College of Letters & Science
UNIVERSITY OF WISCONSIN-MADISON

(V3) Van Vleck Vector

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

June 2016

The **Directed Reading Program (DRP)** pairs undergraduate students with graduate student mentors for semester-long independent study projects.

The student is expected to meet with his or her mentor weekly for about an hour, during which time they talk about the previous week's work. About four hours of independent reading is expected from the student between each meeting. At the end of the semester, the student gives a brief talk on an aspect of his or her work.

A couple of undergraduate students told us about their experiences:

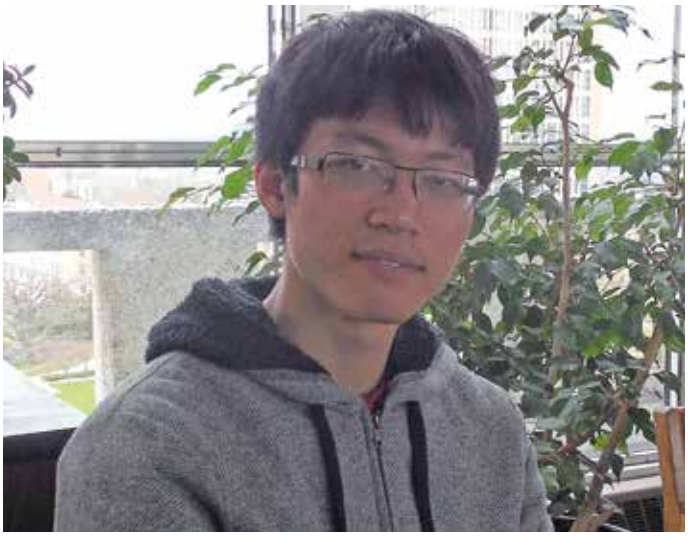
Freshman **Rebekah Dix** heard about the Directed Reading Program from a friend, another math major. Her interest in math developed after taking dual enrollment courses at UW–River Falls during her senior year of high school in Baldwin, WI.

Having already completed the calculus sequence and differential equations, she mentioned her interest in analysis to her new mentor, graduate student Will Mitchell. He found a topic that aligned well: the Conjugate Gradient Method.

They started with background reading and worked through a pedagogical paper before tackling a larger paper on the topic. During this time, Rebekah worked with Mathlab to assist in the research and felt that the experience helped her become a better programmer. "I enjoyed being able to delve deeply into the one topic to know it well," she said.

Will Mitchell recalls, "I remember telling her we'd go over the basics of LaTeX in order to start working on her slides in a week, but she came back already prepared with templates for the presentation, having found them online." Such initiative prompted him to describe Rebekah as a "math department rock star."

Next fall she plans on taking classes aligned with her interest in probability and economics, including theoretical probability and stochastic processes.



Ben Lim looked at his Directed Reading Program experience as a chance to improve the proof-based reasoning that he'd been learning in Math 521. A senior studying Actuarial Science, he was looking to show prospective graduate schools his ability in tackling deep proof-based problems.

Ben initially mentioned a variation on the coupon collector problem to his mentor, Chris Janjigan. He wanted to calculate how many quarters a user might need to collect all 50 state quarters. But Chris suggested a more generic analysis problem, namely the Central Limit Theorem and Brownian Motion.

Ben got started with some readings and problems suggested by Chris. From there, Ben and Chris took the problem into the R programming language, where they analyzed how many coin flips it might take to achieve a roughly 50% heads and tails division. Ben described the process as challenging, but rewarding.

Chris was pleased with the enthusiasm that Ben displayed in pursuing this topic—especially considering he was busy finishing up his dissertation at the same time—and enjoyed working with such a motivated student.

Ben's plan worked: this fall he will attend the University of Iowa in the Statistics program. Congratulations, Ben!

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MAKE A GIFT

To mail a donation to support the Mathematics Department, include the designation "Mathematics Annual Fund" in the check's memo line. The check should be made payable to the UW Foundation.

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If you have any questions or would like information on other giving options, please contact Rebekah Sherman at (608) 572-2077 or rebekah.sherman@supportuw.org.

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A Word from the Chair

Welcome to the 2016 edition of the Van Vleck Vector.

My second year as Chair has perhaps been a bit less dramatic than the first, but certainly not less exciting! Van Vleck corridors are still filled with vibrant mathematical exchanges, our teaching is continuously reinventing itself, and our outreach is trying to cover the great demand for mathematics that exists in the state and beyond. It is indeed a great honor to belong to this superb department.

In this issue you will find many stories: one about Matt Ward (B.S. 2005), a brave and gifted alumnus with autism who became a model for others not only through his graduation, but also through his numerous talks and his busy artistic life, all tied to math and autism. I had the pleasure to be his advisor and to learn about his fascinating world. You will also learn about why our students study math and about our new graduate student-driven DRP program which brings advanced mathematics to every undergraduate who wants to learn it. And we reach beyond to local high schools through our classical Talent Search Program and our Girls Math Night Out!, which encourages the local female high school population to explore the world of mathematics.

On the mathematics research front we are proud to showcase Gheorghe Craciun's recent article on the Global Attractor Conjecture, a problem that has confounded other mathematicians since the 1970s. We also describe the work of Nigel Boston in the so-called Belgian Chocolate problem. And, of course, you will read about the many honors and recognitions that Van Vleck residents have accumulated this year, including the outstanding Packard Fellowship to Melanie Matchett Wood. Only 28 Packard awards have gone to mathematicians since its beginning 25 years ago, and only twice before to someone in our department.

In other news, the College is under a hiring freeze, and we continue to work on our plan to increase our graduate student stipends permanently; we are currently waiting for campus to approve the changes. And changes abound these days! The modifications to our tenure and faculty governance policies have been highly controversial—to put it mildly. Our chancellor, provost and University Committee have worked hard at crafting policies comparable to those of our peers, while staying within the restrictions of the legislature. These efforts have produced a model almost identical to that of Michigan, and with stronger protections than Washington's. The arguments and discussions continue, but we are confident we will have a tenure system comparable to that of our peers.

Campus and the College finally moved to the new budget model. In the earliest phase, only 5% of the budget operated under the new model, but as this percentage increases, Mathematics should see the rewards of the hard work. We are indeed the department with the highest research metrics on campus, and climbing! Our summer program is also being revamped through a new campus initiative aimed at better serving our student populations. We plan on expanding the number of courses available during the summer, helping students to fulfill their requirements during Madison's beautiful summer session and graduate earlier.

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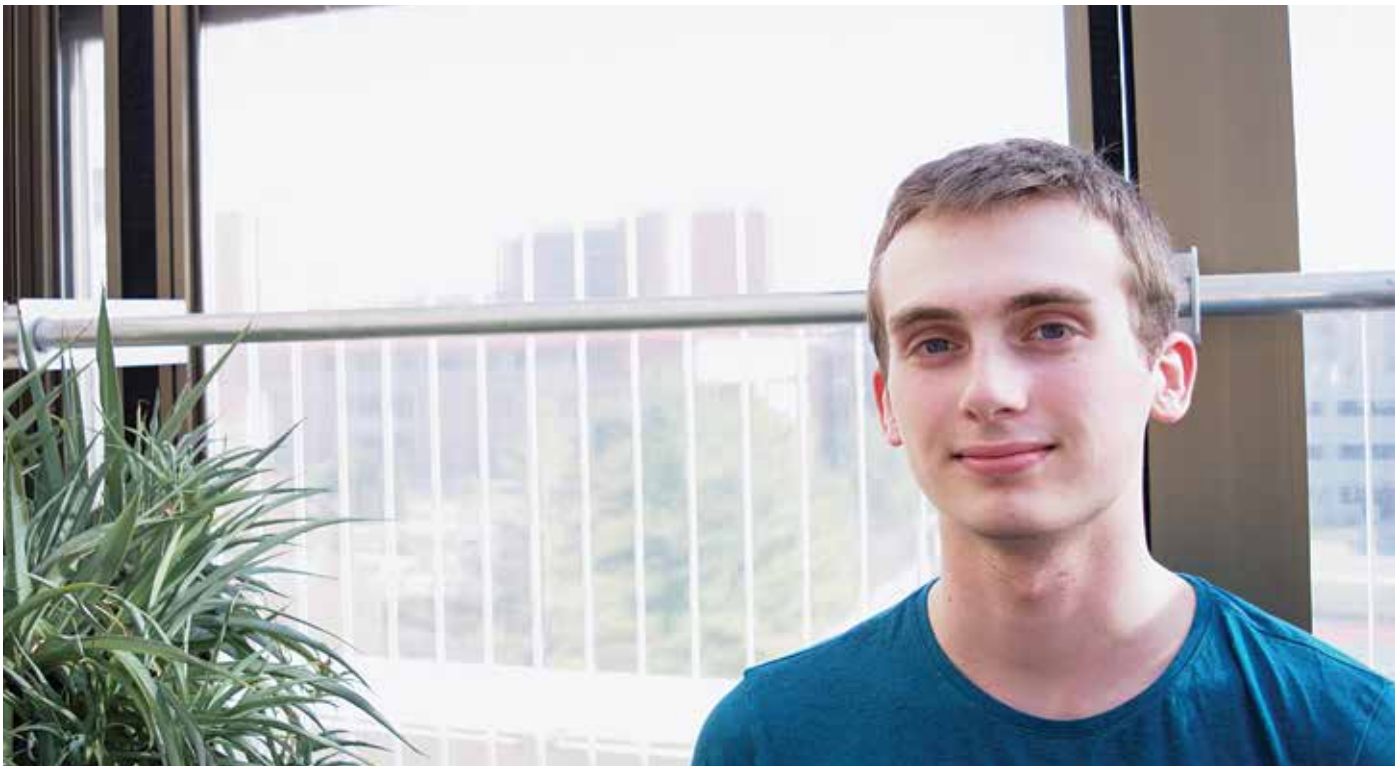
"Why Math?"



Theater Design and Mathematics major Tom Stone

By Alex Hanhart

If you want to know how theater design and mathematics intersect, Tom Stone will tell you: "They both have abstract design and technical elements. So you need to rely on creativity but also technique!" As a mathematics major who also studies theater, you can find this sophomore hurrying from Van Vleck to the studio, though probably not actively thinking about design elements or his most recent topology assignment. "I like to sit on problems for a while and let my subconscious work on it. I realize when I return to them that things seem to fall into place easier."

Tom was not always interested in studying mathematics. He explains, "I didn't think that mathematics was something people normally did!" Fortunately, it was an alumnus of our program that sparked his interest: Dominic Johann-Berkel of Madison West High School. "He showed me that there was so much more than what we were doing in school," says Tom. Encouraged, he began taking more advanced courses while in high school before eventually becoming a student here at UW–Madison. '

Tom's dual interests have already connected him to new friends and colleagues. "I've met people in theatre that ended up being in my math courses and we've worked together a lot, both in math and in theater lighting," he reports. In fact, helping classmates with mathematics has opened up an experience that we as educators all have in common. Tom says, "I like that moment when realization sets in. You can see the recognition in their eyes!"

While Tom's future plans are open, he is considering a career in academia. This summer he will be in Ithaca, NY, attending an undergraduate research program sponsored by Cornell University. "I know I like teaching already. Now I want to find out if I like doing research," Tom explains. If his experiences behind the stage are any indication, then no doubt he will. "I like collaborating with people. Someone will say 'Bear with me, this is a crazy idea...' and then we all work together to make it happen!" ■

A Word from the Chair *continued*

Finally, I would like to thank our many alumni and friends who have contributed to the department. When I observe our exceedingly young faculty, I am reminded of a golden era during the sixties when the faculty was unusually young and historic figures like Rudin, deBoor, and Rabinowitz fell in love with Madison. Our group is second to none and I truly feel the possibilities are at least as bright as they were then. Come and visit us; we very much appreciate your support and want to share with you this special time. ■

Gloria Mari-Beffa, Chair

Undergraduate Alumni Spotlight

SARA NAGREEN

Matt Ward examines one of his origami creations.

Matthew Ward doesn't think he is any different than anyone else. He first found out that he was when his mom sat down and talked with him about being autistic. Now, he tells people how he sees the world and shows them the beauty that he sees in math through his art.

Early on, Matt excelled at math. As part of an initial meeting for an all-state math team in high school, he stood up and read a prepared speech about autism as an introduction. That speech is something that he's developed and given over and over—when meeting new people, taking new classes, or being invited to speak. He now is on the speaker's circuit, giving different talks about being autistic along with his mother, who is able to explain the finer points of what it means to have an autistic son and how to navigate secondary education with these challenges.

Matt was encouraged by his high school math teachers to take advanced classes at UW–Madison as a special student. Those classes helped him transition out of high school into classes at MATC, then back to UW–Madison, graduating with a B.S. degree in Mathematics in 2005. It is believed that Matt is the first person with autism to have graduated from UW–Madison.

While at UW–Madison, he took classes in topics as advanced as analysis and chaos theory. His favorite class was calculus. It helps that Matt sees mathematics visually. He had a team to help him with the many twists and turns at UW–Madison, and he is remembered fondly by his advisor, Gloria Mari-Beffa.

Today, he applies chaos theory to his artwork. He uses a computer program called Ultra Fractal to create fractal art based on published and self-created formulas. In fact, one of his recent Christmas gifts was a book based on chaos theory and patterns by UW physicist Clint Sprott. His artwork has been exhibited multiple times, including at the Eye Institute at UW Hospitals and Clinics and at the Waisman Center as part of its 40th anniversary celebration.

Matt finds origami very calming and enjoys the geometric and visual planning of each creation. He taught himself to make simple cranes at age 9, and moved into making more complex designs with up to 120 pieces of paper. Some of his more intricate pieces can take hours to complete.

Matt works at the Madison Central Library three days a week, and also with a group called ARTworking. Matt started working with ARTworking doing data entry, but soon became an artist with them after they discovered his origami and fractal work. His work is featured on their website at https://artworking.org and on his own website http://mattwardenterprises.com.

When asked by his mother if he likes speaking about autism, he replied "No." He then went on to clarify, "I don't want to stop. I like being famous and I like teaching people about autism." ■

Have a great alumni update to share? Please contact us!
mathnews@math.wisc.edu

Research Highlights

Craciun vs. The Global Attractor Conjecture (GAC)

Manifestations of rapidly advancing any applications of mathematics in biology, physics, and engineering involve mathematical models of specific interaction networks. For example, the dynamics of the infected and healthy populations in an infectious disease model, the dynamics of various species in an ecosystem, and the dynamics of concentrations in a chemical reactor can all be studied using Reaction Network Theory. Some relevant questions are: in the long run, will all the healthy individuals become infected? Or, will any species in this ecosystem go extinct? Or, how can we maximize the total output of a useful product in a chemical reactor?

Reaction Network Theory is an area where a given interaction network gives rise to a dynamical system according to some general rules, and we are looking for dynamical properties that result solely from the network structure (for example, can a network that has only positive feedbacks give rise to oscillations?). The Global Attractor Conjecture states that dynamical systems that have a special reversibility property must also have very stable dynamics: all its solutions converge to a "global attractor," so these systems cannot give rise to oscillations or chaotic dynamics.

The Global Attractor Conjecture is widely regarded as the most important open problem in Reaction Network Theory. Since its formulation in the early 1970s, this conjecture has resulted in a flurry of research activity and dozens of papers. Several special cases of this conjecture have been proved during the last decade.

In his recent manuscript "Toric Differential Inclusions and a Proof of the Global Attractor Conjecture," Professor Gheorghe Craciun proposed a proof of this conjecture in full generality. The manuscript represents the culmination of nearly a decade of work, and involves complex ideas from dynamical systems, differential inclusions, and algebraic geometry. In particular, Craciun's proof also implies that reversible systems are "persistent," i.e., no species can go extinct in such systems. His approach is attracting a lot of attention and was the focus of a workshop organized by researchers at San Jose State University and UC Berkeley in March 2016.

Also, there is a lot of interest in applications of Craciun's results due to strong connections between the Global Attractor Conjecture and some problems in biology (for example, the study of endemic infectious diseases, or homeostatic biochemical networks) and in physics (the quantum Boltzmann equation).

Advanced Computing and Math Research

An emerging story by Steve Goldstein

Manifestations of rapidly advancing technologies are ubiquitous in today's world. From changes in how we communicate with each other to how we observe the physical world from molecular to cosmic scales, the current computer and electronic revolutions are profoundly affecting many aspects of society and science. Across our Math Department, mathematicians are integrating computation with their research. Integration of computation with math research is by no means a recent innovation in our department. However, what is recent is the increase in scale and scope of the use of computation.

When thinking of scaling, the first thing that comes to mind is using more powerful computers to solve bigger instances of problems faster. And mathematicians are doing just that, taking advantage of the department's continuing investment in higher-end computers and of the campus "high-performance computing" resources.

Another, perhaps less obvious, notion of scaling is "high-throughput computing" (HTC). In this paradigm, a computational task is partitioned into large numbers of independent jobs which are farmed out to a loosely-coupled pool of computational nodes. The HTCondor project of the UW–Madison Computer Science Department is a world leader in high-throughput computing, developing and maintaining software enabling high-throughput networks. In two recent notable successes, HTCondor provided the computational infrastructure used in detecting the Higgs Boson [2012] and the black hole collision [2016]. Mathematicians are using HTCondor to run computations on the department's machines as well as on tens of thousands of computational nodes across campus.

For example, Wil Cocke (student of Nigel Boston and Marty Isaacs) and Meng-Che "Turbo" Ho (student of Uri Andrews and Tullia Dymarz) first used a theorem-proving program to investigate a certain property of word maps and are now using HTC to find groups demonstrating minimal examples of the property.

Mathematicians often rely on paper-and-pencil calculations for developing their intuition by computing simple examples that help them to formulate theorems, and they verify and deepen their understanding of the theorems by studying those concrete examples. Computing can vastly expand the scope of concrete examples that are feasible to calculate, especially in algebra where the problems often have combinatorial scaling.

For example, Daniel Erman and his students Jay Yang and DJ Bruce are developing a computational pipeline to compute syzygies of the Veronese of the projective plane. Paper-and-pencil computations work up to degree three; previous algorithms worked in degree four; and by deploying sparse linear algebra techniques on HTC, this group recently computed the degree five case.

The skills necessary for learning to program and for accessing computational platforms are often well within a mathematician's technical expertise. Nonetheless, the details of implementing new computational approaches are often daunting and learning curves can be steep. Fortunately, for the past two years, mathematicians in the department had help from Steve Goldstein, our "Research Computing Facilitator"—an innovative staff position shared with the Botany Department. Goldstein's background fits well with this appointment. After receiving a Ph.D. from our department under Peter Ney, he held research positions in computational biology and has worked as a scientific software engineer.

As advances in technology are providing new tools for mathematicians and suggesting new mathematical questions, it's an exciting time to be a mathematician, particularly at UW–Madison!

The Algebraic Revolution: Solving for Chocolate

ISTOCK : JASCHAASADOV

Change is often the force that drives science forward, enabling big leaps and discoveries. There is a change happening right now in how some scientists are finding solutions to problems, with UW–Madison and WID right at the center. Nigel Boston, Professor of Mathematics and of Electrical and Computer Engineering and collaborator in the optimization theme at WID, is helping to bring applied algebra to a broad range of disciplines with help from a Research Training Grant from the National Science Foundation.

Algebra isn't new, but finding new ways to apply it could result in big gains for all kinds of researchers. "Algebraic methods have played an important role in certain areas of engineering and computer science, particularly in what's called coding theory," says Rob Nowak, a faculty member in the optimization theme. "That's a place where there's always been a lot of points of contact between pure algebra, mathematics, and applied engineering and computer science. Outside of that, there's been less contact between algebra and other areas." But the relationship between algebra and other disciplines may be on the brink of dramatic change.

Applying algebra in engineering and computer science has a number of advantages and can help solve a great host of problems, from helping Netflix give you better recommendations for what to watch tonight to keeping an airplane in the air. Expanding the use of algebra is a relatively new movement with promising implications.

The Netflix Problem is just one example of where algebra plays a key role. "The idea is you have some sparse data—like with Netflix you have 'These people recommend these movies,' but obviously not everyone recommends every movie, so you want to try and fill in the gaps in the table," says Boston. Filling in those gaps requires advanced algebraic methods.

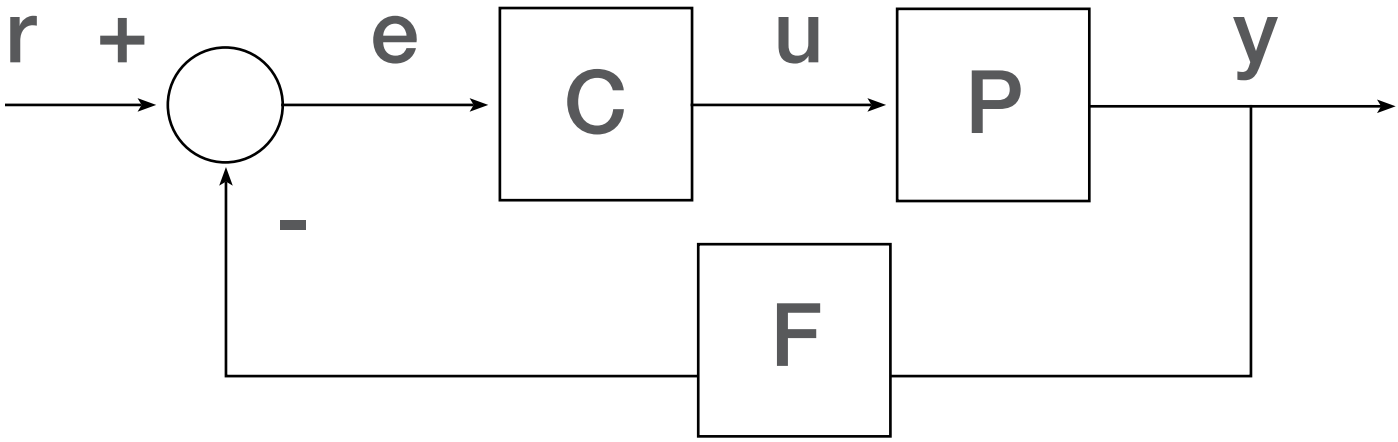
The problem isn't unique to Netflix, or even to a single discipline. "Bringing algebra to bear on problems in engineering and computer science has implications for all the sciences because all the sciences use data analysis methods," says Nowak. "Whenever you are measuring things in the real world, whether it's a biology experiment or you have a bunch of sensors monitoring the power grid, it's almost always the case that you don't get all of the data that you wished you could have gotten—data gets lost, sensors fail, experiments get contaminated." Using algebra to fill in the gaps makes it possible to make meaningful progress even with limited data.

Boston has also had success applying algebra to problems in control theory, an area of engineering and mathematics that deals with dynamical systems, including their stability and controllability. An example of control theory in action is an airplane: a controller receives feedback from sensors to constantly make tiny adjustments to modulate movement of the throttle, flaps, and other systems to keep the plane in control and in the air.

A famous problem in control theory and optimization dubbed the Belgian Chocolate Problem—so named by Belgian mathematician Vincent Blondel, who proposed the problem and offered a kilogram of chocolate to whoever could solve it—has been a subject of Boston's fascination for years. The problem involves finding the largest parameter value (known as δ) for which simultaneous stabilization of three plants, or components of a control system, is possible. This problem is especially challenging because the plants operate in conjunction and as you stabilize one plant, the others become destabilized.

"You have to get enough people on board to make change happen. I think they'll see what we're doing, they'll see it working at Wisconsin, and it will spread."

— Nigel Boston



A simple representation of a control loop

A series of researchers have provided progressively larger solutions, but Boston and his graduate student, Zach Charles, have defined a new algebraic approach. Says Boston, "Traditionally, engineers use complex analysis and probability theory—they haven't really used algebra so much. What happens in the engineering approach is you can keep nudging up this parameter. In our method, we figure out that what this parameter is tending toward is not just a random thing, it is something with very nice properties. You can characterize it algebraically and solve for it that way." So instead of moving incrementally toward the best solution, Boston and Charles can use algebra to describe the optimal solution. Indeed, the researchers now hold the world record δ. As Boston describes, "We spoil the fun and we find out what you're heading toward. This one paper replaces lots of papers."

The grant from NSF will allow researchers to continue enlisting algebra to solve a variety of problems in a wider array of disciplines. Boston is the principal investigator, but the grant includes several other faculty, providing $2 million over the next five years to fund new research positions and applied algebra conferences together with other activity in number theory and algebraic geometry. As algebraic approaches gain more traction, Boston hopes to use the grant to keep UW–Madison on the front lines of the growing domain.

"The idea of algebra is very clean. Communications, coding theory, and cryptography use a lot of algebra; more and more, computer scientists and engineers are having to learn some algebra. But there are so many other applications—we could be at the start of some movement," says Boston. That movement is growing. Boston, together with collaborator Shamgar Gurevich, has already organized two applied algebra conferences hosted by WID and attended by researchers from top institutions, including Princeton, Berkeley, and MIT. As Boston says, "I think we can provide a model that we can export to other places as well. The top places are looking for

Nowak

Boston

something new and something powerful. These conferences should put UW front and center as regards to this movement." The NSF award will allow for formative conferences, influential visitors, and the hiring of premier postdoctoral researchers.

When writing the grant application, Boston pointed to the interdisciplinary nature of UW–Madison, and WID in particular, as great incubators of innovation. "There are a lot of people doing very good math here, and the idea is we can improve on that and have more students and more faculty involved," says Boston. Reviewers agreed that UW is the right place for the ambitious work laid out in the grant, and that Wisconsin could be a leader in applied algebra.

Boston is committed to fulfilling that role and continues to expand the influence of algebra across academia. As he says, "You have to get enough people on board to make change happen. I think they'll see what we're doing, they'll see it working at Wisconsin, and it will spread." — Nolan Lendved, Wisconsin Institute of Discovery ■

Applied Algebra Seminar

The UW Applied Algebra seminar has been running since Fall 2013. It began under the organization of David Dynerman, a former Ph.D. student at UW–Madison. David is now a postdoctoral researcher at UC, Berkeley working with Bern Sturmfels (math) and Eva Nogales (biology), and has also started an Applied Algebra seminar at Berkeley. Current graduate students Zachary Charles and Alisha Zachariah now manage the seminar at UW–Madison.

The topic has grown in popularity over the last few years at UW–Madison with several graduate students and professors actively involved in research. This year the seminar ran approximately every other week and had a total of 15 talks over the course of the academic year.

We were fortunate to have an enormous range of speakers in the newly revived seminar. The speakers came from a variety of universities, departments, and disciplines. The seminar heard from researchers in mathematics, physics, statistics, optimization, computer science, and even music theory. We heard about spectral clustering, quantum computing, secret-sharing schemes, and multi-dimensional scaling and more. While varied in nature, the talks were unified by the use of mathematics and algebraic techniques to solve applied problems. Many of the talks were computational and algorithmic in nature, discussing how to compute useful mathematical concepts.

Applied algebra is an exciting area for our department. Interest both in and outside of the mathematics community is building, especially at UW–Madison. We look forward to great research from our own faculty and graduate students, and more excellent talks on applied algebra in Fall 2016.

Girls Night Out!

By Tullia Dymarz

Girls Math Night Out! is an outreach program for high school girls in the Madison area run by the Math Department. It was started by our very own Gloria Mari-Beffa over ten years ago as a way to encourage high school girls to become interested in math and its applications. Girls Math Night Out! skips the usual 'math contest' model that high school students are exposed to and instead leads students through an in-depth project over the course of an entire semester. Girls meet weekly with graduate student mentors, and at the end of the semester they present their work to an audience of friends and family.

This fall we had twelve high school girls from all over the Madison area (East High School, Memorial High School, La Follette High School and Middleton High School) working with five of our female graduate students on projects involving knots and topology, RSA cryptography, the algebra of robotics, and modeling epidemics.

Next year we are running the program during the spring semester for a change. We are always looking to get the word out, so please pass along the information to any high school math teachers who might be interested!

TULLIA DYMARZ (4)

Undergraduate Honors, Putnam Exam, COMAP, REUs

Putnam Results

Our team (Thomas Hameister, Benjamin Bandli, Daotong Ge) placed 41st. Our top scorer is Daotong Ge, who is also on the list of top 500 contestants.

2016 Undergraduate Math Competition

On April 12, undergraduate students at UW–Madison participated in the second annual UW Undergraduate Math Competition, organized by Dima Arinkin, Benedek Valko, and Simon Marshall. The competition is in the style of the Putnam or Virginia Tech math exams, with the aim being for the students to have fun and demonstrate their problem solving abilities. 16 students took part, and prizes were awarded to the highest placed finishers.

First Prize: Thomas Hameister
Second Prize: Chenwei Ruan, Yongzhe Zhang
Third Prize: Daotong Ge

Students often get very involved in their work for the COMAP Mathematical Contest in Modeling.

2016 COMAP Mathematical Contest in Modeling Competition

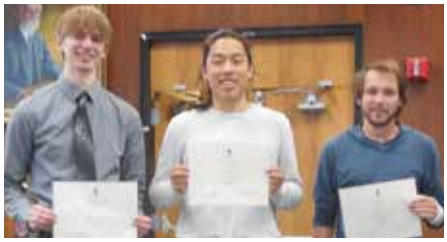
The COMAP Mathematical Contest in Modeling (MCM) is an exciting international competition, and it's a big one. Last year, over 7,400 international teams participated in the contest.

This year, six teams from UW–Madison successfully competed. In the competition, teams of three undergraduate students have 96 hours to research one of six topical, open-ended problems, develop a mathematical model, and write a paper.

Felipe Gutierrez, Jacob Johnson, and **Blake Nigh** received a Meritorious ranking for their paper on reducing the amount of small debris in orbit around the earth, modeled using a continuous-time Markov chain, placing them in the top 10% of more than 7,400 teams worldwide. Their submission, entitled "Too Much Space Junk in Earth's Trunk," benefitted from dangerous field research performed during the contest (see image).

Jianghao Cui, Zonglin Han, and **Yufan Xu** developed a model for measuring the evolution and influence in society's information networks (including the news and social media) and received an Honorable Mention ranking.

Undergraduate Awards



AMEP Leadership Prize:
Blake Nigh, Bai Wang, Felipe Gutierrez

Higgitt Scholarship:
Zijian Tao (not shown), Rebecca Eastham, Amir Alwan

Downling Scholarship:
Matt Olkowski

Irma Newman Scholarship:
Ethan Fricker

Mary Ellen Rudin Scholarship:
Mikayla Kelley, Sherry Cheng

Capstone-Undergraduate Research Award:
Kirill Gura

Department Updates

New faculty

Qin Li received her Ph.D from UW–Madison in 2009. She then went to the California Institute of Technology where she was a von Karman Instructor. She is interested in applied analysis, numerical analysis, and scientific computing as it relates to asymptomatic analysis in kinetic theory, non-adiabatic modeling in quantum systems, and exploring sparse structure in stochastic PDEs.

Steven Sam received his Ph.D. from MIT in 2011, before moving on to become the Miller Research Fellow at UC, Berkeley from 2012 to 2015. He's interested in free resolutions, group actions on algebraic varieties and commutative rings, symmetric functions, algebraic-geometric aspects of multilinear algebra, invariant theory, representations of classical Lie (super) algebras, and computation.

Hung Vinh Tran received his Ph.D. from UC, Berkeley in 2012. He was a Dickson Instructor at the University of Illinois-Chicago. He is interested in partial differential equations as it relates to viscosity solutions in Hamilton-Jacobi equations and their properties and the calculus of variations and regularity theory.

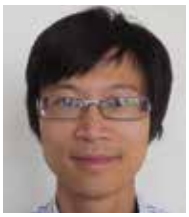
Lu Wang received her Ph.D. from MIT in 2011. She was the J.J. Sylvester Assistant Professor at John's Hopkins before coming here. She studies geometric analysis and geometric flows, including mean curvature flow, Ricci flow, and harmonic heat flow.

New Postdocs

Theresa Anderson is a proud Badger from the alumni class of 2010, with a B.S. in Mathematics, Chemistry, and Spanish Literature. She received her Ph.D. from Brown University in 2015 in harmonic analysis with Jill Pipher. She feels it is great to be back in Wisconsin where her research career started.

Eric Baer, received his Ph.D. from UT-Austin in 2012. He studies calculus of variations, partial differential equations, harmonic analysis, and geometric measure theory.

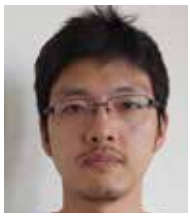
Arthur Evans received his Ph.D. from the University of San Diego in 2011. His thesis was titled "The shape of things to come: examining the interplay of elasticity, activity and geometry of soft matter."



Wai-Tong (Louis) Fan received his Ph.D. from the University of Washington in 2014. He studies probability theory, interacting particle systems, stochastic processes, and stochastic modeling in biological and ecological systems. He enjoys solving problems in natural sciences and reaching out to nature. He is particularly interested in hiking, kayaking and figure skating. http://louisfan.web.unc.edu

Alexandra Kjuchukova (Saskia) received her Ph.D. from the University of Pennsylvania in 2015. She studies low-dimensional topology and knot theory and she self-identifies as an aspiring poet.

Rutger Kuyper received his Ph.D. from Radboud University Nijmegen in 2015. He studies computability theory, Medvedev and Muchnik degrees, algorythimc randomness, and probability logic. http://rutgerkuyper.com/index.html



Donghyun Lee received his Ph.D. from the Courant Institute, NYU, in 2015. He studies kinetic theory and fluid dynamics.

Minh Binh Tran received his Ph.D. from the University of Paris in 2011. He studies numerical analysis and partial differential equations.

Chung-Nan Tzou received his Ph.D. from the University of North Carolina in 2015. He studies mathematical modeling.

Alfredo Wetzel received his Ph.D. from the University of Michigan in 2015. He studies geophysical fluid flow, integrable systems, and nonlinear waves. http://www.math.wisc.edu/~alfredowetzel

Botong Wang received his Ph.D. from Purdue University in 2012. He studies topology of algebraic varieties, particularly the cohomology jump loci of smooth varieties. He also applies topological methods in algebraic statistics. http://www.math.wisc.edu/~wang

New Academic Staff

Leesa Anzaldo received her Ph.D. from UC, Irvine in 2015. She has been involved in the Wisconsin Collaborative Eduation Lab (WisCEL), teaching introductory precalculus, and has taught a transitional course for math majors, which covers both linear algebra and proof-writing, and a core upper division course for math majors. She has also mentored ten new teaching assistants and assisted with the TA training workshops.

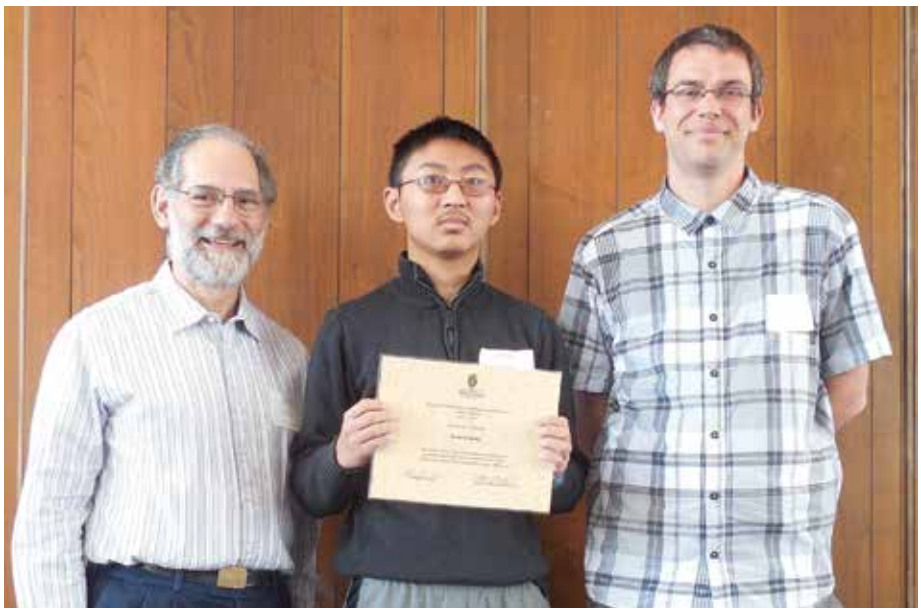
Steven Goldstein received his Ph.D. in math from UW–Madison with Peter Ney in 1988. Since then, he's worked as a computational biology researcher in various labs before returning to the Math and Botany departments to work as a Research Facilitator to assist in linking researchers to new methods of computational research.

New Administrative Staff

Veneta Boyanova came to the Math Department after serving Admissions, OHR, and a Soil Testing Lab since 2014. She graduated from the University of Wisconsin in 2014 with a degree in geography. Veneta has been helping with our travel and conference arrangements since January 2016.

Nibedita Pattniak came to the Math Department after working for eight years in Undergraduate Admissions and Recruitment. She graduated from a university in India with a master's in International Relations with a certificate in Computer Science. She will be working to arrange our timetable scheduling.

SARA NAGREEN



Left: Jonathan Kane (UW–Whitewater), Sean Chang, Benedek Valko (UW–Madison)

Talent Search 2016

On April 29, 2016, the UW–Madison Talent Search honored the best and brightest with a luncheon in the beautiful 9th floor lounge. Twenty-six students traveled from far and wide to receive their results and to learn whether they won the coveted Van Vleck scholarship.

A special speaker was Mike Schweitzer, one of the first students to participate in the Talent Search in the 1960s. He spoke of a time—before the Van Vleck Scholarship—when the reward was getting one's picture taken with the governor. He also talked about teaching high school math, then moving into business. He shared how studying mathematics has helped him and how it may help those students who had participated in the Talent Search, and encouraged the students to go on to study math.

This year's final winner was Sean Chang of Madison West High School. He has received a $24,000 scholarship to UW–Madison. Congratulations to Sean and all who participated!

Graduate Student Awards and Updates

Graduate Student Research Awards 2016

Many of our students contributed to research through their publications and thesis work. The department recognized four students for especially significant contributions in research and ten students for outstanding performance as teaching assistants.

Excellence in Research Awards

Elnur Emrah studied with Timo Seppäläinen. His research is in the part of probability theory that draws its inspiration from statistical physics. Elnur's research results are on the large scale behavior of some inhomogeneous percolation models in the Kardar-Parisi-Zhang universality class. Elnur has accepted a postdoctoral fellowship at Carnegie Mellon University starting in the fall of 2016.

Christopher Janjigian was advised by Benedek Valko. He has obtained several results in probability theory including the study of large deviation properties of directed polymer models. In fall 2016 he will move to Paris Diderot University for a one-year postdoctoral stay, and then continue with a postdoctoral position at the University of Utah.

Xiaoqian Xu works in partial differential equations and was co-advised by Alexander Kiselev and Andrej Zlatos. In his research he has made several contributions on problems in fluid dynamics and mixing. Xiaoqian has accepted a postdoctoral position at Carnegie Mellon University starting in fall 2016. He will also spend a semester at ICERM in the spring of 2017.

Elizabeth Hirschfelder Scholarship

Elizabeth (Stafford) Hirschfelder (1902-2002) received a Ph.D. in mathematics at UW–Madison in 1930 and taught for almost twenty years in the Math Department. In the 1990s she established a scholarship fund for graduate women in mathematics, chemistry, and physics.

Laura Cladek is the recipient of a 2016 Hirschfelder scholarship in the Math Department. She worked with Andreas Seeger in harmonic analysis and made several contributions in Fourier multiplier theory. Laura has accepted a postdoctoral position at the University of British Columbia in Vancouver.

Departmental awards for outstanding performance as Teaching Assistants

Brandon Alberts, Chandan Biswas, Di Fang, Christian Geske, Chris Jianjigian, Ryan Julian, Will Mitchell, Keith Rush, Jeremy Schwend, Dongxi Ye

L&S Teaching Fellows

Carolyn Abbott and Yu Sun were 2015 Letters and Science Teaching Fellows.

Chandan Biswas was named a 2016 Letters and Science Teaching Fellow.

2015 Campus-wide Teaching Assistant Award Receipients

Two teaching assistants from the Department of Mathematics were honored by the campus-wide TA Awards Committee.

Di Fang received an Early Excellence in Teaching Award.

Christopher Janjigian received a Capstone Ph.D. Teaching Award.

2015 Graduates

Name	Advisor	Dissertation Title
Pretel, Gabriel	Terwilliger	Tridiagonal Pairs of Krawtchouk Type and their Compatible Elements
Johnson, Silas	Ellenberg	Weighted Discriminants and Mass Formulas for Number Fields
Dynerman, David	Gurevich	Describing Geometry and Symmetry of Cryo-EM Datasets Using Algebra
Lynch, Alison	Terwilliger	Algebraic Characterizations of Cauchy pairs and Uq(sl2)-modules
Nagpal, Rohit	Ellenberg	FI-modules and the Cohomology of Modular Representations of Symmetric Groups
Alladi, Sriram	Seeger	A Multiplier Theorem for Ultraspherical Polynomials
Zheng, Fan	Yang	On Constructing Eigenfunctions of Weil Representation over p-adic fields
Li, Lei	Spagnolie	Fluid-structure Interaction at Dierent Reynolds Numbers
Nan, Ting-Ting	Boston	Entropy Regions and the Four-Atom Conjecture
Hu, Yueke	Yang	Period Integrals, L–Functions, and Applications to Subconvexity Bound and Mass Equidistribution
Strenner, Balazs	Kent	Algebraic Degrees and Galois Conjugates of Penner Stretch Factors
You, Qian	Angenent	Some Ancient Solutions of Curve Shortening
Zhao, Jie	Wang	Hyperkähler Metrics on Focus-Focus Fibrations

Faculty Retirements

Terry Millar retired in June 2015. After dropping out of college to join the Marines for two years (including a brief stint as forward artillery observer in Vietnam), Terry started graduate school at Cornell and received his Ph.D. in 1976 with Anil Nerode (twenty years his elder and still not retired!).

During the 1980s, Terry was one of the world's foremost researchers in computable model theory, an area which had been started by the Novosibirsk school of Algebra and Logic under Mal'cev and Ershov as well as, in the West, work of Frohlich and Shepherdson, Rabin, and Nerode; and for a decade, Terry and Goncharov from Novosibirsk, both with coauthors, ended up proving the same results independently and almost simultaneously, but leaving many questions open to the current day.

In the late 1980s, computable model theory fell briefly out of fashion, and Terry remembered his other great talent: administration, first serving for many years as Associate Dean in the Graduate School and finally as assistant to the Provost. He also became heavily involved in mathematics education and teacher training and was in charge of large grants for multiple school districts across the country, including Madison's. Three semesters ago, Terry returned full-time to the math department and revived in particular our history of mathematics course (using his unique expertise in both physics and logic).

He will be greatly missed in the department, but we hope that he will return to his first love, computable model theory, which as it turns out, is now one of the more popular fields in logic, still profiting from Terry's early work!

Arnold (Arnie) Miller retired in June 2014. Arnie received his Ph.D. from the University of California, Berkeley in 1978 under the direction of John Addison. He joined our department as a Van Vleck Instructor and then Van Vleck Assistant Professor in 1977 but then left (with Ken Kunen) for the University of Texas-Austin in 1979, where he received tenure in 1984. In 1985 he returned to our department and since then has left only for several visiting appointments, most of them in Toronto, Canada, both at York University and at the Fields Institute.

Arnie is one of the leading set theorists of our time. He is the author of more than sixty research papers and has innovated a number of techniques that are very frequently quoted in the literature; his papers have often settled questions that had been open for many years. The bulk of his work involves independence proofs, producing models of set theory in which various interesting statements are true.

In his thesis (and in a 1979 paper), he showed the consistency of the statement that there are sets of real numbers whose Borel hierarchies have length any desired countable ordinal. In 1980, he proved that it is consistent that there are no Q-points in the space ~N-N; this settled a question that had been open since Walter Rudin started looking at P-points (a related notion) in 1956. ln a 1984 paper, he invented what are now called "Miller reals." This is a general technique for producing models where the Continuum Hypothesis is false. He used Miller reals to solve one particular problem, but they are now frequently used by other researchers to solve other problems. Most recently, Arnie has been interested in the Borel hierarchy in the absence of the Axiom of Choice. Arnie is also the author of a research monograph, with the appropriate subtitle "How to prove theorems about Borel sets the hard way," aptly expressing Arnie's quirky sense of humor, which is also reflected in his lecturing style.

DONOR UPDATE

Thanks to all of you for your continued interest in the University of Wisconsin Mathematics Department, and for your generous and avid support. Without it, we could not offer the quality and excellence of programming and experiences we provide for our students at a time when we must navigate difficult budgetary circumstances.

Because of you and other supporters, the Math Department received a major increase in private donations in the past year! While there remain opportunities to further secure faculty positions through named professorships, and needs for graduate funding support, we are deeply grateful and encouraged by your increased generosity. Your involvement means you believe in our mission and our plans to continue to pursue excellence.

You can make a gift online at https://supportuw.org/giveto/math. Or if you prefer, make a check payable to UW Foundation and note "Mathematics Annual Fund" in the memo line. Please mail checks to UW Foundation, U.S. Bank Lockbox, Box 78807, Milwaukee, WI 53278-0807.

If you have any questions or feedback, memories or offerings, or would like to know more about ways you can support priorities or get involved, please contact Rebekah Sherman at (608) 572-2077 or Rebekah.sherman@supportuw.org. Please visit our website at https://www.math.wisc.edu for updates, events, newsletters and links to our Facebook page and our donation page.

We want to recognize our generous donors to the Math Department and say thank you. It is through private gifts that we can continue to run programs that continue challenging minds and impacting lives. ■

Faculty Updates

Melanie Matchett Wood has been awarded a 2015 Packard Fellowship. This is a highly prestigious and extremely competitive award given to all sciences, math, and engineering. To put it in context, only 20 awards have gone to mathematicians since its beginning 25 years ago, and only twice before to someone in our department (15 to UW–Madison). This is a tremendous and well-deserved achievement.

Additionally, Melanie Matchett Wood was a featured guest on WPR's Central Time on November 17, 2015. She made the case for appreciating the beauty of math—and having fun with it. http://www.wpr.org/better-love-math-fear-it

Lu Wang, our new Assistant Professor, was named a Sloan Research Fellow for 2016. Sloan Fellows are among the most prestigious awards for early career mathematicians, seeking to stimulate fundamental research by early-career scientists and scholars of outstanding promise. Lu Wang's focus is on geometric analysis and geometric partial differential equations like those often used to describe the shape and flow of curved surfaces, fluids and heat.

Tullia Dymarz and **Jun Yin** have been awarded NSF CAREER awards. The Faculty Early Career Development (CAREER) Program is a foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education, and research within the context of the mission of their organizations.

Daniel Erman has been awarded the William H. Kiekhofer Teaching Award. He has been teaching at UW–Madison for only two and a half years, but he has already distinguished himself in courses ranging from first-year calculus to graduate topics. Since he's been on campus, he has written eight papers that have either been published or accepted for publication, and he has five other papers in process. He has also secured a personal research grant from the National Science Foundation. Above all, Erman's love for mathematics and teaching shines through in his tireless search for ways to reach students and his concern for their well-being. http://go.wisc.edu/9iq3y8

David Anderson has been granted one of this year's Vilas Associates awards. The Vilas Associates Competition recognizes new and on-going research of the highest quality and significance. Recipients are chosen competitively by the divisional Research Committees on the basis of a detailed proposal.

Jordan Ellenberg won the 2016 Euler Prize for his book *How Not to Be Wrong: The Power of Mathematical Thinking* (The Penguin Press, New York, 2014). The Euler Book Prize is awarded annually to an author or authors of an outstanding book about mathematics. The prize is intended to recognize authors of exceptionally well-written books with a positive impact on the public's view of mathematics and to encourage the writing of such books.

Arthur Evans, a Van Vleck Assistant Professor in the Math Department, told Live Science about his work, showing how a curved object, like a cone, might be folded. Partly inspired by origami, Evans and his colleagues created 3-D models out of dental rubber to see how they deformed. Possible applications include robots and satellites. http://go.wisc.edu/io16hp

Marshall Slemrod has showed that using Navier-Stokes equations (the fundamental equations of fluid mechanics) to explain the Crookes radiometer are "incomplete." He proposed instead to use the Korteweg theory to better approximate the Boltzmann equations for gases near vacuum. This is related to Hilbert's 6th problem. http://go.wisc.edu/s48q2o

University Housing residents have the opportunity to recognize outstanding classroom instructors through the Honored Instructor program. Over the past seven years, students who live in University Housing have honored hundreds of instructors on campus.

The **Fall 2015 Honored Instructors** in the Math Department were Alexander Hanhart, Carolyn Abbott, Daniel Erman, Di Fang, Eugenia Malitsky, Gabriele Meyer, Josh Blatz, Kurt Ehlert, Soledad Benguria, Qin Li, Robert Grizzard, Saverio Spagnolie, Shirin Malekpour, Tullia Dymarz, Uri Andrews, and Vefa Goksel.

The Spring 2016 Honored Instructors in the Math Department were Ahmet Kabakulak, Kurt Ehlert, Michael Flores, Tullia Dymarz, Daniel Erman, Jennifer Beichman, Saverio Spagnolie, Shirin Malekpour, and Julie Mitchell.

Alumni Updates

Daniel Howard, B.S. 2015, will attend the University of Notre Dame under the Dean's Fellowship as a Ph.D. graduate student in the Applied & Computational Mathematics & Statistics Department.

Joe Timmerman, B.S. 2015, has been working as an analyst for Eccella, a software/data consulting firm in New York.

Andrew Ma, B.S. 2015, is pursuing a Ph.D. in Math at the University of Texas-Austin.

Ayah Almousa, B.S. 2015, is pursuing a Ph.D. in Math at Cornell University, New York.

Kevin Meaney, B.S. 2015, attends graduate school in Physics at the University of New Mexico.

Thomas Ernst, B.S. 2015, is pursuing a Ph.D. at MIT Sloan in Finance.

Nick Derr, B.S. 2015, spent 2015-2016 as Mathematical Tripos, University of Cambridge. Starting in fall 2016, he'll pursue a Ph.D. in Applied Math at Harvard University.

Christopher Alfeld, Ph.D. 2007, works for Google in Madison, WI.

David Seal, Ph.D. 2012, worked as a postdoc at Michigan State University from 2012 to 2015, during which time he spent a summer visiting Oak Ridge National Laboratory. As of fall 2015, he is a tenure track professor at the U.S. Naval Academy.

Where do our 2016 graduates go from here? Anywhere they want!

Sean Green, B.S. 2016, will be working for the U.S. Navy as an engineer.

Bai Wang, B.S. 2016, will pursue a Ph.D. in Physics at Stanford.

Suzanna Wei Ying Kwa, B.S. 2016, will be working as an intern at Thun Financial Advisors.

Zack Briesemeister, B.S. 2016, will attend graduate school for astrophysics and astronomy at UCSC.

Annemarie Schweinert, B.S. 2016, will be working as a Research Associate in Microeconomics at the San Francisco Federal Reserve Bank.

Mikayla Kelley, B.S. 2016, will pursue a Ph.D. in mathematics at UC, Berkeley.

Tyler Odders, B.S. 2016, will be working as a Research Analyst for the Nielsen Company in Chicago.

Yiwen Wang, B.S. 2016, will be working as an actuarial analyst at CUNA Mutual.

Leo Rudberg, B.S. 2016, is starting a year-long co-op at Google in NYC. He says his last interview at Google was with a math Ph.D., so he thinks having a math degree on his resume earned him some points!

Wendan Zhang, M.A. 2016, will pursue a Ph.D. in economics at the University of Arizona.

Xiaoqian Xu, Ph.D. 2016, will attend Carnegie Mellon University as a post-doctoral fellow.

Got an update you'd like to share?
http://go.wisc.edu/9do819

IN MEMORIUM

Kay Strangman passed away February 2016 in a tragic skiing accident.

She studied at UW–Madison with majors in mathematics and mathematics education. She received a master's degree in mathematics from the Illinois Institute of Technology. In 1967, Kay returned to Madison to work at the UW–Madison R & D Center, collaborating with Henry Van Engen on cognitive learning. According to Kay, it was during the two years she spent with Van Engen that she really learned to teach. Kay was a lecturer in both the Mathematics and Computer Sciences Departments. From 1989 to 1999 she taught numerical analysis courses in the CS Department. She taught in the Mathematics Department from 1983 to 2002, primarily the three courses of our calculus sequence in the extended day program, but also courses for future elementary teachers and a course on quantitative reasoning. In 2000, Ms. Strangman was awarded the title of Senior Lecturer. At the dinner, Claire Rider spoke of Kay's reputation as an excellent teacher who used computers and computer software (e.g., Mathematica and Excel) to advantage in the classroom. Kay had several interests outside of computers and mathematics; she was the substitute organist at Bethel Lutheran Church and loved ice-skating.

DEPARTMENT OF
Mathematics
UNIVERSITY OF WISCONSIN–MADISON

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Math Circles are intended to demonstrate the applications of math to a youth audience. Here, Jen Beichman, a Van Vleck Professor, is demonstrating minimal surfaces via soap bubbles. http://www.math.wisc.edu/mathcircle/.