

the LINK

THE MAGAZINE OF CARNEGIE MELLON UNIVERSITY'S SCHOOL OF COMPUTER SCIENCE



**CMU HELPS FRAME
THE NATIONAL AI AGENDA**

Thinking Deeply About AI

**WINTER 2018
ISSUE 12.2**



the LINK

Computer Science at CMU underpins divergent fields and endeavors in today's world, all of which LINK SCS to profound advances in art, culture, nature, the sciences and beyond.

LEDs relight the world

Since the inception of **light emitting diodes** (LEDs) in 1962, the world has undergone a quiet revolution toward solid state lighting. This revolution was powered by George Mueller, Ihor Lys and a team of engineers from CMU's Field Robotics Center.

LEDs have no moving parts and no need for filters or dimmers. They generate little heat, use up to 90 percent less energy than incandescent lighting and last far longer. Today, they can be found in all areas of lighting, from street lamps and headlights to lights for the film industry and colorful decorative lighting featured on buildings.

Back in the early '90s, LEDs were far less powerful and still primarily used as small indicator lights, most often in red and amber. However, the potential was there. This industrious team from CMU saw the potential to revolutionize the lighting industry, forming the startup Color Kinetics.

The Color Kinetics team had multiple problems to solve. First, they had to make the lights more powerful, which Mueller argued would happen with the evolution of semiconductors. Next, they needed to integrate an energy-efficient power supply within the fixture. Tireless work by Lys and his multidisciplinary team led to breakthrough after breakthrough, patent after patent. The chip Lys developed at the time is still widely used for LED controls today.

Bigger players in the lighting industry largely ignored their work, until Color Kinetics rolled out an array of digitally controlled white lighting in 2004. Their advances in digital control revolutionized the industry and, as a result, the Philips company acquired Color Kinetics for \$781 million in 2007.

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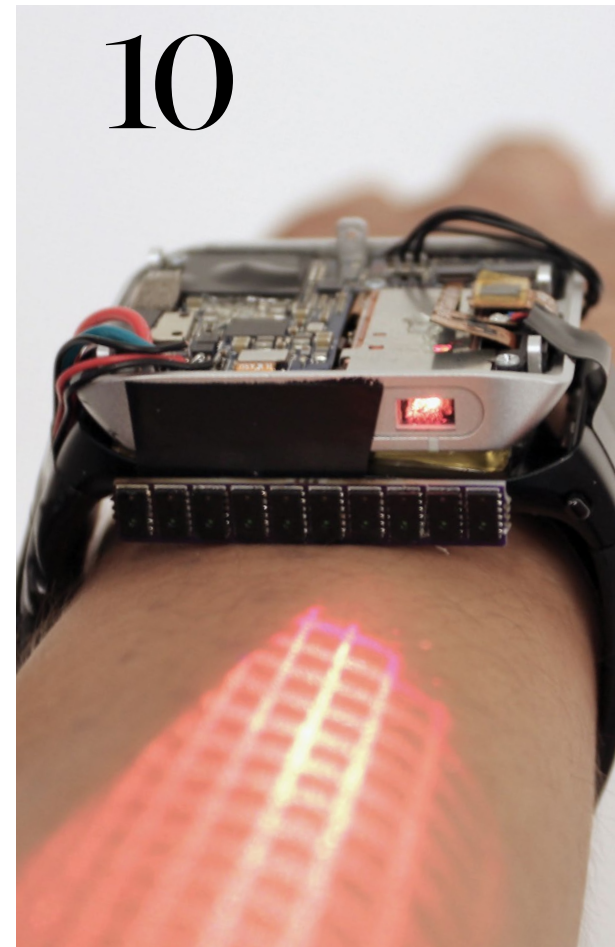
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Time Has

I signed on as dean of the School of Computer Science in August of 2014 — which seems like both forever and a day ago. Early this summer, I started thinking about my upcoming anniversary and what the future might hold for me and my career. As is sometimes the way, forces of nature took over and Google offered me a position to lead their Cloud AI initiative. In September, I accepted. I'll step down as dean of SCS at the end of the fall semester, making this my last "From the Dean" column in The Link.

My decision to leave SCS and CMU wasn't easy. Leading this amazing college has been a great privilege. Every day I'm awed by what happens here. SCS has earned so much respect around the world and accomplished so much since its inception. It attracts absolutely extraordinary humans working on the world's most important and influential projects. I am bursting with excitement to see where SCS goes next.

Flown

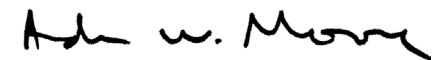
I know that periods of change and uncertainty can sometimes lead to anxiety, but in the case of SCS that's crazy talk. Our faculty, staff, students and alumni have built a unique and unmatched confederation of educational, research and social impact that has justly earned the highest respect from government, industry and our peers in academia. And I'm leaving the school in the incredibly competent hands of Tom Mitchell, who will serve as interim dean. Everything will be just fine.

Lest you still feel twitchy about the future, look no further than this issue of The Link. Our feature stories alone should reassure you that SCS is in an amazing position. Ensuring AI for social good? Check. Using machine learning to create products that help people? We've got that. Teaching computer science to high school students from underrepresented minority groups? Done and done. All of these things have been incredibly important to me, and I'm thrilled that we've made so much progress in my term as dean.

You can read about my legacy in this issue, too. But frankly, it makes me blush a bit. None of it would have been possible without our amazing faculty, staff, students and alumni. Whatever success I've had belongs to all of you, too.

It's been an honor to serve as dean of the best computer science school in the nation. And while I might be leaving CMU, my heart will always be in its work. I certainly plan to support Carnegie Mellon and the School of Computer Science in many ways for years to come. I hope you'll join me.

All the best,



Andrew W. Moore
Dean, School of Computer Science





CMU Helps Frame the National Agenda

Thinking Deeply About AI

Mark Roth

W

hen Google employees started pushing their company to get out of military-funded artificial intelligence research in early 2018, it created ripple effects throughout the technology industry.

One of the early waves from that debate crashed ashore at Carnegie Mellon, where some researchers were involved with the same Pentagon project that had led to protests at Google. Known as Project Maven, the initiative is designed to use machine learning to help analyze video images from military drones to track such activities as movements of terrorists or the presence of hostages.

In May, Andrew Moore, then the dean of CMU's School of Computer Science, convened a town hall meeting on campus to discuss the issue of CMU's involvement with military-funded research after some students and faculty members expressed concern about the ethical implications of such funding.

The meeting, said Moore, led to a "respectful majority" of participants saying that it was appropriate for the university to accept such research money, as long as it abided by a 1988 policy that no one on the main campus would engage in classified or restricted research.

According to the National Science Foundation, CMU received \$52.6 million in Department of Defense research funding in fiscal 2016, the most recent figures available, comprising about 30 percent of all federal research funding flowing in to campus.



While the School of Computer Science and other departments on the main campus do not accept classified or restricted research grants, some affiliated organizations at CMU do, including the National Robotics Engineering Center and the Software Engineering Institute.

At the heart of the debate on campus is the ideal of preserving faculty autonomy, which means not only that individual researchers should be allowed to accept Defense Department research money if they want, Moore said, but also that “we need to look quite carefully to make sure no one is compelled to do research they’re not comfortable with.”

David Danks, department head and L.L. Thurstone Professor of Philosophy and Psychology at CMU and an expert on the ethical implications of AI research in military settings, said the freedom of faculty members to pursue projects within broad ethical boundaries is a central tenet at most top research universities.

“There are people on this campus who may work on problems that I think are not going to pan out and may be a waste of resources. But you never really know how research is going to turn out, so I think it’s critical as a community that we don’t tell one another what to research,” he said.

At the same time, Danks said, there are lines that scientists on the main campus cannot cross.

“We won’t build the targeting system for an autonomous weapon,” he said. “We may build systems that somebody else could repurpose in that way, but it’s a line that we are not going to cross.”

Shane Shaneman, director of strategic government research at CMU and an Air Force veteran himself, said that policy echoes the approach at most major universities. If the military

“One of the ethical challenges of all research, especially in the growing fields of artificial intelligence and machine learning, is the fact that many research discoveries are ‘dual use.’”

— David Danks, Department Head and L.L. Thurstone Professor of Philosophy and Psychology

wants to develop weapons based on research that started at a university, he said, “The DOD has no shortage of service laboratories — the Army Research Lab, the Air Force Research Lab — as well as all the labs under the Department of Energy that get a tremendous amount of money to support those kinds of activities.”

One of the ethical challenges of all research, especially in the growing fields of artificial intelligence and machine learning, is the fact that many research discoveries are “dual use,” Danks said.

“The exact same vision algorithm that someone develops to identify people who might be struggling in a burning building can be used to identify insurgents hiding in a forest,” he said. The same technology that says a factory is producing chemical weapons can be used to say a factory is producing pollutants that are destroying the environment.”

In September, Moore announced he would be leaving Carnegie Mellon to return to Google, where he will head the company’s cloud AI initiative.

In doing so, he will join a firm that not only decided to pull out of Project Maven, but has adopted an ethics policy that says it will not engage in research on “weapons or other technologies whose principal purpose or implementation is to cause or directly facilitate injury to people,” or on “technologies that gather or use information for surveillance violating internationally accepted norms.”

Moore, who headed Google’s Pittsburgh office for eight years before rejoining CMU in 2014, said in an interview that he “would not want to see the United States using AI to create lethal weapons itself, but it needs to be prepared to respond to those weapons if someone else uses them.”

That fits with public views that emerged in a Brookings Institution poll done in August. The survey of adult internet users around the U.S. found Americans are deeply divided over using AI for warfare.

About 30 percent of the survey group believed AI technologies should be developed for warfare, while 39 percent did not and 32 percent were unsure. Importantly, though, when asked what should happen if America’s adversaries were developing such weapons, 45 percent felt the nation should develop AI weapons of its own, compared to 25 percent who were against that and 30 percent who were unsure.

George Darakos, director of partnerships in the School of Computer Science, said he believes one reason many people support AI research for the military is that they see it as helping to protect American troops.

“AI is going to save lives,” Darakos said. “It could mean saving more civilian lives, it could mean saving more of our soldiers’ lives, and if that’s what it means, I think ultimately a lot of people can get behind it.”

“AI is going to save lives. It could mean saving more civilian lives, it could mean saving more of our soldiers’ lives, and if that’s what it means, I think ultimately a lot of people can get behind it.”

— George Darakos, Director of Partnerships, School of Computer Science



“We have our sons and daughters serving in the armed forces overseas,” Shaneman added. “We’re looking to develop advanced algorithms to help keep them safe. And I feel that is a deep moral obligation we have.”

Many of the news stories about Project Maven called it a technology that would help drones target enemies, but Shaneman said there are no targeting algorithms being integrated into the drones as part of that project.

Instead, it’s designed to help human intelligence analysts deal with the overwhelming flood of surveillance data that flows in every minute of the day from drones, satellites and other sources.

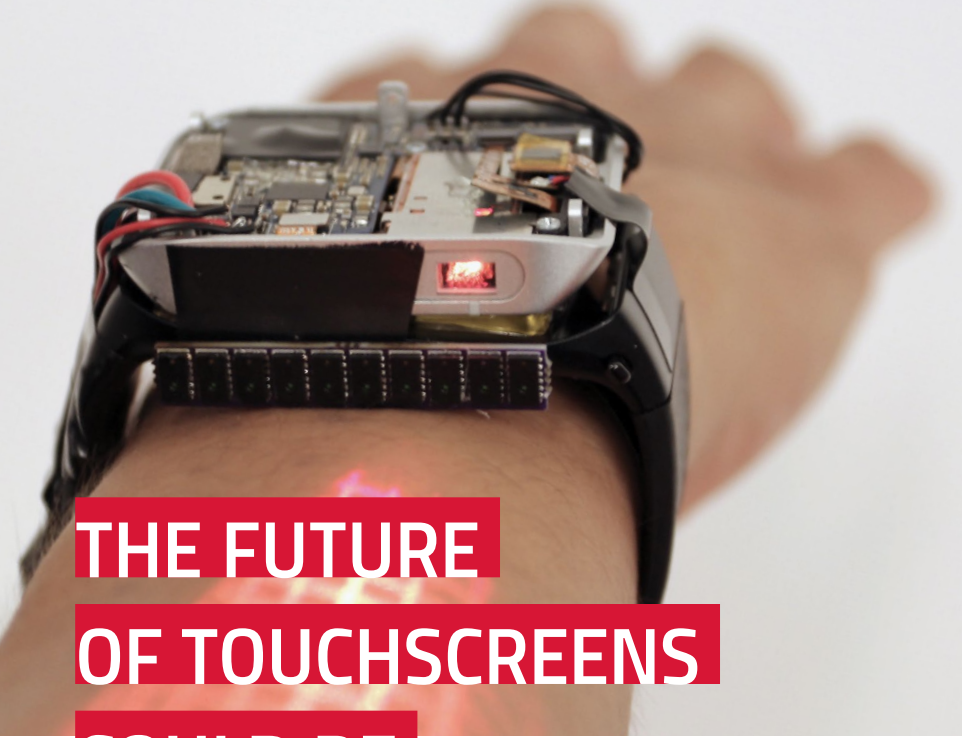
A prominent defense official noted that if we took every intelligence analyst out there, and had them devote the rest of their lives to analyzing geointelligence imagery from satellites alone, we would only get through about one week’s worth of imagery.

The promise of Project Maven, he said, is that “If I have four hours of video from a drone, rather than having to watch that four hours, I can watch 90 seconds with the help of the AI. We would be able to save that human analyst a great amount of time.” That would allow analysts to spend more of their time looking at critical footage that might require a response, he said.

The debate over Project Maven and other military-funded computer science research has shown that every project today carries an ethical burden.

There is no escaping it, Moore said.

“In this modern age, computer scientists have to really think about the ethical, legal and policy issues of what they are creating. There is no way to separate designing computer systems and being a decent human being.” ■



THE FUTURE OF TOUCHSCREENS COULD BE

RIGHT UP YOUR SLEEVE



Matt Wein

About 36 percent of people on the planet own smartphones. But smartwatches haven't quite caught on yet, and there's a good reason why.

"If you look at modern smartwatches, they're stuck between trying to become bigger and trying to become smaller," said Robert Xiao, a recent Ph.D. graduate of the Human-Computer Interaction Institute. "You want a nice, svelte device that sits on your wrist and isn't too intrusive, but if you want to interact with it, it needs to be physically larger to accommodate the fingers you use to manipulate the surface."

That's why Xiao, fellow student Yang Zhang and Chris Harrison, assistant professor in the HCIL, designed and built the LumiWatch. Unlike a regular smartwatch, LumiWatch uses a built-in

microprojector that turns your forearm into an interface very similar to the home screen on your smartphone.

"There's amazing surface area all over our bodies, and we're already taking it everywhere we go," Harrison said. "We can have all the benefits of a smartphone, but in a smartwatch form that's immediately accessible."

A unit mounted beneath the projector contains 10 small proximity sensors that continually send out little pulses of infrared light. They detect when an object enters their field of view, and are angled in a way that they cover a very thin area immediately above your arm.

Xiao says that the team tested the technology against different skin colors and arm sizes, and that there's still a great deal of room for improvement. Next steps include improving the projection's resolution, producing a waterproof prototype and increasing the device's power — the current prototype runs at about 20 hertz, while a normal touchscreen might run at about 150 hertz.

"Clothing is a big one, too," said Xiao. "It tends to provide a very uneven surface texture. In that

direction, we're pursuing intelligent sensing that allows us to recognize the shape and texture of what you're trying to project on and correct the projection to match."

The concept of on-body projection is something Xiao and Harrison had toyed with for several years, but delved even further into once they identified a growing desire for it as a possible consumer technology.

"There were a lot of Kickstarter projects that publicly said, 'Look, we can make a bracelet that projects onto your arm!' And they had fancy concept videos and were backed with large amounts of money, but they produced no working prototypes," Xiao said. "This demonstrated to us that this technology is something people want."

To build the watch, Xiao and Harrison's team collaborated with ASU Tech Co.LTD., a manufacturer of microprojectors.

"They bring the hardware chops," said Harrison. "They can manufacture things that, even at CMU, we'd be hard-pressed to do on that kind of scale."

LumiWatch garnered a fair amount of press when Harrison's team debuted the prototype in the spring of 2018, with many tech reporters noting the item's estimated \$600 price tag. But Xiao and Harrison insist that the implications of the technology that make the watch work are more important than getting a consumer product to market.

"One of the things we really want to focus on," Xiao said, "is determining whether there are any other interactions people might be interested in — potentially sensing how high off the surface your finger is could open up new kinds of interactions that you couldn't perform before, like hover sensing or gesture sensing. These are technically very small things that might have very big user interface ramifications. You could make any surface interactive quite quickly. That's another direction of research we've been pursuing, this direction of ubiquitous projection and interaction."

Still, Harrison thinks functional forms of those technologies remain some time off.

"Projecting touchscreens onto your skin is already kind of sci-fi and insane, so we don't want to go too insane," he said.

So while you won't be seeing the bulky LumiWatch on shelves in time for your holiday shopping, Harrison suggests that the technology as a consumer product isn't far away.

"LumiWatch shows that this technology is actually in striking distance. If we can do this as a one-year collaboration with six or seven people, then it's doable by companies like Google, Apple or Samsung. It's not quite there yet, but we're on that vanguard. As a proof of concept, it was very potent. If there was interest, and if someone really wanted to sink their teeth into this, I think within a year or two you could see a consumer product." ■

WHAT'S THAT WORD AGAIN?

CMU Researchers Help Interpreters Find "Le Mot Juste"

Scott Fybush

Think about all the challenges that go into interpretation:

a human sitting in a booth, listening to live speech in one language and somehow smoothly repeating it in another language, sometimes for hours at a time. Then imagine our interpreter is working at a specialized conference where the speaker is using arcane terminology, forcing them to come up with rarely used words and phrases at a moment's notice.

Add a computer into the mix, and our interpreter's job gets easier, right? Not so fast, said Graham Neubig, an assistant professor in the Language Technologies Institute (LTI) who's been leading a research project to determine how machine translation can help with live interpretation — and just as critically, where and how it gets in the way of smooth translation.

A translator at work at the United Nations in New York.

“The idea is to let both human and computer do what they do best — and the challenge is to find just how best to strike that balance.”

— Graham Neubig

Neubig has been fascinated by the intersection of language and computers since he was a foreign exchange student in Japan while studying computer science at the University of Illinois in the early 2000s. He later returned to Japan to teach English, and brought his work on natural language processing to CMU's LTI in 2016.

The project Neubig's team is working on pairs human interpreters with a computer assistant that listens along with them, offering up just enough on-screen help with specialized terminology and staying silent when its services aren't required.

The idea, said Neubig, is to let both human and computer do what they do best — and the challenge is to find how to strike that balance. Humans, he said, excel at understanding the sort of nuances that are still insurmountable obstacles for machine translation.

“I think human interpreters are incredibly good at dealing with adverse situations,” Neubig said. The precise choice of words can be sensitive, he notes, and the wrong choice of idiom can create an unwelcome incident. “If you interpret in a particular way, it would be very rude in some cultures, for example. So human interpreters know that, and they can adjust accordingly. All of these things would be huge problems if you tried to build a fully automatic system.”



The Language Technologies Institute's Computer-Aided Interpreter team: (l to r) Graham Neubig, assistant professor in LTI; Craig Stewart and Nikolai Vogler, Ph.D. candidates in LTI.

Computers, of course, have their own strengths, especially when it comes to instantly retrieving an almost infinite list of stored words and phrases, no matter how obscure. How do you say “556” in Italian? Numbers, too, are something machine-assisted translation can do well.

Building a model

At this past summer's annual meeting of the Association for Computational Linguistics (ACL), Neubig and his team presented some of the initial findings from that work with real-world translators. One key piece of that work, it turns out, focuses on the importance of listening to the output from the interpreter using the quality of their work to help the computer determine how much help to provide and, just as importantly, when to leave them alone.

“The idea is that if people are struggling, then we should potentially be giving them more help, but if they're doing fine, we don't need to distract them by putting lots of stuff on the screen,” said Neubig.

So Neubig and his team started with an existing machine-learning model designed to assess the quality of automated output, then customized it with additional criteria to analyze the output of a human interpreter.

“We added other things, like how many pauses is the person making, how many times are they saying things like ‘um’ or ‘uh,’ and what is the difference between the number of words in the output and the number of words in the input,” he said. “Because if the output is much shorter than the input, then that's an indicator that things are not going well.”



Nikolai Vogler uses the computer-aided translator program

Whether the interpreter is struggling or cruising along smoothly, Neubig's model still has plenty of work to do behind the scenes to determine what help it should or shouldn't be putting on screen. For example, he said, the system has to know which words are common enough that they never need to be translated on screen.

“In order to learn this model,” said Neubig, “we have a database of interpreted speech, and we have the terms on the input side, and then we also have annotations of whether the interpreter actually got that term correct or not. This gives us yes/no labels about whether the interpreter is going to need help with that term. Then we train our model to try to accurately predict those yes/no labels.”

We're going to need a bigger database

Putting together that database has been quite a challenge, Neubig said.

“It's actually very difficult to get data. There are some databases of interpreter speech, but these are highly curated and they took a lot of time and effort to create. And they're still, from a machine-learning perspective, very small. So getting something to learn what we want to learn properly from these relatively small collections of data has been the biggest challenge.”

Neubig and his team at CMU are already teaming up with outside partners, including the Department of Interpretation and Translation at Italy's University of Bologna, to attempt to build a larger database — and then, perhaps, to try out his system in the real world with interpreters learning their craft.

“I think some form of what we're building could become a commercial product relatively soon,” Neubig said. “The technology is kind of there, but we're still working out the kinks.”

Because the system is listening to its human interpreter and assessing how well they're doing, Neubig said it may eventually provide a side benefit, giving interpretation providers immediate feedback on how well (or how poorly) the interpreters they hire are doing their jobs for their clients. Several companies have already contacted Neubig's team to express interest in that aspect of the technology, though he said no formal work on that part of the project is yet underway.

Along those same lines, Neubig said the technology could have huge benefits in training new interpreters, providing immediate feedback as they practice.

“They go along and interpret,” he said, “and then post facto, it goes in and says, ‘Maybe in this particular part of your interpretation you weren't doing as well. Would you like to go back and review that and see if there was any way you could do better? Maybe these parts are the things that you should concentrate on.’ So I think that might be another direction that we want to pursue in the future.”

Working with interpretation schools has also allowed Neubig's team to sharpen its focus, dropping some potential features that the schools said wouldn't be of any use to their students. ■

New Master's Degree in Automated Science Prepares Researchers for AI-Directed Experimentation

Artificial Intelligence Will Drive More Decisions in Biological Experiments

Byron Spice

Automated Science uses "self-driving instruments" performing the multitude of experiments necessary for scientific discovery.



Computers increasingly are helping scientists identify and select experiments necessary for scientific discoveries, so Carnegie Mellon has created a two-year master's degree program to train the specialists needed to design, configure, operate and maintain these systems.

CMU's Computational Biology Department will offer the Master of Science in Automated Science: Biological Experimentation beginning in fall 2019.

"Automation has disrupted numerous industries and is poised to radically transform the pace and economics of scientific research in academia and industry," said Robert F. Murphy, head of the Computational Biology Department and co-director of the new master's degree program. "We will train students to become leaders in this new field, where automated instruments and artificial intelligence combine to produce scientific discoveries."

Automation such as high-throughput screening is a standard means of experimentation for drug discovery and of basic biological science. Advances in AI and machine learning now make it possible and — given the complexity and scope of today's experiments — even preferable for computers to choose which experiments will fill gaps in knowledge and which only duplicate knowledge and can be skipped.

"The goal is to develop self-driving instruments, similar to self-driving cars that require little if any help from their occupants," Murphy said. "The need for human intervention in experiments will be minimal, though creating these automated systems and planning experiments will require people who are familiar both with experimental methods and with the machine learning and statistical methods necessary to construct predictive models."

"This exciting new program in automated science will break new ground while building upon the unique strengths of Carnegie Mellon," said Carnegie Mellon President Farnam Jahanian. "By training a new generation to develop and use self-driving instruments that combine artificial intelligence with automated research instruments, we will play a leading role in advancing new paradigms in discovery and changing the way that experimental science is done."



Christopher Langmead, associate professor of computational biology and co-director with Murphy of the master's program, said the initial concentration will be in biological experimentation, but additional subject areas are expected to be added in coming years.

The program seeks to attract students who are preparing for laboratory careers and otherwise might pursue master's degrees in biology or chemistry. It will train students for jobs such as laboratory automation specialists and automation engineers. It also will provide excellent preparation for students contemplating Ph.D. studies in related disciplines.

To ensure that it meets industry needs, the program will have an external advisory board drawn from potential employers.

"This program will provide a major boost to the scientific automation field and I am very happy to be involved with it," said DJ Kleinbaum, an external advisory board member and co-founder of Emerald Cloud Lab, a California company that provides automated solutions for contract research.

The MSASBE program will provide training in three areas:

- Hands-on use of automated instruments and study of their design principles, interfaces and capabilities;
- Computational methods for constructing predictive models from experimental data; and
- Algorithmic methods for experimental design and selection.

The interdisciplinary program will draw on faculty from CMU's Computational Biology Department, Machine Learning Department, Computer Science Department, Department of Biological Sciences, Department of Chemistry, Mechanical Engineering Department and Biomedical Engineering Department. ■

8:30 a.m.



10:30 a.m.



12:20 p.m.

A day in the life of a Summer Academy for Math and Science Student

Cristina Rouwalis



W

hen a glorious summer day graces the skies, many high school students set out to soak up some sunshine. But Daniela Velez, a rising high school senior from Florida, spent a recent sunny day inside, soaking up college-level math at the Summer Academy for Math and Science (SAMS) at Carnegie Mellon. Her day began with a Concepts of Mathematics test, where she puzzled through combinations and permutations, followed by an SAT prep session to brush up on geometry. After lunch, she and her classmates worked on their group project involving game theory, specifically with tic-tac-toe and Yahtzee — putting a heady twist on the childhood classics.

Even as classes finished for the day, Velez wasn't done learning. At 7 p.m., she and a group of her classmates visited their professor during office hours, where they bonded over math puzzles and proofs. "To me, this is like a vacation. I love it," said Velez.



2:15 p.m.

Velez was thriving on the computer science track at SAMS, a six-week residential program for rising high school seniors intending to pursue STEM-related careers. SAMS supports students from groups traditionally underrepresented in computer science, as well as students from lower socioeconomic households and first-generation college students.

Those admitted to the highly selective program receive free room and board, with stipends available for additional expenses. Through rigorous academic instruction, group projects and mentoring, SAMS prepares students to succeed at elite universities and strives to one day bring greater diversity to STEM-related career fields.

But the SAMS experience isn't all game theory and no games. Between classes, Velez played Ping-Pong and then tennis with her new friends from around the country. She also squeezed in an hour of piano practice to prepare for an upcoming statewide music competition back home. In the evening, she and her roommate in Donner House stayed up late talking, bonding over details of their days and their lives back home.

"Before I came to SAMS, I thought everyone was going to be a nerd," Velez said. "Everyone here is really studious, but they are also very passionate and supportive of each other."

This is the second year that SAMS has offered a computer science track. The program only accepted 10 percent of applicants, resulting in a class size of

114. In addition to math, Velez and her classmates also took computer science, as well as other science classes. The effort pays off—graduating students receive college credit for Concepts of Mathematics, usually offered to incoming freshmen at CMU.

By design, SAMS opens up new possibilities for underrepresented groups of students. "This program gives kids the extra academic boost they need to apply to a different set of colleges," said Jonathan Reynolds, outreach project manager for the School of Computer Science.

Velez attends American Heritage School in Plantation, Fla., a private school with strong math and computer science programs. Growing up, she was inspired by her parents, both of whom work in computer science.

But not all high school students have access to those resources—only one in four U.S. high schools offers a robust computer science program, Reynolds said. "We are very intentional in expanding access to those who don't have resources," he said. "We look for other things in applications, such as willingness to learn."



3:30 p.m.

"I have learned so much, not only from my classes and professors, but also from the people around me."

Rote memorization—plugging in numbers to get the right answers—might be enough to get by in many high school math classes, but SAMS pushes students to use higher-order thinking skills. Iowa State University Professor Michael Young is a math instructor and project director in SAMS, and challenges his Concepts of Mathematics class with a simple question—Why?

"We never really thought about why these formulas exist or how they were derived," Velez said. "We got into the core of math."

Young also found a way to encourage her to do more collaborative work in the classroom. After the first week of class, the professor pulled her aside and suggested that if she combined her ability to solve problems with the skills of others, she would get even more out of her efforts. As she started to engage with her classmates, she quickly realized he was right.

Velez first visited CMU in the fall of her junior year as part of an East Coast college tour. Carnegie Mellon impressed her with its strong programs in computer science and music, two of her passions.

She wants to go into computer science to make society better and use it to work on critical issues such as transportation, communications and education.

At 17 years old, Velez is already on the path to achieving these goals. Before the SAMS program started at the end of June, she visited her grandmother in Colombia and helped set up a computer-based class using games to teach basic math concepts to young girls in an orphanage. In a country where few women study math and science, Velez encouraged the girls to go into STEM fields.

On the last evening of the SAMS program, the students traditionally come together to listen to

each other give presentations about their group projects. Ty Walton, director of SAMS, announced the recipient of the EQT Fellow award, given to the "most promising student" who shows mastery of the material, willingness to help others and passion for computer science for the good of society. When Daniela Velez heard her name called, she beamed as she went to pick up her award.

"I have learned so much, not only from my classes and professors, but also from the people around me," she said. "I am so thankful to have been able to call this positive community my home away from home for six weeks. Thank you for giving me this amazing experience."

Late that evening, she teared up as she hugged her SAMS friends goodbye. The next day, they returned to their homes across the country.

But it won't be the end of their friendships. Since returning home, Velez and her friends have kept in touch by video calling, and she caught up with a few of them in Miami. As they enjoy their last year of high school, this group of friends has already started planning their SAMS reunion. Velez can hardly wait. ■

7:30 p.m.



Comp Bio's Compeau Rethinks Traditional Teaching

Susie Cribbs

When Phillip Compeau was a child, he dreamed of being whisked away to a new kind of school, one where all the students sat at their own desks with a collection of work and computers to guide them through it. Each student could tackle their personalized task list at their own pace. Need help? Click a button or ask the teacher. It's no surprise, then, that Compeau — now an assistant teaching professor and assistant department head for education in the Computational Biology Department — has spent much of his professional life studying not just his chosen field of computational biology, but also how students learn. And he's worked hard to find the best strategies for teaching them.

In its simplest form, computational biology uses techniques from computer science to solve biological problems. Before computational biology was a mature discipline — CMU awarded its first undergraduate comp bio degrees in 1989, when the program lived in the Mellon College of Science — students interested in the field often majored in computer science and took bio courses, or maybe studied bio with some work in computer science. In Compeau's case, it was math.

As an undergrad at Davidson College in his home state of North Carolina, Compeau studied math but worked at its intersection with biology.

Specifically, his senior thesis focused on a variant of the pancake-sorting problem: determining the minimum number of spatula flips necessary to transform a stack of differently sized pancakes into a pyramid shape. "If you think of the pancakes as different genes, and the flips as certain large-scale mutations, then pancake-sorting offers a model for transforming one chromosome into another," Compeau said. He also played competitive tennis and at one point had an Association of Tennis Professionals (ATP) ranking in doubles.

After a brief excursion to Cambridge University, where he earned a master of advanced study degree in mathematics, Compeau headed west to work with noted computational biologist Pavel Pevzner at the University of California, San Diego. While there, his focus changed.

"I did research during my Ph.D. years, but the larger effort I undertook was doing online educational projects and building an online textbook," Compeau said. "I decided I wanted to be a teaching-track professor, which is not the most common ambition. I was fortunate enough to be in an environment with an advisor who could support that."

While at UCSD, Compeau co-founded Rosalind, an online platform for learning bioinformatics through problem-solving. He also co-instructed the first massive open online course (MOOC) in bioinformatics. Both initiatives have since exploded. Rosalind has reached more than 50,000 people and has been adopted more than a hundred times by universities for offline courses. The MOOC has evolved into the bioinformatics specialization on Coursera and its best-selling print companion, "Bioinformatics Algorithms: An Active Learning Approach." The course has been completed by a few thousand learners and used in some way by more than 200,000 people.

With Rosalind and the MOOC under his belt, Compeau joined the Computational Biology Department faculty in 2015.

"What brought me to CMU was the fact that it has a good history of prioritizing teaching-track faculty and seeing the value in them," he said. "It's a rare environment to have an entire department devoted to computational biology, as well as to be a university that prioritizes teaching."

Since arriving in Pittsburgh, Compeau has made substantial contributions to the department. In his role as assistant department head for education, he led the creation of the undergraduate degree in

"Because SCS is so strong at the undergrad level, we can design a major that simply wouldn't be possible at other places."

— Phillip Compeau,
Assistant Teaching Professor
Computational Biology Department



computational biology, which he directs and whose students he advises. It's the only comp bio degree granted from a school of computer science.

"Because SCS is so strong at the undergrad level, we can design a major that simply wouldn't be possible at other places," Compeau said. "Students hit the ground running in math and science here, and it means that we can teach them computational biology at a deep level. And that means we can produce graduates who fill a huge area of need for solving the big biological and medical problems of the 21st century."

Compeau also collaborated with fellow comp bio teaching professor Josh Kangas to develop the first pre-college computational biology program in the U.S. The program, slated to begin this summer, will first put students in the lab and then in front of computers to analyze the data they generate. "It's going to be an amazing experience for them," Compeau said.

Like his young self, grown-up Compeau still believes there's massive room for using automation to improve education. In his own courses, he's implemented a flipped classroom and relies on active learning. No traditional lectures here. Students complete reading assignments in an interactive textbook before the class meeting, and spend in-class time working on challenge problems and answering questions from their peers to cement their learning.

His strategy, while successful, requires a complete rethinking of learning. And it requires student buy-in.

"We indoctrinate students into thinking they can only learn one way," Compeau said. "Teachers are considered the fountain of knowledge, and when that source of wisdom is asking students to solve problems and guiding them to figure out solutions on their own instead, well, some people have an allergic reaction to that."

To tame that allergy, Compeau spends the first day of his course selling the format to his students by outlining the weaknesses of traditional lectures, the goals of the course and how the flipped course will benefit them. So far, he's seen positive course evaluations and a significant improvement in test scores.

While he's made great strides toward building a student-centric classroom, Compeau still hasn't created that fantasy school of his first-grade dreams. But he doesn't want to. "Removing the teacher from the picture entirely is a naive view," he said. "The modern classroom should find ways to use online materials to improve our teaching — not to replace it." And at Carnegie Mellon, he's happy to have found a cohort of colleagues willing to do whatever it takes to give students the best education possible. ■

How a Computer Learns to Dribble:

Practice ...

Practice ...

Practice ...

Basketball players need lots of practice before they master the dribble, and it turns out that's true for computer-animated players as well. By using deep reinforcement learning, players in basketball video games can glean insights from motion-capture data to sharpen their dribbling skills.

Researchers at Carnegie Mellon and DeepMotion Inc., a California company that develops smart avatars, have for the first time developed a physics-based, real-time method for controlling animated characters that can learn dribbling skills from

experience. In this case, the system learns from motion capture of the movements performed by people dribbling basketballs.

"Once the skills are learned, new motions can be simulated much faster than real-time," said Jessica Hodgins, professor of computer science and robotics, who presented the work with DeepMotion Chief Scientist Libin Liu in August at SIGGRAPH 2018, the Conference on Computer Graphics and Interactive Techniques.



Giving Back to SCS

"Giving back to CMU and the MSE Program has been one of the most fulfilling things I've ever done. Thinking back to everything Carnegie Mellon gave me and how foundational it was for my professional success, setting up a scholarship in my parents' name was a no-brainer."

The Norma and Eduardo Frias Scholarship is meant for students who, as myself, wanted to learn from the best school in the world but needed some extra help to make their dreams possible. I look forward to continuing 'paying it forward' for many generations of CMU students."



Eduardo Frias (CS 1994)
Founder of the Eduardo and Norma Frias Scholarship for the Master of Software Engineering Program

**DIRECTOR'S MESSAGE
OFFICE OF ANNUAL GIVING
AND STEWARDSHIP**

CREATING A LEGACY OF INSPIRATION

As the year comes to a close and we say goodbye to SCS Dean Andrew Moore, it feels like the end of an era. Andrew leaves behind a legacy of impact and innovation that motivates us all as we look toward the future of SCS. But one of my other motivations is our donors, who have created a legacy of their own that inspires me every day I step into my office.

One of the marks of a healthy university is how many of its alumni contribute philanthropically each year. A quick look at the Donor List in this issue confirms that SCS has nothing to worry about. We continue to add pages to this feature each year because the number of donors — alumni, parents, students, faculty, staff and friends alike — just keeps growing.

A portion of the gifts we receive each year are large, and allows us to create chairs, fellowships and scholarships. These are incredibly important to SCS, because they ensure that we can attract and retain the best and brightest students



Nicole Atwell,
Director of Annual Giving
and Stewardship

and faculty members. Some of our endowed chairs, for example, support junior faculty whose work we believe will change the world for the better. Presenting them with the chair not only provides them with financial support for their research, but it also demonstrates our commitment to their career and its importance to CMU.

Like chairs, undergraduate scholarships and graduate fellowships help us support amazing talent — this time, in the form of students. In our “Giving Back” column, alum Eduardo Frias (CS 1994) discusses the fellowship he created to support a master’s student in software engineering and why it was so important to him. His gift, like those from other scholarship and fellowship donors, gives SCS the flexibility to offer support to a deserving student who for financial reasons might otherwise choose another institution. Gifts like Eduardo’s help us help others, while we remain competitive with our peer institutions.

It doesn’t take a large gift to change the world, though. Just look at our Mark Stehlik SCS Alumni Undergraduate Impact Scholarship. In fact, this spring we ran a crowdfunding campaign in honor of Mark graduating his 3,000th advisee — talk about impact and legacy! — and wildly exceeded our

symbolic goal of \$3,000. In fact, we collected more than \$34,000 from 121 donors. The contributions of so many SCS alumni and friends will now allow us to regularly award the Stehlik Scholarship to two students, not just one.

You can see this same kind of impact in our Dean’s Innovation Fund, which helps SCS quickly support exciting new projects that range from student research to faculty endeavors. This summer, we used proceeds from the fund to launch our new bachelor’s degree in artificial intelligence. Thanks to the support of many, our students will be the first in the country to earn a B.S. in AI. That’s the amazing kind of work we can do when we pull together.

As we bid farewell to both Andrew Moore and 2018, I hope you’ll consider supporting the School of Computer Science and all the talent that calls it home. Because at the end of the day, the commitment of our alumni and other donors is what makes SCS strong.

Nicole Atwell
Director
Office of Annual Giving
and Stewardship

Mitchell Named CMU's Interim Dean of School of Computer Science

Carnegie Mellon has named Tom Mitchell, the E. Fredkin University Professor of Machine Learning and Computer Science, interim dean of the School of Computer Science. Mitchell will take the place of Andrew Moore, who has stepped down as SCS dean to head Google's Cloud AI efforts. Carnegie Mellon will conduct a national search for a successor.

Mitchell is a pioneer in the field of machine learning, a burgeoning branch of artificial intelligence that develops systems capable of learning from data, identifying patterns and making decisions. In 1997, he co-founded the Center for Automated Learning and Discovery, which became the world's first Machine Learning Department in 2006 and offered the first Ph.D. program in machine learning. He led the department until 2016.

"As a leading scholar in machine learning and artificial intelligence, Tom Mitchell has been one of the School of Computer Science's most extraordinary founders and pioneers for the past several decades," said Carnegie Mellon President Farnam Jahanian. "He has the profound respect of the entire Carnegie Mellon community and a record of leadership that will make him an excellent interim dean. I am grateful for his willingness to serve the school and the university at this important time."



CMU Team Dives into DARPA Subterranean Challenge

A Carnegie Mellon team will compete in the systems track of the Defense Advanced Research Projects Agency Subterranean Challenge, a multiyear robotics competition with a \$2 million prize in which robots will autonomously search tunnels, caves and underground structures.

The CMU team is one of nine that will receive up to \$4.5 million from DARPA to develop the robotic platforms, sensors and software necessary to accomplish these unprecedented underground missions. The robots will be tasked with rapidly mapping, exploring and exploiting complex underground environments, ranging from spaces so small that humans can only crawl through them to areas big enough to accommodate an all-terrain vehicle. The challenge is designed to provide both warfighters and first responders with the capabilities they need to accomplish a variety of missions in caves, tunnels or urban underground facilities, such as subway stations.

"Successfully completing these missions will require multiple robots, including both drones and ground vehicles," said Sebastian Scherer, who will lead the team with Matt Travers, both systems scientists in the Robotics Institute. "Our team has a wealth of experience in operating robots in mines, enclosed spaces and the wild, and in coordinating the activity of multiple robots."



Rosenfeld Named Machine Learning Department Head

SCS has named Roni Rosenfeld, an expert in epidemiological forecasting and spoken dialogue technologies, head of its Machine Learning Department.

Rosenfeld, a professor in both the Language Technologies Institute and the Machine Learning Department, joined Carnegie Mellon

in 1994. As head of CMU's Delphi Research Group, Rosenfeld aims to make forecasting disease as universally accepted and useful as forecasting the weather. His research also focuses on finding ways to use spoken language technologies — automatic speech recognition, speech synthesis and human-machine dialog systems — to aid global socioeconomic development. In addition to teaching and engaging in his own research, Rosenfeld also oversees CMU's Machine Learning for Social Good fund, which provides opportunities for faculty and students to apply their expertise in data science and machine learning to initiatives that benefit the public sector.

"Machine learning is incredibly important in today's world, and there are few people I trust as much as Roni Rosenfeld to lead our efforts in this area," said SCS Dean Andrew Moore. "Roni's work in forecasting disease and his dedication to machine learning for good make him an excellent choice for this role, especially as we strive to make CMU the hub for artificial intelligence that changes the world for the better. I'm thrilled that he will run our Machine Learning Department."



Actuation Gives New Dimensions to an Old Material

One of the oldest, most versatile and inexpensive materials — paper — seemingly springs to life, bending, folding or flattening itself, by means of a low-cost actuation technology developed in the Human-Computer Interaction Institute.

A thin layer of conducting thermoplastic, applied to common paper with an inexpensive 3D printer or even painted by hand, serves as a low-cost, reversible actuator. When an electrical current is applied, the thermoplastic heats and expands, causing the paper to bend or fold. When the current is removed, the paper returns to a predetermined shape.

"We are reinventing this really old material," said Lining Yao, HCI assistant professor and director of the Morphing Matter Lab, who developed the method with her team. "Actuation truly turns paper into another medium, one that has both artistic and practical uses."

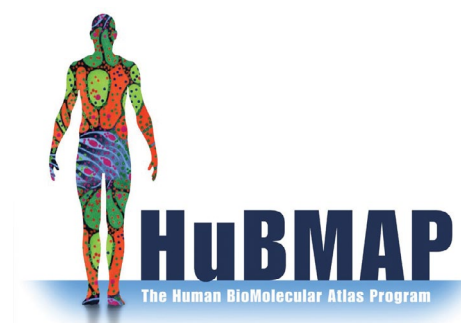
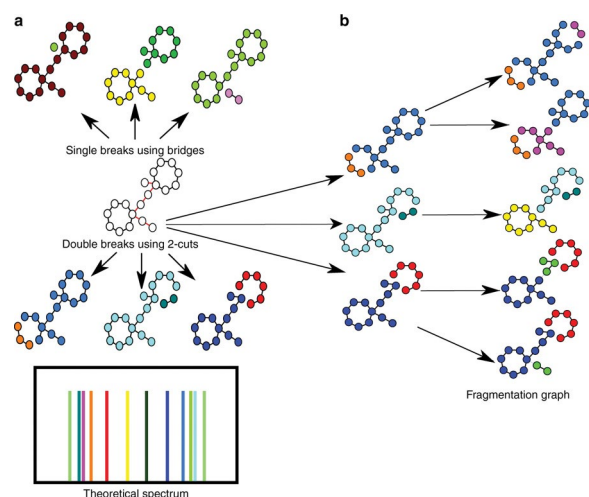
Post-doctoral researcher Guanyun Wang, former research intern Tingyu Cheng and other members of Yao's Morphing Matter Lab have designed basic types of actuators, including some based on origami and kirigami forms. These enable the creation of structures that can turn themselves into balls or cylinders. Or they can be used to construct more elaborate objects, such as a lamp shade that changes its shape and the amount of light it emits, or an artificial mimosa plant with leaf petals that sequentially open when one is touched. In June, more than 50 students in a workshop in China used the technology to create elaborate pop-up books, including interpretations of Van Gogh's "Starry Night" and "Sunflowers."

New Algorithm Efficiently Finds Antibiotic Candidates

If you're looking for a needle in a haystack, it's best to know what hay looks like. An international team of researchers has applied this idea to the search for new pharmaceuticals, developing a technique that reduces the chances of simply rediscovering known compounds.

In an October article in *Nature Communications*, researchers from CMU; the University of California, San Diego; and St. Petersburg State University in Russia describe a new means of searching vast repositories of compounds produced by microbes. By analyzing the mass spectra of the compounds, they were able to identify known compounds within the repository and eliminate them from further analysis, focusing instead on the unknown variants — the needles within the haystack — that could be better or more efficient antibiotics, anticancer drugs or other pharmaceuticals.

In just a week, running on 100 computers, the Dereplicator+ algorithm sorted through a billion mass spectra in the Global Natural Products Social molecular network at UC San Diego and identified more than 5,000 promising, unknown compounds that merit further investigation, said Hosein Mohimani, assistant professor in CMU's Computational Biology Department and first author on the article.



CMU Will Help Build 3D Cellular Map of the Body

CMU computer scientists are helping the National Institutes of Health build a 3D map of the human body that shows how tissues differ on a cellular level and offers deep insights into the body's inner workings.

In September, the NIH announced its first set of research funding awards for the Human BioMolecular Atlas Program (HuBMAP), which it anticipates spending \$54 million on in the next four years. The initiative will provide scientists with a deeper understanding of how the tens of trillions of cells that constitute the body are organized in tissues to carry out the daily processes that keep people alive and healthy. More than \$2 million of that total will fund CMU scientists and their colleagues at the University of California Santa Cruz and the Wellcome Sanger Institute in the U.K.

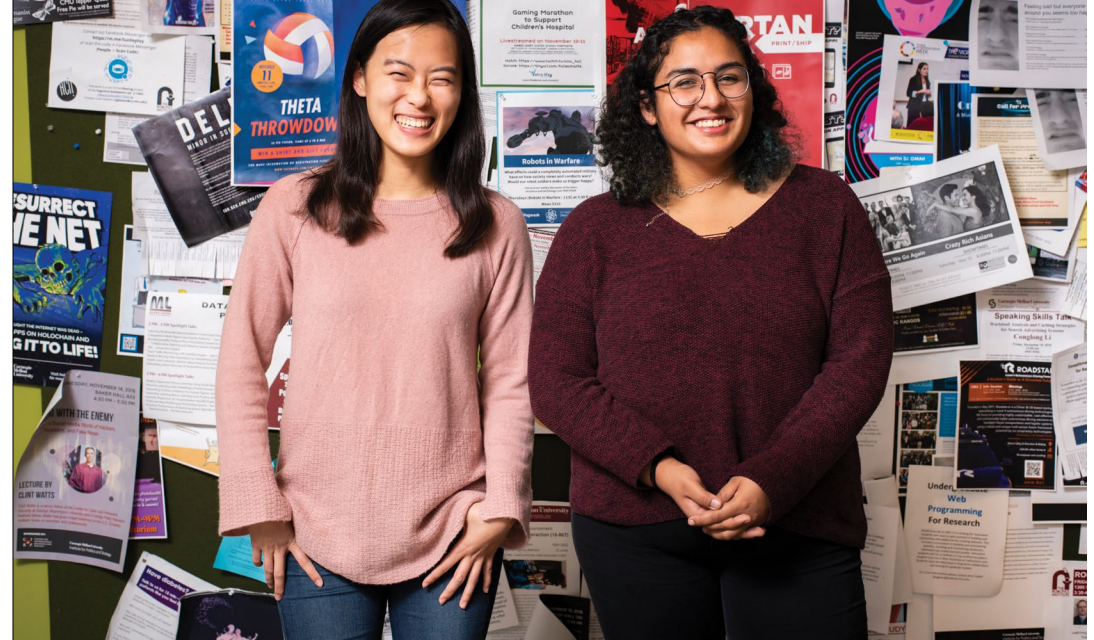
"This is really the next step in the Human Genome Project," said Ziv Bar-Joseph, a professor of computational biology and machine learning who will lead the CMU-based center. "Though the genome — the complete set of genes — is present in all cells, it's clearly doing different things in different organs and tissues. The job now is to create a map that shows which genes and proteins are activated in each part of the body."

Beyond Deep Fakes

Carnegie Mellon researchers have devised a way to automatically transform the content of one video into the style of another, making it possible to transfer the facial expressions of comedian John Oliver to those of a cartoon character, for example, or to make a daffodil bloom in much the same way a hibiscus would.

The technology has the potential to be used for so-called “deep fakes” — videos in which a person’s image is inserted without permission, making it appear that the person has done or said things that are out of character. But the technology offers pluses that outweigh its deep-fake potential. It can rapidly transform large amounts of video, making it a boon to movie production. It can also be used to convert black-and-white films to color and to create content for virtual reality experiences. It could also be useful for developing self-driving cars that can navigate at night.

“I think there are a lot of stories to be told,” said Aayush Bansal, a Ph.D. student in the Robotics Institute who presented the method in September at ECCV 2018, the European Conference on Computer Vision. “It’s a tool for the artist that gives them an initial model that they can then improve.”



Bajpai, Wang Earn Stehlik Scholarships

The School of Computer Science has named current seniors Serena Wang and Tanvi Bajpai (pictured above left to right) the recipients of its 2018 Mark Stehlik SCS Alumni Undergraduate Impact Scholarship. The award, now in its fourth year, recognizes undergraduate students for their commitment and dedication

both in and beyond the classroom. Wang and Bajpai have made noteworthy contributions both to SCS and the computer science field in general. And they both plan to continue doing so after graduation.

Bajpai, who hails from West Windsor, N.J., said that she felt out of place in high school, surrounded by students who were less passionate about learning and more preoccupied with padding their resumes. She cultivated her interests in computer science by participating in programming competitions at the University of Pennsylvania, and attended a summer program at Princeton called the Program in Algorithmic and Combinatorial Thinking. Her exposure to discrete math and algorithm design fueled a desire to pursue computer science at CMU, where she was pleased to finally be surrounded with peers, faculty and mentors who were all just as passionate about the field as she was.

With their senior years nearly half completed, both students are focusing on their post-graduation goals. Bajpai hopes to pursue a Ph.D. in theoretical computer science and Wang will join an enterprise data infrastructure startup called Akita. Both students are incredibly grateful for the resources and opportunities that were theirs for the taking in the School of Computer Science.



How Can AI Improve Humanitarian Assistance and Disaster Relief?

Artificial intelligence for humanitarian assistance and disaster relief was in the spotlight in August, as leading minds from academia, industry and the federal government met at CMU for the Artificial Intelligence and Autonomy for Humanitarian Assistance and Disaster Relief Workshop. At the event, the Office of Naval Research and CMU signed an Education Partnership Agreement to encourage and strengthen studies in the scientific disciplines, particularly as they relate to humanitarian assistance and disaster relief.

"We've brought in some of the best roboticists and technologists in the world, with the single goal of keeping people safe during disasters," said SCS Dean Andrew Moore. "Technology to save lives is inspiring for everyone in the AI field."

New Platform Will Help Students, Researchers Rapidly Solve Real-World Problems

SCS students are collaborating with the digital media intelligence firm Meltwater to advance the state-of-the-art in artificial intelligence education and research using the company's AI platform.

Meltwater, which has the world's most diverse collection of open and licensed data, has opened its underlying AI platform, Fairhair.ai, to Carnegie Mellon and other select universities. The Fairhair.ai platform allows students and faculty to create, connect and organize web-scale information to generate real-time analytics that support decision-making from online data. CMU will use Fairhair.ai in graduate AI courses and as a resource for the university's data science and AI research community.

"Sharing access to real-world data helps students, researchers and data scientists solve real-world problems more rapidly," said Eric Nyberg, a professor in the Language Technologies Institute. "In addition to realistic real-time data sources, the platform also includes AI modeling and integrated cloud computing to greatly simplify the process of building and optimizing new web-scale analytics."



New Computational Method Puts Finer Point on Multispecies Genomic Comparisons

A new computational tool could help geneticists better understand what makes a human a human, or how to differentiate species in general, by providing more detailed comparative information about genome function.

In a report published in the journal *Cell Systems*, researchers led by Associate Professor of Computational Biology Jian Ma describe their Phylogenetic Hidden Markov Gaussian Processes model, or Phylo-HMGP, which analyzes functional genomic data. They used the model to study a new dataset for DNA replication timing across five primate species, including humans.

"With Phylo-HMGP, we can look at each functional genomic value as a continuous signal — showing the actual activity level rather than just a rough level estimate," said Yang Yang, a Ph.D. student in computational biology and first author of the study. "In this way, we're able to fully utilize the data that have been gathered."



Bosch, CMU Partner To Accelerate AI Research

Bosch in North America has launched the Bosch Center for Artificial Intelligence (BCAI) Research Lab in Pittsburgh, which will conduct advanced research in artificial intelligence technologies. As part of the new lab, Bosch will provide more than \$8 million to sponsor research at Carnegie Mellon through 2023. Assistant Professor of Computer Science Zico Kolter will direct the research projects at CMU, in addition to contributing to Bosch's global R&D efforts while still remaining active on the faculty.

"We're excited to establish BCAI Research in Pittsburgh with Zico Kolter as part of the long-term collaboration between CMU and Bosch," said Christoph Peylo, global head of BCAI. "CMU, with its tradition as one of the leading institutions in AI research, is an important pillar in BCAI's mission to develop safe, robust and secure AI for Bosch products and services."

Mon Valley Breathe Cams Document Sources of Visual Pollution

CMU's CREATE Lab is using a new network of cameras to provide 24-hour monitoring of visible air pollution in the Mon Valley. The high-resolution cameras are trained on three plants in U.S. Steel's Mon Valley Works, and their images give residents and government officials a way to detect, monitor and document sources of smoke and other visible air pollution.

The Mon Valley Breathe Cams join the CREATE Lab's existing Breathe Cam network. Since 2014, the system has provided panoramic images to help people in the region visualize what the air over southwestern Pennsylvania looks like on different days and under different atmospheric conditions. The new cameras are being deployed in response to citizen reports to the SmellPGH app, which helps people share reports of unpleasant or peculiar smells with each other and the Allegheny County Health Department.

"Many of the smells being reported appear to emanate from the Mon Valley, based on the report locations, prevailing winds and prevalence of pollution-trapping temperature inversions in the river valley," said Randy Sargent, who directs Breathe Cam for the CREATE Lab. "We hope to get a better idea about what is happening by observing three of the valley's largest pollution sources."



CMU Hosts Inaugural World Artificial Intelligence Competition for Youth

Carnegie Mellon teamed up with the Pittsburgh-based educational company WholeRen Education LLC to host the inaugural World Artificial Intelligence Competition for Youth, or (WAICY 2018), at the end of July. The week of workshops and the final competition demonstrated that students of all ages can understand artificial intelligence if given the proper equipment and training. The competition attracted 130 in-person participants ages 4 to 18, some from as far away as China, Sweden and England, while an additional 20 teams competed remotely from around the world.

Names in the News

Shannon Lin



Jessica Hodgins



Abhinav Gupta



Zachary Quinto



Justine Cassell



Bernhard Haeupler, Louis-Philippe Morency and Jean Yang



Luis von Ahn



Ran Zhao



Elizabeth Board, Elizabeth La, Sashank Gogula, Mehar Sawhney and Jennifer Chou

Shannon Lin, a communication design and HCI double major, was named a 2018 KPCB Fellow in Design.

SCS faculty members **Bernhard Haeupler**, **Louis-Philippe Morency** and **Jean Yang** have received 2018 NSF Faculty Early Career Development awards.

Jessica Hodgins, professor of robotics and computer science, will lead the Facebook AI Research lab in Pittsburgh, where she will be joined by Associate Professor of Robotics **Abhinav Gupta**. Both will remain on the faculty.

An August episode of the HISTORY series "In Search Of," hosted by College of Fine Arts alum **Zachary Quinto**, included a segment shot at the Robotics Institute that featured Assistant Research Professor of Robotics **Nathan Michael** and robotics Ph.D. student **Ellen Cappo**.

Project Olympus Director **Kit Needham** has been named an Alexa Innovation Fellow and LTI Ph.D. student **Ran Zhao** will continue for a second year as an Alexa Graduate Fellow as part of Amazon's expanded Alexa Fellowship Program.

SCS alum **Luis von Ahn**, a consulting professor in the Computer Science Department and co-founder of the language-learning platform Duolingo, has won the prestigious 2018 Lemelson-MIT Prize — a \$500,000 award that honors mid-career inventors.

Associate Dean of Technology Strategy and Impact **Justine Cassell** delivered one of three keynote speeches at this year's Grace Hopper Celebration of Women in Computing Conference, and also gave a talk on how the #MeToo movement is helping women recognize systemic sexism in tech.

CMU students **Elizabeth Board**, **Elizabeth La**, **Sashank Gogula**, **Mehar Sawhney** and alumna **Jennifer Chou** converted a local speech-language pathologist's language creation aid into the Sentence Mosaics iPad app.



Creatively Consider

YOUR LEGACY

Thanks to the generosity of our alumni, parents and friends, Carnegie Mellon University has a distinctive legacy of INNOVATION AND IMPACT that will stand for generations to come.

As you plan your financial and philanthropic future, please consider giving to CMU, where the latest giving opportunities can be tailored to achieve your goals and provide vital support to our students and faculty.

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waskjoebull@andrew.cmu.edu
412-268-5346



As Andrew Moore steps down from his role as dean

and professor of computer science and robotics in SCS, and moves on to lead Google's Cloud AI efforts, it's time to look back at his legacy and to memorialize some of the brightest moments of his tenure as dean. Listing all of Dean Moore's accomplishments and the full impact of his leadership on CMU would be a lengthy task, if not impossible.

If you spend time on the fifth floor of the Gates-Hillman Center — commonly referred to as the Dean's Suite — you will hear it bandied about that Moore lives 25 years in the future. Such is his vision of the world.

Since first joining the SCS faculty in 1993 as a professor of robotics, Moore has been a visionary in embracing technology to improve people's lives. He first left CMU in 2006 to head up Google Pittsburgh where he bolstered the region as a tech hub and a destination for CMU graduates.

Upon his return to CMU as dean, Moore combined that vision with an uncommon talent to communicate the power technology will play in all our lives. This he did exceptionally well to SCS' industry and government partners, as well as to lay audiences. Simply put, Moore's vision has enhanced Carnegie Mellon's reputation and made visible to a broader audience the depth and breadth of the world-renowned research enterprise conducted at CMU.

Not only has his leadership kept SCS steadily on its course, but Moore also expanded upon the work of his predecessors and colleagues, showing deep commitment to making SCS and the field of computer science reflect our society at large. Under Moore, we not only grew the SCS undergraduate program well past 200 first-year students for the 2018–19 academic year, but 50 percent of those incoming undergraduates are women. Traditionally underrepresented minorities in the field have new in-roads for access: programs such as the CS track for the long standing Summer Academy for Math and Science; a 3-week pre-college course in AI for students from diverse backgrounds; and support and commitment to the TEALS program — a partnership that teams a computer scientist with high schools that need instructors. The Pittsburgh region boasts the largest number of TEALS program participants outside of the Seattle area.

Moore's vision of our future requires a pressing need for outstanding and diverse talent entering the computer science profession — not only to enrich SCS and CMU, but also to create better technology that works for more people.

Most recently, Moore spearheaded CMU AI, a campuswide initiative featuring the efforts of more than 200 faculty cooperatively solving society's most challenging problems. This, in addition to CMU pioneering the first bachelor's degree in AI, displays Moore's vision.

We thank Dean Moore for his tenure and for all that he has given to enrich CMU. He has guided us to think and live in the future, and made CMU better equipped than any other place to create that future. His impact on our university community, the city of Pittsburgh, and future generations cannot be overstated.

then & NOW



2018 Donor Recognition

July 1, 2017 – June 30, 2018

With 2018 soon coming to a close, we offer special thanks to our donors for their time, engagement with CMU and the School of Computer Science, volunteerism, and donations to SCS-related funds during fiscal year 2018. We've enjoyed connecting and reconnecting with many of you, and we sincerely appreciate your ongoing or first-time support.

Legend

④ Member of CMU's Order of the May, recognizing individuals who demonstrate an extraordinary degree of loyalty and support by giving to Carnegie Mellon each fiscal year (July 1 – June 30); circled numeral indicates years of consecutive support

■ Donated to SCS-related funds during fiscal year 2018

■ Volunteered time and assistance during fiscal year 2018

Matthew Mark Aasted CS'11 ⑤ ■
Alvin Abad CMU'07 ①
Neil I. Abcouwer E'13, CS'14 ①
Aki Abekawa TPR'17 ②
Roberto L. Abello CS'02 ④
Daniel Otto Abeshouse CS'92 ■
Michael J. Abowd CS'99, TPR'99 ■
Jessica Michelle Abrahams CS'08 ■
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A'12 ⑤ ■
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Matthew Todd Adereth CS'02, S'02 ④ ■
Sara M Adkins BC SA'18 ■
Henny Admoni ■
Yuvraj Agarwal ■
Vijeyta Aggarwal INT'06 ② ■
Vinayak Agrawal CS'12 ⑤
Rukhsar Ahmedkhan ■
Kamesh Ramakrishna Aiyer CS'82
Archana Ajith CS'18 ■
Matthew Michael Aken CS'95 ④ ■
Subbanarasaia Akshintala E'12 ②
Felipe Vicente Albertao CMU'04 ⑤
Jordi Antonio Albornoz Mulligan CS'01
& Jennifer J. Albornoz Mulligan
CS'00 ⑤
Jonathan E. Aldrich
& Becky Billock ⑥ ■
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Charles Michael Allen E'64, E'65 ④ ■
Joao Almeida CS'09 ④ ■
Luis Ricardo Alonso CS'99 ① ■
Timothy Andrew Alper CS'01 ①
Ammar Alrashed CS'12 ④

James Patrick Alstad CS'91 ① ■
Alison Susan Alvarez CS'07, TPR'16 ④ ■
Terence An E'15, CS'15 ■
Joseph Anderson CS'82 ④ ■
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Zachary R. Anderson CS'04
& Christina M. Dinwoodie
CS'05, HNZ'06
Tera Andrianoff CS'08, CS'11
Teri Mae Alene Angell CS'04
& Nicholas B. Angell ④
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Abel Archundia ■
Ganesh Armugam ■
Vasilii Artemev CS'14 ■
Maunika Atmakuri CS'18 ■
Chad Atwell & Nicole Cook Atwell ② ■
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Richard Avil & Karen Mudry ④ ■
Igor Avramovic CS'08 ■
Venkateswara Rao Ayyadevara E'00 ④ ■
Ronald Bacco ■
Timothy M. Bach CS'13 ② ■
Joshua D. Baer DC'99 ② ■
Thomas William Bajzek E'66
& Diana M Bajzek S'70 ■
James Karl Baker CS'75
& Janet MacIver Baker CS'75 ④ ■
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CS'06, CS'08 ② ■
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Christopher M. Balz CMU'05 ④ ■
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& JoAnn Lynn Balzer S'65 ■
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Jaden Alyssa Barney ■
John Bartucz ■
Daniel James Bartz CS'06 ■

Derek James Basehore CS'12
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Parag Harish Batavia CS'97, CS'99 ■
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Nathaniel Robert Bauernfeind CS'08
& Gabriela Bauernfeind ④ ■
Derek Lee Beatty CS'93 ④ ■
Luther Beegle ■
Curtis Andrew Beeson CS'95
& Brenda Batenburg ④
Jenny Belardi ⑤ ■
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& Pamela Bell ⑦ ■
Randy Michele Bender CS'83 ④
Shelly R. Bensal CS'18 ② ■
Andrew D. Benson CS'17 ■
Curt Alexander Bererton CS'00, CS'04
& Mathilde Elodie Pignol
CS'02, CS'04 ④ ■
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& Maria C. Yamanaka E'96 ⑥ ■
Gayatri Bery CS'87 ④ ■
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& Lisa W. Betz ④ ■
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Krishna Mohan Bheemanadham
E'12 ④ ■
Rishav Bhowmick CMU'10 ■
Zhiqiang Bi S'96, CS'02, S'02 ④ ■
Zoltan Ferenc Biacs E'12 ⑥ ■
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& Kimberly Ruane Biagioli A'87 ② ■
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& Emily M. Bianchini ④ ■
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Sarah Bien CS'18 ■
Jeffrey Bigham ⑤ ■
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& Cheryl B. Wehrer
DC'90, TPR'96 ④ ■
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Tiffany Chang Black CS'03 ④ ■
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Arnold N. Blinn CS'87
& Leslie Brewer ④ ■
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Joshua J. Bloch CS'90 ④ ■

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Manuel Blum & Lenore Blum ① ■
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& Audrey A. Bode HNZ'07
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Ananth Vikram Bommireddipalli CMU'17
Amelie Marie Bonde CS'14 ■
Renee Marie Bonzani ④ ■
Sunya Paul Boonyatara CS'04, S'04 ④
Christopher George Bossilina
CMU'04 ⑥ ■
Youcef Bourai & Zineb Nait-Mohamed ■
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& Robin A. Bowers CS'85
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Charles D. Brandt ■
Florence Braszo ■
Brian Patrick Bresnahan CS'91 ⑦ ■
Michael Broglie ⑤ ■
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H. Benjamin Brown E'67, E'77
& Carole G. Brown MM'67 ④ ■
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Jordan M. Brown CS'18
Kevin Quentin Brown CS'80 ④
Anushka Nethisinghe Brownley CS'02 ■
Christian Gale Bruggeman CS'12, MET'14
& Colleen E. Casey DC'14, DC'15 ■
Diana Bucco ■
Ben Buchwald CS'03, MET'06 ④ ■
Taraz E. Buck CS'13
Raluca Budiu CS'99, CS'01
& Mihai-Dan Budiu CS'00, CS'04 ②
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& Julie Buffington Banks ④ ■
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Steven J Bunting CS'18 ②
Rachel Burcin HNZ'07 ■
Anthony J. & Mary Burlando ④ ■
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Kenneth & Carol Burns ■
Amanda Burrows ■
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& Susan L. Campbell CS'88 ④ ■
Ben Cadieux ■
Glenn E. Cahoon CS'87
Linda G. Cai CS'10
Margaret Westbay Calder MM'66 ④ ■

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Rhonda Campanella ■
Murray Scott Campbell CS'87
& Gina Ruth Campbell
DC'83, DC'86 ② ■
Kyle Erik Campbell CS'09 ■
Feng Carl Cao & Weiyu Zhao ■
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& Anita D. Carleton S'83 ⑤ ■
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Jeffrey Wesley Carlson CS'10 ■
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& Kelly Carothers ⑥ ■
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Erin Cawley ■
Daniel Cedarbaum & Caryn Jacobs ■
Laura Lynne Cercone CS'86 ② ■
Iliano Cervasato ② ■
Yujie Cha CS'16 ■
Prasad R. Chalasanani CS'91, CS'94 ④ ■
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Arthur Xi Chan CS'05 ④ ■
Pui Pui Chan & Kin Ung ■
Shu Kit F. Chan CS'99 ■
Girard Chandler CS'87 ②
Arthur Li-Hang Chang CS'02
& Shuhong Li ② ■
Huan Chang CS'01, S'01 ② ■
Robert Joseph Chansler CS'83 ⑤ ■
Laurie Chappell
Aniruddh Chaturvedi CS'15 ④ ■
Connie Chau CS'04 ④
Alexander R.W. Cheek A'09 ■
Chuanfei Chen & Xiang Zhou ■
Daniel Hwei-Kan Chen CS'11 ⑦ ■
Guo Chen CS'12 ⑤ ■
Jiawei Chen CS'12 & Qingxi Wang ⑤
Jie Chen E'17
Jieshi Chen HNZ'12 ■
John Bradley Chen CS'94 ④ ■
Mei Chen CMU'07 ■
Ping Chen E'03, E'06, CS'06 ④
Po-Han Chen CS'05 ④
Qianying Chen CS'17
Ran Chen CS'14 ② ■
Robert Chia-Hua Chen CS'74 ④
Stephanie Chen DC'15, CS'16
Tianming Chen CS'17 ② ■
Xuejing Chen CS'07 ■
Yirng-An Chen CS'98 ④ ■
Carol Cheng CS'16 ■
Haoran Cheng CS'14 ④ ■
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Vicki Cheung CS'11 ④ ■
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Anthony Joseph Chivetta CS'12 ⑦ ■
Je Suk Cho CS'11 ■
Linda Chock ⑤ ■
Seo Hyun Choo CS'17, CS'17
Nivedita Chopra CS'15 ② ■
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Salahuddin Choudhary CS'07 ⑥ ■
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& Jennifer L. Cerully CS'04 ④ ■
Yahui Chu CS'17
Richard Lee & Nancy Chung CS'93 ⑥ ■
Yuan Chi Chung ■
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HNZ'10 ④ ■
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& Lauren Coblenz E'07, E'08 ④ ■
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& Rebecca Chestnut Cohen
Raymond M. Cohen CS'06 ②
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& Deborah J. Cohn TPR'91 ■
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& Laura Comer ④ ■
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& Christina M. Conitzer A'04
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& Lisa Cornack ■
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 Sandeep Nag Dadi CS'15 ②
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 & Melissa Daimler ① ② ③
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 S'85, CS'94 ② ③
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 & Frances Dannenberg ② ③
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 Shapan Dashore CS'16
 Akshay Sameer Dave TPR'11, CS'14 ④ ⑤
 Pratyush Dave E'09
 Andrew Malcolm Davenport CS'98
 & Kathleen Davenport ① ②
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 Bradley Jay Davis CS'84 ④
 Elizabeth McBryde Davis CS'14 ⑤ ⑥
 Ian Lane Davis CS'96 ⑥
 Jay L. Davis CS'87 ①
 John E. Davis CS'13 ⑤ ⑥ ⑦
 Paul J. Davis CS'13, CS'14 ④
 Josh de Cesare E'96, CS'96 ① ② ③
 Drew Dean CS'92 ② ③
 Benjamin T. Debebe CS'16 ②
 Nathan Anthony DeCarolis TPR'17 ② ③
 Kevin George Delafield CS'94 ④ ⑤
 Jaroslav A. Delapedraja CS'99 ④ ⑤
 Frank E. Denbow CS'08 ⑥
 Jason Deng CS'11
 Shi Ping Deng ② ③
 Siqi Deng CS'17
 Barbara Anne Denny CS'81 ①
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 Ravi Pradip Desai CS'97 ② ③
 Salvatore Domenick Desiano CS'99
 David Luke Detlefs CS'90
 & Ann F. Detlefs ②
 Virginie Marie-Pierre Devaux
 CS'86, TPR'88 ⑤
 Raj Dhaka ⑥
 Rishik Dhar E'15 ② ③
 Ishwar & Meenu Dhull ⑥
 Stephen A. & Paula DiAntonio ⑥
 Yifu Diao CS'12
 Roger Dice ⑥
 Scott Richard Dietzen
 CS'84, CS'88, CS'92 ② ③
 Rinaldo E. DiGiorgio '78
 & Margaret DiGiorgio ④ ⑤
 Joan E. Digney ⑥
 Duo Ding CS'14 ⑤ ⑥ ⑦
 Twum Kwesi Djin E'11 & Denise Twum ⑥
 Sharif Faris Doghmi CS'14 ② ③

Marc Daniel Donner CS'82, CS'84 ②
 Christopher David Dornfeld
 CS'01, DC'01 ① ②
 Kevin Joseph Dowling S'83, CS'94, CS'97
 & Mary Jo Dowling A'83 ② ③
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 Richard P. Draves CS'94
 & Martha Moran Draves E'86 ⑤ ⑥
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 Binglei Du INI'16
 Delun Du CS'18
 Kavin Du CS'01 ① ②
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 Michael Thomas Duke E'04, MET'06
 & Tara Katherine Duke ④ ⑤
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 & Connie Deighan Eaton DC'99 ① ②
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 & Louise Carol Eklund S'70 ④
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 & Frances Mary Modugno CS'89, CS'95
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 Fei Fang ⑥
 Liduo Fang CS'12 ⑥
 Ming Fang CS'15 ②
 Ruba Fang & Lin Huang ④ ⑤
 Yicheng Fang CS'17 & Shiyao Qu CS'17 ⑥
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 Henry Farley ① ②
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 Marc Fasnacht S'98, CS'02, S'03
 & Vidhya Ramachandran S'96, S'99
 ① ②
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 & Rebecca Cassler Fearing E'99 ② ③
 William Fecke ⑥
 Christina Fedele ⑥
 Julian Feldman TPR'59 ④ ⑤
 Richard Dean Fennell CS'75 ① ②

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 Arnold Hill Fero E'79 ⑥
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 & Elizabeth Ferrall-Nunge CS'07 ⑥
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 Chiara Figallo ⑥
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 Peter Finley ⑥
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 Alex Fishman CS'06 ② ③ ④
 Jason Nelson Flinn CS'01 ①
 Wing Yu Christine Fok CS'07 ⑥
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 Mike Formica ⑥
 Camille F. Fournier CS'01
 & Christian Kaiserlian ② ③ ④
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 & Talya Lazerus DC'14, DC'17
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 Diane Frank ④ ⑤
 Edward H. Frank CS'85
 & Sarah Gay Ratchye A'83 ② ③
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 & Keiko Horiguchi DC'93 ⑥
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 Dan Patrick Freeman CS'11 ⑥
 Dayne Brian Freitag CS'98
 Eduardo Gustavo Frias CS'94 ④ ⑤ ⑥
 Andrew Michael Friedland CS'10 ④
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 & Amanda Galeotti ⑤ ⑥ ⑦
 Chen Gao CS'13 ⑥
 Chuan Gao & Yihui Zhan ② ③
 Jingkun Gao E'14, CS'16, E'17
 Lili Gao TPR'13, CS'16, TPR'16
 & Tianjiao Dai ④ ⑤
 Tan Gao E'12
 Aseem Vikas Garg CS'03, DC'03
 & Anjali Garg CS'03
 Philip M. Garrison CS'15, S'15 ④
 Charles S. Garrod CS'06, CS'08 ② ③
 David Thomas Gauthier CS'99 ①
 Tanay Gavankar CS'13 ④ ⑤
 Nikhil J. George CS'04 ② ③
 Darren Robert Gergle CS'05, CS'06 ① ②
 Hartmut Geyer ⑥
 Joseph Andrew Giampapa CS'98
 & Anna Maria Berta ⑤ ⑥ ⑦
 Silvia M. Giampapa ⑥
 Philip Wells Gianfortoni CS'09, CS'12 ④

Gregory Dean Gibbons CS'73 ④ ⑤
 David Stephen Gillen CS'92 ⑤ ⑥
 Michael D. Gillinov CS'87, DC'95, DC'96 ②
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 Ioannis Gkioulekas ⑥
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 Brighton Godfrey CS'02
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 Kevin Michael Goldsmith CS'92 ⑥
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 Brian Goler ⑥
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 Hannah Vera Gommerstadt CS'16 ④ ⑤
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 Richard Thomas Goodwin
 CS'93, CS'96 ④ ⑤
 Sakshi Gopal CS'18 ② ③
 Nanda Kishore Gopalabhatla E'10 ②
 Monisha Gopalakrishnan CS'17 ② ③
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 CMU'16 ② ③
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 & Judith Borcz ① ②
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 & Marina Fedner CS'07 ④ ⑤
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 Steven Jay Greenfield E'71
 & Joyce D. Greenfield ④ ⑤ ⑥
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 & Pamela C. Griffith ② ③ ④
 Susan Grisham ⑥
 Klaus Peter Gross CS'89, CS'91
 & Lori Juergens Gross E'90, E'94 ②
 Samuel C. Gruber BC SA'14 ④
 Brian Matthew Grunkemeyer CS'98 ④
 Haijie Gu CS'11, CS'13 ② ③
 Ana R. Guerra de Menezes CS'10 ② ③
 Ralph Jeffrey Guggenheim DC'74, CS'79
 & Marsha Guggenheim ⑤
 Yady Guitana CS'05 ④ ⑤
 Junius A. Gunaratne CS'02 ① ②
 Qian Guo E'06
 & Mengning Fran Zhou S'10 ⑥
 Steven Guo DC'18 ② ③
 Aman Gupta CS'16
 Ashwin Gupta CS'06
 & Ady Gupta A'06, DC'06 ④

Bhavana Gupta CS'11 ②
 Pravir K. Gupta CS'05 ⑤ ⑥
 Rohan Gupta CS'17 ②
 Satish Chandra Gupta CS'79, CS'82
 & Sharon Elsbeth Edwards TPR'82 ⑥
 Varun Gupta CS'06 ④ ⑤ ⑥
 Venkatesan Guruswami ⑥
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 Antonio Guzman CS'14
 Hana Tabassum Habib INI'15 ② ③
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 & Rebecca A. Hamlen ①
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 Jessica Hammer ⑥
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 & Emily Hamner CS'02 ② ③
 Mei Han CS'01 & Wei Hua ④
 Philgoo Han CS'11 ② ③
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 Jessica Harada ⑥
 Samuel Pollock Harbison CS'80 ①
 Mor Harchol-Balter ⑦ ⑧
 Nicholas Andrew Harper CS'11 ⑥ ⑦
 Erik D. Harpstead CS'14, CS'17
 & Kelly Anne Rivers
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 Christopher Harrison CS'13
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 Kenneth Harvey ⑥
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 Chaozhen He & Peiming Li ⑥
 Jiping He CS'12, DC'12 ②
 Wangzi He CS'14, CS'15 ② ③
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 Charles L. Hedrick TPR'73, CS'75 ①
 Ahmed Said Hefny CS'15, CS'18 ②
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 Don Eric Heller S'71, CS'77
 & Molly Dannels Heller S'73 ② ③
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 James D. Herbsleb ⑥
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 & Lingga Herman ⑥
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 Whitney Georgina Hess CS'04, DC'04 ② ③
 Bruno Hessel CS'10 ②
 Allan Heydon CS'92 & Dina Berkowitz ⑤

Estherose Heyman ⑥
 Susan Karen Himrichs CS'92, CS'95 ④
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 & Pamela Torres ② ③
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 & Allison N. Hoch DC'06 ② ③
 Harry Hochheiser ② ③
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 & Diana Hsien
 Goang-Tay Hsu CS'93 ④ ⑤
 Jefferson Hu E'01, E'01, CS'01 ⑦
 Norbert Y. Hu CS'02
 & Jenny Lo CS'01 ④ ⑤
 Qinyu Hu CS'18
 Yanping Hu & Weijia Nie ② ③
 Ginger Huang HNZ'92
 & Xuedong Huang ② ③
 Haoyuan Huang E'16 ②
 Junyu Huang CS'17 ② ③
 Xiaoqi Huang CS'15
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 Robert Lee Hunter CS'06 ⑥
 Thomas F. Hursten E'52 ② ③
 Jeffrey T. Hutzelman CS'98
 Anthony L. Iams CS'87
 & Christine M. Rosen A'88 ⑦
 Soshi Iba E'95, E'96, CS'04 ②
 Jacob Imola CS'18 ⑥
 Savina Naomi Imrhan CS'07 ⑤ ⑥ ⑦
 Dmitry Ivanyuk CS'15
 Howard Ives ⑥
 Dana Hausman Izenson CS'88
 & Martin D. Izenson ② ③
 Joseph L. Jackson S'91
 & Dawn Marie Jackson DC'93 ⑥
 Daniel A. Jacobs E'13, CS'13
 Richard & Janet Jacobs ③ ④
 Alan P. Jaffe CS'18 ② ③
 Senthil Jagadeesan ⑥

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 Andres I. Jager CS'06
 & Lyndsey Jager E'12 ①
 Adesh & Sudha Jain ■
 Usamah Jamaludin CS'05 ⑥
 Pooyan Jamshidi Dermani ■ ■
 Joseph Jasek ■
 David R. Jefferson CS'80 ④ ■
 Merritt Jenkins CS'17
 R. Daniel Jenkins ⑩ ■ ■
 Barbara K. Jensen CS'00 ④ ■ ■
 Michael Jeon CMU'07 ■
 Filipa Jervis CS'08 ③ ■
 Peng Jia CS'02 ① ■ ■
 Yan-Bin Jia CS'93, CS'97 ④ ■
 Jiandong Jiang & Zhiying Li ■
 Sandy Jiang CS'18 ② ■ ■
 Chun Jin CS'02, CS'06 ■
 Di Jin CS'16 ② ■
 Liuyu Jin CS'18, S'18, S'18 ■
 Xiaohan Jin CS'17
 Zhenlan Jin CS'05 ■
 Todd Jochem CS'93, CS'96 ■
 Hope W. Johansen CS'01 ③
 Alexandra L. Johnson CS'14 ⑤ ■
 Craig Karl Johnson CS'97 ⑫
 David C. Johnson CS'87 ④
 Heather N. Johnson HNZ'10 ⑤ ■
 Howard Wayne Johnson
 & Elisabeth Adams Johnson ④ ■
 Shane Jones ■
 Maitreyee Joshi CS'18 ■
 Eric C. Kadehjian CS'01 ⑥ ■ ■
 Edwin Bruno Kaehler CS'77 ②
 Michael Kaess ■
 Michael Steven Kahn CS'12 ⑤ ■
 Jacob G. Kalberer CS'06 ■
 Dirk Lee Kalp S'73 ⑫ ■
 Chitra Malini Kalyanaraman CS'04 ⑦ ■
 Arnold A. Kamis CS'87 ⑩ ■
 John Kang CS'13 ④ ■
 Sing Bing Kang CS'92, CS'94 ⑥
 Joshua D. Kangas CS'13
 Poornima Kaniarasu CS'13 ⑤
 Jeremy B. Kanter DC'09 ② ■
 Joel & Ricki Kanter ⑩ ■
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 Anukul Kapoor CS'97
 & Dana C. Siler E'98 ④ ■ ■
 Kanishk Karanawat CS'16 ②
 Kevin M. Karol BC'SA'16 ■
 Shruti Kataria CS'12, DC'12 ② ■
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 Andrew Joseph Katona CS'07 ⑤ ■
 Ruth Joyce Kaufman E'80 ⑩ ■
 Divyansh Kaushik ■ ■
 Shailesh Ravindernath Kaushik E'11

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 & Rebecca Foster ⑫ ■
 Michele L. Kee CS'87 ⑩
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 & Shweta Kelkar ②
 Sean V. Kelly CS'04 & Eve Chen CS'04 ■
 Michael Kenney ■
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 Manpreet Singh Khaira CS'91 ②
 Afshan R. Khan TPR'91 ■
 Serge V. Khersonsky CS'00
 & Sonya M. Khersonsky S'99 ④ ■
 Alexander & Irina Khutoretsky ■
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 Stephen Killourhy ② ■
 Jin-Oh Kim CS'92 & Hee-Jae Kwun ④
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 Chang Hyuk Kim CS'96
 Jin Seop Kim CS'12 ① ■ ■
 Myung Soo Kim CS'12 ■
 TJ Kim CS'01 ⑫ ■
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 & Jennifer Kimmett ⑩
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 Christopher William Kissell ■ ■
 James Jay Kistler CS'93 ⑩ ■ ■
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 Brian Kjersten ② ■
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 Suzanne Kleiman ■
 Michael Kleyman ■
 Carey Kevin Kloss E'95, E'97 ⑤
 Frederick Colville Knabe
 CS'91, CS'95 ⑩ ■
 Jason Christopher Knichel E'08, CS'08 ■
 Heather Knight CS'13, CS'16
 Andrea M. Knight Dolan DC'04, CS'05
 Craig Alan Knoblock CS'88, CS'91
 & Claire Margaret Bono CS'88 ■
 Heather Mary Knopf TPR'93 ■
 Tuscan Arthur Knox CS'09, DC'09 ■
 Myung-Joo Ko CS'04 ⑤ ■
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 & Mary J. Koes E'02, CS'02, CS'04 ■
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 David William Kohlbrenner CS'11
 & Nina Chen ④
 Paul William Kohlbrenner CS'84
 & Marianne Elise Vakiener
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 Ram Konduru TPR'93
 & Pavani Konduru Reddy
 TPR'00 ② ■ ■
 Xiaoxiao Kong CS'14

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 & Eakta Jain CS'09, CS'12
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 Jack Paul Philip Kosaian ■
 Corey Louis Kosak CS'93 ■
 David Scott Kosbie CS'90 ⑤ ■
 Rachel Kositsky CS'16
 John Richard Koslow CS'82 ⑩
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 Amar Kota CMU'04 & Ivana King ■
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 & Donna M Kovacs
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 Ganesh Kumar CS'07 ③ ■ ■
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 Hwan Jun Kwon CS'07 ■
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 Aapo Tuomas Eerikki Kyrola CS'14, CS'14
 Yen La CMU'06
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 Shook-Tsang Lai ⑩ ■ ■
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 & Eileen T. Landay ⑩ ■
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 & Helen Laroche A'07 ⑫ ■
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 & Kristina M. Lamothe Lauwers
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 Chen Lee E'99 & Morten Welinder ② ■ ■
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 Dongryeol Lee CS'05, S'05 ③
 Han Lee CS'07 ④
 Ilsun Lee CS'06
 Janet C. Lee CS'08 ③
 Peter Lee & Susan L Lee HNZ'95 ④ ■
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 & Jill F. Lehman CS'87, CS'89 ⑫ ■ ■
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 & Wendy Leiserson ① ■
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 & Kisha DeSandies Lester ② ■
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 Bruce Wallace Leverett CS'81 ⑤
 Lorraine S. Levin ② ■ ■
 Roie Levin ■ ■
 Roy Levin CS'77 & Jan Thomson ④ ■ ■
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 & Grace A. Lewis CS'01 ⑩ ■ ■
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 Chao Li CS'15 ② ■
 Guanjie Li CS'15 ②
 Hechao Li CS'16 ■ ■
 Jing Li & Jun Lu ■
 Lucy Li CS'11 ⑥ ■
 Nancy Li CS'17 ■
 Peilun Li CS'17
 Ruiqing Li & Shanguang Huang ② ■
 Tan Li CS'18 ■
 Weichen Li CS'18 ■
 Wendy Li ■ ■
 Xiangtian Li E'17
 Xiao Li MET'14 ■
 Xinchun Li & Xiaowen Mang ② ■
 Yiming Li CS'05
 Yu-Fang Li ■
 Yuling Li ■
 Yushan Li & Guanghao Liang ② ■
 Zeyang Li CS'10 ■
 Zeyuan Li CS'13 ④ ■ ■
 Zhipeng Li E'13 ②
 Zhizhong Li CS'14 ■
 Zhuo Li CS'18 ■
 Wang Liang CS'14 ■
 Jenny Liao CS'15 ■ ■
 Scott Libert ■
 Jeanie Libutti ■
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 CS'13 & Junyun Tay E'14, E'16
 Goldy Go Lim INI'17 ②
 Isaac Lim CS'14 & Yuyang Guo CS'15 ②
 Jack Hang Lim CS'03
 Kelvin Chenhao Lim CS'05, CS'08
 & Margaret Szeto A'07, CS'07 ① ■
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 & Jerene Z. Yang CS'12, S'12 ④ ■
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 Weihao Lin CS'09 ① ■ ■
 Yibin Lin CS'13 & Yu Gong CS'13 ⑤ ■
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 Cong Liu CS'12 ⑤ ■ ■
 Dong Liu INI'13 ■
 Dongyu Liu CS'16 ■
 Felix C. Liu ■
 Han Liu CS'12 ■
 Jimin Liu TPR'02
 & Zhen Shan TPR'02 ⑩ ■ ■
 Juedou Liu CS'16
 Karen Liu CS'10 ④ ■ ■
 Liu Liu CS'10 ④ ■ ■
 Xun Liu TPR'16 ■
 Yancheng Liu CS'16 ■
 Yingchao Liu CS'13 ■
 Yufeng Liu S'99, CS'03, S'03 ④
 Zihao Liu CS'16 ■ ■
 Zongge Liu S'15, CS'17
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 & Jessica Livanos ② ■ ■
 Wan Lo ■
 Doug Locke CS'86 ⑩
 Stuart Renwick Locklear CS'99 ⑩ ■
 Yee Chuan Loh CS'03, TPR'05 ① ■
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 Ralph Leslie London S'60, S'64 ⑫ ■
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 Yucheng Low CS'08, CS'10, CS'13 ⑤ ■
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 Peter John Lund CS'14 ② ■
 Adriel A. Luo CS'18 ■
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 & Yuko Lynch ■
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 Geoffrey Lyon ■
 Chongshen Ma CS'16 ■
 Cong Ma CS'17 ■ ■
 Yifei Ma CS'13, CS'17
 Patricia A. MacKiewicz ■
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 CS'92, CS'97 ② ■ ■
 Kenneth John Magnes CS'93 ⑩ ■
 Joseph Mahan ■
 Jamshid Mahdavi S'86, S'88
 & Karen Capri Fabrizio CS'92, CS'95 ■
 Aravindh Mahendran CS'14 ⑤
 Austin Patrick Maher CS'85 ①
 Madhavi Maheshwari CS'03 ■
 Pranav Maheshwari CS'16 ②
 Asra Mahmood CS'18 ■ ■
 Khalid & Safia Mahmood ④ ■ ■
 Alyssa Mahram ■
 Judy Mai CS'18
 Kai Zhen Mai CMU'05 & Shuai Quan ■ ■
 Sutapa Maity E'12
 Suvrajit Maji CS'12 ③
 Mun-Thye Mak CS'09 ⑤ ■
 Vincent Howe Mak CS'98
 & Ru-Chun Amy Fuh S'97 ⑩ ■ ■
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 Donna Mithra Malayeri CS'05, CS'09 ⑥
 David Maltz CS'01 ⑥ ■
 Naju George Mancheril E'06, CS'06,
 CS'07 & Rowena Mancheril ② ■ ■
 Nivedhitha Manjappur
 Narayanaswamy CS'12
 Rahul Manne CS'17
 Peter J. Marino CS'14
 Victor Manuel Marmol CS'11, E'13 ⑦ ■
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 Chris Martens CS'08, CS'15 ⑤ ■
 Benjamin Thomas Martin TPR'18 ② ■ ■
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 & Jacqueline Martin
 Erik Michael Martin CS'05 ⑩ ■ ■
 Nathan James Martin E'13
 Philip Howard Mason S'68, CS'76 ⑩ ■ ■
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 Gregory F. Mathis CS'02 ④
 Anthony Maurice CS'11 ② ■
 Darren N. Mauro CS'98
 & Kimberly Joyce Sims DC'98 ■
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 & Erin Marie May S'10 ④ ■
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 & Stephanie Y. Lin CMU'05 ⑩ ■ ■
 James Lewis McCann CS'10
 Daniel McCarriar CS'00
 & Margaret E. Schervish CS'13 ① ■ ■
 Mary Ann & Bill McCollough ① ■ ■
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 & Robert McCollum ⑫
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A'00, MET'01 10 ■
Luke W. McCullough CS'00
& Jodi M. Kurtz DC'99 2 ■
Kent D. McElhattan ■
Edward McFowland
DC'09, HNZ'09, HNZ'13, CS'14, HNZ'15
Patrick F. McGehearty CS'80 12
Charles John McGuffey 2 ■
Andrew Abraham McGuier CS'09
& Natalie S. McGuier S'10 4 ■
Andrew R. McHugh CS'16
Kathleen Mcintyre ■
David M. McKeown 5 ■
Laurie Lee McPherson CS'85 5 ■
Maija E. Mednieks CS'14 5 ■
Brendan R. Meeder CS'07, CS'15
& Ariel R. Levavi S'07 12 ■
Patrick Meehan CS'84 4 ■
Siddharth Mehrotra CS'11 ■
Carl N. Meister CS'00 4
Andrew O. Mellinger CS'10 5
Christina M. Melucci ■
Robert Abraham Melvin CS'17
Shahan Ali Memon CMU'17
Michael Grey Merideth CS'05, CS'09 4
Seth Merrin
Nichole C. Merritt 2 ■
Phillip Daniel Michalak CS'98 12
Dylan B. Mikus CS'14 2 ■
Victor Joseph Milenkovic CS'88 2 ■
Lauren Violet Milisits E'13, CS'14 2 ■
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Ashley McKnight Miller CS'04 11
Kevin C. Miller CS'01
& Rebecca Leigh Miller E'04 ■
Lori J. Miller CS'00 & Scott Miller ■
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Parker Henry Mills CS'04, S'04, S'11 5
Rachel H. Min S'17, CS'18 4 ■
Ei Ei Min Thu HNZ'09 ■
Edwin Miranda E'10 4
Jeffrey Scott Mishler CS'94 6 ■
Julian K. Missig CS'06, DC'06
& Alice Ching CS'06 5 ■
Stefan Mitsch ■
Andrew P. Mittereder CS'14 4 ■
Roman W. Mitz CS'00
& Kelli Ireland 4 ■
Kenneth Lee Modesitt CS'69
V. Joseph Mohan CS'80, CS'84
& Shantha Ramaswami Mohan
TPR'82, TPR'85 4
Sidhanth Mohanty CS'18 ■
James Mohr 2 ■
Patrick Michael Moise CMU'07
Sara Monaco ■

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& Elizabeth Monroe 4 ■
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Mathew Alexander Mooty CS'11 2 ■
Deryck Austin Morales CS'02, CS'06
& Natalia T. Guevara
CMU'03, HNZ'05 ■
Kyle J. Morelock A'15 ■
Anne Moroney TPR'00 ■
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& Hana H. Morris
CMU'06, DC'06 ■
James Morris S'63
& Susan Morris MM'66 ■
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Jack Mostow CS'81 & Janet T. Mostow ■
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Jordan Mroziak ■
Linyang Mu CS'16 2
Mohith Reddy Muddasani CS'13
Aditya Mukherji CS'11 ■
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James Mulholland CS'11
Stefan Klein Muller CS'15 4 ■
Ketan D. Mulmuley CS'85
Rob R. Murcek CS'13 4 ■
Steven Douglas Murch CS'86 2 ■
Michael J. Murphy CS'17 4 ■
Timothy & Sue Murphy 5 ■
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& Sreelakshmi M. Dhulipala ■
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John Karl Myers E'82 2 ■
Allison Marie Naaktgeboren CS'08 2 ■
Lee R. Nackman ■
Anushaa Nagarajan CMU'05 11 ■
Patricia Nagle ■
Reggie V. Nair E'11 6
Amal R. Nanavati CS'18 ■
Srinivasa G. Narasimhan 2 ■
Usha Narayanan CMU'07 4
Girija Narlikar CS'95, CS'99 ■
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CMU'05
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& David Karl Neely E'81
Philip Andrew Nemecek CS'95
& Melinda L. Nemecek E'97 2
Karen Nesbitt ■
David Nicholas Nespoli CS'93 ■
Edward W. Neubecker CS'02 11 ■
David J. Neville CS'10 2
Noel Marie Newell 11 ■

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Jiang Ni CS'04, CS'07 2 ■
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Maya Nigrosh CS'03, A'07
Frances Jen-Fung Ning
E'02, CS'02, E'03 6 ■
Alex Nizhner CS'01, INT'05 15 ■
Andrew Noh E'11, CS'11, E'12 5
Michael J. Nollen CS'04 6 ■
Robert Louis Nord CS'92 7 ■
Ariel Christina Norling CS'15 2 ■
Donna Norling 4 ■
Carol Lucile Novak CS'92
Steven Michael Novick CS'09, TPR'10
& Ariel Gold Novick 10 ■
Mathew D. Nulph CS'16 2 ■
Charles Senti Nyame CMU'05, DC'05 2
Matthew J. O'Brien CS'01, S'01 2
Kevin Thomas O'Connell
& Meghan Coughlin 4 ■
Michael O'Day ■
David R. & Helen C. O'Hallaron ■
John Andrew Ockerbloom
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Arsa Oemar CS'05, TPR'10 4 ■
Paul Taylor Ogilvie CS'03, CS'10 7 ■
Jean Hyaemin Oh CS'09 2 ■
Kyung Chul Oh CS'03, CS'06 4 ■
Ronald Bert Ohlander CS'75 4
Koustubh D. Oka 11 ■
Yogesh K. Oka CS'04
& Ripple Sharma 12 ■
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DC'10, CS'15, CS'17 4 ■
Ayobami Olubeko CS'14 2
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David R. Orr CS'14 5
Marcel Oyuela-Bonzani CS'18 ■
Berend Ozceri E'95, E'99 4 ■
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Hilary Packer CS'94 10 ■
Vasudeva Pai Melgongolli CS'14 4 ■
Scott Pakin CS'92 4
Shriphani Palakodety CS'14 2
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Ashutosh Pandey ■
Ippokratis Pandis INT'04, E'12 ■
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Michael Konstantinos Papamichael
CS'15 4
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& Suzanne Papinchak 11 ■
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Ankur Prashant Parikh CS'12, CS'15 2 ■

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Bryan Jeffrey Parno E'05, E'10
& Diana Marwick Seymo Parno
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Darshan Patil CS'18
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& Ashley Williams Patton 5 ■
Manfred Paulini ■
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5 ■
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Andrew Pavlo ■
John Edward Peabody CS'11 ■
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Lingjuan Peng CS'12
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CS'07 4 ■
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& Ria S. David DC'90, DC'99
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Marko Petkovsek CS'91 4
David Pfeffer E'13 2
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& Nancy Marie Pfenning S'79, S'85 ■
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Todd E. Phillips S'02, CS'09 4 ■
Satidchoke Phosaard CMU'03 2 ■
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Ivan Sergeevich Pistov TPR'17 4
Hunter Alexander Pitelka CS'11 6
Clifford D. Platt CS'98
& Tiffany P. Platt E'01 4
Cheryl N. Platz CS'02 11 ■
Andre Platzer 4 ■

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& Lori Roland-Plonski ■
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& Heather Poladian ■
Brandon Polcawich ■
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Zania Susan Pothan CS'13 2
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Jakub Poznanski CS'11
& Anna Konyukhova CS'12 4
Bodicherla Adit Prakash CS'11, CS'12 ■
Ritu Prasad ■
Adarsh Prasad CS'17
Ravi Prasad E'12 & Shylaja Prasad ■
George Walter Price ■
Greg Price CS'06 & Margaret Barusch 4
Keith Edward Price CS'77 11
William Robert Price CS'74 ■
Paige Pritchard CS'16 ■
Jared Pryor CS'11
& Lilian Ngobi TPR'17 2
John M. Przyborski CS'14 4
Robert J. Punkunus CS'01 11 ■
Predrag Punosevac ■
Jianing Qian CS'18 2 ■
Liangsheng Qian CS'04 10 ■
Long Qin CS'13, CS'13 & Yanan Chen ■
Angela Qiu CS'18 4 ■
Yan Qu DC'94, CS'01 12
Trisha Quan CS'10 2 ■
Siong Kar Quek CS'00, TPR'00 4
Mariena E. Quintanilla CS'05
& Jose Quintanilla 7 ■
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Sameer Qureshi CS'01 ■
Paul Raff CS'04, S'04, S'05
& Audria C Stubna S'06 11
Venkataramana Rajagopalan ■
Ananya T. Rajgarhia CS'18 ■
Bharadwaj Ramachandran CS'17 2 ■
Sricharan Amand Ramanujapuram
CMU'05 11
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Barbara J. Ray 15 ■
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Scott Michael Raymond CS'98
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Prashant Reddy CS'12, CS'13
Rajesh C. Reddy CS'98 4 ■
Suhaas Reddy CS'17 ■

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& Carole Warner Reece
Robert Wilson Reeder CS'08 4
Douglas R. Rees S'80 & Sally Rees 11 ■
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Hexing Ren CS'17
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Travers Rhodes ■
Laura Richards ■
Andrew Richards ■
Theresa C. Richards S'90
& Charles H. Richards ■
Jane Elizabeth Richey ■
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Melitta Riley CS'07
& Matthew Riley E'08, CS'08 4 ■
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& Mark D. Davis E'07 4 ■
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& Michael A. Rivera E'07 4
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George Gordon Robertson CS'78 15 ■
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Kathleen A. Romanik CS'85 11 ■
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& Kousalya Valluripalli E'10
Paul Simon Rosenbloom
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Elan K. Rosenfeld CS'16 ■
Ronald Rosenfeld CS'91, CS'94
& Ilana Diamond ■
Michael Hayden Rosenthal CS'97 5
Stephane Ross CS'11, CS'13 2 ■
Manuel A Rosso-Llopert CS'92
& Catherine A. Llopert 12 ■
Patricia A. Rote ■
Christopher David Rotella CS'05
& Natasha Rotella 2
Isaac P. Rothenbaum CS'12
David Christian Rothenberger
CS'93, CS'96 4
Carolee Rowley ■
Deanna Rubin DC'98 2 ■
Steven Michael Rubin
S'74, CS'76, CS'78 11
Zack Rubinstein 4
Ivan Ruchkin CS'14 4 ■
Dawn Rucker ■
James J. Ruggiero TPR'96
& Noor Rosyida Sudin CS'96 ■
Charles Andrew Ruhland CS'09 ■
Joseph Martin Runhe CS'16
Emily Ruppel ■

Paul Martin Russo CS'86
& Allison G. Russo AM'88 7 ■ ■
Thomas W. Ruttle CS'08 4 ■
Olatunji O. Ruwase CS'13 5 ■ ■
Michael David Rychener CS'77 4 ■
Devendra Singh Sachan CS'17
Norman M. Sadeh-Konieczpol CS'91 ■ ■
Matthew A. Saffer CS'07 ■
Engin Cinar Sahin CS'06, CS'08
& Duygu Basaran Sahin 5 ■
Sabesan Saidapet Pachai CS'06 2 ■ ■
Merline Saintil CMU'05 12 ■ ■
Majd F. & Nisrine Sakr ■
Jevan D. Saks CS'03
& Ling Xu CS'04, CS'08, CS'11 10 ■ ■
Shirley J. Saldamarco ■
Matthew Salim DC'18 ■ ■
Tuomas W. Sandholm
& Christina Fong 2 ■ ■ ■
Sandeep Kumar Sanku CMU'16
Javier Orlando Santisteban Rosemberg
CS'13 & Beatriz Maeireizo
Marlene & Jose A. Santos ■ ■
Abulhair Saparov CS'17
Matthew Jacob Sarnoff CS'08 ■
Shigeru Sasao CS'09 ■
Mahadev Satyanarayanan CS'79, CS'83
& Deborah C. Kelly HNZ'94 25 ■ ■
James Benjamin Saxe CS'78, CS'86 11 ■ ■
Alejandro Alberto Schaffer CS'83, S'83 2 ■
Steve R. Schaffer CS'01, S'01 4 ■ ■
William Schatz 20 ■ ■
Steve Scheller ■
Henry Koewing Schenck CS'86
Steven J. Schlesinger CS'73
Matthew Isaac Schnall CS'11, S'11 ■
Joshua P. Schnarr CS'06 4 ■
Janice S. Schneekloth CS'01, CS'03
& Timothy K. Schneekloth CS'03 11 ■
Edward Anton Schneider
S'70, CS'76 4 ■ ■
Henry Will Schneiderman
E'90, CS'00 ■
Arthur T. Schooley E'54
& Jean Ward Schooley MM'55 17 ■ ■ ■
Kyle J. Schriver CMU'02, DC'02
& Michelle Schriver 11 ■ ■
Jeffrey J. Schroder CS'08 4 ■
Brian J. Schuster CS'99 4 ■
Peter Martin Schwarz CS'79, CS'84 14 ■
Elizabeth Marie Schweinsberg
INI'05 4 ■ ■
James David Scott E'62 & Alice Scott ■
Ross Edward Scroggs CS'74 4 ■
Arthur Todd Sedano
CS'96, CS'99, E'17 4 ■ ■
Raphael J. Segal CS'15

Ashwin C. Sekar CS'18 ■
Vyas Sekar CS'10 2 ■ ■ ■
Natarajan Senuvasan CMU'08 4 ■
Kumar P. Setty CS'07 2 ■ ■
Karim A. Shaban CS'08, TPR'12 3 ■ ■
Ilari Alexander Shafer CS'13 5 ■ ■
Clyde H. Shaffer CS'13 ■
Ankur H. Shah CS'06 2 ■ ■
Michael Ian & Julie V. Shamos 4 ■ ■ ■
Kumar Shaurya Shankar CS'14 ■
Edwin Shao TPR'09 4 ■ ■
Paul Y. Shao CS'00 4 ■
Jason Michael Sharp CS'10 4 ■ ■
Sushuma Shashikumar ■
Mary M. Shaw CS'72
& Roy Richard Weil E'70 4 ■ ■ ■
Sergey Alexander Shchukin CS'05 4 ■ ■ ■
Matthew Sheby CS'99 7 ■
Eugene Yi Cheng Shen ■
Pegeen Shen CS'04
Qian Shen E'01, CS'01 4 ■ ■
Andrew D. Sheng CS'13 5 ■ ■ ■
David Lawrence Shepard CS'95
Mark S. Sherman CS'79, CS'83 10 ■ ■ ■
Ruben Carlos Goncalves Martins
& Justine Marie Sherry Martins 2 ■ ■
Satish M. Shetty ■
Vishwanath V. Shetty ■
Hideki Shima CS'06, CS'15
& Mie Shima 4 ■ ■
Byoung-Chul Shin CS'07 10 ■
Michael J. Shin CS'18
Rachel Springly Shipman CS'06 ■
Changning Shou 2 ■ ■
Timothy J. Showalter CS'98 4 ■ ■ ■
Susan Katherine Shrack CS'92
& Gregory Kipp Shrack E'94 ■
Jefferey Allen Shufelt S'90, CS'93, CS'96
& Stacey Lynne Jacobs
TPR'90, TPR'93 21 ■
Heung-Yeung Shum CS'96
& Ka Yan Chan 4 ■ ■ ■
Matthew Abram Siegler E'95, E'99 ■
Robert J. Siemborski CS'03
& Jennifer Kathryn Smith
CS'03, MET'05 12 ■ ■ ■
Mark Brian Silverman CS'97 4 ■
Alexander Gardner Silverstein CS'10 2 ■ ■
Melanie Simko 2 ■ ■ ■
Benjamin Roy Simmons HNZ'18
& Lauren Marie Simmons ■
Reid Gordon Simmons ■
Robert J. Simmons CS'09, CS'12 6 ■ ■
David Anthony Simon
E'87, CS'93, CS'97 2 ■ ■
Avesh C. Singh CS'13, CS'14 2 ■ ■
Ayman Jot Singh CS'11 ■

Sanjiv Singh CS'90, CS'95 ■
Tanmay Sinha CMU'06, CS'06, TPR'14 ■
Shafeeq Sinnamohideen E'00, CS'10 11 ■ ■
Sarjoun Skaff CS'01, CS'07 ■ ■
Robert M. Skalecki CS'04 2 ■ ■
Elizabeth Howard Slate
CS'87, DC'88, DC'91 15 ■
Donald J. Slater 16 ■ ■
Sean Timothy Slattery CS'98, CS'01 ■
Daniel D. Sleator ■ ■
Leeyat Slyper CS'16 ■
Linda Smith ■
Lisa Marie Smith CS'00
& Joshua J. Smith E'00 4 ■ ■
Lori A. Smith CS'85, DC'92 11 ■
Stephen C. Smith CS'15
Sylvia J. Smith ■ ■
Walter R. Smith CS'87 ■
Aaron Butler Snook CS'12
Jeffrey M. Snyder S'89 25 ■ ■ ■
Judy Soga & Tjoen Phoa 4 ■ ■
Ander Alberto Solorzano CS'16
Selvamraju Somalraju CS'13 5 ■ ■
Neema Soman ■
Satya Venkata Ravi Sriram Somanchi
HNZ'13, CS'15, HNZ'16
Norman Keith Sondheimer S'68
& Emily Susan Sondheimer
S'69 25 ■ ■ ■
Hyun Ah Song CS'18
Mingyang Song CS'14 4 ■
Sheng Song CMU'07
Xiangyu Song CMU'18 ■
James J. Soracco A'07, CS'07 2 ■ ■
Kyle Sossi ■ ■
Miguel Sousa CS'09 4 ■
James Thomas Spagnola CS'09 2 ■ ■
Tammo Spalink CS'97 ■
Alfred Z. Spector 19 ■ ■ ■
Byron G. Spice 12 ■ ■ ■
Daniel John Spoonhower CS'09
& Katherine Ann Copic 5 ■ ■ ■
Vivek Sridhar CS'15 2 ■
Anuroop Sriram CS'13
Srishti Srivastava CS'18 ■ ■ ■
Gloriana St. Clair 20 ■ ■ ■
Matthew K. Steedle CS'11 6 ■
Peter A. Steenkiste ■ ■
David A. Steere CS'18
David Cappers Steere CS'92, CS'97
& Jody Steere 4 ■
Mark & Sylvia Stehlik 5 ■ ■ ■
David M. Steier CS'86, CS'89
& Polina Steier 10 ■ ■ ■
Aaron M. Steinfeld ■
Christopher Ryan Stengel
CS'93, TPR'00 4 ■ ■ ■

Craig A. Stephen CS'88
& Christina Stephen 4 ■ ■
Jeffrey R. Stephenson CS'99 ■
Michael A. Stevens CS'07
& Sarah Nacey 14 ■ ■ ■
Matthew L. Stevenson ■
Diane L. Stidle 17 ■ ■
Edward Carl Stocking CS'97 2 ■
Michael & Valentina Storey 4 ■ ■
Cort William Stratton
CS'01, MET'03 4 ■ ■
David A. Strauss CS'05 11 ■
Sienna T. Stritter CS'18 4 ■ ■ ■
Tom Strong S'91, S'92 ■ ■ ■
Eric F. Stuckey CS'97
& Mia K. Markey S'98 4 ■ ■
Jeffrey Su CS'11 6 ■
Peter P. Su S'87 & Karen L. Van Dusen
CS'87, TPR'00 4 ■
Ashok Sudarsanam CS'93 ■
Bruce & Mary L. Summers 5 ■ ■
Hanqi Sun CS'18 ■ ■
Haonan Sun CS'16 & Yao Zhou HNZ'16 2 ■
Ramamurthy & Lakshmi Sunder 4 ■ ■
David Dahwei Sung CS'71
& Linda L. Ma Sung S'70 14 ■
Joshua S. Sunshine CS'13 4 ■ ■
Alan Lawrence Sussman CS'91 15 ■ ■
Robert & Alyssa Sussman 2 ■ ■ ■
Dean F. Sutherland S'83, CS'08
& Elizabeth Bellamy Sutherland
E'84 2 ■ ■
Selva Bharath Swaminathan E'12 ■
Syahrul Nizar Syahabuddin CS'97 4 ■
Katia P. Sycara & Michael Lewis 7 ■ ■
Richard Stephen Szeliski CS'88 2 ■
Priscilla H. Tai CS'18 ■ ■
Muralidhar Talapur CS'02, CS'06
& Chitra Prabhakar
Ken Tamagawa CS'08, TPR'08 ■
Hima Tammineedi CS'18 ■ ■ ■
Desney Swee-Leong Tan CS'04 4 ■
Ming Tan CS'89, CS'91 & Minghui Xie 5 ■
Weimin Tan CS'14
Donald Tang CS'03 ■
Hua Tang CS'16
Zhimin Tang CS'16 ■
Wei Tao & Hong Xie 2 ■ ■
David Read Tarditi CS'97 15 ■ ■
Sannan Tariq CMU'17
Aaron J. Tarnow CS'05 2 ■
Daniel J. Tasse CS'08, CS'15, CS'17 6 ■
James A. & Mary Beth Tawa 6 ■ ■
Stephen J. Tawa CS'12
Anita A. Taylor CS'07 14 ■ ■ ■
Krishan A. Taylor CS'10 4 ■ ■
Michael David Taylor CS'11, CS'16

Omari D. Teel CS'02 6 ■
Suzanne Teele ■
Debra L. Tekavec 11 ■ ■ ■
Sujata Telang CS'00, TPR'10
& Rajendra Telang 11 ■
Ronald Y. Teng CS'01 & Sandy Yong 6 ■ ■
Leong Hwee Teo CS'99, CS'99, CS'11 5 ■ ■
Thomas Terrill CMU'08 10 ■
James Robert Teter S'72
& Elizabeth G. Aby DC'71, TPR'80 41 ■ ■
Avadis Tevanian CS'85, CS'88 4 ■
Brenda S Thayillam CS'18 ■ ■ ■
Brian E. Thompson CS'06
Kathleen Ong Thompson CS'01
& Brandon Thompson 15 ■ ■ ■
Sang Tian CS'13 ■ ■ ■
Ryan Tibshirani 2 ■ ■
Scott Phillips Tietjen CS'82 10 ■
Daniel Jon Tilkin CS'99, S'99 16 ■ ■ ■
Daniel Ross Tobias CS'86 41 ■
Karen Tolchin ■
Gilman Edwin Tolle CS'03
& Diane Marie Loviglio BHA'05 5 ■ ■
Preston H. Tollinger CS'00
& Irene V. Tollinger CS'02 ■
Brandon Jeffrey Tolsch CS'15
Wesley J. Tom CS'02 12 ■
Anthony S. Tomasic TPR'09 ■
Paul David Tompkins CS'01, CS'05 6 ■ ■
Boriska Toth CS'03
David S. Touretzky CS'79, CS'84 ■
William Benjamin Towne CS'12, CS'17 ■
Jonathan Douglas Tran E'06, CS'06 6 ■
Jerome Traugher ■
Nathaniel B. Travis CS'15
Pucktada Treeratpituk CS'01, CS'06
& Atcharya Mahatchavaroj CMU'03
Nadine Marie Tronick CS'92 2 ■
Benjamin Tsai
CS'05, TPR'05, CS'06, E'11 ■
Tom Tseng CS'18 ■ ■ ■
Yanghai Tsin CS'03 2 ■
Emily Y. Tsui CS'17 ■ ■ ■
Yulia Tsvetkov CS'13, CS'16 ■
David Tu CS'10 7 ■
Richard & Lorena Tucker 4 ■ ■ ■
Mark Turcsanyi ■
Christopher L. Tuttle CS'02 4 ■ ■
Britta Kathleen Ulm CS'14 2 ■
Marc Jonathan Unangst E'97 ■
Martin Unsal ■
Rohit Jayasankar Upadhaya CS'15
Vignan Uppugandla CMU'15 4 ■
Chad Ray Urso McDaniel CS'95
& Tina Urso McDaniel DC'94 2 ■
Lydia J. Utkin CS'15 ■

Vijay Sai Vadlamudi CS'04, TPR'13
& Sailakshmi Vadlamudi ■
Sandeep Rao Vadlaputi Manikanta CS'15
David & Daphne Vail 4 ■ ■
Vansi Vallabhaneni CS'14
Justin Chris Vallon CS'94
& Mary Vallon 2 ■
Jacob A Van Buren CS'18 ■ ■ ■
Grant S. Van Nostrand CS'08 ■
Walter van Roggen CS'82 4 ■
J. Michael Vandeweghe CS'02 4 ■ ■
Timothy A. Vaughan CS'13 4 ■
Maria Manuela Veloso CS'89, CS'92
& Jose M.F. Moura 16 ■ ■ ■
Robert Anthony Veltre CS'91, TPR'00 6 ■
Mark Andre Ver CS'97 2 ■
Kyle E. Verrier CS'13 4 ■ ■
Aleksandar Veselinovic CS'02, E'04 2 ■ ■
Jean-Philippe Vidal CS'89 ■
Sumeet S. Vispute E'04 ■
Jorge L. Vittes CS'04 5 ■ ■
Mauricio Vives CS'98
& Laura H. Vives DC'97 11 ■ ■ ■
Andreas Vogt ■
Robert Irwin Voigtman CS'09, TPR'10
& Janice Lee Voigtman E'13 4 ■ ■ ■
Jocelyn P. Popni A'00 6 ■ ■
Richard M. Voyles CS'97 4 ■ ■
Brian A. Wachowicz CS'16 ■
Sudarshan Wadkar CS'14 ■
Angela Z. Wagner DC'00, CS'05
& Michael D. Wagner E'98, E'02 ■ ■
Robert Alan Wagner CS'69 10 ■
Alexander Waibel E'81, CS'86
& Naomi Aoki Waibel
CS'95, CS'97 ■ ■ ■
Ann Wald CS'98
& Aaron Wald CS'98 7 ■ ■ ■
Jacob Charles Walker CS'14, CS'18
Eugene S. & Hui Boon Wan 15 ■ ■
Nathan Lap-Yan Wan E'11, CS'11 4 ■
Jianwei Wang & Lin Wu ■ ■ ■
Carl Wang CS'06 11 ■
Guo-Shiuan Wang CS'07 2 ■
Haohan Wang CS'14
Haoyu Wang CS'15
Jiajun Wang INI'13 2 ■ ■
Jue Wang CS'05 11 ■ ■
Lei Wang E'15, CS'15 4 ■
Mengzhi Wang CS'05 2 ■
Michael W. Wang CS'14
Richun & Daisy Wang 2 ■ ■
Robert Y. Wang CS'04 4 ■
Shimin Wang CS'16 ■
Silun Wang CS'16
Wanjun Wang CS'03 & Lili Ma
William Wang CS'10, CS'11 2 ■

Ye-Yi Wang DC'92, CS'98 ①
 Yuchun Peter Wang E'04
 & Abra Wang ① ②
 Yujun Wang CS'16 ②
 Yun Wang CS'12 ①
 Mary C. Ward CS'85 ①
 Benjamin Ward-Cherrier ①
 John Lawrence Warwick CS'97 ② ③
 Michael E. Wasson CS'07, S'07 ②
 Kang-Lin Steve Wei TPR'95
 & Wendy Wen-Yu Liau INT'94 ① ②
 Ming-Yu Wei INT'17
 Ariana Y. Weinstock CS'17 ②
 Amy Lynn Weis ①
 Lee Elliot Weiss E'76 ①
 Scott Abraham Weiss CS'92 ⑤ ⑥
 Jon Bruce Weissman CS'84 ①
 Justin David Weisz
 CS'03, CS'07, CS'09 ① ② ③
 David A. Weitzman CS'07 ① ②
 William Claude Welch CS'95 ①
 Carl K. Wellington CS'05 ①
 Connie S. Wen CS'14 ①
 Dacheng Wen E'16 ②
 James Wallace Wendorf CS'87
 & Roli Garg Wendorf CS'86 ①
 Zhenzhen Weng CS'16, S'16 ② ③ ④
 Peter Eunsuk Weon TPR'17 ①
 Andrew Michael Wesie CS'11 ① ②
 Jay H. West E'88, CS'94
 & Amy Sakasegawa
 Alex Robert N. Wetmore CS'96 ①
 David S. Wettergreen CS'87, E'89, CS'95
 & Dana R. Wettergreen S'87 ①
 Rebecca Sophia Wettergreen ①
 Colin Robert Willson White CS'16 ② ③
 David W. White E'87, E'89 ①
 Matthew Jason White CS'96 ①
 Spencer M. Whitman CS'07, E'12 ② ③
 Joseph Skeffington Wholey
 S'84, CS'89, CS'91 ① ②
 Andrew P. Widdowson CS'05 ① ②
 Kelly M. Widmaier ①
 Mary Reed Widom & Michael Widom ② ③
 Jill Cherie Wieck
 & Vincent Wieck ② ③ ④
 Karl A. Wieman CS'88 ①
 Philip & Sarah Wildenhain ② ③
 Stephanie Williams ①
 Edward D. Williamson CS'16
 Todd Andrew Williamson
 S'91, S'91, CS'94, CS'98
 Max Willsey CS'16 ① ②
 Gail D. Wilson CS'16 ⑤ ⑥
 Wesley Wayne Wilson CS'85 ②
 John David Wise E'84
 & Tara Lee Wise DC'85 ① ②

Lambert E. Wixson CS'88 ①
 Adam A. Wolbach CS'06, CS'08 ① ②
 Alan A. Wolf ① ②
 Benjamin Scott Wolf CS'10
 Hao-Chi Wong CS'95, CS'00 ⑤ ⑥
 Rebecca Wong CS'02, DC'02 ②
 Theodore Ming-Tao Wong
 CS'01, CS'04 ① ②
 Wesley Sei-Ching Wong E'11
 & Lara Wong ①
 Richard R. Wongsonogoro CS'87 ② ③
 Daniel Colin Wood CS'83 ⑤ ⑥
 James Mark Wright CS'81
 & Pamela J. Wright DC'85 ④ ⑤
 Linda M. Wright ① ② ③
 Grant Wu CS'18 ①
 Leejay Wu CS'98, CS'05 ①
 Lin Wu & Jianwei Wang ② ③
 Ningzhi Wu CS'13 ②
 Pang Wu E'11 ①
 Tian Xia CS'14, DC'14, S'14 ④ ⑤
 Junli Xian CS'10 ①
 Alex Xiao CS'17 ①
 Brian P. Xiao CS'18 ①
 Nancy N. Xiao CS'18 ② ③
 William Xiao CS'18 ② ③
 Xiao Xiao E'13
 Alex Xie CS'12 ①
 Song Xiong CS'15 ②
 Yalin Xiong CS'93, CS'95 ②
 Jiarui Xu ①
 Lawrence Xu CS'18
 Linqiu Xu & Lingling Zhai ①
 Min Xu & Luge Yang ② ③
 Ming Xu CS'99 ①
 Yixun Xu CS'16 ② ③
 Wendy Jingwen Xue CS'09
 & Benjamin Lu TPR'08
 Rohan Yadav ② ③
 Ramarao Yalamanchili E'05 ①
 Maria C. Yamanaka E'96
 Bryan Bo Yan CS'13 ② ③
 Andrew S. Yang A'01, CS'01
 Bo-Chieh Yang CS'99 ⑤ ⑥
 Dewey Yang CS'07 ⑤ ⑥
 Hanyu Yang INT'17
 James Yang CS'02, DC'02
 & Sanghi Suh A'01 ②
 Jeffrey SS Yang CS'94 ④ ⑤
 Jinyu Yang CMU'15
 Ke Yang CS'02, CS'04 ⑤
 Lu Yang CS'14
 Mengyun Yang INT'16
 Raymond Sheungil Yang CS'07
 Yang Yang CS'16
 Zizhuang Yang CS'11 ①
 Zhizhou Yang CS'15 & Jing Tong E'15 ①

Jason Ye CS'13
 Jiacheng Ye CS'17 ②
 Bennet Sze-Bun Yee CS'94 ① ②
 Chei Charles Yeh E'83
 & Mary Mannling Yeh ① ②
 Carl Edward Yeksigian CS'09
 & Alexandra M. Kontopoulos
 DC'10 ① ②
 Mark & Patricia T. Yeksigian ① ②
 Wei-Yu Yen CS'16
 Jessica Yin ② ③
 Michael Stephen Yin CS'07 ①
 Pengcheng Yin ①
 Yepeng Yin CS'16 ②
 John S. Yocca CS'87 ⑤
 Gary Dalton Young CS'98, S'98
 Gregory C. Young ①
 Hua Yu CS'98, CS'04 ② ③
 Yu Yu CS'15 ②
 Jianghe Yuan & Guichun Han ④ ⑤
 Yuehao Yuan INT'17
 John D. Zaiantz CS'01 ①
 Timothy J. Zak CS'86 & Leslie V. Zak ④ ⑤
 AnnMarie Zanger ⑤ ⑥ ⑦
 Carlos Alberto & Silvina Maria Zarate ①
 Hormoz Zarnani CS'09 ③ ④
 Yiye Zeng CS'14 ②
 Guido Zraggen CS'09 & Amelia Matzke
 Zraggen CS'07, CS'11 ① ②
 Chengxiang Zhai DC'95 ④ ⑤
 Amber C. Zhang CS'15
 Amy X. Zhang DC'14
 Chiquan Zhang E'13, E'17, CS'17
 Peng Zhang CS'12 ⑤
 Shikun Zhang CS'14, CS'17 ⑤
 Tom C. Zhang CS'15 ④
 Ying Zhang S'11, E'16, CS'16 S'16 ②
 Zichen Zhang CS'18
 Bing Zhao CS'03, CS'07 ④
 Fuyao Zhao CS'12 ④
 Jiateng Zhao CS'18 ①
 Liang Zhao CS'98, CS'01 ④
 Richard L. Zhao CS'18, S'18 ①
 Ziping Zheng CS'16
 Jingyi Zhong E'18, CS'18 ②
 Wei Zhong E'14 & Yongqing Yang ④
 Bin Zhou CS'98 ② ③
 Giulio Zhe Zhou ①
 Xinyi Zhou CS'16
 Yihuan Zhou CS'14, S'14 ④
 Eric Zhu CS'18 ④ ⑤ ⑥
 Steve Zhu CS'13
 Timothy Zhu CS'08, CS'17 ②
 Yangbo Zhu CS'08 & Betty Zhu ④ ⑤
 Yu Xiang Zhu CS'18 ② ③
 Aldo Zini HNZ'85 ①
 Mikhail M. Zlotnik CS'01
 & Liya Kopylovsky CS'01 ②
 Monte Zweben CS'85 ④ ⑤ ⑥



"Being a TEALS volunteer means using your CS passion and skills to have a lasting impact on students, teachers and schools in a big, fulfilling way."

Susan Neth
 Senior Developer, Twitter
 TEALS Volunteer

Find out more at
tealsk12.org/volunteers



TEALS volunteers work directly with classroom teachers to help them build their CS teaching capacity through yearlong support and training. You'll work with teachers and other industry professionals to help teach introductory and AP computer science curriculum and inspire the next generation of computer scientists.

TEALS courses are taught in hundreds of high schools across the U.S., and our volunteers represent over 400 different companies nationally. If you're looking for a way to give back and provide ongoing professional development, mentoring and peer support, volunteer with TEALS. Plus you'll make a lasting impact in the classroom all while having fun!

TEALS Volunteers Contribute to CS Classroom Success



Nine out of 10 teachers report increased comfort and ability to teach CS with greater independence compared to the start of the year.

86 percent of teachers and **89 percent of students** said TEALS volunteers helped them learn the CS content.

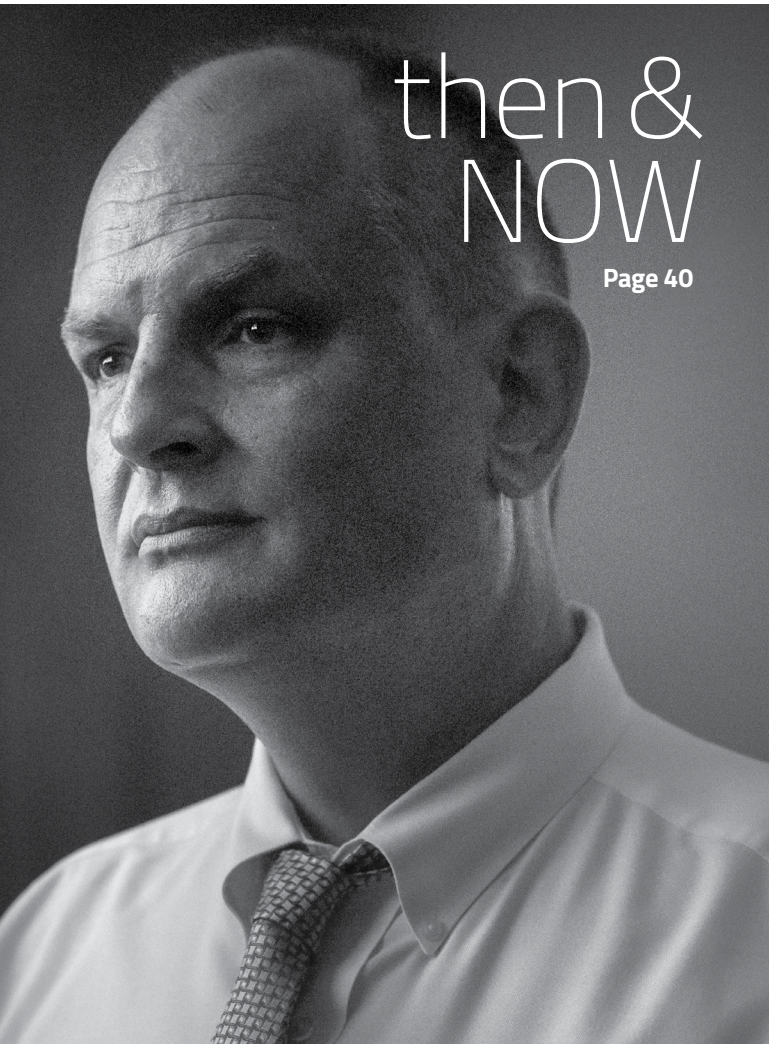
*Data from 2017 end-of-year student survey

Carnegie Mellon University
School of Computer Science

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PITTSBURGH PA 15213-3890

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calendar of events

April 11-14

Spring Carnival

April 12

MOBOT 25 / National Robotics
Week (April 6-14)

May 8

Meeting of the Minds
Undergraduate Research
Symposium

May 19

Commencement

Summer 2019

Regional Alumni Events
Locations TBA