization.


Photo courtesy of Abigail Thompson

Vice President

Abigail Thompson

Professor and Chair of Mathematics, University of California, Davis.

PhD: Rutgers, 1986.

AMS Committees: Centennial Prize Committee, 2002–2004 (Chair, 2003–2004); Editorial Boards Committee, 2005–2008 (Chair, 2007–2008); Committee on the Profession, 2011–2014 (Chair, 2012–2014); Fellows Program Selection Committee, 2015–2018 (Chair, 2016–2017).

Selected Addresses: University of Texas, Austin, Distinguished Women in Mathematics Lecture, 2009; Humboldt State University, Kieval Lecture, 2013; Trinity College, Dublin, William Rowan Hamilton Geometry and Topology Conference, 2015; Institute for Advanced Study, Members' Seminar, 2015; University of Nebraska, Nebraska Conference for Undergraduate Women in Mathematics, 2016.

Additional Information: Lady Davis Fellow, Hebrew University, 1986–1987; UC President's Fellow, 1987–1988; NSF Postdoctoral Fellow, 1988–1991; Member, Institute for Advanced Study, Princeton, 1990–1991, 2000–2001, 2015–2016; Alfred P. Sloan Foundation Research Fellow, 1991–1993; NSF Career Advancement Award, 1994–1995; Director, COSMOS (California State Summer School in Math and Science) program, UC Davis, 2001–2017; American Mathematical Society Ruth Lyttle Satter Prize, 2003; Member, Executive Committee AWM, 2006–2009; UC Davis Distinguished Teaching Award for Graduate Teaching, 2010; Fellow, American Mathematical Society, 2013.

Selected Publications: 1. Thin position and the recognition problem for S_3", *Math. Res. Lett.*, **1** (1994), no. 5, 613–630. **MR1295555 (95k:57015)**; 2. Thin position and bridge position for knots in the 3-sphere, *Topology*, **36** (1997), no. 2, 505–507. **MR1415602 (97m:57013)**; 3. with J. Hass and W. Thurston, Stabilization of Heegaard splittings, *Geom. Topol.*, **13** (2009), no. 4, 2029–2050. **MR2507114 (2010k:57044)**; 4. with R. E. Gompf and M. Scharlemann, Fibered knots and potential counterexamples to the property *2R* and slice-ribbon conjectures, *Geom. Topol.*, **14** (2010), no. 4, 2305–2347. **MR2740649 (2012c:57012)**; 5. Does diversity trump ability? *Notices Amer. Math. Soc.*, **61** (2014), no. 9, 1024–1030. **MR3241558**.

Statement by Candidate: I'm honored to be nominated for this position. Mathematicians and the AMS have been remarkably successful at anticipating and meeting important needs of the mathematical community. MathJobs is a great example. It's crucial for the AMS to proactively identify similar new opportunities to continue to strengthen the community. As an example to consider: While many of our new PhDs want to stay in academia, the academic job market is uncertain at best, and industries should be lining up trying to lure away our new PhDs. With this in mind, we could consider initiating a math-PhD-to-industry pipeline by starting a version of MathJobs for industry internships. More philosophically, mathematics is the search for truth. We need to resist the miasma of relativism spreading through the academy, while striving to make mathematics welcoming to all. Supporting excellent mathematics should be kept in focus as the fundamental goal of the AMS.


Photo courtesy of Matthew Ando

Board of Trustees

Matthew Ando

Professor of Mathematics and Associate Dean for Life and Physical Sciences, University of Illinois at Urbana–Champaign.

PhD: MIT, 1992.

AMS Offices: Member of the Council, 2011–2014.

AMS Committees: Committee on Publications, 2011–2013 (Chair, 2013); Department Chairs Workshop Co-Leader, 2015–2017.

Selected Addresses: Newton Institute, 2002; Abel Symposium, Oslo, 2007; Colloquium, Yale University, 2008; Fields Institute, 2010; Colloquium, University of Göttingen, 2015.

Additional Information: Chair, Department of Mathematics, University of Illinois, 2011–2017; Member, TPSE Mathematics Advisory Group, 2016–present; Member, Steering Committee, BIG Math Network, 2016–2018; Member: AMS, AWM, MAA.

Selected Publications: 1. Power operations in elliptic cohomology and representations of loop groups, *Trans. Amer. Math. Soc.*, **352**, 12 (2000). **MR1637129**. **(2001b:55016)**; 2. with M. Hopkins and N. Strickland, Elliptic spectra, the Witten genus, and the Theorem of the Cube, *Invent. Math.*, **146** (2001). **MR1869850 (2002g:55009)**; 3. The sigma orientation for analytic equivariant elliptic cohomology, *Geom. Topol.*, **7** (2003). **MR1988282 (2004d:55006)**; 4. with A. Blumberg, D. Gepner, M. Hopkins, and C. Rezk, an ∞-categorical approach to *R*-line bundles, *R*-module Thom spectra, and twisted *R*-homology, *J. Topol.*, **7** (2014), 869–893. **MR3252967**; 5. with A. Blumberg and D. Gepner, Parametrized spectra, multiplicative Thom spectra, and the twisted Umkehr map, to appear, *Geom. Topol.*

Statement by Candidate: It has been an honor to serve the American Mathematical Society in a number of ways, for example, as a member of the Council, as a leader of the Department Chairs Workshop, and on the Committee on Publications. The AMS played an important role in supporting my work as department chair, for example by hosting the graduate school fair and poster sessions at the JMM and by hosting the Find Graduate Programs in the Mathematical Sciences web page. For another example, the Committee on Education, the Committee on the Profession, and others repeatedly rose to the task of convening timely and important discussions on issues facing the mathematics profession. The most important challenges facing the profession are broadening participation in and access to the mathematical sciences and increasing public, private, and governmental understanding of and support for mathematical sciences. I am excited by the work that the AMS is doing in these areas, and I am eager to see more. The trustees oversee the business affairs and fiscal health of the AMS. My recent experience with financial stewardship includes chairing my department from 2011 to 2017 and chairing a task force at my university which initiated campus-wide budget reform. From these experiences I have learned that good financial stewardship includes investing in projects which are important to the future of the enterprise.

Board of Trustees

Rick Miranda
Provost and Executive Vice President, Colorado State University.
PhD: Massachusetts Institute of Technology, 1979.
AMS Committees: Committee on Meetings and Conferences, 1999–2002; Committee on International Meetings, 2000; Committee on the Profession, 2007–2010; Committee on Professional Ethics, 2016–present.
Selected Addresses: "Interpolation theorems via degeneration techniques," Algebraic Geometry Colloquium Lecture, Princeton University, November 2007; "Degenerations and applications to interpolation problems," Plenary talk, Conference on Algebraic Geometry, D-Modules, Foliations, and their interactions, Buenos Aires, Argentina, July 2008; "The Role of University Administrators", Workshop on Transforming Post-Secondary Education (TPSE-Math), Washington, September 2015; "Applications of toric methods to interpolation of fat points in P^2," University of Rome Geometry Colloquium, June 2017; "International Education and University Partnerships," Conference of University Presidents, Qingdao, China, October 2017.
Selected Publications: 1. with R. James, A Riemann-Roch theorem for edge-weighted graphs, *Proc. Amer. Math. Soc.*, **141** (2013), no. 11, 3793–3802. MR3091769; 2. with C. Ciliberto, Homogeneous interpolation on ten points, *J. Algebraic Geom.*, **20** (2011), no. 4, 685–726. **MR2819673 (2012h:14013)**; 3. with A. Calabri, C. Ciliberto, and F. Flamini, On the K^2 degenerations of surfaces and the multiple point formula, *Ann. of Math.*, **165** (2007), 335–395. **MR2299737 (2008c:14018)**; 4. Algebraic Curves and Riemann Surfaces, AMS Graduate Studies in Mathematics, **5** (1995), 395 pages. **MR1326604 (96f:14029)**; 5. with C. Ciliberto and A. Lopez, Projective degenerations of K3 surfaces, Gaussian maps, and Fano threefolds, *Invent. Math.*, **114** (1993), no. 3, 641–667. **MR1244915 (94k:14028)**.
Statement by Candidate: It is an honor to be nominated to assist the Society in this role of overseeing its business operations with an eye to long-term financial health and stability. As Provost/Executive Vice President (P/EVP) at Colorado State, I am responsible for academic affairs, university operations, and budgets for the university and work closely with our Board of Governors as the Chief Academic Officer of our System. I hope that my sixteen years of experience as Dean and P/EVP will be useful to the Society. I will work hard to help the Society's leadership in ensuring that we remain an indispensable asset to our members and to the profession.

Member at Large

Dan Freed
Kerr Centennial Professor of Mathematics, University of Texas at Austin.
PhD: University of California, Berkeley, 1985.
AMS Committees: AMS Task Force on Electronic Journals, 1995; AMS National Program Committee, 1998–2001; AMS Committee on Steele Prizes, 2004–2006; AMS Special Program Committee, 2012–2014; AMS Central Section Program Committee, 2014–2016; AMS Committee on Science Policy, 2015–2017; AMS Program Committee for National Meetings, 2018–2021.
Selected Addresses: AMS Eastern Sectional Meeting, Boston, 1995; International Congress of Mathematical Physics, London, 2000; International Congress of Mathematicians, Beijing, 2002; Arbeitstagung, Bonn, 2017; String-Math Conference, Sendai, 2018.
Additional Information: Sloan Fellow, 1988–1992; NSF Presidential Young Investigator Award, 1990–1996; Cofounder and Steering Committee, Park City/IAS Mathematics Institute, 1990–1999; Scientific Advisory Committee, Simons Center for Geometry and Physics, 2000–2010; Guggenheim Fellow, 2002–2003; Scientific Advisory Committee, MSRI, 2002–2006; Scientific Advisory Board, BIRS, 2005–2008; Board of Trustees, MSRI, 2006–2019; Fellow, AMS, 2012; Senior Berwick Prize, London Mathematical Society, 2014; IBM Einstein Fellow, IAS, 2015; General Member, Aspen Center for Physics, 2015–2020; Distinguished Visiting Research Chair, Perimeter Institute, 2016-2018; Poincaré Distinguished Visiting Professor, Stanford, 2017; Organizer of over 30 conferences and workshops.
Selected Publications: 1. with J.-M. Bismut, The analysis of elliptic families. II. Dirac operators, eta invariants, and the holonomy theorem, *Comm. Math. Phys.*, **107** (1986),

no. 1, 103–163. MR0861886 **(88h:58110b)**; 2. Higher algebraic structures and quantization, Comm. *Math. Phys.*, **159** (1994), no. 2, 343–398. MR1256993 **(95c:58034)**; 3. with M. J. Hopkins, Teleman, Constantin, Loop groups and twisted K-theory III., *Ann. of Math. (2)* **174** (2011), no. 2, 947–1007. MR2831111; 4. with R. Melrose, A mod *k* index theorem., *Invent. Math.*, **107** (1992), no. 2, 283–299. MR1144425 **(93c:58212)**; 5. with G. W. Moore, Twisted equivariant matter, *Ann. Henri Poincaré*, **14** (2013), no. 8, 1927–2023. MR3119923.

Statement by Candidate: It is an honor to be nominated for election as a Member at Large of the AMS Council. For 130 years the AMS has represented the interests of mathematics and mathematicians, and I look forward to continuing that advocacy. Mathematics research plays a critical role in society, now and in the future, and strengthening mathematics education at all levels is a profound challenge we must meet. In order to sustain and renew our community, we must nurture mathematical talent in those from a diversity of backgrounds and age ranges. We must also become more effective and visible in the public sphere. I look forward to collaborating with my colleagues on these and many more important issues.

Member at Large

Fernando Q. Gouvêa

Carter Professor of Mathematics, Colby College.

PhD: Harvard, 1987.

Selected Addresses: William M. Bullitt Lecture, University of Louisville, April 2000; Physics Department Colloquium, Brookhaven National Laboratory, May 2000; Frederick V. Pohle Colloquium on the History of Mathematics, Adelphi University, November 2004; Plenary Address, Joint Mathematics Meetings, Atlanta, January 2005; MAA Carriage House Lecture, June 2012.

Additional Information: Member, MAA, 1981–; Lester R. Ford Award, 1995; Editor, *MAA Focus*, 1999–2011; Editor, *MAA Reviews*, 2005–; Beckenbach Book Prize, 2006; Co-organizer, Contributed Paper Session on "Mathematical Texts: Famous, Infamous, and Influential," Joint Mathematics Meetings, 2010; Member of the program committee, X Seminário Nacional de História da Matemática and CLE4Science, Campinas, Brazil, March 2013; Editor, *Carus Mathematical Monographs*, 2013–2019.

Selected Publications: 1. with W.P. Berlinghoff, *Math through the ages: A gentle history for teachers and others*, Expanded second edition, MAA Textbooks. A joint publication of Oxton House Publishers, Farmington, ME; and Mathematical Association of America, Washington, DC, 2015. xiv+331 pp. MR3443340; 2. *A guide to groups, rings, and fields*, The Dolciani Mathematical Expositions, 48. MAA Guides, 8, Mathematical Association of America, Washington, DC, 2012. xviii+309 pp. MR3013267; 3. Was Cantor surprised? *Amer. Math. Monthly*, **118** (2011), no. 3, 198–209. MR2800330 **(2012f:01016)**; 4. Where the slopes are, *J. Ramanujan Math. Soc.*, **16** (2001), no. 1, 75–99. MR1824885 **(2002f:11062)**; 5. *p*-adic numbers. An introduction, Universitext, Springer-Verlag, Berlin, 1993. vi+282 pp. MR1251959 **(95b:11111)**.

Statement by Candidate: As a member of AMS for more than 30 years, I have benefitted from its work promoting mathematics, supporting the mathematics research community, and publishing books and journals. Becoming part of the AMS governance structure would allow me to help the Society continue its work in all of these areas.

Member at Large

Christopher D. Hacon

McMinn Presidential Endowed Chair, Distinguished Professor, University of Utah.

PhD: University of California, Los Angeles, 1993.

AMS Committees: Fellows Program Selection Committee, 2013–2016; Cole Prize Selection Committee, 2015; Western Section Program Committee, 2015–2016 (Chair, 2016).

Selected Addresses: Plenary Speaker, AMS Fall Sectional Meeting, University of California, Riverside, 2009; Invited Lecture, Algebraic and Complex Geometry Session, ICM, 2010; Plenary Speaker, British Mathematical Colloquium, Edinburgh, 2010; Plenary Speaker, European Congress of Mathematics, Krakow, 2012; Plenary Speaker, JMM, Baltimore, 2014; Plenary Speaker, AMS Summer Institute, Salt Lake City, 2015.

Additional Information: MSRI Science Advisory Committee, 2012–2018 (co-chair. 2015–2018); ICM committee for the selection of sectional speakers in Algebraic and Complex Geometry, 2014; Selection Committee, Alfred P. Sloan Research Fellowships in Mathematics, 2015–2018; Editor, *Journal of Algebraic Geometry*, since 2009; Associate Editor, *Journal of the American Mathematical Society*, 2009–2017; Associate Editor, *Annals of Mathematics*, since 2013; Editor, *Bollettino dell'Unione Matematica Italiana*, since 2013; Associate Editor, *Cambridge Journal of Mathematics*, since 2016; Associate editor, *Journal of Pure and Applied Algebra*, since 2016; Clay Research Award, 2007; Frank Nelson Cole Prize in Algebra, 2009; Antonio Feltrinelli Prize in Mathematics, Mechanics, and Applications, 2011; Fellow of the AMS, 2013; University of Utah Distinguished Scholarly and Creative Research Award, 2015; E.H. Moore Research Article Prize, 2016; Member of the American Academy of Arts and Sciences, 2017; Breakthrough Prize, 2018.

Selected Publications: 1. with C. Birkar, P. Cascini, and J. McKernan, Existence of minimal models for varieties of general type, *J. Amer. Math. Soc.*, **23** (2010), no. 2, 405–468, MR2601039 **(2011f:14023)**; 2. with J. McKernan, Existence of minimal models for varieties of general type II: Pl-flips, *J. Amer. Math. Soc.*, **23** (2010), no. 2, 469–490. MR2601040 **(2011f:14024)**; 3. with J. McKernan and C. Xu, ACC for log canonical thresholds, *Ann. of Math. (2)* **180** (2014), 523–

571. MR3224718; 4. with C. Xu, On the three dimensional minimal model program in positive characteristic, *J. Amer. Math. Soc.*, **28** (2015), no. 3, 711–744. MR3327534; 5. with J. McKernan and C. Xu, On the birational automorphisms of varieties of general type, *Ann. of Math. (2)* **177** (2013), 1077–1111. MR3034294.

Statement by Candidate: It is a great honor to have been nominated to run for the position of Member at Large of the AMS Council. The AMS plays an important role in promoting, advancing, and disseminating mathematical research; strengthening and supporting mathematical education; and promoting awareness and appreciation of mathematics and its connections with other disciplines. The Society also aims to create a diverse and inclusive environment inside the mathematical profession by encouraging full participation by all individuals. If elected, I hope to play an active role in strengthening the mathematics community and in helping the AMS to achieve its goals.

Photo courtesy of Max S. Gerber

Member at Large

Daniel Krashen

Professor, Rugers University.

PhD: University of Texas at Austin, 2001.

Selected Addresses: Speaker, Thematic Program on Torsors, Nonassociative Algebras and Cohomological Invariants, Fields Institute, 2013; Invited address, AMS Sectional Meeting, Knoxville, 2014; Speaker, The Use of Linear Algebraic Groups in Geometry and Number Theory, Banff International Research Station, 2015; Course Lecturer, Local-Global Principles and Their Obstructions, University of Pennsylvania, 2015; Speaker, Algebraic Geometry Northeastern Series (AGNES), Yale University, 2016.

Additional Information: Faculty Early Career Development (CAREER) Program Award, 2012; Presidental Early Career Award for Scientists and Engineers (PECASE), 2016; Fellow, American Mathematical Society, 2017.

Selected Publications: 1. with D. Harbater and J. Hartmann, Applications of patching to quadratic forms and central simple algebras, *Invent. Math.*, **178** (2009), 231–263. MR2545681; 2. with E. Matzri, Diophantine and cohomological dimensions, *Proc. Amer. Math. Soc.*, **143** (2015), no. 7, 2779–2788. MR3336603; 3. Period and index, symbol lengths, and generic splittings in Galois cohomology, *Bull. Lond. Math. Soc.*, **48** (2016), no. 6, 985–1000. MR3608943; 4. with B. Antieau and M. Ward, Derived categories of torsors for Abelian schemes., *Adv. Math.*, **306** (2017), 1–23. MR3581296; 5. with D. Harbater and J. Hartmann, Local-global principles for torsors over arithmetic curves., *Amer. J. Math.*, **137** (2015), no. 6, 1559–1612. MR3432268.

Statement by Candidate: I am honored to have the opportunity to serve as a Member at Large for the AMS. I plan to do my best to support the community of research mathematicians, to broaden the scope of outreach, and to work towards better retention of talent in our discipline in the early career stages.

Photo courtesy of Susan Loepp

Member at Large

Susan Loepp

Chair and Professor of Mathematics, Williams College.

PhD: University of Texas at Austin, 1994.

AMS Committees: Committee on the Profession, 2008–2011 (Chair, 2011), Subcommittee on Programs that Make a Difference, 2008–2011 (Chair, 2010, 2011); Task Force on Employment Prospects, 2009; Working Group on the Nominee Program, 2010; Secretary Search Committee, 2010–2011; Committee on Committees, 2011–2013; Committee on Women in Mathematics, 2017–2020.

Selected Addresses: MAA Invited Address, MathFest, Hartford, 2013; Keynote Address, Women In Mathematics In New England (WIMIN) Conference, Smith College, 2013; Richard R. Bernard Lecture, Davidson College, 2015; Invited Speaker, Southwestern Undergraduate Mathematics Research Conference, Arizona State University, 2016; Martin Guterman Lecture, Tufts University, 2017.

Additional Information: Deborah and Franklin Tepper Haimo Award for Distinguished College or University Teaching of Mathematics (MAA), 2012; AMS Fellow, Inaugural Class, 2012; Associate Editor, *The American Mathematical Monthly*, 2012–2022; Director, Williams College SMALL REU program, 2009, 2011, and 2013; member of MAA and AWM.

Selected Publications: 1. Excellent Rings with Local Generic Formal Fibers, *J. Algebra*, **201** (1998), 573–585. MR1612339 **(99a:13013)**; 2. with C. Rotthaus, Some Results on Tight Closure and Completion, *J. Algebra*, **246** (2001), 859–880. MR1872128 **(2002k:13010)**;
3. with P. Charters, Semilocal Generic Formal Fibers, *J. Algebra*, **278** (2004), 370–382. MR2068083 **(2005e:13008)**; 4. with W. Wootters, Protecting Information: From Classical Error Correction to Quantum Cryptography, *Cambridge University Press* (2006). MR2278947 **(2008e:94031)**; 5. with P. Jiang, A. Kirkpatrick, S. Mack-Crane, and S. Tripp, Controlling the Generic Formal Fibers of Local Domains and Their Polynomial Rings, *J. Commut. Algebra*, **7** (2015), no. 2, 241–264. MR3370486.

Statement by Candidate: I am honored to be nominated to run for Member at Large of the AMS Council. If elected, I will work to advance the mission of the AMS, which includes promoting mathematical research, supporting mathematical education at all levels, advancing the status of the profession, and encouraging and facilitating full participation of individuals from a variety of backgrounds. Concrete ways in which the AMS can promote its mission include: supporting opportunities for research collaborations; advocating for resources for faculty and students so that all students can thrive in their mathematical education; and increasing the visibility and support of mathematicians (through, for example, prizes and fellowships) in a way that reflects the increasing diversity of our profession.

Through my experience as both a member and as chair of the AMS Committee on the Profession, I witnessed the positive influence the AMS has on the mathematical community, and, as a member of the AMS Council, I would advocate for changes that would benefit everyone in mathematics.

Photo courtesy of Lenhard Ng

Member at Large

Lenhard Ng
Eads Family Professor of Mathematics, Duke University.
PhD: MIT, 2001.
AMS Committees: Southeastern Section Program Committee, 2014–2016.
Selected Addresses: Salomon Bochner Lectures in Mathematics, Rice University, 2006; Plenary Speaker, Knots in Washington, George Washington University, 2008; Lecture series, O Gosto pela Matemática, Fundação Calouste Gulbenkian, Lisbon, 2010; Invited Address, AMS Sectional Meeting, Tulane University, 2012.
Additional Information: NSF CAREER grant, 2009; Editor, *Quantum Topology*, 2009–present; Subcommittee for the USA Mathematical Olympiad, MAA, 2009–2014; Simons Fellow in Mathematics, 2015; Organizer for the semester program Symplectic Geometry and Topology, Institut Mittag-Leffler, 2015; Bass Society of Fellows (Duke), 2016; Co-director, Duke Opportunities in Mathematics (collaborative undergraduate research), 2017–present; Collaborating editor, Problems section, *American Mathematical Monthly*, 2017–present.
Selected Publications: 1. Framed knot contact homology, *Duke Math. J.*, 141 (2008), no. 2, 365 –406. **MR2376818 (2008k:53202)**; 2. Rational symplectic field theory for Legendrian knots, *Invent. Math.*, **182** (2010), no. 3, 451–512. **MR2737704**; 3. with M. Aganagic, T. Ekholm, and C. Vafa, Topological strings, D-model, and knot contact homology, *Adv. Theor. Math. Phys.*, **18** (2014), no. 4, 827–956. **MR3277674**; 4. with T. Ekholm, Legendrian contact homology in the boundary of a subcritical Weinstein 4-manifold, *J. Differential Geom.*, **101** (2015), no. 1, 67–157. **MR3356070**; 5. with T. Ekholm and V. Shende, A complete knot invariant from contact homology, *Invent. Math.*, **211** (2018), no. 3, 1149–1200. **MR3763406**.
Statement by Candidate: It is an honor to be considered to serve as a Member at Large of the AMS Council. The AMS provides a crucial platform for promoting the subject of mathematics to the outside world and developing the community of research mathematicians in the United States and beyond. I am very interested in issues around growing the base of our community to ensure a vibrant future for our subject. These include strongly promoting diversity in hiring and recruiting at all academic levels, advocating for funding opportunities to be as widely available as possible, and bolstering opportunities for young people (undergraduates and even high school students) to participate in mathematical research. If elected, I would welcome the opportunity to work toward these goals and to help the AMS' broad efforts to support the mathematical community.

Photo courtesy of Faye Levine/University of Maryland

Member at Large

Kasso A. Okoudjou
Professor, University of Maryland.
PhD: Georgia Institute of Technology, 2003.
Selected Addresses: Invited speaker, 19th Conference for African American Researchers in the Mathematical Sciences, UCSD, July 2013; Invited speaker, 5th International Conference, Computational Harmonic Analysis, Vanderbilt University, May 2014; Lecturer, AMS Short Course on Finite Frame Theory: A Complete Introduction to Overcompleteness, JMM, San Antonio, January 2015; Lecturer, IMA PI Summer Graduate Program: Modern Harmonic Analysis and Applications, College Park, July 2015; Invited speaker, 6th Cornell Conference on Analysis, Probability, and Mathematical Physics on Fractals, Cornell University, Ithaca, June 2017.
Additional Information: Junior Faculty Teaching Award, Department of Mathematics, Cornell University, 2004; Dean's Award for Excellence in Teaching, University of Maryland, 2009; Humboldt Research Fellowship for Experienced Researchers, 2010–2012; Organizer, AMS Short Course on Finite Frame Theory: A Complete Introduction to Overcompleteness, JMM, San Antonio, January 2015.
Selected Publications: 1. Embeddings of some classical Banach spaces into modulation spaces, *Proc. Amer. Math. Soc.*, **132** (2004), no.6, 1639–1647. **MR2051124 (2005b:46074)**; 2. with R. S. Strichartz, Weak uncertainty principles on fractals, *J. Fourier Anal. Appl.*, **11** (2005), no. 3, 315–331. **MR2167172 (2006f:28011)**; 3. with A. Bényi, K. Gröchenig, and L. Rogers, Unimodular Fourier multipliers on modulation spaces, *J. Funct. Anal.*, **246** (2007), no. 2, 366–384. **MR2321047 (2008c:42005)**; 4. with I. A. Krishtal, Invertibility of the Gabor frame operator on the Wiener amalgam space, *J. Approximation Theory*, **153** (2008), no. 2, 212–224. **MR2450070 (2009g:42059)**; 5. with G. Kutyniok, F. Philipp, and K. E. Tuley, Scalable frames, Linear Algebra Appl., 438 (2013), 2225–2238. **MR3005286**.
Statement by Candidate: I am honored to be nominated for election as a Member at Large of the AMS Council. The role of the AMS to promote mathematical research and teaching in the USA and abroad is indisputable. At the same time the challenges facing our discipline, e.g., college affordability, the ever decreasing federal and state funding for higher education and research, the reliance of colleges and universities on non-tenured faculty to carry out their teaching mission, the necessity of making our discipline more diverse, and the responsibility to reach out to mathematicians and aspiring mathematicians in

developing countries, all require the AMS to be proactive. If elected, and based on my experience, I shall give my best effort to formulate solutions to these challenges.

Photo courtesy of Maria Cristina Pereyra

Member at Large

Maria Cristina Pereyra

Professor, University of New Mexico.

PhD: Yale University, 1993.

Selected Addresses: Invited Speaker, Fourier Talks (FFT), Norbert Wiener Center, University of Maryland, College Park, 2010; Invited Speaker, 9th International Conference, Harmonic Analysis and Partial Differential Equations, El Escorial, Spain, 2012; Invited Speaker, Conference on Geometry, Analysis and Probability, Korea Institute for Advanced Study (KIAS), Seoul, South Korea, 2017; Invited Speaker, Session on Harmonic Analysis and Approximation Theory, 31st Brazilian Colloquium of Mathematics, IMPA, Rio de Janeiro, Brazil, 2017; Plenary Speaker, Harmonic Analysis Conference Celebrating the Mathematical Legacy of Alan McIntosh, Australian National University, Canberra, Australia, 2018.

Additional Information: Visiting Fellow: Centre de Recerca Matemática, Barcelona, Spain, 2003; Instituto de Matemáticas de la Universidad de Sevilla, Spain, 2011; University of South Australia (UniSA), Adelaide, Australia, 2011 and 2018. Co-director: UNM-PNM Statewide High School Mathematics Contest, New Mexico, 1999–2005. Co-organizer: New Mexico Analysis Seminar Annual Conferences, Albuquerque/Las Cruces, 1998-2009 and 2014-2016; CBMS-NSF Conference, Las Cruces, 2005; Conference honoring Mischa Cotlar, Albuquerque, 2007; Conference honoring Cora Sadosky, Albuquerque, 2014. Organizing Committee, ICM 2018 Satellite Conference, Brazil. Principal/Co-principal Investigator(co-PI): NSF-MCTP University of New Mexico, 2008-2017. Member: Institute for Advanced Study (IAS), Princeton, NJ. Honors and Awards: University of New Mexico Outstanding Teacher of the Year, 2012–2013.

Selected Publications: 1. with A. Kairema, J. Li, and L. A. Ward, Haar bases on quasi-metric measure spaces, and dyadic structure theorems for function spaces on product spaces of homogeneous type, *J. Func. Anal.*, **271** (2016), no. 7, 1793–1843. **MR3535320**; 2. with D. Chung and C. Perez, Sharp bounds for general commutators on weighted Lebesgue spaces, *Trans. Amer. Math. Soc.*, **364** (2012), 1163–1177. **MR2869172 (2012j:42019)**; 3. with O. Dragicevic, L. Grafakos, and S. Petermichl, Extrapolation and sharp norm estimates for classical operators on weighted Lebesgue spaces, *Publ. Mat.*, **49** (2005), no. 1, 73–91. **MR2140200 (2006d:42019)**; 4. with S. Efromovich, J. D. Lakey, and N. Tymes, Data-driven and optimal denoising of a signal and recovery of its derivative using multiwavelets, *IEEE Trans. Signal Process.*, **52** (2004), no. 3, p. 1–8; 5. Lecture notes on dyadic harmonic analysis, Second Summer School in Analysis and Mathematical Physics (Cuernavaca, 2000), 1–60, *Contemp. Math.*, **289**, AMS, 2001.

Statement by Candidate: It is an honor to be nominated for Member at Large of the Council of the AMS. Throughout my career I have devoted a lot of my time to promoting mathematics in the Southwest and beyond. Organizing many conferences, as co-PI for training MCTP-NSF grants, and organizing high school math competitions, all in New Mexico. Mentoring undergraduate/graduate students who have gone on to successful careers in teaching, in industry, and in academia in the US, Brazil, and Korea. Teaching many undergraduate to research level mini-courses in Argentina, Mexico, Spain, and the US (IAS, IMA). I have served my department as graduate chair for several years, as well as in many other departmental and university-wide committees. I have served in NSF research panels, I have coauthored two books and coedited two volumes honoring the late Cora Sadosky. I have been mindful of creating opportunities for junior and women/minority mathematicians. I have yet to serve in an official position in our professional mathematical societies; I do feel the time is ripe for me to step in, learn, and contribute to the overall AMS mission of promoting mathematics to the public at large and to furthering the interests of mathematical research, scholarship, and education.

Photo courtesy of the Department of Mathematics at the University of Illinois at Urbana-Champaign

Member at Large

Hal Schenck

Professor and Chair, Iowa State Mathematics.

PhD: Cornell University, 1997.

AMS Committees: Data Committee, 2006–2008; Math Research Community Advisory Board, 2008–2014; Employment Committee, 2016–present.

Selected Addresses: Invited hour address, AMS sectional meeting, New Orleans 2012; Invited lectures, NSF–DFG conference "Syzygies in Berlin," 2013; Invited lectures, SIAM workshop on applied toric geometry, 2013; Keynote address, 35th annual Pi Mu Epsilon conference, 2014; Invited lectures, KIAS conference, "Syzygies, exterior algebra, and cohomology," 2016.

Additional Information: College of Arts & Sciences Clark Award for distinguished teaching, Cornell, 1997; NSF Postdoc, 1998–2001; Organizer, Oberwolfach workshops 2007 (with Alicia Dickenstein, David Cox, Josef Schicho), 2015 (with Larry L. Schumaker, Tanya Sorokina), 2016, 2019 (with Diane Maclagan, Jürgen Hausen); Organizer, graduate student workshop on toric varieties (with David Cox): MSRI 2009, Cortona 2011, Taipei 2019; SIAM workshop on toric varieties (with John Little), 2013; College of Arts & Sciences award for excellence in undergraduate teaching, Illinois, 2015. Managing Editor: *Journal of Commutative Algebra*, 2008–2017; *Advances in Applied Mathematics*, 2018–present. Editorial boards: *International Journal of Algebra and Computation*, 2011–2017; Advances in Applied Math, 2014–2017; *Journal of Combinatorial Algebra, 2017–present. Officer, United States Army, 1986–1990.*

Selected Publications: 1. with D. Cox and J. Little, Toric varieties, *AMS Graduate Studies in Mathematics*, **124** (2011), 858 pp. MR2810322 **(2012g:14094)**; 2. Equivariant Chow cohomology of nonsimplicial toric varieties, *Trans. Amer. Math. Soc.*, **364** (2012), no. 8, 4041–4051. MR2912444; 3. with M. Stillman, High rank linear syzygies on low rank quadrics, *Amer. J. Math.*, **134** (2012), no. 2, 561–579. MR2905005; 4. with C. Irving, Geometry of Wachspress surfaces, *Algebra Number Theory*, **8** (2014), no.2, 369–396. MR3212860; 5. with D. Cohen, Chen ranks and resonance, *Adv. Math.*, **285** (2015), 1–27. MR3406494.

Statement by Candidate: I am honored to have been nominated for the position of Member at Large of the AMS Council. This is a crucial time for higher education, and I believe the AMS should take the lead in publicizing the value of mathematics and mathematical research. Our voice needs to be heard not only by elected officials and funding agencies, but within academia, as universities respond to financial pressure by replacing tenured faculty with non-tenured faculty. The explosion of jobs that require quantitative literacy means this is also a time of opportunity, and the AMS should foster connections and build bridges to industry and non-academic careers. Finally, it is essential that we work to ensure that our discipline is open and welcoming to all: my own mentoring work has focused on student veterans.

Photo courtesy of Joseph Rabinoff

Member at Large

Melanie Matchett Wood

Vilas Distinguished Achievement Professor, University of Wisconsin–Madison.

PhD: Princeton, 2009.

AMS Committees: AMS-MAA-SIAM Frank and Brennie Morgan Prize Committee, 2016–2019.

Selected Addresses: AMS Western Sectional Meeting Invited Address, 2010; Joint Mathematics Meetings MAA Invited Address, 2011; J. Sutherland Frame Lecture, MAA MathFest, 2012; John G. Kemeny Lectures, Dartmouth, 2016; Beatrice Yormark Distinguished Lecture, Stanford, 2016.

Additional Information: American Institute of Mathematics Five-Year Fellow, 2009; AMS Fellow, 2012; Assistant Director, Wisconsin Mathematics, Engineering, and Science Talent Search, 2012–present; Sloan Research Fellowship, 2015; Packard Fellowship for Science and Engineering, 2015; Editorial Board, *Journal de Théorie des Nombres de Bordeaux*, 2015–present; Regeneron Science Talent Search (formerly Westinghouse, Intel) Judging Panel, 2015–present; NSF CAREER Grant, 2017; AWM-Microsoft Research Prize in Algebra and Number Theory, 2018.

Selected Publications: 1. Parametrization of ideal classes in rings associated to binary forms, *J. Reine Angew. Math.*, **689** (2014), 169–199. MR3187931; 2. with R. Vakil, Discriminants in the Grothendieck ring, *Duke Math. J.*, **164** (2015), no. 6, 1139–1185. MR3336842; 3. with D. Erman, Daniel, Semiample Bertini theorems over finite fields, *Duke Math. J.*, **164** (2015), no. 1, 1–38. MR3299101; 4. with N. Boston, Nigel, Non-abelian Cohen-Lenstra heuristics over function fields, *Compos. Math.*, **153** (2017), no. 7, 1372–1390. MR3705261; 5. The distribution of sandpile groups of random graphs, *J. Amer. Math. Soc.*, **30** (2017), no. 4, 915–958. MR3671933.

Statement by Candidate: I am honored to be nominated to run for Member at Large of the Council of the AMS. The AMS plays a central role in promoting mathematics research and supporting the profession of mathematics. These are both crucial jobs in our world, where declining funding for science makes it even more important to communicate the importance of mathematics beyond our profession. On the one hand, the place of science and technology in the modern world and the key role mathematics plays across the sciences make it appear an easy message to communicate. On the other hand, any mathematician who has struck up a conversation with their neighbor on an airplane knows that there remains a lot of work to be done in properly communicating what we do and why it is important. The AMS is also in a great position to help make our profession more welcoming and encouraging to people of all genders, races, and backgrounds. A bright future requires the mathematical talent that all people have the ability to develop. I would like to see the AMS collect, evaluate, and disseminate best practices for making common processes of our profession, such as hiring and organizing conferences, as inclusive as possible.

Photo courtesy of Sami H. Assaf

Nominating Committee

Sami H. Assaf

Assistant Professor of Mathematics, University of Southern California.

PhD: University of California, Berkeley, 2007.

AMS Committees: AMS Representative for AWM/AMS Noether Lecture Committee, 2013–2016.

Selected Addresses: Invited Speaker, MIT Women in Mathematics: A Celebration, Cambridge MA, 2008; Invited Speaker, Mathematical Society of Japan Seasonal Institute International Conference, Schubert Calculus, Osaka, Japan, 2012; Keynote Speaker, Women in Mathematics in Southern California, Los Angeles, CA, 2017; Plenary Speaker, Formal Power Series and Algebraic Combinatorics, Hanover, NH, 2018.

Additional Information: USC Endowed Chair, Gabilan Assistant Professor of Mathematics, 2012–2017; USC Mentoring Award for Faculty Mentoring Undergraduates, 2017; Founder and Director, Venice Math Circle (weekly outreach program to empower preschool and kindergarten children to explore mathematics), 2017–2018.

Selected Publications: 1. Nonsymmetric Macdonald polynomials and a refinement of Kostka–Foulkes polynomials, *Trans. Amer. Math. Soc.*, to appear; 2. with D. Searles, Schubert polynomials, slide polynomials, Stanley symmetric functions and quasi-Yamanouchi pipe dreams, *Adv.*

Math., **306** (2017), 89–122. MR3581299; 3. Dual equivalence graphs I: A new paradigm for Schur positivity, *Forum Math. Sigma*, **3** (2015), e12, 33 pp. MR3376739; 4. with P. Diaconis, K. Soundararajan, A rule of thumb for riffle shuffling, *Ann. Appl. Probab.*, **21** (2011), no. 3, 843–875. MR2830606 **(2012f:60012)**; 5. with P. R. W. McNamara, A Pieri rule for skew shapes, *J. Combin. Theory Ser. A*, **118** (2011), no. 1, 277–290. MR2737201 **(2011k:05262).**
Statement by Candidate: I am honored to be considered for election to the Nominating Committee of the AMS. If elected, I will take to heart the important task of vetting potential leaders for this important organization, and I will engage in recruiting outstanding candidates to serve–candidates who share the values of the AMS and the larger mathematical community and who will work to advance the interests of mathematical research and education.


Photo courtesy of Ricardo Cortez

Nominating Committee

Ricardo Cortez
Pendergraft William Larkin Duren Professor, Mathematics Department, Tulane University.
PhD: University of California, Berkeley, 1995.
AMS Committees: Consultant, AMS Notices Editorial Board; AMS-Simons Travel Grants Committee; ICM Travel Grants Selection Committee.
Selected Addresses: Invited Address, AMS Southeastern Sectional, NC State, Fall 2016; Plenary, SIAM Southeastern Atlantic Sectional, Chapel Hill, NC, spring 2018; Invited Address, SIAM Conference on Applied Mathematics Education (ED18), July 2018.
Additional Information: NSF Postdoctoral Fellow, Courant Institute, 1995–1998; Director, Center for Computational Science, Tulane University, 2006 –2018; Blackwell–Tapia Prize, 2012; SIAM Fellow, 2017.
Selected Publications: 1. The Method of Regularized Stokeslets, *SIAM J. Sci. Comput.*, **23** (2001), no. 4, 1204–1225. MR1885598 **(2002k:76102)**; 2. With D. Brown, and M. Minion, Accurate Projection Methods for the Incompressible Navier–Stokes Equations., *J. Comput. Phys.*, **168** (2001), 464–499. MR1826523 **(2002a:76112)**; 3. with H.-N. Nguyen, Reduction of the Regularization Error of the Method of Regularized Stokeslets for a Rigid Object Immersed in a Three-Dimensional Stokes Flow, *Commun. Comput. Phys.*, **15** (2014), no. 1, 126–152. MR3094201; 4. with C. Anhalt, Mathematical Modeling: A Structured Process, *Mathematics Teacher*, **108** (2015), 6, February, 446–452, National Council of Teachers of Mathematics; 5. with J. Wrobel, S. Lynch, A. Barrett and L. Fauci, Enhanced flagellar swimming through a compliant viscoelastic network in Stokes flow, *J. Fluid Mech.*, **792** (2016) 775–797. MR3482199.
Statement by Candidate: It is an honor to be considered for the AMS Nominating Committee, whose charge to identify nominees for leadership positions at the Society is extremely important. The Society benefits from the ideas and contributions of people with a variety of viewpoints and a diversity of backgrounds. Over the years I have become involved in work that promotes mathematics and mathematics education research, and work that advances underrepresented minorities in mathematics. If elected, I will reach out to these professional networks in order to help generate a strong pool of diverse candidates who can lead the AMS and facilitate the participation of all its members.


Photo courtesy of Lisa Waters

Nominating Committee

Rebecca Garcia
Professor, Sam Houston State University.
PhD: New Mexico State University, 2004
AMS Committees: AMS Policy Committee on Meetings and Conferences 2017–2019 (Chair, 2018–2019).
Selected Addresses: Invited Speaker, AMS Western Regional Conference, 2012; Plenary Talk, CombinaTexas, 2014; Invited Speaker, SACNAS Scientific Symposium, 2017; Keynote Speaker, ASPiRE Conference, 2017.
Additional Information: Member of the MAA, AWM, and SACNAS; Co-Founder and Co-Director, Pacific Undergraduate Research Experience in Mathematics (PURE Math), 2011–2015; Distinguished College or University Teaching of Mathematics Award, Texas MAA Section, 2015; Co-Director, MSRI-UP, 2017–present.
Selected Publications: 1. with S. Meyer, S. and A. Seitz, Construction and enumeration of Franklin circles, *Involve*, **2** (2009), no. 3, 357–370. MR2551132 **(2011b:05014)**; 2. with M. Lane and B. Loft, Algebraic combinatorics of diametric magic circles, *Math. Comput. Simulation*, **82** (2011), no. 1, 44–53. MR2846414 **(2012j:05033)**; 3. with S. Chapman, R. García, L. Puente, M. Malandro, and K. Smith, Algebraic and combinatorial aspects of sandpile monoids on directed graphs, *J. Combin. Theory Ser. A*, **120** (2013), no. 1, 245–265. MR2971710; 4. with D. Silva, Order dimension of layered generalized crowns, *Ars Combin.*, **113A** (2014), 171–186. MR3202722; 5. with C. Wyels, REU design: broadening participation and promoting success, *Involve* **7** (2014), no. 3, 315–326. MR3423936.
Statement by Candidate: Over the last twenty years, I have participated in and led efforts promoting diversity and inclusiveness in the mathematical sciences: directing undergraduate research programs, organizing sessions at national conferences, and planning and organizing workshops and conferences. Given the honor and opportunity to serve in the Nominating Committee, I will leverage my experience and expertise to assist the AMS in its mission and efforts to broaden participation in the mathematical sciences.

Photo courtesy of Yongbin Ruan

Nominating Committee

Yongbin Ruan

Bill Fulton Collegiate Chair Professor of Mathematics, University of Michigan.

PhD: UC–Berkeley, 1991.

Selected Addresses: International Congress Invited Lecture, Berlin, 1998; Plenary Lecture, AMS Regional Meeting, 2001; Invited Lecture on Latin American Congress of Mathematicians, June 2004; six lectures at Imperial College, 2010; Invited Lecture on Pacific Rim International Congress of Mathematician, June 2013.

Additional Information: Sloan Research Fellowship 1995–1997; Vilas associated award 1998–2000; Distinguished Overseas Young Scientist Awards, National Natural Science Foundation of China, 2000–2003; The Ministry of Education of China, Changjiang (Jiangzhuo) Professor, 2000–2005; Clay Senior Scholar, 2006; AMS Fellow, 2015.

Selected Publications: 1. with G. Tian, A Mathematical Theory of Quantum Cohomology, *J. Differential Geom.*, **42**, no. 2 (1995), 259–367. MR1366548 **(96m:58033)**; 2. Topological sigma model and Donaldson type invariants in Gromov theory, *Duke Math. J.*, **83** (1996), no. 2, 461–500. MR1390655 **(97d:58042)**; 3. with W. Chen, A new cohomology theory of orbifolds, *Comm. Math. Phys.*, **248** (2004), no. 1, 1–31. MR2104605 **(2005j:57036)**; 4. with H. Fan and T. Jarvis, The Witten equation, mirror symmetry and quantum singularity theory, *Ann. of Math. (2)* **178** (2013), no. 1, 1–106. MR3043578; 5. with S-Q Liu and Y. Zhang, BCFG Drinfeld-Sokolov Hierarchies and FJRW-Theory, *Invent. Math.*, **201** (2015), no. 2, 711–772. MR3370624.

Statement by Candidate: With the new administration, mathematics research environments are experiencing a period of uncertainty. Now more than ever, it is important to have strong people leading the AMS. I am both humbled and honored to be a candidate for Nominating Committee.

Photo courtesy of JHU Mathematics Department

Nominating Committee

David Savitt

Professor of Mathematics and Department Chair, Johns Hopkins University.

PhD: Harvard, 2001.

AMS Committees: Committee on the Profession, 2014–2017 (Chair, 2016–2017).

Selected Addresses: AMS Special Session, JMM 2008; Galois Trimester, IHP, Paris, 2010; Lecture series at POSTECH, South Korea, 2011; Workshop on geometric methods in the *P*-adic Langlands correspondence, Pisa, 2016; Workshop on *P*-adic Hodge theory and automorphic forms, Beijing, 2017.

Additional Information: Instructor at Canada/USA Mathcamp, a high school summer program, most years 1996–2014; Board of directors, Canada/USA Mathcamp, 2002–present; Lead organizer of the Arizona Winter School, 2007–2013; Presidential Early Career Award for Scientists and Engineers, 2012; AMS Fellow, 2017.

Selected Publications: 1. On a conjecture of Conrad, Diamond, and Taylor, *Duke Math. J.*, **128** (2005), no. 1, 141–197. MR2137952 **(2006c:11060)**; 2. with T. Gee and T. Liu, The Buzzard-Diamond–Jarvis conjecture for unitary groups, *J. Amer. Math. Soc.*, **27** (2014), no. 2, 389–435. MR3164985; 3. with M. Emerton and T. Gee, Lattices in the cohomology of Shimura curves, *Invent. Math.*, **200** (2015), no. 1, 1–96. MR3323575; 4. with T. Gee and T. Liu, The weight part of Serre's conjecture for GL(2), *Forum Math. Pi 3* (2015), e2, 52 pp. MR3324938; 5. with T. Gee and F. Herzig, General Serre weight conjectures, to appear, *J. Eur. Math. Soc.*

Statement by Candidate: I am honored to have been asked to stand for election to the Nominating Committee; it would be a privilege to serve the AMS and the mathematical community in this capacity. If elected I will do all I can, especially by consulting others with a wide range of lived experiences and from a broad spectrum of institutions, to identify a diverse and capable group of candidates for AMS leadership positions.

Photo courtesy of Deane Yang

Nominating Committee

Deane Yang

Professor of Mathematics, Courant Institute of Mathematical Sciences, New York University.

PhD: Harvard University, 1983.

Selected Addresses: Invited Lecture, First Annual Geometry Festival, University of Pennsylvania; Invited Hour Address, Sectional Meeting of the AMS, South Bend, Indiana, 1991; Invited Lecture, Northwest Geometry Festival, University of Oregon, Eugene, Oregon, 1991; Invited Lecture, Northwest Geometry Festival, University of Washington, Seattle, Washington, 2001; Invited lecture, Caltech/UCLA Joint Analysis Seminar, 2013.

Additional Information: NSF Postdoctoral Fellowship, 1983–1985; Alfred P. Sloan Foundation Fellowship, 1988–1990; Co-Founder (with S. S. Chern and K. Uhlenback), Texas Geometry and Topology Festival; Vice Provost, Polytechnic University, 1996–1997; AMS Fellow, 2012–present; Editorial Board, *Geometriae Dedicata*, 2013–; Editorial Board, *Proceedings of the AMS*, 2018–present.

Selected Publications: 1. with Y. Huang, E. Lutwak and G. Zhang, Geometric measures in the dual Brunn-Minkowski theory and their associated Minkowski problems, *Acta Math.*, **216** (2016), no. 2, 325–388. MR3573332; 2. with K. J. Böröczky, E. Lutwak and G. Zhang, The logarithmic Minkowski problem, *J. Amer. Math. Soc.*, **26** (2013), no. 3, 831–852. MR3037788; 3. with E. Lutwak and G. Zhang, Optimal Sobolev norms and the Lp-Minkowski problem, *Int. Math. Res. Not.*, **2006**, Art. ID 62987, 21 pp., MR2211138 **(2007d:52007)**; 4. with E. Lutwak and G. Zhang, Cramér-

Rao and moment-entropy inequalities for Renyi entropy and generalized Fisher information, *IEEE Trans. Inform. Theory*, **51** (2005), no. 2, 473–478. MR2236062 **(2008a:94056)**; 5. with E. Lutwak and G. Zhang, The Cramer-Rao inequality for star bodies, *Duke Math. J.*, **112** (2002), no. 1, 59–81, MR1890647 **(2003f:52006)**.

Statement by Candidate: I am honored to be nominated to serve on the Nominating Committee. My career as a mathematician has given me a broad perspective on who we should seek out as candidates for the AMS Council and Committees. Although I have always been an active research mathematician, I have experience in other roles. I have worked in the financial sector, as a consultant. During most of my career, I taught at Polytechnic University, at a time when most students came from economically and educationally disadvantaged backgrounds. Often they were the first person in their family to attend college. Both as a professor and as an administrator working closely with my colleagues, I devoted a lot of time and effort to strengthening students' skills and understanding in math through effectively diagnosing their needs. In 2014, Polytechnic became the NYU School of Engineering, and I am now in the Courant math department, which is much more research-focused. I believe that the AMS should continue its efforts to support and promote mathematics and mathematicians in research, education, and industry, from a variety of backgrounds. I am committed to be a part of this effort.

Photo courtesy of Ian Agol

Editorial Boards Committee

Ian Agol

Professor, University of California, Berkeley.

PhD: University of California, San Diego, 1998.

AMS Committees: E. H. Moore Research Article Prize committee, 2016.

Selected Addresses: Plenary speaker, Graduate Student Topology and Geometry Conference, Chicago, 2018; AMS Joint Meetings Plenary speaker, San Antonio, 2015; Plenary speaker, ICM Seoul, 2014; Invited speaker, ICM Madrid, 2006; Invited speaker, Midwest sectional AMS meeting, Evanston, 2004.

Additional Information: Oswald Veblen Prize in Geometry (joint with Dani Wise), 2013; Associate Editor, *Journal of the American Mathematical Society (JAMS)*.

Selected Publications: 1. with F. C. Marques and A. Neves, Min-max theory and the energy of links, *J. Amer. Math. Soc.*, **29** (2016), no. 2, 561–578. MR3454383; 2. with Y. Liu, Presentation length and Simon's conjecture, J. *Amer. Math. Soc.*, **25** (2012), no. 1, 151–187. MR2833481; 3. The minimal volume orientable hyperbolic 2-cusped 3-manifolds., *Proc. Amer. Math. Soc.*, **138** (2010), no. 10, 3723–3732. MR2661571 **(2011k:57023)**; 4. with P. Storm and W. P. Thurston, and an appendix by Nathan Dunfield, Lower bounds on volumes of hyperbolic Haken 3-manifolds, *J. Amer. Math. Soc.*, **20** (2007), no. 4, 1053–1077. MR2328715 **(2008i:53086)**; 5. with J. Hass and W. Thurston, The computational complexity of knot genus and spanning area, *Trans. Amer. Math. Soc.*, **358** (2006), no. 9, 3821–3850. MR2219001 **(2007k:68037)**.

Statement by Candidate: I prefer to publish in accessible journals, and I admire the AMS model of low-cost, widely accessible, green open access journals. I have published several papers in the AMS journals and served on the 2016 E. H. Moore Prize committee. Moreover, I am currently serving as an associate editor for *JAMS*. So I have some familiarity with AMS publications.

Photo courtesy of David Marker

Editorial Boards Committee

David Marker

LAS Distinguished Professor, Department of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago.

PhD: Yale, 1983.

AMS Committees: Publications Committee, 2012–2015; Arnold Ross Lecturer Committee, 2016–2019.

Selected Addresses: AMS Regional Meeting, Stillwater Oklahoma, 1994; Annual Meeting Japanese Math. Society, Nagoya, 1998; Canadian Math Society, Summer Meeting Calgary, 2006.

Additional Information: National Science Foundation Postdoctoral Research Fellow, 1983; AMS Centennial Fellow, 1994; Editor *Journal of Symbolic Logic*, 1994–2000; Editorial Board *Notre Dame Journal of Formal Logic*, 1996–present; MSRI Semester Program Organizer, 1998, 2014; Judge, INTEL Science Talent Search, 2001–2015; Managing Editor *Lecture Notes in Logic*, 2005–2006; Association for Symbolic Logic Publisher, 2006–2008; Association for Symbolic Logic Shoenfield Prize, 2007; AMS Fellow, 2012.

Selected Publications: 1. with L. Harrington and S. Shelah, Borel orderings, *Trans. Amer. Math. Soc.*, **310** (1988), no. 1, 293–302. MR0965754 **(90c:03041)**; 2. with L. P. D. van den Dries and A. Macintyre, The elementary theory of restricted analytic fields with exponentiation, *Ann. of Math. (2)* **140** (1994), no. 1, 183–205. MR1289495 **(95k:12015)**; 3. with L. P. D. van den Dries and A. Macintyre, Logarithmic-exponential power series, *J. London Math. Soc. (2)* **56** (1997), no. 3, 417–434. MR1610431 **(99d:03063)**; 4. Model theory, An introduction, Graduate Texts in Mathematics, **217**, Springer–Verlag, New York (2002). MR1924282 **(2003e:03060)**; 5. A remark on Zilber's pseudoexponentiation, *J. Symbolic Logic*, **71** (2006), no. 3, 791–798. MR2250821 **(2007d:03061)**.

Statement by Candidate: It is an honor to be nominated for the AMS Editorial Boards Committee. Maintaining high quality journals is one of the most important roles of our Society. We should be looking for editors with broad mathematical interests who are fair-minded and efficient. I believe my experience as an editor, managing editor, and publisher will be beneficial in the search for the right individuals.

Editorial Boards Committee

James McKernan
Professor, University of California, San Diego.
PhD: Harvard, 1991.
Selected Addresses: Mori Dreams Spaces, Takagi Lectures, University of Tokyo, 2009; Finite Generation of the canonical ring, Plenary Address, KMS–AMS joint meeting, 2009; Flips and flops, Sectional talk in algebraic geometry, ICM Hyderabad, 2010; Moduli of Varieties, AMS Summer Research Institute on Algebraic Geometry, Salt Lake City, Utah, 2015; Symmetries of Algebraic Varieties, AMS Sectional Meeting Invited Address, Salt Lake City, 2016.
Additional Information: Clay Research Award, 2007; Cole Prize in Algebra, 2009; Fellow, Royal Society, 2011; E. H. Moore Research Article Prize, 2016; Breakthrough Prize in Mathematics, 2018.
Selected Publications: 1. with C. Birkar, P. Cascini and C. Hacon, Existence of minimal models for varieties of log general type, *J. Amer. Math. Soc.*, **23** (2010), no. 2, 405–468. **MR2601039 (2011f:14023)**; 2. with C. Hacon, Boundedness of pluricanonical maps of varieties of general type, *Invent. Math.*, **166** (2006), no. 1, 1–25. **MR2242631 (2007e:14022)**; 3. with S. Keel, Rational curves on quasi-projective surfaces, *Mem. Amer. Math. Soc.*, **140** (1999), no. 669, viii+153. **MR1610249 (99m:14068)**; 4. with C. Hacon and C. Xu, ACC for log canonical thresholds, *Ann. of Math. (2)*, **180** (2014), no. 2, 523–571. **MR3224718**; 5. with C. Hacon and C. Xu, On the birational automorphisms of varieties of general type, *Ann. of Math. (2)* **177** (2013), no. 3, 1077–1111. **MR3034294**.
Statement by Candidate: Journals play a very important role at the AMS and in the mathematics community as a whole. If elected, I will work to nominate editors that reflect the diverse interests of this community.

Editorial Boards Committee

Terence Tao
Professor, University of California, Los Angeles.
PhD: Princeton, 1996.
AMS Committees: JAMS Editorial Board, 2005–2011; Steele Prize Committee, 2009–2010; AMS-MAA Joint Lecture Committee, 2014; von Neumann Symposium Committee, 2014; Committee on National Awards and Public Representation, 2018–2020.
Selected Addresses: CBMS Lectures, Las Cruces, 2005; Current Events Lecture, San Diego, 2008; Einstein Lecture, Los Angeles, 2010; AMS-NZMS Maclaurin Lectures, New Zealand, 2013.
Additional Information: Bôcher Prize, 2002; Levi L. Conant Award, 2004; Fields Medal, 2006; Fellow of the AMS, 2012.
Selected Publications: 1. with A. Knutson, The honeycomb model of GL_n(C) tensor products I. Proof of the saturation conjecture, *J. Amer. Math. Soc.*, **12** (1999), no. 4, 1055–1090. **MR1671451 (2000c:20066)**; 2. with J. Colliander, M. Keel, G. Staffilani, H. Takaoka, Sharp global well-posedness for KdV and modified KdV on R and T, *J. Amer. Math. Soc.*, **16** (2003), no. 3, 705–749. **MR1969209 (2004c:35352)**; 3. with B. Green, The primes contain arbitrarily long arithmetic progressions, *Ann. of Math. (2)* **167** (2008), no. 2, 481–547. **MR2415379 (2009e:11181)**; 4. with K. Ford, B. Green, S. Konyagin, J. Maynard, Long gaps between primes. *J. Amer. Math. Soc.*, **31** (2018), no. 1, 65–105. **MR3718451**; 5. Finite time blowup for an averaged three-dimensional Navier–Stokes equation, J. *Amer. Math. Soc.*, **29** (2016), no. 3, 601–674. **MR3486169**.
Statement by Candidate: I am honored to be nominated for the Editorial Boards Committee. After serving for seven years as an editor of *JAMS* (after three years as an associate editor), I appreciate the complex role that editors play in working with authors, referees, and each other to ensure that a journal publishes high quality research of interest to a wide spectrum of mathematical fields. For the chief AMS journals it is particularly important to me that the editorial boards represent a broad range of mathematical communities, and I look forward to working with these boards to help ensure this.

Call For Suggestions

YOUR VOTE COUNTS! AMS

YOUR SUGGESTIONS ARE WANTED BY:

the Nominating Committee, for the following contested seats in the 2019 AMS elections:
vice president, trustee,
and five members at large of the Council.

Deadline for suggestions: November 1, 2018

the President, for the following contested seats in the 2019 AMS elections:
three members of the Nominating Committee and
two members of the Editorial Boards Committee.

Deadline for suggestions: January 31, 2019

the Editorial Boards Committee, for appointments to various editorial boards of AMS publications.

Deadline for suggestions: Can be submitted any time

Send your suggestions for any of the above to:
Carla D. Savage, Secretary
American Mathematical Society
Department of Computer Science
North Carolina State University
Raleigh, NC 27695-8206 USA
secretary@ams.org
or submit them online at **www.ams.org/committee-nominate**

AMS AMERICAN MATHEMATICAL SOCIETY

AMS American Mathematical Society

2019 AMS Election

Nominations by Petition

VICE PRESIDENT OR MEMBER AT LARGE

One position of vice president and member of the Council *ex officio* for a term of three years is to be filled in the election of 2019. The Council intends to nominate at least two candidates, among whom may be candidates nominated by petition as described in the rules and procedures.

Five positions of member at large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate at least ten candidates, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations.

Prior to presentation to the Council, petitions in support of a candidate for the position of vice president or of member at large of the Council must have at least fifty valid signatures and must conform to several rules and procedures, which are described below.

EDITORIAL BOARDS COMMITTEE

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee.

The President will name at least four candidates for these two places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and procedures, described below, should be followed.

NOMINATING COMMITTEE

Three places on the Nominating Committee will be filled by election. There will be six continuing members of the Nominating Committee.

The President will name at least six candidates for these three places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and procedures, described below, should be followed.

RULES AND PROCEDURES

Use separate copies of the form for each candidate for vice president, member at large, member of the Nominating or Editorial Boards Committees.

1. To be considered, petitions must be addressed to Carla D. Savage, Secretary, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2213 USA, and must arrive by 24 February 2019.
2. The name of the candidate must be given as it appears in the American Mathematical Society's membership records and be accompanied by the member code. If the member code is not known by the candidate, it may be obtained by the candidate contacting the AMS headquarters in Providence (`amsmem@ams.org`).
3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.
4. On the next page is a sample form for petitions. Petitioners may make and use photocopies or reasonable facsimiles.
5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.
6. When a petition meeting these various requirements appears, the secretary will ask the candidate to indicate willingness to be included on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving consent.

Nomination Petition

for 2019 Election

The undersigned members of the American Mathematical Society propose the name of

____

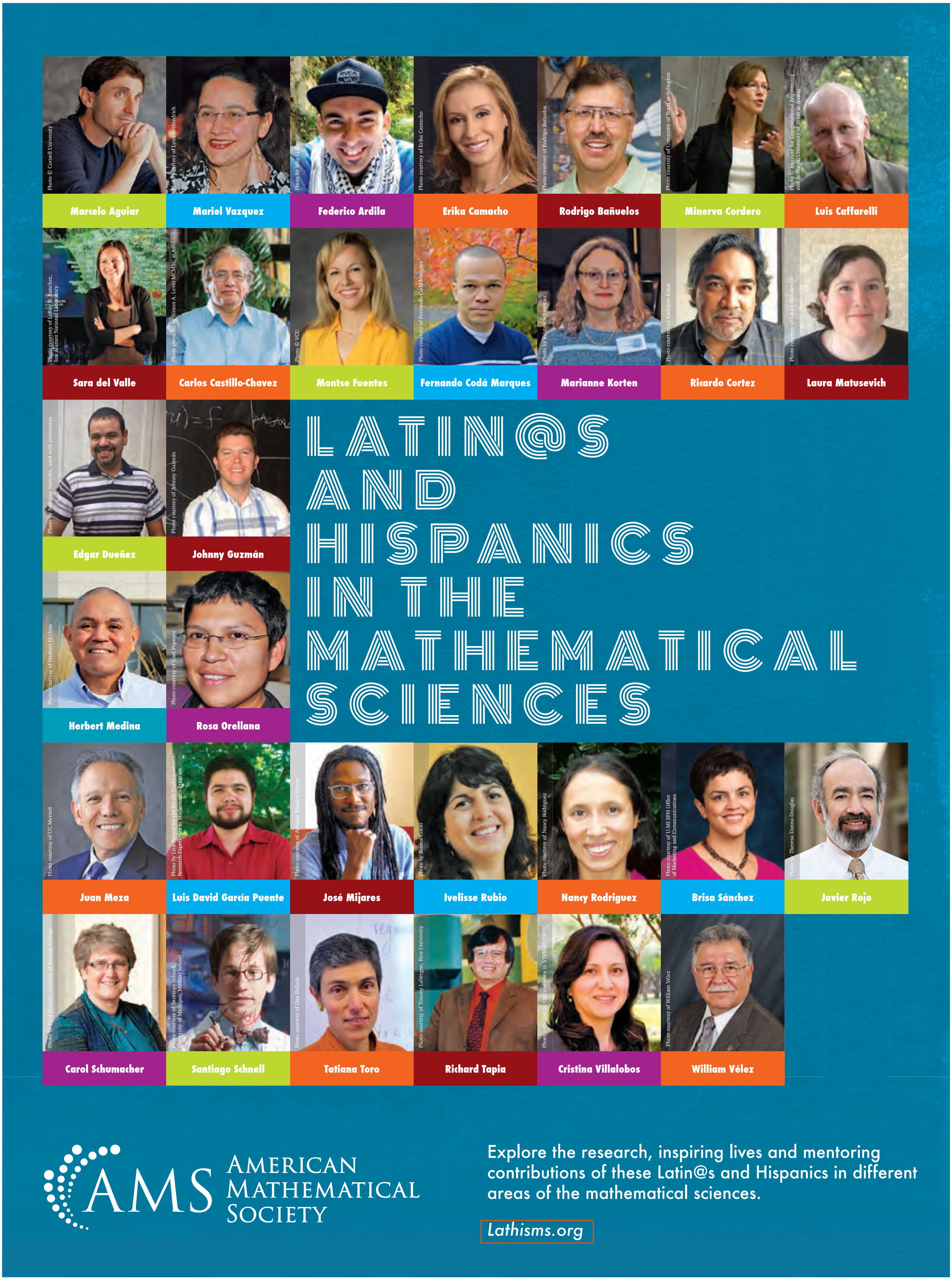
as a candidate for the position of (check one):

- ☐ **Vice President** (term beginning 02/01/2020)
- ☐ **Member at Large of the Council** (term beginning 02/01/2020)
- ☐ **Member of the Nominating Committee** (term beginning 01/01/2020)
- ☐ **Member of the Editorial Boards Committee** (term beginning 02/01/2020)

of the American Mathematical Society.

Return petitions by 24 February 2019 to:
Secretary, AMS, 201 Charles Street, Providence, RI 02904-2213 USA

Name and address (printed or typed)	Signature
	Signature
	Signature
	Signature
	Signature
	Signature
	Signature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Mariel Vazquez
Federico Ardila
Erika Camacho
Rodrigo Bañuelos
Minerva Cordero
Luis Caffarelli
Sara del Valle
Carlos Castillo-Chavez
Montse Fuentes
Fernando Codá Marques
Marianne Korten
Ricardo Cortez
Laura Matusevich
Edgar Dueñez
Johnny Guzmán
Herbert Medina
Rosa Orellana
LATIN@S AND HISPANICS IN THE MATHEMATICAL SCIENCES
Juan Meza
Luis David García Puente
José Mijares
Ivelisse Rubio
Nancy Rodriguez
Brisa Sánchez
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COMMUNICATION

Tapas of Algebraic Statistics

Carlos Améndola, Marta Casanellas, and Luis David García Puente

What is Algebraic Statistics?

Algebraic statistics is an interdisciplinary field that uses tools from computational algebra, algebraic geometry, and combinatorics to address problems in statistics and its applications. A guiding principle in this field is that many statistical models of interest are *semialgebraic sets*—a set of points defined by polynomial equalities and inequalities. Algebraic statistics is not only concerned with understanding the geometry and algebra of the underlying statistical model, but also with applying this knowledge to improve the analysis of statistical procedures, and to devise new methods for analyzing data.

A well-known example of this principle is the *model of independence* of two discrete random variables. Two discrete random variables X, Y are independent if their joint probability factors into the product of the marginal probabilities. Equivalently, X and Y are independent if and only if every 2×2-minor of the matrix of their joint probabilities is zero. These quadratic equations, together with the conditions that the probabilities are nonnegative and sum to one, define a semialgebraic set.

In 1998, Persi Diaconis and Bernd Sturmfels showed how one can use algorithms from computational algebraic geometry to sample from conditional distributions. This work is generally regarded as one of the seminal works of what is now referred to as algebraic statistics. However, algebraic methods can be traced back to R. A. Fisher, who used Abelian groups in the study of factorial designs, and Karl Pearson, who used polynomial algebra to study Gaussian mixture models.

Carlos Améndola is postdoctoral researcher in the department of mathematics at Technische Universität München. His email address is carlos.amendola@tum.de.

Marta Casanellas is associate professor and vice director of research in the department of mathematics at Universitat Politècnica de Catalunya. Her email address is marta.casanellas@upc.edu.

Luis David García Puente is associate professor and assistant department chair in the department of mathematics and statistics at Sam Houston State University. His email address is lgarcia@shsu.edu.

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Algebraic statistics is a broad field actively expanding from discrete statistical models, contingency table analysis, and experimental design to Gaussian models, singular learning theory, and applications to phylogenetics, machine learning, and biochemical reaction networks. In this note, we will address two recent contributions to this field: an extension of Pearson's work on Gaussian mixtures and some recent results in phylogenetics.

Algebraic Statistics of Gaussian Mixtures

In 1894 the famous statistician Karl Pearson [5] wanted to explain the asymmetry observed in data measured from a population of Naples' crabs, believing it was possible that two subpopulations of crabs were present in the sample. The corresponding statistical model is known as a Gaussian mixture; in this case a mixture of two univariate Gaussian distributions, each with its own mean and variance. In order to recover the parameters from the sample, Pearson introduced the *method of moments*, matching the density moments to the sample moments. He obtained the following system of polynomial equations in the means μ_1 and μ_2, variances σ_1^2 and σ_2^2, and mixture proportions α_1 and α_2:

$$
\begin{aligned}
\alpha_1 + \alpha_2 &= 1 \\
\alpha_1\mu_1 + \alpha_2\mu_2 &= 0 \\
\alpha_1(\mu_1^2+\sigma_1^2) + \alpha_2(\mu_2^2+\sigma_2^2) &= m_2 \\
\alpha_1(\mu_1^3+3\mu_1\sigma_1^2) + \alpha_2(\mu_2^3+3\mu_2\sigma_2^2) &= m_3 \\
\alpha_1(\mu_1^4+6\mu_1^2\sigma_1^2+3\sigma_1^4) + \alpha_2(\mu_2^4+6\mu_2^2\sigma_2^2+3\sigma_2^4) &= m_4 \\
\alpha_1(\mu_1^5+10\mu_1^3\sigma_1^2+15\mu_1\sigma_1^4) + \alpha_2(\mu_2^5+10\mu_2^3\sigma_2^2+15\mu_2\sigma_2^4) &= m_5.
\end{aligned} \tag{1}
$$

After considerable effort and cleverness, Pearson managed to eliminate variables to obtain a ninth degree polynomial relation in the single unknown $x = \mu_1\mu_2$,

$$
\begin{aligned}
&24x^9 - 28\lambda_4x^7 + 36m_3^2x^6 - (24m_3\lambda_5 - 10\lambda_4^2)x^5 - (148m_3^2\lambda_4 + 2\lambda_5^2)x^4 + \\
&(288m_3^4 - 12\lambda_4\lambda_5m_3 - \lambda_4^3)x^3 + (24m_3^3\lambda_5 - 7m_3^2\lambda_4^2)x^2 + 32m_3^4\lambda_4x - 24m_3^6 = 0,
\end{aligned} \tag{2}
$$

where $\lambda_4 = 9m_2^2 - 3m_4$ and $\lambda_5 = 30m_2m_3 - 3m_5$. After substituting his numerical moment estimates m_i, he found the real roots of this nonic and determined if they could correspond to a solution for the mixture model. We see his approach as one of the first instances of algebraic statistics. Pearson's work leads to natural questions:

Problem 1. Can Pearson's method be generalized for a mixture of k Gaussians? How many moments are needed to recover the parameters? Is there an analogous polynomial to (2)? What is its degree? What about Gaussians in higher dimensions?

Recovering the parameters from data drawn from a Gaussian mixture is an important problem in statistics, computer science, and machine learning. Answers to the above questions shed light on the computational complexity and the effectiveness of several algorithms proposed in these areas. The key point is that all the moments of a mixture of Gaussians are **polynomials** in the parameters, so they define *moment varieties* that can be studied algebraically.

Recent progress with this approach has been made by Améndola et al. [2, 3], with partial answers. For example, it was shown [3] that considering all the moments up to order $3k-1$ will yield generically a finite number of Gaussian mixture densities with the same matching moments. In other words, the polynomial moment system generalizing (1) will generically have a finite number of solutions for the $3k$ unknown parameters $\mu_i, \sigma_i, \alpha_i$ for $1 \leq i \leq k$. For $k = 2$ this is Pearson's number 9. For $k = 3$ it was found [2] that the corresponding degree is 225. In contrast, perhaps shockingly, the system of 20 polynomial equations in 20 unknowns corresponding to the moments up to order three of mixtures of two Gaussians in 3-dimensional space $\mathbb{R}^3$ will have generically *infinitely* many solutions. This means that one needs to consider higher order moments in order to recover the parameters. A complete classification of such defective cases is still open.

Algebraic Statistical Phylogenetics

Algebraic statistics has been also used in phylogenetics. Phylogenetics seeks to explain the ancestral relationships among a group of living species. These relationships are usually represented in a *phylogenetic tree* as in Figure 1, where the leaves are in bijection with the living species, the interior nodes represent ancestral species, the root is the common ancestor to all the species in the tree, and the edges represent an evolutionary process that led from one ancestral species to the next. Figure 1 shows three possible phylogenetic trees that could explain the evolution of human, gorilla, lemur, and macaque.

In order to infer the phylogenetic tree that best explains the evolution of the species, one uses the genome of the living species and models the substitution of nucleotides using a Markov process on trees, assuming that each position in the genome evolves in the same way and independently of the others. We denote the set of four nucleotides by $\{A, C, G, T\}$. A discrete random variable taking values in this set is assigned to each node of the tree. For each edge, the probabilities of substitution of nucleotides between the two species at the ends of the edge are recorded in a transition matrix (a Markov matrix). The entries of these matrices, together with the distribution of nucleotides at the root of the tree, form the parameters of the model. Then, the probability of observing a certain pattern of nucleotides at the leaves of the tree can be written in terms of these parameters, by assuming that the evolutionary processes of two edges incident at a node v is independent given the observations at v.

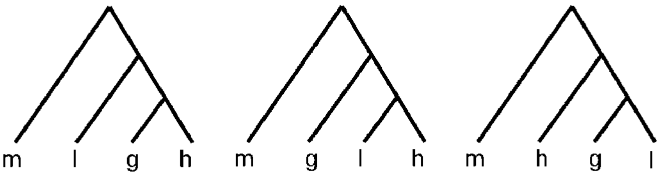

Figure 1. Three phylogenetic trees representing three possible evolutionary histories of human (h), gorilla (g), macaque (m), and lemur (l).

Again, the key point is that for each phylogenetic tree τ, the map φ_τ that sends each set of parameters to the vector of probabilities of patterns $AA\ldots A$, $AA\ldots C$, $\ldots$, $TT\ldots T$ at the leaves is a **polynomial map**, and hence its image is (almost) an algebraic variety V_τ. Different trees (as the ones in Figure 1) lead to different algebraic varieties, and the goal is to use the equations that define these algebraic varieties in order to decide, given a data point (that is, a sequence of nucleotides for each species at the leaves), to which variety is closest (in some sense).

The idea of using polynomial equations in phylogenetics is not due to mathematicians but to biologists. Indeed, in the late 1980s, biologists James A. Cavender, Joseph Felsenstein, and James A. Lake already realized that the equations satisfied by the pattern probabilities on a phylogenetic tree could help in inferring the tree without having to estimate the parameters of the model. It is precisely this, the fact of not having to estimate the parameters, that makes algebraic statistics potentially useful in phylogenetics. However, selecting a set of equations that define the algebraic variety cannot be done in a canonical way. Moreover, the codimension of these varieties grows exponentially in the number of leaves, so using them directly may not be a practical choice.

A recent approach to indirectly using these algebraic varieties is based on the following result due to Elizabeth Allman and John Rhodes: Assume the vector of probabilities $p = (p_{AA\ldots A}, p_{AA\ldots C}, \ldots, p_{TT\ldots T})$ belongs to the image of φ_τ. Any edge of τ splits the set of leaves into two subsets a and b, giving rise to a matrix $M_{a,b}$ whose rows (resp. columns) are labeled by the states at the leaves in a (resp. b) and whose entries are the corresponding probabilities in p. Then the matrix $M_{a,b}$ has rank at most 4. This result leads to equations satisfied by the points of the variety (the 5×5 minors must vanish), and it also gives the possibility to test candidate phylogenetic trees by checking how far certain matrices are from the set of rank 4 matrices. This distance can be easily computed using singular value decomposition. This approach has been recently exploited [1, 4] with great success on both simulated and real data. As a consequence, algebraic tools have finally attracted the attention of biologists and have been implemented in some widely used packages of phylogenetic inference.

There are several books and even a journal dedicated to algebraic statistics. The R package **algstat** contains many computational algebraic statistics tools including the state of the art implementation of the Diaconis-Sturmfels sampling method. The upcoming book *Algebraic Statistics* by Seth Sullivant is a great resource for graduate students and researchers interested in learning more about this exciting field.

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Author headshots courtesy of the authors.

ABOUT THE AUTHORS

Carlos Enrique Améndola Cerón

Carlos Enrique Améndola Cerón wants everyone to know that algebraic statistics is a very cool subject. Inspired by his PhD advisor Bernd Sturmfels, he believes applied algebraic geometry topics have enormous research potential. Additionally, he enjoys playing board games, traveling around the world, and dreaming about far, far away galaxies.

Marta Casanellas

Marta Casanellas did her PhD in algebraic geometry. After a postdoc at UC Berkeley, she shifted her interest towards the applications of algebraic techniques in phylogenetics.

Luis David García Puente

Luis David García Puente works in applied and computational algebraic geometry, algebraic statistics, and algebraic combinatorics. He has devoted much of his professional energy to broadening participation in the mathematical sciences through directing undergraduate research. He also enjoys salsa dancing with his daughters, coaching soccer, and playing racquetball.

2018 Lathisms: Latinxs and Hispanics in the Mathematical Sciences

Alexander Diaz-Lopez, Pamela E. Harris, Alicia Prieto Langarica, and Gabriel Sosa

ABSTRACT. For the third year in a row, Lathisms will celebrate Hispanic Heritage Month (September 15–October 15) by posting a personal vignette of several mathematicians at our website www.lathisms.org. This year we feature up-and-coming Latinxs and Hispanics in the mathematical sciences.

It has been two years since the launching of www.lathisms.org, a website founded to provide an accessible platform that features prominently the extent of research and mentoring contributions of Latinxs and Hispanics in different areas of the mathematical sciences. Thus far, we have featured 61 mathematicians.

The mathematicians featured in 2016 have been commemorated in an AMS poster,[1] which has been distributed nationally. A second edition of this poster, featuring the 2017 Lathisms honorees,[2] is currently in the works. New to the 2018 Lathisms website is the development of short podcasts by featured Lathisms mathematicians. These podcasts will be produced by Evelyn Lamb, with the support of an MAA Tensor-SUMMA grant.

This year we are featuring advanced graduate students, postdoctoral fellows, and early career mathematicians in order to provide visibility to their research and to highlight the work they have undertaken to diversify the mathematical sciences. These young mathematicians push us further in our Lathisms vision: A vibrant and diverse mathematical community where the depiction and participation of Latinxs and Hispanics accurately represent US demographics. In this article, we present six of the 2018 Lathisms honorees.

"To me, the celebration of Hispanic Heritage Month is so important. It allows for the honoring and preservation of Hispanic culture and history, as well as advocating the continued awareness of beauty and strength through diversity."

Anastasia Chavez, President's Postdoctoral Fellow and NSF Postdoctoral Research Fellow at UC Davis.

Anastasia's Bio and Research: As a child, Anastasia's life aspirations centered around her love for sports, music, and writing. In fact, she envisioned being an Olympic softball player, concert clarinetist, journalist, and the first woman president. Needless to say, her life looks pretty different. She did attempt a collegiate softball career, but instead found a future in mathematics.

After obtaining her AS from the Santa Rosa Junior College, Anastasia earned a BS in applied mathematics and MA in mathematics from San Francisco State University. She went on to complete her PhD at the University of California, Berkeley. Currently, Anastasia is a President's Postdoctoral Fellow at the University of California, Davis, and recently was awarded an NSF Postdoctoral Research Fellowship at UC Davis. During her master's work, Anastasia and her amazing husband welcomed their two incredible children into their lives. She attributes her desire to become a research mathematician and advocate

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[1] *See* https://bit.ly/2qaPWbh *and the October 2017* Notices https://bit.ly/2GH50no.

[2] *See* http://lathisms.org.

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for minority students to her daughters, who she feels are her greatest teachers.

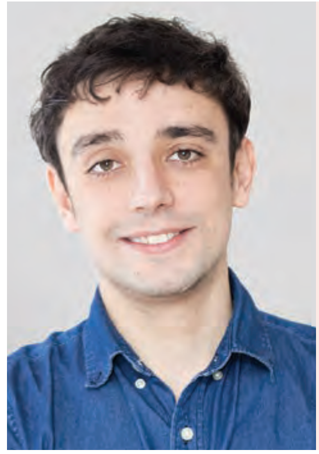
Her research interests are traditionally in algebraic and enumerative combinatorics. Specifically, she is interested in questions that invite matroid theory, polytopes, and curiosity into the mix. As Anastasia embarks on her postdoctoral training, she has begun looking at questions that include aspects of randomness, probability, and computing. Her plan is to develop a research program that hinges on exploring computing and optimization through a matroid theory lens.

"I am very grateful to Lathisms and the AMS for this initiative and honored to be included. It is exciting to learn about the work of friends, role models, and others I haven't met. This initiative not only helps connect Latinx mathematicians, but it also diversifies the concept of a mathematician."

Laura Escobar, assistant professor at Washington University in St. Louis.

Laura's Bio and Research: Laura Escobar grew up in Bogotá, Colombia. She completed her PhD in 2015 at Cornell University. She was a J. L. Doob Research Assistant Professor at UIUC and an Einstein Fellow at TU Berlin. She was a postdoctoral fellow during the Fall 2016 Thematic Program in Combinatorial Algebraic Geometry at The Fields Institute. She is now in her first year as assistant professor at Washington University in St. Louis. Her awards include an AMS Simons Travel Grant and an AWM Mentoring Travel Grant. She has mentored undergraduates as part of the Illinois Geometry Lab and is excited to continue mentoring in her new position.

Her research is in geometric combinatorics and combinatorial algebraic geometry. Laura has developed combinatorial models as part of her program to understand the singularities of Schubert varieties and the action of tori on these varieties. She also constructs and studies polytopes using tools from symplectic and algebraic geometry. She defined the brick varieties and used them to construct and study a classical polytope: the associahedron.



"Congratulations to all the Hispanic and Latinx mathematical community in this Hispanic Heritage Month and special thanks to our mentors, collaborators, and colleagues for promoting diversity through their support and encouragement."

Alejandro Morales, assistant professor at the University of Massachusetts, Amherst.

Alejandro's Bio and Research: Alejandro is originally from Bogotá, Colombia. He earned a bachelor in mathematics at the University of Waterloo and a PhD at MIT under the supervision of Alex Postnikov. He was a CRM-ISM Postdoctoral Fellow at LaCIM in UQAM and was a Hedrick Assistant Adjunct Professor at UCLA before starting last fall as assistant professor at UMass, Amherst. Alejandro was supported by an AMS-Simons Travel Grant, has mentored twelve undergraduate and high school students in summer research programs, and is part of the "Comunidad Colombiana de Combinatoria." He has been part of the organizing committee of four "Encuentro Colombiano de Combinatoria" and co-organized two Southern California Symposia in Discrete Math.

Alejandro's research is in enumerative and algebraic combinatorics. The projects he works on with collaborators often lie in the interface with other fields such as discrete geometry, coding theory, physics, and complexity theory. One project is the study of certain polytopes coming from flows on graphs. These polytopes are related to other families of polytopes (order polytopes and generalized permutahedra) and to other subjects in combinatorics like diagonal harmonics and Schubert polynomials. A motivating question is to understand why one special flow polytope defined by Chan, Robbins, and Yuen has a volume that equals the product of consecutive Catalan numbers, a sequence of nonnegative numbers that count hundreds of combinatorial objects. He recently studied with co-authors a new flow polytope known as the Caracol (*snail* in Spanish) polytope. Another recent project with collaborators is the study of formulas coming from geometry to count classical objects in combinatorics called standard Young tableaux of skew shape. This is related to the asymptotics and uniform generation of the tableaux and even to the simple inequality that states that π is less than twice the golden ratio.

"This is a time to celebrate our Hispanic heritage, but perhaps more importantly, it is a time to reflect on how we can make the future better and brighter for our fellow future minority mathematicians. Let us give them the opportunity to say that they too stand on the shoulders of giants."

Luis Sordo Vieira, postdoctoral associate at The Jackson Laboratory for Genomic Medicine.

Luis' Bio and Research: Due to the political chaos in his home country of Venezuela, Luis emigrated to the US when he was twelve years old. During his undergraduate years, Frank Morgan and Daniel Isaksen took on the role of his academic parents. Because of their encouragement he applied for the NSF Graduate Student Fellowship, which he was awarded.

During graduate school, Luis was primarily interested in Artin's conjecture, a problem dating back to the 1930s involving diagonal forms over p-adic fields. He and his advisor David B. Leep proved Artin's conjecture for diagonal forms over unramified extensions of the rational p-adic fields for p odd. Although Luis thoroughly enjoyed collaborating with his advisor and immersing himself in number theory, he decided to change his focus to mathematical methods for problems in medicine.

His current research can be divided into two areas: multiscale modeling of disease and discrete analysis of how a cell communicates with its environment. He is especially interested in multiscale modeling of the role of iron in cancer progression, using partial differential equations, discrete dynamical systems, and statistical methods, among others. Currently, as a postdoc, Luis has realized how much he enjoys working in a multidisciplinary department. Although his current supervisor Reinhard Laubenbacher is a fellow mathematician, Luis frequently interacts with biologists, engineers, and computer scientists. It has been a very enriching and challenging life experience for him.

"I am so proud of being a Latina. I learned from my family and my culture that working hard, working in teams, and never giving up on my dreams will make me successful in life."

Imelda Trejo, doctoral candidate at the University of Texas, Arlington.

Imelda's Bio and Research: Imelda discovered her passion for mathematics as a child while she was working in her family's business at a local market selling grain products, fruits, and vegetables, quickly doing large numerical calculations in her head. Because of those experiences and her success during her elementary and high school years, she chose to major in mathematics.

In college, while she was working on X-ray computer tomography research, Imelda noticed that she had a great passion for solving real-world problems by using mathematics. Since then, she decided to pursue a mathematical research career. She completed a master's degree in applied mathematics at the Research Center of Mathematics (CIMAT), Guanajuato, Mexico. Now she is in her fourth year of the PhD program in mathematics at the University of Texas at Arlington and expects to graduate in May 2019.

Imelda's research interests are in applied mathematics, solving real-world problems by combining mathematics and computer simulations. Her dissertation focuses on studying the interactions between immune and bone cells during the bone-fracture-healing process. She and her advisor, Hristo Kojouharov, have developed a mathematical model that shows that a correct modulation of inflammation by macrophages and progenitor bone cells promotes the healing of a bone. They are working to validate these results with experimental data and plan to then use the model to explore possible anti-inflammatory treatments.

Because of her research contributions and excellence in the study of mathematics, Imelda has won several awards. She received the 2008 Sotero Prieto Award, which recognizes the best bachelors research in Mexico, and a full scholarship from the Mexican Science Foundation (CONACYT) to work toward her master's and PhD. Recently, while at UTA, Imelda was awarded the 2016 R. Kannan Memorial Scholarship and the 2017 John A. Gardner Scholarship for her excellence in mathematics. In addition, Imelda received the 2017 Outstanding Student Presentation award from the Mathematical Association of America–Texas Section for the best research talk in her session at the 97th Annual Section Meeting at Texas A&M University–Commerce.

"As a mixed-race, non-Spanish speaking Latino, I grew up having a difficult relationship with my heritage. However, I've come to understand that this is not uncommon among younger Latinx people in the US, and I can embrace my Mexican heritage in my own way. I'm proud to celebrate Hispanic Heritage Month and deeply honored to be featured by Lathisms."

Christopher Perez, doctoral candidate at the University of Illinois at Chicago.

Christopher's Bio and Research: Christopher grew up on the South Side of Chicago and attended Whitney Young Magnet High School, where he first became interested in studying math. In 2009, he started his freshman year at the California Institute of Technology. Christopher graduated in 2013 with a BS in pure mathematics. While at Caltech, he was the president of the math club for three years and received the Mellon-Mays Undergraduate Fellowship, which is awarded by the Andrew W. Mellon Foundation with the stated goal of increasing diversity within university faculties.

In 2013, Christopher entered the PhD program in pure mathematics at the University of Illinois at Chicago, where he is currently a doctoral candidate studying geometric group theory with Daniel Groves. In 2015, he married Stephanie Reyes, who is also a graduate student in pure mathematics at UIC.

Christopher's research is in the area of geometric group theory. The elementary theory of a group G is the set $Th(G)$ of all logical sentences in G using existential and universal quantifiers, i.e. the first-order theory of G. In 2006, Zlil Sela—and independently Olga Kharlampovich and Alexei Myasnikov—proved that any two finitely generated, non-abelian free groups have the same elementary theory, solving a problem first posed by Alfred Tarski in 1945. The geometric approach used by Sela to solve Tarski's problem enabled him to apply the same techniques to studying the elementary theory of torsion-free hyperbolic groups. He showed in 2009 that, given a fixed torsion-free hyperbolic group H, if G is a finitely generated group such that $Th(G) = Th(H)$, then G is a torsion-free hyperbolic group—not necessarily isomorphic to H. The implication of such a result is that elementary theories are capable of detecting the geometry of groups. In the past several years, geometric group theorists have been working to generalize the methods of Sela's program and apply them to other problems.

Christopher's research is currently focused on replicating parts of Sela's program for toral relatively hyperbolic groups, which share many structural properties with hyperbolic groups and arise as the fundamental groups of hyperbolic manifolds with torus cusp cross-sections.

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The AMS Committee on Education invites you to attend the

ANNUAL MINI-CONFERENCE ON EDUCATION

“Next steps in the evolution of mathematics education: moving beyond pilots”

Friday, October 12, 2018
8:00 am – 6:00 pm
Washington, DC

In recent years, many innovations in mathematics education have been tried in different contexts. These innovations can serve as pilots for larger-scale changes in the teaching and learning of mathematics. This mini-conference will bring together some of these pioneers from mathematics and nearby fields to share insights and experiences. The goal is to foster an open discussion and appraisal of which ideas should be scaled up in order for education in mathematics to meet future needs.

Join department chairs, directors of undergraduate and graduate studies, and others interested in education to hear from national leaders and participate in lively discussions. We encourage small departmental teams to attend together.

Registration Fee: $200

If you are interested in attending, please register by September 17, 2018 at http://bit.ly/2JjKCJC

AMS AMERICAN MATHEMATICAL SOCIETY

Anthony Várilly-Alvarado Interview

Conducted by Alexander Diaz-Lopez

Anthony (Tony) Várilly-Alvarado is associate professor of mathematics at Rice University. He investigates the arithmetic of surfaces and was awarded an NSF CAREER grant in 2014. He has received several teaching awards and is founder and director of Patterns, Math & You, a STEM program for middle school students. He is currently a member at large of the AMS Council, and a member of the Human Resources Advisory Committee at MSRI.

Diaz-Lopez: *When did you know you wanted to be a mathematician?*

Várilly-Alvarado: When I was in high school, I was introduced to the idea of mathematical proof through Math Olympiads, mostly by accident. On the day of the first round of the Costa Rican Math Olympiad in 1995, one of my high school's team members failed to show up to school. My math teacher, Paul Murray, pulled me out of class early that morning and put me on a bus to go take the first-round test; I think he saw in me a talent I didn't know I had. The questions on the test were like nothing I'd ever seen before, and I was fascinated by this new world.

I loved proof-based problem solving, but I wasn't particularly fast at it. Even as I was finishing high school, I thought I might try my hand at civil engineering, but the only bits of Stewart's calculus book that seemed interesting to me were the explanations of why things worked. Around the same time, I had the chance to write an extended essay for the international baccalaureate in mathematics and proved a small result in triangle geometry. It was thrilling, and by the time I got to college I was seriously interested in a mathematics major.

My father, Joseph Várilly, is a mathematician. Having him as a role model and supporting mentor throughout my teenage years (and beyond!) contributed unquantifiably towards my love for mathematics. Not once did he push me to become a mathematician. He always encouraged me to find my own path. We work in different areas of mathematics, but last year we finally converged at a conference, the Mathematical Congress of the Americas, in Montreal. It was wonderful to be able to share with him in a professional setting a passion that brings us together.

Diaz-Lopez: *Who else encouraged or inspired you?*

Várilly-Alvarado: There are too many people I could name here; I'll try to keep it brief at peril of leaving out some key figures. My PhD advisor, Bjorn Poonen, is another role model I imperfectly strive to emulate. His passion, intuition, patience, work ethic, and generosity shaped who I am today. Brendan Hassett, my post-doctoral mentor, taught me a lot about taste, and how to keep a big picture in mind while working on small parts of a research program. During the six years we overlapped at Rice, Brendan was always generous with his ideas and time (despite being chair for five of the six years!). I learned how to be a professional mathematician through our interactions.

Mathematics is a social activity. I have been deeply inspired by my collaborators. I tend to learn by talking to other people, by trying to understand how they think about mathematical ideas.

In the "otherwise" category, I was fascinated by Jorge Luis Borges' short stories as a teenager. His obsession with infinity and time, and the way he could effortlessly bend language to convey it, encouraged in me a passion for abstraction (and literature!).

DOI: http://dx.doi.org/10.1090/noti1724

Diaz-Lopez: *How would you describe your research to a graduate student?*

Várilly-Alvarado: I work in the part of arithmetic algebraic geometry that studies the structure of the set of rational points on algebraically defined spaces over number fields. Geometric properties of these spaces, like curvature, bear heavily on the qualitative and quantitative nature of the set of its rational points.

Recently, I have been thinking about K3 surfaces, which are 2-dimensional analogues of elliptic curves, but they have no group law. I've also been studying related objects, such as cubic fourfolds and abelian varieties, which often shed light on the cohomology of K3 surfaces. The geometry of K3 surfaces was extensively studied and understood towards the end of the 20th century. Despite much progress in the last 15 years, K3 surfaces are still relatively mysterious from a number-theoretic perspective. It's an exciting time to investigate them!

Diaz-Lopez: *What theorem are you most proud of?*

Várilly-Alvarado: It's probably early in my career to have a favorite theorem, but one paper I am particularly proud of is "Arithmetic of del Pezzo Surfaces of Degree 4 and Vertical Brauer Groups," which is joint work with Bianca Viray. Bianca and I were both post-docs when we began the project, and we were each trying to find a new direction for our research. I visited Bianca in Boston, where she showed me some work she had done on a surface studied in 1975 by Birch and Swinnerton-Dyer. The surface had a cohomological obstruction to the existence of points with $\mathbb{Q}$-coordinates, and Bianca had reinterpreted this obstruction in a beautifully geometrical way. She showed the surface could be fibered into curves, each of which failed to have $\mathbb{Z}/N\mathbb{Z}$-points for some N; it was a stunningly visual interpretation of a Brauer-Manin obstruction. Bianca was convinced this phenomenon is widespread, and I must confess I was skeptical. Bianca was right: we showed that every del Pezzo surface of degree 4 behaved similarly, that in some sense Birch and Swinnerton-Dyer's surface was not special (even though it is a fantastically well-chosen example because it's amenable to explicit computations).

I like that paper a lot. We shed light on the arithmetic of a class of surfaces that had been thoroughly studied for decades. It taught us to not underestimate ourselves. Each one of us has proved fancier-sounding theorems since that paper, but I think that result was a personal watershed moment in each of our careers.

Diaz-Lopez: *What advice do you have for current graduate students?*

Várilly-Alvarado: A few things come to mind:

(1) Choose an advisor, not a subject. You can always move away from your thesis topic after you graduate (slowly, by analytic continuation). Having an advisor who can help you harness your strengths, and push you to improve on weaknesses, is key.

(2) You will feel discouraged periodically throughout your career: this is completely natural, and it does not mean you are not cut out for mathematics. For most of us, the self-doubt never goes away, but over time you learn to co-exist with it in peace.

(3) Don't go at it alone: your dissertation research is your own, but it's important to form a support network with other graduate students. Read and constructively criticize one another's work and application materials. Give practice talks in front of your peers and let them tell you frankly what they understood.

(4) Write up carefully TeXed notes of your research as you go along. You will thank yourself later when putting together a dissertation.

(5) The initial stages of graduate school (coursework, qualifying exams) provide an external workframe that shapes your day-to-day life. Once you have completed these requirements, the onus is on you to keep going (but don't forget item #3 above!).

(6) By and large, advisors want to support your goals and aspirations. Have periodic, frank talks with your advisor about what you want to do after a PhD, whether it's an academic position of one flavor or another, or a job in industry or government. The conversation will change over time, but a clear line of communication between the two of you is paramount if you want a positive outcome.

Diaz-Lopez: *All mathematicians feel discouraged occasionally. How do you deal with discouragement?*

Várilly-Alvarado: First, I think this is something we should be thinking about and discussing much more, at all levels. I often tell students in my undergraduate courses that I spend about 95% of my thinking time in a state of confusion, struggling to put pieces of a puzzle together. They often react with surprise, because our carefully choreographed lectures and problem sets tend to make us look like oracles that always have clever answers or ideas at hand. Students should be aware that it's normal to feel confused and lost when you're learning a new subject.

At the graduate level, discouragement can take several forms. I personally had projects collapse at late developmental stages, strong anxiety about the future, fear of running out of ideas, the feeling of standing in front of insurmountable mathematical walls, etc. I have been very fortunate to have had a strong community of friends and mentors throughout my career that I could talk to openly about these issues. At first, I was amazed to hear their stories and feelings of discouragement. You can derive much comfort and the strength to keep going from a mathematical family. Even as a tenure-track professor, the impostor syndrome did not go away. For me personally, things started getting better when I began advising students and mentoring post-docs. Their talent and drive seems obvious to me, but I can see the self-doubt and discouragement they feel, so similar to my own. Providing a forum for discussion for them has in turn helped me deal with my own discouragement.

Diaz-Lopez: *You are involved in several projects involving students at all levels. For example, you are founder and director of "Patterns, Math & You," a 2-week summer program for middle school students. What are your goals in such activities?*

Várilly-Alvarado: Patterns, Math & You (PMAY) grew out of my personal experience (which is also well-documented in studies) that persistence rates in STEM majors are lower among students from underrepresented groups, in great part because of insufficient high school mathematical preparation. I've met many talented undergraduates who gave up on their dream of being an engineer or a scientist because of their performance in first-year STEM courses. In PMAY, we take in a diverse group of students from the Houston independent school district and get them to discover beautiful patterns in elementary number theory through experimentation. The program is directed at middle school students because we want to encourage their STEM aspirations and help them navigate choices in high school that will prepare them for the rigors of a STEM major.

More broadly, inclusion has become an important priority for me. I want to support activities and initiatives that foster an appreciation and love for mathematics across a wide spectrum of people, at many different levels of experience. I think too often as mathematicians we neglect individuals whose background, available opportunities, and life experiences have placed them at a disadvantage relative to privileged upbringings. To paraphrase one of my mentors, we should be much more interested in the derivative of someone's talent than on its value at any given time marker. In this regard, Federico Ardila has been an inspiring figure for me, and I am a strong believer in the axioms on mathematical talent that he laid out here on the pages of the *Notices*.[1]

Diaz-Lopez: *If you could recommend one book to graduate students, what would it be?*

Várilly-Alvarado: I can't do just one. Several life-changing books and articles come to mind. People wishing to learn a bit of algebraic geometry with a computational flavor should read Cox, Little, and O'Shea's landmark book, I*deals, Varieties, and Algorithms.* At a more abstract level, I am particularly fond of Ravi Vakil's *Foundations of Algebraic Geometry*, a tough read, well worth every minute spent on it. I am also a strong believer in original sources. Several articles of Serre's, e.g., "Faisceaux Algebriques Coherents" and "Géometrie Algébrique et Géométrie Analytique" (GAGA), are masterpieces that everyone with algebro-geometric interests should spend time reading, if only for personal self-edification. Then of course, anything by Grothendieck. One has to be careful, though: the pull of Grothedieck's writing has the strength of a black hole, and it is possible to spend years reveling in it. To some extent one should, but it's important to balance this impulse with one's own research production.

Diaz-Lopez: *Any final comments or advice?*

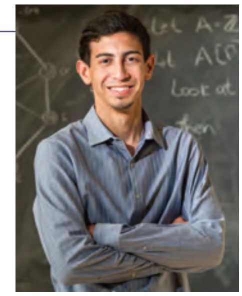
Várilly-Alvarado: We, as mathematicians, could be doing a better job of explaining to the public and to our governments what it is that we do, and why it is worth doing. We give up too easily, thinking that it's too hard (and I am sympathetic; explaining the importance of the arithmetic of Shimura varieties to a congressional aide in 15 minutes is no walk in the park). In my experience, people are happy to listen if you try hard to make things understandable. It empowers them to see glimpses of higher-level mathematics. The thirst from the public is there, and I see it as our moral responsibility to quench it.

[1] *"Todos Cuentan: Cultivating Diversity in Combinatorics," Nov. 2016* Notices, *https://www.ams.org/publications/journals/notices/201610/rnoti-p1164.pdf*

Photo Credits

Interviewee photo taken by Joe Rabinoff in Schney, Germany, 2015.

ABOUT THE INTERVIEWER



Alexander Diaz-Lopez

Alexander Diaz-Lopez, having earned his PhD at the University of Notre Dame, is now assistant professor at Villanova University. Diaz-Lopez was the first graduate student member of the *Notices* Editorial Board.

WHAT IS...

a Matroidal Family of Graphs?

J. M. S. Simões-Pereira

Communicated by Cesar E. Silva

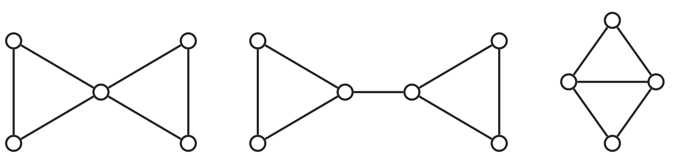


Figure 1. There are three types of bicycle graphs, including cycles as subgraphs. A graph and its cycles provide the simplest example of a matroid. A graph and its bicycles are another example.

In Figure 1, we have three graphs, called bicycles. Their cycles are the triangles and the quadrilateral of the third graph. Given any graph G, its cycles satisfy the following two conditions:

C1: No cycle contains properly another cycle;

C2: If x is an edge belonging to two distinct cycles, then there is a third cycle, in the union of those two, that does not contain x.

These are the defining axioms of a matroid. In the definition of a matroid on a set S, instead of *cycle* we use the word *circuit*.[1]

The edge sets of the cycles of a graph $G = (V, E)$ are the circuits of a matroid on the edge set E of the graph. This matroid is usually denoted by P_1. If we take as subgraphs the bicycles instead of the cycles, their edge sets are the circuits of another matroid on E, denoted P_2. These facts lead us to say that the set of graphs which are cycles, or the set of graphs which are bicycles, form *matroidal families of graphs*. As a general definition we have:

Definition. A *matroidal family of graphs* is a nonempty set P of finite, connected graphs such that, given an arbitrary graph G, the edge sets of subgraphs of G which are members of P are the circuits of a matroid on the edge set of G.

Unfortunately there is no simple generalization to "tricycles" or above. Besides the two examples of cycles and bicycles, P_1 and P_2, only one other nontrivial example P_3 was known: the circuits are the even cycles together with bicycles that have no even cycles. It was at this point that we [3] proved that for any other example of matroidal family no two circuits can be homeomorphic. Shortly afterwards, Thomas Andreae and Rüdiger Schmidt discovered new examples of matroidal families and, indeed, in every one of their examples, no two circuits are homeomorphic. Consequently, no two graphs are similar in their structure: neither "vertically" (one cannot contain another) nor "horizontally" (one cannot be homeomorphic to another). Nevertheless, in each one of those families, there are always two graphs, one of them being a minor of the other, as we are assured by the *minors theorem*, due to Neil Robertson and Paul Seymour, which says that in any infinite family of graphs, at least one of them is a minor of another one. Recall that a graph minor is obtained by deleting edges and vertices and contracting edges. These examples underline the *huge difference between subgraphs and minors*, even though they exhibit similar behaviors in some areas, such as planarity.

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[1] *The "Geometry of Matroids" (page X) gives a dual, equivalent definition of a matroid in which the distinguished subsets of S, called the independents, are the ones which do not contain a circuit.*

DOI: http://dx.doi.org/10.1090/noti1716

We are now ready to describe the infinite matroidal families of graphs $P_{n,r}$ discovered by Andreae [1]: *With n and r integer numbers, $n \geq 0$ and $-2n+1 \leq r \leq 1$, the circuits consist of all edge sets of subgraphs $\Gamma = (V, E)$ with $|V(\Gamma)| \geq 2$ and $|E(\Gamma)| = n|V(\Gamma)| + r$, and which themselves have no such subgraphs.* For example, for $P_{1,0}$ the circuits are just the cycles and we recover P_1. For $P_{1,1}$, the circuits turn out to be the bicycles and we recover P_2. And for $P_{1,-1}$ we recover P_0, whose only member is the graph with just one edge.

The families discovered by Schmidt [2] are even more surprising. We need the concept of a *partly closed set* which is a set of graphs $Q \subseteq P_{n,r}$ and such that, if $X, Y \in Q$, $W = X \cup Y$, $X \neq W \neq Y$ and $|E(W)| = n|V(W)| + r + 1$, then, for each edge $a \in E(X \cap Y)$, there is $Z \in Q$ such that Z is isomorphic to a subgraph of $W - \{a\}$. As an example of a partly closed set, we may take the set $Q \subseteq P_{1,0}$ of the even cycles.

We now define Schmidt's families: *With a partly closed set $Q \subseteq P_{n,r}$, $r \leq 0$, and $P_{n,r+1,Q} = Q \cup P'$, where P' is the set of all graphs of $P_{n,r+1}$ which do not contain a subgraph isomorphic to a graph in Q, we get $P_{n,r+1,Q}$ as a matroidal family.* For example, taking Q to be the set of the even cycles, $P_{1,1,Q} = Q \cup P'$ where P' is the set of bicycles with no even cycle, we recover P_3. Taking Q to be the empty set, which is trivially closed, we recover Andreae's matroidal families: in fact, $P_{n,r+1} = P_{n,r+1,\emptyset}$.

Concerning the matroidal families discovered by Schmidt, his most unexpected result is that *the number of such families is uncountably infinite.* A question remains to challenge our readers: Are there other matroidal families of graphs?

References

[1] Thomas Andreae, Matroidal families of finite, connected, nonhomeomorphic graphs exist, *Journal of Graph Theory* **2** (1978), 149–153. MR493394

[2] Rüdiger Schmidt, On the existence of uncountably many matroidal families, *Discrete Mathematics* **27** (1979), 93–97. MR534956

[3] J. M. S. Simões-Pereira, *Matroidal Families of Graphs*, in Matroid Applications (Neil White, editor), Encyclopedia of Mathematics and its Applications, vol. 40, Cambridge University Press (1992), 91–105. MR1165541

Photo Credit

Author photo courtesy of J. M. S. Simões-Pereira.

J. M. S. Simões-Pereira

ABOUT THE AUTHOR

J. M. S. Simões-Pereira's area of research is discrete mathematics. In his spare time, he enjoys playing piano, grooming his cats, meeting with friends, and reading and speaking languages (besides Portuguese and English, French, German, Spanish, Italian and a bit of Russian).

This month we run a condensed post from the AMS e-Mentoring Network Blog `https://blogs.ams.org/mathmentoringnetwork`.

Reflections of a First-Year Postdoc

by Luis Sordo Vieira

Luis Sordo Vieira, postdoc at UConn Health, and his dog Ivy.

I am Luis Sordo Vieira, a Latino postdoc at UConn Health Center for Quantitative Medicine using mathematics for my profession. Below is my best friend and wife, Sarah Sordo Vieira, MA in mathematics too. She went to grad school and decided that a PhD was not for her, and she is my favorite mathematician.

Before I forget how difficult grad school is (very difficult), let me share some of the most important lessons that I have encountered in my career so far.

Luis Sordo Vieira is now a postdoc at The Jackson Laboratory for Genomic Medicine. His email address is `luis.sordovieira@jax.org`.

Almost everything that you succeed at looks easy in retrospect.

Of course, this does not mean that it was. I got so angry when I would hear situations such as:

1. Graduate student John tells undergraduate Stacey "Undergraduate is nothing compared to graduate school."
2. Post-quals grad student Donald tells the first-year terrorized student Marcos that writing a thesis is much harder than quals.
3. Early faculty Michelle trying to get tenure tells poor graduate student Robert that graduate school is some of the most fun years of your academic career, and nothing compared to the difficulties of pre-tenure.

My best friend and wife Sarah Sordo Vieira is my favorite mathematician.

These insensitive comments are more harmful than helpful. They degrade the difficulties of others and enable the sense of not belonging. These comments are extremely harmful to underrepresented groups. We all have our own struggles.

We are defined by our failures as academics just as much by our success.

This year, I heard from a status quo successful and well-established professor that scientists endure more failures than enjoy success. I wish I would have heard this earlier in grad school! A CV is a cleaned-up version of someone's academic career. It only shows success. Keep that in mind when you decide it is a good idea to compare yourself to others (it never is).

Take your mental and physical health seriously in graduate school and academia.

The impression I got early from my undergraduate years and early graduate school is that a lot of graduate school is about suffering and we seem to be OK with this as a community. This is so wrong, and if you don't believe me, read *this article*[1] on the mental toll grad-school takes on students. This is a very serious issue and not something to just say, "It's normal in grad school." NO. It is not normal to be depressed or feel severe anxiety. Keep a check on your mental health. Have fun in graduate school! Keep a hobby and don't let your personal life fall behind. If you need it, go to the counseling center. Seeking help when you need it is a strength, not a weakness. Never, ever hide your wonderful personality to try to fit in. It is not worth it.

Find a mentor. Be a mentor.

I was privileged to have a good academic advisor, mentor and friend, David B. Leep. Maybe your academic advisor is not a mentor. I was very lucky to find several people outside of my institution that I could always go to for advice, such as my good friend, theorem-proving machine, and fellow dog-lover Pamela Harris.[2] She is an incredible mathematician that takes no nonsense from me. More impressive than her stellar CV is her willingness to stand up for what is right, regardless of how uncomfortable it might be. That includes when I say something insensitive or stupid, as we all do.

My good friend Pamela E. Harris lets me know when I say something insensitive.

Mentors might even lead you into a whole different field from your focus in graduate school. For me, that was my other local mentor at the University of Kentucky, where I earned my PhD. David Murrugarra somehow convinced me that biology is super-cool and mathematical. He is a good friend of mine, and I still come often to him for advice on navigating academic nonsense, such as reviews that make no sense, the ten million journals out there, and the grant-writing landscape. He also gives me good advice on good Peruvian food and where I can get a good Pisco Sour.

David Murrugarra convinced me that biology is super-cool and mathematical.

Pay it back. Find an undergrad in your institution and tell them your experiences. I bet you have plenty of things to contribute.

A plea to the academic community.

My last point is that we please reconsider what a successful mathematician is. Coming into grad school for a PhD, realizing it's not for you, and leaving with a master's degree is **not** a failure. Finishing an REU and realizing research is terrible and you never want to do it again is **not** a failure. Let us redefine a mathematician to encompass our fellow academes in math ed. Math ed is just as important for the math community as number theory. Stop using terms such as number-crunchers for scientists and industry workers applying mathematics. Let us stop considering mathematics as the ultimate science. Let us celebrate diversity in mathematics.

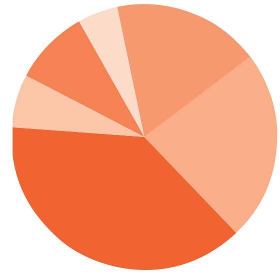
Photo Credits

Photos of Luis Sordo Vieira and Sarah Sordo Vieira courtesy of Luis Sordo Vieira.
Photo of Pamela E Harris by Cesar Silva.
Photo of David Murrugarra courtesy of David Murrugarra.

[1] *"Paying Graduate School's Mental Toll" by Carrie Arnold, Science (Feb. 4, 2014),* www.sciencemag.org/careers/2014/02/paying-graduate-schools-mental-toll.

[2] *See the article on Harris in this issue, page 1025.*

ANNUAL SURVEY



Fall 2016 Departmental Profile Report

Amanda L. Golbeck, Thomas H. Barr, and Colleen A. Rose

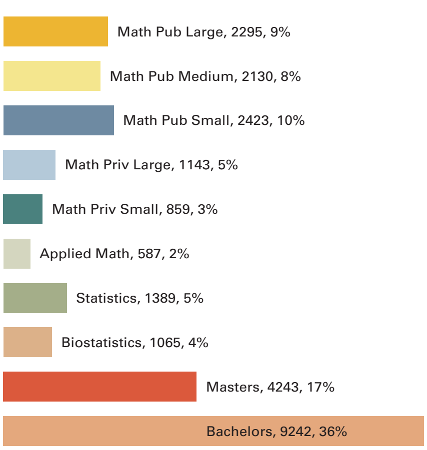
This report presents a profile of mathematical sciences (MS) departments at four-year colleges and universities in the United States, as of fall 2016. The information presented includes the numbers of faculty in various categories, undergraduate and graduate course enrollments, numbers of bachelor's and master's degrees awarded during the preceding year, and the number of graduate students. Definitions of categorized terms such as "Mathematical Sciences," "Math," and "Stats" along with a description of the faculty categories are provided at the end of this report.

Detailed information, including tables on which the graphics are based, is available on the AMS website at `www.ams.org/annual-survey`.

Faculty Size

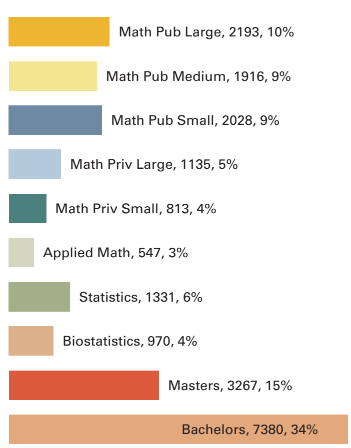
The estimated number of full-time faculty in MS for fall 2016 is 25,376. Of these, 22,922 were in Math (up 2% from 22,373 in 2015) and 2,454 were in Stats (up 9.5% from 2,241). Full-time faculty in the Doctoral Math Group increased 4% to 9,437 from 9,059. In Math we estimate that the number of nondoctoral full-time faculty is 3,643, essentally unchanged from 3,615 in 2015, with a standard error of 127. The total part-time faculty in Math is estimated to be 7,889 (with a standard error of 304), relatively unchanged from 7,684. In Stats, the part-time faculty count is estimated to be 272, but the relatively high standard error of 49 permits no conclusion as to whether this figure represents an increase over the 2015 estimate of 233.

Figure F.1: Full-time Faculty by Department Grouping



Total: 25,376

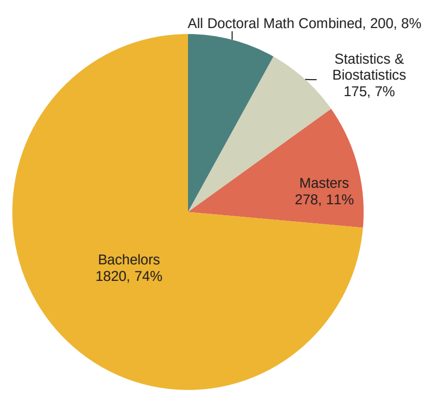
Figure F.2: Full-time Doctoral* Faculty by Department Grouping



Total: 21,580

*Doctoral-holding

Figure F.3 Full-time Faculty Teaching Courses Outside of the Mathematical Sciences



Total: 2,473*

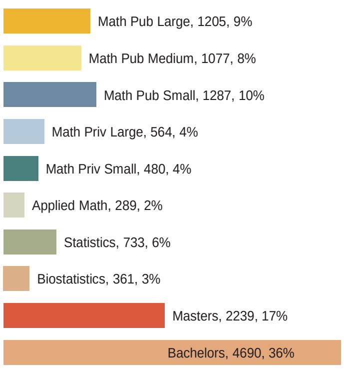
*(32% teach only computer science courses)

Amanda L. Golbeck is Associate Dean for Academic Affairs and Professor of Biostatistics in the Fay W. Boozman College of Public Health at University of Arkansas for Medical Sciences. Thomas H. Barr is AMS Special Projects Officer. Colleen A. Rose is AMS Survey Analyst.

Doctoral Faculty

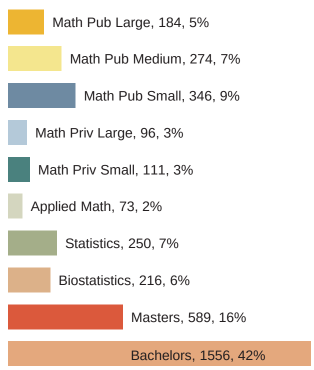
The estimated number of full-time doctoral (i.e., doctorate-holding) faculty in MS is 21,580. In Math this estimate is 19,279 (with a standard error of 127), up 3% from 18,758 for fall 2015; in Stats it is 2,301, up 7% from 2,146. Respectively for Math and Stats, the total doctoral tenured faculty are 11,831 and 1,094 compared to 11,653 and 1,011 for fall 2015. Sixty-five percent of all doctoral tenured faculty in Math are full professors, while 17% of all doctoral faculty are tenure-eligible. Women hold 22% of all doctoral tenured faculty and 18% of doctoral tenured full professor appointments.

Figure D.1: Full-time Tenured Doctoral Faculty by Department Grouping



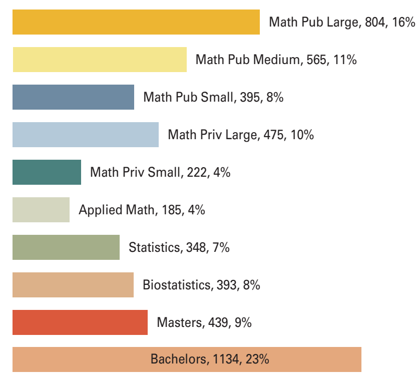
Total: 12,925

Figure D.2: Full-time Tenure-eligible Doctoral Faculty by Department Grouping



Total: 3,695

Figure D.3: Full-time Non-tenure-track Doctoral Faculty by Department Grouping

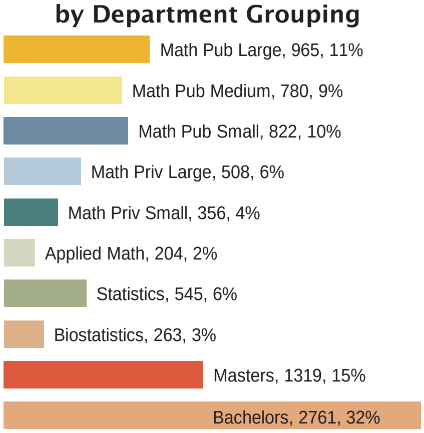


Total: 4,960

Features of full-time doctoral faculty data:

- 74% of all tenured doctoral faculty in the Doctoral Math Group are full professors (3,635), with 71% of these full professor appointments in Math Public departments.
- Over the period fall 2015 to fall 2016, tenure-eligible doctoral faculty increased 6% among the Doctoral Math Group, while the Biostatistics, Masters, and Bachelors Groups showed decreases of 1%, 2%, and 3%, respectively.
- Postdoctoral appointments among the Doctoral Math Group increased to 1,289 for fall 2016. This is a 5% increase from 2015 and 15% of the total full-time doctoral faculty in these departments. In Stats postdocs decreased 21% to 180.

Figure D.4: Full-time Tenured Doctoral Full Professor Faculty by Department Grouping



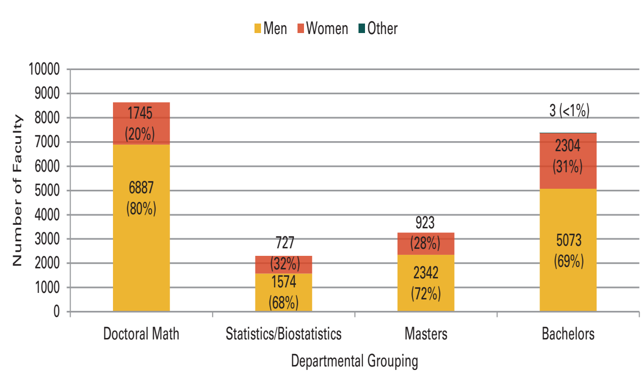
Total: 8,523

- Women hold 22% of all postdoctoral appointments, up from 21% from fall 2015.
- 16% of the doctoral faculty in the Doctoral Math Group are in non-tenure-track positions. The majority of these faculty hold renewable (81%) and fixed-term appointments (17%); in 2015 these percentages were 79% and 17%, respectively.

Features of part-time doctoral faculty data:

- Estimated total part-time doctoral faculty decreased 7% to 1,973 from 2,075. Of these, 28% receive benefits, and 7% are in phased retirement.
- 30% of all part-time doctoral faculty are in Doctoral Math departments.
- Women hold 29% of all part-time doctoral faculty positions, the same as in fall 2015.

Figure D.5: Gender of Full-time Doctoral Faculty

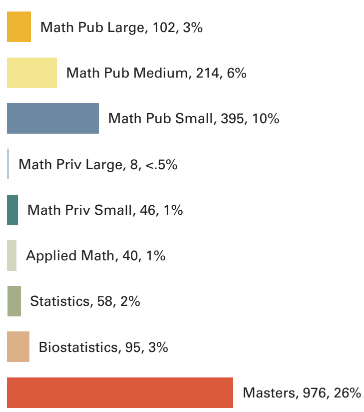


Total: 21,580

Nondoctoral Faculty

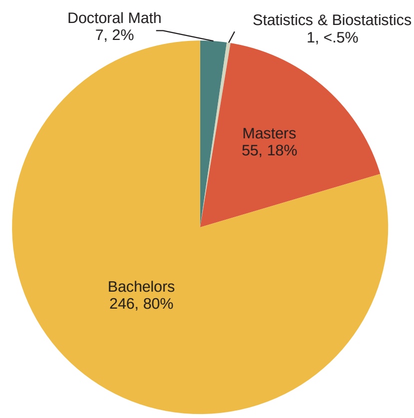
The estimated number of nondoctoral (i.e., without a doctorate) full-time faculty in MS is 3,796, of which 3,643 are in Math and 153 are in Stats. This count is up 2% from 2015, and it represents 15% of all full-time faculty. In Math, nondoctoral tenured faculty increased 4% from 296 to 308; in Stats one nondoctoral tenured faculty member was reported. One hundred twenty-four of the nondoctoral full-time faculty in Math are tenure-eligible, 4% of all those tenure-eligible. Nondoctoral full-time non-tenure-track faculty increased 3% to 3,361; this is 88% of all nondoctoral full-time faculty, the same as fall 2015. Women composed 55% of all nondoctoral faculty, the same as fall 2015.

Figure ND.1: Full-time Nondoctoral Faculty by Department Grouping



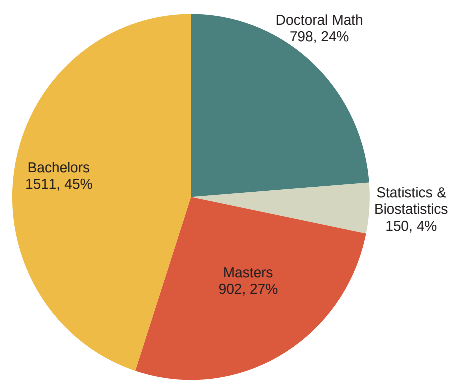
Total: 3,796

Figure ND.2: Full-time Tenured Nondoctoral Faculty by Department Grouping



Total: 309

Figure ND.3: Full-time Non-tenure-track Nondoctoral Faculty by Type of Appointment



Total: 3,361

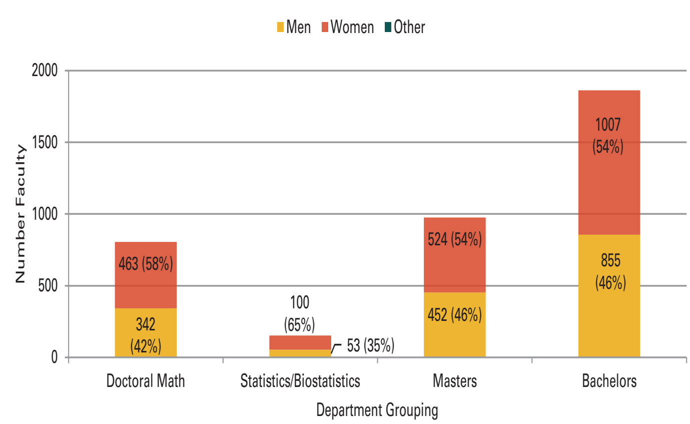
Features of full-time nondoctoral faculty data:

- 35% of all tenured nondoctoral faculty in MS are full professors (109) and 75% of these appointments are in the Bachelors Group. Stats reported no faculty in this category.
- Masters and Bachelors departments combined reported the majority of the nondoctoral nontenure-track faculty holding renewable and fixed-term appointments with 71% and 80%, respectively.
- Women account for 55% of full-time nondoctoral faculty in Math. By comparison, women account for 26% of all doctoral full-time faculty and 30% of all full-time faculty in Math.

Features of part-time nondoctoral faculty data:

- Total part-time nondoctoral faculty increased 2% to 5,974 from 5,842 last year. Of these faculty, 24% receive benefits and 2% are in phased retirement.
- 76% of all part-time faculty are nondoctoral; women hold 47% of these positions.
- Part-time nondoctoral faculty decreased 5% to 772 in Doctoral Math departments, this is 57% of all part-time faculty in this group.

Figure ND.4: Gender of Full-time Nondoctoral Faculty

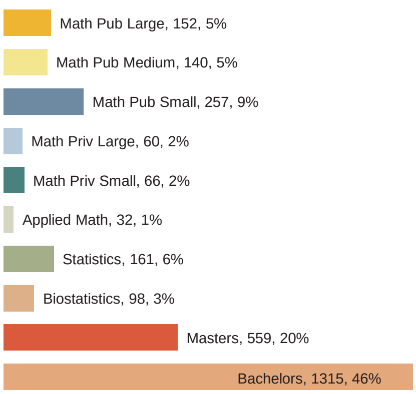


Total: 3,796

Women Faculty

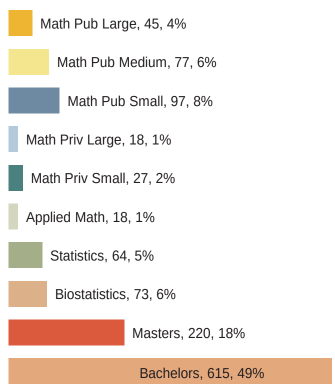
Women account for 31% (7,793) of all full-time faculty in MS. In Math, women made up 30% (6,966 with a standard error of 96) of the full-time faculty (22,922) in fall 2016. For the Doctoral Math departments, women composed 17% of the combined doctorate-holding tenured and tenure-eligible faculty and 33% of the doctorate-holding non-tenure-track (including postdocs) faculty in fall 2016. In the other groups these respective percentages are: 23% and 38% in Statistics, 30% and 51% in Biostatistics, 28% and 33% in Masters, and for Bachelors faculty they are 31% and 33%. Among the nondoctoral full-time faculty in Math, women compose 55%. Women account for 42% of all part-time faculty in Math.

Figure FF.1: Full-time Tenured Women Doctoral Faculty by Department Grouping



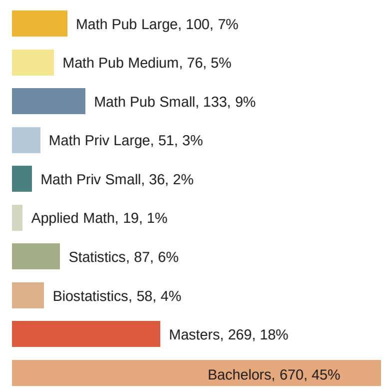
Total: 2,840

Figure FF.2: Full-time Tenure-eligible Women Doctoral Faculty by Department Grouping



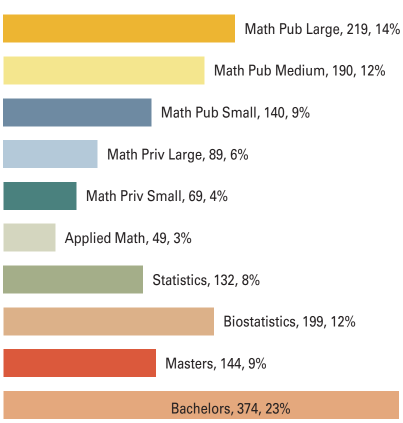
Total: 1,254

Figure FF.3: Full-time Full Professor Women Doctoral Faculty by Department Grouping



Total: 1,499

Figure FF.4: Full-time Non-tenure-track Women Doctoral Faculty by Department Grouping



Total: 1,605

Features of full-time women faculty data:

- Women hold 14% of full-time tenured and 26% of full-time tenure-eligible positions in Doctoral Math departments.
- 42% of all full-time women faculty are in the Bachelors departments.
- Biostatistics departments reported the highest percentage of full-time women faculty (41%), followed by the Bachelors departments (36%), and Masters (34%), while the Math Private Large Group reported the lowest (15%).
- Women hold 22% of all postdoctoral appointments (up from 21% in 2015). Forty-eight percent of postdocs in Biostatistics are held by women. The majority of the Doctoral Math groups reported between 20% and 28% of postdocs were held by women, with only Math Public Small and Math Private Large reporting fewer women in these positions with 15% and 19%, respectively.
- 87% of all women nondoctoral non-tenure-track faculty appointments (1,916) are renewable; 10% are fixed-term, and 2% are other types of appointments.

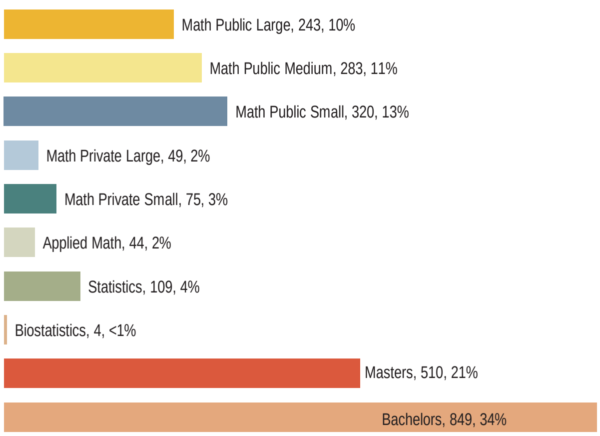
Features of part-time women faculty data:

- 58% of all part-time women faculty in Math are in Bachelors departments.
- 83% of all part-time women faculty hold nondoctoral positions. Of these faculty, 23% receive benefits and 1% are phased retirements.

Undergraduate Course Enrollments

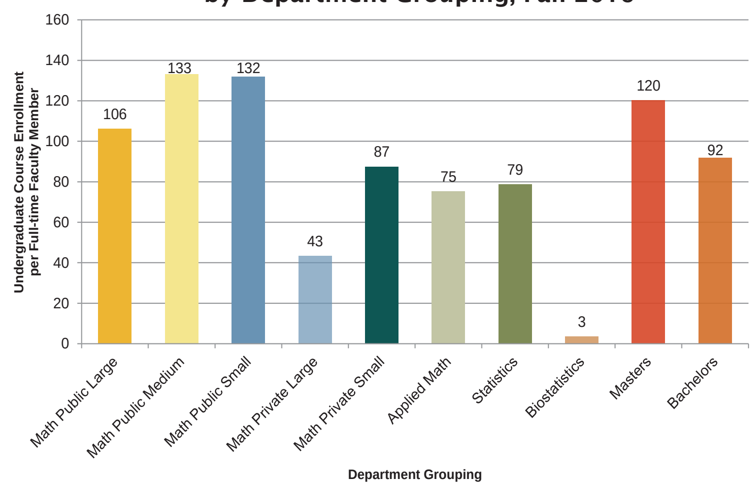
The 2016 estimate of total undergraduate enrollments in MS courses is 2,518,000. With a standard error of 26,000, this figure cannot be used to conclude that enrollments have changed significantly from the 2015 estimate of 2,487,000. MS departments reported an overall decrease of 4% in the number of undergraduate course enrollments per full-time faculty member.

Figure UE.1: Undergraduate Course Enrollments (thousands) by Department Grouping, Fall 2016



Total Undergraduate Enrollments (thousands): 2,487

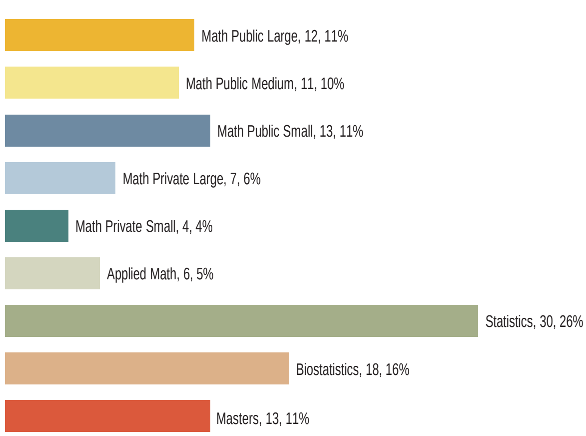
Figure UE.2: Undergraduate Course Enrollment per Full-Time Faculty Member, by Department Grouping, Fall 2016



Graduate Course Enrollments

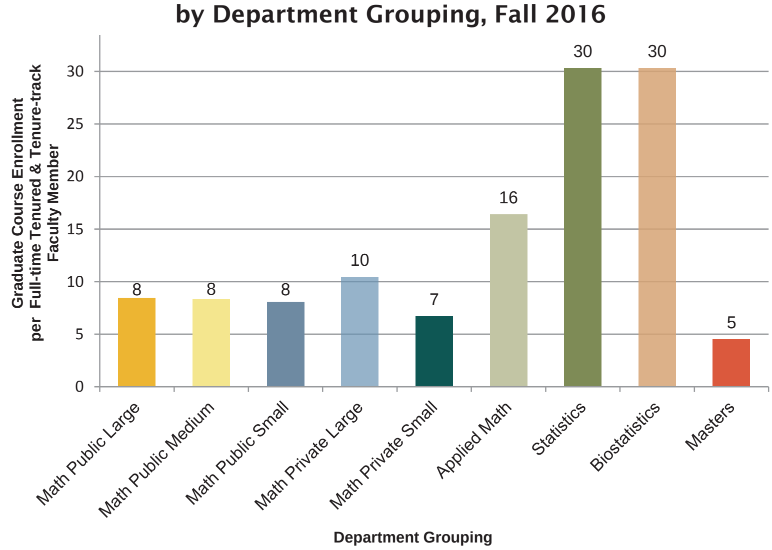
Estimated total graduate course enrollments have increased from 110,000 to 113,000 (with a standard error of 5,000). MS departments reported an overall decrease of 1% in the estimated number of graduate course enrollments per full-time tenured and tenure-eligible faculty member.

Figure GE.1: Graduate Course Enrollments (thousands) by Department Grouping, Fall 2016



Total Graduate Enrollments (thousands): 113

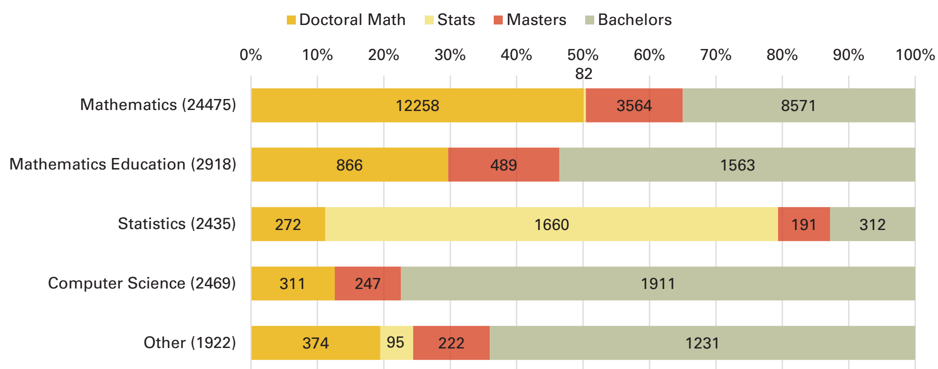
Figure GE.2: Graduate Course Enrollment per Full-Time Tenured & Tenure-eligible Faculty Member, by Department Grouping, Fall 2016



Bachelor's Degrees Awarded

For the period 2015–16, the estimated number of bachelor's degrees awarded in MS departments is 34,219, up 13% from the 2014–15 estimate of 30,397. The standard error is 825. Of these, 13,578 were earned by women (40%), a 9% increase. In Math Departments, the 2015–16 estimated number of bachelor's degrees awarded is 32,382, a count that includes 12,800 degrees earned by women, 24,393 Math degrees, 2,918 Math Ed degrees, 775 Statistics-only degrees, 2,469 Computer-Science-only degrees, and 1,827 other degrees. Approximately 12,800 of these degrees were earned by women. This figure represents an 11% increase from last year's estimate of 29,101 degrees awarded by Math departments. The new breakdown of degrees awarded by major accounts for at least 50% (1,922 Other degrees) of the increase in total degrees awarded.

Figure UD.1: Undergraduate Degrees Awarded by Major and Department Grouping
(Degrees awarded between July 1, 2015 and June 30, 2016)



Total: 34,219

Here are some of the highlights regarding bachelors degrees:

- All department groupings reported increases in the number of undergraduate degrees awarded.
- 40% (13,578) of all bachelors degrees, 61% (1,773) of mathematics education degrees, and 21% (525) of computer science degrees were earned by women.
- Of all degrees in mathematics (24,475, 72% of all bachelors),
  - ◇ 50% (12,258) were awarded in the Doctoral Math group; 36% of these degrees were awarded to women.
  - ◇ 35% (8,571) were awarded in Bachelors departments, and 44% of these were to women.
  - ◇ 15% (3,564) were awarded in Masters departments, and 33% of these were to women.
- Of all degrees in statistics (2,435, or 7% of all bachelors),
  - ◇ 68% (1,660) were awarded in departments of Statistics or Biostatistics
  - ◇ 43% (1,055) were awarded to women
- Of degrees in Computer Science awarded in mathematical sciences departments (2,469, 7% of bachelors awarded), 77% (1,911) were awarded in the Bachelors Group, and 22% of these were to women.

Figure UD.2: Undergraduate Degrees Awarded by Major and Gender
(Degrees awarded between July 1, 2015 and June 30, 2016)

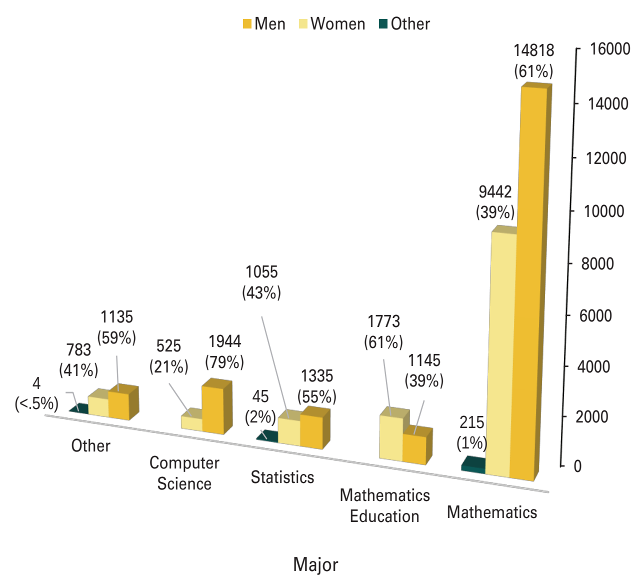
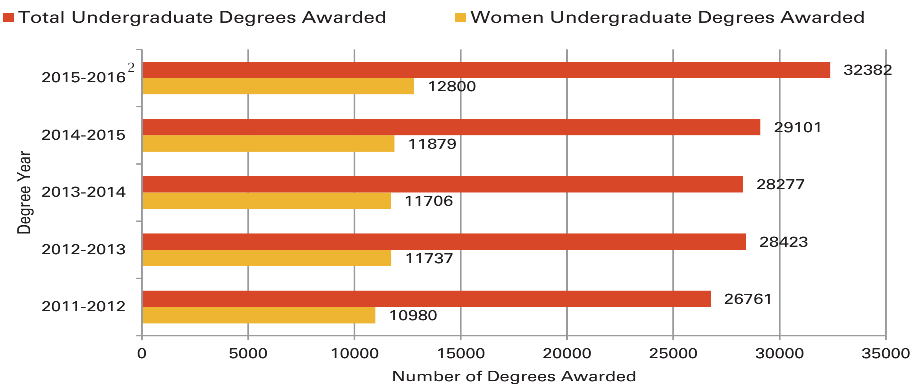


Figure UD.3: Undergraduate Degrees Awarded[1], 2011–2016
All Mathematics Departments

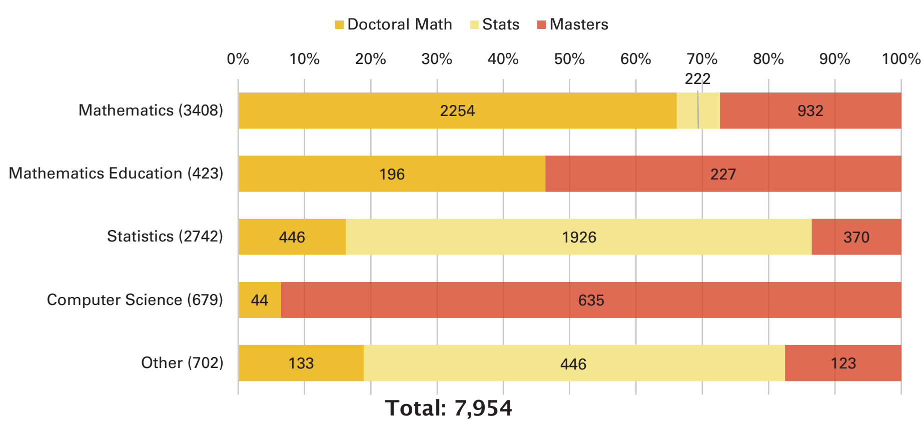


[1] Degrees awarded between July 1 and June 30.
[2] Due to the finer grained detail being collected on majors, it's possible departments have reported degrees not reported in the past.

Master's Degrees Awarded

For the period 2015–2016, the estimated number of master's degrees awarded in MS departments is 7,954, an increase of 12% over the 2014–2015 estimate of 7,132. The standard error in this estimate is 722. Of these, 3,203 or 40% were earned by women, a 6% increase over the 2014–2015 estimate consisting of 3,034. In Math departments, the estimated number of master's degrees awarded is 5,360, a count estimate consisting of 3,186 Math degrees, 423 Math Ed degrees, 816 Statistics-only degrees, 679 Computer-Science-only degrees, and 256 other degrees. Approximately 2,034 of these are earned by women. This figure represents a 5% increase over last year's estimate of 5,087 masters degrees awarded by Math departments.

Figure MD.1: Masters Degrees Awarded by Major and Department Grouping
(Degrees awarded between July 1, 2015 and June 30, 2016)



Here are a few highlights regarding the masters degrees:

- All department groupings reported increases in the number of masters degrees awarded except Math Public Medium and Small, which had decreases of 7% and 1%, respectively.
- 34% (2,742) of masters degrees were in statistics.
- 29% (2,287) of masters degrees were awarded by Masters departments, 25% (1,954) by Statistics, and 9% by Math Public Small.
- 40% of all masters degrees were awarded to women, with the lowest rate of 30% (1,015) among math majors and the highest rate of 66% (279) among mathematics education majors.

- 43% (3,408) of masters degrees represented were awarded in mathematics
  - ◇ 27% (932) of these were awarded by Master departments
  - ◇ 29% (268) of these were awarded to women.
- 5% (423) of masters degrees were in mathematics education.
  - ◇ 54% (227) of these were awarded by Masters departments
  - ◇ Women earned 66% of all mathematics education degrees
- 9% (679) of masters degrees in mathematical sciences departments were in computer science.
  - ◇ 94% (635) of CS masters were awarded by the Masters Group; 33% of these went to women.
  - ◇ Masters in CS conferred by the Masters Group of departments more than doubled to 635 from 2014–15, but most other groups saw decreases.

Figure MD.2: Master's Degrees Awarded by Gender and Major
(Degrees awarded between July 1, 2015 and June 30, 2016)

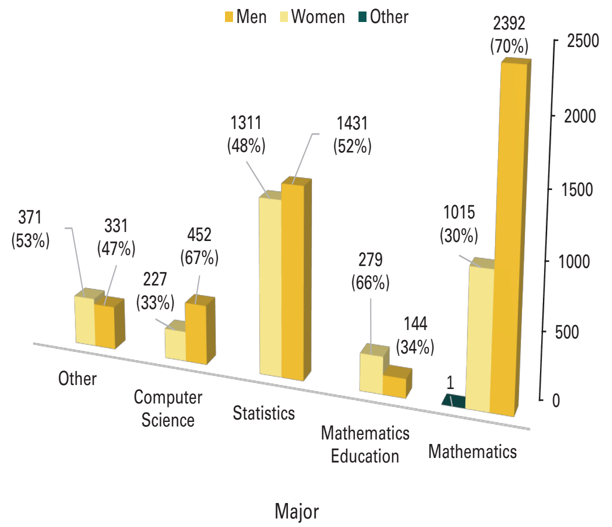
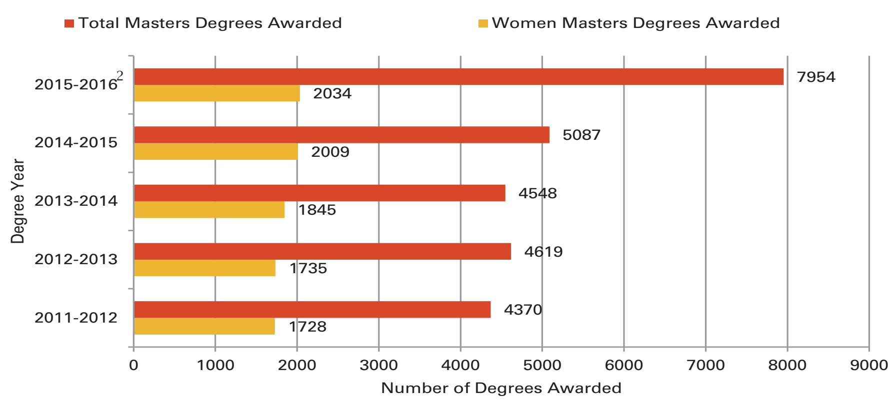


Figure MD.3: Master's Degrees Awarded[1], 2011–2016
All Mathematics Departments

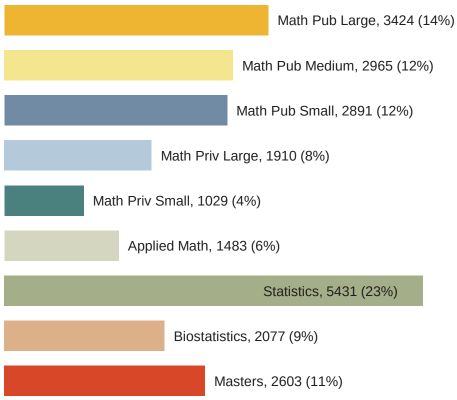


1 Degrees awarded between July 1 and June 30.
2 Due to the finer grained detail being collected on majors, it's possible departments have reported degrees not reported in the past.

Graduate Students

In fall 2016, the total number of full-time graduate students is estimated at 23,813, with 16,305 in Math (essentially unchanged from 16,136 in fall 2015) and 7,508 in Stats. The total number of full-time graduate students in Doctoral Math departments is 13,702 (from 13,431). In Doctoral Math departments, counts of full-time and first-year graduate students who are US citizens or permanent residents have remained essentially unchanged at 7,131 and 1,779, respectively. For the Masters Group, full-time graduate students decreased 4% to 2,603, the number of US citizens and permanent residents is 1,762 (down from 1,930), and the number of first-year students is 1,155 (down from 1,203). Stats reported full-time first-year graduate students at 2,543, up from 2,538. Women account for 36% (8,684) of all full-time graduate students.

Figure GS.1: Graduate Students by Department Grouping, Fall 2016



Total: 23,813

Features of full-time graduate student data:

- Full-time graduate students and full-time women graduate students increased in all groups except Math Public Medium and Masters.
- First-year graduate students remained relatively unchanged at 7,402 from 7,387; only Math Public Large, Math Public Medium, Math Private Large, and the Biostatistics Groups estimates increased by 5%, 1%, 24%, and 2%, respectively.
- US citizen and permanent resident graduate students decreased 2% from 11,823 to 11,587, while most groups reported decreases of less than 5%, the Masters Group decreased 9%, and the Math Public Large, Math Public Small, and Applied Math Groups increased by 1% , 5%, and 6%, respectively.
- Underrepresented minorities accounted for 13% of US citizen and permanent resident graduate students and 5% of first-year graduate students. Women compose 35% and 39%, respectively, of these categories.
- Math Public Small, Math Private Large, Applied Math, and the Statistics Groups all reported increase in underrepresented minorities, while Math Public Large, Math Public Medium, Math Private Small and Biostatistics all reported decreases of 32%, 22%, 39%, and 6%, respecitvely.
- Non-US citizen full-time graduate students increased in all groups except Applied Math which remained relatively unchanged and full-time women graduate student counts increased in all groups except Masters which decreased 6%.

Features of part-time graduate student data:

- Estimates of total part-time graduate student counts increased in the Math Public Small, Math Private Small, Biostatistics, and Masters Groups, while Math Public Large, Math Public Medium, Math Private Large, Applied Math, and Statistics estimates decreased by 22%, 12%, 21%, 8%, and 44%, respectively.
- Part-time US citizen and permanent resident graduate student counts decreased slightly to 3,381 and non-US citizen counts decreased 8% to 665.
- Underrepresented minorities account for 14% of part-time US citizen and permanent resident graduate students, down from 16% in all 2015).

Table GS.2: Full-Time Graduate Students in All Doctoral Math Groups Combined by Gender and Citizenship, Fall 2007–2016

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total full-time graduate students	**10937**	**10883**	**11286**	**13048**	**12514**	**12684**	**12961**	**13023**	**13431**	**13702**
Women	3249	3193	3248	3839	3773	3771	3969	3925	4039	4146
% Women	30%	29%	29%	29%	30%	30%	31%	30%	30%	30%
% US Citizen & Permanent Residents[1]	56%	55%	56%	57%	56%	54%	53%	55%	53%	52%
% Underrepresented minorities[2]	9%	9%	9%	11%	8%	8%	9%	11%	15%	13%
Total first-year graduate students	**2964**	**2924**	**3040**	**3313**	**3288**	**3394**	**3623**	**3551**	**3646**	**3704**
Women	950	870	904	1019	1077	1036	1205	1193	1188	1200
% Women	32%	30%	30%	31%	33%	31%	33%	34%	33%	32%
% US Citizen & Permanent Residents[1]	56%	56%	55%	51%	50%	54%	53%	55%	53%	52%
% Underrepresented minorities[2]	10%	10%	9%	9%	9%	7%	10%	13%	14%	12%

[1] Starting with 2014, departments were asked to report US citizen and permanent resident counts together; previously permanent residents were included in the non-US citizen counts. All percentages prior to 2014 have been updated to allow for comparison with previous years' data.

[2] Prior to 2014 these counts only included US Citizens. Underrepresented minorities includes any person having origins within the categories American Indian or Alaskan Native, Black or African American, Hispanic or Latino, and Native Hawaiian or Other Pacific Islander.

Faculty Categories

The faculty categories used in this report are described below. Departments were asked to report any faculty member who was considered to be full-time in the institution for the academic year and at least half-time in the department. Each faculty member was reported in exactly one of these categories.

Tenure-track faculty includes full-time faculty who hold tenured/tenure-eligible positions (i.e., only those individuals who are tenured full professors, other tenured and tenure-eligible faculty).

Postdoctoral faculty includes full-time faculty who have teaching and/or research responsibilities, but for a strictly limited term of employment (i.e., those individuals who hold a temporary position primarily intended to provide an opportunity to continue training or to further research experience).

Non-tenure-track faculty includes full-time faculty eligible for benefits and with an appointment that lasts at least one academic year. These faculty hold appointments that are renewable (potentially unlimited), fixed-term but not renewable, or temporary. Typical titles for these positions are Lecturer, Senior Lecturer, Instructor, Senior Instructor, Associate/Assistant/Full Teaching Professor, Professor of the Practice, or Clinical Professor, and similar titles for research-only faculty.

Part-time faculty includes those individuals who are hired term-by-term, paid by the course, and/or those in phased retirement.

Department Groupings

In this report, Mathematical Sciences departments are those in four-year institutions in the US that refer to themselves with a name that incorporates (with a few exceptions) "Mathematics" or "Statistics" in some form. For instance, the term includes, but is not limited to, departments of "Mathematics," "Mathematical Sciences," "Mathematics and Statistics," "Mathematics and Computer Science," "Applied Mathematics," "Statistics," and "Biostatistics." Also, Mathematics (Math) refers to departments that (with exceptions) have "mathematics" in the name; Stats refers to departments that incorporate (again, with exceptions) "statistics" or "biostatistics" in the name but do not use "mathematics."

Starting with reports on the 2012 AMS-ASA-IMS-MAA-SIAM Annual Survey of the Mathematical Sciences, the Joint Data Committee implemented a new method for grouping doctorate-granting Mathematics departments. These departments are first grouped into those at public institutions and those at private institutions. These groups are further subdivided according to the size of their doctoral program as reflected in the average annual number of PhDs awarded between 2000 and 2010, based on their reports to the Annual Survey during that period.

For further details on the change in the doctoral department groupings, see the article in the October 2012 issue of Notices of the AMS at www.ams.org/journals/notices/201209/rtx120901262p.pdf.

Math Public Large consists of departments with the highest annual rate of production of PhDs, ranging between 7.0 and 24.2 per year.

Math Public Medium consists of departments with an annual rate of production of PhDs, ranging between 3.9 and 6.9 per year.

Math Public Small consists of departments with an annual rate of production of PhDs of 3.8 or less per year.

Math Private Large consists of departments with an annual rate of production of PhDs, ranging between 3.9 and 19.8 per year.

Math Private Small consists of departments with an annual rate of production of PhDs of 3.8 or less per year.

Applied Mathematics consists of doctoral-degree-granting applied mathematics departments.

Statistics consists of doctoral-degree-granting statistics departments.

Biostatistics consists of doctoral-degree-granting biostatistics departments.

Masters contains US departments granting a master's degree as the highest graduate degree.

Bachelors contains US departments granting a baccalaureate degree only.

Doctoral Math contains all US math public, math private, and applied math mathematics departments granting a PhD as the highest graduate degree.

Mathematics (Math) contains all Math Public, Math Private, and Applied Math, Masters, and Bachelors Groups above.

Stats consists of all doctoral-degree-granting statistics and biostatistics departments.

Listings of the actual departments that compose these groups are available on the AMS website at `www.ams.org/annual-survey/groups`.

Remarks on Statistical Procedures

The questionnaire on which this report is based, “Departmental Profile,” is sent to all Doctoral, Masters, and Bachelors departments in the US.

Response rates vary substantially across the different department groups. For most of the data collected on the Departmental Profile form, the year-to-year changes in a given department’s data are small when compared to the variations among the departments within a given group. As a result of this, the most recent prior year’s response is used (imputed) if deemed suitable. After the inclusion of prior responses, standard adjustments for the remaining nonresponses are then made to arrive at the estimates reported for the entire grouping.

Standard errors were calculated for some of the key estimates for the Doctoral Math Group (Math Public, Math Private, and Applied Math), and for the Masters, Bachelors, Statistics, and Biostatistics Groups. Standard errors are calculated using the variability in the data and can be used to measure how close our estimate is to the true value for the population. As an example, the number of full-time faculty in the Masters Group is estimated at 4,343 with a standard error of 107. This means the actual number of full-time faculty in the Masters Group is most likely between 4,343 plus or minus two standard errors, or between 4,129 and 4,557. This is much more informative than simply giving the estimate of 4,343.

Estimates are also given for parameters that are totals from all groups, such as the total number of full-time faculty. For example, an estimate of the total number of full-time faculty in all groups except Statistics and Biostatistics combined is 22,373, with a standard error of 205.

The careful reader will note that a row or column total may differ slightly from the sum of the individual entries. All table entries are the rounded values of the individual projections associated with each entry, and the differences are the result of this rounding (as the sum of rounded numbers is not always the same as the rounded sum).

Department Grouping Response Rates

Survey Response Rates by Grouping

Departmental Profile
Department Response Rates

Department Group	Number	Percent	Imputed[1]
Math Public Large	25 of 26	96%	8
Math Public Medium	40 of 40	100%	5
Math Public Small	58 of 64	89%	9
Math Private Large	22 of 24	92%	2
Math Private Small	26 of 29	89%	6
Applied Math	24 of 25[2]	96%	2
Statistics	54 of 59	92%	18
Biostatistics	31 of 44[2]	70%	6
Masters	161 of 175	93%	38
Bachelors	545 of 1,012	55%	184
Total	944 of 1,501	63%	278

1 See paragraph two under ‘Remarks on Statistical Procedures.’

2 The populations for Applied Math and Biostatistics are slightly less than for the Doctorates Granted Survey because some programs do not formally “house” faculty, teach undergraduate courses, or award undergraduate degrees.

Acknowledgments

The Annual Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical sciences scene for the use and benefit of the community and for filling the information needs of the professional organizations. Every year, college and university departments in the United States are invited to respond. The Annual Survey relies heavily on the conscientious efforts of the dedicated staff members of these departments for the quality of its information. On behalf of the Data Committee and the Annual Survey Staff, we thank the many secretarial and administrative staff members in the mathematical sciences departments for their cooperation and assistance in responding to the survey questionnaires.

Call for Nominations

AWM–AMS NOETHER LECTURE

The Association for Women in Mathematics (AWM) established the Emmy Noether Lectures in 1980 to honor women who have made fundamental and sustained contributions to the mathematical sciences. In April 2013 this one-hour expository lecture was renamed the AWM–AMS Noether Lecture. The first jointly sponsored lecture was held in January 2015 at the Joint Mathematics Meetings (JMM) in San Antonio, Texas. Emmy Noether was one of the great mathematicians of her time, someone who worked and struggled for what she loved and believed in. Her life and work remain a tremendous inspiration.

The mathematicians who have given the Noether Lectures in the recent past include: Jill C. Pipher, Lisa Jeffrey, Karen E. Smith, Wen-Ching Winnie Li, Georgia Benkart, Raman Parimala, and Barbara Keyfitz. Additional past Noether lecturers can be found at **https://sites.google.com/site/awmmath/programs/noether-lectures/noether-lecturers**.

The letter of nomination should include a one-page outline of the nominee's contribution to mathematics, giving four of her most important papers and other relevant information. Nominations must be submitted by October 15, 2018, and will be held active for three years.

AWM
ASSOCIATION FOR WOMEN IN MATHEMATICS

AMS AMERICAN MATHEMATICAL SOCIETY

The nomination procedure is described here:
https://www.sites.google.com/site/awmmath/programs/noether-lectures.

If you have questions, call **401-455-4042** or email **awm@awm-math.org**.

The State of Academia in Puerto Rico After Hurricane María

Luis A. Medina

September 20, 2017, is a day that marked change in the life of every resident of Puerto Rico. Around 6:15 am, local time, Hurricane María made landfall. María was a powerful high-end Category 4 hurricane packing sustained winds of 155 mph. It is the strongest hurricane to hit Puerto Rico since hurricane San Felipe II hit the archipelago with sustained winds of 160 mph in 1928.

Figure 1. Left: Facundo Bueso Anex building, UPR-Río Piedras was demolished by Hurricane María. Right: Students, faculty, and staff remove debris from the campus.

The catastrophic storm caused a humanitarian crisis from which Puerto Rico is still recovering one year later. No town or city was spared. The storm destroyed many houses, dismantled telecommunication towers, and obliterated the entire island's electrical grid. Potable water quickly became non-existent. Many people lost their lives in hospitals and care centers because no power meant no dialysis, no oxygen, and worse. Most hospitals and care centers had power generators, but they needed diesel fuel, which became scarce. The Governor's office estimates the cost of the storm to be US$94.4 billion. Recovery has been slow and there is still much work that needs to be done. The sense of isolation and crisis was exacerbated by the shared feeling of most Puerto Ricans that the US government's emergency response was slow and inadequate [1].

The crisis greatly affected academia. The infrastructure of every university in Puerto Rico suffered. Some science laboratories, classrooms, and other facilities were destroyed (see Figure 1). A preliminary assessment estimates the losses in infrastructure to the public university alone at US$118 million dollars [2].

The fall semester was halted for every university on the island. When the semester resumed, many students were displaced and power was unavailable. Some classes were being offered in tents, but students had limited time to study, as there was no electrical power at home, and every academic activity needed to end at 5:00 pm when daylight turned to dusk. Professors needed to design examinations that took into account the students' difficulties. Nevertheless, we all welcomed the re-opening of our university

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DOI: http://dx.doi.org/10.1090/noti1715

and were determined to make it work. Many students, professors, and employees volunteered to remove debris and clean the campuses. Many US universities offered tuition-free registration for Puerto Ricans affected by the storm. We in Puerto Rico are very grateful for that gesture.

Most mathematical research coming from Puerto Rico was put on hold right after María. Part of the problem can be traced back to the lack of internet; however, the bulk of the problem can be attributed to the difficult living conditions. Planning for the next hot meal, finding a store with ice available to keep medicine cold, and standing in line for hours to get gasoline or cash were the top priorities for most residents of Puerto Rico.

More than six months after María's wrath, there were still problems to contend with. Some of those problems could be attributed to the instability of the electrical grid and to the overall slow pace of recovery. Others related to what already was an anemic economy. Internet is not as reliable as it used to be. Printing exams can be an odyssey. Deadlines for grant proposals need to be treated with extra care. But we learned to plan things well in advance to ensure that work was not compromised by a sudden power outage or internet failure. Our university is now once again operational. Our students are coming. We are exchanging ideas, solidifying knowledge, and working on our research projects.

As we continue to recover from María, we find ourselves preparing for the onslaught from a storm of a different sort: financial crisis. The causes and effects of this crisis present us with a challenge perhaps greater than that presented by María, with long-lived consequences for our public institutions. Part of this new challenge is the out-migration of young Puerto Ricans. Jens Manuel Krogstad, an editor at the Pew Research Center, was quoted on `CNN.com` in February 2018 as stating that "It sounds possible that we're on pace for a historic net out-migration to the US from Puerto Rico. In 2015, the net out-migration was about 64,000 people...it sounds like it's possible that even after just a few months we're already on pace to overshoot that."

Our island population's steady decline over the past fourteen years is only part of the new challenges facing Puerto Rico. A shrinking population translates into a smaller tax base, which in turn places a greater strain on already overstretched government resources. The Financial Oversight and Management Board for Puerto Rico and the local government have recently made proposals for severe budget cuts to our academic institutions. These proposals have the potential to not only alter our university's mission but also to put all research in peril. We do not know how much different the university is going to be in the coming years. We hope that we can combat this new challenge, that Puerto Rico will see its way through this storm to job creation that will lead to economic growth and an eventual reversal in the population decline. In the face of it all, we in academia are determined to continue doing our work. Enlivening our universities. Making new plans. Exchanging ideas. Solidifying knowledge. Pursuing necessary research.

References

[1] Laignee Barron. US Emergency Response Efforts in Puerto Rico Aren't Good Enough, UN Experts Say. `time.com/5003470/united-nations-puerto-rico-hurricane-response`.

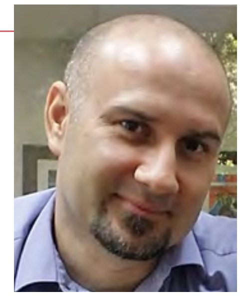
[2] María Soledad Dávila Calero. Ascienden a $118 millones los daños en recintos de la UPR. *CB en Español*, local newspaper, San Juan. Wednesday, October 25, 2017.

Photo Credits

Figure 1, right, courtesy of Dr. José R. Ortiz.
All other article photos courtesy of Luis A. Medina.

ABOUT THE AUTHOR

Luis A. Medina is an experimental mathematician who enjoys using computer technology in fundamental ways to aid research. His work is related to Boolean functions and their applications to information theory and cryptography.



Luis A. Medina

See over 130 Mathematical Moments, **hear** people talk about how they use math, and **read translations** in 13 languages.

NEW!

Keeping the Roof On

Stefan Siegmund
TU Dresden
Photo: © N. Eisfeld.

It's impossible to prevent all the damage caused by a hurricane's wind, rain, and storm surge, but a new idea based on math may prevent some of the wind damage done to homes. Ingeniously designed sheets connected to a roof and anchored to the ground before a storm allow some of a severe storm's wind to pass through and redirect the force so that it pushes down on the roof and counterbalances the forces pushing up. The greater the wind, the greater the downward force. The sheets were created using clever engineering combined with mathematical models built on differential equations, vector analysis, and trigonometry. In a test of prototypes during a hurricane with 110 mph winds, the roof where the sheets were installed held firm while houses next door lost portions of their roofs or entire additions.

Main image: Hurricane Harvey damage, © William Luther/San Antonio Express-News via ZUMA Wire.
Inset: Illustration of home with wind-protection membranes, S. Siegmund & M. Eggers.

Listen Up!

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Protecting Against Hurricane Damage with Mathematics

Stefan Siegmund

The destruction left by hurricanes Harvey, Irma, and Maria can be measured in billions of dollars in damage and dozens of people injured or killed. We focus on using mathematics to prevent such losses due to wind.

As a sample for *Notices* readers, we now describe a model and device we developed, which helps to abate the risk of a complete loss of a mobile home during strong storms. The same principle could be applied to RVs, boats in dry storage facilities, planes, and larger buildings [1].

Imagine strong wind blowing against the side of a home. Similar to an airfoil of a plane the building acts as an obstacle to the passing airflow, which creates local pressure and suction at different parts of the roof (see Figure 1). In the worst case the uplift causes the whole roof to detach, often resulting in a total loss of the home.

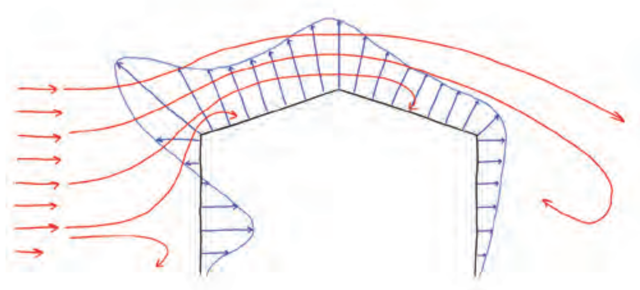

Figure 1: Wind (red) blowing against a building (black) creates pressure and suction/uplift (blue).

Mathematics can help to describe, analyze, and solve the problem of counteracting the uplift to hold the roof in place. As in Figure 2, netting panels, anchored in the ground and connected to straps that cover the roof, redistribute the wind load and counteract the uplift.

Figure 2: Netting panels with straps take some wind load and counteract the uplift.

Starting with a simple model, we assume that wind blows at right angles against the longer side of a building with roof inclination ρ as in Figure 3.

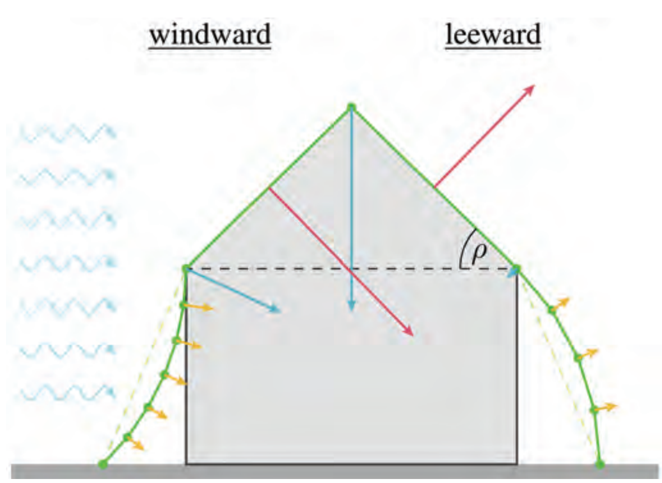

Figure 3: Wind (wiggled, blue arrows) creates pressure and uplift at roof (red force arrows). Nets and straps (green) take some wind load and counteract uplift (blue force arrows).

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A cross section of the netting panel is modeled by a large number of connected short line segments. For the simplest case of only three segments, two pulleys at positions $\vec{X}_1$ and $\vec{X}_2$ are connected to springs with unit vectors $\vec{\xi}_0$, $\vec{\xi}_1$, $\vec{\xi}_2$, denoting the directions of the line segments. The forces $\vec{F}_1$ and $\vec{F}_2$ act on the corresponding pulleys, thereby deforming the system. The ends $\vec{X}_0$ and $\vec{X}_3$ are fixed (see Figure 4).

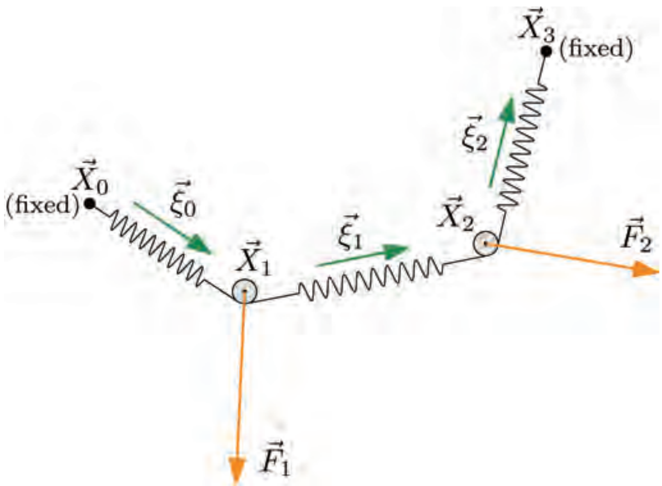

Figure 4: Cross section of netting panel modeled by three springs connected to pulleys and fixed ends.

In general, this is a dynamical problem. We focus on the equilibrium problem, i.e., the configuration the system relaxes to in the long run. In particular, we are interested in the equilibrium positions $\vec{X}_1$ and $\vec{X}_2$. A single spring of relaxed length ℓ with spring constant $\varkappa$ stretched to length $\mathcal{L}$ is in the simplest case described by Hooke's law $s = \frac{\varkappa}{\ell}(\mathcal{L}-\ell)$. In equilibrium, the internal force s along the cross section of the netting panel is constant and therefore $\vec{F}_1 - s\vec{\xi}_0 + s\vec{\xi}_1 = 0$ and $\vec{F}_2 - s\vec{\xi}_1 + s\vec{\xi}_2 = 0$. The slopes $\vec{\alpha}_1, \vec{\alpha}_2$ of the cross sections of the net at the positions $\vec{X}_1$ and $\vec{X}_2$ are defined by the slopes of the straight lines between their neighboring vertices; i.e., $\vec{\alpha}_\kappa = \arccos((\vec{X}_{\kappa+1} - \vec{X}_{\kappa-1}) \cdot \vec{e}_1 / |\vec{X}_{k+1} - \vec{X}_{k-1}|)$, with the unit vector $\vec{e}_1$ in horizontal wind direction. These angles are then used to compute effective wind forces on line segments. Altogether, the model relates those forces and the equilibrium positions of the vertices $\vec{X}_\kappa$ in a system of equations that can be solved numerically (see [2]). As a result, the forces within the straps and on the roof can be computed (see Figure 3, blue arrows).

How large is the uplift for a given wind speed? This depends on the roof inclination ρ and varies along the roof. Engineers have computed the uplift; the German industry standard building codes DIN EN 1991-1-4 provide tables and formulas for position-dependent uplift in terms of ρ (see Figure 3, red arrows). The mathematical model helps to determine the optimal netting size to counteract uplift over a wide range of wind speeds.

With the intention to help, my next steps were clear: build a prototype, test it in a wind tunnel, install it at a mobile home and test it in a real storm.

Over the last 10 years, TU Dresden and the German Klaus Tschira Foundation within their "Research for Society" program supported all steps. In October 2016, a trial installation north of Miami was hit by Hurricane Matthew with sustained wind speeds of over 100 mph. Whereas neighboring homes lost portions of their roofs or entire additions, the roof where the device was installed held firm.

References

[1] US Patent 9,212,500, Device and method for wind loss prevention, Dec. 15, 2015.

[2] M.J. Körber, S. Siegmund. Elastic model for a wind-protection membrane. *J. Wind. Eng. Ind. Aerod.* **165** (2017), 131–136.

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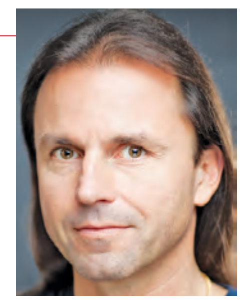
ABOUT THE AUTHOR

Stefan Siegmund works on dynamical systems theory. Recently he also focuses his time on research for society and work on geothermal power generation and seawater desalination.



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2016–2017

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The above list contains the names and thesis titles of recipients of doctoral degrees in the mathematical sciences (July 1, 2016, to June 30, 2017) reported in the 2018 Annual Survey of the Mathematical Sciences by 275 departments in 202 universities in the United States. Each entry contains the name of the recipient and the thesis title. The number in parentheses following the name of the university is the number of degrees listed for that university.

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Walker, Hakim, Computable isomorphisms of directed graphs

Yang, Seung Yeop, Khovanov homology, distributive structure homology and applications to knot theory

FLORIDA

Florida Atlantic University (4)

Department of Mathematical Sciences

Amento, Brittanney, Quantum circuits for cryptanalysis

Hurley, Michael, New geometric large sets

Kasti, Dinesh, An algorithmic approach to the lattice structures of attractors and Lyapunuv functions

Khadka, Bal, Techniques in lattice basis reduction

Florida Institute of Technology (5)

Department of Mathematical Sciences

Ben-Rabha, Raja, Initial boundary value problems for higher order nonlinear hyperbolic equations with two independent variables

Binmahfoudh, Ahmed, New bounds for K-out-of-n type probabilities and their applications

Iqbal, Naveed, On the classification of the second minimal orbits of the continuous endomorphisms on the real line and universality in chaos

Iwezulu, Kenneth, Discrete and continuous operational calculus in stochastic games

Mandelkern, Jeremy, Sturm–Liouville equations with singular endpoints of Poincarè rank zero and one

Florida State University (27)

Department of Mathematics

Aktas, Mehmet, Topology of N-gonal curves

Billet, Robert, Flow equivalence classes and Psuedo-Anosov

Chen, Yuanda, Modeling limit order book dynamics using Hawkes processes

Chiu, Chun-Yuan, Modeling credit risk in the default threshold framework

Dai, Yao, Game-theoretic models of animal behavior observed in some recent experiments

Eilertsen, Justin, Local and global bifurcations in finite-dimensional center manifold equations of double-diffusive convection

Gu, Fangxi, Exponential convergence fourier method and its application to option pricing with Levy processes

Harris, Corey, Effective methods in intersection theory and combinatorial algebraic geometry

Mandel, David, Random Sobol' sensitivity analysis and model robustness

Mayhook, Dane, Conformal tilings and type

McKenna, Joseph, Insulin secretion rhythms: Calcium regulation of beta-cell metabolism and rescue of islet oscillations

Tai, Liang-Hsuan, Trend and variable-phase seasonality estimation from functional data

Weingard, Daniel, Scroll waves: And how they interact with non-reactive knots, tori, and spheres

Wyse, John, The impact of competition on temporal musth strategies: A game-theoretic approach

Yao, Kovadio, Statistical analysis on object spaces with applications to 3D face analysis and exchange rates data

Yildirim, Vehpi, Mathematical modeling and analysis of gene knockout compensation in pancreatic beta-cells

Department of Statistics

Alzahrani, Hissah, Multivariate binary longitudinal data analysis

Anaya, Josue, First steps towards image denoising in low-light conditions

Cleveland, Jason, Robust function registration using depth on the phase variablility

Geng, Junxian, Bayesian models for capturing heterogeneity in discrete data

Gordon, Glenna, Intensity estimation in Poisson processes with phase variability

Gupta, Ajay, Modeling multivariate data with parameter-sensitive subspaces

Gupta, Cherry, Bayesian inference and novel models for survival data with cured fraction

Huang, Xue, Sparse feature and element selection in high-dimensional vector autoregressive models

Lee, JiWon, Small area estimation with automatic random effects selection

Lester, David, High level image analysis on manifolds via projective shapes and 3D reflection shapes

Orndorff, Mark, Nonparametric detection of arbitrary changes to distributions in process control

University of Central Florida (2)

Department of Mathematics

Dutta, Aritra, Weighted low-rank approximation of matrices: Some analytical and numerical aspects

Rolek, Martin, Coloring graphs with forbidden minors

University of Florida (18)

Department of Mathematics

Adams, Francis, Anticliques in Borel graphs on polish spaces and computable ultrahomogeneous structures

Borchering, Rebecca, Population thresholds and disease ecology

Cyr, Christopher, On S-semipermutable subgroups of simple groups

Milliken, Evan, Metrapopulation models of infectious salmon anemia

Molnar, Todd, Local distribution of the number of small prime factors

Saucedo, Omar, Mathematical modeling of avian influenza

Ward, Larie, Shift operators on Hilbert spaces arising from trees

Zhang, Hao, Modeling and algorithm of information sharing in inverse problem

Department of Statistics

Abrahamsen, Tavis, Convergence analysis of MCMC samplers for Bayesian linear mixed models with $P > N$

Feng, Wei, Models for the analysis of repeated attempt designs

Ha, Trung, Convergence analysis of birth-death Markov chains and Gibbs samplers

Parker, Robert, Some strong and weak limit theorems for double sums of random elements in branch spaces

Saha, Abhishek, Bayesian inference in Gaussian graphical models when the underlying graph is non-decomposable

Wang, Chuan, Contributions to Bayesian statistical methods for agricultural and biological engineering

Xiang, Ruoxuan, Consistency of high dimensional Bayesian models

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Zhu, Guangyu, Likelihood based partial least squares

University of Florida College of Public Health (4)

Department of Biostatistics

An, Qi, Optimal group sequential designs

Jingnan, Zhang, An early warning system for modeling and monitoring spatio-temporal pattern of infectious disease

Li, Yang, Population-based unified cure rate model and population-based Gompertz cure rate model

Xinrui, Zhang, Internal pilots with the univariate approach to repeated measures

University of Miami (2)

Department of Mathematics

Cardona Caviria, Jorge, On statistical solutions of evolution equations

Langdon, Christopher, Symmetric 1-twisted differentials and the quadric algebra

University of South Florida (11)

Department of Mathematics and Statistics

Assonken Tonfack, Patrick, Modeling in finance and insurance with Levy-Ito driven dynamic processes under semi Markov-type switching regimes and time domans

Enriquez-Savery, Sherlene, Statistical analysis of a risk factor in finance and environmental models for Belize

Fleeman, Matthew, Putnam's inequality and analytic content in the Bergman space

Hilton, Kristina, Dynamics of multicultural social networks

Kim, Doo Young, Statistical modeling of carbon dioxide and cluster analysis of time dependent information

Lappano, Stephen, Some results concerning permutation polynomials over finite fields

Manukure, Solomon, Hamiltonian formulations and symmetry constraints of Soliton hierarchies of (1+1)-dimensional nonlinear evolution equations

Tharu, Bhikari, Statistical analysis and modeling health data: A longitudinal study

Tu, Junyi, Global attractors and random attractors of reaction diffusion systems

Wang, Xing, Time dependent kernel density estimation: A new parameter estimation algorithm, applications in time series classification and clustering

Zoalroshd, Seyed, On spectral properties of single layer potentials

GEORGIA

Augusta University (3)

Department of Biostatistics and Epidemiology

Chen, Chen-Chun, Classification methods for circular-linear data using periodic functions

Hu, Fengjiao, Statistical methods to detect differentially methylated regions with next generation sequencing data

Jin, Chan, A new method for analyzing $1:N$ matched case control studies with incomplete data

Emory University (11)

Department of Biostatistics and Bioinformatics

Alhanti, Brooke, Methods for estimating the effects of air pollution on asthma under a changing climate

Jiang, Yunxuan, Statistical methods for rare-variant sequencing studies in pedigrees

Kemmer, Phebe, Statistical approaches for exploring brain connectivity with multimodal neuroimaging data

Wang, Lijia, Composite conditional likelihood

Watson, Dominque, Robust statistical methods for handling missing data

Yang, Jing, Flexible association methods for bivariate survival data

Mathematics and Computer Science Department

Chen, Isabel, Centrality measures and contagion and temporal networks

Fuller, Jessica, On saturation spectrum

Gordon-Sarney, Reed, Zero-cycles on Torsars under linear algebraic groups

Kay, William, Extremal problems for graphs and hypergraphs

Shi, Huiqiang, Harmonic measure, reduced extremal length and quasi circles

Georgia Institute of Technology (5)

School of Mathematics

Cohen, Emma, Problems in Catalan mixing and matchings in regular hypergraphs

Conway, James, Transverse surgery on knots in contact three-manifolds

He, Dawei, Special TK5 in graphs containing K4-

Mou, Chenchen, Uniqueness, existence, and regularity of solutions of integro-PDEs in domans if R^n

Xia, Dong, Statistical inference for large matrices

Georgia State University (11)

Department of Mathematics and Statistics

An, Yueheng, Novel nonparametric methods for ROC curves

Gao, Wei, Minimum ranks and refined inertias of sign pattern matrices

Hora, Israel, Estimation of county level diabetes prevalence using Bayesian hierarchical model

Jeyarajah, Jenny, Constructing empirical likelihood confidence intervals for medical cost data with censored observations

Li, Chenxue, Some novel statistical inferences

Mullins, Paula, A mathematical model for beta1-adrenergic regulation of the mouse ventricular myocyte contraction

Rozier, Kelvin, A mathematical model of the combined $\beta1$- and $\beta2$- adrenergic signaling system in the mouse ventricular myocyte

Wang, Jing, Functional principal component analysis for discretely observed functional data and Sparse Fisher's disciminant analysis with thresholded linear constraints

Xia, Jun, Statistical models and analysis of growth processes in biological tissue

Yates, Amy, Intersection of longest paths in graph theory and predicting performance in facial recognition

Zhang, Jiehuan, Analysis of traveling wave propagation in one-dimensional integrate-and-fire neural networks

University of Georgia (14)

Department of Mathematics

Bonsignore, Brian, Cohomological n-equivalence in differential graded algebras

Chapman, Harrison, A diagrammatic theory of random knots

Huckaba, Lauren, Simplices and sets of positive upper density in R^d

Luu, Phong, Optimal pairs trading rules and numerical methods

Slavov, George, Bivariate spline solution to a class of reaction-diffusion equations

Troupe, Lee, Three applications of sieve methods in analytic number theory

Zhang, Jun, Hamiltonian dynamics and persistent homology

Department of Statistics

Chen, Xianyan, Nonlinear constrained optimization in $\mathbb{R}$ and its application for sufficient dimension reduction and variable selection

Cobb, Stacy, Optimizing parameters for sequencing study desings

Ionan, Alexei, Bayesian framework for developing and evaluation medication screening tests for early disease detection with applications in oncology

Lyford, Alexander, Investigating undergraduate student understanding of graphical displays of quantitative data through machine learning algorithms

Martin, Jacob, Topics in zero-inflated count regression coefficients of determination and marginal models

Tong, Hao, Identifying and understanding repetitive patterns

Wang, Li-Yu, Regularized aggregation approaches for complex data

HAWAII

University of Hawaii at Manoa (3)

Department of Mathematics

Brown, Jonathan, The maximum number of covers in a lattice and in other related posets

Mukai, Jared, The log-periodic power law model: An exploration

Verrette, Jean, Results on algebraic realization of equivariant bundles over the 2-sphere

IOWA

Iowa State University (29)

Department of Mathematics

Berikkyzy, Zhanar, The edit distance function: Forbidding induced powers of cycles and other questions

Dagtoros, Kubilay, Large deviation results for random walks in a sparse random environment

Heysse, Kristin, Construction for cospectral graphs for the normalized Laplacian matrix and distance matrix

Li, Jiali, Congruence n-permutable varieties

Lin, Jephian C.-H., Variants of zero forcing and their applications to the minimum rank problem

Martinez Rivera, Xavier, The principal rank characteristic sequence and the enhanced principal rank sequence

Moss, Kevin, Coloring problems in graph theory

Rasberry, Darrin, On minimal support solutions of underdetermined systems of linear equations

Sanyatit, Preechaya, Isomorphisms of uniform algebras on the 2-torus

Wang, Feifei, Computational modeling of impact and deformation

Wang, Stefanie, On free quasigroups and quasigroup representations

Department of Statistics

Almodovar Rivera, Israel, Some contributions to K-means clustering problems

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Cao, Fan, Local polynomial kernel smoothing with correlated error

Foster, Robert Christian, Topics in empirical Bayesian analysis

Hadler, Jeremy, Forensic tool mark comparisions: Tests for the null hypothesis of different sources

Hare, Eric, Statistical methods for bullet matching

Howard, Reka, Evaluation of parametric and nonparametric statistical methods in genomic prediction

King, Emily Anne, Bayesian inference of virus evolutionary models from next-generation sequencing data

Landau, William, High-dimensional hierarchical models and massively parallel computing

Li, Qi, Decision making under uncertainties for renewable energy and precision agriculture

Lock, Dennis, Statistical methods in sports with a focus on win probability and performence

Michaud, Nicholas, Bayesian models and inferential methods for forecasting disease outbreak severity

Sievert, Carson Paul, Interfacing $\mathbb{R}$ with web technologies for interactive statistical graphics and computing with data

Trujillo Rivera, Eduardo, Non parametric regression models with and without measurement error in the covariates, for univariate and vector responses: A Bayesian approach

Xu, Yuhang, Selected topics in measurement error and functional data analysis

Yang, Yueran, To deny or confess: An interrogation decision-making model

Yin, Xin, Porbabilistic Methods for quality improvement in high through put sequencing data

Zhang, Wei, Inference based on data from superpositions of identical renewal processes

University of Iowa (33)

Applied Mathematical and Computational Sciences

Ambrose, Joseph, Dynamic field theory applied to fMRI signal analysis

Barela, Mario, A complimentarity approach to modeling dynamic electric circuits

Dill, Benjamin, Numerical simulation of the impact of a steel ball with a rigid foundation

Hu, Nan, A unified discrepancy-based approach for balancing efficiency and robustness in state-space modeling estimation, selection, and diagnosis

Landgren, Jeffrey, An acoustic eigenvalue problem and its application to electrochemistry

Michlin, Tracie, Using wavelet bases to separate scales in quantum field theory

Ongie, Gregory, Off-the-grid compressive imaging

Richmond, Nathaniel, On stochastic network design: Modeling approaches and solution techniques

Valeva, Silviya, Workforce and inventory management under uncertain demand

Walk, Julia, A mathematical model of the effects of multiple myeloma on renal function

Yang, Kai, Dynamics of energy critical nonlinear Schrödinger equation with inverse square potential

Zhao, Ze, Stochastic volatility models with applications in finance

Department of Biostatistics

Deonovic, Benjamin E, MCMC sampling methods for binary variables with application to Haplotype phasing allele specific expression

Pagan-Rivera, Keyla, A Bayesian correction for measurement error in pooled studies of residential radon and lung cancer

Wu, Hongqian, Proportional likelihood ratio model for longitudinal discrete interval data

Yu, Lixi, Regularized efficient score estimation and testing (RESET) approach in low-dimensional and high-dimensional GLM

Department of Mathematics

Abdulwahid, Adnan, Cofree objects in the categories of comonoids in certain Abelian monoidal categories

Almodovar Velazquez, Leyda, Studying brain networks via topological data analysis and hierarchical clustering

Bates, Dana, On a free boundary problem for ideal viscons and heat conducting gas flow

Druivenga, Nathan, Quantum topology and me

Gerstle, Kevin, On the green rings of pointed, coserial Hopf algebras

Griesenauer, Erin, Algebras of cross sections

Ligo, Richard, Conformal transformations, curvature, and energy

Norton, Rachael, Pick interpolation, displacement equation, and W^*-correspondences

Qin, Huan, Averages of fractional exponential sums weighted by Maass forms

Ramirez, Camila, P-bigon right-veeringness and over twisted contact structures

Rodman, Daniel, An infinite family of links with critical bridge spheres

Tipton, James, Reproducing kernel Hilbert spaces and complex dynamics

Yu, Lu, Wavelets on hierarchical trees

Department of Statistics and Actuarial Science

Somal, Harsimran, Heterogeneous computing for the Bayesian HNICAR model with incomplete data

Yi, Congrui, Penalized methods and algorithms for high-dimensional regression in the presence of heterogeneity

Zhou, Zhenhao, From valuing equity linked death benefits to pricing American options

Zhou, Ziqian, Statistical inference of distributed delay differential equations

IDAHO

Idaho State University (1)

Department of Mathematics and Statistics

Klimas, Caitlin, Picard and Taylor kernels for self-adjoint second order differential equations

University of Idaho (2)

Department of Mathematics

Ikeda, Masaki, enumeration of permutations indexing local complete intersection Schubert varieties

Rupert, Malcolm, An explicit Theta lift from Hilbert to Siegel paramodular forms

ILLINOIS

Illinois Institute of Technology (4)

Department of Applied Mathematics

Ha, Hansen, Numerical methods for two dimensional nonlocal equations arising from non-Gaussian stochastic dynamics

Hernandez, Francisco, A boundary integral method for computing the forces of moving beads in a 3-dimensional linear visoelastic flow

Jimenez Rugama, Lluis Antoni, Adaptive quasi-Monte Carlo cubature

Zhao, Meng, An efficient adaptive rescaling scheme for computing Hele-Shaw problems

Illinois State University (2)

Department of Mathematics

Kanbir, Sinan, An intervention study aimed at enhancing seventh-grade students' development of the concept of a variable

Rupnow, Theodore, Secondary mathematics teachers' learning through practice: The case of Rudy

Northern Illinois University (3)

Department of Mathematical Sciences

Luvsandash, Khulan, Change point detection for dependent spatio-temporal data

Paul, Erina, Approximate Bayesian computation in nonparametric Bayesian models

Wang, Andrew, Constrained and coxeter table algebras

Northwestern University (15)

Department of Mathematics

Couch, Michael, A study of the equivariant Gromov-Witten theory of the projective line and Eynard-Orantin recursion

Gao, Honghao, Augmentations and sheaves for knot conormals

Legg, Robert, An obstruction theory for comodules suited for producing elements of the exotic Picard group

Liang, Weiping Spencer, The Brown-Peterson homology of the connected cover of the j-spectrum

Moy, Richard, Non-CM Hilbert modular forms of partial weight one

Serban, Vlad, Infinitesimal p-adic Manin-Mumford and application to Hida theory

Specter, Joel, Unramifiedness and crystallinity

Wei, Ann Rebecca, What do algebras form?

Wilson, Dylan, Equivariant, parameterized, and chromatic homotopy theory

Wu, Lei, Multi-indexed Deligne extensions and multiplier subsheaves

Yoo, Philsang, Langlands duality and quantum field theory

Zhou, Peng, From Lagrangian thimbles to constructible sheaves

Department of Engineering Science and Applied Mathematics

Jiang, Zuo, Nonlocal effects of interspecific prey competition on the stability of predator-prey equilibria

Kimmel, Gregory, Transport properties of superconductors using the time-dependent Ginzburg-Landau equation: Analytical solutions, numerical methods and optimization

Park, Paul, Mixing with piecewise isometries

Southern Illinois University Carbondale (4)

Department of Mathematics

Adhikari, Kamal Mani, Realizations of simple smale flows on three-manifolds

Al-Hashimi, Ghazwan Mohammed, A zeta function for flows with L (-1,-1) template

Alsulaimani, Hamdan, Strict regularity of positive definite ternary quadratic forms

Pathak, Nimishaben Shailesh, Lyapunov-type inequalify and eigenvalue estimates for fractional problems

University of Chicago (20)

Department of Mathematics

Akin, Victoria, An algebraic characterization of the point-pushing subgroup

Balibanu, Ana, The wonderful compactification and the universal centralizer

Chen, Gong, Dispersive equations with multiple potentials

Chen, Weiyan, Analytic number theory for o-cycles

Fan, Tiangi, D-infinity modules on smooth rigid analytic varieties and locally analytic representations

Ho, Quoc, Free factorization algebra and homology of configuration spaces in algebraic geometry

Howe, Sean, Overconvergent modular forms and the p-adic Jacquet–Langlands correspondece

Johnstone, Daniel, A Gelfond-Graev formula and stable transfer factors for SLn

Lim, Chang Mou, A geometric height on genus one curves

Rodriguez, Casey, Stable soliton resolution for wave maps on a curved spacetime

Sakellaris, Georgios, Boundary value problems in Lipschitz domains for equations with drifts

Salter, Nicholas, The topology of surface bundles: Cohomology and enumeration of fiberings

Wang, Jonathan, On an invariant bilinear form on the space of automorphic forms via asymptotics

Wilmes, John, Structure, automorphisms, and isomorphisms of regular combinatorial objects

Xu, Zhouli, In and around stable homotopy groups of spheres

Department of Statistics

Goessling, Marc, High-dimensional generative models: Shrinkage, composition, and autoregression

Roy, Rishideep, Extreme values of log-correlated Gaussian fields

Xing, Zhengrong, Poisson Multiscale methods for high-throughput sequencing data

Xu, Mengyu, Two problems in high-dimensional inference: L^2 test by resampling and graph estimation of non-stationary time series

Zhu, Yuancheng, Constrained and localized forms of statistical minimax theory

University of Illinois at Chicago (17)

Department of Mathematics, Statistics and Computer Science

Adali, Riza Seckin, Sincular loci of restriction varieties

Austin, Alexander, Logarithmic potentials and quasiconformal flows on the Heisenberg group

Bu, Xianwei, D-optimal designs for multinomial logistic models

Cantrell, Michael, Ergodic theory and geometry of nilpotent groups

Cheng, Ling, Optimal biomarker-stratified design and adaptive design in mixture distributions

Hardwick, John, Graphical algorithms for finding the nucleolus of binary-valued matching games

Jiang, Liyian, A nonparametric estimate of the risk-neutral density and its applications

Jonathon, Yaggie, Topics in knowledge representation belief revision and conditional knowledge bases

Lelkes, Adam Daniel, Algorithms and complexity results for learning and big data

Nie, Keyu, Studies on some inferential aspects of Graybill-deal estimators

Powers, Brian, An analysis of multivariate final-offer arbitration

Ryan, Timothy, The effective cone of moduli spaces of sheaves on a smooth quadric surface

Terry, Caroline, Model theory and extremal combinatorics: Structure, enumeration, and 0-1 laws

Tian, Tian, Optimal design theory in early-phase dose-finding problems

Zaya, Karen, Problems of regularity in models arising from fluid dynamics

Zheng, Xudong, The Hilbert schemes of points on singular varieties and Kodaira non-vanishing in characteristic p

Zielinski, Joseph, Compact structures in descriptive classification theory

University of Illinois, Urbana–Champaign (32)

Department of Mathematics

Andersen, Nickolas, Arithmetic of maass forms of half-integral weight

Aramyan, Nerses, A construction of topological field theories

Compaan, Erin, Smoothing properties of certain dispersive nonlinear partial differential equations

Cong, Lin, Stability thresholds for signed Laplacians on locally-connected networks

Delcourt, Michelle, Viewing extremal and structural problems through a probabilistic lens

Duarte Gelvez, Eliana, Syzygies and implicitization of tensor product surfaces

Fieldsteel, Nathan, Some problems in polynomial interpolation and topological complexity

Gupta, Neha, Certain free group functions and untangling closed curves on surfaces

Heersink, Byron, Applications of dynamical systems to Farey sequences and continued fractions

Huan, Zhen, Quasi-elliptic cohomology

Huo, Zhenghui, A new computation of the Bergman Kernel and related techniques

Klamsakul, Natawat, A look at T1 and Tb theorems on non-homogeneous spaces through time-frequency analysis

Lu, Qu, Intrinsic contractivity for some non-symmetric Lévy processes with non-local operators

McConvey, Andrew, Sufficient conditions for the existence of specified subgraphs in graphs

Nawaz, Tayyab, Applications of Stein's method and large deviations principle's in mean-field $O(\mathbb{N})$ models

Nelson, Peter, A small presentation for Morava E-Theory power operations

Pechenik, Oliver, K-Theoretic Schubert calculus and applications

Petrickova, Sarka, Extremal problems on counting combinatorial structures

Rezvani, Sepideh, Approximating rotation algebras and inclusions of C^*-Algebras

Santana, Michael, Extremal problems on cycle structure and colorings of graphs

Sharifzadeh, Maryam, Embedding problems and Ramsey-Turan variation in extremal graph theory

Spinoza, Hannah, On some problems in reconstruction

Vichitkunakom, Panupong, Cluster algebras and discrete integrable systems

Wise, Jennifer, Games on graphs, visibility representations, and graph colorings

Witsarut, Pho-On, Gromov boundaries of complexes associated to surfaces

Department of Statistics

Bi, Xuan, Dimension reduction and efficient recommender system for large-scale complex data

Eisiner, Robert David, Sampling for conditional inference on contigency tables, multigraphs, and high dimensional tables

Hu, Jianjun, Statistical methods for learning sparse features

Sengupta, Srijan, Statistical analysis of networks with community structure and bootstrap methods for big data

Shand, Lyndsay, Methods and applications for space-time data

Wang, Jin, Scalable algorithms for Bayesian variable selection

Ye, Sangbeak, Sequential mastery detection and Bayesian learning promotion under cognitive diagnostic models

INDIANA

Indiana University–Purdue University Indianapolis (5)

Department of Mathematical Sciences

Carichino, Lucia, Multiscale mathematical modeling of ocular blood flow and oxygenation and their relevance to glaucome

Cassani, Simone, Compliant and collapsible tubes: Modeling, analysis and applications in medicine

Li, Lingnan, Maximum empirical likelihood estimation in U-statistics-based generalized estimating equations

Prada, Daniele, A hybridizable discontinuous Galerkin method for nonlinear porous media viscoelasticity with applications in ophthalmology

Yoo, Yeon Joo, Strategies to tackle ill-posed problems in biological systems

Indiana University, Bloomington (13)

Department of Mathematics

Chen, Yu-Yuan, Generalized Boole transformations with infinitely many singularities

Gupta, Nikhil, Spectral properties of the non-Euclidean Laplacian

Gur, Metin, Hypersurfaces with central convex cross sections

Hu, Hailiang, $Z/3$-actions on $S^8 \times S^8 \times S^8$

Huo, Wenru, The global attractor, finite dimensionality, determining modes and data assimilation of 2D Boussinq system

Kim, Jiwon, Fixed points on p-adic period domains and rational conjugacy classes: An example for GSp(4)

Li, Yingwei, Pointwise stability estimates for shock and reaction diffusion waves

Lightfoot, Ashley, Invariants of link homotopy in dimension four

Nguyen, Phuong, Deterministic and stochastic partial differential equations in fluid and solid mechanics

Ong, Kiah Wah, On some dynamic transition problems

Timko, Edward, Polynomial tuples of commuting isometries constrained by 1-dimensional varieties

Tune, William, A lambda calculus for monotonicity reasoning

Zhang, Le, Very weak solutions of the Stokes problem in a convex polygon and its numerical simulation

Purdue University (18)

Department of Mathematics

Ahn, Sung Won, Oscillation of quenched slowdown asymptotic of RWRE in $\mathbb{Z}$

Chen, Yi, Local polynomial chaos expansion method for high dimensional stochastic differential equations

Lucas, Jason, Connecting models of configuration spaces: From double loops to strings

Mukundan, Vivek, Rees algebras and iterated Jacobian duals

Park, Eun Young, The error estimation in finite element method for the linear elasticity problems

Perlmutter, Michael, Martingales, singular integrals, and fourier multipliers

Yue, Zhao, Inverse surface scattering problems for elastic waves

Zhang, Xin, Extreme-strike and small-time asymptotics for Gaussian stochastic volatility model

Zheng, Yiqiang, Mathematical models of Ebola virus disease and vaccine preventable diseases

Department of Statistics

Bemis, Kylie, A framework for the statistical analysis of mass spectrometry imaging experiments

Chakraborty, Piyas, Some contstructive suggestions on false models

Huang, Qiming, Model-free variable screening, sparse regression analysis and other applications with optimal transformations

Ness, Robert, Bayesian methods for causal inference of cell signal transduction

Pan, Chao, Group transformation and identification with kernel methods and big data mixed logistic regression

Qu, Simeng, Some functional regression models in the frame work of reproducing kernel Hilbert space

Tong, Xiaosu, Divide and recombined for large complex data: Nonparametric-regression modeling of spatial and seasonal-temporal time series

Yu, Zhuqing, High dimensional inference for semiparametric models

Zheng, Faye, The design and statistical analysis of single-cell sequencing experiments

University of Notre Dame (9)

Applied and Computational Mathematics and Statistics

Kupaev, Timur, Multiscale simulation study of the effects of fiber alignment, bending and stress strain relations on fibrin networks

Machen, Michael, Krylov implicit integration factor methods for solving fourth order equations

Mahserejian, Shamt, Modeling study of the connection between microlevel TIP structures with macro-level phases for characterizing microtubule mechanism of dynamic instability

Specht, Alicia, Robust inference and network analysis for non-Gaussian gene-expression data

Department of Mathematics

Ansaldi, Kathleen, Regularity of Tor, LCM-duals and Hilbert functions

Burkard, Edward, First steps in homotopy results for symplectic embeddings of ellipsoids

Ulrickson, Peter, Oriented one-dimensional supersymmetric Euclidean field theories and K-theory

Vander Werf, Nathan, Screening operators for lattice vertex operator algebras and resulting constructions

Wang, Weijia, Closure operator and lattice property of root systems

KANSAS

Kansas State University (4)

Department of Mathematics

Chen, Hui, Counting representations of deformed preprojective algebras

Goerl, Lee, Sheaves of differential operators and D-modules on non-commutative projective spaces

Ostergaard, Misty, Solutions of diagonal congruences with variables restricted to a box

Xiao, Xinli, The double of representations of cohomological hall algebras

University of Kansas (5)

Department of Mathematics

Kang, Su Chen, Quantum families of maps

Ngo, Cuong, Moving mesh methods for numerical solution of porous medium equations

Rajaguru, Biswajit, Projective normality for some families of surfaces of general type

Serio, Grant, Miultiplicities in commutative algebra

Steyer, Andrew, A Lyapunov exponent based stability theory for ordinary differential equation initial value problem solvers

University of Kansas Medical Center (2)

Department of Biostatistics

Chen, Xueyi, Mathematical modeling of the separation process of chromatography and estimation of parameters

Noel-MacDonnel, Janelle, RNA-seq analysis strategies and ethical considerations involved in precision medicine

Wichita State University (3)

Department of Mathematics, Statistics, and Physics

Alghamdi, Suad A, Composite optimal control for interconnected singularly perturbed systems

Hamdan, Mustafa Mahmoud Naji, Unbiasedness of homogeneity test of normal mean vectors under multivariate order restrictions

Mitchell, Colm Patric, A capillary surface with no radial limits

KENTUCKY

University of Kentucky (26)

Department of Biostatistcs

Appiah, Frank, Mixture modeling with applications in Alzheimer's disease

Ding, Xiuhua, Modeling dementia risk, cognitive change, predictive rules in longitudinal studies

Morris, Sarah, Methods for determining time to return to play after recreational injury in field and court sport athletes

Smith, Rachel, Exploration of the misuse, abuse, and diversion of Gabapentin

Starnes, Catherine, Evaluating a bystander intervention program on reproductive coercion: Using quasi-experimental design strategies to address methodologic issues in randomized community prevention trials

Timsina, Lava, Examining the activities, effectiveness, and contribution of local public health departments using a national longitudinal survey of public health systems

Department of Mathematics

Barnard, Kristen, Some take-away games on discrete structures

Croyle, Laura, Solutions to the L^p mixed boundary value problem in $C^{1,1}$ domains

Gu, Shu, Homogenization of Stokes systems with periodic coefficients

Harney, Isaiah, Colorings of Hamming-distance graphs

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Lindgren, Joseph, Orbital stabilty results for soliton solutions to non-linear Schrödinger equations with external potentials

Mosley, John, In search of a class of representatives for SU-cobordism using the Witten genus

Music, Michael, Inverse scattering for the zero-energy Novikov-Veselov equation

Schreffler, Morgan, Approximation of solutions to the mixed Dirichlet-Neumann boundary value problem on Lipschitz domains

Sordo Vieira, Luis, On p-adic fields and p-groups

Wolf, Robert, Compactness of isoresonant potentials

Yaowei, Zhang, The Bourgain spaces and recovery of magnetic and electric potentials of Schrödinger operators

Department of Statistics

Crouch, Rebecca, Aggregated quantitative multifactor dimensionality reduction

Shu, Shen, Developing an alternative way to analyze nanostring data

Wang, Hong, Improved models for differential analysis for genomic data

Wang, Hongyuan, Statistical inference on dynamical systems

Yang, Yifan, Novel computational methods for censored data and regression

Yang, Yuchen, Statistical methods for environment exposure data subject to detection limits

Zhao, Yumin, Statistical inference on trimmed means and partial area under Roc curves by empirical likelihood method

University of Louisville (1)

Department of Mathematics

Paniagua Mejia, Carlos, Mathematical hybrid models for image segmentation

LOUISIANA

Louisiana State University (LSU), Baton Rouge (14)

Department of Mathematics

Abeynanda, Gayan, Dynamic resonant scattering of near-monochromatic fields

Brannan, Tyler, A conditioned Gaussian-Poisson model for default phenomena

Bucher, Eric, Cluster algebras and maximal Green sequences for closed surfaces

Frnka, Richard, Asymptotic formulae for restricted unimodal sequences

Ghulam, Ashar, Method of the Riemann-Hilbert problem for the solution of the Helmholtz equation in a semi-infinite strip

Holmes, Andrew, On the Skein theory of 0-framed surgery along the Trefoil knot

Istvan, Kyle, Manifestations of symmetry in polynomial link invariants

Levitt, Jesse, Properties of polynomial identity quantized Weyl algebras

Matherne, Jacob, Derived geometric Satake equivalence, Springer correspondence, and small representations

Peng, Jun, Beyond the tails of the colored Jones polynomial

Pfeil, Simon, On properties of matroid connectivity

Schoenbaum, Lucius, Towards theory and applications of generalized categories to areas of type theory an categorical logic

Scirratt, Austin, Evolution semigroups for well-posed, non-autonomous evolution families

Viator, Robert, Spectral properties of photonic crystals: Bloch waves and band gaps

LSU Health Science Center, New Orleans (1)

Department of Biostatistics

Zhai, Yi, Optimal designs for some dose-response models

Louisiana Tech University (5)

Program of Mathematics and Statistics

Adkinson, Joshua, Generalized partial directed coherence and centrality measures in brain networks for epileptogenic focus localization

Blazek, Sara, A study of mathematics acheivement, placement, and graduation of engineering students

McAdams, Stacey, Embedding oriented graphs in books

Orndorff, Casey, Thermal analysis in a triple-layered skin structure with embedded vasculature, tumor, and gold nanoshells

Zhang, Sui, An improved imaging method for extended targets

Tulane University (5)

Department of Mathematics

Beyarslan, Selvi, Regularity of powers of edge ideals

Guan, Xiao, Methods in symbolic computation and p-adic valuations of polynomials

Karakoc, Selcuk, On minimum area homotopies

Mannan, Forest, Singly-periodic stokes flow near a plane wall and the simulation of cilia

Zhang, Kui, A symptotic theory for the statistical analysis of anomalous diffusion in single particle tracking experiments

University of Louisiana at Lafayette (3)

Department of Mathematics

Guilbeau, Jared Thomas, A vector parallel branch and bound algorithm

Robin, Tracy James, Density of a normal subgroup of the invertibles in certain multiplier algebras

Wang, Xiao, Inferences on gamma distributions: Uncensored and censored cases

MARYLAND

Johns Hopkins University (8)

Department of Biostatistics

Bai, Jiawei, Statistical methods for wearable devices with applications to epidemiological studies

Cai, Qing, Joint modeling and estimation for recurrent events, longitudinal measurements and survival data

Charu, Vivek, Statistical methods and applications in medicine and public health

He, Bing, FCAT: A flexible classification toolbox for signal detection in high-throughput sequencing data

Kim, Jeongyong, Statistical methods for multivariate failure-time data under competing risks

Qian, Tianchen, Semiparametric estimation in observational studies and randomized trials

Usher, Therri, Likelihood-based methods of mediation analysis in the context of health disparities

Xu, Yuting, Dynamic functional connectivity in functional magnetic resonance imaging data

Johns Hopkins University, Baltimore (4)

Department of Applied Mathematics and Statistics

Chen, Min, Capturing volatility smiles with a perpetual leverage model and its implications to fund overlay designs

Paat, Joseph, On the development of cut-generating functions

Department of Mathematics

Cattell, Stephen, A completion of dominant k-theory

Su, Chenyang, Starshaped locally convex hypersurfaces with prescribed curvature and boundary

University of Maryland, Baltimore County (13)

Department of Mathematics and Statistics

Albertine, April, Statistical meta-analysis methods for publication bias, effect size estimation, and synthetic data

Barouti, Maria, Clustering for monitoring distributed data streams

Bastero, Rowena, A swapping method and exploratory analysis for average treatment effect estimation based on partial balancing and simultaneous inference of regression models

Carey, Bryce, Developing a computational model of neural networks into a learning machine

Graf, Jonathan, Parallel performance of numerical simulations for applied partial differential equation models on the Intel Xeon Phi Knights landing processor

Hajghassem, Mona, Efficient multigrid methods for optimal control of partial differential equations

Jeong, Juyoung, Spectral sets and functions of Euclidean Jordan algebras

Massarelii, Nicole, Analysis of sensory feedback in the Lamprey central pattern generator for locomotion

Orlitzky, Michael, Positive operators, Z-operators, Lyapunov rank, and linear games on closed convex cones

Park, Hyekyung, Robust value-at-risk (VaR) portfolio selection problem under the joint ellipsoidal uncertainty set in the presence of transaction costs

Tay Stamoulas, Serap, Asymptotic analysis of opinion dynamic models

Yang, Ye, The simultaneous assessment of normality and homoscedasticity in some linear model

Zhao, Jian, Some approximate confidence intervals and regions for interlaboratory data analysis

University of Maryland, College Park (5)

Department of Mathematics

Cohen, Jonathan, Transfer of representations and orbital integrals for inner forms of GL(n)

Horn, Marc, A combinatorial formula for test functions with Pro-p Iwahori level structure

Huang, Jonathan, Exponentiation of motivic zeta functions

Kelly, Sean, The adelic differential graded algebra for surfaces

Yu, Luquan, Two goodness-of-fit tests for the density ratio model

MASSACHUSETTS

Boston College (2)

Department of Mathematics

Mullane, Scott, Adventures in the canonical bundles on curves

Soylu, Cihan, Special cycles on GSpin Shimura varieties

Boston University (4)

Department of Mathematics and Statistics

Chaudhary, Osman, Rigorous justification of Taylor dispersion via center manifold theory

Cummings, Patrick, Nonlinear Schrödinger approximations for partial differential equations with quadratic and quasilinear terms

Goeva, Aleksandrina, Complexity penalized methods for structured and unstructured data

Kuklinski, Parker, Absorption phenomena in quantum walks

Boston University School of Public Health (6)

Department of Biostatistics

Enserro, Danielle, Measures of discrimination, reclassification, and calibration for risk prediction models: An exploration in their interrelationships and practical utility and improvement in their estimation

Kane, Elizabeth, Evaluating multiple imputation methods for longitudinal healthy aging index: A score variable with data missing due to death, dropout, and several missing data mechanisms

Manimaran, Solaiappan, Statistical methods for analyzing data with applications in modern biomedical analysis and personalized medicine

McIntosh, Avery, Extensions to Bayesian generalized linear mixed effects models for household Tuberculosis transmission

Perez, Jeremiah, Assessing non-inferiority versus risk difference in one-to-many propensity-score matched studies

Shappell, Heather, Methods for longitudinal complex network analysis in neuroscience

Brandeis University (5)

Department of Mathematics

Raoux, Katherine, Tau-invariants for knots in rational homology spheres

Tirrell, Jordan, Orthogonal polynomials, lattice paths, and skew Young tableaux

Wadleigh, Nick, Shrinking target phenomena applied to zero-one laws for uniform diophantine approximation

Wong, Bi Ji, Torsion invariants of 3-orbifolds, equivarienat corks and Heegard Floer homology

Zhao, Xi, Application of lattice points counting to shrinking target problems

Harvard University School of Public Health (13)

Department of Biostatistics

Anoke, Sarah, Practicable characterization of systematic heterogeneity

Barfield, Richard, Statistical methods for analysis of genetic and genomic data in population science

Chen, Sixing, Hypothesis testing and model selection for complex data

Du, Ye Ting, Adjustment for population statification in sequencing association studies and model averaged matching estimator

Evans, Katherine, Contributions to semiparametric methods for incomplete data

Gronsbell, Jessica, Robust and efficient machine learning methods for the analysis of electronic medical records data

Liu, Shelley Han, Statistical methods for estimating the effects of multi-pollutant exposures in children's health research

Mattie, Heather, On the estimation and prediction of tie strength in social networks

McIntosh Nurse, Christina, An analysis of using pedigrees in family based studies and an exploration of cancer risk and cancer resistance using twin studies

Ren, Boyu, Bayesian statistical framework for high-dimensional count data and its application in microbiome studies

Schlauch, Daniel, Methods for estimating hidden structure and network transitions in genomics

Sun, Ryan, Methods for high-dimensional inference in genetic association studies

Zheng, Yu Evelyn, Efficient assessment of individualized disease risk and treatment response via augmentation

Harvard University (19)

Department of Mathematics

Brantner, David, The Lubin-Tate theory of spectral lie algebras

Knight, Erick, A p-adic Jacquet-Langlands correspondence

Lovering, Thomas, Integral canonical models for G-bundles on Shimura varieties of abelian type

Mathew, Akhil, Nilpotence and descent in stable homotopy theory

Sankar, Krishanu, Symmetric powers and the equivariant dual Steenrod algebra

Shankar, Ananth, The p-curvature conjecture and monodromy about simple closed loops

Zhou, Rong, Mod-p isogeny classes on Shimura varieties with parahoric level structure

Zhu, Yihang, The stabilization of the Frobenius–Hecke traces on the intersection cohomology of orthogonal Shimura varieties

Department of Statistics

Bavli, Hillel, Improving the accuracy of civil damage awards with claim aggregation

Chen, Yang, Expediting scientific discoveries with Bayesian statistical methods

D'Amour, Alexander, Superpopulation generalization in social network analysis

Kao, Edward, Causal inference under network interference: A framework for experiments on social networks

Krakovna, Viktoriya, Building interpretable models: From Bayesian networks to neural networks

Yang, Justin, A grand journey of statistical hierarchical modeling

School of Engineering and Applied Science

Dudte, Levi, Inverse design of shape using folds and cuts in flat sheets

Horvat, Christopher, Theory, modeling, and impacts of the sea ice floe size distribution

Minot, Ariana, Distributed optimization methods for monitoring and operating electric power systems

Perol, Thibaut, Geophysics from small to big data

Weiner, Ian, High-SNR capacity of AWGN channels with generic alphabet constraints

Massachusetts Institute of Technology (19)

Department of Mathematics

Abel, Zachary, On folding and unfolding with linkages and polyhedra

Blaier, Netanel, The quantum Johnson homomorphism and symplectomorphism of 3-folds

Carpentier, Sylvain, Rational matrix differential operators and integrable systems of PDEs

Fan, Chenjie, On long time dynamic and singularity formation of NLS

Farber, Miriam, Arrangements of minors in the positive Grassmannian

Finucane, Hilary, Functional and cross-trait genetic architecture of common diseases and complex traits

Harman, Nate, Deligne categories and representation stability in positive characteristic

Knizel, Alisa, Random tilings: Gap probabilities, local, and global asymptotics

Liu, Gaku, The topology of Baues complexes and flip graphs

Lodhia, Asad, Topics in linear spectral statistics of random matrices

Lovasz, Laszlo, Regularity and removal lemmas and their applications

Nardin, Denis, Stability and distributivity over orbital ∞-categories

Shah, Jay, Parametrized higher category theory

Sun, Xin, Mating of negatively correlated trees with applications to Schnyder woods and bipolar orientations

Thompson, Daniel, Representation theory of the global Cherednik algebra

Vladu, Adrian, Shortest paths, Markov chains, matrix scaling, and beyond: Improved algorithms through the lens of continuous optimization

Wang, Menglu, Gaussian free field, Schramm–Loewner evolution and Liouville quantum gravity

Yang, Ben, Polynomial partitioning and incidence problems in higher dimensions

Yu, Yun William, Compressive algorithms for search and storage in biological data

Northeastern University (8)

Department of Mathematics

Cecchini, Simone, Callias-type operators in C^*-algebras

He, Chou, Localization of certain torus actions on odd-dimensional manifolds and its applications

Hodges, Reuveu, Schubert singularities and Levi subgroup actions on Schubert varieties

Rangachev, Antoni, Local volumes, integral closures, and equisingularity

Rodriguez, José Simental, On Harish-Chandra bimodules for rational Cherednik algebras

Seal, Gouri, Two contributions in topology and geometry: Polynomial assignments for Bott-Samelson manifolds and the triple reduced product and Hamiltonian flows

Zhang, Liwei, Application of statistics in side channel information leakage analysis modeling, metric, detection testing

Zhang, Tong, SCOT modeling and its statistical applications of time series

Tufts University (7)

Department of Mathematics

Chlebak, Lise, The time-changed Q-Wiener process and associated stochastic differential equations

Clay, Erica, Quaternion algebra and Witts theorem

Rothschild, Seth, Unipotent algebraic groups

Sanchez, Andrew, A theory of sub-Finsler surface area in the Heisenberg group

Takeuchi, Ryusei Melody, An analysis of neuronal networks with recurrent exitation

Wu, Qiong, Analysis of stochastic differential equations with multi-time scales and subdiffusion processes in Hilbert

Zhang, Jiani, Design and application of tensor decompositions to problems in model and image compression and analysis

University of Massachusetts, Amherst (9)

Department of Mathematics and Statistics

Beaudry, Isabelle, Inference from network data in hard-to-reach populations

Gourgoulias, Konstantinos, Information metrics for predictive modeling and machine learning

Lowell, Mark, A Siefert-van Kampen theorem for Legendrian submanifolds and exact Lagrangian cobordisms

Nichols, Daniel, Dynamical systems and zeta functions of function fields

Shelly, Thomas, Skein theory and algebraic geometry for the two-variable Kauffman invariant of links

Vogiannou, Anastasios, Spherical tropicalization

Xu, Haitao, Studies on lattice systems motivated by PT-symmetry and granular crystals

Zhang, Zijing, Statistical methods on risk management of extreme events

Department of Biostatistics and Epidemiology

Xu, Hui, Statistical methods for high dimensional data arising from large epidemiological studies

Worcester Polytechnic Institute (5)

Department of Mathematical Sciences

Li, Yiqing, Quasi-static fracture evolution with cohesive energy

Manandhar, Binod, Bayesian models for the analysis of noisy responses from small areas: An application to poverty estimation

Sanguinet, William, Various extensions in the theory of dynamic materials with a specific focus on the checkerboard geometry

Wang, Liang, In Vivo IVUS-based 3D fluid-structure interaction models for human coronary atherosclerotic plaque vulnerability assessment and progression prediction.

Zuo, Heng, 3D multi-physics MRI-based human right ventricle models for human patients with repaired tetralogy of fallot: Cardiac mechanical analysis and surgical outcome prediction

MICHIGAN

Central Michigan University (2)

Department of Mathematics

Anderson, Linda, the role of dynamically linked representations in student conceptualization of vectors and matrices

Witherspoon, Grace, Generalization of the odd Weibull family for competing risk analysis

Michigan State University (16)

Department of Mathematics

Al-Yasiri, Khaldoun Saad Ghalib, Gradient estimates for solutions to divergence form elliptic equations with piecewise constant coefficients in dimension N

Burton, Stephan, Volumes, determinants, and meridian lengths of hyperbolic links

Cho, Hana, Method of lines transpose: High-order schemes for parabolic problems

Feng, Xiao, High order finite difference WENO schemes for ideal magnetohydrodynamics

Gao, Qinfeng, Numerical methods for gravity inversion, synthetic aperture radar, and travel-time tomography

Liu, Qinbo, Estimates on singular values of functions of perturbed operators

Machen, Casey, Abelian varieties associated to Clifford algebras

Nagy, Akos, The berry connection and other aspects of the Ginzburg-Landau theory in dimension 2

Olson, Emily, Progress on the 1/3-2/3 conjecture

Wang, Bao, Mathematical modeling and computation of molecular solvation and binding

Department of Statistics and Probability

Cai, Liqian, High-dimensional inference for spatial error models

Chakraborty, Sayan, Bayesian variable selection and network estimation

Kim, Jiwoong, Regression models with dependent errors and goodness of fit test of errors

Maurya, Ashwini, Estimating covariance structure in high dimensions

Nandy, Siddhartha, High-dimensional variable selection for spatial regression and covariance estimation

Tesnjak, Irena, Limiting properties of infinite superpositions of Ornstein-Uhlenbeck type processes and their applications to finance

Michigan Technological University (3)

Department of Mathematical Sciences

Alokaily, Samer, Modeling and simulation of the peristaltic flow of Newtonian and non-Newtonian fluids with application to the human body

Pastine, Adrian, Two problems of Gerhard Ringel

Shonibare, Olabanji, Numerical simulation of viscoelastic multiphase flows using an improved adaptive approach

Oakland University (7)

Department of Mathematics and Statistics

Almusharrf, Amera, Delay differential equations and the logistic model with two delays

Bahuguna, Manoj, Analytics of asymmetry and transformation to multivariate normality through Copula functions with applications

Elkadry, Alaa, Statistical analyses of "randomly sourced data"

Hoxhaj, Valmira, Some contributions to statistical data analytics with applications in finance

Nierman, Ryan, Combinatorial approaches to continuous problems

Wiggins, Alexander, On the properties and behavior of the condition number for linear programming

Zhamo, Ervisa, Contributions to the statistical analysis of computer experiments

University of Michigan (39)

Department of Biostatistics

He, Zihuai, Set-based tests for genetic association and gene-environment interaction

Lehmann, Douglas, Robust instrumental variable methods for casual inference

Lin, Keng-Han, Statistical methods for detecting rare variant associations in family-based designs

Liu, Zhuqing, Bayesian local smoothing modeling and inference for pre-surgical FMRI data

Rothwell, Rebecca, Statistical methods in population genetics for next generation sequencing data

Shi, Yang, Statistical and computational methods for differential expression analysis in high-throughput gene expression data

Shu, Hai, High dimensional dependent data analysis for neuroimaging

Smith, Abigail Randolph, Sequential stratification for estimating effects of time-dependent treatments on multivariate survival outcomes

Sun, Zhichao, Efficient designs for early-phase clinical trials and exposure enriched outcome trajectory dependent sampling for longitudinal studies of gene-environment interaction

Tao, Yebin, Semiparametric regression and machine learning methods for estimating optimal dynamic treatment regimes

Wu, Fan, Analysis of complex survival and longitudinal data in observational study

Zhu, Jian, Assessment and improvement of a sequential regression multivariate imputation algorithm

Department of Mathematics

Ellis, Dondi, Motivic analogues of MO and MSO

Fraser, Christopher, Correspondences between cluster structures

Karpman, Rachel, Total positivity and network parametrizations: From type A to type C

Levinson, Jake, Foundations of Boij-Soderberg theory for grassmannians

Li, Jiaqi, Stochastic perron for stochastic target problems

Li, Wei, Nonlinear wave propagation in deterministic and stochastic media

Marple, Gary, Fast, high-order algorithms for simulating vesicle flows through constrained geometries

Pal, Suchandan, An explicit jacquet-langlands correspondence

Prigge, David, Absorbing boundary conditions and numerical methods for the linearized water wave equation in 1 and 2 dimensions

Razavi, Hamed, Symmetric hybrid systems: Periodic Gait design for legged robots

Rebhuhn-Glanz, Rebecca, Closure operations that induce big Cohen–Macaulay modules and algebras, and classification of singularities

Renardy, David, Bumping in deformation spaces of hyperbolic 3-manifolds with compressible boundary

Simon, Gregory, Automorphism-invariant integrals forms in Griess algebras

Souza, Andre, An optimal control approach to bounding transport properties of thermal convection

Walch, Olivia, Exploring subconscious vision and circadian rhythms through mathematical modeling

Wiltshire-Gordon, John, Representation theory of combinatorics categories

Department of Statistics

Errickson, Joshua, Two-stage regression for treatment effect estimation

Le, Can, Estimating community structure in networks by spectral methods

Lei, Huitian, An online actor critic algorithm and a statistical decision procedure for personalizing intervention

Nielsen, Karen, Selecting and evaluating models to reflect underlying scientific priciples: Using basis sets to parameterize hypotheses

Park, Seyoung, Selected problems for high-dimensional data - Quantile and errors-in-variables regressions

Sougata, Chaudhuri, Online learning to rank with feedback on top ranked items

Wang, Yingchuan, Logistic-normal mixtures with heterogeneous components and high dimensional covariates

Wu, Tianshuang, Set valued dynamic treatment regimes

Yang, Ziheng, Integrative analysis methods for biological problems using data reduction approaches

Zhang, Yiwei, Regularization and optimization methods for high-dimensional data

Zhang, Yuan, Statistical network analysis: Beyond block models

Wayne State University (7)

Department of Mathematics

Cao, Tan, Optimal control of a perturbed sweeping process with applications to the crow motion model

Hoang, Tuan, Stochastic hybrid systems: Numerical methods, limit results, and controls

Mei, Hongwei, Ergodicity of stochastic switching diffusions and stochastic delay systems

Nguyen, Ba, New combinatorial formulas for cluster monomials of type A quivers

Sarabi, Ebrahim, Variational analysis and stability in optimization

Tran, Ky, Nonlinear stochastic systems and controls: Lotka–Volterra type models, permanence and extinction, optimal harvesting strategies, and numerical methods for systems under partial observations

Zhang, Lu, Multi-parameter and multilinear psuedo-differential operators and sharp Trudinger–Moser inequalities

Western Michigan University (7)

Department of Mathematics

Bi, Zhenming, Highly Hamiltonian graphs and digraphs

Kratky, James, Pedagogical moves as characteristics of one instructor's instrumental orchestrations with Tinkerplots and the TI-73 Explorer: A case study

Department of Statistics

Andrews, Nichole, Subgroup analysis and growth curve models for longitudinal data

Dykes, Bradford, Some nonparametric ordered restricted inference problems in the context of a statistical education study

Mantilla, Libertie, Companion of medians using multivariate mixed design data

Shi, Chenyang, Spatial analysis of time between two consecutive dental and two consecutive well-child visits for foster care youth

Zhang, Shaofeng, Development of traditional and Rank-based algorithms for linear models with autoregressive errors and multivariate logistic regression with spatial random effects

MINNESOTA

University of Minnesota (28)

Division of Biostatistics, School of Public Health

Bai, Yun, Statistical methods for genetic and epigenetic studies

Bose, Maitreyee, Model building for Gaussian process random effects models using the spectral approximation

Coombes, Brandon, Tests for detection of rare variants and gene-environment interaction in cohort and twin family studies

Lin, Lifeng, Statistical methods for meta-analysis

Schnell, Patrick, Credible subgroups: Identifying the population that benefits from treatment

Xu, Zhiyuan, Powerful association testing with application to neuroimaging genetics

School of Mathematics

Arnaldsson, Orn, Involutive moving frames

Binder, Andrew, Development and analysis of computationally efficient methods for analyzing surface effects

Dassbach, Paula, Computational aspects of energy minimization of the Landau–de Gennes model for liquid crystals

Gray, Nathan, Metaplectic ice for Cartan type C

Grodzicki, William, The non-split Bessel model on GSp(4) as on Iwahori–Heche algebra module

Gunawan, Emily, Combinatorics of cluster algebras from surfaces

Hill, Jonathan, Fundamental solutions and green functions for nonhomogeneous second order elliptic operators with discontinuous coefficients

Li, Jun, Symplectomorphism group of rational 4-manifolds

Moulton, Jeffrey, Robust fragmentation: A data-driven approach to decision-making under distributional ambiguity

Ortan, Alexandra, Efficient numerical algorithms for virtual design in nanoplasmonics

Poling, Bryan, Towards a framework for simultaneous feature tracking and segmentation

Senou, Jessica, Weighted differential invarient signatures and applications to shape recognition

Sharma, Amit, Higher Picard groupoids and DW-Theory

Wan, Chen, A local trace formula and the multiplicity one theorem for the Ginzburg–Rallis model

School of Statistics

Eck, Daniel, Statistical inference in multivariate settings

Gu, Yuwen, High dimensional regression and classification and their optimization

Majumdar, Subhabrata, An inferential perspective on data depth

Mallik, Abhirup, Application of functional data on medical images/climate

Molstad, Aaron, Model-based methods for high-dimensional multivariate analysis

Nandy, Abhishek, On small area estimation

Vats, Dootika, Output analysis for Markov chain Monte Carlo

Yang, Fan, Personalized recommender system

MISSOURI

Missouri University of Science and Technology (2)

Department of Mathematics and Statistics

Brigham II, Reginald, A harmonic m-factorial function and applications

Myers III, Donald F, Pointwise and uniform covergence of Fourier series on $SU(2)$

St Louis University (1)

Department of Mathematics and Statistics

Smith, Gerrit, Realizing injective splittings of stable 4-manifolds

University of Missouri–Columbia (11)

Department of Mathematics

Bemrose, Travis, Properties of frames and relationships between them with emphasis on subframes and unconditional convergence

Guo, Victor, Exponential sums, character sums, sieve methods and distribution of prime numbers

McCrady, Andrew, Perinormality in polynomial and module-finite ring extensions

Okamoto, Nicholas, Radiation conditions and integral representations for Clifford algebra-valued null-solutions of the iterated perturbed Dirac operator

Pinkham, Eric, Outer products and frame co-efficients

Polstra, Thomas, Uniform bounds in F-finite rings and their applications

Quinn, Stephen, Sublinear version of the Schur test and weighted norm inequalities

Sukhtaiev, Selim, Topics in spectral theory of differential operators

Tuomanen, Brian, Sequences of rank-1 projections and Gabor tight fusion frames

Xue, Jianfei, On hydrodynamic equations and their relation to kinetic theory and statistical mechanics

Yang, Xinyao, Stability of planer fronts for a class of reaction diffusion equations

University of Missouri–Kansas City (2)

Department of Mathematics and Statistics

Konboon, Malinee, A hybrid modeling approach to assess the efficacy of paratuberculosis control measures on US dairy farms

Song, Xing, First and second order efficiency of sequential designs in a nonlinear situation with applications

University of Missouri–St Louis (2)

Department of Mathematics and Computer Science

Alkhidhr, Hanan, Correspondence between multiwavelet shrinkage/multiple wavelet frame shrinkage and nonlinear diffusion

Kalubowila, Sumudu, Mathematical approaches to digital image inpainting

Washington University (4)

Department of Mathematics

Benge, Philip, Paraproducts and well localized operators

Papiu, Alexandru, Connectivity bounds and S-partitions for triangulated manifolds

Rahm, Robert, Weighted inequalities for three operators

Yang, Yu, Explicit bases of motives over number fields with application to Feynman integrals

MISSISSIPPI

Mississippi State University (3)

Department of Mathematics and Statistics

Ferguson, Joseph, Anisotropic quadrilateral mesh optimization

Krishnasamy Saraswathy, Vidhya, The numerical solutions of fractional differential equations with fractional Taylor vector

Xu, Yang, On non-parametric confidence intervals for density and hazard rate functions and trends in daily snow depth in North America

University of Mississippi (5)

Department of Mathematics

Henegan, James, Asymptotic properties of polynomials orthogonal over multiply connected domains

Nakarmi, Janet, On variable bandwidth kernel density and regression estimation

Naugle, Lynsey, Orthogonal polynomials on an arc of the unit circle with respect to a generalized Jacobi weight: A Risemann-Hilbert approach

Sang, Yongli, Memory properties of transformations of linear processes and symmetric Gini correlations

Wang, Shaohui, On topological indices and denomination numbers of graphs

University of Southern Mississippi (3)

Department of Mathematics

Khatri Ghimire, Balaram, Hybrid Chebyshev polynomial scheme for the numerical solutions of partial differential equations

Lamichhane, Anup, Fast method of particular solutions for solving partial differential equations

Richardson, Megan, Krylov subspace spectral methods for PDEs in polar and cylindrical geometries

MONTANA

Montana State University (6)

Department of Mathematical Sciences

Arnold, Elizabeth, Investigating the teaching of statistics with technology at the high school level through the use of annotated lesson plans

Banner, Katharine, Is model averaging the solution for addressing model uncertainty? Methodological insights, tools assessment, and considerations for practical use

Kanewske, Daniel, Stress Taylor symmetry preserving model applied to the 2-d viscoelastic plan of a biofilm

Lerch, Michael, Statistics in the presence of cost: Cost-considerate variable selection and MCMC convergence diagnostics

McClanahan, Nathan, Seperating the EPS in a biofilm: Models and simulations of movement of the EPS within

Pettry, Danielle, The development of specialized content knowledge among secondary mathematics pre-service teachers

University of Montana–Missoula (1)

Department of Mathematical Sciences

Katerba, Charles, Modules, fields of definition, and the Culler–Shalen norm

NEBRASKA

University of Nebraska–Lincoln (16)

Department of Mathematics

Ahrendt, Kevin, The existence of solutions for a nonlinear self-adjoint difference equation

Edholm, Christina, Management of invasive species using optimal control theory

Egg, Rebekah, Cohen-Macaulay dimension for coherent rings

Falahola, Brittney, Characteristics of Gorenstein rings using Frobenius

Inam, Muhammad, Adian inverse semigroups

Lutz, Jason, Homological characterizations of quasi-complete intersections

Myers, John, Homological criteria for minimal multiplicity

Owad, Nick, Bridge spectra of cables of 2-bridge knots

Parmelee, Caitlyn, Applications of discrete mathematics for understanding dynamics of synapses and networks in neuroscience

Russell, Travis, Abstract characterizations of ordered operator spaces

St. Goar, Julia, A Caputo boundary value problem in Nabia fractional calculus

Tomlinson, Charles, Extremal problems for graph homomorphisms and automata

Tomlinson, Maranda, Languages, geodesics, and HNN extensions

Department of Statistics

Kismiantini, Methods for detecting time lags in animal temperature regulation

Nzouda-Tsotezo, Cyrille, Risk evaluation and portfolio allocation in the context of high frequency trading

Zhang, Yixiang, Novel protein functional analysis based on weighted and directed protein overlap network and adjusted entropy measurements

NEVADA

University of Nevada, Las Vegas (4)

Department of Mathematical Sciences

Breckling, Sean, Numerical and sensitivity analyses of Navier-Stokes alpha models

Ikeda, Emi, Investigation of determinacy for games of variable length

Shields, Sidney, Novel methods for Maxwell's equations and their applications

Xu, Jianbo, Statistical inference of genetic forces using a Poisson random field model with non-constant population size

NEW HAMPSHIRE

Dartmouth College (3)

Department of Mathematics

Dwyer, Timothy, c-Wilf equivalences of permutations

Harris, Seth, On-line algorithms and reverse mathematics

Sullivan, Everett, Linear chord diagrams with long chords

University of New Hampshire (7)

Department of Mathematics and Statistics

Bornstein, Neil, Music of the triangles: How students come to understand trigonometric identities and transformations

Brand, Evan, Spatially-localized solutions of plane Couette flow

Earls, David, Students' misconceptions of sequences and series in second semester calculus

Marshall, Ian, On tensor autoequivalences of graded fusion categories

Sager, Lauren, A Beurling theorem for noncommutative Hardy spaces associated with a semifinite von Neumann algebra with various norms

Storch, Laura, Chaos in ecology: An examination of nonlinear population dynamics in diffusive and advective dispersal environments

Szeto, Mimi, A dynamical-systems approach to understanding turbulence in plane Couette flow

NEW JERSEY

Montclair State University (1)

Mathematical Sciences Department

Flood, Marguerite, Adult learners, learning disabilities, and mathematics: A case study

New Jersey Institute of Technology (6)

Department of Mathematical Sciences

Cheng, Ruihua, Structural exploration and inference of the network

Dong, Nanyi, Instabilities of liquid metal on nanoscale

Kovalcinova, Lenka, Numerical simulations of dense granular systems with and without cohesive effects

Mema, Ensela, Mathematical models for polymer-nematic interactions

Rahman, Aminur, Qualitative modeling and analysis of chaotic logical circuits and walking droplets: A dynamical systems approach

Wang, Shaobo, Efficient high-order integral equation methods for the heat equation

Princeton University (10)

Department of Mathematics

Avdeeva, Maria, Limit theorems for B-free integers and the Moebius function

Gauthier, Gregory, The structure of graphs with no cycles of length 0 (mod 3)

Hernandez, Matthew, Mechanisms of Lagrangian analyticity in fluids

Humphries, Peter, Equidistribution in shrinking sets and L^4-norm bounds for automorphic forms

Liu, Yuchen, Kähler–Einstein metrics and normalized volumes of valuations

Sandon, Colin, Community detection in the stochastic block model: Fundamental limits

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Early, Nicholas, Combinatorics and representation theory for generalized permutohedra

Liao, Hung-Chang, Rokhlin type theorems in operator algebras

Ma, Yicong, Fast solvers for incompressible MHD systems

Vinhage, Kurt, Rigidity of genuinely higher-rank homogeneous flows

Zhang, Qingtian, Uniqueness and singularities of weak solutions to some nonlinear wave equations

Zhang, Siyan, Heat kernels, exponentials in solvable Lie groups and the mean reverting SABR model

Zhen, Yicun, Accounting for the model error and sampling error for ensemble Kalman filter

Temple University (6)

Department of Mathematics

Bao, Dianbin, Identities between Hecke eigenforms

Jacoby, Adam, On representations of Hopf algebras

Ratner, Michael, Quantum walks and structured searches on free groups and networks

Schneider, Geoffrey, Recursively generating formality quasi-isomorphisms with applications to deformati on quantization

Department of Statistical Science

Yang, Chaozheng, Sufficient dimension reduction in complex datasets

Zhang, Yongxu, On two new estimators for the CMS through extensions of OLS

University of Pennsylvania (13)

Department of Applied Mathematics and Computational Science

Lee, Kwonsang, Causal inference beyond estimating average treatment effects

Rogers, Ryan M, Leveraging privacy in data analysis

Department of Biostatistics, Epidemiology, and Informatics

Bender, Shaun, Ignorability conditions for incomplete data and the first-order Markov conditional linear expectation approach for analysis of longitudinal discrete data with overdispersion

Billig, Erica, Detecting and controlling insect vectors in urban environments: Novel Bayesian methods for complex spatial data

Jemielita, Thomas, Efficient baseline utilization in crossover clinical trials through linear combinations of baselines: Parametric, nonparametric, and model selection approaches

Shin, Daniel, Novel statistical methodologies in analysis of position emission tomography data: Applications in segmentation, normalization, and trajectory modeling

Tahirovic, Emin, Sensitivity analysis for non-ignorable dropout of marginal treatment effect in longitudinal trials for *G*-computation based estimators

Department of Mathematics

Albert, Benjamin, Effective field theory on manifolds with boundary

Citoler Saumell, Martin, A gap theorem for half-conformally-flat 4-manifolds

Nayak, Soumyashant, On the diagonals of projections in matrix algebras over von Neumann algebras

Patel, Neel, Rigorous results in fluid and kinetic models

Qiang, Hua, Bott-Chern characteristic forms and index theorems for coherent sheaves on complex manifolds

Tomaskovic-Moore, Sebastian, Galois module structure of Lubin-Tate modules

University of Pittsburgh (30)

Department of Biostatistics

Apfel, Abraham, A stability analysis of sparse *k*-means

Balmert, Lauren, Nonparametric inference and regression on quantile lifespan

Carlson, Jenna, Methods for family-based designs in genetic epidemiology studies

Huo, Zhiguang, Statistical integrative omics methods for disease subtype discovery

Lin, Chien-Wei, Power calculation and study design in RNA-seq and Methyl-seq

Paliwal, Yuvika, Generalized linear models for analysis of cross-correlated binary response in multi-reader studies of diagnostic imaging

Potter, Andrew, Multiscale multivariate functional principal component analysis with an application to multivariate longitudinal cardiac signals

Shan, Ying, Statistical methods for genetic risk confidence intervals, Bayesian disease risk prediction, and estimating mutation screening saturation

Topp, Andrew, Doubly robust estimation in two-stage dynamic treatment regimes in the presence of drop-out

Woolley, Shannon, Tests for random signs censoring in competing risks

Department of Mathematics

Burstein, David, Random graph generation techniques and applications

Cely, Jorge, Applications of motivic integration to the fundamental lemma

Gallagher, Torrey, Averaging and fixed points in banach spaces

Harris, Jeremy, A spatially extended Wilson Cowan model for coutical circuits: Fram patterns to wave

Hu, Jilong, Vortex sheets in elastic fluids

Hurl, Nicholas, Analysis of time filters in multisteps methods

Khankan, Sarah, Predictability of average temperatures using ensemble algorithms

Li, Yong, Time filters for numerical weather predictions

Malekzadeh, Soheil, Unrectifiability of metric spaces and mapping of bounded length distortion

Morgan, Jeremiah, *P*-ordered families and related topological properties

Navrotskaya, Irina, The inverse problem in classical statistical mechanics and its applications to liquid state theory

Snyder, Abigail, Pattern generation multi-functionality in a neural network inspired by turtle scratch rhythms

Stanhope, Shelby, Parameter estimation for dynamical systems

Wang, Changqing, Domain decomposition methods for coupled Stokes–Darcy flows

Wang, Yangyang, Understanding and distiguishing multiple time scale dynamics

Wheeler, Matthew, Rational structures and differential cohomology

Xu, Jiaqing, Modeling defaults in banking and real estate

Young, Glenn, Combating pathogen invasion: Macroscopic and microscopic views

Zhou, Xiaodan, Analysis on metric measure spaces Sobolev and Viscosity approaches

Zimmerman, Scott, Sard in Sobolev space and curves in the Heisenberg group

RHODE ISLAND

Brown University (25)

Department of Biostatistics

Erar, Bahar, Whole genome regression for modeling gene by treatment interactions in structured populations

Gu, Chenyang, Statistical missing data methods with applications to health services research

Yue, Mun Sang, Evaluation of predictive accuracy of tests and impact of tests on patient outcomes

Zhao, Yi, Causal mediation analysis of big data

Department of Mathematics

Ascher, Kenneth, Higher dimensional birational geometry: Moduli and arithmetic

Chen, Xiaoshuang, Duality theorems and special value of Artin 1-functions at zero

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Kim, Semin, Harmonic maps and the moduli of Higgs bundles

Le, Quang Nhat, A family of projectively natural polygon iterations

Liu, Chang, Blow-up for the 10 nonlinear Schrodinger equation with point nonlinearity

Lowry-Duda, David, On some variants of the Gauss circle problem

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Ramassamy, Sanjay, Topics in combinatorics: From probability to geometry

Division of Applied Mathematics

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Lee, Seungjoon, Statistical learning tools for information fusion in computational fluid dynamics

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Volkening, Alexandria, Modeling pattern formation on zebrafish

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Xia, Chao, Traffic flow models: Analysis, estimation and control

Zhang, Hong, Regularity theory of elliptic and parabolic equations and systems

University of Rhode Island (2)

Department of Mathematics

Khyat, Toufik, Bifurcation of some planar discrete dynamial systems with applications

McArdle, David, Global dynamics boundedness of discrete population models

SOUTH CAROLINA

Clemson University (10)

Department of Mathematical Sciences

Adelgren, Nathan, Solution techniques for classes of biobjective and parametric programs

Giberson, Luke, Average Frobenius distributions for elliptic extremal primes and Kobiltz's conjecture

Goodell, Brandon, Assessing non-atomicity in groups of divisibility

He, Qijun, Algebraic geometry arising from discrete models of gene regulatory networks

Joyner, Jason, A new look at matrix analytic methods

Koshy Chenthittayil, Sherli, Chaos to permanence: Through control theory

Lipman, Drew, Normal domains arising from graph theory

Wilson, Anastasia, Modeling, analysis, and simulation of adsorption in functionalized membranes

Wilson, Christopher, Tolerance intervals for hierarchical data

Xu, Shuhan, Numerical study for non-Newtonian fluid-structure interaction problems

Medical University of South Carolina (4)

Department of Public Health Sciences

Cassarly, Christy, Mutistate Markov models for ordinal function outcomes of acute onset disease application in acute stroke therapy trials

Prince Nelson, Sybil, An extension of logic regression to classify and predict disease outcomes from continuous and binary predictors and their interactions

Ward, Ralph, Improving methods for modeling high dimensional binary features data with applications for assessing disease burden from diagnostic history and for dealing with missing covariates in administrative health records

Wei, Wei, Novel design and analytical approaches for phase II cancer clinical trials

University of South Carolina (10)

Department of Mathematics

Boehnlein, Edward, On crown-free set families, diffusion state difference, and non-uniform hypergraphs

Lewis, Tyler, A family of simple codimension two singularities with infinite Cohen-Macaulay representation type

Department of Statistics

Hou, Peijie, Topics in group testing with multiple infections

Kindo, Bereket, Bayesian ensemble of regression trees for multinominal probit and quantile regression

Lee, Han, Some issues in Markov chain Monte Carlo estimation for item response theory

Liu, Jianxuan, Semiparametric estimation and inference in causal inference and measurement error models

Liu, Piao Mu, Semiparametric joint dynamic modeling of a longitudinal marker, recurrent competing risks, and a terminal event

Sarker, MD, Modern estimation problems in group testing

Wang, Sheng-Yang, Adaptive regression model for flexible survival data analysis

Wu, Zizhen, Simultaneous registration and clustering of functional data

SOUTH DAKOTA

South Dakota State University (2)

Department of Mathematics and Statistics

Karki, Laxman, Spatial and spatiotemporal modeling of epidemiological data

O'Brien, Austin, A kernel based approach to determine atypicality

TENNESSEE

Middle Tennessee State University (10)

Department of Mathematical Science

Baum, Britanny Smith, Examining the influence of argumentation on the statistical problem-solving process

Bhatt, Harish, Efficient and accurate exponential time differencing schemes for systems of nonlinear time dependent partial differential equations

Colgin, Zane, Computational improvements for stochastic simulation with multilevel Monte Carlo

Ewool, Richard, Mathematical modeling and simulation of a multiscale tumor induced angiogenesis model

Jones, Zachary, Modeling of cell cycle checkpoints with applications to the analysis of intermitotic time data

Kassaee, Ameneh, Exploring the role of motivation and mindset in achievement of STEM majors in precalculus

Liang, Jingsai, Regularized statistical techniques for high dimensional medical imaging data processing

Liang, Xiao, Efficient numerical methods for nonlinear Schrödinger equations

Reshniak, Viktor, Reducing computational cost of the multilevel Monte Carlo method by construction of suitable pathwise integrators

Yang, Xin, Machine learning techniques for high-dimensional neuroimaging data analysis

University of Memphis (5)

Department of Mathematical Sciences

Abayie Boateng, Nana Akwasi, On some exact nonparametric conditional test for clustered binary data

Binski, Scott, Games on grids and graphs

Sahasrabudhe, Julian, Extremal and Ramsey problems on graphs and the integers

Tag, Hyyung-Joon, Some geometrical properties of Orlicz–Lorentz spaces and their Köthe duals

Taylor, Aaron, Classes of operators on block spaces

University of Tennessee, Knoxville (7)

Department of Mathematics

Kang, Kai, Advanced sequential Monte Carlo methods and their applications to sparse sensor network for detection and estimation

Krumwiede, Tim, Surface energy in bond-counting models on Bravais and non-Bravais lattices

Loga, Christopher, Extension theorems on matrix weighted Sobolev spaces

Massaro, Tyler, Variable selection via penalized regression and the genetic algorithm using information complexity, with applications for high-dimensional-omics data

Pantha, Buddhi, Anthrax models involving immunology, epidemiology and controls

Pollesch, Nathan, Mathematical approaches to sustainability assessment and protocol development for the bioenergy sustainability target assessment resources (Bio-STAR)

Wang, Liguo, Numerical solutions of stochastic differential equations

Vanderbilt University (2)

Department of Mathematics

Tang, Sui, Dynamical Sampling

Wen, Chenxu, Amenable extensions in II_1 factors

Vanderbilt University, School of Medicine (3)

Department Biostatistics

Liu, Qi, Covariate-adjusted Spearman's Rank correlation with probability-scale residuals

Samuels, Lauren, Aspects of casual inference within the evenly matchable population: The average treatment effect on the evenly matchable units, visually guided cohort selection, and bagged one-to-one matching

Smith, Derek, Empirical Bayes methods for modern statistical problems

TEXAS

Baylor University (9)

Department of Mathematics

Averbeck, Nathan, Chaos in dendritic and Julia sets

Hunter, Reeve, The specification property and chaos in multidimensional shift spaces and general compact metric spaces

Department of Statistical Sciences

Blair, Somer, Contributions to the theory and practice of prior elicitation in a biopharmaceutical research

Faya, Paul, Bayesian methods in nonclinical pharmaceutical statistics

Sims, Justin, Modeling nonlinear, nonstationary vector time series: Methods and applications

Vallejo, Jonathon, Some new applications of Bayesian longitudinal models

Van Zyl, Johanna, Evaluating treatment efficacy using AUC modeling

Waken, Robert, Flexible spatial interpolation and uncertainty quantification: With applications in radar rainfall estimation

Wu, Wenqi, Network meta-analysis with rare events and misclassified response

Rice University (20)

Computational and Applied Mathematics Department

Becker, Timothy, Bilevel clique interdictin and related problems

Bencomo, Mario, Representation and estimation of seismic sources via multipoles

Deng, Xiaodi, A parallel-in-time gradient-type method for optimal control problems

Fast, Caleb, Novel techniques for the zero-forcing and p-median graph location problems

Magruder, Caleb, Projection-based model reduction in the context of optimization with implicit PDE constraints

Puelz, Charles, Numerical methods and applications for reduced models of blood flow

Vargas, Arturo, Hermite methods for the simulation of work propagation

Wang, Zheng, GPU-accelerated discontinouos Galerkin methods on hybrid meshes: Applciation in seismic imaging

Zhou, Muhong, Energy-conserving composite staggered-grid finite difference time domain scheme for order wave equation system

Department of Mathematics

Allums, Derek, Notes on real rationally connected varieties and Fano threefolds of genus 12

Bosman, Anthony, Shake slice and shake concordant links

Bregman, Corey, Automorphisms or nonpositively curved cube complexes, right-angled Artin groups, and homology

Do, Tam, Global regularity and finite-time blow-up in model fluid equations

Downs, Carol, A mass minimizing flow for real-valued flat chains with applications to transport networks

Park, JungHwan, Derivatives of genus one and three knots

Department of Statistics

Babkin, Sergii, High-dimensional and dependent data with additional structure

Han, Yu, Impact of news on crude oil futures

Li, Qiwei, Bayesian models for high-dimensional count data with feature selection

Wadsworth, W. Duncan, Bayesian nonparametric methods for microbiome data analysis

Wang, Zeya, Statistical modeling for cellular heterogenity problems in cancer reserach deconvolution, Ganssian graphical models and logistic regression

Southern Methodist University (11)

Department of Mathematics

Castro-Castro, Claudia, Nonlinearity, PT symmetry twist and disorder in the discrete nonlinear Schroedinger equation

Schoenfeld, Jessica, The existence of spontaneous parity-time symmetry breaking, assymetric transport and defect modes in nonlinearity coupled Van Der Pol oscillations

Lagrone, John, Application and optimization of complete radiation boundary conditions

Liu, Yang, The immersed interface method for flow around non-smooth boundaries and its parallelization

Sheffield, Thomas, Collapses and ensemble dynamics in one and two dimensional weak wave turbulence

Statistical Science Department

Allen, Chelsea, Modeling of heaped cigarette count data

Fernando, Mahesh, Confidence intervals for the variance ratios in any unbalanced linear mixed model

Li, Lie (Nathan), Development of meta-analysis methods in biomedical studies

Liu, Bingchen, Ranked set sampling estimators of discrete distributions parameters and estimation of total from a population of unknown size

Lu, Wentao, Meta-analysis approaches to combine multiple gene set environment studies

Wang, Mumu, Using ranked set sampling with binary outcomes in cluster randomized designs

Texas A&M University (29)

Department of Mathematics

Alotibi, Manal, Global-local nonlinear model reduction for flows in heterogeneous porous media

Barquero-Sanchez, Adrian, The Chowla-Selberg formula for CM fields and the Colmez conjecture

Carroll, David, Periodic points in shifts of finite type overgroups with connections to growth

Do, Ngoc, Some spectral problems in mathematical physics

Ergur, Alperen, Sparsity, randomness and convexity in applied algebraic geometry

Farnsworth, Cameron, The polynomial waring problem and the determinant

Gesmundo, Fulvio, Geometry and representation theory in the study of matrix rigidity

Guan, Yonghui, Equations for chow varieties, their secant varieties and other varieties arising in complexity theory

Kocak, Dilber, Growth of algebras and codes

Lee, Chak Shing, Generalization of mixed multiscale finite element methods with applications

Liu, Wen, Degeneracies in the eigenvalue spectrum of quantum graphs

Phillipson, Kaitlyn, Quantitative aspects of sums of squares and sparse polynomial systems

Porter, Curtis, The local equivalence problem for 7-dimensional, 2-nondegenerate CR manifolds whose cubic form is of conformal unitary type

Quezada de Luna, Manuel, Methods for solving the linear scalar conservation law with applications on multiphase flow

Shankara Narayana Rao, Bheemaiah V., On a spatiotemporal population dynamics model to track density and average mass: Application to brown shrimp

Tian, Jing, Study on nonlinear analysis and chaos in vibrations and fluids

Yang, Yanfang, POD-DEIM global-local model reduction for multi-phase flows in heterogeneous porous media

Yang, Yong, Continuous finite element approximation of hyperbolic systems

Ye, Shuai, GMSFEM for nonlinear problems and space-time GMSFEM

Zhang, Bingsheng, On the solutions in the global attractor of the incompressible Navier-Stokes equations

Zhang, Sheng, Nonlinear quotients of Banach spaces

Department of Statistics

Dorn, Mary Francis, Semiparametric classification under a forest density assumption

He, Kejun, Sparsity and low rank structures in functional data analysis

He, Shiyuan, Functional light curve models for type Ia supernovae and Mira variables, with their application of distance determination

Li, Furong, Statistical inference for large spatial data

Liang, Liang, Semiparametric efficient estimators in primary and secondary analysis of case-control studies

Liu, Senmao, A comprhensive approach for sparse principle component analysis using regularized singular value decomposition

Su, Ya, A general approach for asymptotics of penalizes spline estimation in extended linear models

Wang, Xiao, Dynamic othogonal subseries for high-dimensional and nonstationary time series

Texas State University (4)

Department of Mathematics

Miller, Geoffrey, Exploring mathematical flow: A case study of pre-service secondary teachers collaborating on model-eliciting activities

Namakshi, Nama, Creating a pathway to STEM: Role of an informal mathematics program

Rasche, Alexander, Is tutoring teaching? Exploring tutoring's potential to improve mathematics teacher education

Wilkerson, Joshua, Cultivating mathematical affections: Developing a productive disposition through engagement in service-learning

Texas Tech University (11)

Department of Mathematics and Statistics

Celik, Emine, Generalized Forchheimer flows of compressible fluids in heterogeneous porous media

Cherry, Ashley, Piecewise linear approximation for nonlinear programming problems

Dissanayake, Chandani, Finite element simulation of space/time behavior in a two species ecological stoichiometric model

Fan, Wenzhen, Control systems splines on the manifold of lines in $\mathbb{R}^2$

Jeganathan, Pratheepa, Multivariate extensions of saddlepoint-based bootstrap and an empirical saddlepoint approximation method for smoothing survival functions under right-censoring

Li, Bo, Simultaneous inference based on rank regression in biomedical data analysis

Meek, Ashley, Block preconditioned implicit Runge-Kutta methods for the incompressible Navier-Stokes equations

Niu, Xu, Mathematics prerequisites for doctoral level studies in finance

Oki, Takafumi, Tracking orientation control satisfying Donders' constraint on SO(3)

Paragoda, Thanuja, Willmore and generalized Willmore energies in space forms

Prematilake, Chalani, Prediction of lower bounds of the number of sampling points for approximating shapes of planar contours

University of Houston (14)

Department of Mathematics

Bearden, Clifford Alexander, Hilbert C^*-modules over σ^*-algebras

Chaturvedi, Ananya, On holomorphic sectional curvature and fibrations

Chiu, Shang-Huan, 3D DLM/FD methods for sumulating the motion of spheres in bonded shear flows of Oldroyd-B fluids

Chowdhury, Tasadduk, Region-of-interest reconstruction from truncated conebeam CT

Geiger, Brett, Large deviations for dynamical systems with small noise

Hussein, Saud, An improved defect relation and height inequality

Kurzanova, Daria, Efficient numerical treatment of high-contrast diffusion problems

Liao, Hungzen, Some results on the degeneracy of entire curves and integral points in the complements of divisors

Liu, Changan, The impact of STDP and correlated activity on network structure

Mills, Charles, An improved defect relation for holomorphic curves in projective varieties

Park, Jungim, Unicity results for Gauss maps of minimal surfaces immersed in $\mathbb{R}^m$

Poll, Daniel, Stochastic dynamics in bump attractor models of spatial working memory

Suri, Nishant, Naimark's problem for graph C^*-algebras

Ugur, Gul, Uniqueness results of algebraic curves and related topics

University of North Texas (7)

Mathematics Department

Caruvana, Christopher, An extension of the Baire property and uniqueness of topologies on holomorphic functions

Dance, Cody, Contributions to descriptive set theory

Dave, Ojas, Irreducible modules for Yokonuma-type Hecke algebras

Holshouser, Jared, Partition properties for non-ordinal sets under the axiom of determinacy

Martin, James, Rankin–Cohen brackets for Hermitian Jacobi forms and Hermitian modular forms

Tomlin, Drew, A decomposition of the group algebra of a hyperoctahedral group

Uhl, Christine, Quantum Drinfeld Hecke algebras

University of North Texas Health Science Center (1)

Department of Biostatistics and Epidemiology

Atienza, Philamer, Adaptation of the genetic risk prediction model BRCAPRO for primary care settings

University of Texas at Arlington (9)

Department of Mathematics

Al-Dujaly, Hassan Abd Salman, Weighted upwinding compact scheme for shock capturing

Au, Melinda, Three-dimensional image reconstruction (3 direct) of sparse signals with MRI application

Boodhwani, Afshan, Nonparametric adaptive distribution-free procedure for crossover design with repeated measures

Chen, Xi, Numerical construction of diffeomorphism and its application to grid generation and image registration

Mitchell, Christopher, Calculating reproductive numbers for periodic epidemic systems

Poudyal, Basanti Sharma, Existence of exact zero divisors and totally reflexive modules in Artinian rings

Steele, Nathan, Support and rank varieties of totally acyclic complex

Wiangnak, Piyachart, Likelihood based inference for COM-Poisson cure rate model with interval censored data

Xi, Hongguang, A harmonic function method for EEG source reconstruction

University of Texas at Austin (23)

INSTITUTE FOR COMPUTATIONAL ENGINEERING AND SCIENCES

Almani, Tameem, Efficient algorithms for flow models coupled with geomechanics for porous media applications

Arabshahi, Hamidreza, Space-time hybridized discontinuous Galerkin methods for shallow water equations

Bello-Rivas, Juan M., Iterative milestoning

Du, Wei, Mathematical modeling of the interaction between two-phase environmental flow and protective hydraulic structures

Harmon, Michael, Numerical algorithms based on Galerkin methods for the modeling of reactive interfaces in photoelectrochemical solar cells

Kamensky, David, Immersogeometric fluid-structure interaction analysis of bioprosthetic heart valves

Morales Escalante, Jose, Discontinuous Galerkin methods for Boltzmann-Poisson models of electron transport in semiconductors

Neupane, Prapti, Advances itowards a multi-dimensional discontinuous Galerkin method for modeling hurrican storm surge induced flooding in coastal watersheds

Rabidoux, Scott, Extending the reach of algorithms for the calculation of molecular vibronic spectra

Sakamoto, Yusuke, One cell as a mixture: Simulation of the mechanical responses of valve interstitial cells

Voelkel, Stephen, Thermal nonequilibrium models for high-temperature reactive processes

DEPARTMENT OF MATHEMATICS

Akopian, Sona, Global L^p solutions of the Boltzmann equation with an angle-potential concentrated collision kernel and convergence to a Landau solution

Cohn, Lee, Rectifying stable infinity-categories and relative Koszul duality for operads

Colbert, Cory, Cardinality restrictions on Noetherian spectra

Fontes, Ernest E., A weighty theorem of the heart for the algebraic K-theory of higher categories

Ganev, Iordan, The wonderful compactification for quantum groups

Geng, Tianran, Forward portfolio theory and financial time series modeling

Lee, Andrew, Mapping tori and stable pairs

Morales Delgado, Javier Alejandro, Least action principles with applications to gradient flows and kinetic equations

Singh, Sukhpreet, Entropy theory for locally compact sofic groups

Villar Lozano, Maria Soledad, Relax, descend, and certify: Optimization techniques for typically tractable data problems

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Zhang, Rongting, Hybrid inverse problems in molecular imaging

University of Texas at Dallas (9)

DEPARTMENT OF MATHEMATICAL SCIENCES

Acosta-Mejia, Cesar, Pseudolikelihood methods in multichannel change-point detection

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Datta, Ananda, Detecting rare haplotype disease association: Comparison of existing population-based methods and a new family-based quantitative Bayesian lasso method

Herzig, Emily, Spin groups and exponentation

Rathnayake, Lasitha, Modeling and analysis of functional and longitudinal data with biomedical applications

Skaaning, Sonny, Inventory control with pricing optimization in continuous time

Wang, Yunfei, Connections among multivariate rank functions, depth functions, and sign and signed-rank statistics

Zhang, Yuan, Detecting rare haplotype-environment interaction under uncertainty of gene-environment independence assumption with an extension to complex sampling data

UTAH

Brigham Young University (2)

DEPARTMENT OF MATHEMATICS

Jiang, Ana, American spread option pricing with stochastic interest rates

Lytle, Joshua, Stability of planar detonations in the reactive Navier-Stokes equations

University of Utah (15)

DEPARTMENT OF MATHEMATICS

Albright, Eric Jason, Numerical methods based on difference potentials for models with material interfaces

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Lam, Tony, Central limit theorem for random polymers in weak disorder

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Lindo, Haydee, Trace ideals and centers of endomorphism rings

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Xu, Bin, Mathematical models of cell polarization

Utah State University (5)

DEPARTMENT OF MATHEMATICS AND STATISTICS

Bailey, Sean, To dot product graphs and beyond

Hickes, Jesse, Classification of spacetimes with symmetry

Lewis, Matthew, Laboratory experiences in mathematical biology for post-secondary mathematics students

Li, Yuanzhi, Bayesian models for repeated measures data using Markov chain Monte Carlo methods

Yi, Ju, Definition and construction of entropy satisfying multiresolution analysis (MRA)

VIRGINIA

College of William and Mary (1)

DEPARTMENT OF APPLIED SCIENCE

Pelejo, Diane Christine, Matrix results and techniques in quantum information science and related topics

George Mason University (8)

DEPARTMENT OF MATHEMATICAL SCIENCES

Badgaish, Manal, Modeling, analysis, and computation of non-linear soft tissue interaction with flow dynamics with application to aneurysms *de Silva, Hasitha*, Large deviations and rare event simulations for portfolio credit risk

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Whelan, George, Generalized depth and associated primes in the perfect closure $\mathbb{R}^\infty$

Department of Statistics

Zhang, Zijing, Rendered 3D graphical exploration of multivariate data based on truncated octahedron binning, gray-level image processing and cognostics

Old Dominion University (1)

Department of Mathematics and Statistics

Poddar, Arjun, Analysis of dependent discrete choices using Gaussian copula

University of Virginia (7)

Department of Statistics

Diver, Paul, A methodology for two-level product partition model estimation of normal means

Lu, Miao, Single-index models with varying co-efficients

Department of Mathematics

Bonventre, Peter, Comparison of models for equivariant operads

Ko, Hankyung, Representations of quantum groups at roots of unity and their reductions mod p to algebraic group representations

Kochalski, Katelynn, Fluid limits and the batched processor sharing model

Leitmeyer, Keith, Turbulence, regularity, and geometry in solutions to the Navier-Stokes and magnetohydrodynamic equations

Wang, Bo, A generalization of Martingale theory to self-averaging processes

Virginia Commonwealth University (1)

Department of Statistical Sciences and Operations

Moradi Rekabdarkolaee, Hossein, Dimension reduction and variable selection

Virginia Polytechnic Institute and State University (15)

Department of Mathematics

Chen, Xiaofeng, Plane permutations and their applications to graph embeddings and genome rearrangements

Cui, Jing, Boundary controllability and stabilization of nonlinear Schrodinger equations in a finite interval

Eastridge, Samuel, First cohomology of some infinitely generated groups

Erwin, Samantha, Mathematical models of immune responses to infectious diseases

Kuster, George, On the role of student understanding of function and rate of change in learning differential equations

Letona-Bolivar, Cristina, On a class of parametrized domain optimization problems with mixed boundary condition types

Shifler, Ryan, Equivariant quantum cohomology of the odd symplectic Grassmannian

Xie, Xuping, Large Eddy simulation reduced order models

Department of Statistics

Carzolio, Marcos, On a selection of advanced Markov chain Monte Carlo algorithms for everyday use: Weighted particle, tempering practicle reversible jump and extensions

Kang, Xiaoning, Contributions to large covariance and inverse covariance matrices estimation

Keefe, Matthew, Statistical monitoring and modeling for spatial processes

Rhodes, Austin, Accelerated life test modeling using median rank regression

Song, Yuhyun, Linkage based Dirichlet processes

Sun, Jinhui, Robust feature screening procedures for mixed type of data

Yuan, Miao, Corporate default predictions and methods for uncertainty quantifications

WASHINGTON

University of Washington (34)

Applied Mathematics Department

Lansdell, Benjamin, On renewal encoding: Its estimation, application, and development

Ma, Yian, Irreversibility in stochastic dynamic models and efficient Bayesian inference

Massey, Susan, Multi-scale modeling of paracrine PDGF-driven glioma growth and invasion

Moe, Scott, High-order shock capturing methods with compact stencils for use with adaptive mesh refinement and mapped grids

Oleskiw, Timothy, On computing shape: A study of the neural processes concerning naturalistic boundary confirmation within the ventral visual pathway

Rim, Donsub, Uncertainty quantification problems in tsunami modeling and reduced order models for hyperbolic partial differential equations

Segal, Benjamin, The stability and instabilities of stationary solutions to the nonlinear Schroedinger and sine-Gordon equations

Shapero, Daniel, Data assimilation problems in glaciology

Thakkar, Niket, Energy and charge transfer in open plasmonic systems

Department of Biostatistics

Brown, Lisa, Statistical methods in admixture mapping: Mixed model based testing and genome-wide significance thresholds

Chen, Shizhe, Flexible modeling and estimation for high-dimensional graphs

Fisher, Leigh, Modeling of infectious disease surveillance data

Keller, Joshua, Methods for confounding adjustment and high-dimensional environmental exposures

Kirk, Jennifer, Statistical methods for inferring population structure with human genome sequence data

Koh, William Jen Hoe, Adaptive designs in the time to event setting: The potential for benefit and risk

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Bookshelf and Book Reviews

I am greatly disappointed that the *Notices* does not carry the Bookshelf and has had very few reviews of books of general interest to mathematicians and others of the mathematical community. The Bookshelf has reviewed an excellent variety of general interest books. Instead of eliminating it, it should have been expanded.

If it is the case that reviewers cannot be found, perhaps the editors should look to other publications for mini or full reviews. For example, the journal *Leonardo* (Nov., 2017) carried an excellent review (by Phil Dyke) of *The Seduction of Curves* by Allan McRobie, giving us a new glimpse of Rene Thom's seven elementary catastrophes and more.

It is my hope that the editors will revive this important component of the *Notices*.

—*S. Peter Tsatsanis*
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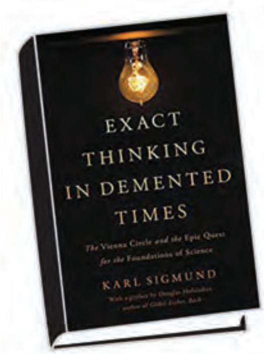
EDITOR'S NOTE. Since the departure of Allyn Jackson, who handled the Bookshelf and book reviews, the editorial board has been gradually taking on that responsibility, and the 2019 Editor-in-Chief, Erica Flapan, will have book reviews and Bookshelf in every issue. In addition, many reviews can be found at the webpage "MATH in the MEDIA: A survey of math in the news" at www.ams.org/news/math-inthe-media/reviews.

We invite readers to submit letters to the editor at notices-letters@ams.org.

BOOK REVIEW

The Vienna Circle and the Epic Quest for the Foundations of Science



A Review by John W. Dawson Jr.

Communicated by Stephen Kennedy

Exact Thinking in Demented Times: The Vienna Circle and the Epic Quest for the Foundations of Science
By Karl Sigmund
Basic Books, 2017
Hardcover, 480 pages
ISBN: 978-0465096954

The phenomenal cultural and intellectual efflorescence that began in Vienna during the last years of the nineteenth century and continued during the interval between the two World Wars, amidst the economic and political chaos that ensued in the wake of the disintegration of the Habsburg empire, has been the subject of numerous studies, including Carl Schorske's *Fin-de-siècle Vienna: Politics and Culture* and Allan Janik's and Stephen Toulmin's *Wittgenstein's Vienna*. Most of those studies, however, have focused on developments in literature and the arts rather than in mathematics and the philosophy of science. Much has also been written about the empiricist philosophy (logical positivism) proclaimed in the manifesto *Wissenschaftliche Weltauffassung—Der Wiener Kreis* (The Scientific Worldview — the Vienna Circle). To my knowledge, however, the present work is the first to provide a collective biography of all of the central and many of the peripheral participants in that Circle and to place their lives and work within the context of those tumultuous times—a daunting task, given the sheer number of individuals involved and the complexity of their interactions.

It is a pleasure to say that Sigmund has succeeded brilliantly in that endeavor. As he remarks in the Afterword, "it was almost inevitable" that he be the one to do so, for he grew up in the shadow of the Circle: A lifelong resident of Vienna, he was enchanted as a schoolboy with Wittgenstein's *Tractatus*, frequented coffeehouses where the Circle met, and, as a student and later professor at the University of Vienna, studied and worked in the same environs as the Circle's leaders had. In addition, he edited the collected works of Hans Hahn and was co-curator of the exhibitions *Gödel's Century* and *The Vienna Circle*, held at that university in 2006 and 2015, respectively.

The work under review is a rewritten expansion by Sigmund of his German original, *Sie nannten sich der Wiener Kreis: Exaktes Denken am Rand des Untergangs* (They Called Themselves the Vienna Circle: Exact Thinking on the Brink of Destruction). In the final stages of its preparation he was assisted by Douglas Hofstadter, who also contributed a short Preface. The result is an absorbing account, written in an informal and engaging style, that provides detailed portraits of a diverse group of thinkers brought together to discuss matters of common philosophical interest through the mediation of the Circle's leader, Moritz Schlick.

Around 1910 such discussion circles, focused on the works of particular thinkers or artists and led by prominent scholars and reformers, were quite common in Vienna. What became the Vienna Circle began inauspiciously as a small group of newly minted PhDs, members of the Philosophical Society of Vienna, who gathered for discussions in the city's coffeehouses. As Sigmund notes, "little

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Figure 1. Karl Sigmund, pictured here outside the University of Vienna, grew up in the shadow of the Vienna Circle.

is known" about that short-lived *Urkreis* except that its main participants were Otto Neurath, Phillip Frank, and Hans and Olga Hahn. According to Frank, although their interests ranged widely, their principal concern was to effect a *rapprochement* between philosophy and the natural and social sciences. Their outlook was anti-metaphysical, influenced by the views of the physicists Ernst Mach and Ludwig Boltzmann, both of whom, later in their careers, had taught philosophy at the University.

The members of the *Urkreis* soon dispersed. Hahn left Vienna to take up a position in Czernowitz; Frank was appointed to a professorship in Prague; and, after marrying Olga Hahn in 1912, Neurath moved about between Vienna, Leipzig, Heidelberg, and Munich. World War I, however, brought Hahn and the Neuraths back to Vienna. Czernowitz fell to the Russians in 1914, forcing Hahn to flee back to Austria-Hungary, where he was drafted into the imperial army. Discharged after being wounded on the Italian front, in 1917 he was appointed to a professorship in Bonn and three years later was offered a chair in mathematics at the University of Vienna. Meanwhile Neurath, because he had served briefly as head of an agency for central economic planning in Munich, was arrested during the turmoil that erupted in Bavaria at the end of the war and, according to Sigmund, "was sentenced to eighteen months in prison for having been an accessory to high treason." Shortly thereafter, though, through the intervention of Austrian Chancellor Karl Renner, he was furtively repatriated to Austria.

In 1922, due in large part to Hahn's lobbying on his behalf, Moritz Schlick was appointed to one of three vacant chairs in philosophy at the University of Vienna. A student of Max Planck, Schlick had become, to use Sigmund's designation, an "evangelist" for Einstein's theory of relativity and was widely respected by both physicists and philosophers. A popular lecturer, he soon attracted a coterie of talented students, among whom were Friedrich Waismann and Herbert Feigl, who persuaded Schlick to organize a private seminar.

Beginning in 1924 the seminar met every second Thursday evening in a small lecture room in the mathematics institute. Attendance was by invitation only and usually involved ten to twenty individuals. Schlick, Waismann, and Feigl, together with the Hahns and Neurath, constituted the core group. Frank often visited from Prague, and Kurt Reidemeister participated briefly before moving to Berlin. Others who joined in included Viktor Kraft, Rudolf Carnap, Edgar Zilsel, Felix Kaufmann, Rose Rand and, somewhat later, Karl Menger and Kurt Gödel (both of whom, after a while, drifted away). Initially the discussions centered on the works of Einstein, Hilbert, and Bertrand Russell. Soon, however, Hahn and Schlick became enthralled by Wittgenstein's *Tractatus Logico-philosophicus*, and the focus of the seminar "shifted from the analysis of sensations to the analysis of language." Not once but twice the *Tractatus* was dissected line by line in the sessions of the Schlick Circle, whose slogan (with unwitting irony) became the final sentence of that work: "*Wovon man nicht sprechen kann, darüber muss man schweigen*" (Whereof one cannot speak, thereof one must be silent).

Wittgenstein himself played cat and mouse with the Circle. For though he talked privately with Schlick and certain others in the group, he insisted that his own views not be regarded as aligned with theirs; and, for their part, some members of the Circle, especially Gödel and Menger, did not have high regard for Wittgenstein's ideas. On that and on many other issues the participants engaged in heated debates. In Sigmund's words, "In no way was the Circle the intellectual collective that a few of its members had hoped it would become … . It teemed with vociferous controversies … . How can it be otherwise when philosophers meet?"

Wittgenstein … played cat and mouse with the Circle.

The Schlick Circle first sought publicly to promulgate "the scientific worldview" in November 1928, when Schlick, Hahn, Carnap, and Neurath organized the Ernst Mach Society in Vienna. The manifesto that gave the group the name by which it would henceforth be known was then issued the following September at a conference of mathematicians and physicists in Prague. It declared that the aim of the Circle was the unification of science through a collaborative effort to clarify the meaning of scientific assertions.

The scientific worldview it advocated was not, it said, characterized by particular theses, but rather by a "basic attitude, point of view and methodology." In particular, the scientific worldview was distinguished by two fundamental tenets: that all knowledge is empirical, resting on what is directly given to us through our senses; and that the meaning of scientific assertions is to be determined through logical analysis. Thus, no matter to what branch of science an assertion may belong, its meaning must be elucidated by tracing the concepts employed in it back through a stepwise regression of simpler concepts to concepts at the most basic level, which themselves refer to what is given to us directly through sense perception.

Authored by Hahn, Carnap, Neurath, Feigl, and Waismann, the manifesto was intended as a tribute to Schlick on his return from a summer spent at Stanford. But Schlick was not consulted about it and was not pleased with its dogmatic and self-promotional tone. Nevertheless, the pamphlet achieved its aim of drawing widespread attention to the Circle's ideas, whose subsequent impact on the philosophy of science extended through much of the remaining years of the twentieth century.

It was fortunate that the manifesto appeared when it did, as the Circle itself continued to function for less than a decade afterward—in part due to the rising tide of fascism and anti-Semitism, which precluded Jews and anyone with socialist or pacifist leanings (such as Carnap, Neurath, and Zilsel) from finding an academic appointment; in part due to conflicts between members themselves (especially Schlick and Neurath); and in part to a series of fortuitous events. Schlick suspended meetings of the Circle in the winter of 1933 because he felt that "some of [its] elder members [had] become too dogmatic and could discredit the whole group." Sessions resumed in the fall of 1934, but by then the Ernst Mach Society had been disbanded by police order, as a consequence of the civil war that broke out in February 1934; Neurath, to escape arrest in its aftermath, had emigrated to the Netherlands; and Hahn had died unexpectedly of stomach cancer in July. In 1935 Carnap emigrated to America, and the following year, on his way to the final lecture of the summer term, Schlick was assassinated on the Philosophers' Staircase in the main building of the University of Vienna (Figure 2) by Johann Nelböck, a psychopathic former doctoral student who had stalked Schlick for years.

Most of those who could escape the coming Anschluss *did.*

In the wake of Schlick's death a few more sessions of the Circle were held in the apartments of Waismann, Zilsel, and Kraft. But soon, most of those who could escape the

Figure 2. "Moritz Schlick, central figure of the Vienna Circle, was murdered on this spot on June 22, 1936. A spiritual climate poisoned by racism and intolerance contributed to the act." (Translation of German inscription on the University of Vienna staircase.)

Figure 3. Dawson with Franz Alt, a member of Karl Menger's mathematical colloquium, who emigrated to the United States in 1938.

coming *Anschluss* did: Menger to Notre Dame in 1937, Waismann to Cambridge in 1938, and Zilsel to England that year and to America the next. Feigl had emigrated to America in 1931, and Gödel finally did so in 1940, at almost the last opportunity. Only two of the original members of the Circle managed to live through the war years in greater Germany: Reidemeister and Kraft.

Synopses of the later careers of all those figures are given in Sigmund's book, along with those of the principal participants in the mathematical colloquium that Karl Menger established in 1929 at about the time that he and Gödel became disaffected with the Schlick Circle's fixation on Wittgenstein. In addition to Menger and Gödel, prominent members of that colloquium were Georg Nöbeling, Abraham Wald, Franz Alt (Figure 3), and Olga Taussky. Like the Schlick Circle, Menger's colloquium was founded at the request of students, and it too dissolved not long after its leader was gone. Taussky moved to England in 1935, and both Alt and Wald emigrated to the United States in 1938. Nöbeling, in contrast, moved to Erlangen in 1933, where he accommodated to the Third Reich and in 1940 was appointed a professor at the university there.

Of the Schlick Circle's principal figures, Herbert Feigl was the last to die, in 1988; the longest-lived was Viktor Kraft, who died in 1975 at age 94. Two members of Menger's colloquium, however, lived on into the twenty-first century and died at age 100: Nöbeling in 2008 and Alt in 2011.

A review such as this can only hint at the wealth of detail contained in Sigmund's book. The achievements of the Circle as a group and of its members as individuals deserve such an accounting, and the book's title, with its allusion to *Götterdämmerung*, makes clear the relevance of the Circle's history to America today, where the scientific worldview and rational thinking in general is once again under assault by an extreme right-wing establishment.

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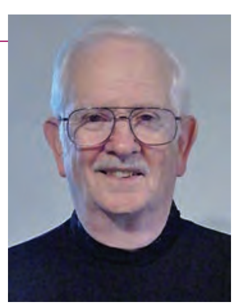

John W. Dawson Jr.

ABOUT THE REVIEWER

One of the editors of Kurt Gödel's *Collected Works*, **John W. Dawson Jr.** is the author of *Logical Dilemmas: The Life and Work of Kurt Gödel* (A.K. Peters, 1997) and *Why Prove it Again? Alternative Proofs in Mathematical Practice* (Springer, 2015). Apart from his mathematical endeavors he is an avid amateur mycologist.

Mathematics Education as a Mathematician's Research Area: An Invitation for Collaboration

Cynthia O. Anhalt and Ricardo Cortez

The current climate around mathematics education research is collaborative.

Mathematicians have made significant contributions to mathematics education, especially at the college level. It is natural for mathematicians in academia to develop effective ways of teaching mathematics. The projects that tend to have more impact are those informed by current research based on established theoretical frameworks. Here, we make a case for more mathematicians to get involved in K–16 education research in collaboration with mathematics educators. While there have been many calls for mathematicians to get involved in mathematics education, especially in teacher preparation,[1] our interest is in promoting collaborative research. Mathematics education is a distinct discipline that mathematicians can study systematically in the same way mathematics is used to understand current research questions in the physical and social sciences. This involves becoming familiar with the body of work that has led to the current questions. Hyman Bass (2005) argued that "the first task of the mathematician who wishes to contribute [to mathematics education] is to understand sensitively the domain of application, the nature of its mathematical problems, and the forms of mathematical knowledge that are useful and usable in this domain" (p. 418). The current climate around mathematics education research is collaborative and inviting of synergistic partnerships. We hope to motivate research mathematicians to establish collaboration with mathematics education researchers. We also describe some issues of current importance where such collaborations are needed.

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[1]*See, for example, the CBMS MET II Report (*https://bit.ly/2q7ZMee*) and the* Notices *special issue (*https://bit.ly/2IulZd2*).*

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Benefits to be Gained from Collaborations

The field of mathematics education is both a research discipline and an area of practical application. From a practical point of view, teaching at any level, from preschool to graduate, involves teacher/instructor flexibility in knowledge of age-appropriate pedagogy and varying content matter. Learning mathematics can differ significantly at the various levels due to the nature of human cognitive development, learning environments, and social contexts. It is within these settings that the research in mathematics education takes place. Research topics may include a focus on how students make sense of certain content or the dynamics of group work.

Social aspects include tensions between agents of change and those who resist it and issues of inclusion, equity, and access. The need for inclusion of traditionally underserved students invites further research. Mathematics education would benefit from collaborative research between mathematics educators and mathematicians.

Developing a Collaboration

The authors of this article collaborate on research projects related to mathematical modeling in K–12 education. This collaboration started through a series of collegial discussions at the 2012 annual conference of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) during a session on the added demands on the K–12 curriculum by the Common Core State Standards. One demand was to make mathematical modeling part of the K–12 curriculum; yet most teachers are not exposed to mathematical modeling in their preparation or professional development.

As a mathematics educator, Cynthia was interested in how mathematical modelers negotiate specific problems and what prompts the decisions they make. As a mathematician whose research involves mathematical modeling, Ricardo was curious about how mathematical modeling should be integrated in K–12 and how teachers develop competency on a topic. In follow-up conversations we began to see that we brought incomplete but complementary knowledge of a topic that we both considered important.

We brought incomplete but complementary knowledge of a topic.

We focused on the specific questions: In what ways can prospective teachers build competency in mathematical modeling? Could carefully designed modeling modules inserted into various courses of a teacher preparation program be effective? These served as motivation to look into what was known on the topic and how we could design a research project that would provide insight. We have conducted several research projects with undergraduate mathematics majors preparing to become teachers in developing mathematical modeling competency with an added layer for teaching mathematical modeling. Our initial project (Anhalt & Cortez 2016) was to design and implement a module of about six 75-minute class periods on the mathematical modeling process that included several modeling tasks given as contextual situations without suggesting predetermined models. We implemented the module in a pedagogy course whose students had no previous experience with mathematical modeling. The study was on a small scale but nevertheless encouraging. By the end, all of the prospective teachers had an accurate understanding of mathematical modeling as distinct from other types of "modeling" done by teachers (such as modeling an algorithmic procedure or using manipulatives as models). Furthermore, half of the prospective teachers showed an improved ability to articulate clearly that modeling is more than problem solving, involving assumptions and validation.

Another study (Anhalt, Cortez, & Been Bennett, 2018) focused on the particular competency of making appropriate assumptions to construct a model. We designed problems that required multiple assumptions and analyzed students' work and their reflections on their work to determine when during the modeling process assumptions were made. We expected to find that assumptions were made mostly before the model was constructed; however, the analysis revealed that students continued to make assumptions through the formulation and solution phases of their modeling process. It also became clear that some assumptions were made to simplify the situation context while others were made to simplify the mathematical model. Figure 1 shows the modeling process that the students described, and it illustrates the results of our study using color-coded curves. These results help us understand the thought process carried out by the students engaged in mathematical modeling.

Initiating Collaborative Work

Initial ideas for collaborative work may stem from reaching out to colleagues; reading articles in mathematics education journals such as *Mathematics Teaching and Learning*, *Journal of Research in Mathematics Education*, or *Journal of Mathematics Teacher Education*; or attending targeted conferences and workshops. One specific opportunity for mathematicians to get introduced to the mathematics education research community is the series

Figure 1. Schematic of the progressive modeling cycle experienced by prospective teachers, Anhalt, Cortez, & Been Bennett, 2018.

of annual workshops, *Critical Issues In Mathematics Education (CIME)*, that takes place at the Mathematical Sciences Research Institute (Figure 2). The purpose of these workshops is to engage mathematicians, mathematics education researchers, and K–12 teachers in learning about research and ongoing projects across the nation. Through presentations, breakout sessions, and discussions, partic-

Figure 2. Meetings such as this 2018 CIME Workshop at MSRI provide opportunities for mathematicians to get introduced to the mathematics education research community.

ipants begin to see where contributions can be made and how to leverage expertise to resolve issues in mathematics education. The workshops provide opportunities for participants to learn about development efforts that can enhance their own work related to course development, research, teaching, and assessment in K–16 education. Many research ideas are offered during the workshops, and it is up to the individuals to further develop newly established connections into collaborations.

The last two CIME workshops have focused on ways of transforming the mathematics education system to remove inequities that result in inadequate mathematical preparation of a significant proportion of students, most of them from minority populations. The theme of the upcoming 2019 workshop is mathematical modeling in K–16 and will include discussions on how to effectively teach and learn modeling, the importance of context in modeling tasks, and the level of preparation and role of mathematicians, teacher educators, and teachers as partners in this endeavor.

Other meetings that have a growing strand in mathematics education include the Joint Mathematics Meetings, the MAA MathFest, and the biennial conference of the SIAM Applied Mathematics Education activity group,[2] which encourages faculty and graduate students in mathematics and mathematics education to become engaged in collaborative efforts.

Other useful resources include MAA reports on college-level programs aimed at mathematics departments to help adapt their undergraduate curricula to the widening mathematics landscape. The *Curriculum Guide to Majors* report, for instance, offers recommendations on content and cognitive matters and includes issues of pedagogy, access, technology, articulation, placement, and diversity. The recommendations can be considered a seed for research projects.

These professional settings provide opportunities for collegial conversations in which mathematicians can learn about mathematics education research methodology, and mathematics educators can broaden their mathematical perspectives. Mathematics education research can be enhanced through a community that involves research mathematicians who are willing to "bring valuable mathematical knowledge, perspectives, and resources to the work of mathematics education" (Bass 2005, p. 430).

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Critical Issues in Mathematics Education (CIME) Workshops at the Mathematical Sciences Research Institute (MSRI), (https://www.msri.org/web/msri/education/for-k-12-educators/critical-issues).

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[2] https://www.siam.org/activity/ed.

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Ricardo Cortez's research is in computational methods for biological fluid dynamics and in mathematical modeling.

Ricardo Cortez

Cynthia Oropesa Anhalt's research is in secondary mathematics teacher education with emphasis in mathematical modeling and issues of equity.

Cynthia O. Anhalt

International Collaboration through the Volunteer Lecturer Program

Padmanabhan Seshaiyer

Communicated by Harriet Pollatsek

ABSTRACT. I describe an international program in which faculty teach intensive mathematics courses at the advanced undergraduate or master's level in a developing country. I also describe the impact on me and on the scientific and professional growth of other faculty and students over the last several years.

In the spring of 2011, I was selected for the Volunteer Lecturer Program (VLP) administered through the Commission for Developing Countries (CDC) of the International Mathematical Union to serve at the Nelson Mandela African Institute of Science and Technology in Arusha, Tanzania. I was invited to provide a 4-week intensive course on numerical analysis and mathematical modeling for graduate students.

The CDC identifies mathematicians interested in contributing to the education of young mathematicians in the developing world. It maintains a VLP database [1] listing each mathematician's curriculum vitae, areas of mathematics, language abilities, typical dates of availability, and previous experience. The CDC also identifies appropriate universities and mathematics degree programs in the developing world. VLP lecturers offer 3- to 4-week mathematics courses in topics at the advanced undergraduate and graduate levels. Two main objectives of the VLP are to build capacity in mathematics and mathematics education in developing countries and to increase interaction between the mathematical community in the developed world and the vast, mostly untapped reservoir of mathematical talent in the developing world. The program receives financial support from the American Mathematical Society, the National Academy of Sciences, and the Abel Board.

Figure 1. When my students failed to arrive, I began my work at the Mandela Institute teaching the teachers.

The involvement of US mathematicians in the VLP began with an appeal from the AMS to US mathematics department chairs. From 2009 to 2014, US mathematicians delivered at least 21 intensive short courses for graduate programs at universities in seven countries in Asia, Central America, and Africa. More details about the VLP and how to apply can be found at their website [1].

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COMMUNICATION

My Personal VLP Experience

The program gave me a great opportunity to learn from faculty and students at Mandela Institute, and I had to be ready for unexpected challenges. Challenges in the developing world can involve communication, governmental protocols, availability of electricity, students' lack of background knowledge, and many more. I came to appreciate Albert Einstein's statement, "The measure of intelligence is the ability to change." Let me explain.

When I landed in Arusha on the Wednesday prior to my beginning week of teaching, the Deputy Vice Chancellor for Research received me. I enjoyed a warm welcome and was happy to learn that I was their first visiting lecturer from the US. The first cohort of students was supposed to arrive that weekend to start classes on the following Monday. My excitement only lasted for a day, until I found out that the government had to postpone the start date of the university by two months, so the students would arrive after my departure, and the situation was out of the university's control. So there I was in Arusha, Tanzania, not knowing what to do for the next four weeks. But I did not give up hope. I learned that the entire NM-AIST faculty, who were both master's and doctoral degree holders from various disciplines, were already working on campus. So the then Vice-Chancellor (equivalent to the President of a US institution) Prof. Burton Mwamila and I decided to create a *Train the Trainers* program, as he felt that all of his faculty needed both mathematical training and professional development. Besides providing them a good exposure in numerical analysis and mathematical modeling, I offered several faculty development workshops on leadership, curriculum development, project management, academic affairs, and best practices for institutional transformation. So my first university students were many of the faculty, who were very happy to be a part of my VLP (see Figure 1).

My Second Visit

The relationship that I developed with the institute as well as the collaboration with faculty and some other activities were very valuable, and I was encouraged to visit the Mandela Institute again as their 2012 VLP lecturer. This time, they already had students. I developed an introductory mathematical modeling and scientific computing course employing MATLAB and OCTAVE, which all future incoming students were expected to take in the first semester. I also created a detailed course guide in the form of a textbook for the faculty. Responding to requests from students and faculty, I gave lectures on creating effective research proposals and helped many students to come up with focused research topics for their masters or PhD. Figure 2 shows a session with three first-year students in my office to learn to program numerical methods for their group project. I was happy to engage the students in interdisciplinary collaborative research opportunities that helped to promote their awareness of the applications of mathematics to solve problems of national importance in areas such as agriculture, food-security, bio-diversity, mobile-medicine, e-learning, disease modeling and prevention, waste management, water resources, and fish harvesting. The university at the same time appointed me to an adjunct professorship, so I was able to direct students and work with the institution on joint proposals.

Figure 2: I taught first-year graduate students to program numerical methods for their group project.

The VLP experience also gave me the opportunity to help Tanzania win their first ever Partnership for Enhanced Engagement in Research (PEER) Science grant. PEER Science is a competitive grants program that invites scientists in developing countries to apply for funds to support research and capacity-building activities on topics of importance to the United States Agency for International Development. The grant is coordinated in partnership with many other agencies in the US, including NASA, NIH, NOAA, NSF, USDA, USGS, and the Smithsonian Institution. My work with Tanzania researchers was a perfect fit for this program and led to the country applying for and winning the PEER Science award in phase 2 of the program, which was administered by the National Academies. The program included me as the US collaborator on creating a new PEER Science research program on Computational Mathematics, Modeling and Analysis of Biological, Bio-inspired and Engineering Systems.[1] The project has helped to increase STEM capacity in Tanzania through research in food security, environment, education, water, and global health. Through these projects, the participants were able to work directly with governmental agencies in Tanzania to collect data that helped to validate their computational model and to create better infrastructure. The project

Figure 3: Graduate students worked with government agencies in Tanzania on their model for better infrastructure (2013).

[1] sites.nationalacademies.org/PGA/PEER/PEERscience/PGA_084056.

offered support to more than 20 graduate students who went on to pursue their masters or PhD degrees (see Figure 3). This has not only been a huge achievement for NM-AIST and Tanzania, but also has helped the Tanzanian government make informed health, educational, and public policy decisions in the country.

Tracking poachers

The collaborations and partnerships that the VLP helped to establish have led to several research and outreach initiatives. In 2015, I led a group of researchers including faculty, graduate and undergraduate students, and high school teachers and students from the US and Tanzania investigating the problem of poaching of elephant tusks and rhino horns. The team identified observation by drones as a solution. The research required them to understand mathematically modeling drone dynamics. Moreover, to find poachers, we proposed using a Bayesian framework as the search pattern continues through the evolution of a belief function. This function was generated through a sequence of observations that allowed for the computation of individual belief probabilities to iteratively identify target locations. This project went on to be one of the 60 projects selected from hundreds of applications to be showcased at the Council on Undergraduate Research Posters on the Hill event in Washington, D.C. in 2016 [2, 3]. My VLP student Erick Massawe (Figure 4) is completing his PhD work on developing intelligent tracking systems to stop poaching.[2] Currently, I am directing another PhD student at the institute, who was a part of a VLP program to develop a mathematical model addressing health risks associated with alcoholism in the presence of religious beliefs in Tanzanian communities. Several of these projects involve mathematical modeling and solutions to systems of coupled non-linear differential equations taught in the VLP course [4, 5].

Figure 4. My VLP student Erick Massawe (right) talks with me about tracking poaching as Vice-Chancellor Mwamila (center) looks on.

How the Program Changed Me

This VLP opportunity helped me to create successful pathways for teaching, research, and service for both US mathematicians and their counterparts in the developing world. Many VLP lecturers like me mentor their students and supervise their MS theses during their visits. Some of them continue these tasks through weekly or monthly virtual meetings after they return to the US. Helen Tyler (Manhattan College), one of the volunteers in Cambodia, said:

> *I have learned so much from my interactions with the Cambodian mathematical community. The students have been the hardest working and hungriest that I have ever taught. And it is possible that I have learned even more from them. At home, my students have become almost too familiar; I am rarely asked a question that I have not been previously asked. But here my students come to the material with a different set of skills, some even stronger than my students at home. And so I feel more present during my lectures here than I often do in the United States. I am more sharply focused on how the students react to the material and to how I present it. I am certain that the experience has made me a better teacher, both here and at home.*

The VLP program has definitely transformed my academic career as it has given me the opportunity to engage in an educational philosophy that promotes development of life-long learning skills including communication, collaboration, critical thinking, and creativity through mathematics. It has continued to help me to practice and preach about finding the mathematics to solve a given real-world problem rather than looking for a real-world problem to apply the mathematics. I currently have students working on poaching in Africa; Zika prevention strategies in Ecuador; the spread of gangs in Puerto Rico; the social dynamics of adults and children involved in trafficking between Latin America, Mexico, and the US; modeling spread of waterborne diseases in networks in India; and identifying landmines in Colombia.

[2] *See the Mathematical Moment on "Thwarting Poachers"* www.ams.org/publicoutreach/mathmoments/mm122-poaching-podcast.

COMMUNICATION

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ABOUT THE AUTHOR

Padhu Seshaiyer

Padhu Seshaiyer's research interests are in computational mathematics, scientific computing, computational biomechanics, and STEM education. He has initiated and directed a variety of educational programs including graduate and undergraduate research, K–12 outreach, and teacher professional development. He serves as the chair of the Diversity Advisory Committee for the Society for Industrial and Applied Mathematics.

Mathematics Opportunities

Listings for upcoming math opportunities to appear in Notices *may be submitted to* `notices@ams.org`*.*

American Mathematical Society Centennial Fellowship

Invitation for Applications for Awards for 2019–2020

Deadline December 1, 2018

Description: The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Society supplements contributions as needed. At least one fellowship will be awarded for the 2019–2020 academic year. A list of previous fellowship winners can be found at `www.ams.org/profession/prizes-awards/ams-awards/centennial-fellow`.

Eligibility: The eligibility rules are as follows: The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or NSF Postdoctoral fellowship. Under normal circumstances, the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award (that is, received between September 1, 2007, and September 1, 2016). Applications will be accepted from those currently holding a tenured, tenure track, postdoctoral, or comparable (at the discretion of the selection committee) position at an institution in North America. Applications should include a cogent plan indicating how the fellowship will be used. The plan should include travel to at least one other institution and should demonstrate that the fellowship will be used for more than reduction of teaching at the candidate's home institution. The selection committee will consider the plan, in addition to the quality of the candidate's research, and will try to award the fellowship to those for whom the award would make a real difference in the development of their research careers. Work in all areas of mathematics, including interdisciplinary work, is eligible.

Deadline: The deadline for receipt of applications is **December 1, 2018**. The award recipient will be announced in February 2019 or earlier, if possible.

Application information: Find Centennial application information at `www.ams.org/ams-fellowships/`. For questions, contact the Professional Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; prof-serv@ams.org; 401-455-4096.

—AMS Professional Programs Department

Call for Nominations for the Henri Poincaré Prize

The Henri Poincaré Prize is awarded to three individuals every three years at the International Congress of Mathematical Physics. Nominations are due by **September 30, 2018**. The one-page nomination, with a recent CV of the nominee and a proposed citation, should be sent to `secretary@iamp.org`. For more information, see `www.iamp.org`.

—From an International Association of Mathematical Physics announcement

Ford Foundation Fellowships

Ford Foundation Fellowships, created to support diversity, are for US citizens or nationals committed to a career in teaching and research at the college or university level. Predoctoral Fellowships will provide three years of support for individuals engaged in graduate study leading to a PhD or ScD degree (deadline **December 13, 2018**), Dissertation Fellowships will provide one year of support for individuals working to complete a dissertation leading to a PhD or ScD degree (deadline **December 6, 2018**), and Postdoctoral Fellowships will provide one year of support for individuals engaged in postdoctoral study after the attainment of the PhD or ScD degree (deadline **Decem-**

ber 8, 2018). See sites.nationalacademies.org/pga/fordfellowships/, or contact infofell@nas.edu.

—From the Ford Foundation Fellowships website

AWM Travel Grants for Women

The National Science Foundation (NSF) and the Association for Women in Mathematics (AWM) sponsor travel grant programs for women mathematicians. AWM Travel Grants for Women Researchers enable women to attend research conferences in their fields. AWM Mathematics Mentoring Travel Grants are designed to help junior women develop long-term working and mentoring relationships with senior mathematicians. See https://sites.google.com/site/awmmath/programs/travel-grants for application materials and deadlines, or email: awm@awm-math.org.

—From an AWM announcement

Call for Nominations for Clay Research Fellowships

The Clay Mathematics Institute solicits nominations for Clay Research Fellowships. Fellows are appointed for a period of one to five years. They may conduct their research at whatever institution or combination of institutions best suits their research. In addition to a generous salary, the fellows receive support for travel, collaboration, and other research expenses. The deadline for nominations is **November 16, 2018**. For more information, see www.claymath.org/programs/fellowship-nominations.

—From a Clay Mathematics Institute announcement

2018 SACNAS Conference

The Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) 2018 National Diversity in STEM Conference, to be held October 11–13, 2018, in San Antonio, Texas, provides three days of cutting-edge science, training, mentoring, and cultural activities for students and scientists at all levels. In particular, there will be programs and mentoring in mathematics. For more information, including travel support, see the conference home page: https://tinyurl.com/ya2e9xwg.

—From a SACNAS announcement

Field of Dreams Conference

The National Alliance for Doctoral Studies in the Mathematical Sciences is pleased to announce the Eleventh Annual Mathematical Field of Dreams Conference, to be held November 1–4, 2018, in St. Louis, Missouri. The conference brings together faculty in the mathematical sciences with students from backgrounds underrepresented in those fields. To learn more and register, visit: https://mathalliance.org/field-of-dreams-conference/2018-field-of-dreams-conference/.

—From a Math Alliance announcement

News from CIRM

The Centro Internazionale per la Ricerca Matematica (CIRM) will hold a series of conferences and mathematical meetings and a program of Research in Pairs for 2019. Proposals for conferences must be submitted before **September 30, 2018**. See the website cirm.fbk.eu/conferences. The Research in Pairs program is for two or three partners to work together at CIRM on specific research projects. Applications should be submitted at least three months before the planned stay. See the website cirm.fbk.eu/research-pairs.

—Marco Andreatta, CIRM

Call for Program Proposals

The Mathematical Sciences Research Institute (MSRI) invites the submission of proposals for full- or half-year programs to be held at MSRI. Planning of such programs is generally done about three years ahead. Except in extraordinary cases, a subject is the focus of a program not more than once in ten years.

The Scientific Advisory Committee (SAC) of the Institute meets in January, May, and November each year to consider proposals for programs. The deadlines to submit proposals of any kind for review by the SAC are **March 1**, **October 1**, and **December 1**. Please see our website for specific proposal requirements and further information: www.msri.org/proposal.

MSRI also invites the submission of proposals for *Hot Topics Workshops* and *Summer Graduate Schools*.

—From an MSRI announcement

NEWS

Call for Proposals for the 2020 AMS Short Courses

The AMS Short Course Subcommittee invites submissions of preliminary proposals for Short Courses to be offered on January 13–14, 2020, in coordination with the 2020 Joint Mathematics Meetings in Denver, Colorado. Members of the mathematical community are also welcome to suggest names of colleagues as potential organizers.

Preliminary proposals may be as short as one page, and suggestions and questions are welcome. Proposals should be sent via email to the Associate Executive Director (aed-mps@ams.org) with a cc to Robin Hagan Aguiar (rha@ams.org).

A short course typically incorporates a sequence of survey lectures and other activities focused on a single theme of applied mathematics. The Subcommittee is also interested in proposals that go beyond the traditional course in methodology and subject matter. Proposers might be interested in a webinar format or other mechanisms for reaching an audience that extends beyond those at the JMM site, or they may want to appeal to mathematicians who are considering careers in business, industry, government, and nonprofit sectors that utilize mathematical training and experience.

For full consideration, 2020 Short Course proposals should be submitted by **December 18, 2018**. More detailed guidance on proposals is available at www.ams.org/meetings/short-courses/2019call.

Luis Caffarelli Awarded Shaw Prize

The Shaw Foundation has announced the awarding of the 2018 Shaw Prize in Mathematical Sciences to Luis Caffarelli of the University of Texas at Austin "for his groundbreaking work on partial differential equations, including creating a theory of regularity for nonlinear equations such as the Monge–Ampère equation, and free-boundary problems such as the obstacle problem, work that has influenced a whole generation of researchers in the field."

Luis Caffarelli.

The Shaw Foundation's statement reads: "Partial differential equations are fundamental to large parts of mathematics, physics, and indeed all the sciences. They are used to model heat flow, fluid motion, electromagnetic waves, quantum mechanics, the shape of soap bubbles, and innumerable other physical phenomena."

"A few very simple equations can be solved explicitly—that is, one can find an exact formula for their solutions—but this is very much the exception rather than the rule. Instead, one has to be content with being able to show that solutions exist, and with being able to say something about how they behave."

"A very important example of this is the Navier–Stokes equation, which describes the motion of a viscous fluid. It is not known whether, given appropriate initial conditions, there must be a solution to the Navier–Stokes equation that remains well-behaved forever, or whether singularities will necessarily develop. To put it more graphically, if you stir a bucket of water, is there a danger that a week later it will blow up? Probably not, but nobody knows how to prove this, and it is one of the major unsolved problems of mathematics."

"Although it is not known how to solve the Navier–Stokes equations, one can find so-called 'weak solutions,' which are abstract objects that solve the equations, but not in quite the sense one wants. If one could show that these solutions were 'regular,' then the Navier–Stokes problem would be solved. A famous result of Caffarelli, Kohn, and Nirenberg is the closest anybody has come to that: it shows that weak solutions exist that are regular except on a set of singularities that has to be very small, in a precise mathematical sense."

"Another area in which Caffarelli has created a new and highly influential theory is obstacle problems. Here one would like to know the shape that will be taken by an elastic membrane with a given boundary if it has to lie above a certain obstacle. The shape taken will be the one that minimizes its energy, but the important questions concern how well-behaved, or 'regular,' a solution of this kind will be. As with all important problems in partial differential equations, this one arises in many contexts, including fluid filtration in porous media, and financial mathematics."

"In general, because one does not usually have explicit formulae for solutions to partial differential equations, the analysis of their properties is very hard, and depends on extremely delicate estimates. Caffarelli is a master at this, frequently coming up with arguments that have left other researchers wondering how he could possibly have thought of them. He continues to work at the forefront of the field and has had a huge influence, both through his own work and that of his doctoral students, many of whom have themselves become extremely distinguished mathematicians. In a way that few mathematicians achieve even once, he has repeatedly created important areas almost from scratch that are extremely active to this day."

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Biographical Sketch

Luis A. Caffarelli was born in Buenos Aires, Argentina, in 1948. He received his PhD in mathematics in 1972 from the University of Buenos Aires. He joined the University of Minnesota, where he held the positions of postdoctoral fellow (1973–1974), assistant professor (1975–1977), associate professor (1977–1979), and professor (1979–1983). He was professor at the Courant Institute of Mathematical Sciences, New York University, from 1980 to 1982, at the University of Chicago from 1983 to 1986, at the Institute for Advanced Study in Princeton from 1986 to 1996, and at the Courant Institute, New York University, from 1994 to 1997. His awards and honors include the Bôcher Memorial Prize (1984), the Rolf Schock Prize (2005), the Steele Prize for Lifetime Achievement (2009), and the Wolf Prize (with Michael Aschbacher, 2012). He is a Fellow of the AMS, SIAM, and the American Academy of Arts and Sciences and a member of the National Academy of Sciences and the Pontifical Academy of Sciences.

About the Prize

The Shaw Prize is an international award established to honor individuals who are currently active in their respective fields and who have achieved distinguished and significant advances, who have made outstanding contributions in culture and the arts, or who have achieved excellence in other domains. The award is dedicated to furthering societal progress, enhancing quality of life, and enriching humanity's spiritual civilization. Preference is given to individuals whose significant work was recently achieved.

The Shaw Prize consists of three annual awards: the Prize in Astronomy, the Prize in Science and Medicine, and the Prize in Mathematical Sciences. Established under the auspices of Run Run Shaw in November 2002, the prize is managed and administered by the Shaw Prize Foundation based in Hong Kong. The prize carries a cash award of US$1,200,000.

Previous recipients of the Shaw Prize in Mathematical Sciences are:

- János Kollár and Claire Voisin (2017)
- Nigel J. Hitchin (2016)
- Gerd Faltings and Henryk Iwaniec (2015)
- George Lusztig (2014)
- David L. Donoho (2013)
- Maxim Kontsevich (2012)
- Demetrios Christodoulou and Richard S. Hamilton (2011)
- Jean Bourgain (2010)
- Simon K. Donaldson and Clifford H. Taubes (2009)
- Vladimir Arnold and Ludwig Faddeev (2008)
- Robert Langlands and Richard Taylor (2007)
- David Mumford and Wen-Tsun Wu (2006)
- Andrew Wiles (2005)
- Shiing-Shen Chern (2004)

—*Shaw Foundation announcement*

Mathematics People

Ooguri Awarded Hamburg Prize

Hirosi Ooguri

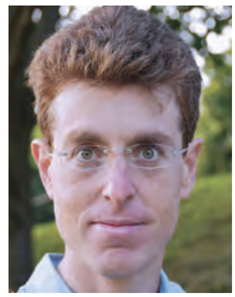
Hirosi Ooguri of the California Institute of Technology has been awarded the 2018 Hamburg Prize for Theoretical Physics for his research involving mathematical superstring theory. According to the prize citation, Ooguri "has succeeded in enabling many physical phenomena to be computed with the aid of string theory. He was able to overcome many of the major mathematical difficulties of string theory. Moreover, Ooguri's research on the quantum mechanics of black holes continues the research of physicist Stephen Hawking."

Ooguri received his PhD from the University of Tokyo in 1989. He has held positions at the University of Tokyo, the University of Chicago, Kyoto University, and the University of California Berkeley before joining the faculty at Caltech. His awards and honors include the AMS Eisenbud Prize (2008, with Andrew Strominger and Cumrun Vafa), a Humboldt Research Award (2008), the Nishina Memorial Prize (2009), a Simons Investigator Award (2012), the Kodansha Prize for Science Books of Japan (2014), and the Chunichi Cultural Award (2016). He is a Fellow of the AMS and of the American Academy of Arts and Sciences (AAAS). He also served as scientific advisor for a 3D movie, *The Man from the 9 Dimensions*, which tells the story of the quest for the "theory of everything" and which premiered in Tokyo.

The Hamburg Prize is awarded by the Joachim Herz Stiftung in partnership with the Wolfgang Pauli Centre of the University of Hamburg, the German Electron Synchrotron DESY, and the Hamburg Centre for Ultrafast Imaging at the University of Hamburg. The prize carries a cash award of 100,000 euros (approximately US$118,000).

—Elaine Kehoe

Regev Awarded Gödel Prize



Oded Regev

Oded Regev of the Courant Institute of Mathematical Sciences, New York University, has been awarded the 2018 Gödel Prize for his paper "On Lattices, Learning with Errors, Random Linear Codes, and Cryptography," *Journal of the ACM* **56** (2009), no. 6.

The paper introduced the Learning with Errors (LWE) problem and proved its average-case hardness assuming the worst-case (quantum) hardness of various well-studied problems on point lattices in R^n. It also gave an LWE-based public-key encryption scheme that is much simpler and more efficient than prior ones having similar worst-case hardness guarantees; this system has served as the foundation for countless subsequent works. Lastly, the paper introduced elegant and powerful techniques, including a beautiful quantum algorithm, for the study of lattice problems in cryptography and computational complexity. Regev's work has ushered in a revolution in cryptography, in both theory and practice. On the theoretical side, LWE has served as a simple and yet amazingly versatile foundation for nearly every kind of cryptographic object imaginable—along with many that were unimaginable until recently, and which still have no known constructions without LWE. Toward the practical end, LWE and its direct descendants are at the heart of several efficient real-world cryptosystems. Regev tells the *Notices*: "Being a theoretical computer scientist allowed me to have lots of fun collaborations with researchers from a wide range of mathematical areas. I enjoy living near the Washington Square campus of NYU, where it seems one lifetime is not enough to explore all the great restaurants. I regularly go jogging or cycling along the beautiful Hudson River park."

The Gödel Prize includes an award of US$5,000 and is named in honor of Kurt Gödel, who was born in Austria-Hungary (now the Czech Republic) in 1906. Gödel's work has had immense impact upon scientific and philosophical thinking in the twentieth century. The award recognizes his major contributions to mathematical logic and the foundations of computer science.

—From a Gödel Prize announcement

NEWS

Ford Foundation Fellows Announced

The Ford Foundation Fellowship Program has announced the names of 125 scholars who have received predoctoral, dissertation, and postdoctoral fellowships in all areas of scholarship. Two mathematical scientists were among the awardees. Elaina K. Aceves of the University of Iowa received a predoctoral fellowship in mathematics and education. Samniqueka Joi-Weaver Halsey of the University of Illinois Urbana–Champaign was awarded a dissertation fellowship in computational biology. The Ford Foundation Fellowship programs seek to increase the diversity of the nation's college and university faculties by increasing their ethnic and racial diversity, to maximize the educational benefits of diversity, and to increase the number of professors who can and will use diversity as a resource for enriching the education of all students.

—From a Ford Foundation announcement

USA Mathematical Olympiad

The 2018 USA Mathematical Olympiad (USAMO) was held in April 2018. The students who participated in the Olympiad were selected on the basis of their performances on the American High School and American Invitational Mathematics Examinations. The twelve highest scorers in this year's AMO, listed in alphabetical order, were:

- Eric Gan, A&M Consolidated High School, College Station, Texas
- Thomas Guo, Phillips Exeter Academy, Exeter, New Hampshire
- Vincent Huang, Plano West Senior High School, Plano, Texas
- Joshua Lee, Fairfax County Association for the Gifted Middle School, Virginia
- Michael Ren, Phillips Academy, Andover, Massachusetts
- Victor Rong, Marc Garneau Collegiate Institute, Toronto, Ontario, Canada
- Carl Schildkraut, Lakeside High School, Nine Mile Falls, Washington
- Mihir Singhal, Palo Alto High School, Palo Alto, California
- Edward Wan, St. John's School, San Juan, Puerto Rico
- Brandon Wang, Saratoga High School, Saratoga, California
- Guanpeng Xu, Phillips Academy, Andover, Massachusetts
- Andrew Yao, Weston High School, Weston, Massachusetts

The twelve USAMO winners attended the Mathematical Olympiad Summer Program (MOSP) at the University of Nebraska, Lincoln, in June 2018. Ten of the twelve took the team selection test to qualify for the US team. The six students with the highest combined scores from the test and the USAMO became members of the US team and competed in the International Mathematical Olympiad (IMO), held July 3–14, 2018, in Cluj-Napoca, Romania. (The results of the IMO will appear in a future issue of the *Notices*.)

—From Mathematical Association of America announcements

Mathematical Sciences Awards at 2018 ISEF

The 2018 Intel International Science and Engineering Fair (ISEF) was held in Pittsburgh, Pennsylvania, in May 2018. The Society for Science and the Public, in partnership with the Intel Foundation, selects a Best of Category contestant, who receives a cash award of US$5,000; in addition, a US$1,000 grant is given to the student's school and the Intel ISEF Affiliated Fair he or she represents. The student chosen this year in the Mathematical Sciences category was Muhammad Abdulla, West Shore Junior/Senior High School, Melbourne, Florida, for his project "A Fine Classification of Second Minimal Odd Orbits." Abdulla also received the First Award of US$3,000, the Dudley R. Herschbach SIYSS Award in Mathematics, and a trip to observe the Nobel Prize ceremony.

All of the award winners in the mathematical sciences and the titles of their projects follow.

First Award (US$3,000): Muhammad Abdulla, "A Fine Classification of Second Minimal Odd Orbits."

Second Award (US$1,500): Gustavo Santiago-Reyes and Omar Santiago-Reyes, Escuela Especializada en Ciencias, Matemáticas y Tecnología, Caguas, Puerto Rico, for "Mathematics of Gene Regulation: Control Theory for Ternary Monomial Dynamical Systems"; Anna Savelyeva, Moscow State School #57, Moscow, Russian Federation, for "On the Maximum Number of Non-Intersecting Diagonals in Unit Squares Filling an $n*n$ Grid"; and Karthik Yegnesh, Methacton High School, Eagleville, Pennsylvania, for "Braid Groups on Triangulated Surfaces and Singular Homology." Yegnesh was the recipient of the Best in Category and First Awards in the 2017 competition.

Third Award (US$1,000): Chavdar Lalov, Geo Milev High School of Mathematics, Pleven, Bulgaria, for "Generating Functions of the Free Generators of Some Submagmas of the Free Omega Magma and Planar Trees"; Gianfranco Cortes-Arroyo, West Port High School, Ocala, Florida, for "Generalized Persistence Parameters for Analyzing Stratified Pseudomanifolds"; Aleksandr Serdiukov, School 564, St. Petersburg, Russian Federation, for "Combinatorics of Circular Codes"; and Theodore Ehrenborg, Henry Clay High School, Lexington, Kentucky, for "Pythagorean Quintuples and Quaternions."

Fourth Award ($500): Kayson Hansen, Twin Falls High School, Twin Falls, Idaho, for "From Lucas Sequences to Lucas Groups"; Gopal Goel, Krishna Homeschool, Oregon, for "Discrete Derivatives of Random Matrix Models and the Gaussian Free Field"; Rachana Madhukara, Canyon

Crest Academy, San Diego, California, for "Asymptotics of Character Sums"; Adisorn Khantong, Kullanut Booranarom, and Witchaya Natemonprapa, all of Princess Chulabhorn Science High School Phetchaburi, Phetchaburi, Thailand, for "The Polar Equations of Water Distribution from Butterfly Sprinkler Heads"; Melih Sahin, Ankara Fen Lisesi, Turkey, for "Number Patterns and Power-Difference Triangles"; and Bryan D. Gopal, Brophy College Preparatory, Phoenix, Arizona, for "A Novel Accelerator for Machine Learning Algorithms."

A number of special awards were also given at ISEF. Mu Alpha Theta, the National High School and Two-Year College Mathematics Honor Society, honored three students. Anna Savelyeva, Moscow State School #57, Moscow, Russian Federation, received a First Award of US$1,500 for "On the Maximum Number of Non-Intersecting Diagonals in Unit Squares Filling an $n*n$ Grid"; Sacheth Sathyanarayanan, National Public School, Chennai, India, also received a First Award for "Solving a Mathematical Mystery: Schinzel's Conjecture." The Second Award of US$1,000 went to Wyatt Howe, Hershey High School, Hershey, Pennsylvania, for "A Practical Cryptosystem with Provable Security: Three New Innovations in Cryptography."

The National Security Agency Research Directorate awarded a First Mathematics Award of US$1,500 to Bryan D. Gopal, Brophy College Preparatory, Phoenix, Arizona, for "A Novel Accelerator for Machine Learning Algorithms." The Second Mathematics Award of US$750 was given to Franklyn H. Wang, Thomas Jefferson High School for Science and Technology, Falls Church, Virginia, for "Monodromy Groups of Indecomposable Rational Functions." The Honorable Mention Mathematics Awards went to Isha Puri, Horace Greeley High School, Chappaqua, New York, for "A Scalable and Freely Accessible Machine Learning Based Application for the Early Detection of Dyslexia" and to Emil Geisler, Bountiful High School, Bountiful, Utah, for "Combinatorics on Path Connections of a Rectangular Graph." Honorable Mention in Science of Security was awarded to Daniel A. Santiago, Centro Residencial de Oportunidades Educativas de Mayagüez, Anasco, Puerto Rico, for "On the Validity of Composite Logical Functions."

Sigma Xi, the Scientific Research Honor Society, awarded First Physical Science Awards of US$2,000 to Adisorn Khantong, Kullanut Booranarom, and Witchaya Natemonprapa, all of Princess Chulabhorn Science High School Phetchaburi, Phetchaburi, Thailand, for "The Polar Equations of Water Distribution from Butterfly Sprinkler Heads."

The Air Force Research Laboratory gave a First Award of US$750 to Wyatt Howe, Hershey High School, Hershey, Pennsylvania, for "A Practical Cryptosystem with Provable Security: Three New Innovations in Cryptography."

The National Center's Junior Academy of Sciences of Ukraine awarded the UN Sustainable Development Goal Award of US$500 to Yuliia Suprun, Municipal Institution Sumy Specialized School of I–III Levels Named After the Hero of the Soviet Union O. Butko, Sumy, Ukraine, for "A Solution of Generalized Legendre's Equation $Cz^n=Ax^2+By^2$ and Its Application to Cryptography."

—From a Society for Science and the Public announcement

AMS Menger Awards at the 2018 ISEF

Bottom row, left to right: Keith Conrad (committee chair), Rachana Madhukara, Yuta Yokohama, Sota Kojima, Ryusei Sakai. Top row, left to right: Chavdar Lalov, Gianfranco Cortes-Arroyo, Gopal Goel, Savelii Novikov, Boris Baranov. Not pictured: Muhammad Abdulla

The Intel International Science and Engineering Fair (ISEF), which is organized each year by the Society for Science and the Public and is the biggest science competition for precollege students in the world, took place in May 2018 in Pittsburgh, Pennsylvania. Students from the United States and many other countries presented their research projects either as individuals or in teams after being selected from ISEF-affiliated regional science fairs. This year there were fifty-three projects being judged in the mathematics category, on both pure and applied topics.

The American Mathematical Society has presented awards at ISEF since 1988, and they have been named after Karl Menger since 1990. This year, as in recent years, the AMS awarded one first-place prize, two second-place prizes, and four third-place prizes. In addition, five more projects received honorable mentions. The award winners were chosen by the 2018 AMS Menger Prize Committee: Mira Bernstein (Tufts University), Keith Conrad (University of Connecticut), and Andrew Whelan (GKN Driveline). The judges were impressed by the work of many students.

The AMS Karl Menger Memorial Prize winners for 2018 are:

First-Place Award (US$2,000): Sota Kojima, Ryusei Sakai, and Yuta Yokohama, Shiga Prefectural Hikone

Higashi High School, Japan, for "Extension of Soddy's Hexlet: Number of Spheres Generated by Nested Hexlets."

Second-Place Awards (US$1,000): Gopal Goel (Krishna Homeschool, Oregon), "Discrete Derivatives of Random Matrix Models and the Gaussian Free Field" and Rachana Madhukara, Canyon Crest Academy, San Diego, California, "Asymptotics of Character Sums." Goel and Madhukara both received Fourth Awards in the ISEF.

Third-Place Awards (US$500): Muhammad Abdulla, West Shore Junior/Senior High School, Melbourne, Florida, "A Fine Classification of Second Minimal Odd Orbits"; Boris Baranov and Savelii Novikov, School 564, St. Petersburg, Russian Federation, "On Two Letter Identities in Lie Rings"; Gianfranco Cortes-Arroyo, West Port High School, Ocala, Florida, "Generalized Persistence Parameters for Analyzing Stratified Pseudomanifolds"; Chavdar Lalov, Geo Milev High School of Mathematics, Pleven, Bulgaria, "Generating Functions of the Free Generators of Some Submagmas of the Free Omega Magma and Planar Trees." In the ISEF, Abdulla received the Best in Category Award, the First Award, the Dudley R. Herschbach SIYSS Award in Mathematics, and a trip to observe the Nobel Prize ceremony. Cortes-Arroyo and Lalov received Third Awards in the ISEF. Novikov was a second-place Menger Awardee in the 2017 competition.

Honorable Mention Awards: Chi-Lung Chiang and Kai Wang, Affiliated Senior High School of National Taiwan Normal University, Chinese Taipei, "Equal Powers Turn Out—Conics, Quadrics, and Beyond"; Kayson Hansen, Twin Falls High School, Twin Falls, Idaho, "From Lucas Sequences to Lucas Groups"; Dmitrii Mikhailovskii, School 564, St. Petersburg, Russian Federation, "New Explicit Solution to the *N*-Queens Problem and the Millennium Problem"; Gustavo Santiago-Reyes and Omar Santiago-Reyes, Escuela Secundaria Especializada en Ciencias, Matematicas y Tecnología, Caguas, Puerto Rico, "Mathematics of Gene Regulation: Control Theory for Ternary Monomial Dynamical Systems"; Karthik Yegnesh, Methacton High School, Eagleville, Pennsylvania, "Braid Groups on Triangulated Surfaces and Singular Homology." In the ISEF Gustavo and Omar Santiago-Reyes and Yegnesh received Second Awards; Hansen received a Fourth Award.

The Intel ISEF finals next year will be held May 12–17, 2019, in Phoenix, Arizona. See https://student.societyforscience.org/intel-isef. The participation of the American Mathematical Society in ISEF is supported through income from two Karl Menger Funds, established by the family of the late Karl Menger, at Duke University and the AMS. An anonymous donor also generously augemented the AMS fund in 2008 (see www.ams.org/profession/menger-award). For more information or to make contributions to this fund, contact the AMS Development Office, 201 Charles Street, Providence, RI 02904-2294; send email to development@ams.org; or telephone 401-455-4111.

—Mira Bernstein, Tufts University
Keith Conrad, University of Connecticut
Andrew Whelan, GKN Driveline

National Academy of Sciences Elections

The National Academy of Sciences (NAS) has elected its new members and foreign associates for 2018. Following are the new members whose work involves the mathematical sciences.

- Sanjeev Arora, Princeton University
- Andrea L. Bertozzi, University of California Los Angeles
- Igor B. Frenkel, Yale University
- Christopher D. Hacon, University of Utah
- Trevor Hastie, Stanford University
- Peter S. Ozsvath, Princeton University
- Umesh V. Vazirani, University of California Berkeley
- Steven R. White, University of California Irvine
- Mihalis Yannakakis, Columbia University

Elected as foreign associates were:

- Gerd Faltings, Max Planck Institute for Mathematics
- Anastasios Xepapadeas, Athens University of Economics and Business

—From an NAS announcement

2018 Royal Society Elections

The Royal Society of London has elected its class of Fellows for 2018, including the following Fellows whose work involves the mathematical sciences.

- Kevin Costello, Perimeter Institute for Theoretical Physics
- Alexander Philip Dawid, University of Cambridge
- Peter O'Hearn, University College London
- Nancy Reid, University of Toronto
- Adi Shamir, Weizmann Institute of Science (Foreign Member)
- Daniel Wise, McGill University
- Geordie Williamson, University of Sydney

—From a Royal Society announcement

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Photo of Hirosi Ooguri courtesy of Hirosi Ooguri.
Photo of Oded Regev credit Erica Kempe Veltman.
Photo of AMS Menger Award winners courtesy of Society for Science and the Public/Chris Ayers Photography.

Pamela Harris: The Mathematical Rise and Social Contribution of a Dreamer

Ricardo Cortez and Federico Ardila

Originally introduced in 2001, the DREAM Act is legislation intended to provide a pathway toward legal status for eligible undocumented youth, known as Dreamers. In 2012, as this pathway was debated, the Obama administration announced the Deferred Action for Children Arrivals (DACA) policy, which deferred deportation for young people who arrived in the United States as children. However, in September of 2017, the United States Department of Homeland Security announced that no new DACA applications would be accepted. Meanwhile, despite bipartisan support for its various iterations, the DREAM Act has not become law.

One of these young Dreamers is Pamela E. Harris, who emigrated from Mexico to the USA with her family when she was twelve years old. Her parents moved away from their families and friends, and gave up their language and their support system in an attempt to provide better opportunities for their children, particularly in education. This sacrifice became a driving force for Pamela to excel in her studies and make her parents proud of her accomplishments. Living under challenging financial strain at times, she became the first member of her family to graduate from high school. It is difficult to overstate the significance of this milestone for her and for her family; Pamela did not feel she had any more to prove. But she always liked mathematics, she was good at it, and she wanted to go further. Even as a young girl she would ponder about scale, the size of the universe, and infinity. As an adult, her determination to keep learning and her desire to serve her community motivated her to push forward.

Pamela Harris emigrated from Mexico to the United States with her family as a young girl.

Ricardo Cortez is the Pendergraft William Larkin Duren Professor of Mathematics at Tulane University. His email address is `rcortez@tulane.edu`.

Federico Ardila is professor of Mathematics at San Francisco State University, and profesor adjunto at Universidad de Los Andes. His email address is `federico@sfsu.edu`.

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Being undocumented is not something one advertises freely. So, how does a young person in that situation, facing discrimination and numerous structural obstacles, manage to go to college? At the time, there were few educational opportunities available to Pamela. Financial aid applications required documentation that she did not have access to, and it was impossible for her to attend college without financial support. It took some creative form-filling, and hoping that nobody found the inconsistencies in the paperwork, for Pamela to be on her way to the Milwaukee Area Technical College, where she earned two associate degrees. Along the way, her connection to mathematics was reinforced. Her personal life was also blossoming: She married her husband Jamual and started a family of her own.

Subsequently, as a US Resident, she attended Marquette University as an undergraduate and received her master's and PhD degrees from the University of Wisconsin at Milwaukee, while raising her young daughter Akira. Pamela went on to be both a teaching postdoc and a Davies Research Postdoctoral Fellow at the United States Military Academy. Since 2016, she has been an assistant professor of mathematics at Williams College.

Pamela is a prolific researcher with broad interests. Since 2016 she has published or submitted thirty research papers, and received grants from the National Science Foundation and the Center for Undergraduate Research in Mathematics. She constantly seeks out new collaborations, connects different points of view, and builds bridges across disciplines. She has brought together a vibrant community of investigators working together on important problems.

Pamela Harris's research is in algebraic combinatorics, particularly in connection with the representation theory of Lie algebras. For example, in her PhD thesis and subsequent papers, she offered a new perspective on Kostant's formula for the multiplicity of a weight in an irreducible representation of a semisimple Lie algebra. This formula is an impractically large sum over the elements of the corresponding Weyl group. For the classical Lie algebras, Pamela [3] and her collaborators [4] determined that the vast majority of the terms in this sum vanish, and they enumerated the contributing terms; these are rather unexpected results on a central object in mathematics.

Another important contribution is her work [2] on peak polynomials, which enumerate permutations with a given set of peaks. These polynomials were conjectured in [1] to have positive coefficients when written in a binomial basis. Pamela and her collaborators proved the conjecture by devising a clever new way of computing peak polynomials, which transparently implies their positivity.

In addition to her outstanding research trajectory, Pamela has an unwavering commitment to her communities. She has worked with more than 25 undergraduate students on research projects and is looking forward to being the research leader for the MSRI Undergraduate Program in 2019. She has led efforts to secure funding for mathematics sessions and for student travel scholarships for the Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conference. She has organized multiple speaker series and conferences with a focus on underrepresented minorities, and co-founded `lathisms.org`, a website and calendar that highlights the research and mentoring contributions of Latinxs in mathematics. By excelling as a researcher, teacher, and advocate for positive change in the mathematical community, Pamela Harris serves as an inspiring example to the next generation of young mathematicians. [5]

Pamela Harris's extraordinary research program and service work are not only deep and meaningful, they also exemplify the talent, drive, and leadership of Dreamers in the United States and their tremendously important professional and social contributions.

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[2] Diaz-Lopez, A., Harris, P. E., Insko, E., & Omar, M., A proof of the peak polynomial positivity conjecture. *J. Combinatorial Theory*, Series A **149** (2017), 21–29. MR3620729

[3] Harris, P. E., On the adjoint representation of $\mathfrak{sl}_n$ and the Fibonacci numbers *C. R. Math. Acad. Sci. Paris* **349** (2011) pp. 935–937. MR2838238

[4] Harris, P. E., Insko, E., & Williams, L. K., The adjoint representation of a classical Lie algebra and the support of Kostant's weight multiplicity formula. *J. Combinatorics* **7**(1) (2016), 75–116. MR2838238

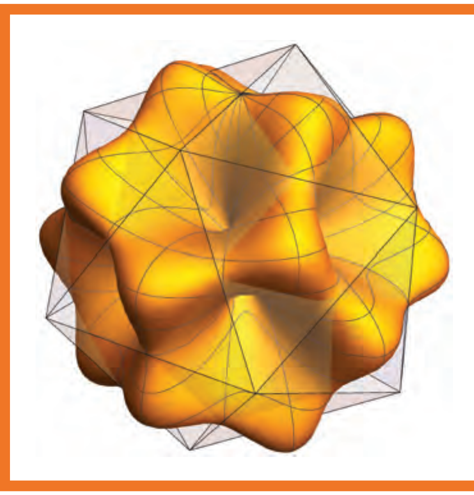
[5] Strength in Numbers. Williams College Web site. Available at: `https://www.williams.edu/feature-stories/strength-in-numbers`. Accessed June 25, 2018.

Photo Credit

Photo of Pamela Harris courtesy of Cesar E. Silva.

AMS SHORT COURSE

Sum of Squares: Theory and Applications



January 14–15, 2019, Baltimore, MD

(in conjunction with the Joint Mathematics Meetings)

The American Mathematical Society's Short Courses connect mathematicians and students to emergent areas of applied mathematics through a series of survey lectures and activities. Short Courses are designed to introduce state-of-the-art research to a non-specialist audience, fueling their curiosity, discovery, and research.

In 2019, the Short Course lecturers focus on the theory and application of sums of squares (SOS) polynomials. These applications span a wide spectrum of mathematical disciplines from real algebraic geometry to convex geometry, combinatorics, real analysis, theoretical computer science, quantum information and engineering.

Course Organizers:

Pablo A. Parrilo, *Massachusetts Institute of Technology*
Rekha R. Thomas, *University of Washington*

Lecture Topics:

Overview of SOS polynomials,
Greg Blekherman, *Georgia Institute of Technology*

Lifts of Convex Sets,
Hamza Fawzi, *University of Cambridge*

Engineering Applications,
Georgina Hall, *Princeton University*

Theoretical Computer Science,
Ankur Moitra, *Massachusetts Institute of Technology*

Algebraic Geometry,
Mauricio Velasco, *Los Andes University*

Geometry of Spectrahedra,
Cynthia Vinzant, *North Carolina State University*

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Inside the AMS

Storm Surge Models on Display at Capitol Hill Exhibition

Professor Talea L. Mayo (r) and Cindi-Ann Findley (l), University of Central Florida.

The AMS sponsored an exhibit at the twenty-fourth annual Coalition for National Science Funding (CNSF) Exhibition and Reception on Capitol Hill held on May 9, 2018. Professor Talea L. Mayo, University of Central Florida, presented "Beyond Coursework: Extending a Successful Model for Building Diversity in STEM to University Campuses."

Mayo, a computational and applied mathematician, uses modeling and simulation to study hurricane storm surges and flood risk analysis. As an undergraduate student, she participated in the Significant Opportunities in Atmospheric Research and Science (SOARS) program, an undergraduate-to-graduate bridge program hosted at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. The program is designed to broaden participation in the atmospheric and related sciences.

The SOARS program has recently been expanded to two college campuses, including the University of Central Florida, where Mayo is now a faculty member in the Department of Civil, Environmental, and Construction Engineering. She supervises the research of undergraduate student Cindi-Ann Findley, and together they study tides and hurricane storm surges in order to improve the understanding of coastal flooding and to better serve coastal communities.

The Coalition for National Science Funding (CNSF) is an alliance of over 140 organizations united by a concern for the future vitality of the national science, mathematics, and engineering enterprise. The CNSF Exhibition is a well-attended annual event that features thirty-five exhibits where researchers present their work and explain the critical importance of increased, sustained federal investments in basic scientific research.

—AMS Office of Government Relations

From the AMS Public Awareness Office

Awards, Fellowships & Other Opportunities Page

Students and faculty can browse and search by type or by audience, and post calls for fellowship and grant applications, prize and award nominations, as well as meeting and workshop proposals. Submit your calls for opportunities or have a look around at `www.ams.org/opportunities`.

Programs for New Faculty

This page is a good source for faculty to find resources about research, teaching, networking, advancement, and membership. See `www.ams.org/profession/new-faculty`.

—Annette Emerson and Mike Breen
AMS Public Awareness Officers
paoffice@ams.org

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Photo courtesy of Rachel Couch.

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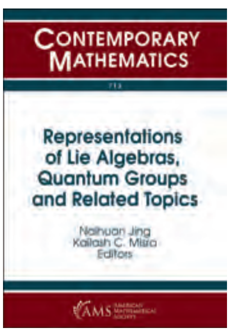
Algebra and Algebraic Geometry



Representations of Lie Algebras, Quantum Groups and Related Topics

Naihuan Jing, *North Carolina State University, Raleigh, NC*, and **Kailash C. Misra**, *North Carolina State University, Raleigh, NC*, Editors

This volume contains the proceedings of the AMS Special Session on Representations of Lie Algebras, Quantum Groups and Related Topics, held from November 12–13, 2016, at North Carolina State University, Raleigh, North Carolina.

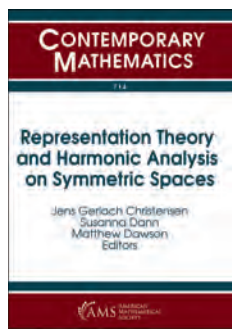
The articles cover various aspects of representations of Kac–Moody Lie algebras and their applications, structure of Leibniz algebras and Krichever–Novikov algebras, representations of quantum groups, and related topics.

Contents: I. I. Anguelova, The two bosonizations of the CKP hierarchy: Overview and character identities; **B. Bakalov** and **M. Sullivan**, Inhomogeneous supersymmetric bilinear forms; **B. Cox**, **V. Futorny**, and **K. C. Misra**, Imaginary crystal bases for $U_q(\widehat{\mathfrak{sl}(2)})$-modules in category $\mathcal{O}^q_{\text{red,im}}$; **B. Cox** and **M. S. Im**, On the module structure of the center of hyperelliptic Krichever-Novikov algebras; **I. Demir**, Classification of 5-dimensional complex nilpotent Leibniz algebras; **V. Futorny**, **D. Grantcharov**, and **L. E. Ramirez**, Gelfand-Tsetlin modules of $\mathfrak{sl}(3)$ in the principal block; **J. Hong**, Fusion rings revisited; **N. Jing**, **K. C. Misra**, and **H. Yamane**, Kostant-Lusztig $\mathbb{A}$-bases of multiparameter quantum groups; **K.-H. Lee** and **S.-J. Oh**, Catalan triangle numbers and binomial coefficients; **D. Muthiah** and **D. Orr**, Walk algebras, distinguished subexpressions, and point counting in Kac-Moody flag varieties; **A. Varchenko** and **T. Woodruff**, Critical points of master functions and mKdV hierarchy of type $A_{2n}^{(2)}$.

Contemporary Mathematics, Volume 713

September 2018, 240 pages, Softcover, ISBN: 978-1-4704-3696-4, LC 2018005031, 2010 *Mathematics Subject Classification:* 05E10, 11B39, 14M15, 17A32, 17B10, 17B37, 17B67, 17B69, 20G05, 81R50, **AMS members US$93.60**, List US$117, Order code CONM/713

Analysis



Representation Theory and Harmonic Analysis on Symmetric Spaces

Jens Gerlach Christensen, *Colgate University, Hamilton, NY*, **Susanna Dann**, *Vienna University of Technology, Wien, Austria*, and **Matthew Dawson**, *CIMAT, Mérida, Mexico*, Editors

This volume contains the proceedings of the AMS Special Session on Harmonic Analysis, in honor of Gestur Ólafsson's 65th birthday, held on January 4, 2017, in Atlanta, Georgia.

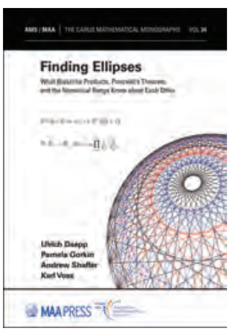
The articles in this volume provide fresh perspectives on many different directions within harmonic analysis, highlighting the connections between harmonic analysis and the areas of integral geometry, complex analysis, operator algebras, Lie algebras, special functions, and differential operators. The breadth of contributions highlights the diversity of current research in harmonic analysis and shows that it continues to be a vibrant and fruitful field of inquiry.

This item will also be of interest to those working in algebra and algebraic geometry.

Contents: A. Alldridge, **S. Sahi**, and **H. Salmasian**, Schur Q-functions and the Capelli eigenvalue problem for the Lie superalgebra $\mathfrak{q}(n)$; **I. Cho** and **P. E. T. Jorgensen**, Analysis of free products of the general linear groups $GL_2(\mathbb{Q}_p)$ and Hecke algebras $\mathcal{H}(GL_2(\mathbb{Q}_p))$ over primes p; **J. G. Christensen**, Atomic decompositions of mixed norm Bergman spaces on tube type domains; **P. Clare**, C*-algebraic normalization and Godement-Jacquet factors; **M. Dawson** and **R. Quiroga-Barranco**, Radial Toeplitz operators on the weighted Bergman spaces of Cartan domains; **R. W. Donley, Jr.** and **W. G. Kim**, A rational theory of Clebsch-Gordan coefficients; **R. Estrada** and **B. Rubin**, Radon-John transforms and spherical harmonics; **S. Helgason**, Spherical functions on Riemannian symmetric spaces; **M. Hunziker**, **M. R. Sepanski**, and **R. J. Stanke**, Schrödinger-type equations and unitary highest weight representations of the metaplectic group; **T. Kobayashi**, Residue formula for regular symmetry breaking operators; **K.-H. Neeb**, On the geometry of standard subspaces; **M. J. Slupinski** and **R. J. Stanton**, Pure spinors and a construction of the E_*-Lie algebras; **J. A. Wolf**, Representations on partially holomorphic cohomology spaces, revisited.

Contemporary Mathematics, Volume 714

September 2018, 303 pages, Softcover, ISBN: 978-1-4704-4070-1, LC 2018005036, 2010 *Mathematics Subject Classification:* 15A66, 17B40, 20C08, 22E46, 22E50, 32L25, 32M15, 43A90, 53C35, 81R40, **AMS members US$93.60**, List US$117, Order code CONM/714



Finding Ellipses

What Blaschke Products, Poncelet's Theorem, and the Numerical Range Know about Each Other

Ulrich Daepp, **Pamela Gorkin**, **Andrew Shaffer**, and **Karl Voss**, *Bucknell University, Lewisburg, PA*

Mathematicians delight in finding surprising connections between seemingly disparate areas of mathematics. Whole domains of modern mathematics have arisen from exploration of such connections—consider analytic number theory or algebraic topology. *Finding Ellipses* is a delight-filled romp across a three-way unexpected connection between complex analysis, linear algebra, and projective geometry.

The book begins with Blaschke products, complex-analytic functions that are generalizations of disk automorphisms. In the analysis of Blaschke products, we encounter, in a quite natural way, an ellipse inside the unit disk. The story continues by introducing the reader to Poncelet's theorem—a beautiful result in projective geometry that ties together two conics and, in particular, two ellipses, one circumscribed by a polygon that is inscribed in the second. The Blaschke ellipse and the Poncelet ellipse turn out to be the same ellipse, and the connection is illuminated by considering the numerical range of a 2×2 matrix. The numerical range is a convex subset of the complex plane that contains information about the geometry of the transformation represented by a matrix. Through the numerical range of $n \times n$ matrices, we learn more about the interplay between Poncelet's theorem and Blaschke products.

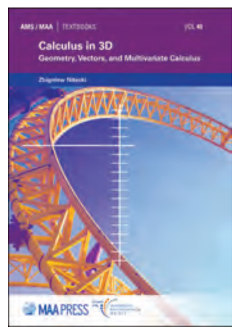
The story ranges widely over analysis, algebra, and geometry, and the exposition of the deep and surprising connections is lucid and compelling. Written for advanced undergraduates or beginning graduate students, this book would be the perfect vehicle for an invigorating and enlightening capstone exploration. The exercises and collection of extensive projects could be used as an embarkation point for a satisfying and rich research project.

You are invited to read actively using the accompanying interactive website, which allows you to visualize the concepts in the book, experiment, and develop original conjectures.

Contents: *Part 1:* The surprising ellipse; The ellipse three ways; Blaschke products; Blaschke products and ellipses; Poncelet's theorem for triangles; The numerical range; The connection revealed; *Intermezzo:* And now for something completely different...Benford's law; *Part 2:* Compressions of the shift operator: The basics; Higher dimensions: Not your Poncelet ellipse; Interpolation with Blaschke products; Poncelet's theorem for n-gons; Kippenhahn's curve and Blaschke's products; Iteration, ellipses, and Blaschke products; On suprising connections; *Part 3:* Fourteen projects for fourteen chapters; Index; Bibliography.

Carus Mathematical Monographs, Volume 34

October 2018, approximately 264 pages, Hardcover, ISBN: 978-1-4704-4383-2, LC 2018021655, 2010 *Mathematics Subject Classification:* 47A05, 47A12, 30J10, 15-02, 15A60, 51-02, 51M04, 51N35, **Individual member US$47.25**, List US$63, Institutional member US$50.40, Order code CAR/34



Calculus in 3D

Geometry, Vectors, and Multivariate Calculus

Zbigniew Nitecki, *Tufts University, Medford, MA*

Calculus in 3D is an accessible, well-written textbook for an honors course in multivariable calculus for mathematically strong first- or second-year university students. The treatment given here carefully balances theoretical rigor, the development of student facility in the procedures and algorithms, and inculcating intuition into underlying geometric principles. The focus throughout is on two or three dimensions. All of the standard multivariable material is thoroughly covered, including vector calculus treated through both vector fields and differential forms. There are rich collections of problems ranging from the routine through the theoretical to deep, challenging problems suitable for in-depth projects. Linear algebra is developed as needed. Unusual features include a rigorous formulation of cross products and determinants as oriented area, an in-depth treatment of conics harking back to the classical Greek ideas, and a more extensive than usual exploration and use of parametrized curves and surfaces.

Zbigniew Nitecki is Professor of Mathematics at Tufts University and a leading authority on smooth dynamical systems. He is the author of *Differentiable Dynamics*, MIT Press; *Differential Equations, A First Course* (with M. Guterman), Saunders; *Differential Equations with Linear Algebra* (with M. Guterman), Saunders; and *Calculus Deconstructed*, MAA Press.

Contents: Coordinates and vectors; Curves and vector-valued functions of one variable; Differential calculus for real-valued functions of several variables; Integral calculus for real-valued functions of several variables; Integral calculus for vector fields and differential forms; Appendix; Bibliography; Index.

MAA Textbooks, Volume 40

October 2018, 405 pages, Hardcover, ISBN: 978-1-4704-4360-3, LC 2018020561, 2010 *Mathematics Subject Classification:* 26-01, **Individual member US$59.25**, List US$79, Institutional member US$63.20, Order code TEXT/40

General Interest

Functions and Graphs

A Clever Study Guide

James Tanton, *Mathematical Association of America, Washington, DC*

A playful, readable, and thorough guide to precalculus, this book is directed at readers who would like a holistic look at the high school curriculum material on functions and their graphs. Tanton provides a coherent guided tour of exploration and discovery of a rich mathematical landscape. The exploration is presented through problems selected from the history of the Mathematical Association of America's American Mathematics Competition (AMC).

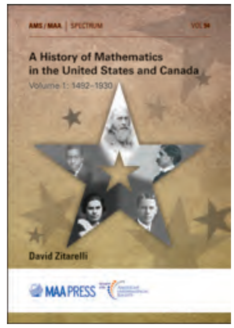
Secondary school teachers looking for supplementary and enrichment materials will find this a rich resource, which aligns with national curriculum standards. High school and college calculus and precalculus students will discover an approachable and thought-provoking review, preview, and overview of these central mathematical ideas. Students preparing for the AMC should find it especially helpful. Active reading, with pencil in hand, will result in a deep appreciation and understanding of the properties of functions.

James Tanton is the MAA's mathematician-at-large. A research mathematician with experience teaching at both the college and high school levels, he now works to encourage and aid all mathematics instructors to teach—and all mathematics students to learn—joyously and effectively.

Contents: *Functions and graphs:* What is a function? A swift conceptual overview; Sequences as functions on ℕ; Numerical functions on ℝ; Composite functions and inverse functions; Graphing; Transformations of graphs; Average rate of change, constant rate of change; Quadratic functions; Polynomial functions; Rational functions; Select special functions and equations; Fitting formulas to data points; *Solutions:* Solutions; *Appendices:* Ten problem-solving strategies; Connections to the Common Core State Standards: Practice standards and content standards.

Problem Books, Volume 29

September 2018, 218 pages, Softcover, ISBN: 978-1-4704-4349-8, 2010 *Mathematics Subject Classification:* 97-XX, **Individual member US$22.50**, List US$30, Institutional member US$24, Order code PRB/29



A History of Mathematics in the United States and Canada

Volume 1: 1492–1930

David E. Zitarelli, *Temple University, Philadelphia, PA*

This is the first truly comprehensive and thorough history of the development of mathematics in the United States and Canada. This first volume of a two-volume work takes the reader from the European encounters with North America in the fifteenth century up to the emergence of the United States as a world leader in mathematics in the 1930s.

In the story of the Colonial period particular emphasis is given to several prominent Colonial figures—Jefferson, Franklin, and Rittenhouse—and four important early colleges—Québec, Harvard, Yale, and William & Mary. During the first three-quarters of the nineteenth century, mathematics in North America was largely the occupation of scattered individual pioneers: Bowditch, Farrar, Adrain, B. Peirce. This period is given a fuller treatment here than previously in the literature, including the creation of the first PhD programs and attempts to form organizations and found journals.

With the founding of Johns Hopkins University in 1876, the American mathematical research community was finally, and firmly, founded. The programs at Hopkins, Chicago, and Clark are detailed as are the influence of major European mathematicians, including especially Klein, Hilbert, and Sylvester. Extensive histories of early areas of American emphasis are provided, including axiomatics, topology, and group theory. Also included are the early histories of statistics and cryptology in America, laying the foundation for the latter topic's role in abstract algebra in the 1950s. The stories of both the American Mathematical Society and the Mathematical Association of America are presented in detail.

David Zitarelli is emeritus Professor of Mathematics at Temple University. A decorated and acclaimed teacher, scholar, and expositor, he is one of the world's leading experts on the development of American mathematics. Author or co-author of over a dozen books, this is his *magnum opus*—sure to become the leading reference on the topic and essential reading, not just for historians. In clear and compelling prose, Zitarelli spins a tale accessible to experts, generalists, and anyone interested in the history of science in North America.

Contents: *Part I: Colonial Era and Period of Confederation, 1492–1800:* Beginnings; Independence; Transition 1776: The patriot; *Part II: New republic, 1800–1876:* The age of Bowditch; The age of Peirce; Transition 1876: Story vs. Klein; *Part III: Research community, 1876–1900:* Sylvester, Klein, AMS; Chicago; The 1890s; Transition 1900: Hilbert's American colony; *Part IV: Consolidation and growth, 1900–1930:* Establishment, 1900–1914; Wartime, 1914–1920; The Roaring Twenties; More Roaring Twenties; Transition 1930: Albert vs. Hasse; Endnotes; Bibliography; Index.

Spectrum, Volume 94

October 2018, 768 pages, Hardcover, ISBN: 978-1-4704-4829-5, 2010 *Mathematics Subject Classification:* 01A60, 01A70, 01A72, 01A73, **Individual member US$90**, List US$120, Institutional member US$96, Order code SPEC/94

New AMS-Distributed Publications

Algebra and Algebraic Geometry

Formes Modulaires p-Adiques sur les Courbes de Shimura Unitaires et Compatibilité Local-Global

Yiwen Ding, *Peking University, Beijing, China*

The author studies p-adic modular forms over unitary Shimura curves and proves the existence of overconvergent companion forms over unitary Shimura curves using p-adic comparison theorems. Together with some locally analytic representation theory of $\mathrm{GL}_2(L)$, the author deduces some local-global compatibility results on the socle for the completed H^1 of unitary Shimura curves. In addition, using an adjunction formula for the Jacquet-Emerton functor in family and global triangulation theory, the author also proves some local-global compatibility results for non semi-simple locally analytic representations.

This item will also be of interest to those working in number theory.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Mémoires de la Société Mathématique de France, Number 155

May 2018, 245 pages, Softcover, ISBN: 978-2-85629-877-0, 2010 *Mathematics Subject Classification:* 11F85, 22E50, **AMS members US$53.60**, List US$67, Order code SMFMEM/155

Actes du 1^{er} Congrès National de la SMF—Tours, 2016

Cédric Lecouvey, *Université François, Rabelais-Tours, France*, Editor

This volume gathers the contributions of plenary speakers of the first congress of the French Mathematical Society, which took place in 2016 in Tours. Marie-Claude Arnaud explains the link between Hamiltonian dynamics and Lagrangian variational methods as a smooth introduction to Aubry-Mather's theory.

Sophie Grivaux, with Catalin Badea, discusses some classes of integers, namely Jamison and Kazhhan sets, in light of operator theory and harmonic analysis. Bertrand Toën, with Gabriele Vezzosi, presents a general approach for establishing Bloch's conductor formula, which is a conjectural formula describing how the topology in a family of algebraic varieties changes when the parameter is specialized to a critical value. Sébastien Gouëzel exploits all the richness of subadditivity properties and of horofunctions to describe the asymptotic behavior of random semi-contractions. Finally, Alexander Tsybakov, with Pierre Bellec and Guilaume Lecué, focuses on the performance of some least squares estimators with convex penalty and presents the main ideas and tools that have shown substantial improvements in recent years.

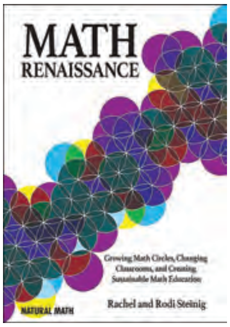
This item will also be of interest to those working in number theory.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Séminaires et Congrès, Number 31

May 2018, 136 pages, Softcover, ISBN: 978-2-85629-866-4, 2010 *Mathematics Subject Classification:* 14A22, 14F05, 14F42, 22D10, 22D40, 37A15, 37A30, 37H15, 37J05, 37J35, 37J40, 37J50, 43A07, 46M05, 47A10, 62J05, 62J07, 70H05, **AMS members US$41.60**, List US$52, Order code SECO/31

Math Education



Math Renaissance

Growing Math Circles, Changing Classrooms, and Creating Sustainable Math Education

Rachel Steinig and **Rodi Steinig**

Math Renaissance is a book for teachers and parents of children ages five and up. The co-authors Rodi and Rachel Steinig share their insights as mother and daughter, co-teachers, and co-learners. In her chapters, Rodi tells stories about her math circle and exactly what happens there. Rachel discusses why so many kids hate math, documents the ways math is taught in the classroom, and celebrates improvements in mathematics education. The book shifts mathematics education toward inquiry, discovery, conceptual understanding, and lasting joy.

The book gives voice to many students, parents, and teachers. It is a grassroots effort to make people aware of problems and successes in math education. It will help you find validation of your feelings, math circle know-how, and classroom investigations of geometry, logic, functions, and optimization.

Everybody can access the beauty and joy in mathematics. Parents, teachers, and mathematicians have a vision of math being taught in a way that's collaborative, profound, and accessible to everybody, a Math Renaissance, if you will. The authors hope the book will repair damaged relationships with math and enhance good ones.

A publication of Delta Stream Media, an imprint of Natural Math. Distributed in North America by the American Mathematical Society.

Natural Math Series, Volume 8

May 2018, 205 pages, Softcover, ISBN: 978-1-945899-04-1, **AMS members US$19.20**, List US$24, Order code NMATH/8

Classified Advertisements

Positions available, items for sale, services available, and more

NEW JERSEY

Princeton University
Program in Applied and Computational Mathematics
Postdoctoral Research Associate

The Program in Applied and Computational Mathematics invites applications for Postdoctoral Research Associates or more senior to join in research efforts of interest to its faculty. Domains of interest include nonlinear partial differential equations, computational fluid dynamics and material science, dynamical systems, numerical analysis, stochastic problems and stochastic analysis, graph theory and applications, mathematical biology, financial mathematics and mathematical approaches to signal analysis, information theory, and structural biology and image processing. Appointments are made for one year, renewable yearly for up to three years, if funding is available and performance is satisfactory. For details on specific faculty members and their research interests, please go to https://www.pacm.princeton.edu/sites/default/files/faculty_interests2017-18apc_0.pdf.

Applicants must submit a cover letter, CV, bibliography/publications list, statement of research and three letters of recommendation online at https://www.mathjobs.org/jobs. PhD required. This position is subject to the University background check policy. Princeton University is an Equal Opportunity/Affirmative Action Employer and all qualified applicants will receive consideration for employment without regard to age, race, color, religion, sex, sexual orientation, gender identity or expression, national origin, disability status, protected veteran status, or any other characteristic protected by law.

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WISCONSIN

University of Wisconsin-Madison
Department of Mathematics

The Department of Mathematics is accepting applications for a faculty position beginning August 19, 2019 contingent upon budgetary approval. Rank will be as assistant professor (tenure-track) or associate professor (tenured). Area of specialization open. PhD in mathematics or related field required prior to start of appointment. Faculty members are expected to contribute to the research, teaching, and service missions of the department. Appointment with tenure requires evidence of excellence in scholarly research, teaching and service. Candidates for a tenure-track position should exhibit evidence of outstanding research potential, normally including significant contributions beyond the doctoral dissertation. The teaching responsibility is three courses per academic year, including both undergraduate- and graduate-level courses, and a strong commitment to excellence in instruction is also expected. Additional departmental information is available on our website: www.math.wisc.edu. An application packet should include a completed AMS Standard Cover Sheet, a curriculum vitae that includes a publication list, and brief descriptions of research and teaching. Application packets should be submitted electronically to www.mathjobs.org. Arrangements should be made to have three to four letters of recommendation, at least one of which must discuss the applicant's teaching experiences and capabilities and potential, sent to the above url address. To ensure full consideration, application packets must be received by November 1, 2018. Applications will be accepted until the position is filled. The Department of Mathematics is committed to increasing the number of women and under represented individuals. The University of Wisconsin-Madison is an Affirmative Action, Equal Opportunity Employer and encourages applications from women and minorities. Unless confidentiality is requested in writing, information regarding the applicants must be released upon request. Finalists cannot be guaranteed confidentiality. A background check will be required prior to employment.

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CHINA

Southern University of Science and Technology (SUSTech)
Faculty Positions of Mathematics
The Department of Mathematics

The Department of Mathematics at Southern University of Science and Technology (SUSTech) is founded in 2015 with a dual mission of creating a first-class research and education organization for mathematics and providing service courses in support of other academic departments at SUSTech. We currently have 36 full-time faculty members, including 6 Chair Professors & 7 Full Professors, 3 Associate Professors, 12 Assistant Professors, and 8 teaching faculty members. Research interests of the faculty members cover a broad array of Mathematics including Pure Mathematics, Computational and Applied Mathematics, Probability and Statistics, and Financial Mathematics.

Call for Applications

We invite applications for full-time faculty positions at all ranks and in all areas of Mathematics, including Financial Mathematics and Statistics. SUSTech has a tenure system. Qualified candidates may apply for appointments with tenure.

Candidates should have demonstrated excellence in research and a strong commitment to teaching. A doctoral degree is required at the time of appointment. A candidate for a senior position must have an established record of research and teaching, and a track-record in securing external funding.

To apply, please visit www.mathjobs.org and look up our job ad for instructions. For an informal discussion about applying to one of our positions, please contact Ms. Xianghui Yu, the Secretary of Department of Mathematics, by phone +86-755-88018703 or email: yuxh@sustc.edu.cn.

SUSTech offers competitive salaries, fringe benefits including medical insurance, retirement and housing subsidy, which are among the best in China. Salary and rank will be commensurate with qualifications and experiences of an appointee.

About the University

Established in 2012, SUSTech is a public institution funded by Shenzhen, a city with a designated special economic zone status in Southern China bordering Hong Kong. As one of China's key gateways to the world, Shenzhen is the country's fastest-growing city in the past three decades. From a small fishing village 30 years ago to a modern city with a population of over 10 million, the city has become the high-tech and manufacturing hub of southern China. It is home to the world's third-busiest container port and the fourth-busiest airport on the Chinese mainland. Being a picturesque coastal city, Shenzhen is also a popular tourist destination.

SUSTech is a pioneer in higher education reform in China. Its mission is to become a globally recognized institution that excels in research and promotes innovation, creativity and entrepreneurship. Ninety percent of SUSTech faculty members have overseas work experiences, and sixty percent studied or worked in top 100 universities in the world. The languages of instruction are English and Chinese. Sitting on five hundred acres of subtropical woodland with hills, rivers and a natural lake in Nanshan District of Shenzhen, the SUSTech campus is a beautiful place for learning and research.

The prosperity of Shenzhen is built on innovations and entrepreneurship of its citizens. The city has some of China's most successful high-tech companies such as Huawei and Tencent. SUSTech strongly supports innovations and entrepreneurship, and provides funding for promising initiatives. The university encourages candidates with intention and experience on entrepreneurship to apply.

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Tianjin University, China
Tenured/Tenure-Track/Postdoctoral Positions at the Center for Applied Mathematics

Dozens of positions at all levels are available at the recently founded Center for Applied Mathematics, Tianjin University, China. We welcome applicants with backgrounds in pure mathematics, applied mathematics, statistics, computer science, bioinformatics, and other related fields. We also welcome applicants who are interested in practical projects with industries. Despite its name attached with an accent of applied mathematics, we also aim to create a strong presence of pure mathematics. Chinese citizenship is not required.

Light or no teaching load, adequate facilities, spacious office environment and strong research support. We are prepared to make quick and competitive offers to self-motivated hard workers, and to potential stars, rising stars, as well as shining stars.

The Center for Applied Mathematics, also known as the Tianjin Center for Applied Mathematics (TCAM), located by a lake in the central campus in a building protected as historical architecture, is jointly sponsored by the Tianjin municipal government and the university. The initiative to establish this center was taken by Professor S. S. Chern. Professor Molin Ge is the Honorary Director, Professor Zhiming Ma is the Director of the Advisory Board. Professor William Y. C. Chen serves as the Director.

TCAM plans to fill in fifty or more permanent faculty positions in the next few years. In addition, there are a number of temporary and visiting positions. We look forward to receiving your application or inquiry at any time. There are no deadlines.

Please send your resume to mathjobs@tju.edu.cn.

For more information, please visit cam.tju.edu.cn or contact Ms. Erica Liu at mathjobs@tju.edu.cn, telephone: 86-22-2740-6039.

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REPUBLIC OF KOREA

Korea Institute for Advanced Study (KIAS)
Assistant Professor & Research Fellow
in Pure and Applied Mathematics

The School of Mathematics at the Korea Institute for Advanced Study (KIAS) invites applicants for the positions at the level of KIAS Assistant Professor and Postdoctoral Research Fellow in pure and applied mathematics. KIAS, founded in 1996, is committed to the excellence of research in basic sciences (mathematics, theoretical physics, and computational sciences) through high-quality research programs and a strong faculty body consisting of distinguished scientists and visiting scholars.

Applicants are expected to have demonstrated exceptional research potential, including major contributions beyond or through the doctoral dissertation.

The annual salary starts from 50,500,000 Korean Won (approximately US$45,900 at current exchange rate) for Research Fellows, and 57,500,000 Korean Won for KIAS Assistant Professors, respectively. In addition, individual research funds of 10,000,000 ~ 13,000,000 Korean Won are available per year. The initial appointment for the position is for two years and is renewable for up to two additional years, depending on research performance and the needs of the research program at KIAS.

Applications will be reviewed twice a year, May 20 and November 20, and selected applicants will be notified in a month after the review. In exceptional cases, applications can be reviewed other times based on the availability of positions. The starting date of the appointment is negotiable. Applications must include a complete vitae with a cover letter, a list of publications, a research plan, and three letters of recommendation (All documents should be in English).

All should be sent by post or e-mail to:

Ms. Sojung Bae (mathkias@kias.re.kr)
School of Mathematics

Korea Institute for Advanced Study (KIAS)
85 Hoegiro (Cheongnyangani-dong 207-43), Dongdaemun-gu,
Seoul 02455, Republic of Korea

014

MISCELLANEOUS

The Remarkably Simple Structure of the 3x + 1 Function

I will offer any reasonable consulting fee, and/or very generous credit in the Acknowledgments, to a mathematician who helps me prepare a paper with the above title for submission to a journal. I feel I need such help because my degree is in computer science, and for most of my career I have been a researcher in the computer industry.

The paper shows how very much simpler the structure I have discovered is than the structures in the literature.

I have received no claims of an error in the paper. Furthermore, a mathematician has recently stated to me that he thinks the paper is correct. It is accessible on occampress.com.

Peter Schorer, peteschorer@gmail.com

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MEETINGS & CONFERENCES OF THE AMS

SEPTEMBER TABLE OF CONTENTS

The Meetings and Conferences section of the Notices gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. Information in this issue may be dated.

The most up-to-date meeting and conference information can be found online at: **www.ams.org/meetings**.

Important Information About AMS Meetings: Potential organizers, speakers, and hosts should refer to page 88 in the January 2018 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts: Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of LaTeX is necessary to submit an electronic form, although those who use LaTeX may submit abstracts with such coding, and all math displays and similarily coded material (such as accent marks in text) must be typeset in LaTeX. Visit **www.ams.org/cgi-bin/abstracts/abstract.pl**. Questions about abstracts may be sent to `abs-info@ams.org`. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

MEETINGS IN THIS ISSUE

2018

2019

2020

2021

2022

2023

See `www.ams.org/meetings` *for the most up-to-date information on the meetings and conferences that we offer.*

ASSOCIATE SECRETARIES OF THE AMS

Central Section: Georgia Benkart, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; email: benkart@math.wisc.edu; telephone: 608-263-4283.

Eastern Section: Steven H. Weintraub, Department of Mathematics, Lehigh University, Bethlehem, PA 18015-3174; email: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: Brian D. Boe, Department of Mathematics, University of Georgia, 220 D W Brooks Drive, Athens, GA 30602-7403, email: brian@math.uga.edu; telephone: 706-542-2547.

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; email: lapidus@math.ucr.edu; telephone: 951-827-5910.

Joint Mathematics Meeting Attendees!

While making your JMM registration plans, be sure to register for the:

AMS *Until Next Time* Social

SATURDAY, JANUARY 19, 2019, 7:00PM–9:30PM

Maryland Science Center,
601 Light Street,
Baltimore, MD

Located in Baltimore's Inner Harbor just 0.6 miles away from the Baltimore Convention Center

Photos coutesy of Maryland Science Center.

Free transportation from the Hilton Baltimore and Baltimore Convention Center to the venue, *live music, access to exhibits* and hands-on displays, various *food stations, interactive activities* and learning opportunities, and a chance to wish your colleagues well until next time!

A limited number of tickets will be available at a special price for students!

AMS American Mathematical Society

Register Today @ jointmathematicsmeetings.org.

Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See www.ams.org/meetings/.
Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL .

Newark, Delaware

University of Delaware

September 29–30, 2018

Saturday – Sunday

Meeting #1141

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: June 2018
Program first available on AMS website: August 9, 2018
Issue of *Abstracts*: Volume 39, Issue 3

Deadlines

For organizers: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Leslie Greengard, New York University, *Linear and nonlinear inverse problems in imaging.*

Elisenda Grigsby, Boston College, *Braids, surfaces, and homological invariants.*

Davesh Maulik, Massachusetts Institute of Technology, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Advances in Numerical Approximation of Partial Differential Equations, **Constantin Bacuta** and **Jingmei Qiu**, University of Delaware.

Applied Algebraic Topology, **Chad Giusti**, University of Delaware, and **Gregory Henselman**, Princeton University.

Billiard Dynamics: Standard and Alternative Collision Models, **Tim Chumley**, Mount Holyoke College, **Chris Cox**, University of Delaware, and **Renato Feres**, Washington University in St. Louis.

Commutative Algebra, **Ela Celikbas**, West Virginia University, **Sema Gunturkun**, University of Michigan, and **Oana Veliche**, Northeastern University.

Convex Geometry and Functional Inequalities, **Mokshay Madiman**, University of Delaware, **Elisabeth Werner**, Case Western Reserve University, and **Artem Zvavitch**, Kent State University.

Fixed Point Theory with Application and Computation, **Clement Boateng Ampadu**, Boston, MA, **Penumarthy Parvateesam Murthy**, Guru Ghasidas Vishwavidyalaya, Bilaspur, India, **Naeem Saleem**, University of Management and Technology, Lahore, Pakistan, **Yaé Ulrich Gaba**, Institut de Mathématiques et de Sciences Physiques (IMSP), Porto-Novo, Bénin, and **Xavier Udo-utun**, University of Uyo, Uyo, Nigeria.

Graph Theory, **Sebastian M. Cioabă**, University of Delaware, **Brian Kronenthal**, Kutztown University of Pennsylvania, **Felix Lazebnik**, University of Delaware, and **Wing Hong Tony Wong**, Kutztown University of Pennsylvania.

Interplay between Analysis and Combinatorics, **Mahya Ghandehari** and **Dominique Guillot**, University of Delaware.

Modern Quasiconformal Analysis and Geometric Function Theory, **David Herron**, University of Cincinnati, and **Yuk-J Leung**, University of Delaware.

Nonlinear Water Waves and Related Problems, **Philippe Guyenne**, University of Delaware.

Operator and Function Theory, **Kelly Bickel**, Bucknell University, **Michael Hartz**, Washington University, St. Louis, **Constanze Liaw**, University of Delaware, and **Alan Sola**, Stockholm University.

Probability, Combinatorics, and Statistical Mechanics, **Nayantara Bhatnagar** and **Douglas Rizzolo**, University of Delaware.

Quantum Correlation Sets in Quantum Information Theory, **Elie Alhajjar** and **Travis B. Russell**, US Military Academy.

Recent Advances in Nonlinear Schrödinger Equations, **Alexander Pankov**, Morgan State University, **Junping Shi**, College of William and Mary, and **Jun Wang**, Jiangsu University.

Recent Analytic and Numeric Results on Nonlinear Evolution Equations, **Xiang Xu**, Old Dominion University, and **Wujun Zhang**, Rutgers University.

Representations of Infinite Dimensional Lie Algebras and Applications, **Marco Aldi**, Virginia Commonwealth University, **Michael Penn**, Randolph College, and **Juan Villarreal**, Virginia Commonwealth University.

Stochastic Processes in Mathematical Biology, **Yao Li**, University of Massachusetts Amherst, and **Abhyudai Singh**, University of Delaware.

The Mathematics of Swimmers and Active Particles, **Louis Rossi**, University of Delaware, and **Enkeleida Lushi**, Flatiron Institute.

Ann Arbor, Michigan

University of Michigan, Ann Arbor

October 20–21, 2018

Saturday – Sunday

Meeting #1143

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: July 2018
Program first available on AMS website: August 30, 2018
Issue of *Abstracts*: Volume 39, Issue 4

Deadlines

For organizers: Expired
For abstracts: August 21, 2018

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Elena Fuchs, University of Illinois Urbana-Champaign, *Title to be announced.*

Andrew Putman, University of Notre Dame, *Title to be announced.*

Charles Smart, University of Chicago, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Advances in Commutative Algebra (Code: SS 15A), **Jack Jeffries**, University of Michigan, **Linquan Ma**, Purdue University, and **Karl Schwede**, University of Utah.

Advances on Analytical and Geometric Aspects of Differential Equations (Code: SS 24A), **Alessandro Arsie**, **Chunhua Shan**, and **Ekaterina Shemyakova**, University of Toledo.

Analytical and Numerical Aspects of Turbulent Transport (Code: SS 23A), **Michele Coti Zelati**, Imperial College London, and **Ian Tobasco** and **Karen Zaya**, University of Michigan.

Aspects of Geometric Mechanics and Dynamics (Code: SS 13A), **Anthony M Bloch** and **Marta Farre Puiggali**, University of Michigan.

Bio-inspired Mechanics and Propulsion (Code: SS 16A), **Silas Alben**, University of Michigan, and **Longhua Zhao**, Case Western Reserve University.

Canonical Operators in Several Complex Variables and Related Topics (Code: SS 21A), **David Barrett** and **Luke Edholm**, University of Michigan, and **Yunus Zeytuncu**, University of Michigan, Dearborn.

Cell Motility: Models and Applications (Code: SS 20A), **Magdalena Stolarska**, University of St. Thomas, and **Nicoleta Tarfulea**, Purdue University Northwest.

Cluster Algebra, Poisson Geometry, and Related Topics (Code: SS 9A), **Eric Bucher**, Michigan State University, and **Maitreyee Kulkarni** and **Bach Nguyen**, Louisiana State University.

Combinatorics in Algebra and Algebraic Geometry (Code: SS 14A), **Zachary Hamaker**, **Steven Karp**, and **Oliver Pechenik**, University of Michigan.

Commutative Algebra and Complexity (Code: SS 32A), **Harm Derksen**, **Francesca Gandini**, and **Visu Makam**, University of Michigan.

Commutative Ring Theory (Code: SS 22A), **Joe Stickles**, Millikin University, and **Darrin Weber**, University of Evansville.

Ergodic and Topological Quantum Systems (Code: SS 28A), **Matthew Cha**, **Ilya Kachkovskiy**, and **Shiwen Zhang**, Michigan State University.

Extensions-Interpolation-Shape Matching in R^d, Symmetry-Invariance, Algorithms and Related Topics (Code: SS 11A), **Steven Damelin**, American Mathematical Society, and **Nir Sharon**, Princeton University.

From Hyperelliptic to Superelliptic Curves (Code: SS 6A), **Tony Shaska**, Oakland University, **Nicola Tarasca**, Rutgers University, and **Yuri Zarhin**, Pennsylvania State University.

Geometry of Submanifolds, in Honor of Bang-Yen Chens 75th Birthday (Code: SS 1A), **Alfonso Carriazo**, University of Sevilla, **Ivko Dimitric**, Penn State Fayette, **Yun Myung Oh**, Andrews University, **Bogdan D. Suceava**, California State University, Fullerton, **Joeri Van der Veken**, University of Leuven, and **Luc Vrancken**, Universite de Valenciennes.

Interactions between Algebra, Machine Learning and Data Privacy (Code: SS 3A), **Jonathan Gryak**, University of Michigan, **Kelsey Horan**, CUNY Graduate Center, **Delaram Kahrobaei**, CUNY Graduate Center and New York University, **Kayvan Najarian** and **Reza Soroushmehr**, University of Michigan, and **Alexander Wood**, CUNY Graduate Center.

Large Cardinals and Combinatorial Set Theory (Code: SS 10A), **Andres E. Caicedo**, Mathematical Reviews, and **Paul B. Larson**, Miami University.

Mathematics of the Genome (Code: SS 30A), **Anthony Bloch**, **Daniel Burns**, and **Indika Rajapakse**, University of Michigan.

Modern Trends in Integrable Systems (Code: SS 12A), **Deniz Bilman**, **Peter Miller**, **Michael Music**, and **Guilherme Silva**, University of Michigan.

Multiplicities and Volumes: An Interplay Among Algebra, Combinatorics, and Geometry (Code: SS 19A), **Federico Castillo**, University of Kansas, and **Jonathan Montaño**, New Mexico State University.

New Trends in Numerical Methods for Partial Differential Equations: Theory and Applications (Code: SS 17A), **Fatih Celiker**, Wayne State University.

Nonlocality in Models for Kinetic, Chemical, and Population Dynamics (Code: SS 25A), **Christopher Henderson**, University of Chicago, **Stanley Snelson**, Florida Institute of Technology, and **Andrei Tarfulea**, University of Chicago.

Probabilistic Methods in Combinatorics (Code: SS 7A), **Patrick Bennett** and **Andrzej Dudek**, Western Michigan University, and **David Galvin**, University of Notre Dame.

Random Matrix Theory Beyond Wigner and Wishart (Code: SS 2A), **Elizabeth Meckes** and **Mark Meckes**, Case Western Reserve University, and **Mark Rudelson**, University of Michigan.

Recent Advances in Nonlinear PDE (Code: SS 31A), **Jessica Lin**, McGill University, and **Russell Schwab**, Michigan State University.

Recent Developments in Discontinuous Galerkin Methods for Differential Equations (Code: SS 34A), **Mahboub Baccouch**, University of Nebraska at Omaha.

Recent Developments in Mathematical Analysis of Some Nonlinear Partial Differential Equations (Code: SS 18A), **Mimi Dai**, University of Illinois at Chicago.

Recent Developments in the Mathematics of Tomography and Scattering (Code: SS 26A), **Shixu Meng**, University of Michigan, and **Yang Yang**, Michigan State University.

Recent Trends on Local, Nonlocal and Fractional Partial Differential Equations (Code: SS 27A), **Pablo Raúl Stinga**, Iowa State University, **Peiyong Wang**, Wayne State University, and **Jiuyi Zhu**, Louisiana State University.

Representations of Reductive Groups over Local Fields and Related Topics (Code: SS 8A), **Anne-Marie Aubert**, Institut Mathématiques de Jussieu, Paris Rive Gauche, **Jessica Fintzen**, IAS, University of Michigan, University of Cambridge, and **Camelia Karimianpour**, University of Michigan.

Self-similarity and Long-range Dependence in Stochastic Processes (Code: SS 4A), **Takashi Owada**, Purdue University, **Yi Shen**, University of Waterloo, and **Yizao Wang**, University of Cincinnati.

Structured Homotopy Theory (Code: SS 5A), **Thomas Fiore**, University of Michigan, Dearborn, **Po Hu** and **Dan Isaksen**, Wayne State University, and **Igor Kriz**, University of Michigan.

The Mathematics of Decisions, Elections, and Games (Code: SS 29A), **Michael A. Jones**, Mathematical Reviews, and **David McCune**, William Jewell College.

Topics in Graph Theory, Hypergraphs and Set Systems (Code: SS 33A), **John Engbers**, Marquette University, and **Cliff Smyth**, University of North Carolina, Greensboro.

San Francisco, California

San Francisco State University

October 27–28, 2018

Saturday – Sunday

Meeting #1144

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: July 2018
Program first available on AMS website: September 6, 2018
Issue of *Abstracts*: Volume 39, Issue 4

Deadlines

For organizers: Expired
For abstracts: August 28, 2018

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Srikanth B. Iyengar, University of Utah, *Title to be announced*.

Sarah Witherspoon, Texas A&M University, *Derivatives, Derivations, and Hochschild Cohomology*.

Abdul-Aziz Yakubu, Howard University, *Population cycles in discrete-time infectious disease models.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Advances in Operator Theory, Operator Algebras, and Operator Semigroups (Code: SS 14A), **Asuman G. Aksoy**, Claremont McKenna College, **Michael Hartglass**, Santa Clara University, **Zair Ibragimov**, California State University, Fullerton, and **Marat Markin**, California State University, Fresno.

Algebraic Geometry (Code: SS 21A), **Emily Clader** and **Dustin Ross**, San Francisco State University, and **Mark Shoemaker**, Colorado State University.

Analysis and Geometry of Fractals (Code: SS 7A), **Kyle Hambrook**, University of Rochester, **Chun-Kit Lai**, San Francisco State University, and **Sze-Man Ngai**, Georgia Southern University.

Applied Harmonic Analysis: Frame Theory and Applications (Code: SS 9A), **Chun-Kit Lai** and **Shidong Li**, San Francisco State University.

Big Data and Statistical Analytics (Code: SS 17A), **Tao He**, **Mohammad Kafai**, and **Alexandra Piryatinska**, San Francisco State University.

Combinatorial and Categorical Aspects of Representation Theory (Code: SS 10A), **Nicholas Davidson** and **Jonathan Kujawa**, University of Oklahoma, and **Robert Muth**, Tarleton State University.

Coupling in Probability and Related Fields (Code: SS 3A), **Sayan Banerjee**, University of North Carolina, Chapel Hill, and **Terry Soo**, University of Kansas.

Geometric Analysis (Code: SS 8A), **Ovidiu Munteanu**, University of Connecticut, and **David Bao**, San Francisco State University.

Geometric Methods in Hypercomplex Analysis (Code: SS 13A), **Paula Cerejeiras**, Universidade de Aveiro, **Matvei Libine**, Indiana University, Bloomington, and **Mihaela B. Vajiac**, Chapman University.

Geometric and Analytic Inequalities and their Applications (Code: SS 4A), **Nicholas Brubaker**, **Isabel M. Serrano**, and **Bogdan D. Suceavă**, California State University, Fullerton.

Homological Aspects in Commutative Algebra and Representation Theory (Code: SS 5A), **Srikanth B. Iyengar**, University of Utah, and **Julia Pevtsova**, University of Washington.

Homological Aspects of Noncommutative Algebra and Geometry (Code: SS 2A), **Dan Rogalski**, University of California San Diego, **Sarah Witherspoon**, Texas A&M University, and **James Zhang**, University of Washington, Seattle.

Markov Processes, Gaussian Processes and Applications (Code: SS 18A), **Alan Krinik** and **Randall J. Swift**, California State Polytechnic University.

Mathematical Biology with a focus on Modeling, Analysis, and Simulation (Code: SS 1A), **Jim Cushing**, The University of Arizona, **Saber Elaydi**, Trinity University, **Suzanne Sindi**, University of California, Merced, and **Abdul-Aziz Yakubu**, Howard University.

Mathematical Methods for the study of the Three Dimensional Structure of Biopolymers (Code: SS 22A), **Javier Arsuaga** and **Mariel Vazquez**, University of California Davis, Davis, and **Robin Wilson**, Cal Poly Pomona.

Noncommutative Geometry and Fundamental Applications (Code: SS 12A), **Konrad Aguilar**, Arizona State University, and **Frederic Latremoliere**, University of Denver.

Nonlocal PDEs via Harmonic Analysis (Code: SS 20A), **Tadele Mengesha**, University of Tennessee, Knoxville, and **Armin Schikorra**, University of Pittsburgh.

Probabilistic and Statistical Problems in Stochastic Dynamics (Code: SS 16A), **Tao He**, **Mohammad Kafai**, and **Alexandra Piryatinska**, San Francisco State University.

Research in Mathematics by Early Career Graduate Students (Code: SS 11A), **Michael Bishop**, **Marat Markin**, **Jenna Tague**, and **Khang Tran**, California State University, Fresno.

Social Change In and Through Mathematics and Education (Code: SS 19A), **Federico Ardila** and **Matthias Beck**, San Francisco State University, **Jamylle Carter**, Diablo Valley Community College, and **Kimberly Seashore**, San Francisco State University.

Statistical and Geometrical Properties of Dynamical Systems (Code: SS 6A), **Joanna Furno** and **Matthew Nicol**, University of Houston, and **Mariusz Urbanski**, University of North Texas.

Topics in Operator Theory: CANCELLED (Code: SS 15A), **Anna Skripka** and **Maxim Zinchenko**, University of New Mexico.

Fayetteville, Arkansas

University of Arkansas

November 3–4, 2018

Saturday – Sunday

Meeting #1142

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: July 2018
Program first available on AMS website: August 16, 2018
Issue of *Abstracts*: Volume 39, Issue 3

Deadlines

For organizers: Expired
For abstracts: September 4, 2018

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Mihalis Dafermos, Princeton University, *On falling into black holes.*

Jonathan Hauenstein, University of Notre Dame, *Numerical Algebraic Geometry and Optimization.*

Kathryn Mann, Brown University, *Group actions, geometry and rigidity.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Advances in Birational Geometry (Code: SS 11A), **Roi Docampo**, University of Oklahoma, and **Lance Edward Miller** and **Wenbo Niu**, University of Arkansas.

Commutative Algebra (Code: SS 3A), **Alessandro De Stefani**, University of Nebraska-Lincoln, **Paolo Mantero**, University of Arkansas, and **Thomas Polstra**, University of Utah.

Groups in Low-dimensional Topology and Dynamics (Code: SS 7A), **Matt Clay**, University of Arkansas, and **Kathryn Mann**, Brown University.

Harmonic Analysis and Partial Differential Equations (Code: SS 8A), **Ariel Barton**, University of Arkansas, and **Simon Bortz**, University of Minnesota.

Interactions Between Combinatorics and Commutative Algebra (Code: SS 10A), **Ashwini Bhat**, **Chris Francisco**, and **Jeffrey Mermin**, Oklahoma State University.

Interactions Between Contact and Symplectic Geometry and Low-dimensional Topology (Code: SS 5A), **Jeremy Van Horn-Morris**, University of Arkansas, and **David Shea Vela-Vick**, Louisiana State University.

Non-associative Algebraic Structures and their (Co)homology Theories (Code: SS 12A), **Michael Kinyon**, University of Denver, **Jozef H Przytycki**, The George Washington University, and **Petr Vojtechovsky** and **Seung Yeop Yang**, University of Denver.

Numerical Methods for Nonlinear Systems (Code: SS 9A), **Jonathan Hauenstein** and **Tingting Tang**, University of Notre Dame.

Operator Theory and Function Spaces of Analytic Functions (Code: SS 13A), **Daniel Luecking** and **Maria Tjani**, University of Arkansas.

Partial Differential Equations in Several Complex Variables (Code: SS 2A), **Phillip Harrington** and **Andrew Raich**, University of Arkansas.

Recent Advances in Mathematical Fluid Mechanics (Code: SS 1A), **Zachary Bradshaw**, University of Arkansas.

Recent Developments on Fluid Turbulence (Code: SS 6A), **Eleftherios Gkioulekas**, University of Texas Rio Grande Valley.

The Geometry of Curves and Applications (Code: SS 14A), **Jason Cantarella** and **Philipp Reiter**, University of Georgia.

Validation and Verification Strategies in Multiphysics Problems (Code: SS 4A), **Tulin Kaman**, University of Arkansas.

Baltimore, Maryland

Baltimore Convention Center,
Hilton Baltimore, and
Baltimore Marriott Inner Harbor Hotel

January 16–19, 2019
Wednesday – Saturday

Meeting #1145
Joint Mathematics Meetings, including the 125th Annual Meeting of the AMS, 102nd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2018
Program first available on AMS website: November 1, 2018
Issue of *Abstracts*: Volume 40, Issue 1

Deadlines
For organizers: Expired
For abstracts: September 25, 2018

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/national.html.

Joint Invited Addresses
Sarah Koch, University of Michigan, *Title to be announced* (AMS-MAA Invited Address).

Bryna Kra, Northwestern University, *Dynamics of systems with low complexity* (AWM-AMS Noether Lecture).

Cathy O'Neil, ORCAA, *Big data, inequality, and democracy* (MAA-AMS-SIAM Gerald and Judith Porter Public Lecture).

Daniel Spielman, Yale University, *Miracles of Algebraic Graph Theory* (AMS-MAA Invited Address).

AMS Invited Addresses
Jesus De Loera, University of California Davis, *Title to be announced.*

Benedict H. Gross, University of California San Diego, *Complex multiplication: past, present, future* (AMS Colloquium Lectures: Lecture I).

Benedict H. Gross, University of California San Diego, *Complex multiplication: past, present, future* (AMS Colloquium Lectures: Lecture II).

Benedict H. Gross, University of California San Diego, *Complex multiplication: past, present, future* (AMS Colloquium Lectures: Lecture III).

Peter Oszvath, Princeton University, *Title to be announced.*

Lior Pachter, University of California Berkeley, *Title to be announced.*

Karen Hunger Parshall, University of Virginia, *The Roaring Twenties in American Mathematics.*

Alan Perelson, Los Alamos National Laboratory, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

Lillian Pierce, Duke University, *Title to be announced.*

AMS Special Sessions
If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at jointmathematicsmeetings.org/meetings/abstracts/abstract.pl?type=jmm.

Some sessions are cosponsored with other organizations. These are noted within the parenthesis at the end of each listing, where applicable.

25 years of Conferences for African-American Researchers in the Mathematical Sciences (CAARMS times 25) (Code: SS 82A), **William A. Massey**, Princeton University.

A Showcase of Number Theory at Undergraduate Institutions (Code: SS 76A), **Adriana Salerno**, Bates College, and **Lola Thompson**, Oberlin College.

Advances and Applications in Integral and Differential Equations (Code: SS 40A), **Jeffrey T. Neugebauer**, Eastern Kentucky University, and **Min Wang**, Kennesaw State University.

Advances by Early Career Women in Discrete Mathematics (Code: SS 75A), **Jessalyn Bolkema**, State University of New York at Oswego, and **Jessica De Silva**, California State University, Stanislaus.

Advances in Operator Theory, Operator Algebras, and Operator Semigroups (Code: SS 30A), **Joseph Ball**, Virginia Tech, **Marat Markin**, California State University, Fresno, **Igor Nikolaev**, St. John's University, and **Ilya Spitkovsky**, New York University, Abu Dhabi.

Advances in Quantum Walks, Quantum Simulations, and Related Quantum Theory (Code: SS 18A), **Radhakrishnan Balu**, US Army Research Lab, **Chaobin Liu**, Bowie State University, and **Takuya Machida**, Nihon University, Japan.

Agent-based Modeling in Biological and Social Systems(a Mathematics Research Communities Session) (Code: SS 15A), **Maryann Hohn**, University of California, Santa Barbara, **Angelika Manhart**, Imperial College, London, **Christopher Miles**, Courant Institute, New York University, **Cole Zmurchok**, University of British Columbia.

Algebraic Structures Motivated by Knot Theory (Code: SS 51A), **Mikhail Khovanov**, Columbia University, and **Jozef H. Przytycki** and **Alexander Shumakovitch**, George Washington University.

Algebraic and Geometric Methods in Discrete Optimization (Code: SS 2A), **Amitabh Basu**, Johns Hopkins University, and **Jesus De Loera**, University of California, Davis.

Algebraic, Discrete, Topological and Stochastic Approaches to Modeling in Mathematical Biology (Code: SS 43A), **Olcay Akman**, Illinois State University, **Timothy D. Comar**, Benedictine University, **Daniel Hrozencik**, Chicago State University, and **Raina Robeva**, Sweet Briar College.

Algorithmic Dimensions and Fractal Geometry (Code: SS 37A), **Jack H. Lutz**, Iowa State University, and **Elvira Mayordomo**, University of Zaragoza, Spain (AMS-ASL).

Analysis and Geometry of Nonlinear Evolution Equations (Code: SS 65A), **Marius Beceanu**, University at Albany, State University of New York, and **Dan-Andrei Geba**, University of Rochester.

Analysis of Fractional, Stochastic, and Hybrid Dynamic Systems with Applications (Code: SS 19A), **John R. Graef**, University of Tennessee at Chattanooga, **G. S. Ladde**, University of South Florida, and **A. S. Vatsala**, University of Louisiana at Lafayette.

Analytic Number Theory (Code: SS 33A), **Thomas A. Hulse**, Boston College, **Angel V. Kumchev** and **Nathan McNew**, Towson University, and **John Miller**, The Johns Hopkins University.

Arithmetic Statistics (Code: SS 53A), **Michael Chou** and **Robert Lemke Oliver**, Tufts University, and **Ari Shnidman**, Center for Communications Research-Princeton.

Bifurcations of Difference Equations and Discrete Dynamical Systems with Applications (Code: SS 72A), **Arzu Bilgin**, Recep Tayyip Erdogan University, Turkey, and **Toufik Khyat**, Trinity College.

Commutative Ring Theory: Research for Undergraduate and Early Graduate Students (Code: SS 60A), **Nicholas Baeth**, Franklin and Marshall College, and **Branden Stone**, Hamilton College.

Continued Fractions (Code: SS 35A), **Geremías Polanco Encarnación**, Hampshire College, **James McLaughlin**, West Chester University, **Barry Smith**, Lebanon Valley College, and **Nancy J. Wyshinski**, Trinity College.

Counting Methods in Number Theory (Code: SS 6A), **Lillian Pierce**, Duke University, **Arindam Roy**, Rice University, and **Jiyua Wang**, University of Wisconsin.

Definability and Decidability Problems in Number Theory (Code: SS 24A), **Kirsten Eisenträger**, Pennsylvania State University, **Deidre Haskell**, McMaster University, Ontario, Canada, **Jennifer Park**, University of Michigan, and **Alexandra Shlapentokh**, East Carolina University (AMS-ASL).

Differential Equations on Fractals (Code: SS 87A), **Patricia Alonso-Ruiz**, University of Connecticut, **Joe Chen**, Colgate University, **Luke Rogers**, University of Connecticut, **Robert Strichartz**, Cornell University, and **Alexander Teplyaev**, University of Connecticut.

Enumerative Combinatorics (Code: SS 26A), **Miklos Bona**, University of Florida, and **Cheyne Homberger**, University of Maryland, Baltimore County.

Financial Mathematics (Code: SS 66A), **Maxim Bichuch**, Johns Hopkins University, **Anja Richter**, Baruch College, City University of New York, and **Stephan Sturm**, Worcester Polytechnic Institute.

Geometric and Topological Combinatorics (Code: SS 39A), **Anastasia Chavez** and **Jamie Haddock**, University of California, Davis, and **Annie Raymond**, University of Massachusetts, Amherst.

Geometric and Topological Generalization of Groups (Code: SS 74A), **Amrita Acharyya**, University of Toledo, and **Bikash C. Das**, University of North Georgia.

Geometry Labs United: Research, Visualization, and Outreach (Code: SS 57A), **Marianne Korten**, Kansas State University, and **Sean Lawton** and **Anton Lukyanenko**, George Mason University.

Geometry and Dynamics of Continued Fractions (Code: SS 47A), **Anton Lukyanenko**, George Mason University, and **Joseph Vandehey**, Ohio State University.

Geometry of Representation Spaces (Code: SS 58A), **Sean Lawton**, George Mason University, **Chris Manon**, University of Kentucky, and **Daniel Ramras**, Indiana University-Purdue University Indianapolis.

Group Representation Theory and Character Theory (Code: SS 38A), **Mohammad Reza Darafsheh**, University of Tehran, Iran, and **Manouchehr Misaghian**, Prairie View A&M University.

Harmonic Analysis, Partial Differential Equations, and Applications (Code: SS 44A), **Russell Brown**, University of Kentucky, and **Irina Mitrea**, Temple University.

Harmonic Analysis: Recent Developments in Oscillatory Integrals (a Mathematics Research Communities Session) (Code: SS 12A), **Taryn C. Flock**, University of Massachusetts Amherst, **Xiumin Du**, University of Maryland,**Yakun Xi**, University of Rochester.

History of Mathematics (Code: SS 42A), **Sloan Despeaux**, Western Carolina University, **Jemma Lorenat**, Pitzer College, **Daniel E. Otero**, Xavier University, and **Adrian Rice**, Randolph-Macon College (AMS-MAA-ICHM).

Hopf Algebras and Tensor Categories (Code: SS 62A), **Siu-Hung Ng**, Louisiana State University, **Julia Plavnik**, Texas A&M University, and **Henry Tucker**, University of California, San Diego.

How to Guard an Art Gallery and Other Discrete Mathematical Adventures (In Memory of T. S. Michael, 1960 to 2016) (Code: SS 16A), **Joseph Bonin**, The George Washington University, **Carolyn Chun**, US Naval Academy, and **Nancy Neudauer**, Pacific University.

If You Build It They Will Come: Presentations by Scholars in the National Alliance for Doctoral Studies in the Mathematical Sciences (Code: SS 54A), **David Goldberg**, Purdue University, and **Phil Kutzko**, University of Iowa.

Latinx in Math (Code: SS 34A), **Alexander Diaz-Lopez**, Villanova University, **Laura Escobar**, University of Illinois, and **Juanita Pinzón-Caicedo**, North Carolina State University.

Lattice Path Combinatorics and Applications (Code: SS 68A), **Christian Krattenthaler**, University of Vienna, Austria, and **Alan Krinik** and **Randall J. Swift**, California State Polytechnic University.

Localization and Delocalization for Disordered Quantum Systems (Code: SS 83A), **Peter D. Hislop**, University of Kentucky, **Christoph A. Marx**, Oberlin College, and **Jeffery Schenker**, Michigan State University.

Low Complexity Models in Data Analysis and Machine Learning (Code: SS 55A), **Emily J. King**, University of Bremen, Germany, **Nate Strawn**, Georgetown University, and **Soledad Villar**, New York University.

Mappings on Metric and Banach Spaces with Applications to Fixed Point Theory (Code: SS 63A), **Torrey M. Gal-**

lagher, Bucknell University, and **Christopher J. Lennard**, University of Pittsburgh.

Mathematical Analysis in Fluid Dynamics (Code: SS 31A), **Yanqiu Guo**, Florida International University, **Jinkai Li**, South China Normal University, **Jing Tian**, Towson University, and **Yuncheng You**, University of South Florida.

Mathematical Investigations of Spatial Ecology and Epidemiology (Code: SS 79A), **Leah Shaw** and **Junping Shi**, College of William and Mary, and **Zhisheng Shuai**, University of Central Florida.

Mathematical Models in Ecology, Epidemiology, and Medicine (Code: SS 85A), **Richard Schugart**, Western Kentucky University, and **Najat Ziyadi**, Morgan State University.

Mathematicians at Sea (in the Sky, or on Land): Defense Applications of Mathematics (Code: SS 21A), **Tegan Emerson**, **Timothy Doster**, and **George Stantchev**, Naval Research Laboratory.

Mathematics in the Realm of Cyber Research (Code: SS 22A), **Daniel Bennett**, Army Cyber Institute, **Paul Goethals**, United States Military Academy, and **Natalie Scala**, Towson University.

Mathematics of Coding Theory and Applications (Code: SS 78A), **Hiram Lopez-Valdez** and **Felice Manganiello**, Clemson University, and **Gretchen L. Matthews**, Virginia Tech.

Mathematics of Gravity and Light (a Mathematics Research Communities Session) (Code: SS 11A), **Sougata Dhar**, University of Maine, **Chad R. Mangum**, Niagara University, and **Nadine Stritzelberger**, University of Waterloo.

Multiscale Problems in the Calculus of Variations (Code: SS 46A), **Elisa Davoli**, University of Vienna, Austria, and **Rita Ferreira**, King Abdullah University of Science and Technology, Saudi Arabia.

Natural Resources Modeling (Code: SS 56A), **Julie Blackwood**, Williams College, and **Shandelle M. Henson**, Andrews University.

Network Science (Code: SS 52A), **David Burstein**, Swarthmore College, **Franklin Kenter**, United States Naval Academy, and **Feng 'Bill' Shi**, University of North Carolina.

New Directions in the Theory of Complex Multiplication (Code: SS 1A), **Henri Darmon**, McGill University, **Samit Dasgupta**, University of California, Santa Cruz, and **Benedict Gross**, Harvard University.

Nonlinear Evolution Equations and Their Applications (Code: SS 20A), **Mingchao Cai**, Morgan State University, **Gisele Mophou Loudjom**, University of French West Indies, Guadeloupe, France, and **Gaston N'Guerekata**, **Alexander Pankov**, **Xuming Xie**, and **Guoping Zhang**, Morgan State University.

Not KNerds: A Community for Knot Theory (Code: SS 77A), **Moshe Cohen**, Vassar College, **Elizabeth Denne**, Washington and Lee University, and **Adam Lowrance**, Vassar College.

Number Theoretic Methods in Hyperbolic Geometry (a Mathematics Research Communities Session) (Code: SS 14A), **Samantha Fairchild**, University of Washington, **Junxian Li**, University of Illinois Urbana–Champaign, and **Richard Vradenburgh**, University of Virginia.

Number Theory, Arithmetic Geometry, and Computation (Code: SS 61A), **Brendan Hassett**, Brown University, **Drew Sutherland**, Massachusetts Institute of Technology, and **John Voight**, Dartmouth College.

Numerical Methods for PDEs and Applications (Code: SS 41A), **Wenrui Hao**, **Qingguo Hong**, and **Jinchao Xu**, Pennsylvania State University.

Optimal Methods in Applicable Analysis: Variational Inequalities, Low Rank Matrix Approximations, Systems Engineering, Cyber Security (Code: SS 81A), **Aritra Dutta**, King Abdullah University of Science and Technology, Saudi Arabia, **Ram Mohapatra**, University of Central Florida, **Gayatri Pany**, Singapore University of Technology and Design, Singapore, and **Nabin Kumar Sahu**, Dhirubhai Ambani Institute of Information and Communication Technology, India.

Orthogonal Polynomials, Quantum Probability, Harmonic and Stochastic Analysis (Code: SS 27A), **Nobuhiro Asai**, Aichi University of Education, Kariya, Japan, **Rodica Costin**, The Ohio State University, **Aurel I. Stan**, The Ohio State University at Marion, and **Hiroaki Yoshida**, Ochanomizu University, Tokyo, Japan.

Partition Theory and Related Topics (Code: SS 80A), **Dennis Eichhorn**, University of California, Irvine, **Tim Huber**, University of Texas, Rio Grande Valley, and **Amita Malik**, Rutgers University.

Problems in Partial Differential Equations (Code: SS 36A), **Alex Himonas**, University of Notre Dame, and **Curtis Holliman**, The Catholic University of America.

Quantum Symmetries: Subfactors and Fusion Categories (a Mathematics Research Communities Session) (Code: SS 13A), **Cain Edie-Michell**, Vanderbilt University, **Lauren Ruth**, Vanderbilt University, and **Yilong Wang**, Louisiana State University.

Quaternions (Code: SS 28A), **Terrence Blackman**, Medgar Evers College, City University of New York, and **Johannes Familton** and **Chris McCarthy**, Borough of Manhattan Community College, City University of New York.

Recent Advancements in Mathematical Modeling of Cancer (Code: SS 49A), **Kamila Larripa**, Humboldt State University, and **Hwayeon Ryu**, University of Hartford.

Recent Advances and Trends in Computable Structure Theory (in honor of J. Remmel) (Code: SS 64A), **Jennifer Chubb**, University of San Francisco, and **Tim McNicholl**, Iowa State University.

Recent Advances in Biological Modeling and Related Dynamical Analysis (Code: SS 69A), **Joshi Raj Hem**, Xavier University, and **Yanyu Xiao**, University of Cincinnati.

Recent Advances in Homological and Commutative Algebra (Code: SS 70A), **Neil Epstein**, George Mason University, **Claudiu Raicu**, Notre Dame University, and **Alexandra Seceleanu**, University of Nebraska.

Recent Advances in Inverse Problems and Imaging (Code: SS 25A), **Kui Ren**, University of Texas at Austin, and **Yang Yang**, Michigan State University.

Recent Advances in Regularity Lemmas (Code: SS 71A), **Gabriel Conant**, University of Notre Dame, **Rehana Patel**, and **Julia Wolf**, University of Bristol, UK.

Recent Progress in Multivariable Operator Theory (Code: SS 86A), **Dmitry Kaliuzhnyi-Verbovetsky** and **Hugo Woerdeman**, Drexel University.

Research in Mathematics by Early Career Graduate Students (Code: SS 84A), **Marat Markin**, **Morgan Rodgers**, **Khang Tran**, and **Oscar Vega**, California State University, Fresno.

Research in Mathematics by Undergraduates and Students in Post-Baccalaureate Programs (Code: SS 32A), **Darren A. Narayan**, Rochester Institute of Technology, **Khang Tran**, California State University, Fresno, **Mark David Ward**, Purdue University, and **John Wierman**, The Johns Hopkins University (AMS-MAA-SIAM).

Riordan Arrays (Code: SS 50A), **Alexander Burstein** and **Dennis Davenport**, Howard University, **Asamoah Nkwanta**, Morgan State University, **Lou Shapiro**, Howard University, and **Leon Woodson**, Morgan State University.

Statistical, Variational, and Learning Techniques in Image Analysis and their Applications to Biomedical, Hyperspectral, and Other Imaging (Code: SS 45A), **Justin Marks**, Gonzaga University, **Laramie Paxton**, Washington State University, and **Viktoria Taroudaki**, Eastern Washington University.

Stochastic Analysis and Applications in Finance, Actuarial Science and Related Fields (Code: SS 17A), **Julius N. Esunge**, University of Mary Washington, **See Keong Lee**, University of the Sciences, Malaysia, and **Aurel I. Stan**, The Ohio State University at Marion.

Stochastic Differential Equations and Applications (Code: SS 59A), **Carey Caginalp**, University of Pittsburgh.

Symbolic Dynamics (Code: SS 9A), **Van Cyr**, Bucknell University, and **Bryna Kra**, Northwestern University.

The Mathematics of Historically Black Colleges and Universities (HBCUs) in the Mid-Atlantic (Code: SS 88A), **Edray Goins**, Purdue University, **Janis Oldham**, North Carolina A&T, **Talitha Washington**, Howard University, and **Scott Williams**, University at Buffalo, State University of New York.

Topological Data Analysis: Theory and Applications (Code: SS 73A), **Justin Curry**, University at Albany, State University of New York, **Mikael Vejdemo-Johansson**, College of Staten Island, City University of New York, and **Sara Kalisnik Verovsek**, Wesleyan University.

Topology, Structure and Symmetry in Graph Theory (Code: SS 48A), **Lowell Abrams**, George Washington University, and **Mark Ellingham**, Vanderbilt University.

Using Modeling to Motivate the Study of Differential Equations (Code: SS 29A), **Robert Kennedy**, Centennial High School, Ellicott City MD, **Audrey Malagon**, Virginia Wesleyan University, **Brian Winkel**, SIMIODE, Cornwall NY, and **Dina Yagodich**, Frederick Community College.

Women in Topology (Code: SS 67A), **Jocelyn Bell**, Hobart and William Smith Colleges, **Rosemary Guzman**, University of Chicago, **Candice Price**, University of San Diego, and **Arunima Ray**, Max Planck Institute for Mathematics, Germany.

Auburn, Alabama

Auburn University

March 15–17, 2019

Friday – Sunday

Meeting #1146

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: January, 2019
Program first available on AMS website: January 31, 2019
Issue of *Abstracts*: Volume 40, Issue 2

Deadlines

For organizers: Expired
For abstracts: January 22, 2019

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Grigoriy Blekherman, Georgia Institute of Technology, *To be announced.*

Carina Curto, Pennsylvania State University, *To be announced.*

Ming Liao, Auburn University, *To be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `www.ams.org/cgi-bin/abstracts/abstract.pl`.

Combinatorial Matrix Theory (Code: SS 2A), **Zhongshan Li**, Georgia State University, and **Xavier Martínez-Rivera**, Auburn University.

Commutative and Combinatorial Algebra (Code: SS 3A), **Selvi Kara Beyarslan**, University of South Alabama, and **Alessandra Costantini**, Purdue University.

Developments in Commutative Algebra (Code: SS 1A), **Eloísa Grifo**, University of Michigan, and **Patricia Klein**, University of Kentucky.

Differential Equations in Mathematical Biology (Code: SS 7A), **Guihong Fan**, Columbus State University, **Zhongwei Shen**, University of Alberta, **Xiaoxia Xie**, Idaho State University.

Experimental Mathematics in Number Theory, Analysis, and Combinatorics (Code: SS 6A), **Amita Malik**, Rutgers University, and **Armin Straub**, University of South Alabama.

Graph Theory in Honor of Robert E. Jamison's 70th Birthday (Code: SS 4A), **Robert A Beeler**, East Tennessee State University, **Gretchen Matthews**, Virginia Tech, and **Beth Novick**, Clemson University.

Probability and Stochastic Processes (Code: SS 5A), **Ming Liao**, **Erkan Nane**, and **Jerzy Szulga**, Auburn University.

Honolulu, Hawaii

University of Hawaii at Manoa

March 22–24, 2019
Friday – Sunday

Meeting #1147

Central Section
Associate secretaries: Georgia Benkart and Michel L. Lapidus
Announcement issue of *Notices*: January, 2019
Program first available on AMS website: February 7, 2019
Issue of *Abstracts*: Volume 40, Issue 2

Deadlines

For organizers: Expired
For abstracts: January 29, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Barry Mazur, Harvard University, *On the Arithmetic of Curves* (Einstein Public Lecture in Mathematics).

Aaron Naber, Northwestern University, *Analysis of Geometric Nonlinear Partial Differential Equations*.

Deanna Needell, University of California, Los Angeles, *Simple approaches to complicated data analysis*.

Katherine Stange, University of Colorado, Boulder, *Title to be announced*.

Andrew Suk, University of California, San Diego, *Title to be announced*.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Advances in Iwasawa Theory (Code: SS 12A), **Frauke Bleher**, University of Iowa, **Ted Chinburg**, University of Pennsylvania, and **Robert Harron**, University of Hawaii at Manoa.

Advances in Mathematical Fluid Mechanics (Code: SS 32A), **Kazuo Yamazaki**, University of Rochester, and **Adam Larios**, University of Nebraska - Lincoln.

Algebraic Groups, Galois Cohomology, and Local-Global Principles (Code: SS 3A), **Raman Parimala**, Emory University, **Andrei Rapinchuk**, University of Virginia, and **Igor Rapinchuk**, Michigan State University.

Algebraic Number Theory and Diophantine Equations (Code: SS 20A), **Claude Levesque**, University of Laval.

Algebraic Points (Code: SS 36A), **Barry Mazur** and **Hector Pasten**, Harvard University.

Algebraic and Combinatorial Structures in Knot Theory (Code: SS 9A), **Sam Nelson**, Claremont McKenna College, **Natsumi Oyamaguchi**, Shumei University, and **Kanako Oshiro**, Sophia University.

Algebraic and Geometric Combinatorics (Code: SS 17A), **Andrew Berget**, Western Washington University, and **Steven Klee**, Seattle University.

Analysis of Nonlinear Geometric Equations (Code: SS 23A), **Aaron Naber**, Northwestern University, and **Richard Bamler**, University of California Berkeley.

Analytic and Probabilistic Methods in Convex Geometry (Code: SS 27A), **Alexander Koldobsky**, University of Missouri, **Alexander Litvak**, University of Alberta, **Dmitry Ryabogin**, Kent State University, **Vladyslav Yaskin**, University of Alberta, and **Artem Zvavitch**, Kent State University.

Applications of Ultrafilters and Nonstandard Methods (Code: SS 33A), **Isaac Goldbring**, University of California, Irvine, and **Steven Leth**, University of Northern Colorado.

Arithmetic Dynamics (Code: SS 29A), **Andrew Bridy**, Texas A&M University, **Michelle Manes**, University of Hawai‘i at Manoa, and **Bianca Thompson**, Harvey Mudd College.

Arithmetic Geometry and Its Connections (Code: SS 51A), **Laura Capuano**, University of Oxford, and **Amos Turchet**, University of Washington.

Arithmetic and Transcendence of Special Functions and Special Values (Code: SS 56A), **Matthew A. Papanikolas**, Texas A&M University, and **Federico Pellarin**, Université Jean Monnet, St. Étienne.

Coarse Geometry, Index Theory, and Operator Algebras: Around the Mathematics of John Roe (Code: SS 53A), **Erik Guentner**, University of Hawai‘i at Manoa, **Nigel Higson**, Penn State University, and **Rufus Willett**, University of Hawai‘i at Manoa.

Coding Theory and Information Theory (Code: SS 39A), **Manabu Hagiwara**, Chiba University, and **James B. Nation**, University of Hawaii.

Combinatorial and Experimental Methods in Mathematical Phylogeny (Code: SS 47A), **Sean Cleary**, City College of New York and the CUNY Graduate Center, and **Katherine St. John**, Hunter College and the American Museum of Natural History.

Commutative Algebra and its Environs (Code: SS 4A), **Olgur Celikbas** and **Ela Celikbas**, West Virginia University, and **Ryo Takahashi**, Nagoya University.

Computability, Complexity, and Learning (Code: SS 45A), **Achilles A. Beros** and **Bjørn Kjos-Hanssen**, University of Hawai‘i at Manoa.

Computational and Data-Enabled Sciences (Code: SS 54A), **Roummel Marcia**, **Boaz Ilan**, and **Suzanne Sindi**, University of California, Merced.

Constructive Aspects of Complex Analysis (Code: SS 7A), **Ilia Binder** and **Michael Yampolsky**, University of Toronto, and **Malik Younsi**, University of Hawaii at Manoa.

Differential Geometry (Code: SS 10A), **Vincent B. Bonini**, Cal Poly San Luis Obispo, **Jie Qing**, University of California, Santa Cruz, and **Bogdan D. Suceava**, California State University, Fullerton.

Emerging Connections with Number Theory (Code: SS 43A), **Katherine Stange**, University of Colorado, Boulder, and **Renate Scheidler**, University of Calgary.

Factorization and Arithmetic Properties of Integral Domains and Monoids (Code: SS 31A), **Scott Chapman**, Sam Houston State University, **Jim Coykendall**, Clemson University, and **Christopher O'Neill**, University California, Davis.

Generalizations of Symmetric Spaces (Code: SS 22A), **Aloysius Helminck**, University of Hawaii at Manoa, **Vicky Klima**, Appalachian State University, **Jennifer Schaefer**, Dickinson College, and **Carmen Wright**, Jackson State University.

Geometric Approaches to Mechanics and Control (Code: SS 55A), **Monique Chyba**, University of Hawaii at Manoa, **Tomoki Ohsawa**, The University of Texas at Dallas, and **Vakhtang Putkaradze**, University of Alberta.

Geometry, Analysis, Dynamics and Mathematical Physics on Fractal Spaces (Code: SS 8A), **Joe P. Chen**, Colgate University, **Lũ (Tim) Hùng**, Hawai'i Pacific University, **Machiel van Frankenhuijsen**, Utah Valley University, and **Robert G. Niemeyer**, University of the Incarnate Word.

Homotopy Theory (Code: SS 48A), **Kyle Ormsby** and **Angélica Osorno**, Reed College.

Interactions between Geometric Measure Theory, PDE, and Harmonic Analysis (Code: SS 41A), **Mark Allen**, Brigham Young University, **Spencer Becker-Kahn**, University of Washington, **Max Engelstein**, Massachusetts Institute of Technology, and **Mariana Smit Vega Garcia**, University of Washington.

Interactions between Noncommutative Algebra and Noncommutative Algebraic Geometry (Code: SS 24A), **Garrett Johnson**, North Carolina Central University, **Bach Nguyen** and **Xingting Wang**, Temple University, and **Daniel Yee**, Bradley University.

Lie Theory in the Representations of Groups and Related Structures (Code: SS 14A), **Christopher Drupieski**, DePaul University, and **Kay Magaard**, University of Arizona.

Mapping Class Groups (Code: SS 35A), **Asaf Hadari**, University of Hawaii.

Mathematical Analysis of Nonlinear Phenomena (Code: SS 16A), **Mimi Dai**, University of Illinois at Chicago.

Mathematical Methods and Models in Medicine (Code: SS 19A), **Monique Chyba**, University of Hawaii, and **Jakob Kotas**, University of Hawaii and University of Portland.

New Trends in Geometric Measure Theory (Code: SS 37A), **Antonio De Rosa**, Courant Institute of Mathematical Sciences, New York University, and **Luca Spolaor**, Massachusetts Institute of Technology.

New Trends on Variational Calculus and Non-Linear Partial Differential Equations (Code: SS 44A), **Craig Cowan**, University of Manitoba, **Michinori Ishiwata**, Osaka University, **Abbas Moameni**, Carleton University, and **Futoshi Takahashi**, Osaka City University.

Nonlinear Wave Equations and Applications (Code: SS 42A), **Boaz Ilan**, University of California, Merced, and **Barbara Prinari**, University of Colorado, Colorado Springs.

Numerical Methods for Partial Differential Equations (Code: SS 50A), **Evan Gawlik**, **Michael Holst**, and **Martin Licht**, University of California, San Diego.

Real and Complex Singularities (Code: SS 34A), **Leslie Charles Wilson**, University of Hawaii, Manoa, **Goo Ishikawa**, Hokkaido University, and **David Trotman**, Université de Provence.

Recent Advances and Applications of Modular Forms (Code: SS 1A), **Amanda Folsom**, Amherst College, **Pavel Guerzhoy**, University of Hawaii at Manoa, **Masanobu Kaneko**, Kyushu University, and **Ken Ono**, Emory University.

Recent Advances in Lie and Related Algebras and their Representations (Code: SS 28A), **Brian D. Boe**, University of Georgia, and **Jonathan Kujawa**, University of Oklahoma.

Recent Advances in Numerical Methods for PDEs (Code: 2249A), **Hengguang Li**, Wayne State University, and **Sara Pollock**, University of Florida.

Recent Advances in Numerical Methods for PDEs (Code: SS 49A), **Hengguang Li**, Wayne State University, and **Sara Pollock**, University of Florida.

Recent Developments in Automorphic Forms (Code: SS 2A), **Solomon Friedberg**, Boston College, and **Jayce Getz**, Duke University.

Recent Trends in Algebraic Graph Theory (Code: SS 26A), **Sebastian Cioaba**, University of Delaware, and **Shaun Fallat**, University of Regina.

SYZ Mirror Symmetry and Enumerative Geometry (Code: SS 11A), **Siu Cheong Lau**, Boston University, **Naichung Leung**, The Chinese University of Hong Kong, and **Hsian-Hua Tseng**, Ohio State University.

Several Complex Variables (Code: SS 5A), **Peter Ebenfelt**, University of California, San Diego, **John Erik Fornaess**, University of Michigan and Norwegian University of Science and Technology, **Ming Xiao**, University of California, San Diego, and **Yuan Yuan**, Syracuse University.

Spaces of Holomorphic Functions and Their Operators (Code: SS 21A), **Mirjana Jovovic** and **Wayne Smith**, University of Hawaii.

Sparsity, Randomness, and Optimization (Code: SS 15A), **Deanna Needell** and **Jamie Haddock**, University of California, Los Angeles.

Spectral Geometry: The Length and Laplace Spectra of Riemannian Manifolds (Code: SS 25A), **Benjamin Linowitz**, Oberlin College, and **Jeffrey S. Meyer**, California State University at San Bernardino.

Stability and Singularity in Fluid Dynamics (Code: SS 40A), **Tristan Buckmaster**, Princeton University, **Steve Shkoller**, University of California, Davis, and **Vlad Vicol**, Princeton University.

Structural Graph Theory (Code: SS 30A), **Zixia Song**, University of Central Florida, **Martin Rolek**, College of William and Mary, and **Yue Zhao**, University of Central Florida.

Teaching Mathematics for Understanding (Code: SS 13A), **Tara Davis** and **Hung Lu**, Hawai'i Pacific University, **Prasad Senesi**, The Catholic University of America, and **Machiel van Frankenhuijsen**, Utah Valley University.

The Mathematics of Cryptography (Code: SS 18A), **Shahed Sharif**, California State University, San Marcos, and **Alice Silverberg**, University of California, Irvine.

Three-dimensional Floer Theory, Contact Geometry, and Foliations (Code: SS 6A), **Joan Licata**, Australian National University, and **Robert Lipshitz**, University of Oregon.

Topics at the Interface of Analysis and Geometry (Code: SS 38A), **Alex Austin** and **Sylvester Eriksson-Bique**, University of California, Los Angeles.

Valuations on Algebraic Function Fields and Their Subrings (Code: SS 46A), **Ron Brown**, University of Hawaii, **Steven Dale Cutkosky**, University of Missouri, and **Franz-Viktor Kuhlmann**, University of Szczecin.

What is Happening in Mathematical Epidemiology? Current Theory, New Methods, and Open Questions (Code: SS 52A), **Olivia Prosper**, University of Kentucky.

Hartford, Connecticut

University of Connecticut Hartford (Hartford Regional Campus)

April 13–14, 2019

Saturday – Sunday

Meeting #1148

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: February, 2019
Program first available on AMS website: February 21, 2019
Issue of *Abstracts*: Volume 40, Issue 2

Deadlines

For organizers: September 13, 2018
For abstracts: February 5, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Olivier Bernardi, Brandeis University, *Title to be announced.*

Brian Hall, Notre Dame University, *Title to be announced.*

Christina Sormani, City University of New York, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Analysis, Geometry, and PDEs in Non-smooth Metric Spaces (Code: SS 1A), **Vyron Vellis**, University of Connecticut, **Xiaodan Zhou**, Worcester Polytechnic Institute, and **Scott Zimmerman**, University of Connecticut.

Computability Theory (Code: SS 2A), **Damir Dzhafarov** and **Reed Solomon**, University of Connecticut, and **Linda Brown Westrick**, Pennsylvania State University.

Mathematical Cryptology (Code: SS 8A), **Lubjana Beshaj**, United States Military Academy, and **Jamie Jaime Gutierrez**, University of Cantabria, Santander, Spain.

Modeling and Qualitative Study of PDEs from Materials Science and Geometry. (Code: SS 6A), **Yung-Sze Choi**, **Changfeng Gui**, and **Xiaodong Yan**, University of Connecticut.

Recent Development of Geometric Analysis and Nonlinear PDEs (Code: SS 3A), **Ovidiu Munteanu**, **Lihan Wang**, and **Ling Xiao**, University of Connecticut.

Special Session on Regularity Theory of PDEs and Calculus of Variations on Domains with Rough Boundaries (Code: SS 5A), **Murat Akman**, University of Connecticut, and **Zihui Zhao**, University of Washington.

Stochastic Analysis and Related Fields (Code: SS 7A), **Fabrice Baudoin**, University of Connecticut, and **Cheng Ouyang**, University of Illinois at Chicago.

Stochastic Processes, Random Walks, and Heat Kernels (Code: SS 4A), **Patricia Alonso Ruiz**, University of Connecticut, and **Phanuel Mariano**, Purdue University.

Sub-Riemannian and CR Geometric Analysis (Code: SS 9A), **Fabrice Baudoin**, University of Connecticut, and **Luca Capogna**, Worcester Polytechnic Institute.

Quy Nhon City, Vietnam

Quy Nhon University

June 10–13, 2019

Monday – Thursday

Meeting #1149

Associate secretary: Brian D. Boe
Announcement issue of *Notices*: April, 2019
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: November 30, 2018
For abstracts: To be announced

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/internmtgs.html.

Invited Addresses

Henry Cohn, Microsoft Research, *To be announced.*

Robert Guralnick, University of Southern California, *To be announced.*

Le Tuan Hoa, Hanoi Institute of Mathematics, *To be announced.*

Nguyen Dong Yen, Hanoi Institute of Mathematics, *To be announced.*

Zhiwei Yun, Massachusetts Institute of Technology, *To be announced.*

Nguyen Tien Zung, Toulouse Mathematics Institute, *To be announced.*

Madison, Wisconsin

University of Wisconsin-Madison

September 14–15, 2019

Saturday – Sunday

Meeting #1150

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: June/July 2019
Program first available on AMS website: July 23, 2019
Issue of *Abstracts*: Volume 40, Issue 3

Deadlines

For organizers: February 14, 2019
For abstracts: July 16, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Nathan Dunfield, University of Illinois, Urbana–Champaign, *Title to be announced.*

Teena Gerhardt, Michigan State University, *Title to be announced.*

Lauren Williams, University of California, Berkeley, *Title to be announced* (Erdős Memorial Lecture).

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Homological and Characteristic $p > 0$ Methods in Commutative Algebra (Code: SS 1A), **Michael Brown**, University of Wisconsin-Madison, and **Eric Canton**, University of Michigan.

Recent Developments in Harmonic Analysis (Code: SS 3A), **Theresa Anderson**, Purdue University, and **Joris Roos**, University of Wisconsin-Madison.

Recent Work in the Philosophy of Mathematics (Code: SS 4A), **Thomas Drucker**, University of Wisconsin-Whitewater, and **Dan Sloughter**, Furman University.

Special Functions and Orthogonal Polynomials (Code: SS 2A), **Sarah Post**, University of Hawai‘i at Manoa, and **Paul Terwilliger**, University of Wisconsin–Madison.

Binghamton, New York

Binghamton University

October 12–13, 2019
Saturday – Sunday

Meeting #1151

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: August, 2019
Program first available on AMS website: August 29, 2019
Issue of *Abstracts*: Volume 40, Issue 3

Deadlines

For organizers: March 12, 2019
For abstracts: August 20, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Richard Kenyon, Brown University, *Title to be announced.*

Tony Pantev, University of Pennsylvania, *Title to be announced.*

Lai-Sang Young, New York University, *Title to be announced.*

Gainesville, Florida

University of Florida

November 2–3, 2019
Saturday – Sunday

Meeting #1152

Southeastern Section
Associate secretary: Brian D. Boe
Program first available on AMS website: September 19, 2019
Program issue of electronic *Notices*: September, 2019
Issue of *Abstracts*: Volume 40, Issue 4

Deadlines

For organizers: April 2, 2019
For abstracts: September 10, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Jonathan Mattingly, Duke University, *To be announced.*

Isabella Novik, University of Washington, *To be announced.*

Eduardo Teixeira, University of Central Florida, *To be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Geometric and Topological Combinatorics (Code: SS 1A), **Bruno Benedetti**, University of Miami, **Steve Klee**, Seattle University, and **Isabella Novik**, University of Washington.

Riverside, California

University of California, Riverside

November 9–10, 2019
Saturday – Sunday

Meeting #1153
Western Section
Associate secretary: Michel L. Lapidus
Program first available on AMS website: September 12, 2019
Program issue of electronic *Notices*: September, 2019
Issue of *Abstracts*: Volume 40, Issue 4

Deadlines
For organizers: April 9, 2019
For abstracts: September 3, 2019

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Robert Boltje, University of California, Santa Cruz, *Title to be announced*.

Jonathan Novak, University of California, San Diego, *Title to be announced*.

Anna Skripka, University of New Mexico, Albuquerque, *Title to be announced*.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Topics in Operator Theory (Code: SS 1A), **Anna Skripka** and **Maxim Zinchenko**, University of New Mexico.

Random Matrices and Related Structures (Code: SS 2A), **Jonathan Novak, University of California, San Diego,** and **Kari Liechty**, De Paul.

Denver, Colorado

Colorado Convention Center

January 15–18, 2020
Wednesday – Saturday

Meeting #1154
Joint Mathematics Meetings, including the 126th Annual Meeting of the AMS, 103rd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM)
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2019
Program first available on AMS website: November 1, 2019
Issue of *Abstracts*: To be announced

Deadlines
For organizers: April 1, 2019
For abstracts: To be announced

Charlottesville, Virginia

University of Virginia

March 13–15, 2020
Friday – Sunday
Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Fresno, California

California State University, Fresno

May 2–3, 2020
Saturday – Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Washington, District of Columbia

Walter E. Washington Convention Center

January 6–9, 2021
Wednesday – Saturday
Joint Mathematics Meetings, including the 127th Annual Meeting of the AMS, 104th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: October 2020
Program first available on AMS website: November 1, 2020
Issue of *Abstracts*: To be announced

Deadlines
For organizers: April 1, 2020
For abstracts: To be announced

Grenoble, France

Université Grenoble Alpes

July 5–9, 2021
Monday – Friday
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Buenos Aires, Argentina

The University of Buenos Aires

July 19–23, 2021
Monday – Friday
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Seattle, Washington

Washington State Convention Center and the Sheraton Seattle Hotel

January 5–8, 2022
Wednesday – Saturday
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: October 2021
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced
For abstracts: To be announced

Boston, Massachusetts

John B. Hynes Veterans Memorial Convention Center, Boston Marriott Hotel, and Boston Sheraton Hotel

January 4–7, 2023
Wednesday – Saturday
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2022
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines

For organizers: To be announced
For abstracts: To be announced

Research Funding

Artwork drawn by Michael Berg.

"There's not enough room
in seventeen syllables
to contain infin—"

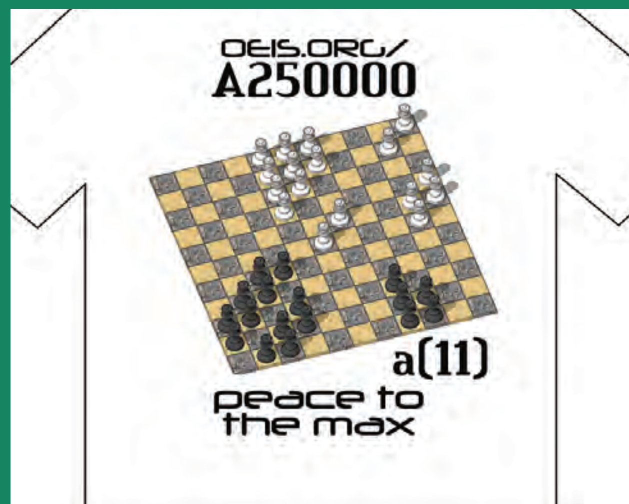
by Teena Carroll, From Math in Seventeen Syllables: A Folder of Mathematical Haiku, *J. Humanistic Math.* 8 (Jan. 2018), scholarship.claremont.edu/jhm/vol8/iss1/22.

For a probable prime which on a phone screen looks like a giraffe, see tinyurl.com/ycuy77we.

IN THE NEXT ISSUE OF NOTICES

OCTOBER 2018

Sampler of the AMS Fall Western Sectional Meeting Invited Addresses



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David E. Zitarelli, *Temple University, Philadelphia, PA*

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Spectrum, Volume 94; 2018; 768 pages; Hardcover; ISBN: 978-1-4704-4829-5; List US$120; MAA members US$90; Individual member US$90; Order code SPEC/94

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MAA Textbooks, Volume 40; 2018; 405 pages; Hardcover; ISBN: 978-1-4704-4360-3; List US$79; MAA members US$59.25; Individual member US$59.25; Order code TEXT/40

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John M. Erdman, *Portland State University, OR*

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