College of Letters & Science
UNIVERSITY OF WISCONSIN–MADISON

(V3) Van Vleck Vector

V3: a newsletter for alumni and friends of mathematics at UW–Madison

2024

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About the Cover Photo
Cover photo by Shi Chen

During May graduation weekend, Wisconsin experienced ideal conditions for Madison to see the northern lights, a.k.a. the aurora borealis. Van Vleck Hall at night.

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University of Wisconsin–Madison
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A Word from the Chair

The end of May also marks the end of my first year as Chair of the math department, and what a learning experience it has been! Until taking up the position, I had not appreciated just how many interlocking pieces need to move together for the department to function. The hard work and good will of many, many individuals — students, faculty, staff — are required for us to accomplish our primary missions of education and research.

We've had a year filled with incredible academics. Chancellor Jennifer Mnookin chose our department to learn from in a visit to the College of Letters and Science, and dropped in to observe one of our first year calculus courses. Our Math Learning Center and the Madison eXperimental Math Lab impressed her during her whirlwind tour.

We continue to stand out with newsworthy research, such as Jordan Ellenberg's work with DeepMind and AI, and Saverio Spagnolie's work with the study of dynamics of bodies in supersaturated fluids. Yue Sun, a graduate student of Chris Rycroft's, won a prestigious award for her video on the fluid dynamics of the ancient art of paint marbling. Our undergraduates have been flocking to our research projects, thanks to the MXM and AMEP labs.

This year marked the 175th year since the establishment of the UW, and the Math Department celebrated as well. In October, we hosted a commemorative dinner, and in April, we hosted a special lecture from a former student, Mikayla Kelley, now a philosophy professor at the University of Chicago, on patterns of rational credence.

But sadly, two of our emeritus professors have passed away, and we will miss them. Pat Ahern was a longtime fixture of our department, and continued to maintain his ties to the department well past his retirement. Nigel Boston left us much too soon a few weeks ago, having only retired in 2019.

The next year promises to be an exciting one, with many new faculty, staff, and students joining us. Let us continue together to foster an ideal environment for mathematical learning and scholarship to thrive.

Jean-Luc Thiffeault

Chair and Professor
University of Wisconsin Math Department

Chancellor's Math Department visit

On September 28, 2023, the Math Department was visited by Chancellor Jennifer Mnookin. During her visit, she stopped in the Math Learning Center, where she was seen chatting with students about their research with Madison Experimental Math (MXM) lab, and with tutors about working with students. She even jumped in to watch TA Logan Heath teach a section of Calculus I. Her visit was capped off by a round table discussion of teaching assistant mentorships and TA support in the College of Letters and Science.

Chancellor Jennifer Mnookin and Associate Dean Shirin Malekpour watch a class of calculus taught by Logan Heath.

(L-R) Pramana Saldin, Katerine Stuopis, Noah Jilson, Chancellor Jennifer Mnookin, MXM Associate Director Grace Work.

Logan Heath teaching Math 221.

(L-R) Chancellor Jennifer Mnookin, MLC Director Tracii Friedman, MLC Peer Mentor and undergrad student Jenny Thanh Hang Dang, and L&S Dean Eric Wilcots at the Math Learning Center.

‘Dancing’ raisins – a simple kitchen experiment reveals how objects can extract energy from their environment and come to life

Scientific discovery doesn’t always require a high-tech laboratory or a hefty budget. Many people have a first-rate lab right in their own homes — their kitchen. The kitchen offers plenty of opportunities to explore ‘soft matter’ and ‘complex fluids’. Everyday phenomena, such as Cheerios clustering in milk or rings left when drops of coffee evaporate, have led to discoveries at the intersection of physics and chemistry.

Two students, Sam Christianson and Carsen Grote, and I published a study in *Nature Communications* this year about such an observation: that objects can levitate in carbonated fluids, including the famed ‘dancing raisins’. The research was carried out in the AMEP lab, part of the Applied Mathematics, Engineering and Physics degree program, and made possible by the generosity of alumni donors.

An accompanying Twitter thread about our research went viral, amassing over half a million views in just two days. Why did this experiment captivate so many?

Modeling the Bubbly Flamenco

Carbonated beverages are “supersaturated” with gas — they fizz with bubbles because they contain more gas than the fluid can support. But bubbles don't usually form spontaneously. Surface tension and fluid pressure normally squeeze any forming bubbles back out of existence. Rough patches and dirt on the container wall, however, can protect new bubbles as they grow beyond a critical size, at which point gas accumulation can outpace pressure-driven collapse.

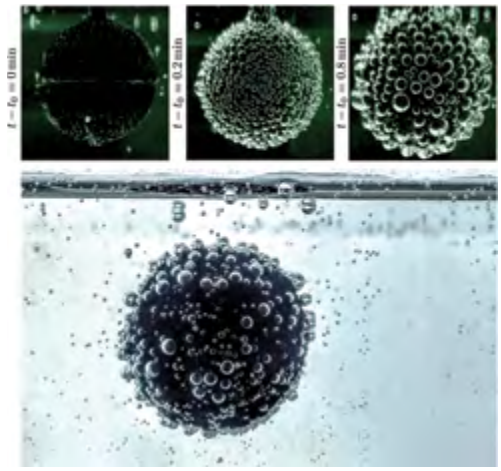
Small objects like raisins offer additional protected sites for bubbles to grow. Once enough bubbles have grown on the object, they can lift it to the surface of the liquid. Then upon reaching the surface, the bubbles pop, dropping the object back down, resulting in a periodic vertical dancing motion.

Raisins are particularly good dancers. It takes only a few seconds for enough bubbles to form on a raisin’s wrinkly surface before it starts to rise. When dropped into just-opened sparkling water, a raisin can dance a vigorous tango for 20 minutes, and then a slower waltz for another hour or so. In one experiment, we placed a 3D-printed sphere in a glass of just-opened sparkling water. The sphere traveled from the bottom to the top over 750 times in one hour!

In the paper, we developed a mathematical model to predict how many trips to the surface we would expect an object like a raisin to make. The model incorporated the rate of bubble growth, and the object’s shape, size, and surface roughness. It also considered how quickly the fluid loses carbonation based on the container’s geometry and the flow created by the bubbles. The model helped us determine which forces influence the object’s dancing the most. For example, the fluid drag on the object was relatively unimportant, but the ratio of the object’s surface area to its volume was critical. We also performed numerical simulations to compare the predictions of a discrete model, in which bubbles were represented as individuals, and a continuum model, using a surface buoyancy density.

Different Dances in Different Theaters

Supersaturated fluids exist in nature, too — magma is one example. As magma in a volcano rises closer to the Earth’s surface, it rapidly depressurizes, and dissolved gasses from inside the volcano escape, forming large, high-pressure bubbles



Objects in supersaturated fluids ‘dance’, rising due to bubble growth, and plummeting once their lifting agents have popped.

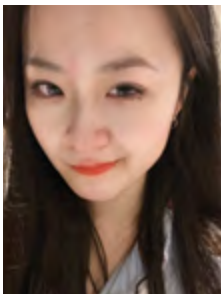
that can lead to a volcanic eruption. The particulate matter in magma may not dance like raisins in soda water, but tiny objects in the magma can affect these explosive events.

The past decades have also seen an eruption of a different kind — thousands of scientific studies devoted to active matter in fluids. These studies look at things such as swimming microorganisms and the insides of our fluid-filled cells. Most of these active systems do not exist in water but in more complicated biological fluids that contain the energy necessary to produce activity. Microorganisms absorb nutrients from the fluid around them to continue swimming. Molecular motors carry cargo in our cells by pulling energy in the form of ATP from the environment.

While raisins in soda water seem simple compared to microorganisms swimming through biological fluids, they offer an accessible way to study generic features in more challenging settings. In both cases, bodies extract energy from their complex fluid environment while also affecting it, and fascinating behaviors ensue.

Continued on Page 11

Psychology and Math combine to create educational insights



Yuhan Shi
Undergraduate Researcher

Yuhan Shi graduated in Dec 2023 with a double major in Mathematics and Psychology from the UW. We recently asked her about her research, her goals, and what got her started along this path. Mathematics and psychology may be considered an odd pairing. When she initially embarked on her college career, she was questioned about the suitability of majoring in these majors, but she really felt this was the right direction based on her interests and persisted.

"My academic journey is driven by a passion for understanding how people learn and process complex information particularly in areas of numerical and spatial analysis. I have a keen interest in how digital media like video games can be used to enhance learning like in developing logical and mathematical reasoning skills." she explained.

Starting during the pandemic, she was forced to go through the rigors of remote learning, but she supplemented her work by working with 1st through 3rd grade students in her hometown of Xi'an, China in one-to-one remote math tutoring. She saw how some students were given cartoons to teach certain concepts but didn't see students grasp the topics. She transformed herself into Miss Bear, inspired by an Apple emoji, for certain office hours, changing her voice and appearance with technology to engage with students while still teaching the same content. "The students were really excited because it was something very different from the teaching that they would normally receive. For most children, this did increase their engagement."

When she was actually able to come back to campus, she started to work in the psychology lab of C. Shawn Green. The lab analyzed how certain aspects of video games could be used in learning concepts, and this idea of learning assisted by technology continued to play a featured part in her education. Her senior thesis was on exploring the relationship between the challenges in video games and the experienced players' abilities. Future studies may help potentially identify games as tools for perceptual (e.g., selective visual attention) and cognitive (e.g., logical reasoning) skills training.

But what about math? "Mathematics provided tools to analytical tools and problem solving mindsets. This was really necessary for my quantitative research like my senior thesis, where I assessed human cognitive ability. From this incredibly amazing combination of majors, I balance an analytical but nuanced approach to understanding human minds. It allowed me to approach social issues from both a rational and humanistic angle."

Professor Jordan Ellenberg, who taught her in Real Analysis, inspired her "by his approach to teaching, building a foundation for students through consistent practices, where the tools and beliefs we learn touch on everything we do … Effective learning is more than just knowing it, but then using it, multiplying it, and integrating it into our life context."

In a research project with Assistant Professor Nan Chen, she used a Kalman filter on noisy data to distill important points and make predictions. "This gave me a tremendous amount of confidence in my ability to conduct quantitative research. It allowed me to put this into an educational context, such as human learning in dynamic environments. For instance, in this Kalman Filter project, in my opinion, I considered that the mechanism of the Bayesian approach to update prior information in response to new evidence is similar to the dynamic nature of human learning, as echoed in Piaget's concept of equilibrium, where prior knowledge is continually refined and transformed in response to new information. This is a great combination of mathematics and psychology."

Her joint focus on psychology and math has informed her future plans. She will be pursuing a Master's degree in human development and education at Harvard. In this program, the research focus she is very interested in exploring the cognitive development of mathematical learning skills like numerical skills and spatial perception, especially visual perception of shapes and colors. She is also interested in how digital media, like video games, can help improve these skills, and thus, help learners better learn and apply math. Beyond that, she plans to pursue a Ph.D. in psychology with a focus on visual cognition, particularly the human visual system.

Recently, she has been conducting research using functional near-infrared spectroscopy (fNIRS) and eye trackers to study brain and eye function during creative tasks at the Shaanxi Normal University in Xi'an, China. She found herself enjoying and proficient in using these neuroimaging and electrophysiology devices. Inspired by this, she found a growing interest in understanding how the human brain and especially visual systems operate when performing mathematical tasks. One of the research projects she hopes to undertake is to explore how individuals' brain activity and visual patterns vary when solving different types of mathematical problems, such as algebra and geometry. To achieve this, she will apply brain imaging tools like functional MRIs, along with eye trackers, to collect and analyze neural and visual response data.

— By Sara Nagreen

How a card game can help engineers predict catastrophic failure

Humans are very good at spotting patterns, or repeating features people can recognize.

Very recently, mathematicians like me have started to study large collections of objects that have no patterns of a particular sort. How large can collections be before a specified pattern has to appear somewhere in the collection? Understanding such scenarios can have significant real-world implications: For example, what's the smallest number of server failures that would lead to the severing of the internet?

Research from mathematician Jordan Ellenberg at the University of Wisconsin and researchers at Google's DeepMind have proposed a novel approach to this problem. Their work uses artificial intelligence to find large collections that don't contain a specified pattern, which can help us understand some worst-case scenarios.

Patterns in the card game Set

The idea of patternless collections can be illustrated by a popular card game called Set. In this game, players lay out 12 cards, face up. Each card has a different simple picture on it. They vary in terms of number, color, shape and shading. Each of these four features can have one of three values.

Players race to look for "sets," which are groups of three cards in which every feature is either the same or different in each card. For instance, cards with one solid red diamond, two solid green diamonds and three solid purple diamonds form a set: All three have different numbers (one, two, three), the same shading (solid), different colors (red, green, purple) and the same shape (diamond).

Finding a set is usually possible — but not always. If none of the players can find a set from the 12 cards on the table, then they flip over three more cards. But they still might not be able to find a set in these 15 cards. The players continue to flip over cards, three at a time, until someone spots a set.

So what is the maximum number of cards you can lay out without forming a set?

In 1971, mathematician Giuseppe Pellegrino showed that the largest collection of cards without a set is 20. But if you chose 20 cards at random, "no set" would happen only about one in a trillion times. And finding these "no set" collections is an extremely hard problem to solve.

Finding 'no set' with AI

If you wanted to find the smallest collection of cards with no set, you could in principle do an exhaustive search of every possible collection of cards chosen from the deck of 81 cards. But there are an enormous number of possibilities — on the order of 1024 (that's a "1" followed by 24 zeros). And if you increase the number of features of the cards from four to, say, eight, the complexity of the problem would overwhelm any computer doing an exhaustive search for "no set" collections.

It's easier to find best-case scenarios — here, that would mean the fewest number of cards that could contain a set. But there were few known strategies that could explore bad scenarios — here, that would mean a large collection of cards that do not contain a set.

Ellenberg and his collaborators approached the bad scenario with a type of AI called large language models, or LLMs. The researchers first wrote computer programs that generate some examples of collections of many that contain no set. These collections typically have "cards" with more than four features.

Then they fed these programs to the LLM, which soon learned how to write many similar programs and choose the ones that give rise to the largest set-free collections to undergo the process again. Iterating that process by repeatedly tweaking the most successful programs enables them to find larger and larger set-free collections.

This method allows people to explore disordered collections — in this instance, collections of cards that contain no set — in an entirely new way. It does not guarantee that researchers will find the absolute worst-case scenario, but they will find scenarios that are much worse than a random generation would yield.

Their work can help researchers understand how events might align in a way that leads to catastrophic failure.

For example, how vulnerable is the electrical grid to a malicious attacker who destroys select substations? Suppose that a bad collection of substations is one where they don't form a connected grid. The worst-case scenario is now a very large number of substations that, when taken all together, still don't yield a connected grid. The amount of substations excluded from this collection make up the smallest number a malicious actor needs to destroy to deliberately disconnect the grid.

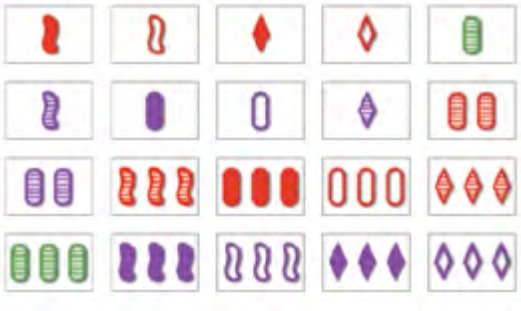
The work of Ellenberg and his collaborators demonstrates yet another way that AI is a very powerful tool. But to solve very complex problems, at least for now, it still needs human ingenuity to guide it.

— By John Edward McCarthy

Professor of Mathematics, Arts & Sciences at Washington University in St. Louis

As published in The Conversation

Nature paper:
https://doi.org/10.1145%2F2490301.2451150



FLICKR.COM/PHOTOS/BREVITY/411191602

Lab Corner

Undergraduate research exploring number theory with machine learning

The Madison Experimental Math (MXM) program sets up small groups of undergraduate students to work on specialized math research projects. Just one of the many that occurred this year was an approach to pure mathematics using machine learning (ML). Jordan Ellenberg was the faculty member in charge and his graduate student, Karan Srivastava, ran weekly visits with the students to guide them through the research process.

The students started this project with no specialized knowledge, noted Karan Srivastava. “It helped in having a diverse set of backgrounds so some of the students could lend their expertise. They didn’t need the fanciest backgrounds. All of them picked up what they needed very quickly”. Sophia Cohen, a senior majoring in computer science and math, was one of the four initial students involved in the MXM project. This was her first machine learning experience. “We had a really great group dynamic. We had really great open communication with each other and would meet independently without Professor Ellenberg or Karan. We could say what we were struggling with, or what worked well.”

The first question posed to the four students in the research group was “Can we get a machine to learn an algorithm that we already know?” In this case, it was the Euclidean algorithm, which involved starting with two numbers and then a step by step process of dividing them and computing the remainder and then swapping out with which number you divide. This allows you to figure out the biggest common divisor. It is a well known problem in number theory. This challenge proved easy for the group, and within a week, they were ready to move on.

The next question was more difficult. In the Euclidean algorithm, you can start with any pair of numbers and get a result. For more general problems of the same class (known in group theory as "finding paths in a Cayley graph for a subgroup of $SL_2(\mathbb{Z})$") there could be initial inputs for which there is no solution. How do you train a machine to solve problems when in some cases the problem can't be solved? To train a model for this problem, the students moved towards a technique called reinforcement learning. Reinforcement learning teaches the model being created by rewarding correct answers and penalizing incorrect answers. Thus, as the students started to analyze the contents of the subgroup, the neural network started to learn what was required.

Sophia explained about how the group collaborated on the project. “We had a central GitHub repository that we all had access to, but we were doing individual projects each week. Breaking down our problems into individual tasks. For example, I would be working on a feed forward neural network while some of my teammates would be working on a reinforcement learning model, and yet another of my teammates would be working more on the math, all at the same time. Then we would come together and discuss our findings.”

The students started with a million random matrices and tried to get the machine to find its way back to the origin. This worked in some simple situations, but started to fail in more complicated cases. They trained the model on the simple subgroup set to create the algorithm, and then adapted that to analyze the more complicated subgroups. “They designed a tool that could learn from groups that we care about and looked at the decision rules that brought them to that conclusion and proved that those decision rules are actually correct,” explained Karan. This was ultimately what was used to present on their poster in the Fall 2023 and again, with new data, in Spring 2024.

Sophia valued her participation in the MXM program, saying “I would love to continue MXM. I am doing an REU at Washington University this summer, on large language models (LLMs), which is related to some of the research done by Jordan. The relationships that I’ve created with my teammates and my advisors will continue whether or not we have another formal MXM project.”

Karan noted that this type of research is not merely about the final result, but the progression of the problem. “The work that they did show the value of applying these techniques to questions in the pure math space. There might be things that a machine could learn from these problems that could be of use to mathematicians in continuing research in these areas.”

— By Sara Nagreen

Link:
Poster 1: https://go.wisc.edu/mxm_ai_fall23
Poster 2: https://go.wisc.edu/mxm_ai_sp24

Undergraduate Math Competition, May 2024

Haran Mouli (1st place)

Pramana Saldin (2nd place)

and Lucas Allen (3rd place)

Putnam Club, December 2023

UW Madison placed 34th this year – please congratulate our three top scorers:

Jonah Guse
(also placed in the top 200 individually)

Haran Mouli and **Yuval Lerman**
(in the top 500)

Marbelous work in the AMEP Lab

Yue Sun, a student of Chris Rycroft, won the top prize in the hotly contested "Gallery of Fluid Motion" competition at this year's annual American Physical Society Fluids Meeting! She did her beautiful experiments in the AMEP lab in Sterling Hall. The video is lovely and worth watching even if you're not well-versed in fluids or math! (Link: https://go.wisc.edu/sunpaintvid)

The Gallery of Fluid Motion is a contest started a few decades ago to showcase the beauty of fluid dynamics. It used to be a small affair with only photographs, but over time has become highly competitive, so this is no small feat! Congratulations, Yue and the team!

COMAP MCM

The department supported 18 students to compete in the international Mathematical Contest in Modeling this February. Teams of three undergraduate students were tasked with developing a mathematical model of a real world problem, exploring and analyzing the model, and writing a paper, in only 96 hours. Over 10,000 teams compete worldwide every year.

Harry Luo, Pramana Saldin, and Minghao Yin wrote a paper modeling resource availability and sex ratios in lamprey eel populations.

This year, the problems that could be selected ranged from using data to probe the sustainability of property insurance, developing strategies for reducing illegal wildlife trade, and finding out whether 'momentum' in tennis is real.

Participation in the contest was supported by donors to the AMEP program, and is organized locally by Professors Saverio Spagnolie and Amy Cochran. https://people.math.wisc.edu/~spagnolie/COMAP/

Applied math group attends American Physical Society in Minneapolis

This past November and March, the AMEP lab sent students to participate in the annual fluids meeting and 'March' meeting of the American Physical Society (APS). Thousands of mathematicians, physicists, chemists, biologists, and engineers convened in Washington, DC and in Minneapolis this year to share their latest results.

(L-R) Graduate students Carson Grote and Hanzhang Mao, undergraduates Mark Han and Michael Zhao, Postdoc Thomas Chandler, graduate student Jingyi Li, and Professor Saverio Spagnolie.

VISP/MA Program's Annual Day Trip to Devil's Lake

Algebraic Statistics and Our Changing World and Wisconsin.

In Fall 2023, there was an Institute for Mathematical and Statistical Innovation (IMSI) long program called *Algebraic Statistics and Our Changing World* https://www.imsi.institute/activities/algebraic-statistics-and-our-changing-world/ that brought together biologists, social scientists, economists, statisticians, and mathematicians to view challenges in our changing world through the lens of algebraic statistics and more generally, nonlinear algebra. Jose Rodriguez was one of the organizers.

A deliverable of note is this survey on new directions

https://arxiv.org/abs/2402.13961 (submitted to the Journal of Algebraic Statistics, in revision)

Madison to host Applied Algebraic Geometry Conference

Next year on July 7-11, 2025 (Monday – Friday) the Mathematics Department will host the SIAM Applied Algebraic Geometry (AG) Conference. The purpose of this conference is to bring together several hundred (perhaps a thousand!) researchers who use algebraic geometry in industrial and applied mathematics. We welcome participation from everyone interested in a broadly interpreted notion of algebraic geometry and its applications. Feel free to contact any of the local organizers Gheorghe Craciun, Laurentiu Maxim, Jose Israel Rodriguez (lead), Botong Wang if you want to be involved, and for additional information see https://go.wisc.edu/siamag

Join Math Alumni

Help us build the new Math Alumni site!

When you come to Wisconsin to study math, you become part of the Wisconsin family. We'd love to hear back from you how your life is going, and what exciting things are happening!

We've built a brand new Math Alumni page to better sort and display the updates that our alumni provide, and we'd love to have your help in building it.

Your information is the most valuable part of this site. There's no accounts to create, just a form to tell us about your accomplishments. And then we'll take your post and make sure it is put on display to share with your fellow alumni.

Check it out:
https://mathalumni.math.wisc.edu

Decades of department photos now available online

Throughout the years, there's been a steady culture of collegiality and community in the Math Department. Sometimes there's even been a person with a camera there, ready to snap a picture, to record for posterity.

These pictures are being assembled at the new site https://photos.math.wisc.edu. We don't always know who is in the photos, but we are happy to hear from you if you do. Please email photos@math.wisc.edu if you have information on someone who is uncredited.

What can you do with a math degree?

Undergraduate Gender-minorities in Math at Wisconsin (UGmMaW), the newly formed undergraduate counterpart to GmMaW, hosted a panel of local professionals and academics to share their experiences with choosing a mathematical career path, titled "What can you do with a math degree?".

Ranging from technical support engineers to professors, the panelists discussed finding supportive communities, figuring out what areas of math to specialize in, coping with feelings of inadequacy, and what their day-to-day jobs look like. They compared the strengths and drawbacks of their chosen careers, and what they wished they would have known earlier on, with the goal of helping math majors fully utilize the options available to them.

The undergraduates in attendance received advice on dealing with being gender-minorities in their math classes, and later on in the workforce. They were also reassured that there is nothing wrong with not knowing what they want to do for the rest of their lives, or even next year.

Current graduate students shared their suggestions for preparing for and choosing a graduate school, and a former software engineer shared why they came to graduate school for math after working for a few years following graduation with a computer science degree.

UGmMaW seeks to build community and support among the gender-minority undergraduates in the math department. In their first year they have also held pizza socials and game nights, as well as an introductory workshop on typesetting math with LaTeX.

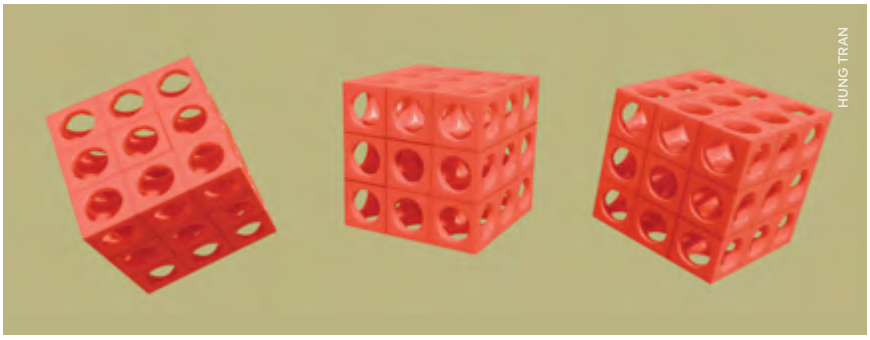
— By Haley Kottler

Bung-Fung Lee Torng Fellowships

Two more graduate students were supported by generous Bung-Fung Lee Torng awards this summer: Yuxi Han, who is working with Professor Hung Tran, and Kaiyi Huang, who is working with Professor Betsy Stovall. Here is what they will actually be able to focus on this summer thanks to donor support:

Yuxi Han — My research focuses on understanding and exploring properties of solutions to nonlinear partial differential equations. Specifically, I delve into the realm of Hamilton-Jacobi equations, employing the concept of a viscosity solution as a type of weak solution. My work includes asymptotic analysis and regularity of viscosity solutions to a range of equations with various boundary conditions. This support is critical for my research in homogenizations of Hamilton-Jacobi equations in perforated domains. My recent paper was just posted to the arXiv https://arxiv.org/pdf/2405.01408. I will continue exploring this direction in the summer before starting my new position as a Golomb Visiting Assistant Professor at Purdue University in Fall 2024.

Kaiyi Huang — I am interested in Lebesgue space estimates for a class of multilinear integral operators called generalized Radon transforms and some related combinatorial problems. In particular, the Brascamp-Lieb inequalities are very important in harmonic analysis, partial differential equations, and statistical mechanics. In Brascamp-Lieb inequalities, one integrates over linear objects (e.g., lines and planes). I am working to understand the case when curvature is introduced.



Yuxi Han's research illustrated by a periodic perforated domain in 3D

'Dancing' raisins (continuation)

New insights about the physical world, from geophysics to biology, will continue to emerge from tabletop-scale experiments — and perhaps from right in the kitchen.

Final notes:

Some posters online didn't understand how such a familiar effect could appear in a Nature journal. I tried to point out that there is often a wide gulf between feeling like you understand something, and being able to describe and predict it accurately. The latter is one of the most important things that we do here in Van Vleck!

Alumni donations were used to purchase equipment (a 3D printer and cameras, which can now be used for future projects) and to pay undergraduate students to carry out research — an experience that many cite as formative in launching their lifelong investment in the mathematical sciences. Just as bubbles only grow beyond a critical size, and collapse below it, so too can donations provide critical support for efforts that might otherwise fail to launch. Your support goes much further than you might imagine.

— By Saverio Spagnolie
University of Wisconsin–Madison

The Nature Communications Article published by Saverio Spagnolie et al. is available at https://doi.org/10.1038/s41467-024-47672-z

The original X post that went viral can be seen at https://x.com/SaverioIV/status/1701996622425514473

THE EXCELLENCE IN RESEARCH GRADUATE STUDENT AWARDS

Shi Chen
Yuxi Han
Phillip Harris
Yunfan He
Josiah Jacobsen-Grocott
Jiwoong Jang
Ruofan Jiang
Daniel Levitin
Yandi Wu
Jiaming Xu
Chenyun Zhou

JOHN NOHEL PRIZE IN APPLIED MATHEMATICS AWARDS

Aidan Howells
Wilson Lough

HENRY SCHAERF MATHEMATICS GRADUATE AWARDS

Jacob Denson
Jacob Fiedler
Diego Rojas La Luz

EARLY EXCELLENCE AWARDS

Summer Al Hamdani
Peiyi (Penny) Chen
Ethan Schondorf
Hongyu Zhu

LTTA TEACHING AWARD

Otto Baier

EXCEPTIONAL TEACHING AWARD

Ivan Aidun
Varun Gudibanda
Logan Heath
Hyun Jong Kim
Boyana Martinova
Antonio Nakid Cordero
Zaidan Wu
John Yin

EXCEPTIONAL SERVICE AWARD

Jacob Fiedler
Haley Kottler

CAPSTONE AWARD

Maya Banks
Karen Duffy
Aidan Howells
Daniel Levitin
Nathan Nicholson
Sun Woo Park

Our Graduates

2023-2024

PhD Graduates

Jeff Covington (Chen)
Alex Hof (Maxim)
Maya Banks (Erman/Kent)
Shi Chen (Q. Li)
John Cobb (Erman/Kemeny)
Rebecca Eastham (Kent/Loving)
Yunfan He (Caldararu)
Aidan Howells (Anderson)
Josiah Jacobsen-Grocott (Soskova)
Ruofan Jiang (Shankar)
Jeremy Johnson (Pimentel-Alarcon/Ellenberg)
Hyun Jong Kim (Ellenberg)
Daniel Levitin (Dymarz)
Nianzi Li (Chen/Waldron)
Sun Woo Park (Ellenberg)
Chenwei "Peter" Ruan (Terwilliger)
Zinan Wang (Rodriguez)
Yandi Wu (Valko)
Jiaming Xu (Valko)
John Yin (Ellenberg)
Yuxi Han (Tran)
Jiwoong Jang (Tran)
Connor Simpson (Wang)
Junyi "Jenny" Wei (Li/Liang (CS))

MA GRADUATES

Apoorva Agarwal
Otto Bair
Jing Cao
Sanchita Chakraborty
Yanbo Chen
Hart E
Jiankun Li
Xiang Li
Yijie He
Alexander Pahlow
Jingpeng Shen
Eline van Ophem
Alice Vidrine
Yuchen Zhang
Yangrong Zhao
Keru Zhou
Chenyun Zhou

VISP GRADUATES

Yiwen Bai
Shuqi Bi
Yifan Chen
Yangkun Dai
Yihuan Dong
Tianlong Huang
Nengke Lin
Yikai Dai
Shinuo Ma
Yilan Miao
Haowei QI
Xiaoyang Shi
Shuyao Sun
Zihao Sun
Ke Wang
Mingjie Wang
Chenxi Wang
Yuxuan Xie
Minyang Xu
Qiyang Zhu
Jia Wan

Graduating Students are headed ...

Chenwei (Peter) Ruan (Ph.D., 2024, Terwilliger) has accepted a postdoctoral research position at BIMSA, Beijing Institute of Mathematical Sciences and Applications.

John Cobb (Ph.D., 2024, Erman/Kemeny) has been awarded an NSF postdoc at Auburn University.

Yandi Wu (Ph.D., 2024, Dymarz) has accepted a postdoctoral position at Rice University.

John Yin (Ph.D., 2024, Ellenberg) has accepted an Zassenhaus Visiting Assistant Professor position at the Ohio State University.

Becky Eastham (Ph.D., 2024, Kent) has accepted a postdoctoral position at University of California - Riverside.

Yuxi Han (Ph.D., 2024, Tran) has accepted a position at Purdue University as an Golomb Visiting Assistant Professor.

Shi Chen (Ph.D., 2024, Q. Li) has accepted a position as an applied math instructor at Massachusetts Institute of Technology.

Jiaming Xu (Ph.D., 2024, Valko) has accepted a postdoctoral position at KTH Royal Institute of Technology.

Yuxi Han (Ph.D., 2024, Tran) has accepted a position as a Golomb Visiting Assistant Professor at Purdue University.

Apoorva Agarwal, Northwestern, Math PhD

Otto Baier, Purdue, Math PhD

Sanchita Chakraborty, Notre Dame, PhD in Applied and Computational Mathematics and Statistics

Jiankun Li, UW–M, Math PhD

Yijie He, UW–M, Math PhD

Jingpeng Shen, TAMU, Math PhD

Yuchen Zhang, University of Connecticut, Math PhD

Keru Zhou, Georgia Tech, Math PhD

Shuqi Bi, UW–M, Math PhD

Yihuan Dong, Stevens Institute of Technology, Financial Engineering PhD

Nengke Lin, Purdue, Industrial Engineering PhD program

Yikai Liu, UC-Irvine, Math PhD

Haowei Qi, Chinese University of Hong Kong, Math PhD

Zihao Sun, UW–M, Math PhD

Chenxi Wang, Texas A&M University, Math PhD

Jia Wan, UW–M, Math PhD

Awards

The Math Department unveiled two new awards for our postdoctoral staff, known as our Van Vleck Assistant Professors. Two awards, for excellence in teaching, and one award, for excellence in mentoring and outreach, will be awarded each year. The prize for each award will be $1000.

The Postdoctoral Excellence in Teaching Awards: Nate Fisher and Boya Wen.

The Postdoctoral Excellence in Mentoring and Outreach Award: Aleksandra Sobieska.

FACULTY/STAFF News & Awards

UNIVERSITY COMMUNICATIONS

Faculty News

Benedek Valko has been named a Vilas Associate. The Vilas Associates Competition recognizes new and ongoing research of the highest quality and significance. Recipients are chosen competitively by the divisional Research Committees on the basis of a detailed proposal. Link: https://go.wisc.edu/mathvilasassociates

Sébastien Roch has won a Vilas Distinguished Achievement Professorship, awarded by the Provost's office.

Vilas Distinguished Achievement Professorships (VDAP) recognize UW–Madison faculty members whose distinguished scholarship has advanced the confines of knowledge, and whose excellence also includes teaching or service. Faculty members receiving this award keep the Vilas Distinguished Achievement Professorship title for the duration of their careers. Link: https://go.wisc.edu/mathvilasprofs

Our own **Marissa Loving** has an article in February's Notices! Especially of interest to those at the beginning of their careers. https://go.wisc.edu/lovingams

Jordan Ellenberg recently published an article in Nature. He collaborated with a group of researchers working with Google DeepMind to train artificial intelligence (AI) to better evaluate responses. This is intended to better train AI to consider how to answer the question and offer fact based responses instead of "hallucinating" data. The work offers FunSearch (short for searching in the function space), an evolutionary procedure based on pairing a pre-trained LLM with a systematic evaluator.

In contrast to most computer search approaches, FunSearch searches for programs that describe how to solve a problem, rather than what the solution is. Beyond being an effective and scalable strategy, discovered programs tend to be more interpretable than raw solutions, enabling feedback loops between domain experts and FunSearch, and the deployment of such programs in real-world applications. Link: https://go.wisc.edu/ellenbergnature

Autumn Kent has been named a 2024 fellow of the American Mathematical Society. The Fellows of the American Mathematical Society program recognizes members who have made outstanding contributions to the creation, exposition, advancement, communication, and utilization of mathematics.

Our own **Melissa Lindsey** was part of a panel discussion about preparing to teach the first day of classes. L&S Instructional Design Collaborative puts together podcasts for a variety of instructional topics. Link: https://go.wisc.edu/lindseyidcpodcast

Jordan Ellenberg is expanding the impact of his service to the UW by hosting a first-year student course on writing and data. First-year Interest Groups (FIGs) are usually groups of 3 classes that are open to only incoming freshmen and are part of a theme. These students take these courses together as a cohort and build close connections, something sometimes difficult to do on a campus as large as ours.

In Jordan's class, it's all about teaching students the skills needed to write compelling stories that are based on the literal mountains of quantitative data being generated in every field of study. He wanted to call the course "Making Words Count," and that double-edged pun likely comes closer to his intent. Instead, it morphed into "Welcome to Writing and Data", which Ellenberg developed and debuted this semester. Link: https://go.wisc.edu/ellenbergwords

Nan Chen has just received a Young Investigator Award from the Office of Naval Research — congratulations, Nan! Link: https://go.wisc.edu/cheninvestigators

A new AMS Prize for Excellence in Mathematical Writing is named after our esteemed Emeritus colleague **Martin Isaacs.** The prize is for a paper published in a primary AMS journal in the previous two years.

From the description: "The prize focuses on the attributes of excellent writing, including clarity, grace, and accessibility; the quality of the research is implied by the article's publication in Communications of the AMS, Journal of the AMS, Mathematics of Computation, Memoirs, Proceedings of the AMS, or Transactions of the AMS, and is therefore not a prize selection criterion." Link: https://go.wisc.edu/isaacsprize

HUNG TRAN

A quick snap of just one table of a recent lunch for visiting prof Yanyan Li from Rutgers. Clockwise: Dallas Albritton, Shaoming Guo, Chanwoo Kim, Brian Street, Hung Tran, Paul Rabinowitz, Yanyan Li (Rutgers), Andreas Seeger, Mikhail Feldman.

Alumni News

The Remarkable Ramanujan, and the history of his bust.

Mathematicians rightly revere the Indian scholar Ramanujan, whose genius was finally recognized after he sent a fortuitous letter to renowned mathematician G. H. Hardy. Hardy invited him to England in 1914 where he was able to engage in the mathematical research he most craved, and where his work became the stuff of legends. In failing health, he returned to India in 1919 and died under his wife's care in 1920.

More than 60 years later, in 1983, Ramanujan's widow Janaki Ammal, asked why the statue of her husband for her hometown had never materialized, despite being promised. UW Madison professor Dick Askey immediately sprang to action, and worked with sculptor Paul T. Granlund, to produce a bust using the passport photograph taken when Ramanujan left for England. Granlund required commitments for the purchase of at least three copies of the bust. Dick and Liz Askey purchased one, Prof. S. Chandrasekhar and Mrs. Lalitha Chandrasekhar purchased another, and money was raised by a crowdfunding campaign from more than 100 mathematicians to help pay for a third for Janaki Ammal. Eventually ten copies of the bust were created.

The ten busts are scattered throughout the world: five of them are in India; two are in England; and three are in the United States, including the one that sits proudly in the Van Vleck lounge. The artist's proof is in Minnesota, at Granlund's studio in Gustavus Adolphus College in Minnesota.

Alumni News

William (aka Bill, "Wild Bill") **James Laubenheimer,** M.S. 1979
August 19, 1956 – July 19, 2023

Bill grew up in Milwaukee, WI, graduated from Carroll College at age 19, and attended UW Madison where he received double major master degrees in Mathematics and Computer Science in 1979. While at Madison, he developed tight friendships over the bridge table. Further educational opportunities took him to the U.C. Berkeley Computer Science department where he decided after a certain point that "instead of a PhD, he wanted a j-o-b" because he decided that he did not want to research computer science, he wanted to create it.

Bill was fortunate that of the five start-ups he participated in, two were very successful. One of them became Macromedia, which was acquired by Adobe.

While working in San Francisco, he noticed a woman on the Caltrain (commuter train between San Jose and San Francisco) bike car and said "hi." That led to conversations, which led to bike rides and dating, and five months later, Bill proposed to her in the Caltrain bike car. Eight months later, they were married on the Caltrain (with Amtrak's cooperation) with family and friends in attendance.

Their common interests in science fiction, the musical form associated with science fiction, called filking, similar love of sports, bridge, and travel contributed to a successful marriage of 23 years. Bill had written more than 60 songs - several of them on the topic of computers, science, and science fiction topics.

Bill is survived by his wife, Carole Parker, three siblings, and three siblings-in-law along with numerous nieces, nephews, grand nieces, and grand nephews.

Mark Wilson (Ph.D., 1995, Passman) will be the next Editor-in-Chief (first issue Jan 2025) of Notices of the American Mathematical Society. He'll also have a new research monograph published next week, written jointly with Robin Pemantle (and other co-authors).
https://www.ams.org/news?news_id=7191

Mark met Robin in Van Vleck when Robin was an assistant prof and he was a grad student, and that they have collaborated since 1998 in this area (analytic combinatorics in several variables).
www.cambridge.org/9781108836623

The winner of the 2024 Rolf Schock Prize in Math, **Lai-Sang Young,** is one of our former undergrads.

Lai-Sang Young, Courant Institute, New York University, has been awarded the 2024 Rolf Schock Prize in Mathematics "for long-lasting and deep contribution to the theory of non-uniformly hyperbolic dynamical systems," according to the prize citation.
Link: https://go.wisc.edu/youngprize

Our recently-graduated PhD student **Parvathi Kooloth** has won one of the two AWM Dissertation Prizes, which will be presented at the JMM. Parvathi did her PhD under Leslie Smith's supervision.

The AWM Dissertation Prize was established in 2016, an annual award recognizing exceptional work in a dissertation defended in the last 24 months. The award is intended to be based entirely on the dissertation itself, not on other work of the individual.

Link: https://go.wisc.edu/koolothprize

Márton Balázs (Van Vleck 2003-2006 with T. Seppäläinen) has been appointed Professor of Probability at University of Bristol, UK.

Daniel Lecoanet (B.S., 2010) was the 2nd author on a paper published in Nature and featured on the cover on the magnet dynamo cycle of the sun. Daniel received his B.S. in 2010 from the UW. He currently is at Northwestern.

Link: https://go.wisc.edu/naturedynamo

In Memoriam

UNIVERSITY COMMUNICATIONS(2)

PATRICK ROBERT AHERN

Patrick Robert Ahern died Tuesday, September 26, 2023, at 86, succumbing to Alzheimer's disease. He passed peacefully at home surrounded by his family.

He is survived by his wife, Katherine; children: Joan, John (Kathy Kermott), and Lee (Colleen); his grandchildren: Robert Wolfgang Moore (Cicely), Ryan Moore (Kristen), Abigail, Eleanor, and Shaughn; great-grandchildren: Garrett and Maverick Moore; and siblings: William (Myra), Richard (Cathy) and Sharon Schrantz.

Pat was born in Albert Lea Minnesota in 1936, to Garrett Patrick and Marion Dorothy (Doran) Ahern. He graduated from Albert Lea high school, where his father was a math teacher and football coach and Pat excelled at math and football, as well as other classes and sports. He promptly earned bachelor's, master's, and Ph.D. degrees in math from the University of Minnesota. His studies were supported with a National Science Foundation Graduate Fellowship, awarded in 1960. Also, while at "The U" he met Kay, his wife and partner for the next 66 years. He remained a productive scholar and fierce athletic competitor throughout his life, but was reliably mild mannered, affable, and caring in the ample time he dedicated to family and friends. He will be remembered by many as a competitive local handball player in the 1960s and a champion regional road cyclist in the 1970s.

Pat and Kay's three children had all been born when the family left Minnesota in 1963, moving from St. Paul, to Princeton, to Los Angeles, and then to Madison as Pat juggled the responsibilities of raising a family and of being a junior faculty member in a demanding academic discipline. After Pat earned tenure in 1970, he took the family for a year's sabbatical to Pisa, Italy, the first of many international trips for the Ahern family. At various times over the years Pat was fluent in Spanish, French, Italian, and Serbo-Croatian, and conversational in other languages. Prominent mathematicians from around the world knew him as a co-author, mentor, and friend. The life he shared with his family was rich with explorations, adventures, cultures, and cuisines.

During his 42-year career at the University of Wisconsin–Madison he instructed thousands of undergraduates, mentored dozens of graduate students, collaborated with colleagues, and produced a steady stream of innovative research. Pat's area was analysis, the complexity of which is reflected in the title of his most cited paper according to Web of Science: "A theorem of Brown-Halmos type for Bergman space Toeplitz operators." He built elegant, symbolic models in pursuit of math's most elusive secrets, exercises in thought every bit as long, difficult, and lonely as one of his epic and grueling bike rides through the rolling hills of Southern Wisconsin. Time vanquished Pat's ability to continue these pursuits, but in his prime he thought astoundingly deeply, and could climb impressive heights with enviable strength.

NIGEL BOSTON

Nigel Boston passed away unexpectedly on March 31, 2024.

Nigel was a faculty member at the University of Wisconsin from 2002-2019, and before that he worked as a tenure-track professor at the University of Illinois at Urbana-Champaign from 1990-2002. He graduated from Harvard in 1987, under Barry Mazur. He did a postdoc at UC-Berkeley from 1988-1990 under Kenneth Ribet.

After impulsively picking up a book on coding theory at Cambridge, he shifted his mathematical focus to studying ways that algebra can help solve real-world problems. His research spanned wide fields, such as algebraic number theory, group theory, arithmetic geometry, computational algebra, coding theory, cryptography, and other applications of algebra to electrical engineering.

According to the Mathematical Genealogy Project, Nigel Boston had 39 students and 59 descendants. A link to a Kudoboard relating to his retirement may be found at: https://go.wisc.edu/bostonkudos

A special edition of the journal "Topological Methods in Nonlinear Analysis", No 1 of volume 61, 2023, has been published and is dedicated to the memory of our deceased former faculty Ed Fadell and Sufian Husseini.

Issue:
https://go.wisc.edu/fadellhusseinivolume

MSRI Conference held inspired by work of Georgia Benkart

On May 1-3, 2024, MSRI hosted a conference inspired by the work of Georgia Benkart called "Advances in Lie Theory, Representation Theory, and Combinatorics" at SLMath (MSRI) in Berkeley, California and online.

This meeting featured principal contributors in these areas in a celebration of the work of Georgia Benkart. With the same focus and tenacity that Georgia always had, we strived to provide a conference full of beautiful mathematics, incredible inspiration, and the warmth of Georgia's welcoming personality to our field and our community.

Link:
https://go.wisc.edu/benkartmemorial

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Department of Mathematics
UNIVERSITY OF WISCONSIN–MADISON

215 Van Vleck Hall
480 Lincoln Drive
Madison, WI 53706

SARA NAGREEN

On May 10, 2024, the Math Department hosted a graduation party, complete with a Ph.D. hooding ceremony, for all graduates. Congratulations to the class of 2024!