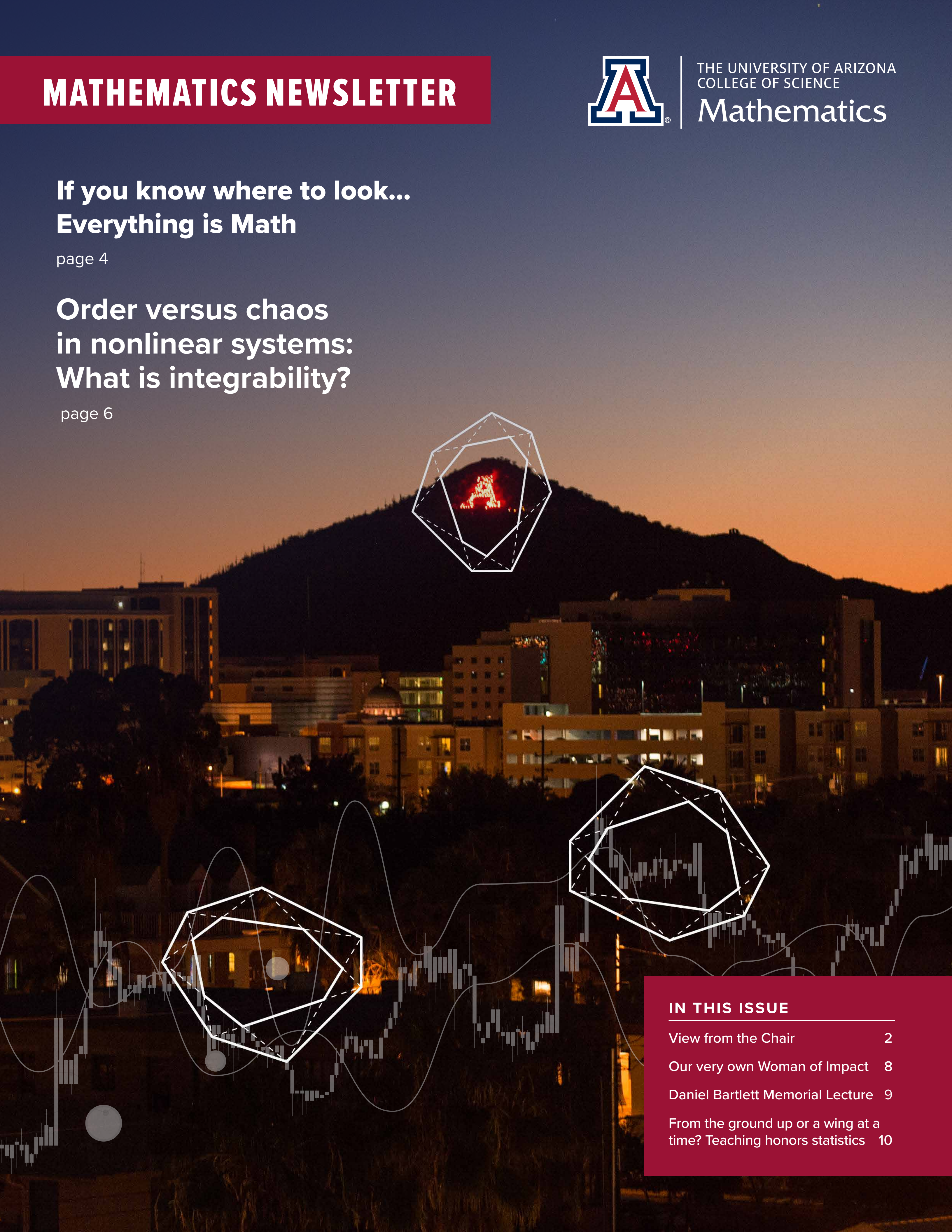
MATHEMATICS NEWSLETTER

THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Mathematics



If you know where to look... Everything is Math

page 4

Order versus chaos in nonlinear systems: What is integrability?

page 6

IN THIS ISSUE

WE WOULD LOVE TO KEEP IN TOUCH

Please consider opting-in to learn about upcoming public lectures and get this newsletter by email. Scan the code below to sign up.

forms.math.arizona.edu/outreach/subscribe

Producer and Editor:
Guadalupe Lozano

Design:
Chris Bohnsack, BohnsackDesign.com

Cover photo credit:
Jacob Chinn, brand.arizona.edu

The Department of Mathematics
Newsletter 2024

Volume XXIV, Single Issue, is published annually by The University of Arizona Department of Mathematics, PO Box 210089, Tucson, AZ 85721-0089.

View from the Chair

By Bob Sims

It is mid-October, and there is a crisp chill in the morning. The monsoons have passed, and decorated pumpkins are popping up in various places throughout Tucson. Here in our Math building, we are starting to see a colorful transformation into the whimsical landscape of scenes from Inside Out 2, this year's theme for our campus-renowned Halloween party. Fall is here, and we have much to celebrate.

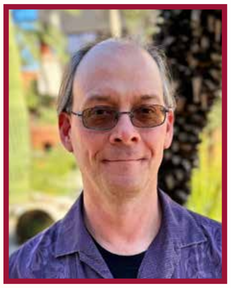
To begin, we have several new colleagues this year: three staff members, two postdocs, one global professor, two assistant professors, and one professor. You can meet them through their bios in the coming pages.

Next, we have had an impressive number of faculty promotions. Chris Henderson and Anton Izosimov were promoted to Associate Professor with tenure. Moysey Brio was promoted to Professor. Cynthia Anhalt and Guada Lozano were promoted to Research Professor. In our Career Track, we now have our very first Principal Lecturer: Donna Krawczyk. In addition, Julie Baum, Heonmi Kim, and Cathy Yslas have been promoted to Lecturers. Congratulations to all our phenomenal faculty.

Our faculty and staff continue to be recognized for their incredible accomplishments. Adi Adiredja received the 2024 College of Science Innovation in Teaching Award. Hanh Do was awarded the College of Science Staff Advisory Council Staff Excellence Award. Chris Henderson received an NSF CAREER grant. Alison Mirin was awarded the Outstanding Postdoctoral Scholar Award from the Office of Postdoctoral Affairs. Tonatiuh Sanchez-Vizuet received the William Y. Velez Outstanding Faculty Advisor Award. Finally, Helen Zhang has been recognized as one of U of A's 2024 Women of Impact (see page 8). It is an honor to work among such amazing colleagues.

In addition to our consummate faculty, we are also having a year filled with exciting activities. Early October brought the second iteration of meetings with our Industry Advisory Board where students and postdocs have an opportunity to gain valuable insights on careers in industry. Late October will bring our next Buell Everything is Math Lecture, featuring our very own Bryden Cais (see pages 4-5) for a glimpse of this generously sponsored endowed series. In early 2025, the Center for Recruitment and Retention of Mathematics Teachers (CRR) will host the 21st annual Mathematics Educator Appreciation Day (MEAD) conference, Arizona's largest mathematics education event. In Spring 2025, U of A will host the next Arizona Winter School, and Alain Goriely will give the next Daniel Bartlett Memorial Lecture. See inside for more on some of these events and consider joining us.

Being department head, even in an acting capacity, has given me a new appreciation for the efforts our faculty and staff put into maintaining the excellence for which we are known. Thank you all for making this year an enjoyable learning experience. We wish everyone in our mathematical community a meaningful, healthy, and productive year filled with exciting discoveries.



Bob Sims is a mathematical physicist whose research investigates many-body models relevant in the study of quantum statistical mechanics. He enjoys discussing mathematics, training junior scientists, and spending time with his family.

Contact him at: rsims@arizona.edu

Department of Mathematics
The University of Arizona®

ARIZONA WINTER SCHOOL 2025

Southwest Center
for Arithmetic Geometry

https://swc-math.github.io/

Deadline to Apply
November 21st, 2024

REPRESENTATION THEORY OF p-ADIC GROUPS

Jessica Fintzen
Representations of p-adic groups

Tasho Kaletha
Characters of representations of p-adic groups

Charlotte Chan
Geometrizations of representations of p-adic groups

Florian Herzig
Mod-p representations of p-adic groups

with **Marie-France Vignéras,** Clay Lecturer

TUCSON, MARCH 8-12, 2025

Funded by the National Science Foundation
and organized in partnership
with the Clay Mathematics Institute

Learn More

If you know where to look...Everything is Math

By McKenzie Meza

This year marked the return of the Duncan Buell Everything is Math (EIM) Lecture Series, a distinctive endowed lecture opportunity for the general public. Officially inaugurated in 2017, the goal of the lecture series is to "give the Tucson community a window into the research of U of A Mathematics faculty." Made possible by a generous endowment from Duncan Buell, U of A mathematics alumnus and recently recognized College of Science Alumnus of the Year, EIM amplifies our departmental history of making math more widely accessible, stressing the fundamental role it plays in our everyday lives.

Duncan Buell graduated from the University of Arizona with a Bachelor of Science in Mathematics in 1971 and served as a professor and department head of Computer Science and Engineering at the University of South Carolina. Duncan, a public intellectual himself, was all smiles as he attended this year's lecture after generously doubling his endowment.

"One of the things that I appreciate about this department is that it doesn't just do ivory tower pure mathematics," Duncan shared, "It applies mathematics to a lot of other things. I think that's important because there are a lot of areas that are becoming more mathematical. In order to get these things right, we need people who really know mathematics to do them."

Everything is Math was put on hold after the 2019 series but made a successful return this year with a full house of attendees eager to learn about the mathematics behind search and rescue in Southern Arizona. Friends, family, colleagues, students, and community members gathered downtown at the beautiful Leo Kent Hotel to listen to this year's speaker, Professor Bryden Cais, an accomplished mathematics faculty member and proud member of the Southern Arizona Rescue Association (SARA). Bryden has a track record of shining reviews from students and colleagues alike, and a passion for telling stories involving much more than mathematics. One attendee noted: "An excellent presentation by a true renaissance man."

Something that sets this lecture apart is that it is crafted for the public—the content is "audience proofed" beforehand, making sure it is both meaningful and engaging for the general public. This year's lecture made use of authentic, real-life examples to do just that.

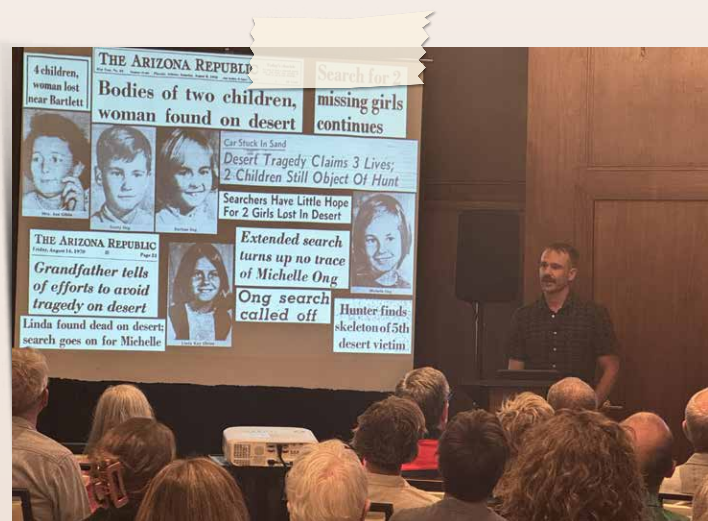
After some lively mingling, the lecture began with an emotional anecdote about a failed search and rescue mission for a family lost in the Southern Arizona desert, back in 1971. As Bryden noted, "they could have been found sooner and that's where math comes in."

Bryden beautifully demonstrated how math can be applied to searching for anything, including car keys. An "I lost my keys" example showed the audience how searching in one area unsuccessfully might simply mean the probability of finding one's keys elsewhere grows a bit. Yet, there are caveats that nuance the decision on where to search next. The mathematics underpinning this probability-based decision making is known as Bayes Theorem.

"Mathematical reasoning and statistics play a central role in modern search management and are instrumental in locating lost subjects as efficiently as possible," Bryden shared, "The [perhaps surprising!] application of mathematics to search and rescue provides a beautiful example of the many ways in which mathematical ideas and thinking improve and—in some cases—save our lives."

"The [perhaps surprising!] application of mathematics to search and rescue provides a beautiful example of the many ways in which mathematical ideas and thinking improve and—in some cases—save our lives."

Bryden's Everything is Mathematics opening story at the Leo Kent Hotel, in downtown Tucson



But how did this mathematics make its way into the world of search and rescue in the first place? Our department's involvement in SARA goes back to the 1970's. It was two U of A professors—John Bownds and David Lovelock—who jointly contributed to drastically improving search and rescue efforts by bringing in tools like Bayesian decision making. Had such tools been available to the search teams from the opening story, the lost family may have been found alive.

Bayesian search, first used in a maritime context, was adapted for practical use to land search and rescue by John Bownds. David Lovelock joined Bownds in the early 1980's to create the Computer Aided Search Information Exchange (CASIE). The program is a free software that aids in search and rescue operations by simplifying calculations and determining where resources should first be deployed. In 1990, CASIE was distributed by the National Association for Search & Rescue (NASAR) and is a reliable tool for all search and rescue operations to this day.

Winding down the evening after a wonderful EIM relaunch. From left: Bob Sims (Professor and Acting Head), Bryden Cais, Duncan Buell, and Guada Lozano (Research Professor and EIM Convener)

An engaged audience—Southern Arizona Search and Rescue members identify themselves during the opening words at the EIM 2024 relaunch

The lecture closed with excellent questions and comments from a very engaged audience. Emphasizing the value of collaboration and partnership, both Bryden and a Tucson Police Department Deputy who works with the search and rescue, tag teamed to answer most questions. Bryden and the deputy made sure to note that they don't blindly follow the math. There is also a human factor. The night ended with a call to action. More data is needed to fine tune these tools, but we're more successful nowadays than in previous eras. "I found myself excited to go home and share what I learned with my friends and family and have a discussion," said one attendee. Math can be found everywhere if you know where to look.

McKenzie Meza, communications specialist for U of A Mathematics, enjoys making information digestible and engaging, which made her perfect for writing this story. She has recently helped redesign math.arizona.edu and is also involved in supporting other units on our campus.

Contact her at: mim4@arizona.edu

Order versus chaos in nonlinear systems: What is integrability?

By Anton Izosimov

Integrability is a fashionable term. These days, mathematicians would talk about integrable probability, integrable combinatorics, etc. In all these contexts, the rough translation of integrable into everyday language is nice and well-behaved. In this piece, we discuss integrability in the context of dynamical systems.

Dynamics and chaos

For lack of a definition that is both precise and sufficiently general, we define a dynamical system as any entity whose current state determines its behavior in the future. An example of such a system is the Fibonacci numbers

$$1,1,2,3,5,8,\ldots$$

Each number in this sequence is the sum of the previous two. Knowing two consecutive terms of the Fibonacci sequence, we can compute all the terms that follow. Thus, the present of the system (the terms that have already been written out) determines its future (the terms that have yet to appear).

More generally, dynamical systems may be described by ordinary or partial differential equations. Our planet's atmosphere, for example, can be modeled with the Euler equation,

$$u_t+\nabla_u u=-\nabla p$$

relating the time evolution of the air velocity u and the pressure p. As expected of a differential equation, the initial value problem for the Euler equation is uniquely solvable: knowing the weather today tells us what it will be tomorrow, the day after, and, theoretically, at any point in the future. In practice, despite this apparent determinism, long-term weather predictions are not feasible. More generally, we cannot really predict the future of most dynamical systems by simply observing their current state. Indeed, for a typical dynamical system, inevitable errors in the initial measurements, no matter how small, lead to drastically different future behavior.

This kind of sensitive behavior in dynamical systems is known as chaos. Consider, for instance, a dynamical system known as double pendulum. A double pendulum consists of two rods connected via a hinge and suspended from a fixed support. **Figure 1** shows how the free end of the pendulum moves depending on its initial position. Remarkably, even though the two chosen starting positions are close, the motions are not alike. Thus, the future of the double pendulum, while predictable in theory, is unpredictable in practice. The double pendulum is a chaotic system.

Integrability: Well-behaved systems need not be linear

In the late 19th century, French mathematician Henri Poincaré suggested that, unless the law underlying a given dynamical system is described by a linear equation, the behavior of the system is most likely to be chaotic. Only a few exceptions to Poincaré's claim were known at his time (including, for instance, the revolution of Earth around the Sun—not linear, yet predictable). However, in the 1960s, mathematicians started to realize that there do exist, and in fact abundant, nonlinear dynamical systems whose behavior is quite the opposite of chaotic. This very regular behavior in dynamics is nowadays known as integrability. Roughly speaking, integrable systems are those whose future can be predicted, unlike what we see for the weather and double pendulum.

The regularity of integrable systems comes from their rich underlying structure and hidden symmetries, making these systems fascinating objects to study for mathematicians. Consider, for example, one of the most famous integrable systems, the Korteweg-de Vries (KdV) equation:

$$u_t + 6uu_x + u_{xxx} = 0.$$

While initially introduced to model the propagation of waves in shallow water, the mathematics of KdV goes far beyond its physical origin and is, indeed, a convergence point of many mathematical areas, from infinite-dimensional Lie algebras to Teichmüller geometry.

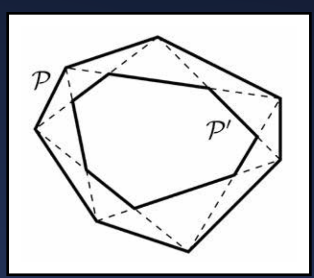
Integrable pentagrams

My personal favorite integrable system is the pentagram map introduced by Richard Schwartz in 1992. The definition of this map is shown in **Figure 2**: given a polygon $\mathcal{P}$ in the plane, construct a new polygon $\mathcal{P}'$ by intersecting diagonals of $\mathcal{P}$ that join second-nearest-neighbors. Since the polygon $\mathcal{P}$ determines $\mathcal{P}'$, we can think of the pentagram map as time evolution, or in other words, dynamics of polygons. The integrability of the pentagram map can be seen in **Figure 3**. Repeated application of the map creates a regular, self-similar pattern as opposed to chaotic curves traced by the double pendulum (Figure 1).

As for the readers more interested in applications, they may be surprised to learn that the pentagram map can be viewed as a discretization of another shallow water model—the Boussinesq equation. In other words, if we draw a polygon and produce from it a sequence of polygons $\mathcal{P}'$, $\mathcal{P}''$,... in the manner described above, then what we will see will roughly remind us of how waves propagate in a shallow harbor.◂

Figure 1. Three motions of a double pendulum with similar initial conditions. The white curves are the trajectories of the free end of the pendulum. Credit: Cristian V., CC BY-SA 4.0, https://creativecommons.org/licenses/by-sa/4.0, via Wikimedia Commons.

Figure 2 (right). A step of the pentagram map dynamics. The two dotted lines stemming from each vertex of the initial polygon $\mathcal{P}$ intersect to create the polygon $\mathcal{P}'$. Repeating this process generates a sequence of polygons which can be viewed as a dynamical system.



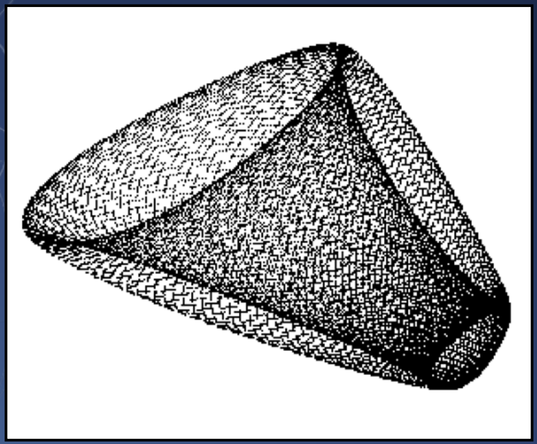


Figure 3 (left). A two-dimensional projection of an orbit of a heptagon under repeated application of the pentagram map. Credit: V. Ovsienko, R. Schwartz, and S. Tabachnikov. *Liouville–Arnold integrability of the pentagram map on closed polygons.* Duke Math. J. 162 (12) 2149 - 2196, 2013. https://doi.org/10.1215/00127094-2348219

Anton Izosimov is an Associate Professor of Mathematics at the U of A, working on integrable systems and related topics. He received his Ph.D. from Loughborough University in the United Kingdom in 2012.

Contact him at: izosimov@arizona.edu

BIOGRAPHIES

Global Faculty

Sudhakar Raju is currently a Global Professor at the Capital University of Economics & Business (CUEB) in Beijing, China. He has a Ph.D. in Financial Economics and is a past recipient of the Harvard Kennedy School award for Teaching Excellence. Sudhakar has been a consultant to various organizations including the World Bank. He has published papers on financial risk management, portfolio management, econometrics and machine learning.

Tenured Faculty

Robert Pollack is a number theorist whose main area of research is embedded in the p-adic world of numbers. For each prime p, one has a different ruler to measure distance leading to enchanting kinds of geometry where every triangle is isosceles and every point inside a circle is its center. When Robert puts down his p-adic rulers, he enjoys board games, hiking, biking, and spending time with his family.

Tenure Track Faculty

Giorgio Cipolloni is originally from a small town near Rome, Italy. Before coming to Tucson, he completed his Ph.D. in Vienna, as well as a postdoc at Princeton University. Giorgio mostly works in probability and mathematical physics, with a focus on random matrices and random operators. On a personal note, Giorgio likes all nerdy things, and considers himself a collector of collections.

Anna Medvedovsky is a number theorist studying p-adic and mod-p modular forms, Hecke algebras, and Galois representations. She has postdoc'ed at Boston University and Max Planck in Bonn. Her Ph.D. is from Brandeis. She is new in town and likes biking around town, hiking (she notes she's very ambitious yet very slow!), and delicious food (but tragically can't do spicy). Her favorite things about Tucson so far: all the pools, all the butterflies and lizards, the night sky, how quickly wet laundry dries.

Continued on page 10

Our very own Woman of Impact

The University of Arizona has named Professor Hao Helen Zhang a 2024 Woman of Impact, recognizing her exceptional contributions to the University's mission, research innovation, educational advancements, community engagement and empowerment of others. She is the first recipient of this prestigious accolade from the Department of Mathematics.

Helen (Hao) Zhang, 2024 Women of Impact Honoree

As a distinguished statistician and data scientist, Helen has transformed these fields at U of A since joining the faculty in 2011. She pioneered the University's first statistical machine learning course, and quickly became the cornerstone of campus-wide data science initiatives and degree programs. As Chair of the Statistics and Data Science Graduate Interdisciplinary Program Helen has significantly boosted the program's national visibility and standing. Professor Doug Ulmer shared: "Helen has grown the number of students, their success has increased, and she has made major contributions to the creation of new degrees within that program and in the Department of Mathematics."

Helen's impact extends beyond our department through her leadership of the NSF-funded Transdisciplinary Research in Principles of Data Science project—TRIPODS, over 2017-21. She was one of only two statistician Principal Investigators among twelve national centers. Under her leadership of this $1.3M initiative, the program fostered cross-disciplinary collaboration to tackle foundational problems in data science, and successfully built a robust, highly interdisciplinary data science community at U of A.

Helen's research impact is profound. She's carried out vast amounts of ground-breaking research in Statistics and its applications, with over 100 publications in leading journals, two field-defining monographs, and over 7000 citations. Her collaborations span an impressive breadth of disciplines, from biology to medicine to engineering, demonstrating statistics' crucial role in advancing sciences. Notably, Helen's statistical machine learning methods have made key contributions in developing data-driven tools for early cancer diagnosis with the U of A Cancer Center, unraveling cell cycles, discovering COVID-19 pathobiology, and optimizing engineering designs.

Helen is also a dedicated mentor. She's advised about 30 Ph.D. students in Statistics and Data Science, Mathematics, and Applied Mathematics. According to Professor Joe Watkins, "Helen is overwhelmingly the most popular dissertation director among the Statistics and Data Science faculty." She has also served on a large number of doctoral dissertation committees beyond mathematics and statistics, offering valuable research guidance across disciplines. Joe adds, "With Helen as mentor extraordinaire, the candidate leaves the examination room with a suite of new ideas on the topic of the dissertation. From every point of view, Helen has made an impact. She has engaged with the community through a variety of new educational initiatives."

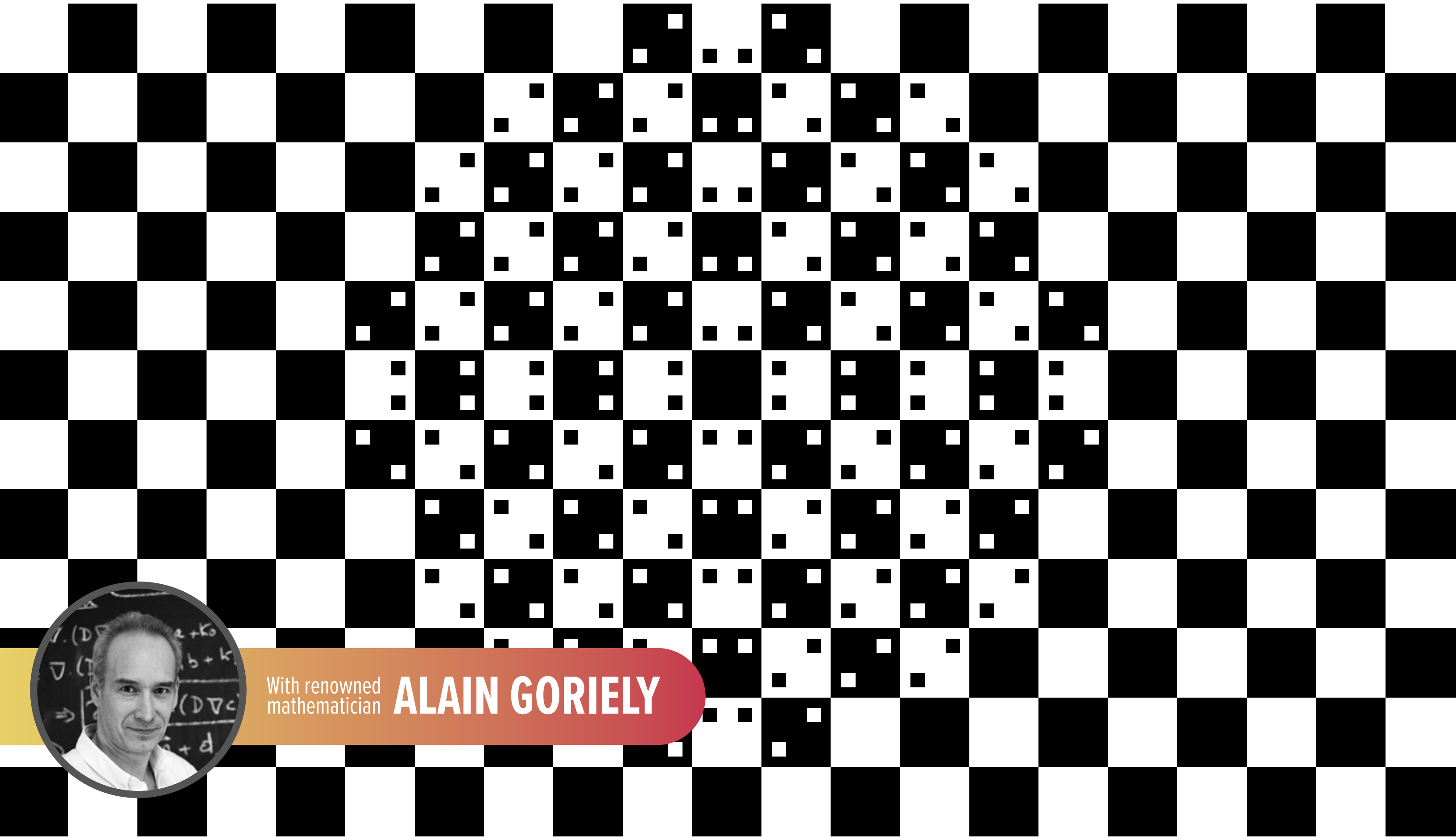
Congratulations to Helen on this well-deserved recognition. Her original research, dedicated mentorship, and collaborative spirit truly exemplify the transformative power of statistical science in advancing knowledge and fostering cross-disciplinary innovation on campus and beyond.◂

This article is an abridged collection of excerpts from Helen Zhang's 2024 Woman of Impact nomination letters written by Joe Watkins and Doug Ulmer, with the input of many.

2025 DANIEL BARTLETT MEMORIAL LECTURE

THE UNIVERSITY OF ARIZONA DEPARTMENT OF MATHEMATICS PRESENTS

SEEING IS DECEIVING: THE MATHEMATICS OF VISUAL ILLUSIONS



With renowned mathematician **ALAIN GORIELY**

THURSDAY, APRIL 17, 2025 | 6:30 PM

U of A Campus, ENR2 Building, Room N120
1064 E. Lowell Street, Tucson, AZ

THE UNIVERSITY OF ARIZONA

Dessert and hosted bar reception on the ENR2 Rooftop following the lecture

math.arizona.edu/bartlett

Biographies continued from page 8

Postdoctoral Research Associates

Ilaria Fontana grew up in Italy, where she obtained her Bachelor's and Master's degrees in Mathematics. After earning her Ph.D. at the University of Montpellier in France, she spent two years as a Visiting Assistant Professor at Northwestern University. Her research focuses on applied mathematics, specifically analyzing numerical methods for partial differential equations in computational mechanics and fluid dynamics. In her free time, she enjoys reading, listening to music, and biking.

Staff

Melissa Gomez is a dedicated professional with over a decade of experience in the non-profit sector. Her career reflects a deep commitment to creating genuine, purpose-driven initiatives that foster community development and empowerment. Melissa serves as the Grants and Contracts Specialist for the CRR and will contribute to grant writing and development for the CRR's programs and events.

Agi Post was a classroom teacher for 20 years. She has always enjoyed mathematics learning and teaching, and her participation in CRR workshops transformed her career. She is passionate about helping educators create a student-centered experience for lasting enjoyment and success in mathematics. She enjoys spending time with her family, gardening and kayaking.

Marco Cubillas is an educator at heart and U of A alum. He spent several years in the Air Force before being able to return to college to complete his B.S. He then spent several years as a bilingual science teacher in middle school followed by a year as an instructor in the Schedule for Success program. Marco then had the opportunity to join the Math Center Advising team. He has always been motivated to make a positive impact on young people's lives.

From the ground up or a wing at a time? Teaching honors statistics

By DeAnna McDonald

The Fall of 2021 brought my colleague Taryn Laird and I an exciting challenge—the opportunity to co-develop an honors version of Math 263, the department's Intro to Statistics and Biostatistics course. What does it mean to create an honors course? How did we get started?

The University of Arizona W.A. Franke Honors College offers its students six pathways to pursue their honors degree, including service learning, study abroad, research, and Franke Honors courses—variants of existing courses that embrace the honors' mission in some specific way. To create a Franke Honors course, our first task was to decide what approach would provide an appropriate and worthwhile variant to Math 263. I attended a week-long workshop on simulation-based approaches to teaching statistics while teaching at University High School here in Tucson and felt excited by the prospect of trying this approach in the honors class. Taryn readily agreed.

What makes this pedagogical approach different? Imagine crafting a dwelling. In our traditional course sections, we build our statistical house one thematic unit at a time. The data analysis wing of the building is created first, followed by the probability portion. We complete the dwelling with the hall of inference (cue uplifting music!) where we answer questions such as 'does this data give us convincing evidence to believe?' In contrast, the simulation approach is more like the same dwelling being 3-D printed from the ground up, layer after layer, with each wing, portion, or hall addressed in nearly every lesson.

How does it look for students? Prior to class, students are presented with a story such as the following. Imagine a dog is given two biological samples, one from a person with a particular cancer and one from a person without that cancer. Buster the dog has been trained to alert on the sample from the person with cancer and to do so (hopefully) with better accuracy than would be due

to chance alone. Buster is presented with 24 pairs of samples, one pair at a time, and correctly identifies the cancer samples 20 times. Do we think Buster's results are due to random chance? Or could Buster's results be due to his ability to sniff out cancer?

Students begin by assuming that Buster is just 'guessing,' or that each result is due to random chance. If so, then the probability of being correct in a set of two samples would be 50%. A coin flip represents a single pair of samples with heads as a correct guess. Students flip a coin 24 times—to represent the 24 pairs of samples—and count the number of heads. They bring their results to class the next day, combine them to make a dot plot of all results, and then discuss what they see. They quickly realize that more simulation is needed! But now use a computer applet to run thousands of sets of 24 trials, display the results, and answer the questions, 'If Buster were just guessing, what is the probability that he would get 20 or more correct? Based on this, would you reject the assumption that his results are due to random chance? Why, or why not?'

In contrast, the simulation approach is more like the same dwelling being 3-D printed from the ground up, layer after layer, with each wing, portion, or hall addressed in nearly every lesson.

A process like this Buster-the-dog example happens on the second day of the course. By the sixth day, students are ready to use a theory-based approach. In just two weeks, students are able to answer inference questions. This simulation first, theory after process repeats itself over and over throughout the semester. In contrast, our standard course sections don't arrive at the inference wing of our building until week eight of the course.

How does the course support the honors mission? In addition to the simulation-based approach, this course includes a project component. Students work in groups to formulate a question, then collect and analyze data on a topic of interest. Previous projects included comparing the variability of two different students' commutes to campus from opposite ends of the Tucson valley and exploring whether subjects could identify the photo of a real human face in a set that included five AI-generated photos (see Figure 1). Students participating in undergraduate research have also analyzed their own lab results and argued for the promise of research in medicine, for example. This project component contributes to the W. A. Franke honors mission

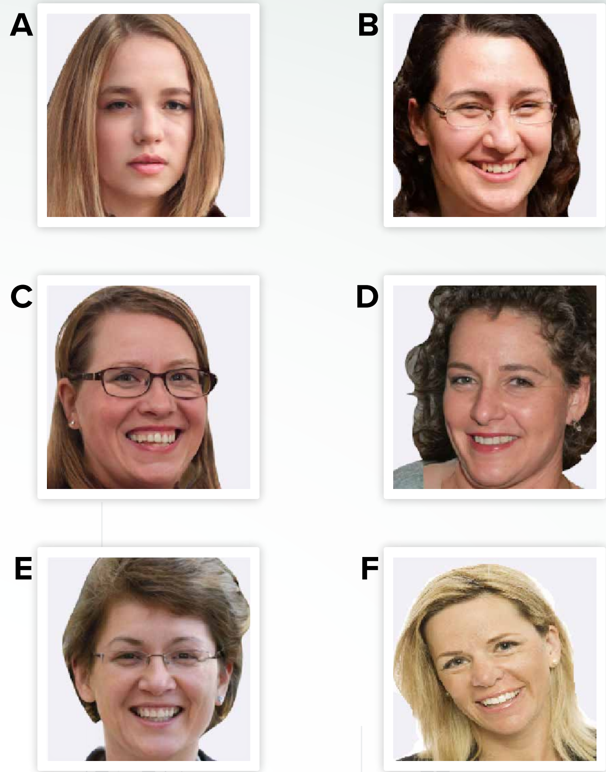


Figure 1. Can you spot the photo of a real person? Image adapted from the Spring 2023 Honors project entitled *Exploring the Uncanny Valley,* by students including Kaitlyn Lai, Abby LoCasio, and Sansita Singh. Five of these individual images were generated by Canva AI. The sixth image (of a real person) was downloaded from Adobe Stock. (Canva AI images fall under acceptable use policy; Adobe image #4230745). Answer on page 12.

by offering students a stepping-stone experience towards completing their honors thesis in their senior year.

What are we learning from this teaching experience? This course challenges me to think about what enduring understandings can be fostered using an approach that is also uncomfortable for me as an instructor. At the start, Taryn said "you have to be okay with not knowing exactly what direction your lesson is going to take because with simulation there is a high probability that the simulated results students generate are going to look like real life—messy, but manageable." She is right. The messy part occurs nearly daily, but managing it gives the students and I the opportunity to explore and enrich the learning in unique ways every term.

DeAnna McDonald is a Lecturer in Mathematics. She worked in secondary education for 34 years prior to joining the University of Arizona in 2017. She has been teaching Math 263—Introduction to Statistics and Biostatistics—each semester ever since.

Contact her at: dmcdonald@arizona.edu

THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Mathematics

The University of Arizona
Department of Mathematics
PO Box 210089
Tucson, AZ 85721-0089

NONPROFIT ORG
US POSTAGE PAID
TUCSON ARIZONA
PERMIT NO. 2216

U of A Mathematics
2024 Master's and Ph.D. recipients

Doctoral degrees

Bud Denny
An Unstructured Mesh Coordinate Transformation Based Finite-Difference Time-Domain (FDTD) Method
Advisor: Moysey Brio
Employer/Position: Air Force Research Laboratory / Computational Scientist

Abigayle Dirdak
The Gale Transform and the Pentagram Map
Advisor: Anton Izosimov
Employer/Position: College of the Sequoias/Adjunct Professor

Anthony Guzman
Reductions of Some Crystalline Representations in the Unramified Setting
Advisors: Brandon Levin, Bryden Cais

Leaha Hand
Difference Operators and Pentagram Maps Over Rings
Advisor: Anton Izosimov

Tugce Koc
Supervised Learning by Low Rank Estimation on Tensor Data
Advisor: Helen Zhang

Jorge Ledesma Granados
Trivial Source Character Tables of Sporadic Groups
Advisor: Klaus Lux

Daniel Lewis
Newton Slopes of Specializations
Advisor: Bryden Cais

Alexandre Loomis
Many Interacting Worlds (MIW) Sequences
Advisor: Sunder Sethuraman

Eric Roon
Two Spatial Correlation Estimates in Quantum Statistical Mechanics
Advisor: Robert Sims
Employer/Position: Michigan State University/Visiting Assistant Professor

Lee Sidbury
Convergence of Discrete Conformal Maps of Surfaces
Advisor: David Glickenstein

Bolun Wei
L-Functions for a Family of Generalized Kloosterman Sums in Two Variables
Advisor: C. Douglas Haessig

Master's degrees

Joseph Arreguin
Nicholas Juricic
Martin Lamb
Henrik Morseth
Christopher Mount
Ashley Roberts
Jeremy Roberts
Haris Serdarevic

A complete list of graduates since 1992, including links to recent theses, may be found online.

Answer for challenge in pages 10-11: Image F