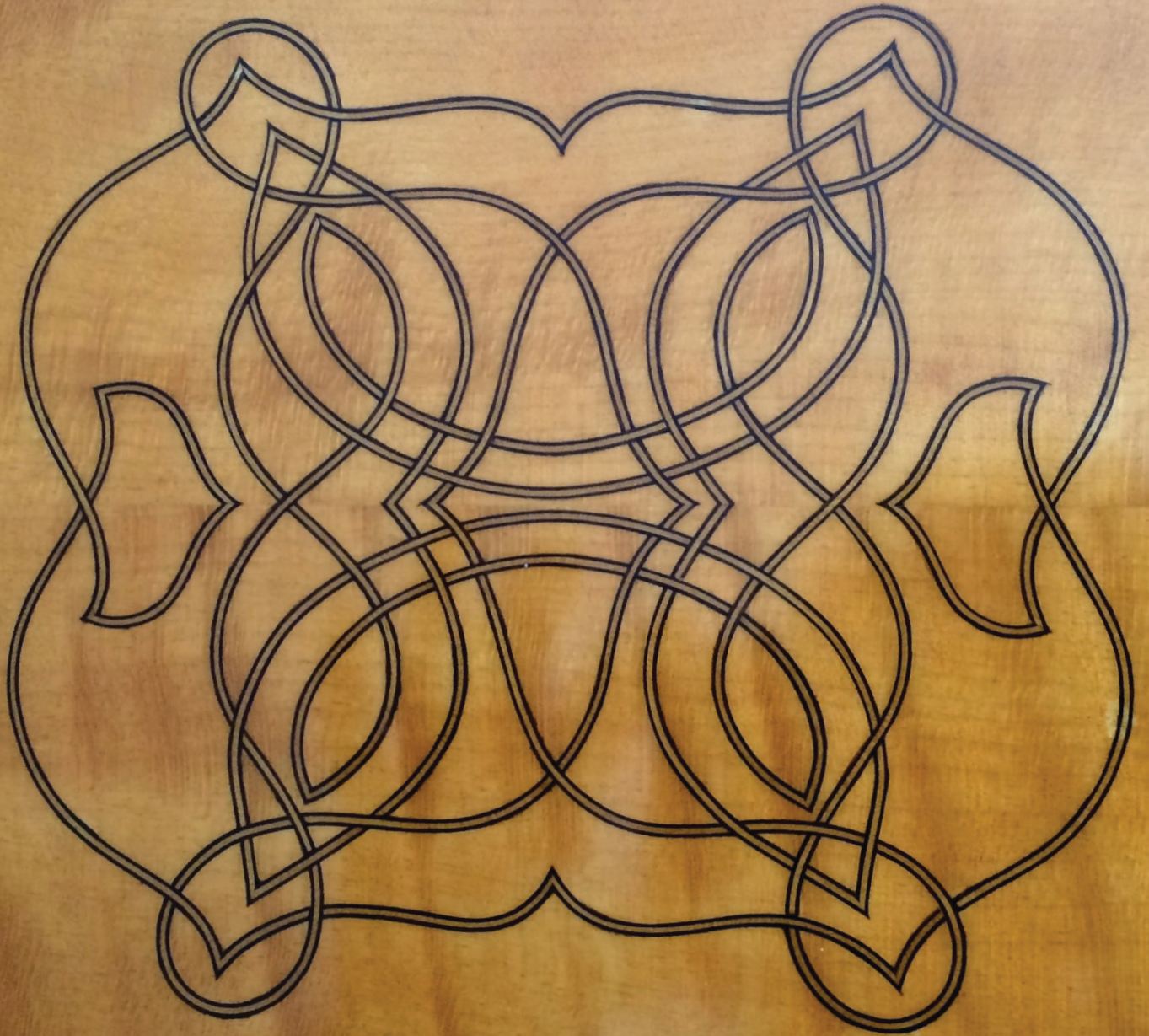


UC DAVIS

MATHEMATICS NEWSLETTER



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Letter from the Chair

by Abigail Thompson, Department Chair

We had a great year for hiring in 2017-18, with three new Assistant Professors (Laura Starkston, Roger Casals, and Rishidev Chaudhuri) and three Krener Assistant Professors (Annalaura Stingo, Tair Akhmejanov, Martin Gebert) joining our Department. Two long-time members of the faculty retired this June. We hope that Emerita Professor Angela Cheer and Continuing Lecturer Emeritus Lawrence Marx will continue to contribute their valuable experience and expertise to the Department. A celebration of Angela Cheer's research career in October featured two members of the National Academy of Sciences in a fascinating afternoon of talks describing applications of mathematics to everything from fluid flows in cells to how, exactly, lobsters smell.



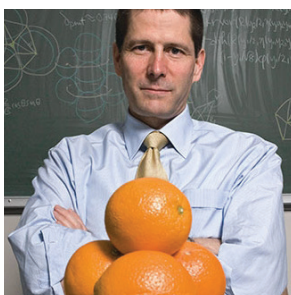
Angela Cheer and Lawrence Marx are both retiring

Last spring the Department hosted several exciting events. The Thurston Lectures, our endowed annual lecture series, were given by Professor Thomas Hales, who described his work on the Kepler conjecture and on its formal (computer) verification. Associate Dean Motohico Mulase gave an inspiring lecture to honor the work of the late Fields Medalist Maryam Mirzakhani, and Professor Janko Gravner conducted a fascinating symposium on Mathematics and Music (joint with the UC Davis Music Department).

We continue to struggle to accommodate our burgeoning undergraduate student population. Our faculty and staff have really risen to the challenges this has brought us, from mentoring more students to streamlining advising. We're hoping that the campus is able to provide us more resources so we can maintain the high standards we set for our teaching mission.

Among the honors collected by our Department this year, Jesús De Loera will be giving an invited address at the Joint Mathematics Meeting this January, and Anne Schilling has been elected a Fellow of the American Mathematical Society. Tudor Dimofte won a prestigious National Science Foundation CAREER award. Postdoctoral fellow Anastasia Chavez added to her achievements by winning an NSF Postdoctoral Fellowship. Nicholas Sherman, who wrote a senior thesis with Professor Bruno Nachtergaele as an undergraduate at UC Davis, won the American Physical Society LeRoy Apker Award for his work in mathematical physics. Nicholas is currently in the graduate program in physics at UC Berkeley. Dr. Edward Tavernetti's TEDx talk on the beauty of mathematics

<https://youtu.be/V1bjHIGMjQM> has garnered over 100,000 views. One of our former Krener Assistant Professors, Moon Duchin (now a Professor at Tufts University) won a Guggenheim Fellowship, in part for her work on the geometry of gerrymandering.



Thomas Hales, Thurston Lecture



Motohico Mulase on Mihzakhani



Janko Gravner, Math & Music



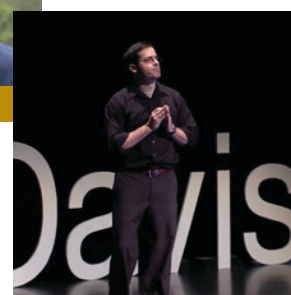
Jesús De Loera



Anne Schilling



Tudor Dimofte



Edward Tavernetti

We are very grateful for the support we get from our alumni and friends. Gifts make a critical contribution to our students and to the mathematical environment. I hope that you consider adding a gift to the Department to your giving plans. Gifts can be designated towards scholarships, research, lecture series or general uses. More can be found on donation in the center of this newsletter, page 9, or please contact us to learn about donation possibilities.

Seminars on Mathematics

The Department of Mathematics has seminars on a wide range of topics, which are focused on a diverse audience. Regular weekly seminars are usually focused on emergent math in that area. Regular weekly seminars change as research evolves, and a new seminar was started last year in the Mathematics of Data and Decisions. Special Events are a mix of special speakers as well as talks intended to be more accessible.

You can view upcoming seminars on our web page: <https://www.math.ucdavis.edu/research/seminars/>

Incoming Academic Staff

Roger Casals • Assistant Professor



Roger Casals received a B.S. in Mathematics from the Universitat Politècnica de Catalunya, a M.S. from the Universidad Complutense de Madrid and a Ph.D. in Mathematics (2015) from the Universidad Autónoma de Madrid and the Instituto de Ciencias Matemáticas.

His thesis research started with the construction of contact structures in 5-dimensional spaces. Contact structures are the geometric objects that underlie the physical principles in optics and thermodynamics. In recent years, the study of contact structures has become a central part of pure mathematics, especially in geometry and topology. R. Casals's thesis showed that contact structures always exist in 5-dimensional spaces.

Following his Ph.D., Casals was a CLE Moore Instructor at the Massachusetts Institute of Technology, a time during which he developed a calculus for studying the contact structures coming from affine varieties (zero

sets of polynomials) in any dimension. Figure 1 gives an instance of how a 6-dimensional space with a 5-dimensional contact structure on its boundary can be described and effectively understood via his planar colored diagrams. This work featured this year in the Geometry Section at the International Congress of Mathematics 2018.

His work is known for providing new constructions. He strongly follows the principle that any geometric space that can a priori exist, must actually exist. This perspective is called the study of h-principles. In his research, Roger has proven several h-principles and used them to give new applications, including new results on contact structures, Engel structures (in 4-dimensions) and complex geometry. Recently, he has been actively developing a connection between contact geometry and the combinatorics of planar graphs.

Laura Starkston • Assistant Professor



Laura Starkston studies manifolds, particularly 4-dimensional spaces, which have additional geometric data called a symplectic form which gives a way of measuring areas of surfaces inside the manifold. Depending on the angle and orientation of the surface, its symplectic area can be positive, negative, or zero. When every part of the surface contributes zero to the area, it is called a Lagrangian surface, and when every part of the surface contributes positively to the area, it is called a symplectic surface.

Many people have studied properties of Lagrangian submanifolds, but very little is known about symplectic submanifolds. Starkston is working to understand symplectic surfaces in one of the most fundamental examples of a symplectic 4-manifold: the complex projective plane. The classification of these surfaces has been open for decades and she is working on this open problem as well as singular generalizations. It is particularly interesting to compare this problem in symplectic geometry with the analogous problem in algebraic

geometry classifying (singular) plane curves, and Laura looks for differences and similarities between these two geometric settings.

A running theme in Laura's approach to geometric questions, is to use topology to encode the geometric structure. An example of this in her recent and current work is to encode the symplectic topology of an open Stein manifold, using a core skeleton of the manifold. The skeleton is built from gluing polygonal objects along their boundaries and corners, and the data of how the edges are glued onto other polygons completely determine the symplectic geometry on the manifold which surrounds this skeleton.

Although spaces in high dimensions can be very complicated and their geometric information can be difficult to access, Laura looks for settings where these spaces can be explored with pictures and broken up into simpler pieces that can be understood individually and then put back together to get a global understanding of the space.

Incoming Academic Staff



Tair Akhmejanov
Krener Assistant Professor

Tair Akhmejanov was born in Aktau, Kazakhstan, later growing up in the Boston area. He received his undergraduate degree from Boston College, and a M.A.S. degree (Part III) from Cambridge University. He received his Ph.D. from Cornell in 2018 under the supervision of Allen Knutson. He joined the Math Department in Fall 2018 and will be working with Professor Greg Kuperberg.

Tair's research is in algebraic combinatorics, in particular, the interplay between combinatorics, representation theory, and algebraic geometry. This includes Schubert calculus, geometric representation theory, and combinatorial representation theory. He has also had a long-standing interest in complexity theory and quantum computation.

His hobbies outside of math are playing basketball, watching sports, and reading.



Martin Gebert
Krener Assistant Professor

Martin Gebert studied in the beautiful city of Munich and received his Ph.D. at the end of 2015 from Ludwig-Maximilian University Munich. After a short intermezzo at ETH Zurich he held Post-Doc positions at King's College London and Queen Mary University of London before joining UC Davis in the fall quarter 2018.

Martin is interested in Analysis and his research is located between Operator Theory, Mathematical Physics and Probability. A special focus is on random operators and many-body quantum systems. At UC Davis, he will be working with Professor Bruno Nachtergaele.

When not doing mathematics, Martin enjoys playing soccer, hiking and the Californian sun.



Annalaura Stingo
Krener Assistant Professor

Annalaura Stingo started her study of Mathematics at University Federico II and earned her Ph.D. at the University of Paris 13, under the supervision of Jean-Marc Delort. Her thesis, *Problems of global existence for critical non-linear evolution equations with small data and semi-classical analysis*, studies the global existence problem and asymptotic behavior of solutions for quasi-linear Klein-Gordon equations in one space dimension with cubic non linearities, when small initial data are not compactly supported but only mildly decaying at infinity in space. With the use of the Klainerman vector fields method and a semi-classical micro-local analysis of the problem, she showed that solutions are global, provided that the data is sufficiently small and that a structure condition, introduced by Delort, is satisfied by the non-linearity.

She then studied systems formed by a coupling between a Klein-Gordon equation and a wave equation in two space dimensions (again in the quasi-linear framework). The goal was again to prove global existence and to develop a robust theory that could apply also to more general non-linearities.

In 2017 she was awarded the "Fellowship For Women in Science" by Fondation L'Oréal-UNESCO, together with Academie des Sciences.

Finding Connections in Math

Is there really a separation between pure and applied mathematics? The great mathematician Lobachevsky is attributed with saying “there is no branch of mathematics, however abstract, which may not some day be applied to phenomena of the real world.” There are plenty of examples of how this is evidently true for algebra (broadly including number theory too), geometry, and topology.

Here is one way in which algebraic geometry, sometimes mistakenly considered a pure and non-applicable part of mathematics, has helped us understand a well-known algorithm in *Optimization*. Optimization deals with finding the best solution or best choice among multiple valid solutions.

The concrete challenge in question is to maximize a linear functional under linear inequality and equation constraints. A very simple example is to find two numbers x_1 and x_2 , with $x_i \geq 0$ and so that $2x_1 + 3x_2$ is as large as possible. In matrix form we can write this as

$$\text{Maximize } \mathbf{c}^T \mathbf{x} \text{ subject to } \mathbf{A}\mathbf{x} = \mathbf{b} \text{ and } \mathbf{x} \geq 0.$$

Here A is a real $m \times n$ matrix, and \mathbf{c} , \mathbf{b} are n and m vectors respectively. Despite its simplicity this is engine used in solving other optimization problems.

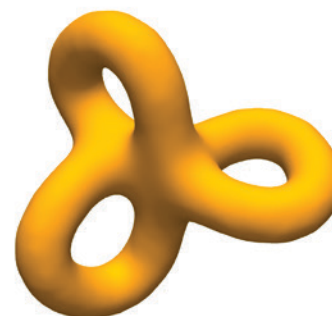
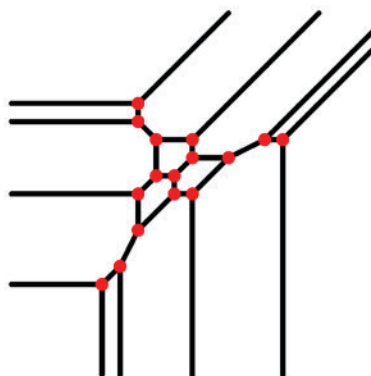
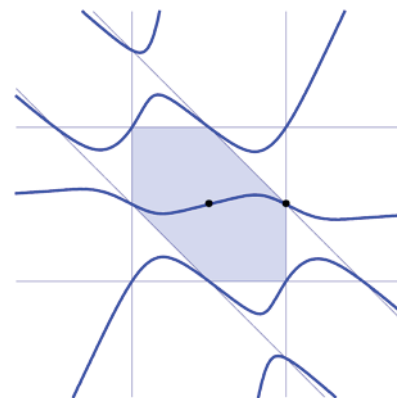
To solve the problem, Interior point methods follow a piecewise-linear approximation to the central path using Newton methods steps (see left figure). In reality, the central path is an algebraic curve, given by the following system of quadratic and linear polynomial equations. When $\lambda = 0$, we obtain the optimum solution

$$\mathbf{A}\mathbf{x} = \mathbf{b}, \mathbf{A}^T \mathbf{y} - \mathbf{s} = \mathbf{c}, \text{ and } x_i s_i = \lambda \text{ for } i = 1, 2, \dots, n.$$

Understanding the *exact* central path is important. How “curvy” can the central path really be? Our intuition is that curves with small curvature are easier to approximate using fewer line segments and fewer Newton steps. Recently, using exciting new methods from tropical algebraic geometry, X. Allamigeon, P. Benchimol, S. Gaubert, and M. Joswig showed that the total curvature of the central path can grow *exponentially* with the input data. This implies a major breakthrough, that some interior-point methods cannot run in strongly polynomial time! Tropical algebraic geometry is a method to go from a polynomial system to a simpler combinatorial version (see figure right). These techniques are fresh and unexpected, and there are many other examples like this with novel applications of algebraic and geometric techniques in Optimization. Here at UC Davis we have a thriving research group on this subject.



by Jesús De Loera



Above, a view of the entire central curve of a linear program projected to primal variable space (credit C. Vinzant). Below, on the the left and right, a cartoon of the tropicalization of a genus three Riemann surface (credit M. Joswig)

Crinkled Spacetime

In the early 20th century, Einstein proposed a set of equations that related the gravitational force to the curvature of space time. Understanding the mathematical theory of these questions is a central challenge that is far from complete. Recent work in this area by Professor Blake Temple with coauthor Moritz Reintjes has attracted attention in the Math and Physics communities. They have developed a new theory of “metric smoothing” in General Relativity, based on what they call *Regularity Transformation Equations*, or RT-equations.

Their studies began by investigating whether the interaction of shock waves in General Relativity (GR) could create a new kind of *regularity singularity* where spacetime itself is not smooth. Earlier work on shock waves was only able to prove existence of shock wave solutions for metrics that are Lipschitz continuous. A more regular spacetime, one order smoother, is required to make the correspondence between Einstein’s theory of General Relativity and the physics of Special Relativity, the case when there is no gravitational curvature. What was unclear was whether the lack of smoothness was inherent in the spacetime itself, or in contrast, whether it was a feature of the way that space was being modeled, or *parametrized*. That is, was the lack of smoothness due only to a bad choice of map, or coordinate system, used to describe the spacetime? Reintjes and Temple set out to investigate this phenomenon.

In a series of five papers (two of which have appeared), they have now succeeded in characterizing the mechanism for smoothing out the wrinkles in a wrinkled map. Specifically, by a wrinkled map, they mean a map in which the gravitational metric is one, not the usual two derivatives more regular than the curvature; and unwrinkling the map means lifting the regularity of the metric up one order, to two full derivatives above the curvature. They prove that to construct a new smoothed

out map from the original, it is necessary and sufficient to solve the RT-equations. In their final paper, they establish the general theory by proving solutions of the RT-equations always exist for wrinkled maps at least one order smoother than the shock wave case. In other words, for wrinkled maps above a threshold smoothness, the lack of smoothness is *never* caused by the nature of spacetime, but always by the way it is being modeled. As they put it, “a crinkled map of spacetime can always be smoothed out by a coordinate transformation.” The theory still leaves open the problem of regularity singularities at GR shock waves, but reduces it to the problem of finding solutions of the RT-equations at the lowest level of smoothness.

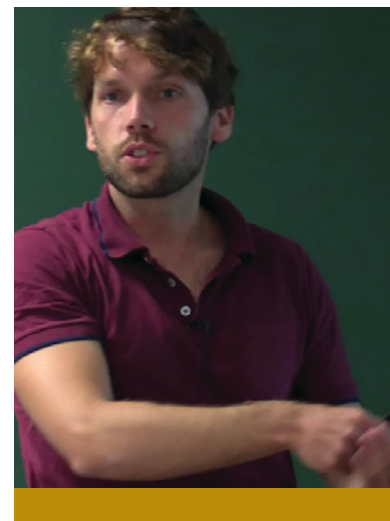
In fact, their methods apply beyond Einstein’s theory of relativity, to the general problem of smoothing the spaces that arise in analysis and differential geometry. A rather surprising aspect of their argument is that it relies on the theory of *elliptic* partial differential equations to find coordinate systems which smooth out solutions to the equations of General Relativity, which are *hyperbolic*. This is unexpected because hyperbolic PDE’s, which govern sound waves and give rise to shocks, behave very differently than elliptic PDE’s, which typically apply to more regular settings like electric fields or the distribution of heat. The RT-equations reduce the problem of regularity singularities at shock waves in GR, to the existence of well-studied *Calderon-Zygmund* type singularities in elliptic PDE theory, establishing a connection between two different kinds of singularities from two (apparently) different subjects.

The new theory enlarges the space of solutions to the Einstein equations, puts the problem of regularity singularities at GR shock waves on a solid mathematical foundation, and introduces a new direction for geometrical analysis.



by Blake Temple

Blake Temple is a Distinguished Professor of Mathematics at UC Davis.

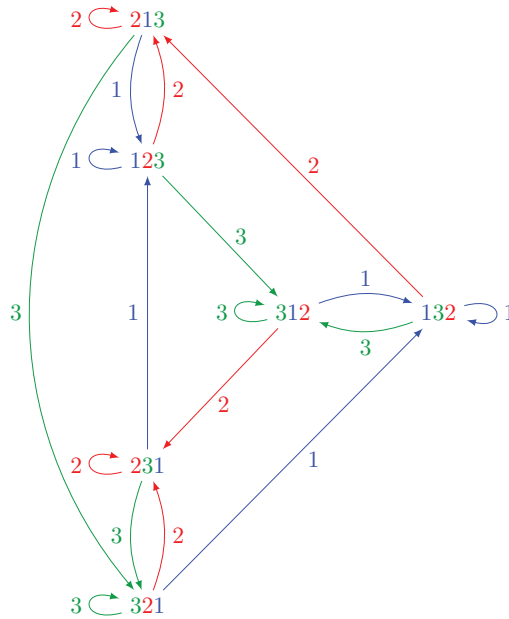


Moritz Reintjes completed his Ph.D. with Professor Temple at UC Davis. Afterwards he was a postdoc at the University Regensburg, at the Max Planck Institute for Gravitational Physics in Potsdam and at the University of Michigan in Ann Arbor. From 2013 until 2016 Moritz was a postdoc at IMPA in Rio de Janeiro, Brazil. Since 2017 he is a postdoc at the Instituto Superior Tecnico in Lisbon, Portugal. Moritz received a “Research Scholarship” from the German Research Foundation (2013-2014), a “Postdoc of Excellence” scholarship at IMPA (2015-2016). His research concerns General Relativity, Shock Waves, Fluid Dynamics and the Dirac equation of Quantum Mechanics.

How Popular Are Your Books?

Suppose your library has one shelf with n books. If someone checks out book i and returns it, this book gets placed at the beginning of the shelf. After a while, the popular books accumulate at the front of the bookshelf.

This library is called the *Tsetlin library*. It is a Markov chain T_n , where the states are the $n!$ permutations of the n books. The Tsetlin library T_3 is depicted in the figure at the left, where an arrow labeled $1 \leq i \leq n$ from permutation π to permutation π' means that book i is moved to the front. The question is now, what will be the distribution of books if we wait for a while? In mathematics, this is called the *stationary distribution*, which is the right eigenvector with eigenvalue 1 of the transition matrix of the Markov chain. If book i is picked with probability x_i , then the transition matrix for T_3 is



$$M_{T_3} = \begin{pmatrix} x_1 & 0 & x_1 & x_1 & 0 & 0 \\ 0 & x_1 & 0 & 0 & x_1 & x_1 \\ x_2 & x_2 & x_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & x_2 & x_2 & x_2 \\ x_3 & x_3 & 0 & 0 & x_3 & 0 \\ 0 & 0 & x_3 & x_3 & 0 & x_3 \end{pmatrix},$$

where we have ordered the 6 permutations as (123; 132; 213; 231; 312; 321). For example, the entry in the column associated to permutation 312 and the row associated to permutation 132 (which is the entry in row 2 and column 5) is x_1 , which is the probability of transitioning from 312 to 132 by moving book 1 to the front. Using that $x_1 + x_2 + x_3 = 1$ (since they are probabilities), one can compute the eigenvalues $1, x_1, x_2, x_3$ and 0 with multiplicity 2. Hendricks computed the stationary distribution for the permutation π for general n

$$\psi_\pi = \prod_{i=1}^n \frac{x_{\pi_i}}{1 - \sum_{j=1}^{i-1} x_{\pi_j}}.$$

Can we compute the stationary distribution of a general finite Markov chain? The answer is Yes, using new techniques from semi-group theory. In fact, this means that one can compute an eigenvector of a matrix without any linear algebra!



by Anne Schilling



Updates from the Undergraduate Program

by Monica Vazirani, Vice Chair for Undergraduate Affairs

This past year, the Department of Mathematics awarded 167 undergraduate degrees (141 majors and 26 minors) — up by 15 from the previous year. Of these, 65 students graduated in Mathematics, 33 students graduated in Applied Mathematics, 11 students graduated in Mathematical and Scientific Computation, and 32 students graduated from our new Mathematical Analytics & Operations Research (LMOR) major, up by 33% from last year, showing its growing popularity. At last count, we have 118 LMOR majors, and a total of 887 math majors, which has set a new record.

Among our graduates, 9 received Departmental Honors awards for their senior theses and for outstanding performance. Details are provided in the Departmental Awards article in this newsletter.

Several of last year's graduating students went on to graduate school at prestigious institutions, such as UCB, UCLA, UCSC, UCSD, University of Michigan, Columbia University, Duke University, Cornell University. Many other graduates went on to jobs in industry such as Financial Advisors, or as K-12 teachers. These achievements testify to the commitment and dedication of our students.

The Math Department places great importance in providing our students with a supportive and encouraging environment throughout their time with us. We began the 2018-2019 academic year by inviting all our students to attend our Undergrad Welcome Event, which took place on September 28th. At the event, we discussed the great things that one can do with a major in mathematics. We also talked about the importance of starting early to plan an individual program of study in concert with the staff and faculty advisors. We stressed that we are here to help all our students succeed, and we described the multiple sources of support that are available when needed.

A variety of activities are designed to foster this atmosphere. All students are welcomed to the Math Club, which meets weekly (Thursdays 5:10-6:00pm in the Mathematical Sciences Building). The Math Club is dedicated to advancing mathematics by building a strong community between mathematicians and people who enjoy math. They host guest lecturers that range from professionals to professors and provide a network of opportunities for our members, as well as tasty snacks. Our undergraduate lounge just had a make-over; come check out the new space! The UC Davis

student chapter of the Association for Women in Mathematics (AWM) held a Mentorship Social on October 26 for not only undergraduates, but also graduate students, post-doctoral scholars and faculty.

Throughout the 2017-18 year they hosted several social events such as Game Night and Ice Cream Social, as well as outreach events such as a visiting local middle and high schools and an interactive knot theory workshop at STEM for Girls.

Several of our math majors participated in mathematically based internships, for which some received degree credit. The companies our students worked at in past summers include banks, industries in China, and Kaiser Permanente. The activities they engaged in included cyber-security, marketing, and data analysis, implementing techniques they learned in their mathematics classes at Davis. The Department of Mathematics continues to expand our course offerings and to hone its curriculum to enhance the experience of our undergraduate students and to attract more students to mathematics. This year, we will offer three special topics courses for undergraduates (MAT 180): "The Mathematics of Theoretical Physics" (Professor Andrew Waldron) in Fall quarter, "Invitation to Classical Analysis" (Professor Naoki Saito) in Winter, and "Introduction to Analytic Number Theory" (Professor Craig Tracy) in Spring. Last Spring, approximately 40 students took our second annual one-unit career seminar "Get the Maximal Value out of your Math Degree." Led by Tim Lewis and Malina Gillies-Doherty, the course included a presentation by the Internship and Career Center, a graduate school panel, and visits from alumni who now work as data scientists, network engineers, web developers, digital marketing analysts, and math teachers.



Undergraduates working in the newly furnished Undergraduate Study Lounge

Undergraduate Research

Undergraduate research helps students thrive in graduate education and in industry. Students enrolled in research programs expand their skills in a subject matter, learn to think independently, and solve problems outside the standard class environment. Students learn to present their research results at local and international conferences and some of them become co-authors in scientific papers.

The UC Davis Department of Mathematics has been providing undergraduate students with research opportunities for many years. Students doing research in our Department are introduced to the latest problems in mathematical research and work directly with our faculty members and their graduate students.

Undergraduate advisor Malina Gillies-Doherty and Professor Javier Arsuaga are starting a new effort to increase research opportunities for our students. The new program allows students to choose among different projects proposed by faculty members, and research programs have grown from mostly summer experiences to year-round opportunities.

This Fall, the Department hosted the first mathematics undergraduate research conference for UC Davis students. On a Friday afternoon, students presented their research orally



Undergraduate Research Conference

to a large audience of undergraduate students and faculty members; and vivid discussions followed during the poster session. These include Kyle Chickering, Michelle Flanner, Polina Khapikova, Aparna Komarla, Yuanbo Li, Diwen Lu, Lingyun Ye, Ruicong Zheng, and Zihao Zhu. To see samples of the research that our students have done and to get information on how to get involved in undergraduate research visit <http://math.ucdavis.edu/undergrad/research>.

Malina and Javier are working to expand this program further so that prospective

students nationwide know about our research opportunities.

Undergraduate research is a great way to jump start a mathematics career!

Mathematics for the Future

The Department of Mathematics wishes to thank all alumni, parents, students, faculty, staff and friends who support the Department each year. For a list of our endowed funds, please see our web site:

<http://www.math.ucdavis.edu/about/donation/>

Your gift to the Department is tax deductible as allowable by law, and you can choose to have your name published or remain anonymous.

Your gift can be used towards undergraduate and graduate support, faculty and research support, and/or Departmental priorities. Your gifts ensure our future success.

Give Online

If you would like to give, please go to the UC Davis secured giving site at:

<https://give.ucdavis.edu/Go/MathGift>

Please click on "Donate to this Fund" and follow the prompts.

A list of donors can be found at the end of this newsletter. Thank you for your continuing support.

We appreciate the many donors who double or triple the impact of their gifts through their employers' matching gift program. For more information about matching gifts, you can go to:

<http://matchinggifts.com/ucdavis/>

For additional questions please contact the Development Office at (530) 752-3429. For your reference, disclosures can be viewed at:

<http://giving.ucdavis.edu/ways-to-give/disclosures.html>.



Sallee Teaching - Allison Moore



Schwarze - Nathaniel Gallup



Schwarze - "Karry" Wong



Ruliffson - Katharine Scott



Ruliffson - Michael Venturino

Department Awards for 2018

G. Thomas Sallee Mathematics Teaching Award

The G. Thomas Sallee Mathematics Teaching Award honors Professor Emeritus Tom Sallee's 40-year career with the Department, his dedication to being an excellent teacher, and his life goal of developing and supporting talented mathematics educators.

An endowment was established in his name that allows the Department to recognize the best teaching of lower-division mathematics courses on an annual basis.

Recipient – Allison Moore

G. Thomas Sallee Mathematics Prize

This award is also given in recognition of Professor Emeritus Tom Sallee, and reaffirms his life goal of developing and supporting talented individuals in mathematics. This prize recognizes exceptional undergraduate students of junior or senior standing who competed in this year's Spring Mathematics Competition.

Recipient – Zhenyi Chen

Henry L. Alder Award

Professor Henry L. Alder received his Ph.D. from UC Berkeley in 1947. After spending a year on the faculty in the Department of Mathematics at Berkeley, he joined the Davis faculty as an Instructor of Mathematics. He advanced to the rank of Professor in 1965, and officially retired in 1992. He then served as Department Chair from 1992 to 1994. After his retirement, Professor Alder continued to teach in the Department for many years.

Professor Alder was also active in other campus programs and was always a strong advocate for quality teaching. In 1999, Professor Alder gave a gift to the UC Davis Foundation to establish an endowment. This provides support to mathematics graduate students at UC Davis through the Henry L. Alder Prize for Excellence in Teaching, an award given each year to the graduate student who is deemed to be the top teacher among all graduate students in mathematics.

Recipient – Andrew Gallatin

William K. Schwarze Scholarship in Mathematics

William Karl Schwarze was born in 1942 in San Francisco. He excelled in mathematics in high school and at UC Davis, where he received a bachelor's degree. He went on to graduate school at Berkeley and a career as a mathematics teacher in San Francisco. Perhaps due to his mathematical insights, Bill also became a successful investor in real estate. After his death in 1988, a trust he established with the SF Foundation has donated to a variety of humanitarian purposes, in particular to the Schwarze Scholarship to be presented today. This award is given to graduate students in Mathematics who have demonstrated outstanding mathematical scholarship and exceptional promise of making a strong professional contribution as a mathematics teacher and educator at the pre-college or college level.

Recipients – Nathaniel Gallup and Ka Wai "Karry" Wong

McCurdy Family Scholarship

The McCurdy Family Scholarship is to be made to undergraduate student(s) in the College of Letters and Sciences at UC Davis. As a scholarship, selection of recipients is based on academic merit and promise, therefore a minimum cumulative GPA is required; at the time of this pledge agreement, the minimum cumulative GPA for scholarships is 3.25 or better. The Scholarship should be restricted to students with junior or senior class standing, and may include all undergraduate majors offered in the Department of Mathematics, with a preference for females.

Recipient – David Williamson

Robert Lewis Wasser Memorial Scholarship

Robert Lewis Wasser was born in 1973 in Sacramento. He excelled in many areas—he was selected as a National Merit Scholar in 1991 and participated in the Academic Decathlon. Robert began at UC Davis in 1991. His academic achievements were numerous and impressive. He was one of the few students in our Department who had already taken as a sophomore some of our most challenging courses, such as Math 127. His instructor in that course, Professor Don Chakerian, said how much he was inspired by their discussions and that Robert's presence made the whole class much more lively and spirited. After his tragic death in an automobile accident in 1993, prior to his Junior year, his grandmother, Vera May Wasser, initiated the Robert Lewis Wasser Endowment in his memory, with contributions from family and friends. Its goal is to benefit promising mathematics students at UC Davis.

Recipients – Mengzhu Yuan, runner up Bohan Yang



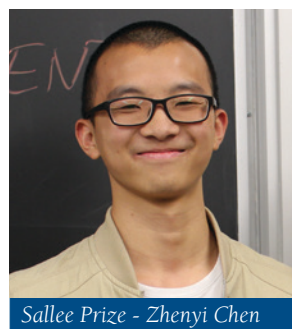
Wasser - Mengzhu Yuan



Wasser - Bohan Yang



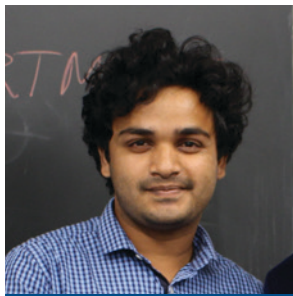
Alder - Andrew Gallatin



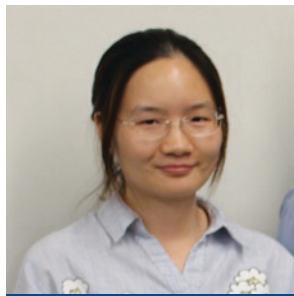
Sallee Prize - Zhenyi Chen



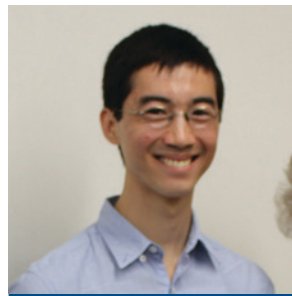
McCurdy - David Williamson



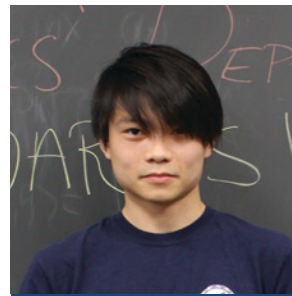
Leung - Subhadip Dey



Lin - Beibei Liu



Lin - Alec Todd



Silvia - Yuk Shing Lam



Galois Service - Tina Denena

Eric C. Ruliffson Scholarship in Mathematics

Eric Canady Ruliffson attended UC Davis from 1964-1968, loved the study of math and excelled in it. He was first and foremost a problem solver, which helped him to achieve life-long personal and professional success. While attending UC Davis, Eric worked as a summer intern in the actuarial department of Pacific Mutual Insurance in Los Angeles and was hired by them upon graduation. After serving in the Navy, Eric attended graduate school in demography at UC Berkeley. In 1973 he resumed his actuarial career at Pacific Mutual Insurance. He became a partner at the San Francisco office of Coopers & Lybrand and named a Fellow in the Society of Actuaries. He was subsequently elected to the Board of Partners for Coopers and Lybrand, the first actuary to be so honored, and later served on the Board of Partners for PricewaterhouseCoopers, the world's largest consulting firm. The Eric C. Ruliffson Scholarship in Mathematics is awarded annually to students of junior or senior standing majoring in mathematics.

Recipients – Katharine Scott and Michael Venturino

Alice Leung Scholarship in Mathematics

Alice Siu-Fun Leung received a Master's degree in Mathematics in 1975 from UC Davis. She later worked as a global property management accountant in Hong Kong. She remembered with fondness her days at UC Davis. She enjoyed gardening and working as a volunteer helping animals.

In her will, Ms. Leung generously provided funding to award scholarships annually to graduate students in Mathematics. This award is given to students who have shown exceptional promise in all aspects of mathematics, including research, scholarship and teaching.

Recipient – Subhadip Dey

Evelyn M. Silvia Scholarship for Future Mathematics Teachers

The Evelyn M. Silvia Scholarship for Future Mathematics Teachers was established by generous donations from family and friends of the late Professor Evelyn Silvia. Evelyn was hired by the Department in 1973 after receiving her Ph.D. from Clark University. The focus of Evelyn's passion and unwavering commitment was to develop talented mathematics teachers at the K-12 grade level. She was extremely generous with her time, whether it was as a campus committee member or as an adviser assisting students.

This scholarship honors Professor Silvia's memory by encouraging students who aspire to be future mathematics teachers. It recognizes a junior or senior with a major in mathematics, applied mathematics or statistics who has shown an interest in teaching mathematics.

Recipient – Yuk Shing Lam

Yueh-Jing Lin Scholarship in Mathematics

Yueh-Jing (Jean) Lin and Chau-Hsiung (Mike) Chuang created the Yueh-Jing Lin Fund in 2009. This endowment provides scholarship support to one or more mathematics students each year. The scholarships are available to high-achieving mathematics students, either undergraduate or graduate. Mr. and Mrs. Chuang are alumni of UC Davis who met while they were graduate students on campus. Jean received her Master's degree in mathematics in 1971, and Mike received his master's degree in agricultural education in 1969.

Recipients – Beibei Liu and Alec Todd

Galois Group Service Award

The Galois Group is "the official voice of the graduate students in Mathematics." All graduate students in the Department of Mathematics are members of Galois; this is how graduate students in mathematics collectively communicate with Department faculty and staff. The group also coordinates and facilitates various activities, such as Monthly Game Nights and New Student Welcomes.

Every year, the Galois Group presents an award to recognize outstanding service and/or sustained commitment to the graduate group.

Recipient – Tina Denena

Departmental Citation Awards

The Department recognizes undergraduate students of exceptional ability who have taken both a very strong selection of mathematics courses and have made substantial contributions to the Department or their program. In addition, they have all received strong recommendations from the faculty.

Recipients – Sophie Jean Quynn, Shengwei Huang, Gu Wu, Jacqueline Xiao Sun, Alondra Garcia Horta, Zachary Spaulding

Departmental Honors Awards

Every year, undergraduate students have the opportunity to participate in mathematical research, culminating in a senior thesis. Students typically work under the guidance of a faculty mentor to complete original research. The results are reviewed, and pending on the quality and substance, the student can receive Departmental high or highest honors.

Recipients – Yuzhe Bai, Dominic Tianli Yang, Joel Ryan Barnett, Nicholas Edward Sherman, Alec Lin Todd, Zachary Spaulding, Madeline Ashley Chen, Franklin James Kerstetter, Jake Parkhurst



Citation - Spaulding, Quynn, Horta, Huang, Sun



Departmental Honors - Spaulding, Sherman, Parkhurst, Kerstetter, Chen, ?, Barnett, Todd

Updates from the Graduate Programs

by John Hunter, Acting Vice Chair for Graduate Affairs

by Matthias Köppe, Chair of the Graduate Group in Applied Math



John Hunter, Acting Graduate Vice Chair



Matthias Köppe, Chair of GGAM

The Graduate Program in Mathematics continues to thrive, with a diverse group of excellent and committed students. The program awarded 9 Ph.D.s in mathematics in 2017-2018, whose recipients went on to various academic, postdoctoral, and industry positions, and 14 new graduate students are entering the program, including a Gates Millennium Scholar. The total number of students in the program is now 71.

Several of our graduate students were recognized in the annual Department Awards ceremony, featured in this newsletter.

The Department and its graduate programs hosted several distinguished visitors during the year. In particular, Thomas Hales gave the second Thurston Lecture, an annual lecture series named after Fields Medalist and former UC Davis mathematician William Thurston that was recently endowed by Ian Agol, and spoke on computer assisted proofs of mathematical theorems.

In Fall 2018 the Graduate Program in Applied Mathematics welcomed an incoming class of 14 new Ph.D. students, selected from a highly competitive pool of applicants. The total number of graduate students in the Applied Mathematics program is 64.

We are proud of our program graduates, who go on to impressive careers in academia and industry. Here is a small selection. Tom Chartrand, who wrote his dissertation on “The Role of Subthreshold Phenomena in Synchronization by Electrical Synapses” joined the Allen Institute for Brain Science as a Scientist. Jamie Haddock, who wrote a dissertation on topics in optimization, started a postdoctoral position at UCLA. Steffen Docken joined the Kirby Institute, UNSW Australia, as a postdoc.

The GGAM faculty keeps growing, giving our graduate students new opportunities for research interactions. Within the last year, two faculty joined:

Javier Arsuaga, professor in the Dept. of Molecular and Cellular Biology and in the Dept. of Mathematics. His research concerns the analysis of data in molecular biology and in particular in the field of DNA, 3D chromosome structure and genetics of chromosome aberrations. His methods include random knotting, topological data analysis and numerical methods in statistical physics of polymers.

Krishnakumar Balasubramanian, newly appointed assistant professor in the Department of Statistics, works in the intersection of theoretical statistics, optimization and machine learning with a focus on addressing theoretical issues arising regarding inferential and computational aspects of analyzing large scale heterogeneous datasets.

The academic activities of GGAM during the last year included:

The GGAM Annual Meeting, held in the afternoon of October 18, 2017, with a lecture by a distinguished external speaker and a short talk by a new GGAM faculty member.

The GGAM Mini-Conference, held in the afternoon of February 15, showcased the breadth of research that GGAM offers, with 6 talks by Applied Mathematics faculty, as well

Are You a Graduate?

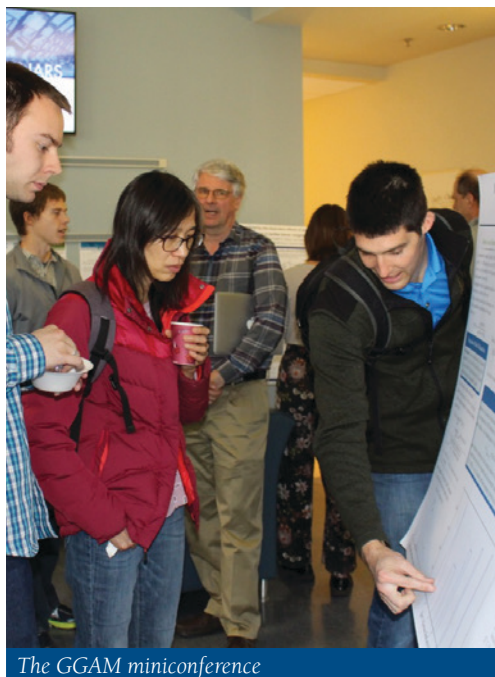
We want to hear from you! Please send us information about yourself so that we can stay in touch and share in your experiences outside of UC Davis.

Please complete our Alumni Questionnaire: http://www.math.ucdavis.edu/news/alumni_quest or send e-mail to:

mso@math.ucdavis.edu

We will do our best to include it in the next newsletter.

Graduate Degrees Awarded



The GGAM miniconference

as a lively poster session, in which graduate students and postdocs explained their recent research. On February 15 and 16, a group of prospective Ph.D. students visited our campus, and our mini-conference contributed to their impression of our Department and campus.

The conference ended with a reception and Lunar New Year celebration held jointly with the Department of Mathematics.

In Spring 2018 we continued our series of Ph.D. exit seminars, established in 2017, each with a reception to celebrate the research achievements of our graduating Ph.D. students.

Fall 2018 began with a well-attended inaugural event of the new seminar on the Mathematics of Data and Decisions at Davis (MADDD) on October 1.

- Hagemeyer, Colin** • Ph.D., Math • *Spiders and Generalized Confluence*, Kuperberg
Bassett, Robert • Ph.D., Math • *Stochastic and Convex Optimization in Statistical Estimation*, Wets
 Post Degree Placement: Assistant Professor, Naval Postgraduate School
Berrian, Alexander • Ph.D., Applied • *The Chirped Quilted Synchrosqueezing Transform and Its Application to Bioacoustic Signal Analysis*, Saito
 Post Degree Placement: Audio Research Engineer, Gracenote
Chartrand, Thomas • Ph.D., Applied • *The Role of Subthreshold Phenomena in Synchronization by Electrical Synapses*, Lewis
Docken, Steffen • Ph.D., Applied • *Mechanisms Underlying Functional Effects of Drugs on Cardiac Dynamics (Insights from Idealized Models)*, Lewis
Haddock, Jamie • Ph.D., Applied • *Projection Algorithms for Convex and Combinatorial Optimization*, De Loera
 Post Degree Placement: Postdoc, UCLA
He, Xiang • Ph.D., Math • *Lifting Properties of Tropicalization and Their Connection to Brill-Noether Theory*, Osserman
 Post Degree Placement: Postdoc, Hebrew University of Jerusalem
Lamb, Kevin • Ph.D., Math • *A Distance for Circular Heegaard Splittings*, Thompson
 Post Degree Placement: Assistant Professor of Applied Mathematics, University of the Pacific
Liu, Wen • Ph.D., Math • *Limit Linear Series on Cycle Curves*, Osserman
Paramonov, Kirill • Ph.D., Math • *Essays in Combinatorics: Crystals on Shifted Primed Tableaux, Graded Fibonacci Numbers and Data Mining on Social Graphs*, Schilling
 Post Degree Placement: Software Engineer (Machine Learning), YouTube
Samperton, Eric • Ph.D., Math • *Computational Complexity of Enumerative 3-Manifold Invariants*, Kuperberg
 Post Degree Placement: Visiting Assistant Professor, UCSB
Shin, Gicheol • Ph.D., Math • *The rectangular representation of the rational Cherednik algebra of type A*, Vazirani
 Post Degree Placement: Lecturer, Korea National University of Education
Smothers, Evan • Ph.D., Math • *Self-Similar Solutions and Local Wavefront Analysis of a Degenerate Schrodinger Equation Arising from Nonlinear Acoustics*, Hunter
 Post Degree Placement: Data Scientist, Uber
Tam, Patrick • Ph.D., Math • *Nearly Finitary Matroids*, Babson
Xu, Yuanyuan • Ph.D., Applied • *On several problems in Random Matrix Theory and Statistical Mechanics*, Soshnikov
- Haley, David** • M.S., Applied
Blaine, Alexander • M.A., Math
Gallatin, Andrew • M.A., Math
Gibbons, Alaina • M.S., Applied
Gorman, Kara • M.S., Applied
Jarvis, Katelyn • M.S., Applied
Kim, Albert • M.S., Applied
- Meyer, Alexander** • M.S., Applied
Parker, Joshua • M.S., Applied
Ponce, Michael • M.A., Math
Rose, Adam • M.S., Applied
Sheng, Stephen • M.A., Math
Sheu, Norman • M.A., Math
Sumpter, Joshua • M.A., Math



Life After Davis

Alex Berrain, Ph.D. 2018

I'm an Audio Research Engineer at Gracenote, which is owned by Nielsen. I've been doing work on audio fingerprinting and automatic music style classification, as well as some other secret stuff that we'll be presenting at the Consumer Electronics Show in Vegas this upcoming January. Most days I'm programming, generally in C or Python. I collaborate with my fellow audio and video research engineers to design new algorithms, and I've also been brought onto projects midway through to help push them out into production.

When I found out that audio signal processing existed as a field (I really had no idea until like February 2014, midway through my second year at UCD), I fortunately was already enrolled in Professor Naoki Saito's class Applied and Computational Harmonic Analysis. I told him about a source separation problem I was interested in: given a mono or stereo song recording, how can you cleanly isolate the vocals from the rest of the track? He referred me to an article he had read about a related problem of melody extraction. Eventually it became clear that we were of very similar mind, being both musicians interested in how math can be used in music signal processing, and I became his student.

Through this time I realized I had to do a lot of exploring on my own to tie this newfound audio interest into my career path. Professor Saito allowed me a lot of freedom to tread my personal path of study, while also very helpfully connecting me with collaborators in the anthropology and neuroscience departments who helped me expand my projects out from mathematical theory into fun, real-world applications. He also allowed me the time to pursue internships in the music technology industry that helped me get where I am now. I was able to get these internships in part due

to UCD's proximity to the SF Bay Area, which is a good place to find networking events in audio signal processing and music technology. But the knowledge I gained through working on a harmonic analysis dissertation was central to my career progress.

Over my college years, I was first a pure math guy, then I switched gradually to applied math over time. I transferred to UC Davis from the University of Iowa, and I was originally focused on fluid dynamics and PDE before I switched over to applied harmonic analysis.

I've always been into math, though honestly not as much as my fellow grad students at UC Davis, whose passion for the study I always admired. My biggest passion in life has generally been music, and I didn't think that I should combine my biggest passion with my career path. I've never been so happy to be wrong about something.

I took classical piano lessons starting from when I was 5 until I was 18. I also sung a lot of karaoke with my relatives growing up, and dabbled only a small amount in composition. I generally play and sing pop and R&B music nowadays. I play a lot of ultimate frisbee and I captained the math ultimate intramural team Perpendicular for two seasons. I'm a proud gay man, and I think that it's important for us as a community to take steps towards ensuring inclusivity of queer and trans mathematicians.

I've always been into math, though honestly not as much as my fellow grad students at UC Davis, whose passion for the study I always admired. My biggest passion in life has generally been music, and I didn't think that I should combine my biggest passion with my career path. I've never been so happy to be wrong about something.

The Galois Group

by Jennifer Brown, President

Varied as ever, this Fall Quarter's main graduate seminar featured student talks ranging from discovering low dimensional behavior in presumably high-dimensional dynamical processes to generalizing spin geometry to infinite dimensional loop spaces.

Speakers in the Geometry/Topology seminar have been holding introductory talks during its student run counterpart, and graciously partaking in a pizza lunch organized by graduate students. Large reading courses, including ones in symplectic geometry and information theory, and numerous smaller reading groups have helped keep graduate students bustling.

Math Circles, an entirely student-run volunteer-based organization, has continued holding math classes each Saturday. Weekly attendance ranges up to 35 high school or middle school students, and sessions include a mixture of competition preparation and guest lectures.

On the social front, the Galois Group held its traditional Fall Quarter BBQ at Slide Hill Park, provided light breakfast during the preliminary exams and a celebratory atmosphere (and snacks) during its traditional "postlim" party. All 28 incoming graduate students were paired with a mentor as part of the "dual pairs" program and presented with a set of the notoriously bright-neon Hagomoro chalk.

Alumni Updates

Karen W. Owen, M.A. 1978

Karen Owen was a member of the technical staff at AT&T Bell Laboratories and Lucent Technologies.

Karen is now retired and living in northern Illinois.

David F. Hayes, Ph.D. 1980

After graduation at UC Davis, David was a professor at College of Notre Dame de Namur for a year. He then joined San Jose State University as part of their Mathematics faculty. In 2001, he served as chair for both Math and Computer Science Departments, after which he continued as faculty for both Math and Computer Science until 2006.

David is retired and presently living in Portland, Oregon.

Staff Update

by Gladis Lopez, Department Manager

The Department staff had a very good year.

The administrative team is fully staffed. The newest member is Joann Pyon who joined the Department as Advising Coordinator. Joann filled the vacancy left by Stephanie Myers who accepted a position in another UC Davis Department.

Our chair, Abigail Thompson, was elected Vice President of the American Mathematical Society, the largest organization in the world for research mathematics, with 28,000 individual and 560 institutional members. She will serve a three year term from 2019 through 2021.

The past year saw 19 merit and promotion actions. The Department processed numerous research proposals to funding agencies, of which twenty one proposals were awarded, producing a total of \$3,390,403 in new research funding.

Tina Denena received the Galois Group Service Award. Sarah Driver was a co-organizer of the first Graduate Student Advisors conference at UC Davis, an event that had over 100 participants. Malina Gillies-Doherty has been creative in coming up with programs to enhance our undergraduate student sense of community by organizing a new mentoring program for transfer students and a coffee-with-a Prof program for Mathematics majors and upper division students.

I thank all the administrative staff for all their great contributions and look forward to another productive year.

Join us on Facebook!

The Department of Mathematics is on Facebook! Visit us there to get updates on current seminars, events and news. We'd be happy to include any memories or photos you have of the Department on our wall.

To "like" us, search for "Department of Mathematics - UC Davis" on the Facebook web page:

<https://www.facebook.com/>



Emeriti Update

Art Krener

Art Krener continues to teach and do research at Naval Postgraduate School. Last year two Army Captains and a Coast Guard Lieutenant Commander wrote their masters' thesis under his supervision. He gave talks at UCSB, UCSD and University of Colorado. and a short course on computational issues in nonlinear control at the University of Padua.



Interested in the Past?

Prior newsletters back to 1994 are available on the Department of Mathematics website.

<https://www.math.ucdavis.edu/research/news/archive/>



The Winter AWM mentorship social

AWM Update

by Katy Jarvis, Co-president

This year, the UC Davis Student Chapter of the Association for Women in Mathematics (AWM) has hosted events and workshops, with the goal of encouraging inclusivity and supporting women in math.

For the third year in a row, AWM hosted a mentorship program. Undergraduate students, graduate students, and faculty were paired into mentor/mentee groups to foster a sense of community and provide support to students.

AWM also continued a local outreach program. Members visit local schools and connect with young female students, teaching students to see the possibilities of mathematics and inspiring them to continue learning about math. AWM is additionally starting a new math club for girls at Pioneer High School in Woodland.

In the past year, AWM has also hosted quarterly workshops aimed at educating members.

In late 2017, our chapter was honored to be named by UC Davis as "The Inspirational Aggies of the Year" at the 2017 Center for Student Leadership Awards.

Finally, AWM has hosted speakers, promoting prominent women mathematicians to speak at Davis.

It has been a great year with AWM and we are excited for what comes next!

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Featured on cover:

Many members of the Mathematics Department play musical instruments. The beautiful alternating link shown on the cover is inlaid on the back of a viola da gamba belonging to Department Chair Abigail Thompson, and was made by local luthier Devin Hough. Knots such as this one are studied in the mathematical area called Topology.

Featuring the 2017-18 Academic Year

Newsletter Committee:

Joel Hass, Editor

Gladis Lopez, Management Services Officer

Marianne Waage, Designer

Thanks For Your Support

The Department of Mathematics wishes to gratefully acknowledge the generosity of the following donors, who have contributed to its support over the past several years.

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