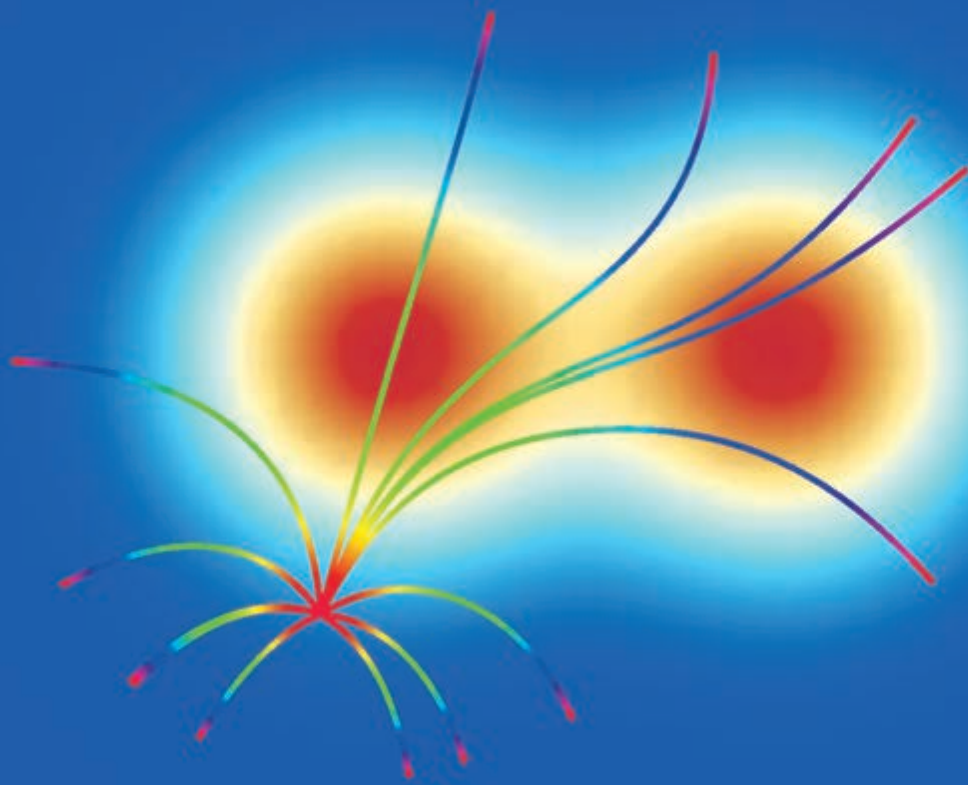# MUDD MATH

HARVEY
MUDD
COLLEGE

Letter From the Chair

Dear HMC Mathematics Friends,

Thanks to the generosity of Professor Emeritus John Greever, we are pleased to announce the establishment of a new prize: the John Greever Mathematical Research Prize. The purpose of the Greever Prize is to honor one student majoring in mathematics who has made an original contribution to the theory of mathematics as evidenced by publication in a periodical, book or senior paper, or in abstract form when the originality of the contribution is attested by the student's faculty research supervisor.

This year's inaugural prize was awarded to Madeleine Weinstein '16 for her paper "Invariance of the Sprague-Grundy Function for Variants of Wythoff's Game," which has been accepted for publication in *Integers*.

An expert in topology and biomathematics, Greever was hired by the College in 1961 and retired in 1996. Greever played a leading role in the founding of the Mathematics Clinic program in 1973 and chaired the department from 1972 to 1975. Another prize named after him—the Greever Clinic Prize—honors outstanding student contributions (individually or as a team) to the HMC Mathematics Clinic program.

The Department of Mathematics awards several other endowed prizes, and you will read about the winners in this issue.

Our faculty are not only active scholars and top-notch teachers, many of them also have a talent for administration. Rachel Levy was promoted to full professor this year and now serves as the associate dean for faculty development. She also is the point person for our upcoming departmental review, taking place during the 2016–2017 academic year.

Darryl Yong '96 has stepped down after several years of service as the associate dean for diversity and is on a leave of absence. During the next two years, Yong will lead the new Claremont Colleges Center for Teaching and Learning, which was created to help faculty members enhance their teaching through programming, consultation services and support programs. Dagan Karp assumes the role of associate dean for diversity for a three-year term.

Jon Jacobsen is the vice president for student affairs/dean of students and, from all accounts, he continues to do a terrific job. We miss having him in the department.

Susan Martonosi will assume directorship of the Harvey Mudd College Global Clinic (a program very close to my heart).

Alfonso Castro is completing a year as director of the Claremont Center for the Mathematical Sciences and will be heading out on sabbatical this year.

Comings and Goings

Talithia Williams, Mike Orrison and Susan Martonosi returned from some very successful sabbatical year experiences. We're glad to have them back!

We say goodbye to visiting Professor Satyan Devadoss (read more on page 7 about his research and Moody Lecture) as well as postdoctoral fellows Nora Youngs and Ivan Ventura '07.

Youngs, who studies neuroscience from the viewpoint of algebraic geometry, worked with Mohamed Omar on several mathematical projects and begins a tenure-track position at Colby College this fall. Ventura begins a tenure-track position at Cal Poly Pomona this fall. He returned to HMC in fall 2014 to work with Alfonso Castro as a postdoctoral fellow, having received his PhD in mathematics from UC Berkeley.

We say "hello" to full-time visitors Bianca Thompson (PhD in mathematics, University of Hawaii at Manoa), Lauren Lazarus (PhD in theoretical and applied mechanics, Cornell University) and alumnus Kenji Kozai '08 (PhD in mathematics, Stanford University).

Our faculty and students continue to be very active scholars. This past year, the math department sponsored over 30 students to attend a wide variety of research conferences, including the JMM, SACNAS, SIAM and MAA annual meetings, as well as conferences in algebra and tropical geometry and the National Society of Black Engineers meeting.

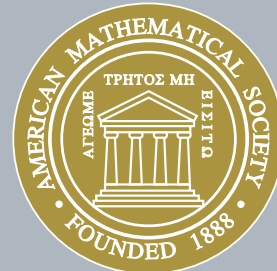I hope you'll enjoy reading more in this issue of *MuddMath*.

Lisette de Pillis
Chair, Harvey Mudd College Department of Mathematics and Norman F. Sprague Professor of Life Sciences

Contents

In 2006, the HMC Department of Mathematics received the very first Award for Exemplary Program by the American Mathematical Society.

Harvey Mudd College is a co-educational liberal arts college of engineering, science and mathematics that also places strong emphasis on humanities and the social sciences. The College's aim is to graduate engineers, scientists and mathematicians sensitive to the impact of their work on society.

About the Cover

The cover image was created by Casey Chu '16, who wrote his senior thesis on the geometry of data under the direction of Professor of Mathematics Weiqing Gu. The image illustrates how Riemannian geometry redefines the measurement of distance and direction in space. Here, probability theory and Riemannian geometry intersect: The two normal distributions in the background warp space in such a way that if a bunch of ants started marching from the red point at the same time and moved at constant speed and direction, they would reach the ends of the rainbow paths at the same time.

arxiv.org/abs/1508.00150
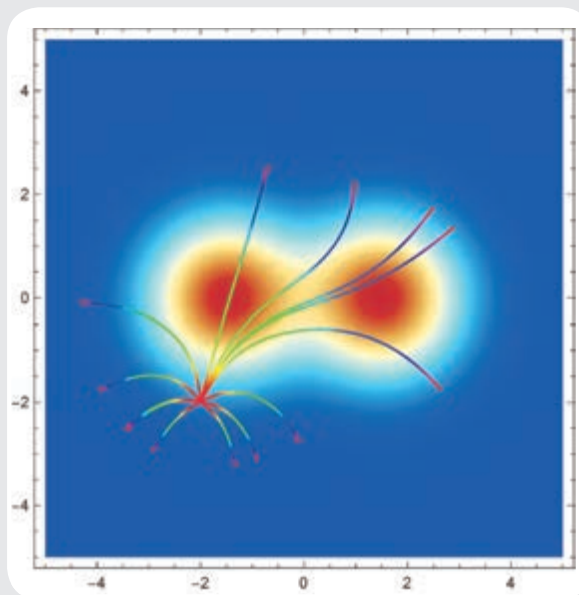
Moody Lecture Series

Where Art Meets Math in Nature

On Sept. 17, 2015, visiting mathematics Professor Satyan Devadoss delivered the fall Michael E. Moody Lecture, "The Shape of Nature: Bee, Tree, Origami." Devadoss explored the intersection of modern art and research mathematics, including architectural monuments inspired by the mysteries of honeycomb designs, paintings and visualizations motivated by the genetic data of novels, and paper sculptures spawned from the folding of leaves and proteins.

"The Renaissance was a time when art and science were not polar opposites, but extensions of one another," says Devadoss. "With the advent of the Enlightenment Era, a dualistic tension between visual arts and scientific research was introduced. Today, the study of nature is serving as a bridge between these worlds once again."

A mathematician and professor at Williams College, Devadoss holds a PhD from Johns Hopkins. He is an inaugural Fellow of the American Mathematical Society and has received teaching awards from the Mathematical Association of America. His works, which range from cartography and origami to phylogenetics and art, is supported by the National Science Foundation, the John Templeton Foundation, the Mellon Foundation and the Department of Defense. In addition to invitations at Google, Pixar and LucasFilm, he has held visiting positions at Ohio State, UC Berkeley, the Mathematical Sciences Research Institute and Stanford.
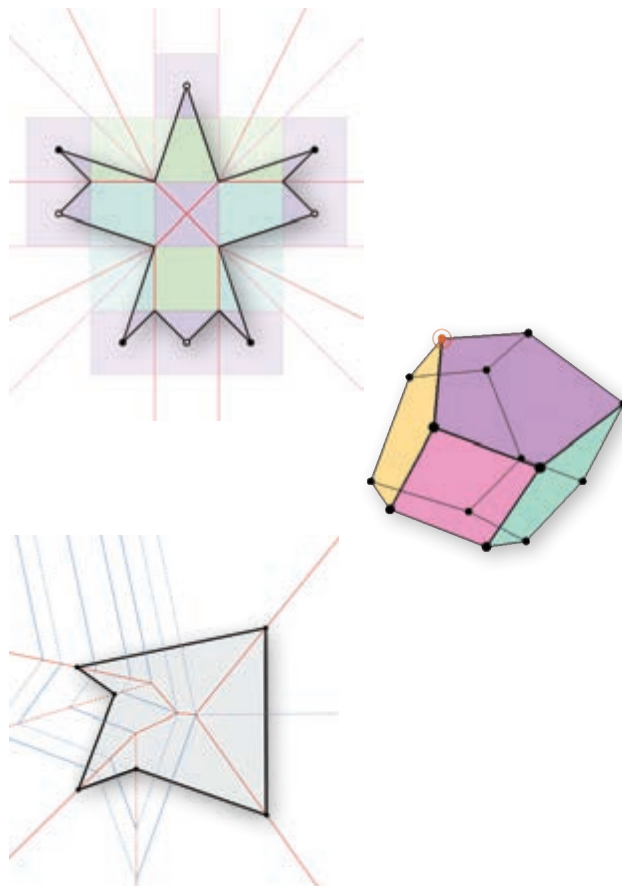
Mathematics of Crime
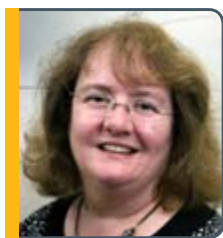
Law enforcement agencies across the country have discovered that partnering with a team of mathematicians and social scientists from UCLA can help them determine where crime is likely to occur. At the spring Moody Lecture, "The Mathematics of Crime," on March 3, 2016, UCLA Professor of Mathematics Andrea L. Bertozzi discussed her participation on the UCLA team that developed a "predictive policing" computer program to zero in on areas that have the highest probability of crime. The usefulness of mathematics in studying gang crimes and other criminal activities was also discussed. Commercial use of the predictive policing program allows communities to put police officers in the right place at the right time, stopping crime before it happens.

Bertozzi is an applied mathematician with expertise in nonlinear, partial differential equations and fluid dynamics. She also works in the areas of geometric methods for image processing, crime modeling and analysis, and swarming/cooperative dynamics. She became a professor of mathematics at UCLA in 2003 and began serving two years later as director of applied mathematics, overseeing UCLA's graduate and undergraduate research training programs. Her honors include the Sloan Research Fellowship, the Presidential Early Career Award for Scientists and Engineers and SIAM's Kovalevsky Prize. She was elected to the American Academy of Arts and Sciences and is a Fellow of the Society of Industrial and Applied Mathematics and of the American Mathematical Society. Bertozzi completed all her degrees in mathematics at Princeton.

Founded in remembrance of Harvey Mudd Professor of Mathematics Michael E. Moody, the Michael E. Moody Lecture Series brings to campus speakers who illuminate the joy, wonder and applicability of mathematics.

Community Partnerships

SIAM VP Role Provides Inside View of Fantastic Organization

by Rachel Levy, SIAM vice president for education
Article excerpted from SIAM.org
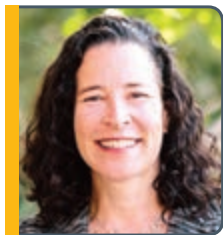
My first SIAM conference was the one held in Philadelphia on the occasion of the 50-year anniversary. SIAM stands for the Society for Industrial and Applied Mathematics, an international professional organization that brings together people from academia, business and government. I remember my graduate advisor, Michael Shearer, bringing me around to meet people whom he admired. My favorite session was a retrospective plenary where they projected old black-and-white photos of young people standing by room-sized computers and then pointing out who was in the room that day (usually making them stand up and tell a story about the picture). As a new grad student at NC State, I had just learned to use MATLAB, and there was founder Cleve Moler in the pic as a youngster and in the room shouting out names of people in the pics. A day later, Cleve gave a provocative talk about the role of computing in the mathematics community. As we think about the growing role of computing and data science for our alums, that conversation continues to be an important one.

Most of all at that conference I felt a strong sense of community, and a society interested in doing important work with a positive impact on society—an idea that would resonate again when I chose to join Harvey Mudd. What I would never have predicted was that 14 years later I would become vice president for education for the same organization. As VP, I have had a chance to see the organization from the inside. SIAM has an amazing staff but also runs on the significant effort of volunteers. I'm happy (and maybe relieved) to report that seeing SIAM from the inside has confirmed my positive view of the organization, its staff, its leaders and its members.

I have the fun job of supporting the SIAM programs that involve students. One is the SIAM student chapters, which have grown in number and global reach over the past decade. There are now 173 active chapters. Of those, 120, including one at HMC, are located in the United States, and 53 chapters are in countries outside the U.S. The chapters get some money for activities and send a representative to the annual meeting. At the annual meeting there are tons of activities for students—a poster session, undergraduate and graduate paper sessions, a Communication Doctor's Booth where people can practice pitching their work for the press or a job interview, a book giveaway, social events put on by the local student chapters and all the regular activities of the conference.

Before serving as VP, I had the pleasure of serving as editor-in-chief for *SIAM Undergraduate Research Online*. This publishing venue requires that the undergraduates be the authors of the papers published, and they get a full review experience, essentially like they would get if they submitted to a regular journal, but hopefully also friendly and encouraging. As VP, I get to support the new editor in chief and watch it continue to grow!

The previous VP of education, Peter Turner, initiated a new focus for SIAM and its education committee called Modeling Across the Curriculum. A couple of workshops have led to some significant changes: There is a new joint committee with the National Council of Teachers of Mathematics (NCTM). NCTM was my first professional society when I had my first job teaching fifth- and sixth-grade math, so it is especially nice for me to see these two organizations working together! A group of people sponsored by SIAM and COMAP spent a year writing national Guidelines for Assessment and Instruction in Mathematical Modeling Education (the GAIMME report, free here: siam.org/reports/gaimme.php). You might know COMAP because it runs the MCM/ICM competition that many Mudders have enjoyed.

SIAM has a new Activity Group in Education, which means if you are a SIAM member, you will have a new way to connect to other industrial and applied mathematicians who are interested in education. The first conference was in September in Philadelphia, and included a strand on what we call BIG-MAC (BIG standing for "business, industry and government." See siam.org/bigmathnetwork/.). SIAM is interested in connecting more mathematicians to jobs in BIG because not only are there more math PhDs than tenure-track jobs, there are also interesting positions for mathematicians in all kinds of workforce sectors. You can see a report on issues related to this pipeline here: ipam.ucla.edu/wp-content/uploads/2015/10/NSF-IPAM-industry-internship-workshop-report.pdf.

The SIAM VP also has the responsibility to work with the policy committee to produce statements related to education issues. I was able to work on a response to the PCAST report, which raised some criticisms of mathematics teaching at the undergraduate and graduate levels, as well as a new report on undergraduate applied mathematics programs to help guide people wanting to start a new major or minor.

I'll end with an especially fun project. The Communication Doctor's Booth at the last meeting was such a success that we decided to run a SIAM Research in Action contest. People submitted a video pitch about why they should get professional assistance making a video about their research for YouTube. We had a lot of submissions from undergrads, grads, postdocs, profs and even institutes! The final winner was a researcher from Brazil working on green roofs—you can see his video here: youtu.be/doKroODAVLA.

If you are not a SIAM member and you have interest in industrial and applied mathematics, I encourage you to join. It is a fantastic community with great conferences and opportunities to see what's happening. Here's a link to upcoming conferences: siam.org/meetings/calendar.php. Hope to see you at one soon!

De Pillis Earns Top AMS Honor

Professor of Mathematics and department Chair Lisette de Pillis has been elected into the 2016 class of Fellows of the American Mathematical Society (AMS). The Fellows program recognized de Pillis for contributions to mathematical oncology and immunology research, leadership in mathematical biology education and service to the mathematical community.

De Pillis is one of 50 AMS Fellows recognized this year for making outstanding contributions to the creation, exposition, advancement, communication and utilization of mathematics. She has made pivotal contributions to mathematical oncology and immunology research. With over 60 highly cited research publications, de Pillis is highly respected in the mathematical biology community. Her cutting-edge developments in the mathematical modeling of cancer immunology and the work she does in collaboration with physicians and biological scientists make her a recognized leader in her field.

De Pillis serves as the Norman F. Sprague Jr. Professor of Mathematics and the Life Sciences, an endowed professorship honoring a faculty member who has contributed to interdisciplinary work at the College and who has significant ties to the Department of Biology. De Pillis was instrumental in helping to develop the College's mathematical biology major, one of the first such undergraduate majors in the country. More broadly, de Pillis is recognized among students and faculty alike for her mentorship and guidance.

"Lisette is committed to providing research experiences for students and has co-authored numerous papers with undergraduates, most of whom have gone on to PhD programs in mathematics, applied mathematics, biology, epidemiology, veterinary medicine and more," says Smallwood Family Chair and mathematics Professor Art Benjamin, who nominated de Pillis. "She is also a dedicated mentor to younger faculty members and an active advocate for women in the mathematical sciences."

De Pillis has served on numerous editorial boards and, in 2014, served as guest co-editor of the *American Mathematical Monthly*, a special issue devoted to mathematical biology. She has given numerous keynote and plenary addresses, including SIAM 2009, Mathematical Biosciences Institute 2014 and SCALA (Scientific Computing Around Louisiana) 2015. She has been recognized by Argonne National Laboratories as a Maria Goeppart Mayer Fellow—the only scholar from an undergraduate institution and only the second mathematician to receive this distinction.

De Pillis has served as director of Harvey Mudd's Global Clinic Program and as founding director of the College's Quantitative Life Sciences Center and has received over $1 million in research funding from the National Science Foundation and other funding agencies.

This summer, de Pillis travelled to Nottingham to present at the annual Society for Mathematical Biology Board meeting. She also organized a mini-symposium titled "How to Heal? Models of Injury, Illness and Treatment."

Su Continues MAA Duties

Francis Su continues his work as president of the Mathematical Association of America, which has involved numerous speaking and writing engagements as well as presiding over the centennial celebration of MAA at MathFest last summer. In addition, Su authors articles for the President's Column of the MAA news magazine, including "The Value of Struggle" (bit.ly/the-value-of-struggle).

Su directed Research Experiences for Undergraduates (REU) last summer at the Mathematical Sciences Research Institute at Berkeley. Called MSRI-UP, it was aimed at underrepresented groups in mathematics. With a postdoc and two graduate students, Su led 17 students on six research projects. A paper from that REU was recently accepted for publication.

Jacobsen Takes on Student Affairs Role

Professor of Mathematics Jon Jacobsen was appointed vice president for student affairs and dean of students. As part of the Division of Students Affairs (DSA), Jacobsen is responsible for Harvey Mudd's residential life and student support programs and will oversee the offices of Institutional Diversity, Health and Wellness, Residential Life, Campus Life, Career Services and Community Engagement. Hired in 2002, Jacobsen was promoted to full professor in 2014; his research interests include differential and integral equations and their applications, particularly in mathematical ecology. As associate dean for academic affairs since 2010, he oversaw the first-year academic program and helped students make a smooth transition from high school to college. He is also deeply involved in Pathways, a mathematics community outreach program featuring faculty members eager to share their love of mathematics with elementary, junior high and high school students.

Martonosi on the Move

Joseph B. Platt Associate Professor of Mathematics Susan Martonosi has had an eventful year. Her second child, Maryhelen, was born in September 2015. Shortly after that, she was elected to the Institute for Operations Research and Management Science (INFORMS) board of directors and became the organization's vice president of membership and professional recognition. This past spring, Martonosi and student researchers developed a mathematical model for allocating malaria interventions across geographic regions and time, the results of which were published in *Malaria Journal*.

In addition to directing the Global Clinic, Martonosi is president of INFORMS' Forum for Women in Operations Research and Management Science (WORMS), vice president for programs of INFORMS' Forum on Education (INFORM-Ed), chair of the INFORMS Academic Programs Database Committee and a member of the INFORMS Professional Recognition Committee. Her research focuses on the application of operations research models and methodology to problems in homeland security, using game theory, social network analysis and graph theory to solve problems in resource allocation and terrorist network disruption. In addition to working in homeland security, Martonosi is also developing mathematical models for malaria intervention policy.

Susan Martonosi with Maryhelen

Levy Promoted to Full Professor

The board of trustees approved the recommendation of the Reappointment, Promotion and Tenure Committee and President Maria Klawe that Associate Professor of Mathematics Rachel Levy be promoted to full professor.

Hired in 2007, Levy researches applications of mathematics to biological and industrial problems. Levy's work in fluid dynamics has included the motion of surfactants on thin liquid films, algorithms for coordination of remotely operated robots (mini-submarines) in an aquatic testbed, and the hydrodynamics of whale flukeprints. Other collaborations include the modeling of protein aggregation and the spectroscopy of environmental pollutants.

Levy is co-director of the IMMERSION project, an NSF-funded study examining how intensive training can affect elementary school teachers' use of mathematical modeling in the classroom. Levy specializes in math curriculum and innovative design of instruction for both undergraduate and K–12 mathematics education. Her research in this area has focused on flipped classrooms in undergraduate education and mathematical modeling in K–8 education. She is passionate about sharing mathematics by facilitating hands-on outreach activities that help people experience what mathematicians do.

As vice president of education for SIAM, Levy has created opportunities for mathematics students and faculty to improve their research communication with the press and the general public. She has led workshops in press communication for faculty in mathematics, biology and physics. Levy has also served as associate dean for faculty development, and has served on the College's Teaching and Learning Committee. At the fourth annual HMC Leadership Awards event, Levy received the Outstanding Faculty Member award. A nominator wrote, "[She] consistently goes above and beyond in her mentorship role both to students and faculty."

Karp Appointed Associate Dean for Diversity

Associate Professor of Mathematics Dagan Karp will serve as the College's associate dean for diversity for the next three years. He will co-direct Summer Institute and the College's mentoring program as well as provide input during searches for faculty positions. Karp is active in STEM diversity causes, including the Society for Advancement of Chicano and Native Americans in Science (SACNAS) and the diversity committee of the Mathematical Sciences Research Institute. Karp has a passion for civil rights, including gender equity, and is active in the National Alliance for Doctoral Studies in the Mathematical Sciences and the e-Mentoring Network in the Mathematical Sciences (See blogs.ams.org/mathmentoringnetwork/).

State of the Art

Art Benjamin's latest book, *The Magic of Math: Solving for X and Figuring out Why* (September 2015), made the *New York Times* Bestseller List for Education and has received many positive reviews. Benjamin shows how the math we learn in school—from basic counting and arithmetic to algebra, geometry and beyond—can be easy, intuitive and fun. "Numbers, shapes and pure logic can yield delightful surprises," Benjamin says. "And with just a little bit of algebra or geometry, you can often discover the secrets behind the magic."

Benjamin's previous book, *The Fascinating World of Graph Theory*, recently earned the American Library Association's Outstanding Academic Title distinction. Based on overall presentation, scholarship, academic relevance and value to students, the Outstanding Academic Title distinction is afforded to a small number of academic texts reviewed each year in *Choice*, the American Library Association's magazine. This prestigious list reflects the best in scholarly titles selected by the editors of *Choice* and brings with it the recognition of the academic library community.

Benjamin was a keynote speaker at MAA MathFest this past August, speaking on magical mathematics. He also ran an invited paper session on mathematics and magic in August and emceed the closing banquet with a Tom Lehrer singalong. "Speaking of songs," says Benjamin, "I wrote a *Sound of Music* parody for my temple called *The Sound of Purim*, which I'm willing to share with others."

Holder of the Smallwood Family Chair at Harvey Mudd, Benjamin has been called America's Best Math Whiz by *Reader's Digest* and was named one of America's 300 Best Professors by *Princeton Review*. Also a magician, he has performed his "mathemagics" shows at thousands of schools, universities, conferences and public venues around the world. Combined, his three TED talks on math have been viewed more than 11 million times.
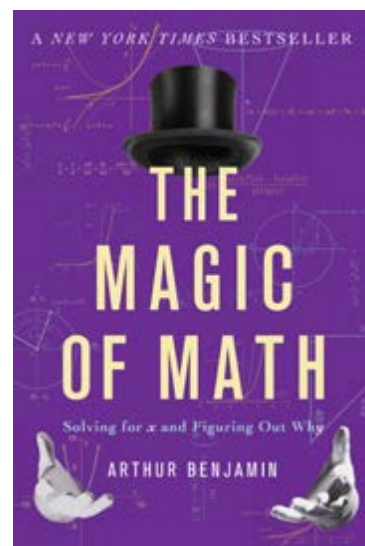
What a Ride!

By Satyan Devadoss,
visiting professor of mathematics

I took a leave from Williams College this year to be a visiting professor in the HMC mathematics department. Although I knew of Mudd's great reputation, I was most interested in examining its amazing claim to be a haven for scientists steeped in the humanities and the arts. I am a deep believer in the liberal arts philosophy, not just theoretically, but in my own mathematics research. And so I was excited to discover whether HMC practiced its beliefs.

The department welcomed me with open arms. It started with a kind invitation to give the fall 2015 Michael E. Moody Lecture, along with opportunities to teach core courses (multivariable, oh! so delicious), lead math forum (remember: style beats substance), supervise a thesis student (shout out to Patrick Tierney '16) and collaborate on the side (with Wee Pittayakanchit '16 on juggling!).

But the freedom to design my own topics course topped it all. It was a project-driven course on geometry and topology that valued creating physical designs (with hands and tools) on par with studying theoretical ideas. It was a success, with superb student creations that can be found here: sites.google.com/a/g.hmc.edu/dcg/home.

But more than just HMC math showed me grace. I was invited to give a biology colloquium, joined a faculty reading group on "the Senses," crashed a few dorm parties, made several ice cream runs with students and caused trouble at the new Office of Institutional Diversity headquarters. In all of this, I was able to observe students, staff and faculty struggling with and worrying about the courses and the Core, trying to include the humanities and the arts without crushing them by its sheer weight. I was encouraged and touched.

I did have one point of worry about Mudd: success seems to be measured on short-term values (e.g., job placement and starting salary rates of graduates) rather than the long-term (and more difficult) task of producing scientists steeped in the arts and humanities. But, I am confident that this school that has come so far will push through this hurdle as well. And so, my time at Harvey Mudd can be captured in one word: beyond.

Weinstein Receives Inaugural Greever Research Prize

Madeleine Weinstein '16 is the inaugural recipient of the Department of Mathematics' Greever Mathematical Research Prize. The prize honors a student majoring in mathematics who has made an original contribution to the theory of mathematics as evidenced by publication in a periodical, book or senior paper, or in abstract form when the originality of the contribution is attested by the student's faculty research supervisor. Weinstein was recognized for her paper "Invariance of the Sprague-Grundy Function for Variants of Wythoff's Game," which has been accepted for publication in *Integers*. Weinstein also received two other departmental honors: the Giovanni Borrelli Mathematics Prize and the Robert James Prize.

Wythoff's game is a combinatorial game that has a simple winning strategy, but its Sprague-Grundy function (which describes how it interacts with other impartial games) has eluded all attempts at explicit description and has been described as "chaotic." In her paper, Weinstein proves three conjectures made by Aviezri Fraenkel and Nhan Bao Ho, making a significant contribution to the study of this fascinating topic.

Already a published mathematician and seasoned presenter, Weinstein earlier this year received an Honorable Mention for the Alice T. Schafer Prize for Undergraduate Women in Mathematics. Given by the Association for Women in Mathematics, the prize is for the most outstanding female mathematics undergraduate in the United States, and receiving honorable mention is a notable honor. A unicyclist who loves musicals and NPR, Weinstein's long-term goal is to earn a PhD in mathematics and teach at the university level.

Whirlwind Year for After School Specials!

The After School Specials! a capella group, which features students from each of the five undergraduate Claremont Colleges— including Mudders Annalise Schweickart '18 and mathematics graduate Aleina Wachtel '16—won the Sing for Survivors Contest with its arrangement of the Oscar-nominated song "Til It Happens To You," written by Diane Warren and Lady Gaga for *The Hunting Ground*, a documentary that explores sexual assault on college and university campuses. Shortly after winning the nationwide contest, the After School Specials! performed the song at the White House Champions of Change event in April. Wachtel was an After School Specials! member all four years. See http://bit.ly/5Cvote
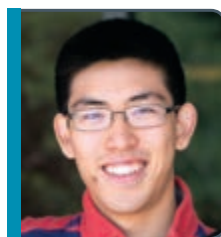
Astronaut Scholar

Mathematics and physics double major Calvin Leung '17 was named an Astronaut Scholar by the Astronaut Scholarship Foundation, which supports college students pursuing science and technology careers. Leung is one of 40 recipients of the prestigious $10,000 award for the 2016–2017 academic year.

In 2014, Leung worked with Soumya Mohanty of the Laser Interferometer Gravitational-wave Observatory (LIGO) Scientific Collaboration—a team of international physics institutes and research groups dedicated to the search for gravitational waves—at the University of Texas, Brownsville, to develop an algorithm for the detection of gravitational wave signals. Since the most interesting gravitational wave events don't have robust theoretical models to back them up, Leung says, there is interest in developing algorithms to detect arbitrary gravitational wave signals in noisy data. Using evolutionary optimization and techniques from machine learning, Leung developed a data pipeline that synthesized data from multiple gravitational wave detectors, including LIGO, in order to pinpoint the source of the signal and extract the waveform accurately even without prior knowledge of what the signal looked like.

More recently, Leung has been involved in two research projects: one devised by him and another student with Assistant Professor of Physics Jason Gallicchio. Over the last four semesters, Leung developed a fast and effective way to quantify the resolution of a camera—research he's excited to incorporate into Physics 134 (Optics Lab) curriculum and to submit to the *American Journal of Physics*. With Gallicchio, Leung has been building an experiment combining cosmological observation with quantum optics, examining light from distant quasars billions of light years away to determine whether quantum mechanics offers a correct description of the universe.

Leung also is an Academic Excellence physics tutor and a member of the Honor Board. He was Judiciary Board chair in 2015–2016. He enjoys "rocking out on the cello, singing in the shower and unicycling silently past unsuspecting tour groups."

After graduation, he plans to obtain his PhD in physics and join the effort to bring gravitational wave astronomy to fruition. "Gravitational wave astronomy will be an entirely new way to do astronomy and learn about the universe," says Leung.

Fine Fellows

Three 2016 mathematics graduates were recipients of 2016 National Science Foundation Graduate Research Fellowships, which help ensure the vitality and diversity of the nation's base of science, mathematics and engineering candidates.

Reyna Hulett, a joint computer science and mathematics graduate researching algorithms and theoretical foundations, plans to intern at DropBox before attending graduate school at Stanford, Berkeley or University of Washington. Also a joint CS/math major, Jennifer Rogers is researching bioinformatics and will join Microsoft as a data scientist. Madeleine Weinstein (algebra, number theory and combinatorics) will attend UC Berkeley's PhD program in pure mathematics.

Matthew Dannenberg '16, a double major in mathematics and physics, received an honorable mention for his research in computational and data-enabled science.

Jennifer Rogers '16

Reyna Hulett '17



Madeleine Weinstein '16

Gold Standard

Mathematics students Christopher Hoyt '18 and Dina Sinclair '17 each earned 2016 Barry Goldwater Scholarships. The Goldwater is the most prestigious national award for undergraduate STEM researchers, covering up to $7,500 of college expenses.

Hoyt worked with University of Wyoming researchers to analyze the phenotypes of maize mutants using various methods of microscopy. He also worked to develop a computational method of taking images of cells and producing an approximation of where the future division sites will occur. This summer, he'll conduct research at the National Institute of Standards and Technology (NIST) 2016 Summer Undergraduate Research Fellowship program to conduct measurements of wireless propagation channels using NIST's robotic system in order to develop standards for the next generation of wireless cellular communications systems. His career goal is to earn a PhD in mathematics and conduct research and teach mathematics at a research university.

With mathematics Professor Rachel Levy, Sinclair studied computational fluid dynamics. Their research looked at ways in which lung surfactants are modeled so that doctors can better understand how to medicate premature babies whose lungs are surfactant deficient. She hopes to obtain a PhD in operations research, conduct research in applied mathematics with a focus on public policy applications and teach at the university level.
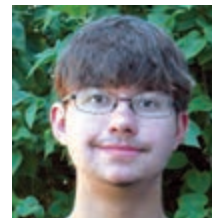

Christopher Hoyt '18

Dina Sinclair '17

Mudders Impress at Putnam

Harvey Mudd was once again the top-scoring undergraduate institution in the William Lowell Putnam Mathematical Competition. Thirty-five Harvey Mudd students took the challenging six-hour exam last December, which requires a unique blend of cleverness and problem-solving skills. In the United States and Canada, 4,275 students competed, and this year the median score was 1 out of a total of 120 points.

In the team competition, Adam Busis '19, Abram Sanderson '17 and Natchanon Suaysom '18 placed an extremely impressive 7th out of 554 institutions—the sole undergraduate-only institution among the top 10 teams.

In the individual category, Busis scored 46th and Ben Lowenstein '16 tied for 81st and 82nd place—both received Honorable Mentions. Five other Mudders—Jordan Haack '19, Bo Li '16, Colin Okasaki '17, Sanderson and Suaysom—placed in the top 200. Seven additional students placed in the top 500: Shyan Akmal '19, Christopher Hoyt '18, Sam Miller '17, Josh Petrack '16, Dina Sinclair '17, Matthew Wilber '17 and Daniel Zhang '18.
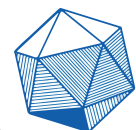
Mudders Finish Strong at MCM/ICM

Faced with problems ranging from space junk to refugee immigration patterns, four Harvey Mudd student teams earned Honorable Mention in the Mathematical Contest in Modeling and Interdisciplinary Contest in Modeling in February.

In the MCM, senior team Kevin Eades, Stephen Schein and Avi Thaker and another of Matthew Dannenberg '16, Justin Lee '16 and Micah Pedrick '17 each received Honorable Mention for their solution to Problem A, which required the development of a model for maintaining a hot bath while minimizing water used. Casey Chu '16, Cheng Wai Koo '16 and Matthew Wilber '17 earned Honorable Mention for Problem C—determining an optimal investment strategy on behalf of The Goodgrant Foundation.

In the ICM, seniors Joana Perdomo, Jennifer Rogers and Lin Yang received Honorable Mention for their work on Problem F, which asked teams to develop a model to better understand factors involved in facilitating the movement of refugees from countries of origin to safe-haven countries.

Two teams were designated Successful Participant in the ICM: sophomores Katelyn Barnes, Amy Huang and Josh Miller for Problem D, for which they created a model to measure how global information networks influence public opinion; and Weerapat Pittayakanchit '16, Natchanon Suaysom '18 and Yossathorn Tawabutr '17 for Problem F.

The competitions give each team 96 consecutive hours to develop a mathematical model that solves a real-world problem and then write a formal paper describing their work. Solutions are judged not only in terms of scientific and mathematical accuracy, but also on creativity and clarity of exposition. Worldwide, 7,421 teams participated in the MCM, and 5,025 teams participated in the ICM.

2015–2016 Senior Theses

Amzi Jeffs: **Convexity of Neural Codes**
Advisors: Mohamed Omar and Nora Youngs

Joana L. Perdomo: **Mathematical Models of Blood Coagulation**
Advisors: Lisette de Pillis and Darryl Yong '96

Alec M. Dunton: **Topological Data Analysis for Systems of Coupled Oscillators**
Advisors: Andrew Bernoff and Chad Topaz, professor of mathematics, Macalester College

Madeleine Weinstein: **Adinkras and Arithmetical Graphs**
Advisors: Dagan Karp and Charles Doran, professor of mathematics, University of Alberta

Ryan C. Jones: **Hopper Bands: Locust Aggregation**
Advisors: Andrew Bernoff and Chad Topaz

Margaux L. Hujoel: **Assessment of Chlamydia Procedures for Treatment and Screening**
Advisor: Lisette de Pillis

Kennedy Agwamba: **Computational Exploration of Integrodifference Population Models**
Advisor: Jon Jacobsen

John Phillpot: **Line-of-sight Pursuit and Evasion Games on Polytopes in Rn**
Advisors: Ran Libeskind-Hadas and Nicholas Pippenger

Bo Li: **Model for the Control of Criminality in Cities**
Advisors: Alfonso Castro and Ivan Ventura

Matthew Dannenberg: **Pattern Recognition in High-Dimensional Data**
Advisor: Weiqing Gu

Weerapat Pittayakanchit: **Global Stability of Equilibria in a Model of Swarming**
Advisors: Andrew Bernoff and Chad Topaz

Matthew Wilber: **Building a History of Horizontal Gene Transfer in E. coli**
Advisor: Eliot Bush

Matthew S. Lin: **Graph Cohomology**
Advisor: Dagan Karp

Joyce C. Yang: **Interval Graphs**
Advisor: Nicholas Pippenger

Robert Bennett: **The Fibonomia Coefficients and Other Up-Down Tilings**
Advisor: Arthur Benjamin

Casey Chu: **Probing Big Data Using Differential Geometry**
Advisor: Weiqing Gu

Cheng Wai Koo: **A Bound on the Number of Spanning Trees in Bipartite Graphs**
Advisor: Mohamed Omar

Patrick N. Tierney: **Constructing the 2-Associahedron**
Advisor: Satyan Devadoss, visiting professor of mathematics

2015–2016

Senior Clinic Projects

Mathematics

EDR: Algorithms for Property Search and Identification
Team: Sean O'Keeffe, Michael Libucha, Ben Lowenstein, Bo Zhang
Advisor: Darryl Yong '96

HRL Laboratories: Analysis of Quantum Communication Network Protocols
Team: Wenhao Lu, Yossathorn Tawabutr, Ben Johnson, Reyna Hulett, Kilian Fa
Advisor: Weiqing Gu

Microsoft Corporation: Anomaly Detection for Live Site Incident Detection
Team: Angela Chin, Lucy Gao, Alison Kingman, Sam Jun
Advisor: Rachel Levy

NOAA-Alaska Fisheries: Parameter Estimation on Marine Biological Models
Team: Nathan Geldner, Tasman Loustalet, Rowan Zellers
Advisor: Alfonso Castro

Engineering/Mathematics

Pharmavite LLC: Finite Scheduling
Team: Allison Barry, Aleina Wachtel, Stephen Schein, Kanak Singh, Rachel O'Neill, Jessica de la Fuente
Advisors: Patrick Little, Weiqing Gu

Departmental Awards and Recognition

Giovanni Borrelli Mathematics Prize: Benjamin Lowenstein '16, Madeleine Weinstein '16

Stavros Busenberg Prize in Applied Mathematics: Matthew Dannenberg '16, Alec Dunton '16

Henry A. Krieger Prize in Decision Sciences: Margaux Hujoel '16

Courtney S. Coleman Prize: Anna Ma '17, Dina Sinclair '17, Josh Tawabutr '17

Chavin Prize for Best Mathematics Paper: Casey Chu '16, Amzi Jeffs '16, Joana Perdomo '16

Robert James Prize: Daniel Johnson '18, Cynthia Yan '18

Greever Clinic Prize: Reyna Hulett '16

Greever Mathematics Research Prize: Madeleine Weinstein '16

RIF Hutchings Prize for Outstanding Performance in the Putnam Competition: Adam Busis '19, Jordan Haack '18, Benjamin Lowenstein '16, Abram Sanderson '17, Natchanon Suaysom '18

Leadership Awards

Class of 2016 Departmental Honors: Casey Chu, Maxfield Comstock, Matthew Dannenberg, Alec Dunton, Margaux Louise Hujoel, Reyna Hulett, Amzi Jeffs, Cheng Wai Koo, Bo Li, Michael Libucha, Benjamin Lowenstein, Sean O'Keeffe, Joshua Petrack, Weerapat Pittayakanchit, Jennifer Rogers, Patrick Tierney, Madeleine Weinstein, Rowan Zellers

Harvey Mudd honored its outstanding community members April 28 at the fourth annual Leadership Awards ceremony, which celebrates students, faculty and staff for their contributions on campus and beyond.

Spacapan Memorial Scholarship (community service award): Caitlin Lienkaemper '17 (mathematics) has worked on Claremont Homeless Advocacy Program community cafés since their inception in September 2014. She is a representative in CHAP's monthly food working group meetings and is an overnight volunteer.

Joana Perdomo '16 (mathematics) was an avid volunteer, working for the Natural History Museum of Los Angeles County, Pomona Valley Community Hospital Medical Center, Habitat for Humanity, the Los Angeles Regional Food Bank and Pomona Unified School District. She also served as a co-president of HMC's Society of Professional Latinos in STEMs.

## Math Grads Swagged Out for Annual Magic Castle Evening

Back row:
Siddarth Srinivasan '16, Vincent Fiorentini '16, Matthew Wilber '17, Cheng Wai Koo '16, Rowan Zellers '16, Andrew Fishberg '16, Daniel Bork '16, Benjamin Lowenstein '16, Skyler Young '16, Heather Seaman '16, Reyna Hulett '16, Kathryn Aplin '16, Jozi McKiernan '16, Naomi Epstein '16

Front Row standing:
Michael Libucha '16, Sakshi Shah '17, Lauren Burke, Marina Haukness '16, Aleina Wachtel '16, Megan Shao '16, Eamon Brennan, Jennifer Rogers '16, Emma Meersman '16, Maggie Rabasca '16, Angela Chin '16, Joyce Yang '17, Hannah Rose '16, Max Comstock '16, Kaitlin Kimberling '16, Kevin Heath '16

Seated:
Paula Yuan '16, Jean Sung '16, Margaux Hujoel '16, Professor Art Benjamin, Linda Seaman, Thendal Govindaraj '16
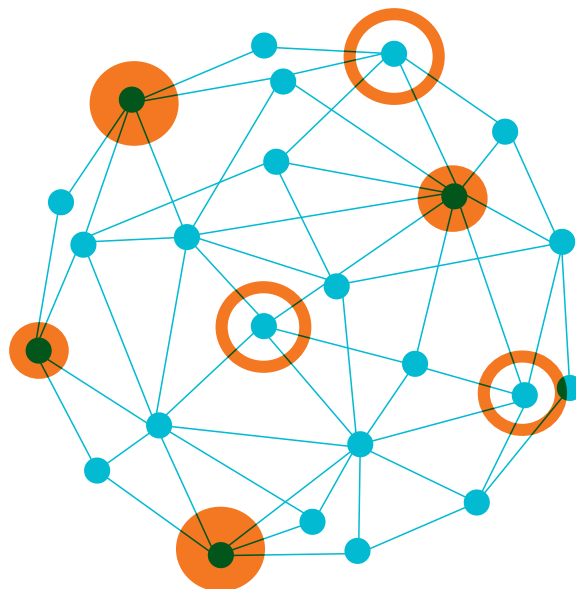
Years in the Making

A Reminiscence About MATHLIB/ODE Toolkit

By Dan Newman '85

Under the supervision of professors Bob Borrelli, Courtney Coleman, Michael Raugh, Chris Stone, Francis Su, Talithia Williams and Darryl Yong, the HMC Department of Mathematics has shepherded a multi-decade project of mathematical modeling tools known under several names, including MATHLIB and, more recently, ODE Toolkit. The package's origins date back to at least Tony Noe '74 and David Bakin '77. Over the decades, many students have had a hand in growing it and directing its development.

One popular component of MATHLIB in the '80s was the ODE solver, DEQSOLVE, which produced many of the figures in Borrelli's and Coleman's heroic text on differential equations. Other professors and researchers put DEQSOLVE to good use as well. This tale relates how a group of numerical analysts at Lawrence Livermore National Laboratory (LLNL)—without whom DEQSOLVE would have never existed—found themselves vindicated by DEQSOLVE.

Earlier incarnations of the ODE solver in MATHLIB used a Runge-Kutta solver. Professors Borrelli and Coleman pointed me at LLNL's growing library of state-of-the-art ordinary differential equation solvers, ODEPACK. Knowing a good thing when I saw it, I wrapped ODEPACK with MATHLIB's terminal-based, interactive command interface and named it DEQSOLVE. Ned Freed '82, then lead developer of MATHLIB, made quite a few extensions to the lower-level libraries supporting DEQSOLVE (e.g., new features in MATHLIB's symbolic algebra library, improved interactive facilities for manipulating large systems of equations, and so forth). The results proved quite popular.

Harvey Mudd chemistry Professor Paul van Eikeren began using DEQSOLVE to deal with an extremely stiff system of over 200 ODEs. Ned, Kevin Carosso '82, Kristin Hubner '87 and I became aware of his usage when he congratulated us on producing software capable of handling the problem he was working on and enabling him to validate the model against experimental results. Van Eikeren's results also impressed the group funding his research—who themselves were unsuccessful in attempts to numerically solve the problem. These sponsors, upon learning that software written by college students succeeded where their attempts had failed, decided to launch some poisoned arrows at another research group who had been advising them.

Cut to Professor Borrelli. Borrelli received a phone call from Dr. Alan Hindmarsh, lead researcher and developer of ODEPACK at LLNL. This phone call resulted in my receiving an exciting trip to the labs to meet with Hindmarsh's group. I was escorted around LLNL by Jeffrey Painter '73, who worked with Hindmarsh. As it turned out, the group funding Professor van Eikeren—Group X—was also at LLNL and, on advice from Hindmarsh's group, had tried to solve their problem using ODEPACK. They had written their own program using ODEPACK, coding in FORTRAN their complicated system of over 200 differential equations. Likely they had to hand-derive the system's Jacobian matrix and code that as well. When Group X failed to solve their problem with ODEPACK, they felt that the fault was with ODEPACK: that ODEPACK wasn't up to solving their system of stiff ODEs. And, when they learned that software written by mere college students handily solved their problem, they took that as further proof of ODEPACK's inadequacy and apparently said as much to the ODEPACK team at LLNL. Well, that backfired when Hindmarsh's group closed the loop and showed that the college students had used ODEPACK. Which is to say, mere college students were able to implement Group X's model better than Group X could themselves.

In point of fact, what enabled Professor van Eikeren to succeed was having an interface in which he could symbolically enter and easily modify the large, cumbersome system of equations and have the Jacobian automatically (and symbolically) generated. This work resulted from the math department's commitment to mentoring and developing the talents of Mudd students.

Jack Cuzick '70 Elected to Royal Society
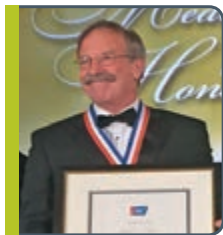
Harvey Mudd's 2010 Outstanding Alumnus Jack Cuzick '70 was recently elected as a new Fellow of the Royal Society, the oldest scientific academy in continuous existence. Made up of eminent scientists, engineers and technologists working in the United Kingdom, past Fellows include Isaac Newton, Charles Darwin, Albert Einstein and Stephen Hawking.

Cuzick is head of the Centre for Cancer Prevention and John Snow Professor of Epidemiology at Queen Mary University of London. He has been a leading epidemiologist working in cancer screening and prevention for more than three decades and has played a major role in developing chemopreventive breast cancer medications that reduce risk in women with a high chance of developing the disease.

The mathematics alumnus also received the 2015 American Cancer Society Medal of Honor in the category of clinical research for his contributions to the field of biostatistics, epidemiology and clinical medicine.

## Alumnus Receives NSF Graduate Research Fellowship
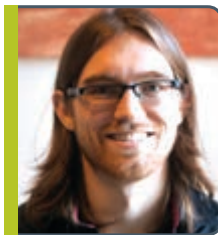
For his research in applied mathematics, alumnus Matthew McDermott '14 received the prestigious National Science Foundation Graduate Research Fellowship for 2015–2016. Recipients are awarded three years of research support, including an annual $34,000 stipend and $12,000 cost-of-education allowance. Fellows also have access to collaborative research opportunities abroad through the Graduate Research Opportunities Worldwide initiative and professional career development with federal internships provided through the Graduate Research Internship Program.

NSF Honorable Mentions went to Madison Hansen '15 (mathematics and computational biology) for work being conducted in evolutionary biology at the Richard Gilder Graduate School and to Natasha Parikh '14 (mathematics and computational biology) for research in cognitive neuroscience at Duke University.

Class Notes
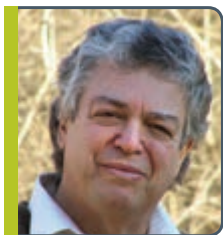
Written by **Peter Loeb '59**, one of the first Harvey Mudd graduates and a leading scholar in his field, *Real Analysis* includes a novel presentation of differentiation and absolute continuity using a local maximum function, resulting in an exposition that is both simpler and more general than the traditional approach. Theorems are stated for Lebesgue and Borel measures, with a note indicating when the same proof works only for Lebesgue measures. Appendices cover additional material, including theorems for higher dimensions and a short introduction to nonstandard analysis: springer.com/us/book/9783319307428

Loeb also has published "End Compactifications and General Compactifications" (with M. Insall and M. Marciniak) in the *Journal of Logic and Analysis* 6:7 (2014) and wrote four chapters and co-edited the second edition of *Nonstandard Analysis for the Working Mathematician* (2015).

Paula Diehr '63 and **Michael Diehr '90** have developed a Healthy Life Calculator that allows seniors to estimate the number of "good" years they have remaining. Unlike other web calculators, this one estimates how long you'll be healthy and active, gives ranges of likely values and is documented in a scientific publication. healthylifecalculator.org

Frank Greitzer '68 is celebrating the fourth anniversary of his company, PsyberAnalytix. Greitzer founded PsyberAnalytix in May 2012 after retiring from the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL). PsyberAnalytix specializes in human factors research and consulting in application domains of counterintelligence/insider threats, information analysis, cybersecurity expertise, cyber situation awareness and secure power systems decision making. Read more about Greitzer and his company in the spring 2015 issue of *Harvey Mudd College Magazine*: bit.ly/293anSi

Greitzer recently earned two national awards for advanced technology development for a system that he co-invented prior to retiring from PNNL. Last November, *R&D Magazine* recognized Greitzer and other PNNL co-inventors for development of the CHAMPION advanced reasoning system. He also received the R&D 100 award that honors inventors of the 100 most technologically significant products and advancements for the past year. (See pnl.gov/about/rd100awards.asp.) CHAMPION uses advanced Semantic Web technologies—which translate human knowledge into machine-readable form—and then applies descriptive logic to reason like an analyst and determines whether activity is suspicious. Once identified, the software alerts an analyst of

the suspicious activity in order to potentially thwart an attack. The transfer of this technology from the Department of Energy laboratory to the private sector earned the development team another prestigious award: Last March, the team won a 2016 Federal Laboratory Consortium (FLC) Award for Excellence in Technology Transfer. (See pnnl.gov/news/release.aspx?id=4256.) The system has been licensed to Champion Technology Co. Inc., which is further developing the tool as DarkLight.

As founder and principal scientist at PsyberAnalytix, Greitzer continues to support research to enhance decision-making in critical domains, such as cybersecurity. Recently, he chaired the Workshop on Research for Insider Threat (WRIT). (See writ2016.compute.dtu.dk/.) WRIT workshops have been conducted for several years in association with the annual IEEE Security & Privacy Symposium, which brings together cybersecurity researchers and practitioners to share scientific, peer-reviewed research.

Jon Johnson '70 writes: This spring, I was elected governor of the Illinois Section of the Mathematical Association of America (MAA). The board of governors includes representatives of each of the 29 sections, national officers, ex-officio members and six governors-at-large. HMC faculty have been very involved in the MAA; if you have a chance, look at the video link under Art Benjamin's picture on the governance page—Art, Talithia Williams and Francis Su, the current MAA president, are featured.

Dick Jones '72 is finishing up his latest state department assignment as the chargé d'affaires of the U.S. Embassy in Beirut, Lebanon. The department asked Dick to come out of retirement to take this "two-month" assignment last October, and he is still there. His wife, Joan, joined him recently, but they will return to the U.S. for a summer to attend weddings of family and friends from coast to coast.

Karl Rudnick '72 writes: I retired from SAIC in summer of 2013. Since then, my new "job" is bicycle advocacy + lots of bike riding + grandparent. As part of bike advocacy, I was able to create and complete a math project. Here's the problem: In the San Diego County Bicycle Coalition, we had an important function to align bike coalition members with their Community Planning Groups so that we could notify members in each Community Planning Area (CPA) when important meetings occur that have to do with improving bicycling in their community. The mathematical part was that we obtained boundaries of each CPA from county surveys as a finite sequence of geodetic (latitude, longitude) vertices, and we had street addresses for all the members. Step 1 was to convert the street addresses to geodetic (lat, lon)—a simple problem known as "geocoding" where Google data is available to help. Step 2 was then to assign members to the correct CPA. The math problem in Step 2 was one for which I developed an algorithm at the Aerospace Corporation in the 1980s, where we had to determine whether a satellite orbiting the earth had visibility (line of sight within angle constraints) to the interior of a polygonal region of great circle arcs on Earth. Hint: A closed polygon (need

not be convex and can have "holes") in the infinite plane defines a bounded and an unbounded region. To determine whether an arbitrary point in the plane is interior to the bounded region, extend an infinite ray in any direction from the point. The number of times it crosses the boundary tells you whether it is interior or exterior—you figure what odd and even number of crossings say about the answer. The idea can be extended to a polygon of great circle arcs on a spherical ellipsoid (Earth). The algorithms I developed at Aerospace were written in Fortran, and I later used the same algorithm (for a completely different application that boiled down to the same math problem) at SAIC (now Leidos) and coded the algorithm in both MATLAB and C++. The version I provided to the San Diego County Bicycle Coalition was written entirely in Python, as the software needed to be free and open source. I still like figuring out how to turn any question I come up against into a math problem, whether it be trivial or not. Software projects, too, still manage to excite me.

John Lavrakas '74 writes: For me, the big adjustment in my life has been to become president of the board of the Newport Symphony Orchestra in Newport, Oregon. I liken it to taking over a business with 70 employees, 15 live events and the need to raise funds to keep it all going. Though I do not play an instrument, I sang in a symphonic choir in the late 1970s in South Bend. This opened my eyes and ears to the beauties of symphonic music. We are fortunate the small community we live in (10,000 in population) has a full-season professional orchestra—one more grand reason to live on the Oregon coast.


Dave Abrahamson '76 writes: I have just completed 35 years of full-time teaching, the last 30 at Rhode Island College (a 10,000-student, public, master's-granting institution in Providence). I expect to teach for approximately 10 more years or till I can afford to retire, whichever comes first. My wife, Rebecca Sparks, is also a full professor here at RIC. We have a 10-year-old son, Luke, and we spend all our non-work time driving him back and forth to swim practices and meets around New England. I continue to be in debt to the great faculty at HMC back in my time. The mathematical education I got put me ahead of the game when I got to a doctoral program, and the College's emphasis on a broad-based education to create responsible citizens helped me to no end, as well.

▲ **Jim Bean '77** writes: One year ago, I joined Northeastern University in Boston as provost and senior vice president for academic affairs. Northeastern is a global, experiential research university that has seen a meteoric rise in rankings the past 10 years. This summer we have four Mudders working as research assistants in Northeastern labs.

Alex Feldman '78 writes: I retired from my faculty position at Boise State in 2008 and have been picking up odd jobs ever since. I have done occasional work for the State Board of Education and a local attorney, but probably the most interesting thing I did was teach math on Navy ships. I did one deployment on a destroyer in the Persian Gulf and another on an aircraft carrier going around South America.
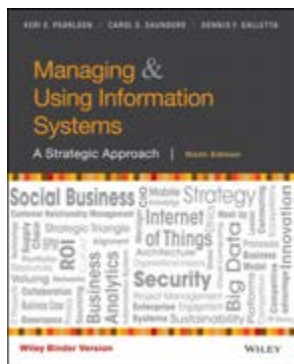
Keri Pearlson '79 writes: I've recently published the sixth edition of my textbook for graduate management information systems courses, *Managing and Using Information Systems: A Strategic Approach* (Pearlson, Saunders and Galletta, Wiley, Jan 2016: wiley.com/WileyCDA/WileyTitle/productCd-1119244285.html). It's used in about 100 schools around the world and is the No. 1 book in its category. I continue to live in Austin, Texas, with my husband, Dr. Yale Pearlson. Our daughter, Hana, is at Tulane University studying—what else?—computer science and finance, because they don't actually offer a major in MIS.
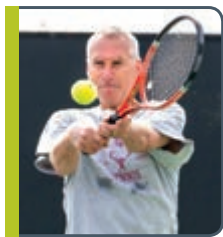
Willie Konya '83 writes: I'm in my 18th year and still love being a math professor at Santa Monica College. With 10 prior years of experience in applied math, I believe I'm the only one of about 30 full timers in our department with significant real-world experience, which I use to enhance my teaching. I find success in trying to emulate some of my past teachers, including HMC professors Busenberg, Coleman and Krieger. I teach a variety of courses, including algebra, geometry, calculus, statistics and finite math, and I teach differential equations almost every semester. I get some strong students and dream that one of them will transfer to Mudd one of these years! I still compete in tournament tennis and was ranked No. 13 in the U.S. by the United States Tennis Association in the Men's 50s Singles division last year.

Orna Amir '95 writes: I started working for Google at Waze as head of the analytics team. We have an amazing wealth of interesting data at Waze, and I manage a team of 17 analysts working on problems spanning from machine-learning models for in-app ad click-thru rates and speed limit detection to statistical analyses for supporting data-driven decision making.

Christian Jones '99 writes: Since my last update, my family's moved to Baltimore and I've become a trauma surgeon at Johns Hopkins. Not all of my prior life in math is lost (my clinical research includes analysis of big data to evaluate patient outcomes), but my greatest ongoing exposure is following Dr. Su on Twitter. Yes, some days I miss it!

Andromeda Yelton '99 writes: I was elected president of LITA, the technology division of the American Library Association! I'm still doing freelance software work for (among others) the Wikimedia Foundation and Amy Herzog POM '97.

Joel Miller '00 writes: Over the last four years, my career path has bounced around a bit. I was an assistant professor at Penn State while my wife worked in Boston. Following the birth of our daughter (Maaike Slim), we found positions together at Monash University in Melbourne (mine in joint mathematics and biology). I recently started work at the Institute for Disease Modeling in Bellevue, Washington, and I'm commuting between Melbourne and Seattle. I'm currently putting finishing touches on a monograph, "Mathematics of network epidemics: from exact to approximate models," together with Istvan Z. Kiss and Péter L. Simon. People who did BSM may know Peter—he occasionally teaches for them. We anticipate it coming out at the end of this year or early next year.

Jennifer Lindsay '02 continues to doggedly pursue a second career as a professional opera singer. She is relieved that three years of hard work have finally begun to pay off this year. In January, she was an award winner in the National Opera Association's Vocal Competition, and last spring she was a resident artist at Opera Naples in Florida. In April, she made her debut with the Los Angeles Philharmonic's Green Umbrella recital series, and over the summer she will be one of only 15 singers chosen from among several hundred applicants to participate in the Bel Canto Young Artist program at the Caramoor International Music Festival. More info at JenniferLindsayMusic.com.

Colin Little '02 writes: After working in predictive analytics at FICO doing algorithm development, then novel anti-fraud prevention at PayPal, I decided to shift gears and move into a different field. I went back to school and received my M.D. from the University of Arizona College of Medicine, Phoenix, in 2015 and will finish my first year of emergency medicine residency at Stanford in June. After finishing residency in another two years, I plan to sub-specialize in wilderness medicine and keep doing the work I've been doing with the search-an-rescue community for the last nine years. I haven't given up on my math background though; there are several projects at Stanford looking at using predictive analytics in health care that I'm really excited about, and I think one of the next big applications of data science will be in clinical medicine, so it's a very exciting time to be working in the hospital with a background in mathematics.

▲ **Ross Richardson '03** writes: In January, Meghan Powers SCR '04 and I welcomed our first child, Remy Elias Richardson, into our lives. In related news, we've also moved to the Upper West Side neighborhood of New York City. Meghan and I continue to enjoy city life and travel.

Kevin Andrew '04 left the Dominican Order last summer and returned to Seattle. Since March, he's been working as a benefit analyst at Milliman and studying for the actuarial exams.
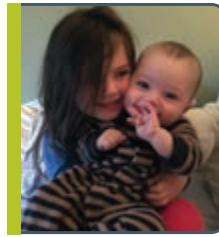
Eric Harley '04 and Sarah Rice CMC '04 welcomed their second child, Richard Thomas Harley, born Nov. 28, 2015.

Kathe Todd-Brown '04 is the Linus Pauling Distinguished Postdoctoral Fellow at the Pacific Northwest National Labs in Richland, Washington, developing mathematical and computational models of soil biogeochemical cycles. She and her husband, Dan Cicio '04, are preparing to celebrate their 10th anniversary.

Jeff Brenion '05 writes: I'm now a librarian with San Jose Public Library helping run the after-school STEAM program and having a lot of fun doing it. I even created an original program about codes and ciphers that was adopted by Instruction and Programming Services for use at other branches.

▲ **Akemi Kashiwada '05** and **Brian Tagiku '05** welcomed their first child, Ellie Koharu Tagiku, in February. They write: "Here's a family picture we took recently (you can easily see from her expression that she wasn't in the best mood when we took this picture, ha ha)."

Carl Yerger '05 writes: I was recently promoted to associate professor with tenure at Davidson College. I have also been appointed AMC 10 exam co-chair and continue my involvement with talented high school students as one of the coordinators of the Charlotte Math Club.

▲ Debbie and **Tyler Seacrest '06** write: On July 11, we adopted Dallas and Rachael, whom we have been fostering since late fall of 2014. Dallas is three, and Rachael will be two in a few months. We are so glad to have these two as officially part of our family!

Victor Camacho '07 writes: I technically graduated from the University of Utah this past May, although I am not scheduled to submit my thesis and defend it until this September. I have been working on it for a long time, and part of the reason it has taken this long is because I have spent a good amount of time and energy working on a number of unrelated projects. I published a paper back in November 2015 in the SIAM *Journal of Applied Mathematics* (bit.ly/294dCqW). The paper focuses on using a mixed Eulerian-Lagrangian approach to study gel dynamics. In a manner of speaking, it is a generalization of the Immersed Boundary Method. The model I derived is a full 3-D model, but the paper focuses on the 1-D reduction for which I developed a numerical algorithm that achieves 2nd order convergence. My thesis work currently focuses on developing the numerics for the 2-D reduction.

I started a tutoring company (called High Performance Tutoring) back in May 2011 that currently employs 23 tutors. Right now, we mostly serve people within about a 50-mile radius of Salt Lake City, but this fall, I have plans to expand geographically into a few other metro areas around the U.S. We mainly serve high school and college students, primarily in the STEM disciplines as well as SAT/ACT prep. While tutoring is typically a premium service for those who can afford it, I am taking steps to make it more affordable and accessible to lower-income students by offering scholarships to promising students who qualify for free or or reduced lunch at their high school. Tutoring, teaching and growing my company is my real passion these days, and it has allowed me to be both creative and analytical. Improving efficiency in operations and marketing are great projects to work on. They require a good deal of collecting data, doing statistics, running simulations (often in MATLAB) and making reasonable assumptions about future trends and human behavior. This has encouraged me to read more, take business and education

classes online, join business groups in my area and volunteer in classrooms. I have also spent time developing an app to help students prep for the ACT and have spent about two years developing a robust software program to automate a lot of important processes for my company. In fact, I am noticing the same concepts built into my software can also be used to assist companies in other industries with similar business models.

Maureen Saint Georges Chaumet '07 writes: I am currently right at the cusp of the next step in this very long process that is medicine. I will be done with my pediatric residency at the Children's Hospital of Los Angeles in a couple of weeks and will be flying off to Nashville, Tennessee, to start a three-year Pediatric Emergency Medicine Fellowship at Vanderbilt. Soon enough, I'll be a country music and barbecue aficionado! After Nashville, the possibilities are endless.

▲ **Craig Weidert '07** married Carol Feucht on March 26. Herbie Huff '07 officiated the wedding. Other attendees included Stephen Jones '07, Jessica Harwood SCR '07, Julia Fornaca '07, Holly Johnsen '07, George Tucker '08, Arran McNabb '06, David Schimon '08, Stephen Brawner '07, Jason Santiago '07, Alice Izsak '07, Claire O'Hanlon '09 and James Egan '07 (not pictured).

Asaf Bernstein '08 writes: I just completed my PhD in financial economics at the MIT-Sloan School of Management in May 2016 and am starting a tenure-track position as an assistant professor of finance at the University of Colorado at Boulder's Leeds School of Business. Not exactly the standard outcome for Mudd math majors, but perhaps less uncommon a choice of field than it used to be. My heartfelt thanks to the math department for helping to instill the passion for academics that led me down my current path.

Michael Ernst '08 writes: With the help of a little graph theory, I settled a longstanding question in the philosophy of mathematics concerning unlimited categories. As it turns out, any satisfactory theory of such categories would be inconsistent. This is part of some more general intellectual tidying I have done for the category theory vs. set theory foundational debate. Now I work for a software startup trying to improve medical device maintenance.

Jason Fennell '08 writes: Lilly and I are still living in San Francisco. I'm still working for Yelp and was recently promoted to vice president for data mining. I also joined the HMC Board of Trustees in September.

▲ **Karen Morrison Brown '08** and **David Morrison '08** are happy to announce the birth of their son, Isaac Edward Morrison. David also started a new job at Yelp in June 2016.

George Tucker '08 and **Holly Johnsen '07** got married on July 10, 2016. George started working at Google Brain in June.

Nadia Abuelezam '09 will be an assistant professor at Boston College in the Connell School of Nursing starting in fall 2016. She is excited about the opportunity to teach and continue her research in epidemiology.

Bob Chen '10 has moved from San Francisco to New York City to work at Two Sigma.

Josh Swanson '10 writes: I continue to pursue my PhD at the University of Washington under Sara Billey. Recently, my work has focused on the interplay between algebraic combinatorics and representation theory, especially sieving phenomena, which has gone well and which I expect to result in several papers soon. I've also been leading a seminar on Haiman's geometric proof of the n! conjecture and follow-up work related to diagonal coinvariants. Generally, life continues!

Sarah Loeb '11 is finishing up graduate school at University of Illinois at Urbana–Champaign. She anticipates some papers being accepted and being on the academic job market in the very near future.

August Guang '12 writes: I'm still in my PhD program (applied math/computational biology at Brown), but I am currently doing an internship at Genentech for the summer. My first head author paper was published in *Trends in Ecology and Evolution* earlier this year: "An Integrated Perspective on Phylogenetic Workflows." I will also be a Blue Waters Fellow for the 2016–2017 academic year.

▲ **Jenny Iglesias '12** writes: I just finished up my fourth year of my PhD program at Carnegie Mellon University. I am in the algorithms, combinatorics and optimization program, and I'm studying approximation algorithms on network design problems. In the past year, two very exciting things have happened. I helped Kevin Riley '12 develop a board game, Aeon's End. It was successfully Kickstarted in April and should be on shelves by the end of the year. I also received an NSF grant to do research in Japan for the summer. I will be working with Professor Takuro Fukunaga at the National Institute of Informatics in Tokyo.

Dhruv Ranganathan '12 obtained his PhD in mathematics from Yale University in May 2016 and will become a CLE Moore Instructor at MIT this fall. He will also be a visiting member at the Institute for Advanced Study in spring 2017.

Taylor McAdam '13 writes: I'm still at UT Austin working toward my PhD in math. I'm now done with all of my prelims, and I'm beginning to start research in the field of homogeneous dynamics with my advisor, Amir Mohammadi. I'm enjoying living in Austin and really looking forward to this next stage in my education/career!

Natasha Parikh '14 was awarded a three-year National Defense Science and Engineering Graduate fellowship for her work in cognitive neuroscience at Duke University. With this funding, she will use brain imaging data from people with anxiety to inform more effective ways to make negative/traumatic memories less emotional over time.

Allison Arnold-Roksandich '14 writes: A lot has happened in the last year. I passed quals, got my master's degree in mathematics, and I'm currently planning for two math conferences this summer. This first one is for two weeks in Sarajevo (third Building Bridges Conference), and the second is for a week in Connecticut (UConn Summer School and Conference in Number Theory).

Andrew Gibiansky '15 began a new position in July as a deep-learning research scientist at the Baidu Silicon Valley AI Lab, working on deep-learning research for natural language processing and speech recognition (deep recurrent neural networks). "The laboratory is a research group funded by Baidu and led by Andrew Ng and Adam Coates," he writes. "It's quite a new lab (only two papers so far) and just really getting started, so it should be quite exciting!"

Sarah Scheffler '15 writes: I'm about to start a PhD in cryptography at Boston University this fall. I'm excited to keep progressing in the joint CS/math direction. I'm also growing more interested in the politics of technology. Recent high-profile cases (e.g., FBI vs. Apple, Oracle vs. Google) have illustrated to me that there is an incredible need for greater public knowledge (or at least awareness) of the nature of tech. I'm hoping that I and others like me (who like finding simple, elegant ways of explaining complex issues) will find venues in the coming years.

In my spare time, I've also been hunting for cool uses of the NIST randomness beacon (beacon.nist.gov/home). My current side-project is a verifiably random di roller. (There is a personal motive here—I would really like to play Dungeons & Dragons with the ability to prove to the game master that I really did roll three 20s in a row.) The idea is to use the NIST beacon as a seed for an RNG (or as the RNG itself) so that you can prove that you rolled the di value you said you did. The tricky bit comes in ensuring that you can't know your results in advance and only report favorable rolls. As ever, the devil is in the details.

And another project! This summer I'm helping to coordinate a new program called "Codebreakers" through Boston University, a three-week course on cybersecurity for high school girls! It includes some basic number theory and cryptography, a crash course on programming and some computer science. I also hope to have some discussions with them about gender in STEM. The

"I miss Mudd every day."

— SARAH SCHEFFLER '15

field is improving dramatically, but cisgender men still make up the vast majority of tech fields. I really want to empower their gender expression and gender identity.

I miss Mudd every day. I've made some wonderful friends here in Boston and I've done some cool work, but nothing compares to the culture of collaboration, innovation and acceptance that is Harvey Mudd College. We may have our squabbles—who doesn't?—but in my experience, Mudders have always been willing to go out of their way to accommodate the needs of their peers, and I miss having that immediate community that generates ideas like there's no tomorrow. Not to mention, I have yet to find people with higher work ethics. I actually think my work ethic has slipped a bit since graduating—I'm hoping to kick myself back into Mudd gear when I go to grad school!

YOUR NEWS MATTERS

Have you changed jobs? Retired? Celebrated a milestone? We'd love to hear about it and share your news in HMC publications.

Please submit updates online at **alumni.hmc.edu/class-notes.**

PUZZLE

BY MOHAMED OMAR

PROBLEM: Find a closed expression for the sum

$$\frac{1}{4!} + \frac{4!}{8!} + \frac{8!}{12!} + \frac{12!}{16!} + \cdots$$

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