

the LINK

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

The Drive for Autonomy

CELEBRATING THE 10TH ANNIVERSARY
OF THE DARPA URBAN CHALLENGE VICTORY

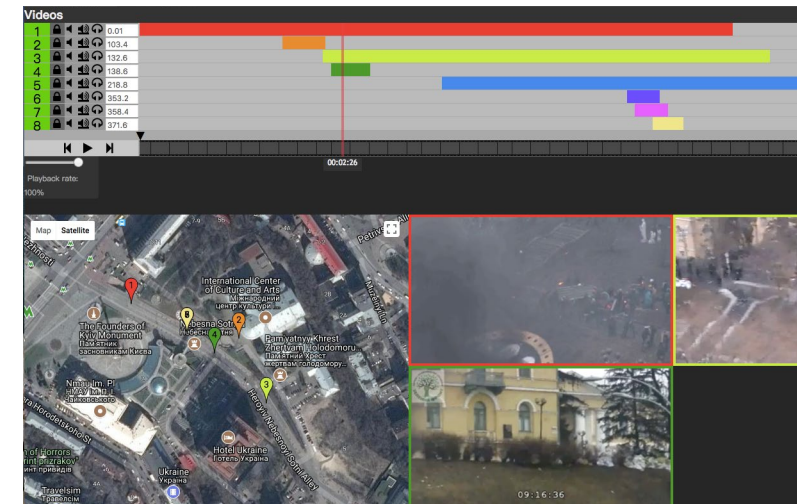
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the LINK

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.

CMU's Video Analysis Toolbox allows for easier tagging of large quantities of videos gathered in war-torn regions.



Can computers help protect human rights?

Alex Hauptmann, a research professor in the Language Technologies Institute, thinks so. Hauptmann and his team create tools that help solve the difficult problem of analyzing, processing and indexing videos captured in war-torn countries like Syria.

Viewing and hand-tagging videos collected from disparate sources to make them searchable and relational is a difficult task. Add to that the need to tag thousands upon thousands of videos, all with subtle contextual differences, and it can overwhelm humans.

Computer tools developed by Hauptmann's team help human rights professionals amass evidence against perpetrators of injustice for criminal trials. Though it's often difficult for computers to distinguish what defines torture, bombings aimed at civilians and other such crimes of war, the end goal is to make it easy to later find videos that relate to one another, gather evidence and build strong legal cases against perpetrators.

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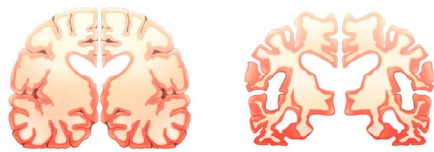
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Our Not-So-Secret Secret

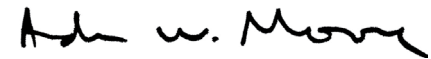
You may have read a great article this summer in the New York Times called “Pittsburgh Gets a Tech Makeover.” It hit newsstands on a Sunday in July, in the Style section of all places. None of us really saw it coming. But it had a lot to say about how the School of Computer Science has contributed to Pittsburgh’s recent boom. We don’t usually toot our own horns around here, but we’ll admit it was blush-inducingly complimentary.

Of the many wonderful things the author wrote — about our appeal for employers and collaborators like Amazon and Google, and how our projects often spill into and improve the city around us — I keep coming back to this line: “Put simply, where the tech world is going — self-driving cars; personal AI concierges; robot workers — is where Carnegie Mellon’s faculty and students have been for decades.”

It’s so true, isn’t it? The things we read in stories like the one in the Times or that we see on programs like the “60 Minutes” special on AI retell a narrative we know by heart: SCS *does* stuff. And the stuff we do and the products we create go into the world and make a difference. It’s like an unintentional secret we’ve all been privy to since our founding. And while we don’t like to brag, we don’t mind letting the rest of the world in on the secret. Now’s the perfect time for that.

The stories in this issue of The Link underscore and support all the recent hype around computer science at Carnegie Mellon. On one hand, we celebrate our history in a story about the 10th anniversary of our DARPA Urban Challenge win, while on the other we look ahead to our exciting new research initiatives and what they mean for the future. You’ll learn about how we’re working with the community to improve diversity in computer science before students even think about college, and how our researchers use computer science to understand the inner workings of our brains.

The New York Times author also wrote “perhaps the secret, underlying driver for both the economy and the cool factor — the reason Pittsburgh now gets mentioned alongside Brooklyn and Portland, Ore., as an urban hot spot for millennials — isn’t chefs or artists but geeks.” We’re happy to be those geeks. And that our secret isn’t so secret anymore.



Andrew W. Moore
Dean, School of Computer Science



EQUAL ACCESS

BRIDGING THE DIVERSITY GAP IN COMPUTER SCIENCE

Kevin O'Connell



Pittsburgh Public Schools students take part in the TEALS program to gain early access to computer science education.

Mark Stehlik thinks a lot about the state of computer science in America. And it worries him.

According to Stehlik, assistant dean for outreach in SCS, roughly 500,000 technology jobs remain unfilled in the United States. And while SCS strives each year to graduate more than 200 of the brightest computing minds, that number represents a drop in the proverbial bucket.

“The U.S. is at risk of losing preeminence in the tech economy if we don’t get on this problem ... and fast,” Stehlik says.

Alongside SCS Dean Andrew Moore and other senior college leadership, Stehlik hopes to tackle this problem at all levels: sparking more interest in students of all backgrounds prior to college, working on tricky policy issues that inhibit growth and building greater capacity in the U.S. educational system.

Computer Science for All

A large segment of U.S.-born college-bound computer science students come from well-funded high schools. They’re often the children of parents already working in technology, which makes attaining diversity in the field a difficult challenge.

Moore believes we are in danger of creating a technological hegemony in our society. “We can’t afford to have large parts of the population disenfranchised from the technological revolution we’re living in,” Stehlik adds. “It’s vitally important to change the demographics of computer science.”

To address the lack of diversity in computer science and increase the capacity of students who want to study computer science in college, SCS works hand-in-hand with the TEALS program, a partnership with Microsoft Philanthropies. TEALS recruits computer science professionals to volunteer their time with teachers and students in high school classrooms across the country that lack quality computer science education and curriculum.

According to Jonathan Reynolds, SCS outreach project manager, the TEALS program reaches across the country, but this year has expanded to eight of the nine Pittsburgh public high schools, in part because CMU graduates make up the largest group of TEALS volunteers after the University of Washington. But there is plenty of room for growth.

More volunteers equates to more students gaining access and increased capacity. “The students we engage are very capable of learning the content and understanding the material, but no one has told them that before,” Reynolds says.

Because computer scientists make more money than teachers, there is a dearth of qualified instructors. The knowledge gained in the industry never returns to the educational system — a problem that will compound as the U.S. economy becomes increasingly technology-based.

“We put this in the category of ‘wicked’ problems — those without clear beginning and end points,” says Ashley Patton, director of engagement. “And those take a lot of thoughtful tactics to avoid doing more harm than good.”



Reynolds sees growth of the TEALS program as vital. When kids get exposure to computer science at an early age, it piques their interest, and applications to college computer science programs across the country rise.

To spark further interest, CMU offers the Summer Academy for Mathematics and Science (SAMS), a precollege program that draws high school students from across the country. SAMS has offered STEM-related courses since 2001, but this past summer 36 students took courses in a new CS track, designed to simulate the rigor of attending an institution like CMU. Other universities have programs like SAMS, but CMU remains one of a few that cover costs for students who can't afford it.

"Some students come out of the program, and their decision to study computer science is absolutely crystalized by the experience," Reynolds says. "Others say 'The class was amazing, but computer science isn't for me. I'm going to go another route.' Both of those are wins for us."

Programs like TEALS and SAMS help dispel the myth that you have to be a genius to work in computer science. Obviously not everyone will go on to become computer scientists. Along the way, learning computational thinking and problem-solving skills benefits everyone — regardless of their chosen field. But demystifying the technology field, inspiring confidence and providing all students with the option to participate remain vital to the SCS outreach team.

Making Computer Science Count

Piquing student interest and building capacity for computer science might not be the most difficult parts of this wicked problem. Achieving a cohesive governmental approach to policy and convincing disparate school districts to invest in computer science must also be addressed.

Computer science teachers are often poached from their school's mathematics department. So in a zero-sum game with tightening school budgets, a principal who hires a computer science teacher often loses a math teacher. That's a tough sell to school boards, even as they recognize the advantages of educating for a growing tech economy.

"The focus has been on math and reading, and then STEM," Stehlik says. "I think the key now is putting the 'C' [of computer science] into STEM — making 'C' a first-class player at this table."

Even when school districts do hire CS teachers, most of them receive little to no training in CS certification before standing in front of a classroom. A full third of U.S. states still consider computer science education an elective, and the states where it counts as a science credit still value physics and math over computer science curriculum. Most of those CS curricula are not very good and are certainly inconsistent. Computer science does not exist on any of the college entrance exams, which inhibits potential incentives for teaching it. Since no national and few state standards exist for CS, no broadly adopted standardized textbooks have been written. And because all school districts make their own decisions, there are thousands of tiny governing bodies to try to convince. These are all large-scale challenges.

"EVEN PLACES THAT HAVE A STRONG TEACHER STILL NEED CURRICULUM AND SUPPORT FOR THAT TEACHER."

CS Academy

SCS has a history of solving big problems, and it's tackling the challenges inherent in increasing the CS workforce on many fronts and through numerous channels. SCS experts routinely speak before Congress and at all levels of government, to school boards, and to any and all potential influencers. Workforce redevelopment, a summer "Teach the Teachers" program and a variety of other outreach efforts all have their place in the equation.

But a new effort led by Stehlik and David Kosbie, associate teaching professor, tackles these problems head on. In the spring, SCS will launch a pilot program called CS Academy that will provide high-quality computer science curriculum and teacher support — all developed and chiefly maintained by CMU undergraduate students as part of a class taught by Kosbie.

According to Kosbie, the planets have aligned and the time is right.

"There's this strong consensus that high school administrators are looking to CMU to provide leadership and guidance in this area," Kosbie says. "Even places that have a strong teacher still need curriculum and support for that teacher."

CMU's backing for this program makes an enormous difference toward its success. Kosbie also notes several other elements that will help the program succeed in high schools. First, it has to be offered free of charge because many high schools are financially strapped, and it must be made available to everyone. Second, the program has to be world-class. It needs to start great and get better. Third, it has to employ automatic grading to remove the burden of marking mountains of homework each night for the teachers. And fourth, it must include embedded professional development, down to the individual exercise level. This also includes videos describing how to derive the solutions, online teacher training and summer institutes.

The CS Academy pilot launching this coming spring deploys a Python course for ninth grade students. The pilot will run in 17 school districts mostly in the Pittsburgh region, initially reaching 700 students. For fall of 2018, Kosbie hopes to grow that number five to 10 times, eventually reaching Moore's ultimate goal of one million students within five years.

"That's a home run," Kosbie says. "But we are seriously trying to hit that goal. We are making the decisions we need to do that."

After the ninth grade Python course, a slate of follow-up, second-level courses has been planned, including computational math, computational art, computational science, AP computer science test principles, and perhaps web development and robotics. Level three will be the more difficult AP Computer Science A exam and advanced topics courses. In the vision, level four — which is for very few people — will be CMU's 15-112: Fundamentals of Programming course, offered for college credit.

As an added benefit, the CMU students developing the CS Academy are gaining real-world experiential learning. "They're leading and being part of real development teams," Kosbie says. "They're working in the field with high school students and the process of developing the product for them. There's a lot of excitement in the class right now over these possibilities. There's also a lot of consternation in the class, because this is not just a class. It's not sanitized for their protection."

The CS Academy represents a huge effort to bridge an equally huge gap.

"We are going to succeed or fail in a big way, either way," Kosbie says. ■





As part of the celebration of the 10th anniversary of the DARPA Challenge victory, William "Red" Whitaker poses with a lineage of robotic vehicles developed at CMU.

CMU Celebrates 10th Anniversary of DARPA Challenge Victory

THE RACE FOR SELF-DRIVING CARS

Nick Keppler

On the day the Tartan Racing Team turned over Boss, their autonomous Chevy Tahoe, to military officials, Bryan Salesky says he felt like a parent dropping off a child on the first day of preschool.

“What’s he going to do to the other cars?” Salesky, the software lead for the team, recalls thinking. “Can he handle this? Did we raise him right?”

That moment, at a decommissioned Air Force base in the Mojave Desert in November 2007, separated theory from practice. The CMU team had built Boss with a range of capabilities specified for the DARPA Urban Challenge. The military’s Defense Advanced Research Projects Agency mandated that cars in the competition merge into traffic, avoid roadway obstacles, recognize signals like stop signs and parallel park — all without a driver. With just software and sensors, the cars had to display all the skills 16-year-olds learn to obtain a driver’s license. Until this point, the Tartan Racing Team could tweak a system when Boss faltered. Once in DARPA’s hands, Boss had to show all those abilities independently.

And it did. Among 53 collegiate robotics teams, 11 produced autonomous cars that qualified for the final rounds of the challenge. DARPA ranked those 11 by how quickly and efficiently they performed various tasks. Boss came in first, netting the \$2 million prize. The deciding factor was the road race component of the challenge, in which Boss finished 20 minutes ahead of the next competitor.

The race was a pivotal event in the development of autonomous cars. Two years prior, DARPA gathered teams, including Tartan Racing, to create cars that could drive down a desert road unaided. But Boss and its best 2007 competitors could, theoretically, drive safely down any road in the U.S., alongside human-driven and other autonomous cars. This sparked the interest of auto companies, specialty vehicle manufacturers and tech giants. CMU celebrated the anniversary of this milestone this past October with a four-day seminar, where students and faculty met with corporate sponsors looking to augment their own autonomous development — an area of research proven commercially viable by the Urban Challenge.

“Most of the world looks at that as a Lindbergh-takes-Paris moment,” says William “Red” Whittaker, Fredkin University Research Professor at the Robotics Institute and leader of the 2007 Tartan Racing Team.

By the mid-2000s, robotics had reached a point where the military was interested in developing autonomous vehicles for supply lines. Congress mandated that the Defense Department make one-third of its vehicles driverless by 2015 (a goal that proved infeasible). It wasn’t cost-effective to task a contractor with creating them. But for a few million dollars in prize money, DARPA could incentivize some of the best minds in robotics to work on the problem.

CMU researchers received the specifications for the 2007 challenge 18 months before the event. They secured a site off campus in a decommissioned steel mill near the Monongahela River. Dubbed “Robot City,” the area had a make-shift racetrack and a few trailers where key personnel set up desks. It gave them enough space to test a roboticized SUV on a daily basis. The sponsor, GM, donated the Tahoe and named

it “Boss” after the nickname of GM research and development founder Charles F. Kettering.

Boss utilized years of research on sensor recognition. “Someone had done work on how to stay on traffic lines and some on how a vehicle would pick up on signs,” says Salesky. “It was a matter of cobbling it all together and seeing it in action.” About 70 to 80 CMU faculty had some involvement in developing the software or hardware.

“It was months of devising and switching out systems,” says John Dolan, principal systems scientist and professor in the Robotics Institute, “and then we had to freeze the software at a certain point and only work on fixing bugs. ... I don’t think we knew it would work at race time. I don’t think you ever really know in robotics.”

For the challenge, DARPA made the former Air Force facility look like a NASCAR track, with a JumboTron-like screen and sports announcers. “It was a better setup than previous Grand Challenges,” recalls Spencer Spiker, a principal research engineer at the time. “There was a lot more to see for the crowd. A lot of people came out.”

Declaring a winner also had an echo of sports. “They counted down the top competitors by rank,” says Salesky. “When we heard the second-place

Chris Urmson, technology lead for the 2007 Tartan Racing Team, stands with Boss, the winning autonomous vehicle in the DARPA Urban Challenge.



winner was someone else, we started cheering. We knew then.”

Weeks later, Tartan Racing Team leaders attended a reception with DARPA officials in Washington, D.C. Dolan recalls that Tony Tether, then head of the agency, told them the private sector would take over advancement. “It was not good timing,” says Dolan. “There was a huge slump in the auto industry.”

After digging out from the recession, auto and tech manufacturers poured billions into getting autonomous vehicles ready for public roads. Members of the 2007 Tartan Racing Team have been at the forefront of this effort. Salesky is CEO of Argo, a tech startup into which GM has invested \$1 billion. Chris Urmson, the technology lead for the 2007 team, spent years in Google’s autonomous division and is now heading his own startup, Aurora.

“I think it taught me to have a sense of pride,” says Spiker, who works for a company developing autonomous helicopters. He says his work is “similar to grand challenges, in that you know it will take years to work out the bugs and you keep patience.”

Uber established a pilot program for self-driving cars in Pittsburgh, where human drivers maintain ultimate control but the vehicles mainly navigate

with autonomous sensors. This Uber division has consistently hired CMU robotics veterans.

The first-place trophy meant CMU has been first in line for advanced military research projects, says Whittaker.

Dolan, who continues to study robotics at CMU, says the work ahead for autonomous vehicle developers is still staggering. GPS isn’t reliable in all conditions and there isn’t a localized tool that can consistently measure distances of an inch or two, necessary for everyday transportation. Cars will have to be programmed around different country’s driving customs and habits. Then there is the human element. People will have to learn to trust and share the road with driverless cars. The insurance industry will have to measure their risk potential. It’s a long way until there’s a self-driving car in every middle-class driveway, but Dolan can see that future.

“I think there will be more pilot programs like the one in Pittsburgh,” he says. “Someday, they’ll be all over a city and the residents will get to a point when they don’t even think about them anymore, and then it will be time.” ■

Eye Gaze Controls Robotic Assistive Devices

The Eyes Have It

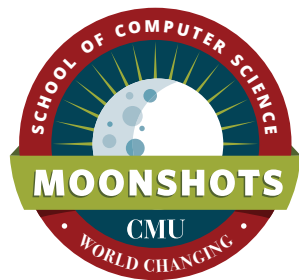
Linda K. Schmitmeyer

The key to developing truly assistive robots — those that can navigate the unpredictable and often disorderly world in which humans live — may lie in the earliest and most basic form of human interaction: eye gaze. Carnegie Mellon Assistant Professor Henny

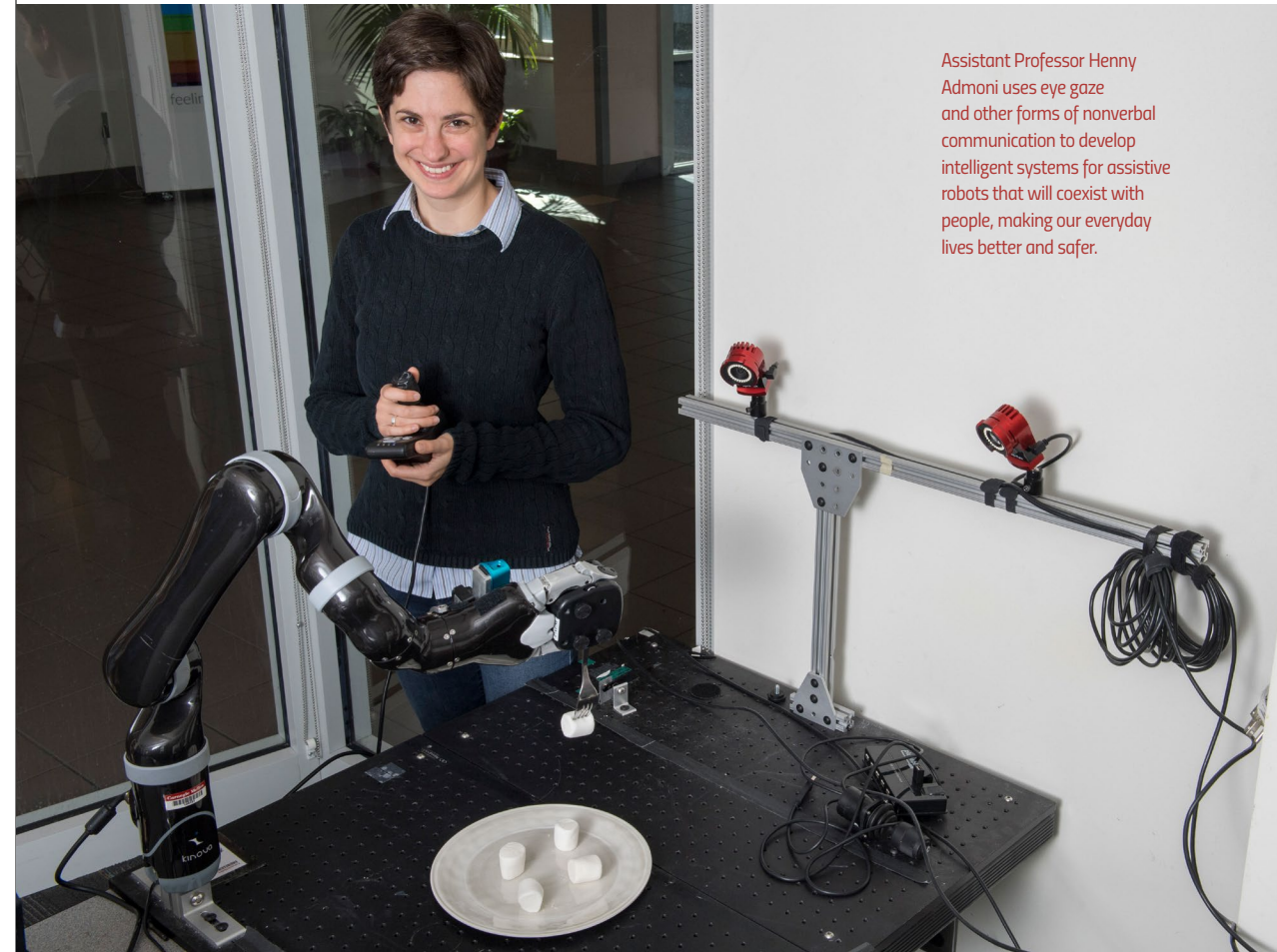
Admoni uses eye gaze and other forms of nonverbal communication to develop intelligent systems for assistive robots that will coexist seamlessly with people, making our everyday lives better and safer.

The field of robotics is in the throes of a massive transition, from robots that function autonomously in such settings as factory floors to those designed to function harmoniously with humans in their homes. Carnegie Mellon researchers remain at the forefront of developing intelligent systems for our daily lives that will simplify routine tasks and, more importantly, enable the elderly and people with disabilities to maintain independence.

But for robots to be really helpful to people, they have to understand people, says Admoni, who applies insights from her earlier work in cognitive science to her work in CMU's Robotics Institute. Through their own research, cognitive scientists recognize human eye gaze as an important and meaningful tool humans use to communicate. They know, for example, that people look at an object before reaching for it. The eye's



The SCS Moonshots initiative continues our rich history of boundary-breaking innovation. While research projects abound in all seven SCS academic units, those selected as Moonshots have been presented to an interdisciplinary team of faculty and staff who have deemed them the most likely to significantly impact the world in years to come.



Assistant Professor Henny Admoni uses eye gaze and other forms of nonverbal communication to develop intelligent systems for assistive robots that will coexist with people, making our everyday lives better and safer.

physical characteristics have evolved to make it easier for humans to follow one another's gaze in conversation or while working together on a task. Admoni's work applies this data to human-robot interactions.

"One key way to achieve shared autonomy for a task involving humans and robots is to leverage nonverbal behaviors that humans are already producing," Admoni says.

Part of Admoni's research focuses on assistive robot manipulator arms that people can control to achieve important daily tasks like taking a sip of water. Today, that control occurs primarily through joysticks and adaptive devices operated by mouth or an array of buttons on the headrest of a wheelchair. These approaches can be time-consuming and mentally and physically challenging endeavors for people with physical disabilities, some of the primary users of assistive robots. They often lead to operator fatigue and diminished performance, sometimes even to abandonment.

"Our researchers want to introduce intelligence into human-robot interactions that will mitigate these challenges," Admoni says. "We want a system where the robot can predict what the user is trying to accomplish, and then take action to assist the user."

To achieve truly shared autonomy for tasks involving humans and robots — like retrieving a jar of pickles from the refrigerator using an assistive arm — robots must learn to recognize meaning in people's nonverbal behaviors, and from those behaviors decipher intent. They also have to produce nonverbal signals of their own that have meaning for people.

In Admoni's Human and Robot Partners (HARP) lab, she and her research team use eye-gaze trackers to gather data and develop algorithms for use in commercially available assistive devices for people with upper-body mobility impairment. The team strives to make software that brings about



Carnegie Mellon researchers remain at the forefront of developing intelligent systems for our daily lives that will simplify routine tasks and, more importantly, enable the elderly and people with disabilities to maintain independence.

progressive, shared autonomy for human-robot tasks capable of adapting over the lifetime of the individual and being used in a variety of situations.

HARP's eye-gaze research is a multidisciplinary effort that involves fundamental robotics algorithms and techniques from artificial intelligence and machine learning. In the lab, researchers are developing computer models of how humans use gaze to represent intention and direct their attention in a scene. They're modeling how people make decisions about what they intend to do, and how they communicate those intentions verbally and nonverbally.

But the unpredictable and sometimes disorderly approach human beings take to doing things creates research challenges.

"Even though eye gaze can predict what a person is about to do, it is an extremely noisy signal because people are always using their eyes for different kinds of tasks," Admoni says. In simple conversation, people may look at each other most of the time, but not all the time. A person may look away when distracted or to reference an object someone is talking about. As a result, the data can appear to be in conflict with itself.

HARP research tackles the scientific challenge by applying machine-learning techniques that will extract specific features from the eye-gaze data.

Machine learning can then analyze the data and learn a function for predicting when eye gaze is indicative of human intention.

To extract meaningful data, the HARP team also looks to cognitive science to define eye-gaze features that suggest a certain effect, like looking away in a conversation to indicate that a person is thinking. Or that people's eyes naturally turn in the direction someone else is looking.

Robotics is on the cusp of allowing humans and artificial intelligence systems to work in close collaboration, and the melding of these two sciences pushes the field to the next level.

"These tightly coupled human-robot systems are a great way to take advantage of the power of human capability and the power of robots," says Admoni, who believes sharing autonomy with robots for daily chores will be available commercially within two decades.

Computer science and cognitive science have gone hand-in-hand for a long time, but now tools like eye trackers investigate cognitive science in real time. Admoni and her team's visionary research continues Carnegie Mellon's decades-long tradition of developing technology that enriches human life and solves real-world problems.

"I get really excited about the potential of this technology to help people," Admoni says, "especially for the elderly and people with disabilities." ■

"We want a system where the robot can predict what the user is trying to accomplish, and then take action to assist the user."

— Assistant Professor Henry Admoni

Speech
Recognition
Technologies
Developed
at CMU
Make Alexa
and Siri
Possible

DO YOU HEAR WHAT I HEAR?

Mark Roth

When Raj Reddy, Moza Bint Nasser University Professor of Computer Science and Robotics, was a young computer science student at Stanford University in the early 1960s, his advisor suggested he try to use a computer to understand human speech.

“That was the first time we had a computer that could actually listen to speech, and I was able to do a simple word recognizer in a month or two. I said, ‘You know, I think I can solve the speech problem in two or three years.’”

He was just a wee bit overoptimistic.

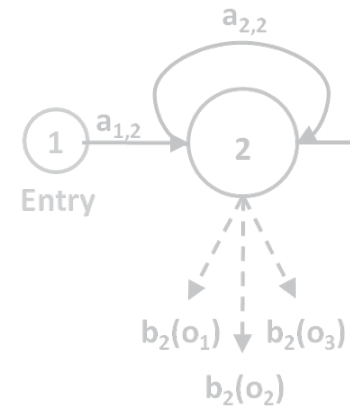
In fact, it took until last year for computer speech recognition systems to match humans in the ability to accurately perceive telephone-quality conversations by random speakers.

One of the ongoing challenges of computer speech recognition programs is accurately identifying what is being said, regardless of who is saying it—a child or an adult, a man or a woman, a person with a Southern or Indian accent.

That ability—to recognize speech from a wide variety of people—was what stymied early speech recognition systems and formed the early challenges to the field after Reddy moved to Carnegie Mellon in 1969.

Reddy’s early success was based on a computer understanding a single speaker, but he noted that “recognizing the speech of one person is a far different matter than recognizing speech by anyone in an open population.”

Today, thanks to advances in artificial intelligence and a vast trove of speech samples that computers can educate themselves on, speech recognition systems like Siri, Alexa, Cortana and Google are highly accurate in hearing and responding to people’s questions.



“I used to say 15 years ago that human-like speech recognition will never happen in my lifetime,” Reddy said. “But they now have millions of hours of speech and huge cloud-based computing capabilities to train these systems.”

Still, all of today’s digital assistants owe much of their chatty fluency to the early work done at Carnegie Mellon by Reddy, graduate student Kai-Fu Lee (CS 1988) and Professor Geoffrey Hinton, who went on to pioneer deep-learning computer systems at the University of Toronto and Google.

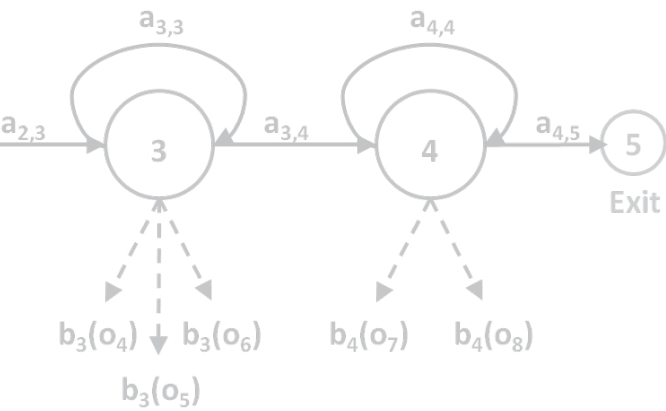
In particular, current systems owe a debt to two early programs: Harpy, developed by Reddy and his colleagues at CMU in the 1970s, and Sphinx, developed by Lee as part of his Ph.D. dissertation at CMU in the 1980s, with Reddy as supervisor.

Harpy used a statistical method for discerning patterns in speech sounds known as the Hidden Markov Model. It was pioneered by the husband-wife team of James (CS 1975) and Janet Baker (CS 1975), who came to CMU from the University of Rochester. The approach was refined further by colleague Bruce Lowerre (CS 1976), who developed a streamlined way to hunt for possible solutions to translating human speech.

The work was funded by the Defense Advanced Research Project Agency, and while Harpy achieved decent accuracy in understanding a single speaker,



Kai-Fu Lee



The Harpy system used a statistical method for discerning patterns in speech sounds known as the Hidden Markov Model.

Current systems owe a debt to two early programs: Harpy, developed by Reddy and his colleagues at CMU in the 1970s, and Sphinx, developed by Lee as part of his Ph.D. dissertation at CMU in the 1980s, with Reddy as supervisor.

it couldn't do it in real time. "In those days," Reddy said, "people would say, 'Give me an hour and I'll get it right,' and people would get tired of waiting."

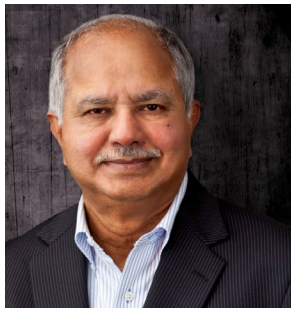
When Kai-Fu Lee came to Pittsburgh to work on his Ph.D., he had to reinvent the wheel.

Lee also used the Hidden Markov Model to develop his program, but by then, Carnegie Mellon no longer had the source code for the original Harpy system, Baker said in an email. So Lee developed a new system, Sphinx, from scratch, and it outperformed competing computer systems.

The key breakthrough of Sphinx was its ability to translate words from a variety of speakers.

What was remarkable about the project, Lee recalled in a speech he gave in Beijing six years ago, was that Reddy gave him permission to completely switch direction on his thesis and use the statistical approach to speech recognition, even though the federal funding CMU had at the time was supposed to be spent on another technique known as the expert system model.

"After a year," he said, "I went back to Reddy and said, 'Raj, I love working on speech recognition and I love working for you, but can you let me use statistical methods to collect data, train discriminate models and do pattern recognition?' He asked me a bunch of questions, after which he said, 'Kai-Fu, I don't agree with you, but I support you.'"



Raj Reddy

"There is one untapped area of the global economy where speech recognition may have a major impact — the estimated 780 million adults around the world who are illiterate."

—Raj Reddy

"And that nearly threw me off my chair," Lee recalled. "But then he explained that he believed everybody is equal in the pursuit of science, and that if they got to work on what they were very passionate about, they were much more likely to be successful. And with all that support, I was able to create the first speaker-independent continuous speech recognition system."

While Harpy and Sphinx may be the ancestors of Siri and Alexa, they were not nearly as accurate, fast and flexible as today's systems.

The big breakthroughs that enabled the current speech recognition programs to leapfrog ahead over the last six years, Lee said, were deep-learning approaches pioneered by Hinton, who taught at Carnegie Mellon in the 1980s and now is a distinguished researcher for Google.

The key to these systems, Reddy said, is that they can learn and get better as they go along, using the huge volumes of recorded speech available from tech giants like Google, Apple, Microsoft and Amazon. "There has been machine learning throughout on speech recognition systems," he said. "The main difference is that the learning was happening before on much smaller amounts of data. Now, the machine learning is happening on much larger amounts of data."

Despite the rapid progress in speech recognition, Lee doesn't think it is destined to eliminate typing and touch.

Not only were the first computer apps developed based on typing and using a mouse, he said, but "interestingly, most of us don't talk to our phones' software because we are used to dragging and resizing and using touch."

He thinks speech recognition will be useful mostly in a "hands-busy, eyes-busy" setting, like driving a car, or for voice-assistant devices like the Echo.

But Reddy said there is one untapped area of the global economy where speech recognition may have a major impact — the estimated 780 million adults around the world who are illiterate.

"These are people on the bottom of the pyramid who don't read and write, and if you want to have access to that market, which is trillions of dollars a day in economic value, you need these voice recognition systems," Reddy said.

But that raises another major challenge, he said — the need to train speech-recognition systems to understand many other languages, not just English, Chinese, German, Spanish and other major tongues.

"The economic power is there if you can hear and understand languages. That's what I've been saying to people at Amazon. If you want to sell stuff to illiterate people in Africa and Asia, you need your computers to speak those languages." ■

Andreas Pfenning is part of an international consortium using data-driven research that unites computer science and biology to help treat the nation's sixth leading cause of death

Getting to the Heart of Alzheimer's

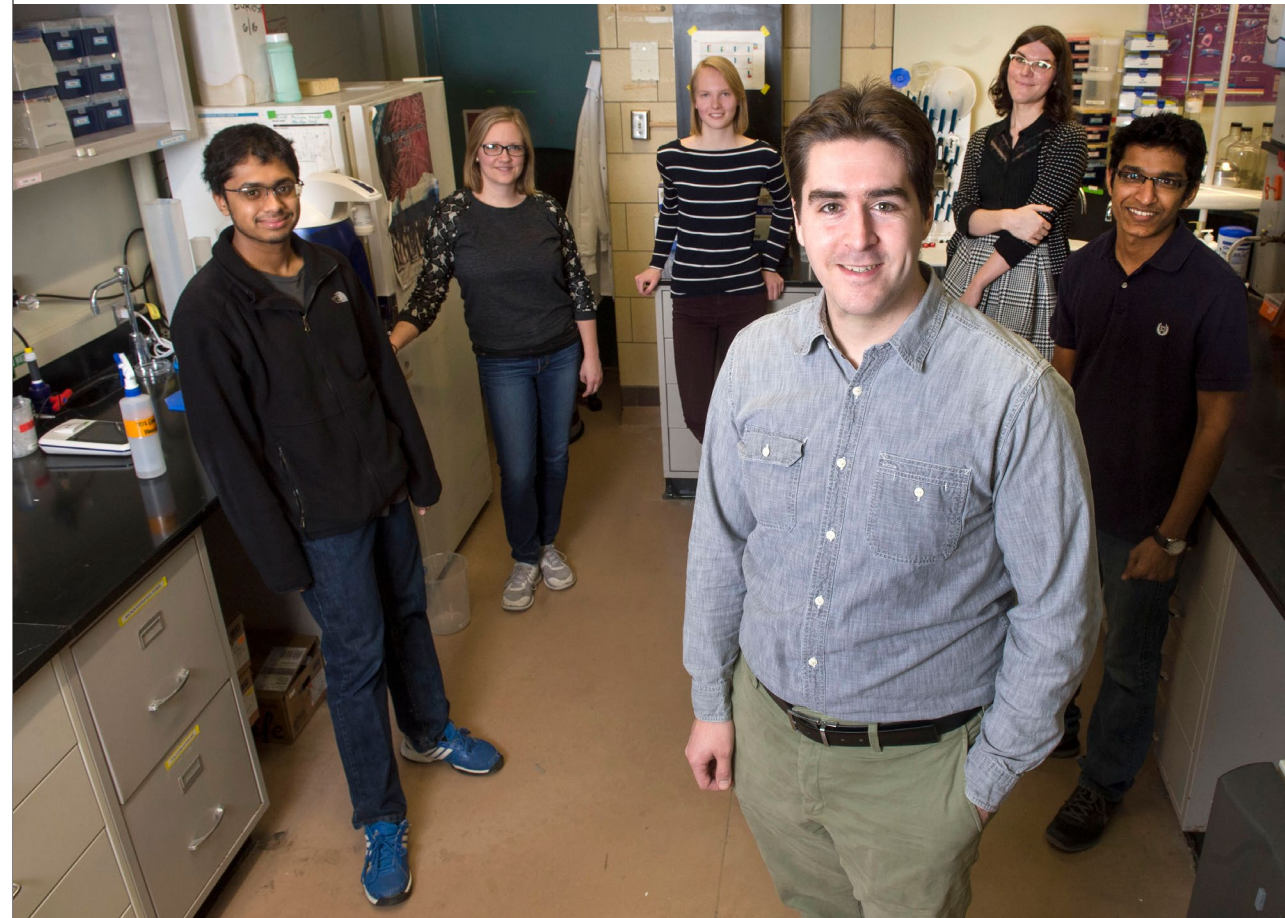
Susie Cribbs

In less time than it takes to read this article, one person in the United States will develop Alzheimer's disease. It kills more people than breast cancer and prostate cancer combined. And while heart disease still ranks as the country's top killer, deaths from it have decreased 14 percent since 2000. But deaths associated with Alzheimer's disease? They've increased by 89 percent during that same time period.

Andreas Pfenning wants to reverse that trend.

An assistant professor in the Computational Biology Department, Pfenning belongs to a research consortium using data-driven computer science, biology, neuroscience and genomic research methods to develop new therapies for Alzheimer's disease. Earlier this year, the group — Collaboration to Infer Regulatory Circuits and to Uncover Innovative Therapeutic Strategies (CIRCUITS) — received \$2 million from the Cure Alzheimer's Fund to support their efforts, with a commitment for another \$2 million next year.

So far, those efforts exhibit real promise, at least in Pfenning's Neurogenomics Lab in Pittsburgh.



Pfenning's group is just one link in a chain that could one day lead to incredible advances in how we understand and treat Alzheimer's.

To understand Pfenning's research, partially supported by the university's BrainHub initiative, you need to know a little bit about the underlying biology of genomics. An organism's complete set of DNA is its genome, and almost every cell in the body houses a complete copy of that genome. But different parts of the genome are activated in different parts of the body, effectively defining each individual cell's role. Mutations or variations in the genome can indicate a predisposition to problems like developing a disease or the potential for birth defects.

While he was a post-doc at MIT, Pfenning belonged to a group that mapped the parts of the genome that are active in different cell types and tissues. Now, his lab at Carnegie Mellon is using that data — plus data on the genetic mutations that may lead to Alzheimer's disease — to help interpret what the cells associated with the mutation are doing and how the mutations may eventually lead to the disease.

It's no small undertaking, which is where the computational part of computational biology comes into play.

Pfenning's team works with two large sets of data: a genome-wide association study that gives them a sense of which parts of the genome are related to Alzheimer's disease predisposition, and data from the Cure Alzheimer's Fund that sequences the genome of people with Alzheimer's disease and compares it to a control group. The problem is that the first set of data doesn't tell them anything about the

mutation that actually causes Alzheimer's. And the second set of data lacks the statistical power to make decisive conclusions about which mutations cause the disease.

"In both cases, you're left with the question of how a mutation in the genome leads to Alzheimer's disease," Pfenning said. "We want to interpret what that mutation is doing. That's where the computational methods come in."

Using deep learning and machine learning techniques, his team built convolutional neural network models. In layman's terms, they created a neural network model that uses the genome and mutation data as input. As output, it estimates how active that part of the genome is in a different cell type or tissue. Ideally, the model could tell researchers how a genetic mutation related to Alzheimer's could impact a specific cell type.

"The model is really complicated computer code that links the genome sequence to function across different cell types," Pfenning said. "These methods excel at learning hidden and more complicated interactions between different types of genetic sequences."

At the end of the day, though, all computer science can offer is a hypothesis like "I think this mutation will impact Alzheimer's disease in these cells." So Pfenning has also established an experimental lab to complement the group's computational efforts with high-throughput biological methods for developing new technologies.

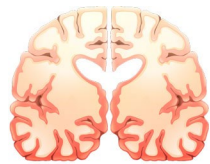
Here's how it works.

Based on the hypotheses generated in the computer model, the Pfenning group can order two versions of the genome: one with an Alzheimer's-associated mutation and one without. They can do this for anywhere from hundreds to thousands of points on the genome.

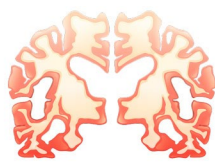
Under the direction of lab manager Ashley Brown and BrainHub post-doc Morgan Wirthlin, Pfenning's team created a method to insert those fragments of genetic code into small, circular pieces of DNA and inject them behind a mouse's eyeball. The pieces of DNA integrate into the animal, which continues to behave and function normally. Later, they dissect out parts of the brain they think are related to Alzheimer's and use the tissue they collect to measure how active those genomic fragments are. They then plug these

findings back into the computer model. The more data they feed into the model, the more accurate it becomes.

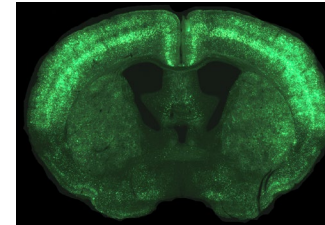
"This is part of the vision of the Computational Biology Department at CMU," Pfenning said. "There aren't too many computational biology departments out there, and traditionally they've analyzed existing data sets or built theoretical models for researchers. Where I'm trying to go with this research is to integrate computer science and biology in very progressive ways. To design the computational problem in a way that we can follow



Healthy Brain



Alzheimer's Disease



"If you know the various biological pathways by which nature influences the predisposition to Alzheimer's, you're in a better position to develop the drugs that target those pathways."

—Andreas Pfenning

up on experimentally, and then design our experimental system to feed back into the computational model."

So far, Pfenning's group has proven their laboratory technique works. And computational biology Ph.D. student Easwaran Ramamurthy has built the first generation of computational models that use deep learning to predict what mutations are doing in different tissues and cell types.

Pfenning hopes to release the results from initial experiments soon. Meanwhile, his group continues to refine the model with laboratory data and bolster the dataset of the parts of the genome they're confident are connected to Alzheimer's disease. They also hope to start building more detailed biological models for how specific mutations impact the

disease process. Ultimately, they want to move into drug development.

"If you know the various biological pathways by which nature influences the predisposition to Alzheimer's, you're in a better position to develop the drugs that target those pathways," Pfenning said.

He's not alone in his efforts. Members of the CIRCUITS consortium live and work all over the globe — at MIT, the Salk Institute for

Biological Studies in California, Massachusetts General Hospital, the University of Sheffield in the UK and Germany's University of Luebeck. Each group has undertaken different components of the project, from sequencing the genome to performing genomic research on post-mortem brain samples.

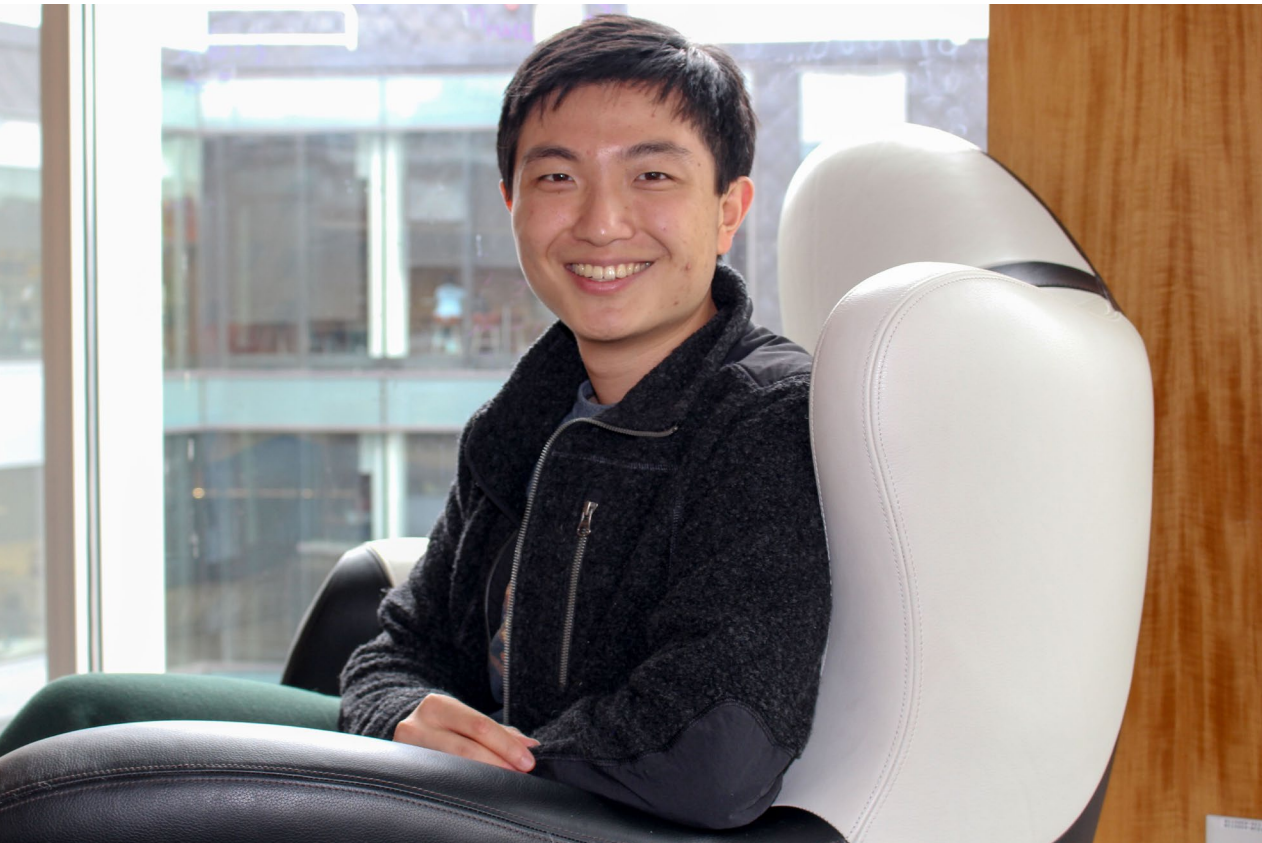
Pfenning's group is just one link in a chain that could one day lead to incredible advances in how we understand and treat Alzheimer's. Much of that has to do with treating the problem as a computational one.

"Data drives my approach," Pfenning said. "It's not like we have this symptom or hypothesis and we try to trace the biological origins of it. Instead, we start with an unbiased approach, like a statistical analysis of the parts of the genome related to Alzheimer's, and we build up to the underlying biological mechanisms." Another reason to be hopeful for their success is the CIRCUITS group itself.

"We designed the group strategically to hit all of these relevant and interrelated research areas," Pfenning said. "This broad and diverse group of people coming together is analogous to the size and distance of the problem we're trying to solve with all these moving parts."

With one person developing Alzheimer's Disease every 66 seconds, there's no time to waste.

"We're getting better at treating heart disease and cancer, and people are living longer. A lot of those treatments have come from big investments at the national level," Pfenning said. "We're reaching a crisis point where we really need to start investing more in Alzheimer's research to come up with effective treatments and cures. It's important." ■



Eric Zhu

Susie Cribbs

SCS senior Eric Zhu arrived at Carnegie Mellon four years ago and felt a little unfocused. He'd had a great Sleeping Bag Weekend experience at CMU when he was a high school senior, and even decided to major in computer science based on conversations he had with a few upperclassmen he met during that trip. He earned decent grades and participated in Student Senate and a few other activities. But the Bergen County, N.J., native still felt a little unsettled.

Then something amazing happened.

"At the end of freshman year, someone I really admired pulled me aside and told me she was part of a tradition where a sophomore identifies a first-year student they think is most likely to change the world. And that student was me," Zhu said. "In that moment, I went from being someone who was unsure of myself at CMU to someone with the confidence to pursue my dreams."

Flash forward three years and Zhu is a self-assured senior about to embark on what will undoubtedly be a successful career in the tech industry. He officially majors in computer science but he's also served two years on CMU's Student Senate, spent a year as a resident assistant, made an effort to take at least one humanities course each semester, participated in CMU Mock Trial and has never abandoned his love of classical piano.

He's a true Renaissance man.

Within SCS, Zhu has not only excelled in his courses, but has also undertaken a senior research project with Taylor

Berg-Kirkpatrick, assistant professor in the Language Technologies Institute, and Matt Gormley, assistant teaching professor in the Machine Learning Department. Together, they're investigating how natural language processing techniques can be applied to music.

"Right now, if you use long short-term memory networks to generate music, it sounds like someone who used to know how to play piano forgot how to play good music," Zhu said. "We're trying to see if we can adapt models to automatically learn to compose a song that sounds coherent."

Zhu also spent the past two summers interning at Google — working in the Ads group the first year, and then the Knowledge Engine project this past summer.

In addition to his academic work, Zhu has played an important role in the larger CMU community. While on Student Senate, he spearheaded the Faculty Student Lunch program, which brings students and faculty members together outside the classroom to discuss issues beyond academics. He's served on the Provost's Working Group for Health and Well-Being Services, and belongs to CMU's student alumni association, the Highland Ambassadors.

For those reasons and more, he's also received this year's Mark Stehlik SCS Alumni Undergraduate Impact Scholarship.

"Eric embodies what is best about Carnegie Mellon students. He is sharp intellectually and technically, but is also caring and concerned about his fellow students," said Mark Stehlik, assistant dean for outreach.

Before he leaves CMU, he has advice for students following in his footsteps.

"Don't forget why you came here," Zhu said. "A lot of people come to CMU and get stuck in the minutiae of each course. But there's a reason that you chose CMU and it's probably not to get all A's. It's important to remember the bigger picture."

But what about that tradition of pulling aside a talented first-year, the one that gave him the confidence to be successful at CMU? Obviously, he continued it. And to this day, it keeps on going.

It's amazing what a little confidence boost can do. ■



CMU doctoral students play the card game Buffalo as they study ways to encourage empathy.

The Hero's Mindset

Nick Keppler

Although employed by the School of Computer Science, Geoff Kaufman isn't a tech researcher.

The psychologist studies how fiction, games and other simulated experiences reshape a person's worldview. It's a niche that has moved online, where social media is the most widespread simulated experience ever shared. Hence, Kaufman is at the Human-Computer Interaction Institute studying it.

"I was seeing all the technologies being developed and the ubiquity of computing and how it was introducing new ways of interacting," Kaufman says. "I knew my work would be to understand those interactions and use new technologies to reduce prejudice."

At The Ohio State University and then Dartmouth College, Kaufman built a body of research showing the persuasive influence of fiction. In one study, he found that a brief fictitious account about sexism at a college physics lab elicited more sympathy for the narrator than did the same scenario presented as a nonfiction essay. In another, he found that the later a short story author introduces a character's affiliation with an "outsider group" — such as a racial minority or place in the LGBT spectrum — the more college-aged readers outside that group say they identified with that character.

"There is an unconscious resistance to a person you know is trying to persuade you," Kaufman says. "When you are reading something as entertainment, those guards are down and you become more accepting and open." He sought some practical use for this knowledge.

Social media seems to be doing the opposite of challenging prejudices. Streams of it are channeled into ideological echo chambers, and it's provided a platform for vitriol and bullying.

Kaufman and his doctoral students are researching ways to tweak online interactions to encourage empathy. One is compiling research about trolling — making provocative comments just to illicit reactions. Another is looking at the unique language of memes. He and some of his students have contracted with a website design firm to find ways to cool down user interactions. A surprisingly successful method: have users look at a set of eyes and report the mood they convey, instead of one of those prove-you're-not-a-robot tests of typing a set of numbers and letters displayed in an image.

Kaufman's current project is a social media simulation, where students in a group make up a character and interact with other groups posting as a single fictional figurehead on the social network Slack. They're encouraged to add biographical details to build the character: one student will contribute the birthplace, another an ethnicity, another the sexual orientation, etc. "It's a way of recognizing commonalities while acknowledging differences," he says.

Ultimately, he would like to create a series of digital and physical games for pre-high school audiences meant to subtly reduce prejudice, but the key is not to seem "educational." "Once a game is labeled educational, kids are 50 percent less likely to play it," he says. "These games have to work on their own."

He says this interest stems from childhood. He also noticed his classmates' tendency to target emotionally stunted or mentally disabled classmates or those from families of lower socio-economic status. "I felt like I wanted to intervene in some way," he says, "not that I had a unique ability to. I just noticed how naturally most kids picked up on that and wanted some way to change it." ■

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

CELEBRATING THE FOUNDER IN US ALL

This fall, we kicked off a yearlong "For the Founders" celebration commemorating Carnegie Tech's merger with the Mellon Institute to form the Carnegie Mellon University we all know and love. We're not just honoring our founders, the Andrews Carnegie and Mellon — we're also paying tribute to all the founders who came after them. The "innovation and innovators who have transformed education, our society and our world."

As you'll see from the following stories, we have plenty of people to honor in SCS. The most obvious, of course, are AI founders Allen Newell and Herb Simon. This issue's "Then and Now" feature includes a reproduction of what their office might have looked like when they developed The Logic Theorist in

1956. You'll also read about Anoop Gupta, a CS grad from back when we were part of the Mellon College of Science, who is co-founder and CEO of Zipstorm Inc., which uses machine learning and other advanced techniques to help employers find the most qualified candidates for job openings. And you already read about current senior Eric Zhu, who has made huge contributions to our community while he's been on campus, through his work both in and out of the classroom.

We can only feature a few of our founders within these pages, but we celebrate all of you every day. Your incredible support of SCS has helped make us the best computer science program in the country. Your hard work and dedication have allowed us to reach out and give back to the community where we live. Your ceaseless effort sustains our tradition of making things that matter.

At the end of this issue, we've included a donor list to formally recognize everyone who supported SCS during the previous academic year. To all of you, we offer a huge thanks. If you're not on that list, there's still time to make a gift to be included in next year's list. Either way, you're an integral part of our SCS community.

As we head into a new year, we celebrate the founder in all of you. ■

Ashley Patton

Director of Engagement
and Annual Giving
School of Computer Science
awpatton@cs.cmu.edu



Nicole Atwell, senior associate director of Engagement and Annual Giving, and Ashley Patton

Anoop Gupta

Kevin O'Connell

Anoop Gupta (CS 1986) is the co-founder and CEO of Zipstorm Inc., the startup behind SeekOut. Prior to that, he was the corporate vice president for technology policy and strategy at Microsoft, as well as the technology assistant to Bill Gates.

Tell us about your career journey.

When I came to CMU from India in 1980, I never could have imagined the amazing opportunities I would be given. From being a CS prof at Stanford, to founding one of the earliest streaming-media startups in 1995 (VXtreme was acquired by Microsoft in 1997), joining Microsoft and changing research focus from parallel computation to communications and collaboration systems at Microsoft Research, to reporting directly to Bill Gates advising on product and strategy, to heading the entire multibillion enterprise communications business at Microsoft, heading global technology policy for Microsoft, and now coming full circle to co-founding SeekOut, a six-person startup. What I have relished most is the opportunity to work closely and learn from some of the best minds in the world, across a variety of disciplines. Each opportunity has allowed me to get out of my comfort zone and learn something new from my failures and successes.

How has SCS influenced or prepared you for your career path?

My years at CMU provided the foundation for my career going forward — from deep conviction about the value of interdisciplinary research, to the systems-building and deployment mindset, to the “reasonable-person” principle as a foundation for how we must approach people in our communities. At every step of my journey, I have found incredible alumni from CMU as partners, mentors and managers. Being a CMU SCS alum creates a default trust that you must be good and trustworthy; it opens doors to new opportunities. People are willing to take a chance on you. That is an incredible head start for any journey one undertakes, and I feel grateful for having this association with CMU.

You and your family have an incredible legacy at CMU.

When I am asked what has been the most lasting and incredible gift from CMU, my answer is simple. I met my life partner, my best friend, my wife of 29 years (Yumi Iwasaki) at CMU. She was Herb Simon's Ph.D. student and I was Allen Newell's Ph.D. student, so you all know now how the hierarchy works in our household. It was incredible to have had the opportunity to work with the founders of SCS; to learn not just about the field of CS but what it meant to live a life of intellectual pursuit and innovation. We have also been extremely blessed that two of our children have attended CMU — our daughter, Meena, graduated from SCS in 2017 and our youngest son, Nikhil, is a sophomore in SCS. My nephew, Akhil Wable, graduated from SCS in 2005 and was one of the early employees at Facebook.

What does SCS mean to you and your family?

SCS and CMU feel like our extended family. I have often found that you may not have had the opportunity to be with a family member for a few years, but when you do get together, it instantly feels like you were never apart. There is instant connection, there is familiarity. You know the deep values that you both hold dear, you know they care and you care. When we visit CMU, there is an instant bond, and amazingly Raj Reddy hasn't changed at all in the last 30 years. Whenever we get together with fellow alumni, there is instant connection. And we know that CMU and SCS will always be there, pushing the boundaries of the field, pushing interdisciplinary research to solve society's hardest problems, and churning out the best students in the world.



What was the initial idea that gave rise to SeekOut?

Our trajectory through life — what opportunities we work on, who we get to work with, what impact we make — is a big part of how we find meaning and fulfillment in our lives. Our starting point was the belief that great opportunities often arise when we step beyond our immediate circles of friends and colleagues. However, the problem of finding relevant professionals outside of our immediate circles is not well addressed. Our mission is to build the best people-search engine that allows you to discover and reach relevant professionals beyond your existing networks.

What does SeekOut offer that is unique and better than its competition?

When it comes to people-search, Google and Bing are not great at allowing you to discover relevant professionals based on sophisticated criteria of background, skills and interests. LinkedIn is the biggest player, but we believe they also provide subpar results, both due to business-model considerations and underlying technology. SeekOut brings together many diverse sources of information. Our results are not limited by your existing connections, we leverage machine-learning in unique ways to improve results and we provide more user-friendly ways to communicate.

How does SeekOut use AI?

Just a couple of examples. When you are aggregating data about people from diverse sources, the textual information you get is extremely diverse and not normalized in any way. To extract relevant entities that would make sense to our users is a hard categorization and machine-learning problem. Similarly, when you search for people, and you say ‘find me people similar to current data-scientists at Facebook’, there may be hundreds of features in the search vector. How one optimizes results in such complex search spaces is also a hard machine-learning problem.

Why is that important?

Eventually, we will be judged by the intuitiveness and the quality of results that our people-search engine provides. Without the data-driven machine learning, it would be infeasible to deliver quality results.

What do you enjoy most about your work?

Working with my amazing colleagues on a deep, relevant problem in a fast-changing dynamic environment. Having conversations with our users to deeply understand their pain points (implicit and explicit) and ways in which we could innovate to make their lives just a little bit better.

What advice would you offer current students and entrepreneurs?

As behavioral economists would tell us, most of us are not very rational about estimating what is risky and what is not, and so we often don't take enough of the right risks. Remember, when you're early in your career, before you have families to support and big mortgages to pay, you have tremendous ability to take more risks in pursuing your vision for a better world. And, if you're like me, don't ever stop taking risks, reaching beyond your comfort zone, and learning and growing.



RoboTutor Named Global Learning XPRIZE Finalist

RoboTutor LLC, a Carnegie Mellon spinoff created by Robotics Institute Professor Emeritus Jack Mostow, was named one of five Global Learning XPRIZE finalists for its RoboTutor software — educational technology that teaches children basic math and reading skills. To become a finalist, the RoboTutor team beat out nearly 200 teams from 40 different countries.

XPRIZE aims to address the shortage of teachers in developing countries by funding an international competition to create open-source Android tablet apps that enable children ages 7 to 10 to learn basic reading, writing and math skills without adult assistance.

Each finalist team receives \$1 million. XPRIZE will now conduct an independent, 15-month, large-scale study to field-test the finalists' apps in nearly 200 Tanzanian villages. A \$10 million grand prize will be awarded to the team whose app achieves the highest learning gains.

"It's hard to explain the gratifying feeling knowing that your career's work, which has helped thousands of children so far, could now potentially change the lives of millions — even billions — of children. XPRIZE and the RoboTutor team have given me the opportunity of a lifetime," Mostow said.



Jason Hong

Smartphone Privacy Technologies Take Center Stage at UbiComp 2017

Two new CMU-developed technologies to safeguard your smartphone debuted this semester at the ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2017).

The first, PrivacyStreams, enables app developers to access the smartphone data they need for app functionality while assuring users that their private information is safe.

The library includes a number of programs that transform personal data into a desired output. A weather app, for instance, might need to access a smartphone's location, but the output would only need to identify a city or a neighborhood to display the forecast.

"We're creating a new way of doing programming that makes it easier for the developer and also enhances privacy," said HCL Associate Professor Jason Hong.

CMU researchers also introduced the Protect My Privacy (PmP) app for Android at the conference. Apps that share users' locations, contacts and other sensitive information with third parties often do so through a handful of services called third-party libraries. PmP manages interactions with these libraries and tells users how each library treats the data, giving the user more context for making privacy decisions.

"Making decisions about what information to share with each library, rather than just what each app should share, dramatically reduces the number of decisions a user has to make to protect privacy," said Yuvraj Agarwal, assistant professor in the Institute for Software Research.

Snake Robot Searches for Mexico City Quake Survivors

CMU researchers deployed a snake-like robot to search for trapped survivors in an apartment building that collapsed following the earthquake that shook Mexico City in late September. The multijointed snakebot provided rescue workers with a video feed from two different passes through the rubble, but did not find any survivors, said Matt Travers, systems scientist in the Robotics Institute.

"We had hoped our robot could in some small way reduce the tragedy that occurred in Mexico City," said Travers, who is co-director of the Biorobotics Lab that developed the snakebot. "The robot performed well, and the Mexican Red Cross workers with us said they would like to have a similar tool in the future."

Howie Choset, a robotics professor who has led development of the snake robots for more than two decades, said the experience in Mexico City was valuable in demonstrating the robot's capabilities and identifying additional qualities it needs to make it a useful search-and-rescue robot.

"This robot performed admirably," Choset added. "But this experience has shown how much work and further development we still have to do."



Forlizzi Named HCII Director

SCS Dean Andrew Moore has appointed Jodi Forlizzi as the new Charles M. Geschke Director of the Human-Computer Interaction Institute (HCII), where she has been a faculty member since 2000.

Forlizzi, who earned a self-defined Ph.D. in human-computer interaction and design at CMU, specializes in interaction design and has also served on the faculty of CMU's School of Design.

"Jodi has repeatedly demonstrated with significant effectiveness her clear perspective on the important role HCII plays for all of SCS and for CMU more generally," Moore said. "I have no doubt that during this critical decade — when advanced technology will change the rules of the game for everyone — we will succeed or fail based on the extent to which we incorporate technology to understand, assist and educate people, and base our design for the future on clear humanistic principles. Jodi is the perfect person to lead our efforts in this area."

Forlizzi designs and researches systems ranging from peripheral displays to social and assistive robots. Her current research interests include designing educational games that are engaging and effective, designing services that adapt to people's needs, and designing for healthcare.

She is a member of the Association for Computing Machinery's CHI Academy, a group of researchers who have been judged by their peers as having made significant, cumulative contributions to the development of the HCI field. She has been honored by the Walter Reed Army Medical Center for excellence in HRI design research. She also has consulted with Disney and General Motors to create innovative product-service systems.



Delphi Group's Flu Forecasts Prove Most Accurate

For the third year running, the Delphi research group's forecasts of national influenza activity proved the most accurate among all forecasting systems evaluated by the U.S. Centers for Disease Control and Prevention.

The researchers fielded two forecasting systems during the flu season that ended this past May. The systems ranked first and second among the 28 submitted to the CDC's forecasting research initiative by university and governmental research groups.

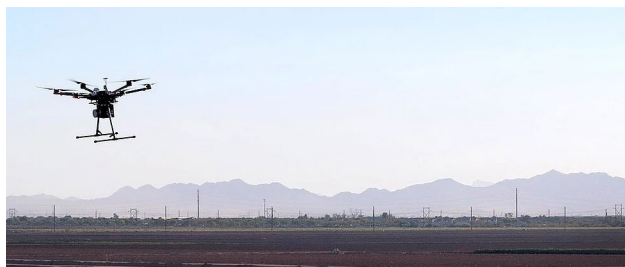
"We're gratified that our forecasting methods continue to perform as well as they do, but it's important to remember that epidemiological forecasting remains in its infancy," said Roni Rosenfeld, Delphi leader and professor in the Machine Learning Department and Language Technologies Institute (LTI). "The CDC's flu forecasting initiative has proven invaluable to us, providing us with both the up-to-the-minute data and the feedback we need to constantly improve."

Boeing Invests in Autonomous Flight Spinoff

Boeing has invested in Near Earth Autonomy, a spinoff of the Robotics Institute that focuses on autonomous flight technology, as well as a partnership in which the companies will explore emerging markets such as flying cars and other forms of urban mobility.

"This is an exciting opportunity for Near Earth," said Sanjiv Singh, research professor of robotics and CEO of Near Earth Autonomy. "The Boeing HorizonX investment will accelerate the development of robust products and enable access to a broader portfolio of applications for aerial autonomy."

Near Earth Autonomy leverages decades of Robotics Institute expertise in autonomous flight, ranging from small drones to full-size aircraft. Its achievements include the first full-size autonomous helicopter flights in partnership with the U.S. Army in 2010, and ongoing work with the Office of Naval Research developing an autonomous aerial cargo delivery platform for the U.S. Marines.



Undergraduate Women Meet Leading Researchers at OurCS

About 100 female computer science majors gathered at CMU earlier this fall for OurCS, a workshop designed to give them hands-on experience with research.

Attendants heard from Nancy Amato, Regents Professor and Unocal Professor in computer science and engineering at Texas A&M University, and Alison Derbenwick Miller, vice president of Oracle Academy, who shared their insights on computer science research. The CS students also worked on projects in teams guided by scientists from academia and industry, and presented talks on their findings. Organizers hope the experience will motivate the women to consider graduate studies in computer science — a discipline in which women are underrepresented.

"This was an intense weekend of problem-solving for these undergraduates," said Carol Frieze, OurCS chair and director of Women@SCS. "Thanks to our speakers, panelists and research team leaders, it was also an inspirational event for us all."



Smart Traffic Signals Will Help the Blind Cross Streets

Robotics Institute researchers have begun a two-year project to develop a system that relays information from a user's smartphone directly to smart traffic signals. These signals, designed to improve the flow of traffic, could also help pedestrians who have visual or other disabilities safely cross streets, or even catch a bus.

"The smartphone can learn how fast the pedestrian moves, or if the user might have difficulty at certain intersections," explained Research Professor of Robotics Stephen Smith. "The intersection could extend the green in real time to give her the extra time she needs. And it might monitor the phone's location so that it notices if she starts moving outside the crosswalk."

Development of the system will initially involve a set of existing smart signals on Pittsburgh's Baum Boulevard and Centre Avenue near the Carnegie Library for the Blind and Physically Handicapped. In the program's second year, two additional intersections will be equipped with smart signals to connect the system with the Western Pennsylvania School for Blind Children in Oakland.

Uptake Donates \$1 Million for "Machine Learning for Good"

Uptake, a Chicago-based predictive analytics software company, has donated \$1 million to SCS to establish a faculty and student project fund, called Machine Learning for Social Good. The fund, overseen by Machine Learning and LTI Professor Roni Rosenfeld, will provide opportunities for faculty and students to apply their data science and machine learning expertise to initiatives that benefit the public sector.

"Machine learning and data science have already contributed immensely to improving education, public health, economic development, international aid and other pressing social needs," Rosenfeld said. "That's why this support from Uptake is so critical, and why we will engage faculty members and students from across SCS to bring forth our best talent to new applications."

CMU will use the fund to support research projects for nongovernmental organizations, nonprofits and government agencies.

Get Ready for a Computer That Reads Body Language

Thanks to Robotics Institute researchers, computers can now understand the body poses and movements of multiple people from video in real time—including the pose of each individual's fingers.

This new method was developed with the help of CMU's Panoptic Studio, a two-story dome embedded with 500 video cameras. The insights gained from experiments in that facility now make it possible to detect the pose of a group of people using a single camera and a laptop.

Associate Professor of Robotics Yaser Sheikh said these methods for tracking 2-D human form and motion open up new ways for people and machines to interact, and for people to use machines to better understand the world around them. Recognizing hand poses, for instance, will help people interact with computers in new and more natural ways, such as by simply pointing at things.

"We communicate almost as much with the movement of our bodies as we do with our voice," Sheikh said. "But computers are more or less blind to it."



Names in the News

Alexander Waibel (right) with wife Naomi and HRK president Horst Hippler



Jessica Hodgins



David Garlan

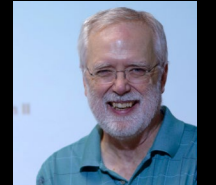


Ivan Cao-Berg, Javier Spivey, Rosana Guernica, Gabriel Ostolaza, José López Sánchez and Dr. Yasdet Maldonado

Carol Frieze



Matthew T. Mason



Stephen Smith



Shefali Umrانيا



CMU's hacking team

CMU's hacking team, the Plaid Parliament of Pwning, won its fourth World Series of Hacking title this summer at the DefCon security conference in Las Vegas. The team has more wins than any other team in the competition's 21-year history.

Computer Science and Robotics Professor **Jessica Hodgins** received the 2017 Steven Anson Coons Award for Outstanding Creative Contributions to Computer Graphics from the ACM's Special Interest Group on Computer Graphics and Interactive Techniques (SIGGRAPH). She was also elected president of the organization.

Ruslan Salakhutdinov, Kathryn Roeder and **Larry Wasserman** received endowed professorships from UPMC to fund work in statistics, artificial intelligence, machine learning and data analytics, and help shape the future of healthcare.

LTI Professor **Alexander Waibel** has been named to the Leopoldina, the National Academy of Germany. He was also named honorary senator of the Hochschul-RektorenKonferenz, an umbrella organization that represents German academia with the government and the public.

David Garlan, professor of computer science in the Institute for Software Research, will receive the Nancy Mead Award for Excellence in Software Engineering Education.

Rosana Guernica, a third-year student majoring in decision science and minoring in innovation and entrepreneurship in CMU's Dietrich College of Humanities and Social Sciences, has (at the time of publication) raised more than \$211,000 for Puerto Rico hurricane relief. **Ivan Cao-Berg**, a senior research programmer in the Computational Biology Department, is part of the team working to raise funds and distribute supplies. So far, they have chartered four planes and delivered roughly 76,500 pounds of supplies to the island.

Carol Frieze, director of Women@SCS and SCS4All, received the Computing Research Association's A. Nico Habermann Award at this year's Grace Hopper celebration.

Robotics Institute Research Professor **Stephen Smith** received the Pittsburgh Business Times inaugural 2017 Innovation Award for Transportation.

Computer Science and Robotics Professor **Matthew T. Mason** won the 2018 IEEE Robotics and Automation Award — one of the top awards in robotics.

The Association for Computing Machinery's Special Interest Group on High-Performance Computing has named School of Computer Science master's student **Shefali Umrانيا** a 2017 ACM SIGHPC/Intel Computational and Data Science fellow.

Petuum Inc., a CMU spinoff headed by Machine Learning Professor **Eric Xing**, has closed \$93 million in Series B funding. It's also been named one of the "10 Hottest Startups of 2017" by Investopedia.com.



then & NOW



OFFICE C317, DOHERTY HALL

Daniel Pillis, artist-in-residence at the Robotics Institute, recreated the workspace of AI founders Allen Newell and Herbert Simon — down to every possible detail.

Using archival photographs, some of the very technology Newell and Simon utilized in their own work and oral accounts from CMU employees that knew them, Pillis spent three years researching and building the installation. His work is a testament to the visionary role these men played in the inception of artificial intelligence.

While the installation has closed, a trove of images remain posted at danielpillis.com/virtual-newell-simon-simulation.



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July 1, 2016 – June 30, 2017

With 2017 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 2017. We've enjoyed connecting and reconnecting with many of you, and we sincerely appreciate your ongoing or first-time support.

Legend

M 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

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 Neil S. Halelamien CS'04, DC'04 ①
 Andrew Thomas Hall CS'09 ① ■
 Sean J. Hallgren CS'94 ②
 Nathan Ryan Halstead CS'04 ⑥
 Ferras R. Hamad CS'13, CMU'17 ①
 Ian Alan Hamilton CS'99 ④ ■
 Kevin William Hamlen CS'98
 & Rebecca A. Hamlen ①
 Kenn Brooks Hamm CS'03 ⑤ ■
 Mei Han CS'01 & Wei Hua ②
 Na-Rae Han ① ■
 Philgoo Han CS'11 ① ■
 Xiao Han CS'16 ⑦
 John Arthur Hancock CS'99 ⑤
 Samuel Pollock Harbison CS'80 ⑤
 Christopher Harrison CS'13
 & Amy Elizabeth Ogan CS'03,
 CS'08, CS'11 ④ ■
 Nicholas Andrew Harper CS'11 ②
 Kelly Hope Harrington CS'13 ①
 Michael G. Harris CS'15 ②
 Brian Michael Hawkins CS'96 ①

Wangzi He CS'14, CS'15 ① ■
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 Douglas R. Heckmann DC'13 ② ■
 Charles L. Hedrick ⑫
 Tyler A. Hedrick CS'13 ① ■
 Frederik W. Heger CS'07, CS'11 ①
 Alexander C. Heinricher CS'13 ④
 Don Eric Heller S'71, CS'77
 & Molly Dannels Heller S'73 ⑫
 Amalya Henderson CS'15 ② ■
 Alan Herman A'14, CS'15 ①
 Matthew Benjamin Hershman TPR'17 ①
 Mrs. Leonore H. Hess MM'55 ⑫ ■
 Allan Heydon CS'92 & Dina Berkowitz ④
 George Mack Hicks CS'75 ①
 Elias & Lisa Jo Hilal ② ■
 Susan Karen Hinrichs CS'92, CS'95 ②
 Laurie Satsue Hiyakumoto CS'08 ① ■
 Jeffrey Beng-Hee Ho
 & Pamela Torres ② ■
 Gregory S. Hoch CS'06
 & Allison N. Hoch DC'06 ① ■
 Bridget Catherine Hogan CS'11 ⑤
 Rachel M. Holladay CS'17 ① ■
 Ralph & Elizabeth A. Hollis ④ ■
 Amanda Marie Holt CS'17 ① ■
 Robert John Holtgraver E'67 ⑥ ■
 Ashley Marie Holtgraver CS'04 ① ■
 Jennifer Lynn Hood CS'82
 & Michael J. Butensky S'82 ①
 Jesse Niklaus Horan HNZ'12 ⑥ ■
 Michael L. Horowitz CS'88 ⑥ ■
 Andrew G. Hoskins CS'02 ⑤
 David Jeffrey Housman TPR'05, E'14 ⑥
 John David Hrivnak E'78 ⑫ ■
 Amy R. Hsieh CS'02 ① ■
 Aaron Hsu E'15, CS'15 ②
 Andy & Amy Lin Hsu ② ■
 Christopher J. Hsu CS'14 ①
 Goang-Tay Hsu CS'93 ⑥ ■
 Jefferson Hu E'01, E'01, CS'01 ⑥
 Ningning Hu CS'05, CS'06 ①
 Norbert Y. Hu CS'02 & Jenny Lo CS'01 ②
 Xiaoxin Hu CS'05 & Liang Yi ①
 Yanping Hu & Weijia Nie ① ■
 Han Hua CS'13 ①
 Junyu Huang CS'17 ①
 Shengjun Huang CS'05 ⑤
 Ginger Huang HNZ'92
 & Xuedong Huang ① ■
 Zehua Huang CS'15 ① ■
 Wing Hing Huen CS'74 ⑫
 Fabian Hueppi CS'07 ⑦
 Debbie Y. Hugh CMU'05, CS'05 ② ■
 Christine Chi-May Hui CS'98 ⑩
 Dale Y. Hui CS'07 ② ■
 Andrew Thomas Hundt CS'09 ⑦

Jun Huo CS'16 ①
 Syed Taha Ali Hussain E'11 ①
 Max Chia-Hsing Hwang CMU'05 ④ ■
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 & Christine M. Rosen A'88 ⑥
 Savina Naomi Imrhan CS'07 ④ ■
 Christian Iniguez CS'05, DC'05 ④ ■
 Brian C. Ip CS'15 ①
 Ted Darius Irani CS'97, CS'97 ① ■
 Dana Hausman Izenson CS'88
 & Martin D. Izenson ⑫
 Jeffrey Kenneth Jackson CMU'07 ① ■
 Richard & Janet Jacobs ⑤ ■
 Andres I. Jager CS'06
 & Lyndsey Jager E'12 ⑦
 Siddharth Jain CS'09
 & Andrea KJ Davis ② ■
 Usamah Jamaludin CS'05 ⑤
 David R. Jefferson CS'80 ④
 Martin Samuel Jelin CS'13 ①
 R. Daniel Jenkins ③ ■
 Barbara K. Jensen CS'00 ④ ■
 Filipa Jervis CS'08 ⑦
 Peng Jia CS'02 ② ■
 Yan-Bin Jia CS'93, CS'97 ④
 Yanan Jian CS'14 ① ■
 Warfa A. Jibril CS'17 ①
 Di Jin CS'16 ①
 Jay F. Jin CS'15, CS'16 ①
 Jianping Jin ② ■
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 Alexandra L. Johnson CS'14 ①
 Andrew Edie Johnson CS'95, CS'97 ④
 Craig Karl Johnson CS'97 ⑫
 David C. Johnson CS'87 ③
 Gregory Johnson E'12, CS'16 ①
 Howard Wayne
 & Elisabeth Adams Johnson ④ ■
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 Rosie Ellen Jones DC'97, CS'05 ①
 Shannon A. Joyner CS'14 ①
 Heather Lynn Justice CS'10 ① ■
 Eric C. Kadehjian CS'01 ⑦ ■
 Edwin Bruno Kaehler CS'77 ①
 Matthew Alan Kaemmerer CS'11 ④ ■
 Michael Steven Kahn CS'12 ⑤ ■
 Marilyn R. Kail ① ■
 Thomas L. & Maria Kalapos ① ■
 Dirk Lee Kalp S'73 ⑫ ■
 Chitra Malini Kalyanaraman CS'04 ⑥
 Dheeraj Reddy Kambam CS'14 ②
 Arnold A. Kamis CS'87 ⑩
 Simhalu Kandala IN'07 ① ■
 Hongwen Kang CS'09, CS'12
 & Xiaolan Shu ③ ■
 John Kang CS'13 ④
 Madison L. Kang CS'13 ①

Sing Bing Kang CS'92, CS'94 ⑤
 Poornima Kanararu CS'13 ④
 Jeremy B. Kanter DC'09 ① ■
 Joel & Ricki Kanter ⑫ ■
 Jonathan Kantrowitz CS'10 ⑥ ■
 Max F. Kaplan CS'16 ①
 Anukul Kapoor CS'97
 & Dana C. Siler E'98 ② ■
 Rajat Kapoor CS'15 ①
 Kanishk Karanawat CS'16 ①
 Christopher Paul Karr CMU'16 ①
 Shruti Kataria CS'12, DC'12 ① ■
 Andrew Joseph Katona CS'07 ④ ■
 Fumiya Kawai TPR'17 ①
 Jennifer Sheila Kay CS'93, CS'96 ④ ■
 Michael L. Kazar S'85
 & Rebecca Foster ②
 Qifa Ke CS'02, CS'03
 & Yinglian Xie CS'02, CS'05 ① ■
 Kevin Dale Keck CS'95 ①
 Michele L. Kee CS'87 ⑩
 Rohit Y. Kelkar CS'05
 & Shweta Kelkar ①
 John Ronald Kender CS'80 ③ ■
 Marc J. Khadpe CS'00 ① ■
 Manpreet Singh Khaira CS'91 ①
 Alex Khripin CS'06 ②
 Jonathan Daniel Kilgallon CS'10 ① ■
 Stephen Killourhy ① ■
 Andrew K. Kim CS'02 ① ■
 Jaepyoung Kim CS'04 ⑤
 Jin Seop Kim CS'12 ①
 Taewan Kim TPR'17 ①
 TJ Kim CS'01 ① ■
 Woo Tae Kim CS'05, CS'07
 & Sunmin Park ②
 Michael Kimmitt CMU'06
 & Jennifer Kimmitt ⑩
 Nick Kindberg CS'13 ④
 James Cornelius King CS'69 ⑫ ■
 James Jay Kistler CS'93 ④ ■
 Brian Kjersten ① ■
 Carey Kevin Kloss E'95, E'97 ⑤
 Frederick Colville Knabe CS'91, CS'95 ⑫ ■
 Myung-Joo Ko CS'04 ④
 Wing-Hong A. Ko CS'09, CS'10 ① ■
 Kenneth R. Koedinger DC'88, DC'90
 & Anna V. Fisher ① ■
 Sonia Koesterer A'04, CS'04 ⑥
 David William Kohlbrenner CS'11
 & Nina Chen ④
 Paul William Kohlbrenner CS'84
 & Marianne Elise Vakiener S'77,
 TPR'83 ⑫
 Vamshi Krishna Konduri CS'14 ①
 David Scott Kosbie CS'90 ④
 John Richard Koslow CS'82 ⑫

Constantin Kostenko CMU'02 15 ■
 Igor Kozin & Gylunar Fattakhova 2 ■
 Danielle Elaine Kramer CS'09 1 ■
 Queenie J. Kravitz HNZ'13 3 ■
 Marcin Marek Krieger CS'00 5 ■
 Akshay Krishnamurthy CS'14, CS'15 2 ■
 Michael David Kross CS'09 1
 Kevin Ku CS'16 1 ■
 Aik-Meng Kuah CS'98, S'98 1
 Timothy Kuehn CS'14 2
 Jeffrey & Joanne E. Kulka 4 ■
 Ganesh Kumar CS'07 2 ■
 Kapisthalam & Katherine L. Kumar 2 ■
 Manu Kumar E'95, CS'97 10
 Nandhita Kumar CS'13 2 ■
 Gaurav Kumkar COMU'03 2
 Augustine J.H. Kuo E'93
 & Lisa LeJeune 1 ■
 Yenni Kwek CS'98 1
 Jonathan Leslie Kyle CS'98 1
 Richard Scott Labarca CS'98, CS'99 1 ■
 Jay Steven Laefer CS'93 1 ■
 Harper LaFave CS'12 1
 Shook-Tsang Lai 10 ■
 Sarah Laiwala CMU'08
 & Murad Pirani 1 ■
 James Neil Lampe TPR'00 2 ■
 James Anthony Landay CS'93, CS'96
 & Eileen T. Landay 10 ■
 Raymond J. & Stephanie Lane 2 ■
 Jonathan L. Lange CS'87 1 ■
 Dirk Langer CS'97 3
 Matt Laroche CS'06
 & Helen Laroche A'07 11 ■
 Katherine Lau CS'03 1 ■
 Hugh Conrad Lauer S'67, CS'73 4 ■
 Sarah Tann Lautzenheiser E'10 6
 Samuel Palumbo Lavery BHA'12, CS'13 5
 Anthony S. Lazar CS'09 7
 Andrew Adam Lazes CS'94 2 ■
 Quan Anh Le CS'92 1
 Emily J. Leathers E'07, CS'07 1
 Christian J. Lebiere CS'90, CS'98 24
 Chen Lee E'99
 & Morten Welinder 1 ■
 Chung Sing Lee 6 ■
 Dong Ha Lee CS'07 1
 Donghee Lee & Eunah Kim 3 ■
 Dongryeol Lee CS'05, S'05 2 ■
 Han Lee CS'07 7
 Janet C. Lee CS'08 2
 Kai-Fu Lee CS'88, H'15 1
 Robert Seon Wai Lee CS'11, S'11 5 ■
 Susan L. Lee HNZ'95 & Peter Lee 4 ■
 Ting-Yen Lee E'13 3
 Daniel Leeds CS'10 1
 Philip L. & Jill F. Lehman 4 ■

Bo Lei CS'14 & Peiyun Ren 2 ■
 Michael John Leibensperger CS'82 7
 Charles E. Leiserson
 & Wendy Leiserson 7 ■
 Erren D. Lester CS'99, TPR'08
 & Kisha DeSandies Lester 1 ■
 Derek Leung CS'04 10
 Bruce Wallace Leverett CS'81 4
 Lorraine S. Levin 1 ■
 Roy Levin CS'77 & Jan Thomson 2 ■
 Grace A. Lewis CS'01
 & Michael E. Lewis CS'02 15 ■
 Michael Lewis & Katia P. Sycara 5 ■
 Tom Lewkowitz CS'10 1
 Anna Leyderman CS'94 20
 Bohan Li CS'15 1 ■
 Chao Li CS'15 1 ■
 Donghui Li CS'16 1
 Guanjie Li CS'15 1
 Jason M. Li CS'15 1 ■
 Lucy Li CS'11 5
 Ruiqing Li & Shanguang Huang 1 ■
 Runxin Li CS'10 2
 Xinchun Li & Xiaowen Mang 1 ■
 Yuheng Li CS'16 1
 Yushan Li & Guanghao Liang 1 ■
 Zeyuan Li CS'13 3 ■
 Zhipeng Li E'13 1
 Zhoucheng Li CS'16 1 ■
 Benjamin S. Lichtman CS'17 1
 Eujern Lim CS'06 1
 Dirk Langer CS'97 3
 Isaac Lim CS'14
 & Yuyang Guo CS'15 1 ■
 Kelvin Chenhao Lim CS'05, CS'08
 & Margaret Szeto A'07, CS'07 7
 Brent Lim Tze Hao CS'12
 & Jerene Z. Yang CS'12, S'12 2 ■
 Alex Wilhelm Limpaecher CS'13 4
 Weihao Lin CS'09 1 ■
 Yibin Lin CS'13 4
 Alejandro A. Lince CS'07 1
 Elizabeth M. Lingg CS'07, DC'07 2
 Jim Litsas CS'77, S'77 20
 Stanislav Litvinov CS'15 1
 Chunlei Liu CS'13 1
 Cong Liu CS'12 4 ■
 Haoran Liu CS'13 1
 Hui Liu & Ying Shan 2 ■
 Jay Liu CS'15 1
 Jimin Liu TPR'02
 & Zhen Shan TPR'02 10 ■
 Karen Liu CS'10 2 ■
 Ligong Liu & Aiyng Li 4 ■
 Liu Liu CS'10 2 ■
 Yandong Liu CS'11 4
 Yichi Liu CS'15 1
 Youbang Liu & Yubing Tang 2 ■

Yufeng Liu S'99, CS'03, S'03 4
 Michael T. Livanos CS'04
 & Jessica Livanos 1 ■
 Doug Locke CS'86 10
 Stuart Renwick Locklear CS'99 15 ■
 Yee Chuan Loh CS'03, TPR'05 7
 James Derek Lomas CS'14, CS'14 1
 Ralph Leslie London S'60, S'64 15 ■
 William G. Long DC'01, CS'02 4
 William James Lovas CS'10 2
 Adam T. Lovrovich DC'05 5 ■
 Yucheng Low CS'08, CS'10, CS'13 4
 Peixin Lu CS'16 1
 Xiaoxu Lu CS'16 2 ■
 Peter John Lund CS'14 1
 William D. Lusen CS'87 2
 Hannah D. Lyness E'16, CS'17 4 ■
 Jun Ma CS'14 & Chialing Tsai 1 ■
 James F. Maclean E'14, CS'14 1 ■
 William Ross Macrae CS'13, S'13 1
 Christopher Michael Maeda CS'92,
 CS'97 1 ■
 Kenneth John Magnes CS'93 10 ■
 Aravindh Mahendran CS'14 4 ■
 Austin Patrick Maher CS'85 7
 Pranav Maheshwari CS'16 1
 Suvrajit Maji CS'12 2
 Mun-Thye Mak CS'09 4 ■
 Vincent Howe Mak CS'98
 & Ru-Chun Amy Fuh S'97 10 ■
 Martin S. Makowiecki CS'02 4
 Tomasz R. Makowiecki CS'13 1 ■
 Donna Mithra Malayeri CS'05, CS'09 5
 Robert Gary Malkin DC'96,
 CS'98, CS'06 1
 David Maltz CS'01 5 ■
 Pratyusa Kumar Manadhata CS'07, CS'08
 & Sargam Garg 5
 Naju George Mancheril E'06, CS'06, CS'07
 & Rowena Mancheril 6 ■
 Kechun Mao CS'15 1
 Anand Vijay Marathe CS'00 2
 Dimitris Margaritis CS'03 15 ■
 Craig S. Markovitz 1 ■
 Joshua Joseph Marks CS'95 4
 Victor Manuel Marmol CS'11, E'13 6
 David Alexander Marshall CS'85 1
 Chris Martens CS'08, CS'15 4
 Erik Michael Martin CS'05 15 ■
 Ruben Carlos Goncalves Martins
 & Justine Marie Sherry Martins 1 ■
 Christopher Marusich 1 ■
 Philip Howard Mason S'68, CS'76 15 ■
 Santosh A. Mathan CS'96, DC'00, CS'03 2
 Gregory F. Mathis CS'02 4
 Auldyn Matthews CS'13 2
 Thomas Braun Mattson S'55, S'57 4 ■

Daniel Ignacio Maturana CS'14 2
 Anthony Maurice CS'11 1
 Alexander Kan May E'09, CS'10
 & Erin Marie May S'10 1
 Brian Patrick McBarron CS'97 15 ■
 Benjamin John McCann CS'06, TPR'06
 & Stephanie Y. Lin CMU'05 12
 Justin McCann 1 ■
 Daniel McCarriar CS'00
 & Margaret E. Schervish CS'13 7 ■
 Catherine Dianne McCollum CS'81
 & Robert McCollum 2
 Michael & Janet McConville 5 ■
 Zachary John McCord CS'10 1 ■
 Ian Makemson McCullough A'00,
 MET'01 4 ■
 Patrick F. McGehearty CS'80 11
 Andrew Abraham McGuiar CS'09
 & Natalie S. McGuiar S'10 2 ■
 Christopher H. McIntyre CS'92 1
 David M. McKeown 5 ■
 Roderick T. McMullen CMU'07, CS'08
 & Nazli Kfoury DC'07 1
 Laurie Lee McPherson CS'85 4
 Kristofer Robert McQueen CS'96 1
 Maija E. Mednieks CS'14 4
 Brendan R. Meeder CS'07, CS'15
 & Ariel R. Levavi S'07 11 ■
 Patrick Meehan CS'84 1
 Carl N. Meister CS'00 2
 Andrew O. Mellinger CS'10 4
 Dennis D. Meng CS'13 1 ■
 Michael Grey Merideth CS'05, CS'09 10
 Nichole C. Merritt 1 ■
 Gregory Michael Methvin CS'11 5 ■
 Phillip Daniel Michalak CS'98 11
 Gary Edward Middleton CS'86 4
 Chase P. T. Midler DC'10, INT'12 2 ■
 Dylan B. Mikus CS'14 1
 Victor Joseph Milenkovic CS'88 6
 Lauren Violet Milisits E'13, CS'14 5 ■
 Ashley McKnight Miller CS'04 10
 Carla Reid Miller CS'11 1 ■
 Paul P. Miller BCBA'13 3
 Danielle M. Millett CS'09 4
 Parker Henry Mills CS'04, S'04, S'11 4
 Edward A. Miner CS'88 2
 Edwin Miranda E'10 7
 Jeffrey Scott Mishler CS'94 7 ■
 Julian K. Missig CS'06, DC'06
 & Alice Ching CS'06 5
 Andrew P. Mittereder CS'14 4 ■
 Roman W. Mitz CS'00 & Kelli Ireland 7
 Archie Lee Moberly CS'95, CS'96 1
 V. Joseph Mohan CS'80, CS'84
 & Shantha Mohan TPR'82, TPR'85 2
 James Mohr 1 ■

Robert T. Monroe CS'95, CS'99
 & Elizabeth Monroe 1
 Andrew W. Moore & Mary S. Lee 3 ■
 Mathew Alexander Mooty CS'11 6 ■
 Daniel Moses TPR'03 6 ■
 Casimir Mostowy 1 ■
 Divya Mouli BCBA'15 1
 Linda H. Moya DC'11, HNZ'11
 & Phillip B. Gibbons 1 ■
 Linyang Mu CS'16 1
 Christine G. Mular CS'88 5
 Stefan Klein Muller CS'15 3 ■
 Rob R. Murcek CS'13 4
 Steven Douglas Murch CS'86 1
 Michael J. Murphy CS'17 2 ■
 Timothy & Sue Murphy 4 ■
 David I. Murray A'06, CS'06 1 ■
 Elizabeth A. Myers CS'84, TPR'88 4
 John Karl Myers E'82 1 ■
 Allison Marie Naaktgeboren CS'08 1 ■
 Varshaa Naganathan CS'16 1
 Anushaa Nagarajan CMU'05 10 ■
 Umashankar Nagarajan CS'08, CS'12 1
 Koyo Nagashima TPR'17 1
 Hardik Manish Nagrecha CS'15 1
 Mohak Nahta DC'17 3 ■
 Armaghan W. Naik S'02, CS'13 4
 Reggie V. Nair E'11 5
 Srinivasa G. Narasimhan 1 ■
 Nisha Narayan CS'09 2
 Usha Narayanan CMU'07 2
 David Thomas Naylor CS'15, CS'17 1 ■
 Cliff & Katherine Needham 4 ■
 Daniel Bertrand Neill CS'04, CS'06 10
 Phillip Andrew Nemecek CS'95
 & Melinda L. Nemecek E'97 1
 Scott McBride Nettles CS'93, CS'96 1 ■
 Edward W. Neubecker CS'02 15 ■
 David J. Neville CS'10 6 ■
 Noel Marie Newell 45 ■
 William J. Ng CS'12 1
 Jiang Ni CS'04, CS'07 1
 Constantine A. Nicolaidis S'97, CS'00 1
 Edward W. Neubecker CS'02 15 ■
 Suresh Antony Nidhiry CS'07 1 ■
 Christopher T. Niessl CS'10 2 ■
 Edward & Hana Niessl 11 ■
 Tanachat Nilanon CS'12 5 ■
 Frances Jen-Fung Ning E'02, CS'02,
 E'03 5 ■
 Alex Nizhner CS'01, INT'05 15 ■
 Andrew Noh E'11, CS'11, E'12 4 ■
 Michael J. Nollen CS'04 7 ■
 Robert Louis Nord CS'92 5
 Ariel Christina Norling CS'15 1 ■
 Donna Norling 2 ■
 Steven Michael Novick CS'09, TPR'10
 & Ariel Gold Novick 4 ■

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 Evan L. Numbers CS'17, S'17 1
 Charles Senti Nyame CMU'05, DC'05 1
 Adam Nye 1 ■
 Matthew J. O'Brien CS'01, S'01 1 ■
 Kevin Thomas O'Connell 3 ■
 Alexander Brian O'Neill CS'17 1 ■
 Chris C. O'Rourke CS'97
 & Stephanie Ellen O'Rourke 1 ■
 John Andrew Ockerbloom CS'93, CS'98 1
 Judith Ifechukwude Odili HNZ'08
 & Uchenna Uchidiuno 1 ■
 Arsa Oemar CS'05, TPR'10 4
 Kemal Ofazer CS'87 4 ■
 Paul Taylor Ogilvie CS'03, CS'10 6
 Mopewa Ogundipe CS'16 1
 Jean Hyaejin Oh CS'09 1 ■
 Kyung Chul Oh CS'03, CS'06 2 ■
 Siyoung Oh CS'12, S'12
 Allison Marie Naaktgeboren CS'08 1 ■
 Ronald Bert Ohlander CS'75 2
 Koustubh D. Oka 10 ■
 Yogesh K. Oka CS'04
 & Ripple Sharma 11 ■
 Jennifer Kaitlyn Olsen DC'10, CS'15,
 CS'17 3 ■
 Adam Michael Olshansky E'14 2
 Ayobami Olubeko CS'14 1
 Steven J. Onorato E'04, CS'04 14 ■
 David R. Orr CS'14 4
 Jiazi Ou CS'05 1
 Jaime Oviedo Silva CS'04 3 ■
 Berend Ozceri E'95, E'99 2 ■
 Daniel J. Paciulan CS'01 10
 Hilary Packer CS'94 3 ■
 Arturo E. Paez CS'15 1
 Aroon A. Pahwa CS'07 1
 Vasudeva Pai Melgangolli CS'14 2
 Landon Yun Suk Paik CS'15 1 ■
 Scott Pakin CS'92 7
 Shriphani Palakodety CS'14 1 ■
 David & Edna Palmer 2 ■
 Manish Pandey CS'95, CS'97 1 ■
 Brian M. Pantano CS'05 1
 Michael Konstantinos Papamichael
 CS'15 2
 Rebecca L. Paren CS'15 4 ■
 Ankur Prashant Parikh CS'12, CS'15 1
 Daesik Park E'04, CS'04 1
 Jean-Luc Hoon Park CS'94, DC'94,
 TPR'98 7 ■
 Jun Woo Park E'10, CS'16 3
 Amy Suzanne Parker CS'81 1
 Randy J. & Sue A. Parker 1 ■
 Scott M. Parker CS'01 5 ■
 William Marion Parker CMU'08 1

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& Ellen F. Olshansky 4 ■
Brad James Patton MET'07
& Ashley Williams Patton 4 ■ ■ ■
Matt Pavelle CS'98 6 ■ ■
Lingjuan Peng CS'12 1 ■ ■
Adam G. Pennington CS'01, E'03 11 ■ ■
Crispin Stone Perdue CS'77 6 ■ ■
Francisco Machado Aires Pereira
CS'07 6 ■ ■
Mark L. Perlis & Ruth Lis 2 ■ ■
Marko Petkovsek CS'91 4
David Pfeffer E'13 4
Timothy & Carol Phillips 1 ■ ■
Todd E. Phillips S'02, CS'09 6 ■ ■
Jessica Phoa CS'15, DC'15 1 ■ ■
Tjoen Phoa & Judy Soga 4 ■ ■
Patrick S. Piemonte CS'07 1 ■ ■
David R. Pierce CS'93 2
Mindy M. Pile CS'15 1
Christy Marie Pino MM'66 4 ■ ■
Ivan Sergeevich Pistov TPR'17 2
Hunter Alexander Pitelka CS'11 7
Clifford D. Platt CS'98
& Tiffany P. Platt E'01 4
Samuel J. Platt CS'17 1
Cheryl N. Platz CS'02 11
David C. Plaut CS'91
& Marlene Behrmann 2
Mark D. Pollard CS'96 6 ■ ■
Dean Arthur Pomerleau CS'92 1 ■ ■
Federico Ponte E'16 1
Tyler W. Porten BHA'15, CS'15 1
Eric Andrew Porter CS'03, CS'04 1 ■ ■
Boris Portman CS'96, CS'96 1
Zania Susan Pothan CS'13 1
Mark R. Power 2 ■ ■
Jakub Poznanski CS'11
& Anna Konyukhova CS'12 2
Alex Pramoda E'11 1
Greg Price CS'06
& Margaret Barusch 7
Keith Edward Price CS'77 4
Tarun Pruthi 1 ■ ■
Jared Pryor CS'11
& Lilian Ngobi TPR'17 1
John M. Przyborski CS'14 2
Robert J. Punkunus CS'01 5 ■ ■ ■
Jie James Qi CS'09, S'09 7
Liangsheng Qian CS'04 4 ■ ■
Jinyuan Qiu CS'16 1
Yan Qu DC'94, CS'01 11
Trisha Quan CS'10 1
Siong Kar Quek CS'00, TPR'00 7 ■ ■
Mariena E. Quintanilla CS'05
& Jose Quintanilla 6 ■ ■ ■
Thomas R. Quisel CS'07 1

Amy Mija Catalina Quispe CS'13
& Jonathan J. Paulson CS'13 4 ■ ■
Dragomir R. Radev 1 ■ ■
Paul Raff CS'04, S'04, S'05
& Audria C. Stubna S'06 4
Shyam Raghavan CS'17 1
Diane Ragoza & Mark Rosenman 5 ■ ■
Aishanou Osha Rait CS'16 1
Bharadwaj Ramachandran CS'17 1 ■ ■
Sricharan Amand Ramanujapuram
CMU'05 4
Kannan Ramaswamy CS'00 2
Ramesh Ramiah CS'13 2 ■ ■
Chenyang Ran CS'16 2 ■ ■
Vishal Rao CS'00 11
Robert Stephen Raposa CS'97 4
Antoine Roland Raux CS'09 6 ■ ■
Barbara J. Ray 15 ■ ■
Pinaki Ray E'10 1
Rajesh C. Reddy CS'98 6 ■ ■
Robert Wilson Reeder CS'08 6
Douglas R. Rees S'80 4 ■ ■
Alex Reese 1 ■ ■
Paul Carl Rehmet CS'94 1 ■ ■
Giselle Reis 1 ■ ■
Liu Ren CS'04, CS'06 1 ■ ■
John A. Rentzepis CS'88 4
John C. Retterer-Moore CS'14 1 ■ ■
Margaret E. Richards CS'07 5
Glen Meyers Riley CS'81 4
Matthew Riley E'08, CS'08
& Melitta Riley CS'07 4 ■ ■ ■
Jose German Rivera CS'95 2
Meghan P. Rivera CS'06
& Michael A. Rivera E'07 4
Christopher John Roberts CS'09 1
George Gordon Robertson CS'78 15 ■ ■
Ivan Rodriguez-Mesa CMU'06 1
Christopher J. Rodriguez CS'00,
CMU'07 11
Douglas Lee Taylor Rohde CS'02 4
Kathleen A. Romanik CS'85 15
Merle E. Romesberg CS'00, S'00 1
Paul Simon Rosenbloom CS'78,
CS'83 4 ■ ■
Jared Rosenthal 1 ■ ■
Michael Hayden Rosenthal CS'97 4
Stephane Ross CS'11, CS'13 1 ■ ■
Manuel A. Rosso-Llopert CS'92
& Catherine A. Llopert 11 ■ ■
Christopher David Rotella CS'05
& Natasha Rotella 1
David Christian Rothenberger CS'93,
CS'96 7
Deanna Rubin DC'98 1 ■ ■
Steven Michael Rubin S'74, CS'76,
CS'78 4

Ivan Ruchkin CS'14 4 ■ ■
Paul Martin Russo CS'86
& Allison G. Russo AM'88 6 ■ ■
Thomas W. Ruttle CS'08 2
Olatunji O. Ruwase CS'13 4 ■ ■
Michael David Rychener CS'77 6
Ajay Sahai 1 ■ ■
Engin Cinar Sahin CS'06, CS'08
& Duygu Basaran Sahin 1
Sabesan Saidapet Pachai CS'06 1 ■ ■
Merline Saintil CMU'05 11 ■ ■
Jevan D. Saks CS'03
& Ling Xu CS'04, CS'08, CS'11 4
Tuomas W. Sandholm
& Christina Fong 1 ■ ■
Cindy Saroha CS'15 2 ■ ■
Mahadev Satyanarayanan S'79, '83
& Deborah C. Kelly HNZ'94 25 ■ ■
James Benjamin Saxe CS'78, CS'86 11 ■ ■
Alejandro Alberto Schaffer CS'83, S'83 1
Steve R. Schaffer CS'01, S'01 2 ■ ■
William Schatz 21 ■ ■
William L. & Ann Gibbons Scherlis 6 ■ ■
Eric E. Schmidt H'09
& Wendy Schmidt 1 ■ ■ ■
Bob Schmidt TPR'86
& Patricia J. Schmidt 40 ■ ■
Joshua P. Schnarr CS'06 4
Timothy K. Schneekloth CS'03
& Janice S. Schneekloth CS'01,
CS'03 11
Edward Anton Schneider S'70, CS'76 5 ■ ■
Gregory C. Schohn CS'00 4 ■ ■
Arthur T. Schooley E'54
& Jean Ward Schooley MM'55 15 ■ ■
Kyle J. Schriver CMU'02, DC'02
& Michelle Schriver 4 ■ ■
Jeffrey J. Schroder CS'08 2
Brian J. Schuster CS'99 4
Peter Martin Schwarz CS'79, CS'84 11
Ross Edward Scroggs CS'74 2 ■ ■
Bora A. Sebuktekin CS'16 4
Arthur Todd Sedano CS'96, CS'99, E'17 2
Richard Earle Seeger CS'94, DC'94 1
Vyas Sekar CS'10 1
Alexa Selwood 2 ■ ■
Natarajan Senuvasan CMU'08 4
Steven J. Sermarini CS'15 1
Kumar P. Setty CS'07 1
Karim A. Shaban CS'08, TPR'12 2
Ilari Alexander Shafer CS'13 4 ■ ■
Ankur H. Shah CS'06 1 ■ ■
Vinay Shankar CS'16 1 ■ ■
Edwin Shao TPR'09 4
Paul Y. Shao CS'00 7
Abram Benjamin Shapiro CS'99 1
Abhinav Sharma CS'12 1 ■ ■

Jason Michael Sharp CS'10 7
Jay Michael Shaughnessy CS'86 1
Sergey Alexander Shchukin CS'05 4 ■ ■
Matthew Sheby CS'99 6
Qian Shen E'01, CS'01 4 ■ ■
Andrew D. Sheng CS'13 4 ■ ■
Alexander Benjamin Sher CS'14 2
Mark S. Sherman CS'79, CS'83 4 ■ ■
Ben Shi & Guilan Chen 4 ■ ■
Shanshan Shi & Guowu Meng 2 ■ ■
Hideki Shima CS'06, CS'15
& Mie Shima 4 ■ ■
Byoung-Chul Shin CS'07 4
Timothy J. Showalter CS'98 2
Geeta Shroff E'07, CS'07, CS'10
& Divyanshu Vats E'09, E'11 4 ■ ■
Jefferey Allen Shufelt S'90, CS'93, CS'96
& Stacey Lynne Jacobs TPR'90,
TPR'93 4
Heung-Yeung Shum CS'96 6 ■ ■
Robert J. Siemborski CS'03
& Jennifer Kathryn Smith CS'03,
MET'05 11 ■ ■
David Bruce Signor CMU'05 1
Mark Brian Silverman CS'97 4
Alexander Gardner Silverstein CS'10 1 ■ ■
Robert J. Simmons CS'09, CS'12 5
David Anthony Simon E'87, CS'93,
CS'97 1
Neil Martin Simon E'65 1 ■ ■
Jane Simpson 1 ■ ■
Avesh C. Singh CS'13, CS'14 1 ■ ■
Shafeeq Sinnamohideen E'00, CS'10 7 ■ ■
Robert M. Skalecki CS'04 1
Mary Beth Sklar 1 ■ ■
Elizabeth Howard Slate CS'87, DC'88,
DC'91 15
Donald J. Slater 17 ■ ■
Lisa Marie Smith CS'00
& Joshua J. Smith E'00 5 ■ ■
Lori A. Smith CS'85, DC'92 7
Michael & Lauren Snow 1 ■ ■
Jeffrey M. Snyder S'89 40 ■ ■ ■
Boris Sofman E'05, CS'05, CS'07,
CS'10 2 ■ ■
Selvamraju Somalaju CS'13 4 ■ ■
Mingyang Song CS'14 4
Yanze Song CS'14 2 ■ ■
Yujun Song CS'14 1
Ziyuan Song CS'15 1
James J. Soracco A'07, CS'07 1
Luis Miguel Sousa CS'09 6
James Thomas Spagnola CS'09 1
Alfred Z. Spector 12 ■ ■ ■
Byron G. Spice 11 ■ ■
Daniel John Spoonhower CS'09
& Katherine Ann Copic 4

Vivek Sridhar CS'15 1
Siddhartha Srinivasa CS'01, CS'05 1 ■ ■
Matthew K. Steedle CS'11 5 ■ ■
David Cappers Steere CS'92, CS'97
& Jody Steere 2 ■ ■
Mark & Sylvia Stehlik 5 ■ ■
David M Steier CS'86, CS'89
& Polina Steier 4 ■ ■ ■
Christopher Ryan Stengel CS'93,
TPR'00 4 ■ ■
Craig A. Stephen CS'88
& Christina Stephen 4
Benjamin Stephens CS'09, CS'11 5
Julie L. Stern CS'88 1
Michael A. Stevens CS'07
& Sarah Nacey 15 ■ ■ ■
Diane L. Stidle 15 ■ ■
Edward Carl Stocking CS'97 1
Martin Stolle CS'06, CS'08 1
Stanley Stone 40 ■ ■
Michael & Valentina Storey 2 ■ ■
Cort William Stratton CS'01, MET'03 2 ■ ■
David A. Strauss CS'05 10 ■ ■
Dow M. Street CS'97 7
Eric F. Stuckey CS'97
& Mia K. Markey S'98 2
Jeffrey Su CS'11 5 ■ ■
Bruce & Mary L. Summers 4 ■ ■
Haonan Sun CS'16 1
Xiangyu Sun CS'15 1
David Dahwei Sung CS'71
& Linda L. Ma Sung S'70 15 ■ ■
Kishore Sunkeswari Prahallad CS'10 4 ■ ■
Joshua S. Sunshine CS'13 2 ■ ■
Harshit Surana CS'10 1
Alan Lawrence Sussman CS'91 14 ■ ■
Robert & Alyssa Sussman 1 ■ ■
Dean F. Sutherland S'83, CS'08
& Elizabeth Bellamy Sutherland
E'84 1 ■ ■
Murali Swaminathan CMU'07 1
Charles W. Swanson CS'14 4
Syahrul Nizar Syahabuddin CS'97 6
Richard Stephen Szeliski CS'88 1
Michelle Tai TPR'17 1 ■ ■
Desney Swee-Leong Tan CS'04 7 ■ ■ ■
Chun How Tan E'12, E'12, CS'12 5
Ming Tan CS'89, CS'91
& Minghui Xie 4
Bingrui Tang CS'16 1
Hai Tang & Helen Y. Zha 1 ■ ■
Zhen Tang S'11, CS'14, S'14 1
Paul Tanner CS'09 4
Wei Tao & Hong Xie 1 ■ ■
David Read Tarditi CS'97 12 ■ ■
Aaron J. Tarnow CS'05 1
Daniel J. Tasse CS'08, CS'15, CS'17 4

James A. & Mary Beth Tawa 5 ■ ■
Anita A. Taylor CS'07 15 ■ ■ ■
Krishan A. Taylor CS'10 2 ■ ■
Omari D. Teel CS'02 5 ■ ■
Ming Han Teh CS'12 2
Ronald Y. Teng CS'01
& Sandy Yong 7 ■ ■
Chye Liang Vincent Teo CS'11,
CS'12 4 ■ ■ ■
Leong Hwee Teo CS'99, CS'99, CS'11 4 ■ ■
Thomas Terrill CMU'08 4
Avadis Tevanian CS'85, CS'88 2 ■ ■
Jacob Thomas E'06 1 ■ ■
Leila K. Thomas CS'17 2 ■ ■
Kathleen Ong Thompson CS'01
& Brandon Thompson 14 ■ ■
Ariel S. Tian CS'17 4
Scott Phillips Tietjen CS'82 4
Daniel Jon Tilkin CS'99, S'99 17 ■ ■ ■
Vivek Tiptur Umaphathi CS'13 1
Daniel Ross Tobias CS'86 40
James Arthur Tolbert CS'10 1
Gilman Edwin Tolle CS'03
& Diane Marie Loviglio BHA'05 4
David A. Tolliver CS'98, CS'00, CS'06 1
Wesley J. Tom CS'02 11 ■ ■
Paul David Tompkins CS'01, CS'05 5 ■ ■
Tianqi Tong CS'14 & Ziwei Hu CS'14 2
Joe Patrick Toomey CS'93 1
Chanh-Duy N. Tran CS'02 5
Jonathan Douglas Tran E'06, CS'06 4
Christopher M. Tremonte CS'02 11 ■ ■
Sukit Tretriluxana CMU'07 11
Nadine Marie Tronick CS'92 1
Yanghai Tsin CS'03 1
David Tu CS'10 6
Christopher L. Tuttle CS'02 7
Julia Elizabeth Tuttle CS'11 6 ■ ■
Britta Kathleen Ulm CS'14 1 ■ ■
Ahmet Emre Unal CS'16 2
Puneet & Abhilasha Uppal 2 ■ ■
Vignan Uppugandla CMU'15 2
Chad Ray Urso McDaniel CS'95
& Tina Urso McDaniel DC'94 14
Prany Vadisirisak 1 ■ ■
David Vail 4 ■ ■
Ruben E. Valas CS'05 1
Marat Valiev CS'15 1 ■ ■
Justin Chris Vallon CS'94 1 ■ ■
Karen L. Van Dusen CS'87, TPR'00
& Peter P. Su S'87 2
Richard Van Horn CMU'07 2
Walter van Roggen CS'82 2
Martin Van Velsen 1 ■ ■
J. Michael Vandeweghe CS'02 7
Timothy A. Vaughan CS'13 4
Robert Anthony Veltre CS'91, TPR'00 5

Maria Manuela Veloso CS'89, CS'92
& Jose M.F. Moura 17 ■
Peter Venable CS'00, CS'03 1
Shweta Venkateswaran CS'15 1
Mark Andre Ver CS'97 1 ■
Kyle E. Verrier CS'13 2
Aleksandar Veselinovic CS'02, E'04 1
Jorge L. Vittes CS'04 4
Mauricio Vives CS'98
& Laura H. Vives DC'97 10
Robert Irwin Voigtman CS'09, TPR'10
& Janice Lee Chen E'13 1 ■ ■
Jocelyn P. Vopni A'00 5 ■
Richard M. Voyles CS'97 2 ■
Krishna Vudata CS'12 1 ■
Robert Dorman Waaser E'11, CS'11,
INI'12 4
Siddhant Wadhwa CS'17 1
Robert Alan Wagner CS'69 11
Aaron Wald CS'98
& Ann Wald CS'98 6 ■ ■
Kevin Rathbun Walker CS'96, CS'00 2 ■
Corinne Michelle Walters CS'11 2
Eugene S. & Hui Boon Wan 15 ■
Nathan Lap-Yan Wan E'11, CS'11 2
Carl Wang CS'06 10
Fan Wang CS'11 1
Guo-Shiuan Wang CS'07 1
Jue Wang CS'05 10
Kaipeng Wang CS'16 1 ■
Lei Wang E'15, CS'15 2 ■
Mengzhi Wang CS'05 1
Pengfei Wang CS'16 1
Robert Y. Wang CS'04 2
William Wang CS'10, CS'11 1 ■
Yan Wang CS'15 1 ■
Ye-Yi Wang DC'92, CS'98 7
Yijie Wang CS'13 1
Yuchun Peter Wang E'04
& Abra Wang 12 ■
Yujun Wang CS'16 1 ■ ■
Yun Wang CS'12 2
Mary C. Ward CS'85 10
John Lawrence Warwick CS'97 1 ■
Benjamin L. Wasserman E'13, E'13 2 ■
Michael E. Wasson CS'07, S'07 1
Roy Richard Weil E'70
& Mary M. Shaw S'72 15 ■
Jason P. Weill CS'03 1 ■ ■
Scott Abraham Weiss CS'92 4 ■
Stephen Fredrick Weiss S'66 15 ■
Jon Bruce Weissman CS'84 3
Justin David Weisz CS'03, CS'07,
CS'09 2 ■ ■
David A. Weitzman CS'07 10 ■
Connie S. Wen CS'14 3

James Wallace Wendorf CS'87
& Roli Garg Wendorf CS'86 15
Zhenzhen Weng CS'16, S'16 1
John Charles Wenn CS'88 1
Andrew Michael Wesie CS'11 2 ■
Alex Robert N. Wetmore CS'96 5
Bradley William White CS'88
& Barbara White 4
Brian S. White CS'98 1
Colin Robert Willson White CS'16 1 ■
Elizabeth Ann Whiteman
& Susan A. Dawkins 3 ■
Joseph Skeffington Wholey S'84, CS'89,
CS'91 2 ■
Andrew P. Widdowson CS'05 4 ■ ■
Vincent & Jill Cherie Wieck 1 ■
Karl A. Wieman CS'88 5
Jarek J. Wilkiewicz E'09 1
Shannon R. Williams CS'15 1
Max Willsey CS'16 4 ■
Gail D. Wilson CS'16 4 ■
Wesley Wayne Wilson CS'85 1 ■
David Karl Witmer CS'14, CS'17 1
Lambert E. Wixson CS'88 2
Adam A. Wolbach CS'06, CS'08 3 ■
Hao-Chi Wong CS'95, CS'00 5 ■
Theodore Ming-Tao Wong CS'01,
CS'04 1 ■
Wesley Sei-Ching Wong E'11 5
Richard R. Wongsonogoro CS'87 20 ■
Daniel Colin Wood CS'83 4
Tracey L. Wortham CS'00 1
Evan C. Wright INI'08
& Erica F. Sandbothe CS'09 6
James Mark Wright CS'81
& Pamela J. Wright DC'85 2
Leejay Wu CS'98, CS'05 14
Ningzhi Wu CS'13 1
Pang Wu E'11 3
Si Wu CS'12 & Xinpan Xiao CS'12 1
Yicong Wu CS'16 1 ■
Zhimin Wu & Ping Zhou 1 ■
Ruth Lorraine Wylie CS'07, CS'11 1 ■
Cedric & Lily Xia 1 ■
Guangyu Xia CS'13, CS'16 1
Tian Xia CS'14, DC'14, S'14 2 ■
Ran Xian CS'16 1 ■
Michael Xiao & Xudong Chen 2 ■
Minjie Xin E'13 3
Yuzhou Xin CS'11, S'11 1 ■
Ming Xu CS'99 14
Yixun Xu CS'16 1
Prajwal Yadapadithaya CS'15 1
Philip K. Yam CS'04 1 ■
Bo-Chieh Yang CS'99 1
Dewey Yang CS'07 5 ■

James Yang CS'02, DC'02
& Sanghi Suh A'01 1
Jeffrey Shiann Shuey Yang CS'94 2
Ke Yang CS'02, CS'04 4
Xiaoquan Yang & Yiwen Dong 1 ■
Zhengrong Yang CS'01 6
Jiajun Yao CS'15 1 ■
Litianlong Yao CS'16 1
Jiacheng Ye CS'17 1
Bennet Sze-Bun Yee CS'94 6 ■
Chei Charles Yeh E'83
& Mary Mannling Yeh 2 ■
Carl Edward Yeksigian CS'09
& Alexandra M. Kontopoulos
DC'10 6 ■
Mark & Patricia T. Yeksigian 11 ■
Stephanie Yeung CS'13 1
Ling Yin & Qi Xu 1 ■
Michael Stephen Yin CS'07 2 ■
Yepeng Yin CS'16 1
John S. Yocca CS'87 4
YoungSeok Yoon CS'15 1
Gregg Richard Yost CS'85, CS'92 1
Hua Yu CS'98, CS'04 1 ■
Yu Yu CS'15 1
Timothy J. Zak CS'86 & Leslie V. Zak 4
AnnMarie Zanger 5 ■
Hormoz Zarnani CS'09 2
Qianxu Zeng CS'16 1
Xianqi Zeng CS'16 1
Yiye Zeng CS'14 1
Guido Zraggen CS'09
Amelia Matzke Zraggen CS'07,
CS'11 11 ■ ■
Chengxiang Zhai DC'95 2 ■
Peng Zhang CS'12 4 ■
Ryan X. Zhang CS'17 1
Shikun Zhang CS'14, CS'17 4
Tom C. Zhang CS'15 3 ■
Ying Zhang S'11, E'16, CS'16, S'16 1
Ariss Xin Zhao CS'02, TPR'02 4 ■
Bing Zhao CS'03, CS'07 3
Chengguang Zhao CS'00 1
Fuyao Zhao CS'12 3
Liang Zhao CS'98, CS'01 2 ■
Randy L. Zhao CS'17 1 ■
Yu Zhao CS'13 3 ■
Wei Zhong E'14 & Yongqing Yang 2
Bin Zhou CS'98 1 ■
Andy Zhou CS'00 & Debbie Fu 2 ■
Danny Zhu CS'15 1 ■
Yangbo Zhu CS'08 & Betty Zhu 3 ■
Qiankun Zhuang CS'16 1 ■
Brian David Ziebart CS'07, CS'10 1
Mikhail M. Zlotnik CS'01
& Liya Kopylovsky CS'01 1
Monte Zweben CS'85 2 ■ ■

Carnegie Mellon University
School of Computer Science

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calendar of events

February 5

Let's Talk: The Spring Edition

April 20

MOBOT 24 /
National Robotics Week

April 19–22

Spring Carnival

May 9

Meeting of the Minds
Undergraduate Research
Symposium

May 20

Commencement

Summer 2018

Regional Alumni Events
Locations TBA