MUDDMATH

HARVEY
MUDD
COLLEGE

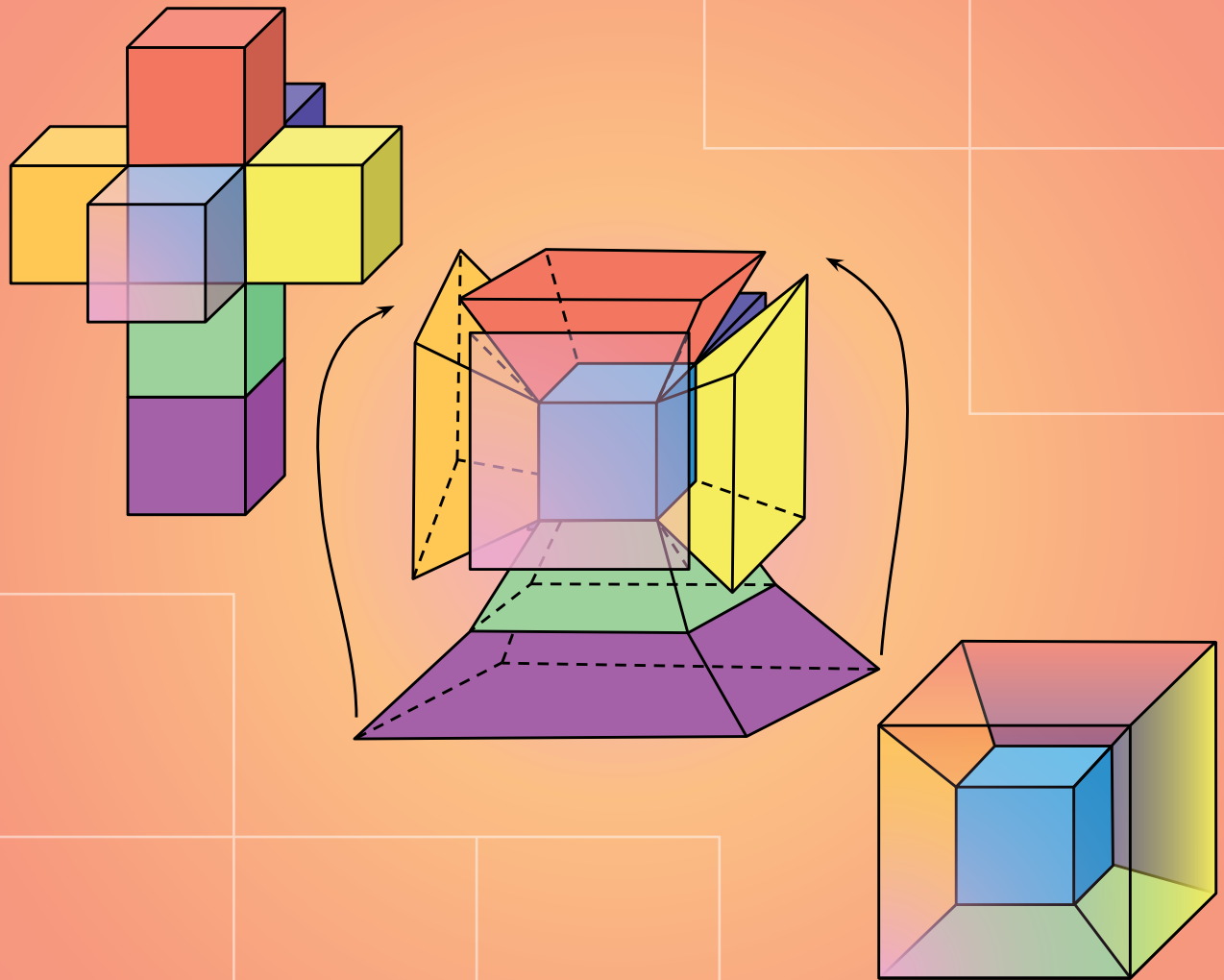## Letter From the Chair

Dear Math Alumni, Families and Friends,

Last year brought the return of in-person classes and after a two-year hiatus, we were thrilled to return to in-person summer research, with over 20 students engaged in department-supported research experiences. A new summer feature was an on-campus weekly Journal Club where students and faculty gathered for chalk talks and collegial discussions about their mathematical pursuits. Following Journal Club, the participants enjoyed a department-sponsored group lunch at the Hoch-Shanahan Dining Commons. These activities may seem small, but they are precisely the kind of informal interaction and community building that we were so deprived of during the two years of social distancing and COVID-19 protocols. It is a true joy to have them back!

We have many exciting news items to share with you in this issue of *MuddMath*. Our majors continue to flourish, with 91 graduates in spring 2022 (54 CS/math, 16 math, 10 math/physics, nine math/comp/bio and two IPS [mathematical and computational physics, mathematical and computational modeling/applied dynamical systems]). Two of our graduates—Madelyn Andersen '22 (mathematics, MIT) and Daniel Yang '22 (joint cs-math, USC)—received NSF Graduate Fellowships to support their PhD studies. Our graduates who seek PhD programs continue to matriculate to many excellent schools, including UC Berkeley, UCLA, Cornell University, University of California San Diego, MIT, Stanford University, Caltech, Washington State University, Rutgers University, Northwestern University, Tri-Institutional PhD Program, Georgetown University, Stony Brook University, Brown University, Cambridge University, USC, Princeton University, University of Illinois and Yale University.

Graduates who seek industry jobs also find exciting opportunities with companies such as Google, Jane Street, Roblox, Pure Storage, Stripe, Thumbtack, Hulu, JP Morgan, Citadel, Wells Fargo, Goldman Sachs, CrowdStrike, Meta, KAVsports, Instabase, Microsoft, ZipRecruiter, Flycoin, Databricks, ServiceNow, Miso Robotics, Qualtrix, Juniper Networks, Weill Cornell Medicine, Areté, Citi, ExtraHop, ServiceNow and Airbnb. We also have a graduate entering the Navy as a nuclear submarine officer. We are proud of all our graduates and wish them all the best for their next steps.

Faculty in the Department of Mathematics continue to be recognized for their teaching, scholarship and professional activities. Notably, Talithia Williams was awarded the 2022 Joint Policy Board for Mathematics Communications Award, Mohamed Omar was awarded the inaugural American Mathematical Society Claytor-Gilmer Fellowship and Darryl Yong was awarded an ACE Fellowship and was co-PI for a $2.6 million NSF grant. Susan Martonosi was recently elected to a three-year term as chair of the faculty, which is a great honor and recognition of her talent as a strategic thinker and campus leader.

We are deeply saddened by the passing of Emeritus Professor of Mathematics Hank Krieger June 29, 2022. Hank taught for 37 years at the College and was a beloved colleague and mentor. Within the department, he was known for his kindness, supportive and generous nature, and depth of knowledge across many fields of mathematics. On many occasions, Hank and Rita generously opened their home for colleagues to stay or to host department events and retreats. After his retirement in 2005, Hank remained a frequent visitor to campus and was always happy to chat about mathematics, tennis and other topics of interest. Hank will be dearly missed.

I hope you enjoy reading this issue of *MuddMath* and learning about some of the many activities and achievements in our mathematics community. Please keep in touch; we love hearing from you!

Jon Jacobsen
Kenneth and Diana Jonsson Professor of Mathematics and Department Chair
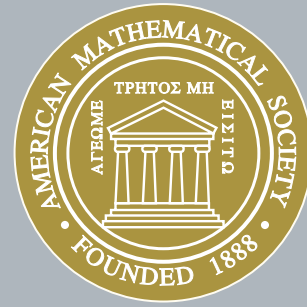
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To continue receiving *MuddMath* in print, email muddmath@math.hmc.edu by Nov. 1. No response is necessary if you prefer to receive the electronic-only version.

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 the humanities, social sciences and the arts. The College's aims to graduate engineers, scientists and mathematicians sensitive to the impact of their work on society.

About the Cover

Folding Hypercubes (and failing)

SENIOR THESIS BY FLETCHER NICKERSON '22

In the way that cubes are made of six square faces, four-dimensional hypercubes are made of eight cubes. This image shows how a specific eight-cube shape can be folded into a hypercube. Although the hypercube might look like a small cube inside of a larger one (with their corresponding vertices attached), the color coding reveals that the trapezoidal 3D shapes surrounding the central blue cube are cubes as well.
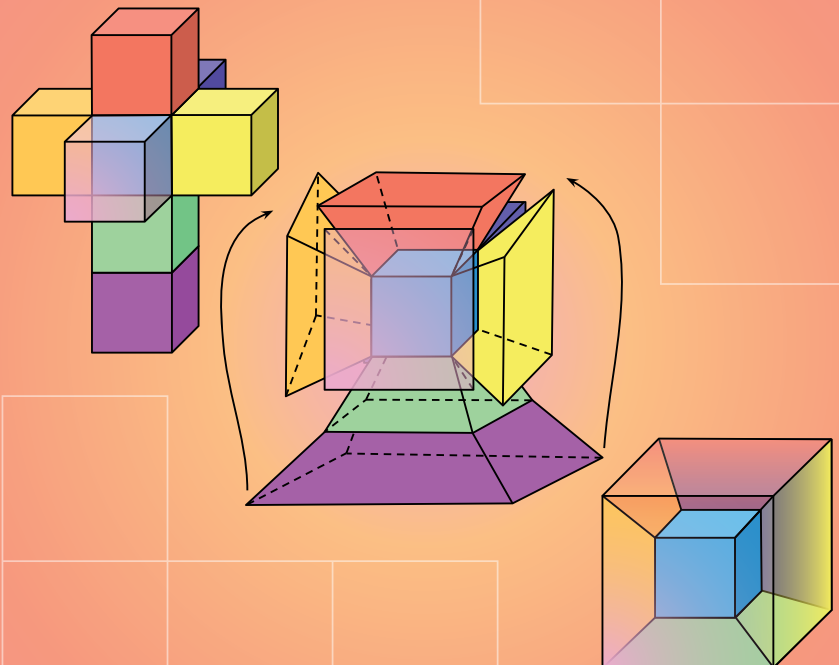
Campus Snapshots

Arcade fun

Faculty having an in-person, hence masked, office meeting

Senior Magic Castle trip
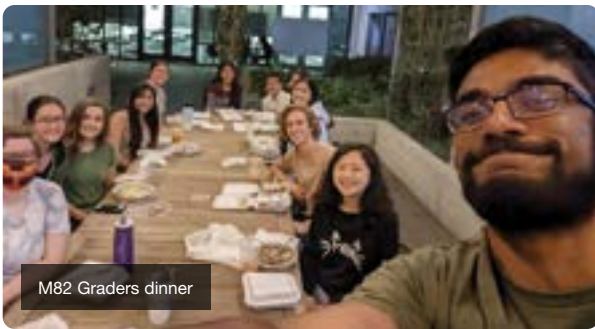

Thesis students in their thesis jackets

Celebratory thesis student pizza lunch (San Biagio's, of course!)

Winning Brainteaser Battle team

M82 Graders dinner

Mason Acevedo '23 and Amit Harlev '23 in the new, student-designed MuddMath T-shirt

Martonosi Elected Chair of the Faculty

Harvey Mudd College faculty members have elected Susan Martonosi, professor of mathematics, to a three-year term as chair of the faculty.

An elected chair of the faculty sits ex officio on the Reappointment, Promotion and Tenure Committee and on the board of trustees Educational Planning Committee. The faculty chair also presides over faculty meetings and meetings of the Faculty Executive Committee. Martonosi succeeds Tom Donnelly, physics professor and vice president for academic affairs and R. Michael Shanahan Dean of the Faculty.

Martonosi says she is eager to "foster open and efficient lines of communication among faculty as well as between faculty and the administration. As we emerge from the COVID-19 pandemic and prepare for the transition to a new president of the College, the chair of the faculty will need to facilitate discourse on how to emerge from the pandemic stronger than ever while serving as an important touchstone of institutional memory and norms that have shaped the College thus far. I am humbled and honored to have been elected by my peers to serve in this role."

Martonosi joined the HMC faculty in 2005. In addition to being active on committees, serving as a student ally and as associate chair in the Department of Mathematics, she has served as a Clinic Program director for Mathematics and for Global Clinic. She has served in leadership positions, including vice president for membership and professional recognition of INFORMS, and is currently a member of the INFORMS Diversity, Equity and Inclusion Committee, and the INFORMS Finance Committee. Her research area is the application of operations research and analytics methodology to problems in the public sector, including the pricing and procurement of pediatric vaccines, the propagation of fake news on social media and public policy. In 2012, she received the Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member from the Mathematical Association of America. In 2020, she received the INFORMS Award for the Teaching of OperationsResearch and Management Science practice.

Donnelly says, "Susan will be a great leader for the College as we meet new challenges over the next three years and welcome a new president."

Statistician Talithia Williams Receives 2022 JPBM Communications Award

Mathematics professor Talithia Williams received the 2022 Joint Policy Board for Mathematics (JPBM) Communications Award during a prize reception at the Joint Mathematics Meetings in Seattle, in January. Williams was recognized for bringing mathematics and statistics into the homes and hands of millions through her work as a TV host, renowned speaker and author.

Reacting to news of the award, Williams said, "I am thrilled to be receiving the JPBM Communications Award for 2022. Sharing my enthusiasm for data science and mathematics with broad audiences has become one of the stories I truly enjoy telling. I'd like to thank the JPBM committee, all of my Harvey Mudd College colleagues, especially Arthur Benjamin, and my wonderful husband, Donald and sons, Josiah, Noah and Micaiah. And my momma, Delores. I can't forget my momma!"

Williams is an innovative, award-winning college professor, a co-host of the PBS NOVA series *NOVA Wonders* and a speaker whose popular TED Talk, "Own Your Body's Data," extols the value of statistics in quantifying personal health information. She demystifies the mathematical process in amusing and insightful ways to excite students, parents, educators and the larger community about STEM education and its possibilities. In 2015, she won the Mathematical Association of America's Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member, which honors faculty members whose teaching is effective and extraordinary, and extends its influence beyond the classroom.

A current MAA Pólya Lecturer, Williams developed a 24-part college-level lecture series, "Learning Statistics: Concepts and Applications in R," for The Great Courses, an online platform for lifelong learners. She is the author of *Power in Numbers: The Rebel Women of Mathematics*, a full-color book highlighting the influence of women in the mathematical sciences in the last two millennia, and she has narrated several science documentary films, including *Hindenburg: The New Evidence, Our Beautiful Planet, Secrets in our DNA* and the upcoming joint BBC and NOVA 5-part series *Universe*.

The JPBM Communication Award was established by the JPBM in 1988 and is given annually to reward and encourage communicators who, on a sustained basis, bring mathematical ideas and information to non-mathematical audiences. The JPBM is a collaborative effort of the American Mathematical Society, American Statistical Association, Mathematical Association of America, and Society for Industrial and Applied Mathematics.

Researchers Study Therapeutic Strategies for "Natural Killer Cells"

White blood cells known as "natural killer cells"—named for their ability to attack disease without requiring activation by the immune system—could play a vital role in battling cancer, according to new research by Lisette de Pillis, Norman F. Sprague Professor of Life Sciences.

The so-called NK cells might be effective in the development of oncolytic virus therapies, a treatment engineered to selectively target, infect and kill cancer cells, de Pillis writes in the *Bulletin of Mathematical Biology* (May 2021). She collaborated on the paper, "Natural Killer Cells Recruitment in Oncolytic Virotherapy: A Mathematical Model," with researchers from the National University of Lesotho, the University of Pretoria and The College of Saint Rose.

"It's a very promising therapeutic strategy," de Pillis says, "but there is still much to learn, including how these virus particles interact with other components of the immune system and what effects that may have on treatment efficacy."

NK cells are thought to account for between 5% to 20% of all lymphocytes (or white blood cells) in the human body. They have a faster immune reaction than other white cells, making them critical "first responders" when a cancer or infection is emerging, de Pillis notes. Further, NK cells are known to detect and eliminate infected or mutated cells that might be overlooked by other parts of the immune system.

De Pillis began the research collaboration in 2015, when she was invited to present work on tumor-immune modeling at a workshop held at the American Institute for Mathematics. "We are all motivated by knowing that our work is contributing to the ongoing effort to help cancer sufferers, and that is particularly rewarding," she says.

Math Professor Mohamed Omar Awarded Inaugural AMS Claytor-Gilmer Fellowship

Mohamed Omar, an associate professor of mathematics and the Joseph B. Platt Chair in Effective Teaching, is the inaugural AMS Claytor-Gilmer Fellow (2021–2022). The yearlong fellowship was established to further excellence in mathematics research and to help generate wider and sustained participation by Black mathematicians. Omar has an excellent track record in research and a notable research program, and he has displayed impressive leadership in mentoring and service to the mathematics community.

Omar uses algebra in areas of discrete mathematics such as combinatorics, graph theory and discrete/convex geometry. During the fellowship, Omar has studied applications of the recently developed Slice-Rank Polynomial Method, which harnesses linear algebra to solve problems in extremal combinatorics involving restrictions on more than two sets from a family of sets. He also explored graph propagation through an algebraic lens.

Omar is heavily engaged in mathematics outreach and mathematics competition creation. He has served on organizing committees for the American Mathematics Competitions and Canadian competitions through the Center for Education

in Mathematics and Computing. (Watch his invited address at the 2020 Joint Mathematics Meetings on the art and craft of problem design for both classes and competitions.)

"Though it may not sound like traditional outreach, one of the most enriching activities for me is direct contact with Black math faculty from across the United States," Omar said. "We are few and far between; having a close network has had a tremendously positive impact on my well-being while in the career."

The AMS Claytor-Gilmer Fellowship aims to further excellence in mathematics research and to help generate wider and sustained participation by Black mathematicians. Awardees may use the $50,000 fellowship in any way that most effectively enables their research—for instance, for release time, participation in research programs, travel support, childcare, etc. The most likely awardee is a mid-career Black mathematician based at a U.S. institution whose achievements demonstrate significant potential for further contributions to mathematics.

Darryl Yong '96 Named ACE Fellow

Darryl Yong '96, known for his work on active and inquiry-based learning, inclusive pedagogy and curriculum, and teacher training programs, has been named an American Council on Education (ACE) Fellow for academic year 2022–2023.

The ACE fellowship program combines retreats, interactive learning opportunities, visits to campuses and other higher education-related organizations, and placement at another higher education institution to condense years of on-the-job experience and skills development into a single year. Fellows also conduct projects of pressing concern for their home institution and seek to implement their findings upon completion of the fellowship placement.

Yong focuses his research on secondary and tertiary mathematics education. He is primarily interested in how secondary-school mathematics teachers deepen their content knowledge for teaching, gain leadership skills and learn new pedagogical strategies, particularly through peer communities. He serves on the steering committee for Math for America Los Angeles, an organization that he helped to start in 2007, and has worked closely with the Teacher Leadership Program of the IAS/Park City Mathematics Institute since 2003.

Yong also researches effective strategies for teaching and learning mathematics in higher education. He has a special interest in inclusive pedagogy and seeks to broaden participation in the mathematical sciences. Yong has served as the College's associate dean for diversity and was the inaugural director of The Claremont Center for Teaching and Learning. His awards have included the American Mathematical Society Award for Impact on the Teaching and Learning of Mathematics, the Mathematical Association of America Southern California-Nevada Section Teaching Awards and a Pomona Unified School District Community Service Award.

About 2,500 higher education leaders have participated in the ACE Fellows Program over the past five decades, with more than 80% of Fellows going on to serve as senior leaders of colleges and universities. Recent ACE Fellows from HMC include Associate Professor of Mathematics Talithia Williams (2015–2016) and Elizabeth Orwin '95 (2019-2020), former engineering professor and department chair, now dean of the School of Engineering and CS at the University of the Pacific.

Faculty promotions

Haydee Lindo and Heather Zinn-Brooks were approved by the HMC Board of Trustees for second two-year appointments as assistant professors of mathematics. Lindo is a commutative algebraist with research interests in homological algebra and representation theory. She is editor in chief and chair of the Publications and Publicity Committee for the National Association of Mathematicians. Zinn-Brooks specializes in mathematical modeling of complex systems. She uses analytical and computational techniques to study phenomena in social and biological applications.

NSF Supports Mathematics Research

The National Science Foundation awarded grants to Darryl Yong '96 and Haydee Lindo.

Yong, Ilana Horn (Vanderbilt University), Brette Garner (University of Denver) and Benjamin Rydal Shapiro (Georgia State University), were awarded $2.6M from the NSF for the project, "Teaching Amidst Uncertainty: Developing Mathematics Teachers' Groupwork Monitoring Practices." This work, dubbed "Project TAU," is a four-year project to study how experienced mathematics teachers develop groupwork monitoring: what teachers do as they observe, check in with and support the progress and quality of student-directed collaborative work around the classroom.

Lindo received an NSF grant of $160,175 for "LEAPS-MPS: Singularities, Rigidity, and Trace Modules."

Art Benjamin is on sabbatical with plans to visit 25 countries.

Andrew Bernoff is on sabbatical through spring 2023. While most of his time will be spent in Minneapolis, he is particularly looking forward to spending six weeks in Australia next spring working on the next generation of locust swarming models with a group of mathematicians and field biologists.

Alfonso Castro keeps busy thinking about semipositone problems (with Professor M. Chhetri, UNCG), radial solutions (with Professor J. Cossio, S. Herron and C. Velez, University of Colombia, Medellin), the wave equation (with A. Sanjuan University of Distrital, Bogota, and R. Duque, University of Colombia, Palmira) and evolution equations (with D. Le, UTSA San Antonio).

Weiqing Gu had a productive summer. She supervised five summer research students, published one paper and submitted two. Another paper will be submitted two weeks before the fall semester starts. She enjoys working on math and machine learning research because she can visualize the math in her head and see patterns in big data, so she has been having a good time.

Jamie Haddock has thoroughly enjoyed the past year, including designing a new course titled "Mathematical Data Science & Topic Modeling" and spending an amazing summer mentoring six research students in the HADD research group. In personal news, she got engaged!

Melissa Hernandez-Alvarez has enjoyed her first year at Mudd working with the students, faculty and staff as well as attending math events. She will continue to further immerse herself within Mudd culture, and she hopes to crochet another mathematical concept that isn't the Möbius strip.

Jon Jacobsen can hardly believe he just completed his 20th year in the department. A personal highlight in May was attending his daughter Reya's graduation ceremony for her Master of Arts in Teaching and multiple subject teaching credential at Chapman University.

Peter Kagey joined the mathematics department as a visiting assistant professor after completing his PhD at USC in June. He spent the summer traveling with his wife to visit friends and family around the U.S.

Dagan Karp is on sabbatical this year, thinking about moduli spaces. He's been skateboarding more recently, and just welcomed the arrival of his first grandchild.

Jina Kim is a visiting assistant professor during the 2022–2023 academic year. She recently received her PhD from Iowa State University and is looking forward to an exciting and productive year at HMC!

Susan Martonosi spent the summer enjoying weekly visits to the beach with her kids to boogie board and watch the dolphins go by.

Mohamed Omar spent the past year dividing into several new exciting research directions, supported by the Claytor-Gilmer and Karen-EDGE fellowships, taking students along the way. He wrote a book on graph theory based on Math 55 material. He's excited about monthly meetups with his LGBT book club.

Francis Su's book *Mathematics for Human Flourishing* has been translated into Romanian, Korean and Chinese, and will soon appear in Turkish, Taiwanese, Japanese and Spanish. These days, he's both full of joy and fatigue, because his toddler seems to require less sleep than he does.

Talithia Williams is the incoming Mathematics Clinic director and just finished taping a new PBS NOVA film, *Zero to Infinity*, which debuts in October 2022. She celebrated her 18th wedding anniversary with a surprise trip to Temecula's wine country.

Darryl Yong enjoyed being on the teaching team that piloted CORE 179A, STEM & Social Impact: Climate Change, which will be a part of the new Core curriculum starting in 2022. This fall, he'll be spending time at California State University, Long Beach, as an American Council on Education Fellow.

Heather Zinn Brooks co-organized two exciting events in the applied mathematics community: The Southern California Applied Mathematics Symposium (at HMC) and the ICERM Summer Program on Data Science and Social Justice. She did some climbing in Joshua Tree and Bishop, California, this past year and is looking forward to more trips.

Harvey Mudd College Wins Citadel West Coast Data Open

Defeating teams of graduate students, two groups of Harvey Mudd College first years placed first and third in Citadel's West Coast Data Open. Members of Harvey Mudd's first-place team—Milo Knell '25 (CS and math), Alan Wu '25 (CS and math), David Chen '25 (CS) and Forrest Bicker '25 (CS and math)—received a $10,000 cash prize and interview offers at Citadel, a leading alternative investment manager. As winners of the West Coast regional, they qualified for the Datathon Global Championship and the opportunity to compete against other top regional teams for a $100,000 cash prize.

The third-place finishers were Sahil Rane '25, Baltazar Zuniga-Ruiz '25, Karina Walker '25 and Shahnawaz Mogal '25 (University of Arizona). They received a $2,500 prize.

At the competition, participants work in teams on large and complex dataset challenges impacting the global markets then present their findings to a panel of judges. Both teams were given a dataset from the research archive of Upworthy, a digital media platform often credited for the rise of overly dramatic clickbait headlines, due in large part to a series of A/B tests they conducted from 2013 to 2015. The teams analyzed and reported on findings of a dataset of Upworthy's A/B tests consisting of 150,817 different article packages and the respective number of clicks each received.

"Given Upworthy's interesting reputation for clickbait, we wanted to build a machine learning model to measure whether an article is clickbait and see what it said about Upworthy's headlines," said Bicker, a member of HMC's first-place team, whose members all share a love for computer science and machine learning. "To do this, we theorized that fake news tends to look very similar to clickbait because both aim to pull in viewers, so we trained an AI classifier on an external dataset of fake news.

"Applying the classifier on Upworthy's dataset of headlines, we found that fake news predicted clickbait more accurately than click rate alone," he said. "We found that predicted fake news is a good proxy to examine clickbait that avoids the influence of confounding variables like overall business performance and external factors that are not accounted for in the Upworthy data. Using a variety of Natural Language Processing techniques, we also found that clickbait tends to use more extreme emotional language (very positive or negative) that is potentially harmful to the public's mental health and emotional wellbeing."

Bicker said the team took a learning-focused approach to the competition, using it as an opportunity to explore new analytical techniques. "We wanted to push ourselves to think of novel, creative solutions to the problem, so we experimented with a number of distinct approaches. It was also our priority to bring a high standard of rigor to our work, making sure not to cut corners on our analysis and budget time appropriately for quality checks," he said.

Update: HMC came out of a multiway tie for first place as the fourth-place team based on the tiebreaking metric. They finished behind a PhD student from the University of Warsaw and Errichto, a well-known competitive programmer and Youtuber.

2022 Harvey Mudd College Leadership Awards

Outstanding Mudder Award

Lian Morales '22, a mathematics and computational biology major, received the Outstanding Mudder Award, which recognizes students who contribute to the community and demonstrate creativity, leadership, teamwork, ethics, inclusion, community engagement, wellness and communication in curricular and co-curricular endeavors.

A nominator wrote, "[Lian] is set apart by her artistic talents and her passion for biology that helps people. Within STEM, she is passionate about disease and cancer biology, with a special emphasis on HIV/AIDs." Morales has shown leadership via her initiative to create an exhibition for art concerning social justice and making a space for LGBTQ+, POC and other minority communities.

Dean Sundberg Prize

Established by Dana Seaton '06, and with support from Warren Katzenstein '04 and Nate Yoder '06, the Dean Chris Sundberg Prize ($500) recognizes a rising junior who demonstrates exceptional leadership and a positive impact on the College community.

Camilo Morales '24 (computer science and math) is the co-president of Society of Professional Latinos in STEM, has served as a Summer Institute mentor, will be a Chicano Latino Student Affairs sponsor, grutors for CS5 and volunteers with Uncommon Good. He mentors classmates, helping them adjust to life at Mudd and gain a sense of belonging.

A nominator wrote, "As an SI mentor, he had dinner every single week with his mentees in order to provide them with a sense of community and an older student that they could count on as a friend. Camilo goes above and beyond ... He encourages and inspires so many and has shown the value of helping others in your community."

Dorman Student Altruism Prize

Established by the Dorman Family Foundation, the $250 award recognizes a graduating senior student who is selected by their peers as the one who has done the most for their fellow students.

A nominator described Mason Acevedo '22 (math) as "kind, considerate, a good listener, honest, hardworking and always a friend. He often shows extraordinary leadership in his role as a proctor, putting in particular effort to make sure freshmen feel welcome. He is extremely approachable and is always a positive presence at Atwood and across campus, helping the dorm culture feel fun and inclusive. He does the most for the students around him by not only being accessible, but also doing so in such a nice way. From inviting people to have meals with him to checking in on those not feeling well, or even just waving as he passes around campus, his intentionality helps create a sense of belonging and comfort. He has been a huge source of support for frosh and all students at Atwood and across campus."

Recipients of 2022 NSF Graduate Research Fellowships

Madelyn Andersen '22 and Daniel Yang '22 were granted the National Science Foundation Graduate Research Fellowship (NSF GRF). Mathematics major Havi Ellers '20 was awarded an honorable mention, a significant academic achievement.

The NSF GRF Program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines who are pursuing research-based master's and doctoral degrees at accredited United States institutions. Program participants are expected to become experts who contribute significantly to research, education and innovation in the STEM fields.

Mathematics major Andersen conducted her thesis research in commutative algebra. After graduation, she will travel and spend time with her family before starting her graduate studies in machine learning and statistics at MIT.

Computer science and mathematics major Yang researched music information retrieval with a multimodal approach with engineering professor TJ Tsai. Their work has been published by nine organizations, including the International Society for Music Information Retrieval (nominated for 2021 best student paper), the International Conference on Acoustics, Speech, and Signal Processing, and the Institute of Electrical and Electronics Engineers Transactions on Multimedia. "My best research project uses a large amount of publicly available sheet music to train a language model on music and use it to classify the composer of musical instrument digital interface and audio files," Yang says.

Yang will attend University of Southern California to conduct graduate research on foundational multimodal models capable of combining audio, text and image data. He says, "The idea is that incorporating such data will allow for AI to perform human-centric tasks downstream. Although I haven't decided with certainty which downstream tasks to specialize in, I am interested in computational media, affective computing and speech production."

Class of 2022 Departmental Recognition

Departmental Honors
Madelyn Andersen, Isabella Duan, Ryan Edmonds, Nicolas Espinosa Dice, Thomas Michael Fleming, William Gilroy, Amit Harlev, Tristan Winslow Johnson, Jessica Kwok, Benjamin Langton, Jingyi Liu, Ryan Martinez, Arjun Rajesh Natarajan, Jack H. Ontiveros, Shaurya Pednekar, Vibha Rohilla, Kye Shi, Anna Singe, Mia Taylor, Solomon Vito Valore-Caplan, Xintong Wang, David Webber, Mengjun Zhao

Giovanni Borrelli Mathematics Fellowship
Hannah Friedman
David Pitt (honorable mention)

The Giovanni Borrelli Mathematics Prize
Amit Harlev

The Stavros Busenberg Prize in Applied Mathematics
Solomon Valore-Caplan

Henry A. Krieger Prize in Decision Sciences
David Webber

The Courtney S. Coleman Prize (Sophomore Mathematics Award)
Tomas Aguilar-Fraga
Hannah Friedman
Elizabeth Lucas-Foley

The Robert James Prize (First-Year Mathematics Award)
Kanalu Monaco
Amy Yuan

The Alvin White Prize
Madelyn Andersen
Amit Harlev

The Chavin Prize
Fletcher Nickerson
Kye Shi

2021–2022 Mathematics Senior Theses

Red Willow Coleman
Investigating the Use of Generative Adversarial Networks (GANs) for Pansharpening Thermal Satellite Imagery
Advisors: Matina Donaldson-Matasci, associate professor of biology; Natasha Stavros, Earth Lab Director, University of Colorado Boulder

Tom Chenlian Fu
Improving Segmentation and Classification Scalability in Honey Bee Forage Mapping
Advisor: Matina Donaldson-Matasci, associate professor of biology

Tonatiuh Gonzalez
Differences in Evolutionary Reasons for Horizontal Gene Transfer
Advisor: Eliot Bush, professor of biology and department chair

Lucinda Paddock
Investigating the Role of Bromodomain Proteins in the Epigenetic Regulation of Transcription during T. brucei Differentiation.
Advisor: Danae Schulz, Barbara Stokes Dewey assistant professor of biology

Mason Acevedo
An Exploration of Voting with Partial Orders
Advisors: Michael Orrison, professor of mathematics; Darryl Yong '96, professor of mathematics and Mathematics Clinic director

Madelyn Andersen
Trace Modules: A Peak into Ring Theory
Advisor: Haydee Lindo, assistant professor of mathematics

Eric Chavez
Fundamental Tribrackets and Link Homotopy
Advisors: Francis Su, Benediktsson-Karwa Professor of Mathematics; Sam Nelson, professor of mathematics, Claremont McKenna College

Aitzín Cornejo-Reynoso
Mathematics Senior Thesis
Advisors: Dagan Karp, professor of mathematics; Robin Wilson, professor of mathematics, California State Polytechnic University, Pomona

Will Gilroy
Check Yourself Before You WREK Yourself
Advisors: Jamie Haddock, assistant professor of mathematics; Heather Zinn-Brooks, assistant professor of mathematics

Amit Harlev
Combinatorial Fixed Points in Polytopes
Advisor: Francis Su, Benediktsson-Karwa Professor of Mathematics

Max Holloway
Mechanisms for the Efficient Hedging of Public Information Events
Advisors: Susan Martonosi, professor of mathematics; Yaron Raviv, economics, Claremont McKenna College

Ben Langton
Some Results on the Generalized Covering Radius of Error Correcting Codes
Advisors: Mohamed Omar, associate professor of mathematics; Michael Orrison, professor of mathematics

Athena Li
Acoustic Localization in Secondary School Classrooms
Advisors: Darryl Yong '96, professor of mathematics and Mathematics Clinic director; Ilana Horn, professor of mathematics education, Vanderbilt University

Ryan Martinez
Knot Projections on the Torus
Advisors: Alfonso Castro, McAlister Professor of Mathematics; Sam Nelson, professor of mathematics, Claremont McKenna College

Lian Y. Morales
Multidimensional Integration of Protein Interactomes with Genomic Data to Identify Casual Networks Underlying Rheumatoid Arthritis
Advisors: Lisette de Pillis, professor of mathematics and Norman F. Sprague Jr. Professor of Life Sciences; Jishnu Das, assistant professor, Departments of Immunology and Computational and Systems Biology, University of Pittsburgh

Fletcher Nickerson
Folding Hypercubes (and failing)
Advisors: Francis Su, Benediktsson-Karwa Professor of Mathematics; and Satyan Devadoss, Fletcher Jones Chair of Applied Mathematics, University of San Diego

Phousawanh Peaungvongpakdy
An Adaptive Hegselmann-Krause Model of Opinion Dynamics
Advisors: Heather Zinn-Brooks, assistant professor of mathematics; Andrew Bernoff, professor of mathematics

Kye Shi
Games for One, Games for Two: Computationally Complex Activities for a Polynomial-hierarchical Family
Advisors: Nicholas Pippenger, emeritus professor of mathematics; Arthur Benjamin, Smallwood Family Professor of Mathematics and associate department chair

Solomon Valore-Caplan
A Smoothed Bounded-Confidence Model of Opinion Dynamics on Complete Graphs
Advisors: Heather Zinn-Brooks, assistant professor of mathematics; Vin de Silva, professor of mathematics, Pomona College

2021–2022 Mathematics Clinic Projects

Collaborative Drug Discovery Inc.: Novel Deep Learning Strategy to Better Predict Pharmacological Properties of Candidate Drugs and Focus Discovery Efforts
Liaisons: Philip Cheung '96, Mike Bowles, Rachel Schibler '20, Alex Clark, Peter Gedeck
Advisor: Lisette de Pillis
Students: Mia Taylor, Alex Bishka, Jorge Canedo, Bryan Uribe, Jack Weiler, Daniel Yang
Collaborative Drug Discovery Inc. (CDD) is a cheminformatics company that has been developing an automated drug discovery application to identify molecules predicted to be safe and effective drugs. CDD's existing approach represents molecules as a sequence of characters. This character string representation contains artifacts that do not reflect chemical properties of the molecule, thereby obfuscating the real chemical properties that the model must learn. The team has investigated, prototyped, and tested two molecule generation models that represent the molecule as a graph rather than as a character string. With these models, the team has been able to generate chemically valid novel molecules.

eBayMathematics: Optimizing eBay Payments through Modeling and Forecasting
Liaisons: Dr. Stephanie Moyerman '06, Kishore Paul, Xiaolin Wang
Advisor: Talithia Williams
Students: Kyle Rong, Rory Zhao, Thomas Cintra, Vivian Pou, Yuki Wang
eBay is a technology company that connects buyers and sellers. To facilitate monetary transactions between the two parties, eBay has to disburse funds to sellers before transactions from buyers have fully settled by "floating" the required money from its own reserve accounts. This project aims to better predict the monetary amount that eBay needs to float, thereby preventing cash flow risk exposure while empowering sellers to be paid faster. We achieve this goal by developing different statistical and machine learning forecasting models.

Harvard Center for Computational Biomedicine: Semi-automatic Mapping of Medical Data onto Ontologies
Liaisons: Dr. Rafael Goncalves, Dr. Robert Gentleman
Advisor: Jamie Haddock
Students: Carmen Benitez, Cindy Lay (PM-F), An Nguyen, Kobe Rico (PM-S), Matthew Waddell
Harvard's Center for Computational Biomedicine designs methods and tools to aid scientists to discover, integrate, and carry out meta-analyses over heterogeneous sources of data, such as using ontologies to effectively structure and search data. The Harvard CCB Clinic Team is building upon an existing prototype tool for semi-automatically mapping phenotype terms to controlled terms in ontologies in three ways. First, they are implementing graphical user interfaces to use the tool and to interactively browse and verify the automatic mappings. Second, they are testing and implementing NLP-based, semantic methods to improve the tool's mapping performance. Third, they are creating an automated testing harness to measure the tool's mapping performance as changes are made.

HMC Equity in Policing Fairness
Liaison: Darryl Yong '96
Advisor: Heather Zinn-Brooks
Students: Chuksi Emuwa (PM-S), Robbie Fulton, Fatima Omer (PM-F), Elakshi Shah, and Samin Zachariah
In this project we aim to use mathematical and computational modeling to identify factors influencing the distribution of arrests in the Los Angeles region. To accomplish this goal, we are creating agent based simulations of police activity and arrest patterns. We plan to vary the probability of arrest and the police-agent path parameters in order to generate different arrest distributions. We will compare our model outputs to recent LAPD arrest data with the aim of identifying factors that contribute to LA's arrest distributions. These factors will include demographic data along with police-agent patrol patterns. We anticipate this comparison will lead to a better understanding of LAPD arrests and correlating factors that we can use in related future work.

Tempus Ex: Low Latency Telemetry Pipeline
Liaisons: Connor Hanlon, Steve Xing
Advisor: Jasper Weinburd
Students: Sofia Devin, Ryan Edmonds, Robert Gallardo, Callie Morken (PM), Bennett Mountain
Tempus Ex Machina aims to leverage real-time tracking data for predictions and inferences, but currently has no generalized low-latency framework to clean, process, and analyze the incoming telemetry data. The goal of our Clinic project is to develop a robust, flexible, and sport-agnostic pipeline that can standardize and process various sources of telemetry data to generate real-time inferences.

UNIS LLC: Warehouse Slotting Optimization
Liaison: Tom Yu, Tim Park, Andy Mi
Advisor: Weiqing Gu
Students: Michael Giordano, Shaurya Pednekar, Shanni Lam, Jack Ontiveros, Vibha Rohilla
UNIS LLC is a third-party logistics provider that helps companies manage their supply chain, including warehouses, through technology and information services. A particular challenge is organizing inventory within warehouses, a process known as slotting. The goal of this project is to develop a warehouse slotting algorithm to minimize the time for workers to access products, increase worker safety, and save on operation costs, while following appropriate business rules (e.g. grouping similar items, storing heavy items in prescribed areas).

Peter A Loeb '59: My two talks on nonstandard analysis and compactifications at the American Mathematical Society winter meeting in Seattle have been moved to the virtual meeting in April. I am continuing work with H.J. Keisler on an edition of his calculus text replacing infinitesimal errors with standard error functions.

Leo Marcus '66: Model-theoretic systems biology approach to logically specifying and reasoning about the intracellular communication pathways among organelles. A typical question that would be addressed is: given a known (or hypothesized) property, P, of the cell as a system, and given known (or hypothesized) properties of proposed components, $C_1, ..., C_n$, what semantics of a communication rule-set is sufficient to logically prove P?

▲ **Dale Stirn '69:** Just retired after 32 years developing Stirnco Steel Structures Inc., an industrial general construction company. Just got back from the Galapagos on an eight-day diving trip, visiting my hammerhead and whale shark friends. Spent much of my time with wife, Gwen, traveling and bicycling, sometimes both at the same time, including a trip around France replicating a LeTour route with a good friend. Somehow have managed to beat the odds and avoid COVID-19 for two years. Probability anomaly, I suppose. Life is good, and we are thankful to remain so happy and healthy.

Jack Cuzick '70: Heavy focus on identifying women at high risk of breast cancer and offering them prophylactic treatment. Also very keen to promote self-sampling for cervical screening, https://bit.ly/3AoBEoc.

Michael Smithson '72: I've been emeritus for a year now but during that time, I've added to the collection of probability distributions with support on the unit interval. Unlike most distributions in this collection, mine always have finite densities at 0 and at 1-i.e., their support is [0,1] rather than just (0,1), so they potentially are a solution to a long-standing statistics problem. I've spent the last six months coding them in a couple of statistical computing environments and crash-testing them on simulated and real data. I'm now putting the finishing touches on a paper to be submitted to the tender mercies of peer review. Fingers crossed!

Rich Holman '78: I've been dean of faculty at Minerva University since 2019 (having been professor of physics at Carnegie Mellon before that, then dean of computational sciences at Minerva prior to this). I'm currently seconded to Zayed University in the UAE as the founding dean of the College of Interdisciplinary Studies. After having helped build two colleges, I've decided to retire at the end of August 2022 and my wife, Prudy, and I will move to Alcobaça, Portugal! We've bought a lovely house there and can go to nearby Nazaré to watch the (VERY) big wave surfing competitions!

Michael Prendergast '79: After getting my PhD from Caltech in applied math, I spent 36 years in the aerospace and defense industry, retiring in 2019 to Colorado Springs, Colorado. I am married to my lovely wife, Madeleine (Pomona class of 1977), and we live in a house overlooking and adjoining an 800-acre park full of wildlife. We love Colorado. My wife and I like to travel, mostly visiting places in Europe or within the United States. On one trip, we hired a guide who took us up the Dalton Highway to the northernmost part of Alaska. For fun, I develop relatively complex "big data" econometric models to optimize my investment portfolio and am writing a book on quantum computer programming. I also volunteer at a food bank and am a member of a county commission tasked with enabling innovation and technology within county government.

Tony Li '82: I'm now at Juniper Networks and am continuing to build out the internet.

▲ **Bill Consoli '86:** Last summer, I had the honor of being one of Isaac Bruce's guests at his NFL Hall of Fame induction in Canton, Ohio. Had a great time with Isaac and caught up with many former co-workers. Still enjoying my work at Edward Jones, and looking forward to retirement in a couple of years.

Timothy Prescott '02: I have two daughters, ages 12 and 8. I'm an associate professor of math at the University of North Dakota, managing the data for our math emporium. I've also helped adapt the three-semester, open-source, APEX calculus textbook to our uses. It is now available as a PDF, website and ebook.

Carl Yerger '05: I'm now in my sixth year as co-editor in chief of the AMC 10/12 exam and continue organizing local activities with the Charlotte Mathematics Club. I continue my work at Davidson College as chair of the Department of Mathematics and Computer Science. In February, I returned to Claremont to play in the CMS Men's Tennis Ducey Cup alumni match! This summer, I'll be assisting at the World Games in Birmingham, Alabama, as president of the U.S. Korfball Federation.

◄ **Dan Halperin '06:** I am running engineering at Intentionet, a startup aiming to keep computer networks secure and reliable. The exciting mathy part is the automated theorem provers and symbolic analysis tools we use to prove that networks do what their operators want, but I spend most of my time on "leadership." In more-important-but-not-math news, my wife, Sammy, and I are delighted with our 3.5-month-old daughter, Ursula, if she lets us sleep.

▲ **Josh Swanson '10:** Postdoc at USC, writing papers, spring break in Tahiti!

Andrea Levy '11: As of this February, I'm taking a civic leave of absence from Alation to work in the government for a year. I was selected into the 2022 cohort of White House Presidential Innovation Fellows. The program matches private-sector technologists with government agencies tackling hard problems for a yearlong fellowship. I'll be working with FEMA Region IX, helping them build out their data management and analytics capabilities. I'm still based in the Bay Area; the FEMA Region IX offices are in Oakland. I'll have occasion to travel to D.C., so let me know if you're there and would like to meet up.

◄ **Aleina Wachtel '16:** Hey Mudders! It's been a crazy last couple of years, so I thought I'd share some updates! After completing my M.S. in math at CGU, I've been at Microsoft for almost five years. I have had the pleasure of working on three different teams with tons of varying types of work: I started in network infrastructure and connectivity, then moved to a technical program manager role working on the experimentation platform for Office development, and just recently took on a role as a product manager on the Microsoft Word team! I get to utilize my technical and analytical skills as much as my customer-centric UX and design skills, and I couldn't be happier. For fun, I recently fell in love with powerlifting and starting working out with a personal trainer, and I've been taking virtual film classes with SIFF (Seattle International Film Festival). You can catch me in the Greater Seattle area continuing to make music, collecting boardgames and buying books at a faster rate than I can read them.

◄ **Brendan Murran '18:** After graduating college, I have been working in investment research in Southern California. For the first couple of years, I enjoyed partnering with companies that change the way the world does business with emerging technologies, particularly with payments software. More recently, I have been producing investment research for fixed-income markets on asset-backed securities to help companies and people finance airplanes, rental cars, shipping containers, home mortgages, you name it! I am excited to see and be a part of the transformation of investment management via technology as investment strategies, vehicles and public education all improve rapidly. I have a passion for financial literacy and look for ways to demystify and break down language barriers to help all people become more financially wise and healthy. Apart from work, I enjoy the beauty of mathematics and try to find ways to make it a bigger part of my life. I get so much joy from working with mathematics, so we will see if there is any news there to come.

Ziyang Zhang '19: Brown University's physics master program, working on supersymmetry research.

Max Chao-Haft '21: I've been on a gap year, applying to graduate school and doing a bit of tutoring. I did some research with Prof. Sam Nelson (CMC) over the summer on braid invariants and braid group representations. I will attend math grad school in the fall; haven't decided which one yet.

In Memorium: Hank Krieger

The Harvey Mudd College community mourns the loss of mathematics Professor Emeritus Hank Krieger, who passed away on June 29. During his 37 years at Harvey Mudd College, Krieger held many leadership roles on campus, including chair of the Department of Mathematics and chair of the faculty. Within the math department, he was known for his kind, supportive and generous nature, and depth of knowledge across many fields of mathematics. He was a versatile problem solver who appreciated all areas of theoretical and applied mathematics.

Krieger was a graduate of Rensselaer Polytechnic Institute (B.A.E., 1957), earned a Fulbright Scholarship to University of Manchester, England, and received his PhD from Brown University (1964). He wrote his dissertation "Toeplitz Operators on Locally Compact Abelian Groups" under the supervision of Murray Rosenblatt. While serving on active duty as an officer in the Naval Reserve (1958–1961), he was a mathematics instructor in the Advanced Sciences Division of the U.S. Naval Nuclear Power School, U.S.N. Submarine Base, New London, Connecticut. In 1964, he became a Bateman Research Fellow then assistant professor of mathematics at California Institute of Technology before joining the Harvey Mudd College mathematics faculty in 1968. During his career, he also taught statistics at Technion-Israel Institute of Technology.

Krieger was an expert in probability theory and stochastic processes. He is the author of the college textbook *Measure-Theoretic Probability*. In addition to supervising countless Clinic projects and senior theses, Krieger mentored three PhD students—two during his time at Harvey Mudd College—through the Claremont Graduate University. Notably, Krieger's mathematical grandfather was Mark Kac and great-great grandfather, David Hilbert.

Krieger was also a legendary Claremont-Mudd-Scripps tennis coach. He was named to the CMS Athletic Hall of Fame for his 22 years of outstanding leadership in the men's tennis program. The CMS men's tennis coach from 1976–1999, he coached the first CMS team to win a national team championship in the NCAA Division III (1981). His SCIAC match record was 212–33, and his teams were ranked in the Top 15 nationally 20 times in 22 seasons. He was NCAA Division 3 Coach of the Year in 1985 and 1993, and he had an overall match record of 407 wins and 222 losses. Visit the College's Hank Krieger memorial website, https://bit.ly/3zs01GF.